# ELECTRIC WIRES AND CABLES

## 1. GENERAL

### 1.1 Description

.1 Provide a complete system of wiring, making all connections necessary for the installation shown on Drawings.

.2 Supply and install wireways and auxiliary gutters and fittings as a means for flexible wiring system. All wireways and gutters to be two pieces with removable cover to provide access to wiring.

### 1.2 References

.1 Canadian Standards Association (CSA), latest adopted revisions:

.1 CSA C22.2 No. 0.3-09 (R2014), Test Methods for Electrical Wires and Cables, and Update No. 1 (2010).

.2 CSA-C22.2 No. 131-14, Type TECK 90 Cable, and Update No. 1 (2016).

### 1.3 Submittals

.1 Submit the following in accordance with Section 01 33 00:

.1 Outline drawings of termination cabinets showing dimensions, cables, jumpers and associated hardware for termination.

.2 Provide written confirmation that product is to be submitted as acceptable to control systems supplier.

.3 For each component and material submit shop drawing which shall include:

.1 Manufacturer.

.2 Model number.

.3 General data and description.

.4 Engineering specifications and data sheets.

.5 Catalog cuts.

.6 For information purposes only, submit manufacturer's printed installation instructions.

.2 Submit a drawing showing the routing for the cables. Include the following information:

.1 Routing and length.

.2 Cable and conduit identification.

.3 Location and table of terminations.

## 1.4 Delivery, Storage and Handling

.1 Provide in accordance with Section 01 66 10 and as specified.

## 1.5 Equipment Identification

.1 Each conductor shall be labeled at each termination point and all splice location. Conductor or circuit identification shall be applied at specified points with circuit numbers or other identification stamped on terminal boards when provided, or on the cable itself in such a manner that the identification is visible around the cable's circumference.

.2 Conductor or circuit identification to follow the City of Winnipeg Identification Standard

## 1.6 Warranty

.1 The Contractor shall warrant that all materials and equipment furnished under the contract are in good working order, free from defects, and in conformance with system specifications. All installed equipment shall conform to the manufacturer's official published specifications. The warranty shall begin at the system acceptance date and remain in effect for a period of five years from that date. The Contractor shall agree to repair, adjust, and/or replace (as determined by the Contract Administrator to be in its best interest) any defective equipment, materials, or other parts of the system at the Contractor's sole cost. The Owner will incur no costs for service or replacement of parts during the warranty period of five years. All third party warranties shall be passed through from the Contractor to the Owner.

.2 The Contractor shall warrant and supply evidence that the installation of materials and hardware will be made in strict compliance with all applicable provisions of the CEC.

.3 The Contractor shall warrant that the system will function in accordance with the manufacturer's published technical description guide.

# 2. PRODUCTS

## 2.1 600V Teck90 Cable

.1 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, minimum size #12 AWG or as indicated.

.2 Outer Jacket:

.1 Thermoplastic polyvinyl chloride material with heat, flame, and moisture retardant properties.

.2 Flame retardancy of outer jacket to be rated in accordance with CSA C22.2, No. 0.3.

.3 Armour: interlocking aluminum.

.4 Inner Jacket: polyvinyl chloride material.

.5 Insulation:

.1 Type: ethylene propylene rubber.

.2 Chemically cross-linked thermosetting polyethylene rated type RW90, 600V.

.6 Fastenings:

.1 One-hole malleable iron straps to secure surface cables 50 mm and smaller. Two-hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two (2) or more cables at 300 mm centers.

.3 Six (6) mm minimum diameter threaded rods to support suspended channels.

.7 Connectors:

.1 Watertight, approved for TECK cable.

.2 To reduce corrosion based on dissimilar metals, TECK connectors to be of the same type of metal (if applicable) as to the enclosure it is fastened to.

**2.2 Type RW90 Conductor**

.1 In accordance with CSA C22.2 No.38.

.2 Circuit conductors shall be concentric stranded soft copper, size as indicated (#12 AWG minimum where not indicated).

.3 Insulation to be chemically cross-linked thermosetting polyethylene (XLPE) material rated RW90 XLPE, 600V.

.4 Suitable for installation in temperatures down to -40°C.

.5 90°C conductor operating temperature.

**2.3 600V Teck90 Control Cables**

.1 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, as indicated and minimum #14 AWG otherwise.

.2 Outer Jacket:

.1 Thermoplastic polyvinyl chloride material with heat, flame, and moisture retardant properties.

.2 Flame retardancy of outer jacket to be rated in accordance with CSA C22.2, No. 0.3.

.3 Armour: interlocking aluminum.

.4 Inner Jacket: polyvinyl chloride material.

.5 Insulation:

.1 Type: ethylene propylene rubber.

.2 Chemically cross-linked thermosetting polyethylene rated type RW90, 600V.

.6 Fastenings:

.1 One-hole malleable iron straps to secure surface cables 50 mm and smaller. Two-hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two (2) or more cables at 300 mm centers.

.3 Six (6) mm minimum diameter threaded rods to support suspended channels.

.7 Connectors:

.1 Watertight, approved for TECK cable.

.2 To reduce corrosion based on dissimilar metals, TECK connectors to be of the same type of metal (if applicable) as to the enclosure it is fastened to.

.3 Hazardous Locations:

.1 CSA approved.

.2 Watertight type with:

.1 an elastomeric bevelled bushing.

.2 a funnel entry, splined gland nut.

.3 a non-magnetic, stainless steel grounding device with dual grounding action.

.4 a taper threaded hub.

.5 a hexagonal body and gland nut.

.3 Integral seal type with metal-to-metal contact construction.

.4 Sealing of multi-conductor cable shall be accomplished with a liquid type polyurethane compound.

.5 The fitting must:

.1 Provide an environmental seal around the outer jacket of the cable and electrically bond the fitting to the cable armour prior to potting the explosion-proof seal.

.2 Allow the possibility of disconnection without disturbing the environmental seal, the electrical bonding or the explosionproof seal.

.6 All metal-clad cable fittings, for jacketed and non-jacketed interlocked armour cable, shall incorporate an easily-removable armour stop (not requiring fitting disassembly) ensuring proper positioning of the cable armour during cable termination.

**2.4 Armoured/Unarmoured Control and Instrument Cables (ACIC/CIC)**

.1 Cable: to CAN/CSA-C22.2 No. 239, Control and Instrumentation Cables.

.2 Conductors:

.1 Minimum #18AWG or as noted on the drawings.

.2 Seven (7) strand concentric lay.

.3 Class B tinned copper.

.4 Twisted pairs/triads.

.5 Number of pairs as indicated on drawings.

.3 Insulation: PVC TW75, 75°C Wet, 105 °C Dry (-40°C), Voltage as noted.

.4 Inner jacket: XLPE.

.5 Overall armour: interlocking aluminum armour.

.6 Overall outer jacket: FT4 flame-retardant rated outer jacket.

.7 Shielding:

.1 Individual twisted pairs/triads with complete electrical isolation between shields.

.2 Induvial shielded pairs/triads.

.3 Aluminum/mylar shield with ST drain wire, 100% shield.

.4 Overall aluminum/mylar shield with ST drain wire.

.5 Individual drain wires one size smaller than conductor AWG.

.8 Cable shall be provided with a black, white, colour code and number code for each pair.

.9 The entire cable assembly to be suitable for pulling in conduit or laying in cable tray.

.10 Fastenings:

.1 One-hole malleable iron straps to secure surface cables 50 mm and smaller. Two-hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two (2) or more cables at 300 mm centers.

.3 Six (6) mm minimum diameter threaded rods to support suspended channels.

.11 Connectors:

.1 Watertight, approved for TECK cable.

.2 To reduce corrosion based on dissimilar metals, TECK connectors to be of the same type of metal (if applicable) as to the enclosure it is fastened to.

.3 Hazardous Locations:

.1 CSA approved.

.2 Watertight type with:

.1 an elastomeric bevelled bushing.

.2 a funnel entry, splined gland nut.

.3 a non-magnetic, stainless steel grounding device with dual grounding action.

.4 a taper threaded hub.

.5 a hexagonal body and gland nut.

.3 Integral seal type with metal-to-metal contact construction.

.4 Sealing of multi-conductor cable shall be accomplished with a liquid type polyurethane compound.

.5 The fitting must:

.1 Provide an environmental seal around the outer jacket of the cable and electrically bond the fitting to the cable armour prior to potting the explosion-proof seal.

.2 Allow the possibility of disconnection without disturbing the environmental seal, the electrical bonding or the explosionproof seal.

.6 All metal-clad cable fittings, for jacketed and non-jacketed interlocked armour cable, shall incorporate an easily-removable armour stop (not requiring fitting disassembly) ensuring proper positioning of the cable armour during cable termination.

**2.5 Ethernet Cable – Shielded – 300V – Non-Armored – Low Bend Radius For Use Only in Automation Panels Patch Cords and Between Ganged Automation Panels**

.1 Requirements:

.1 Cable: Industrial Grade Cat 6, 300V, Shielded, Ethernet cable.

.2 Shield Design: Overlapped aluminum-clad foil, sheathed in a braided screen of tin-plated copper wires.

.3 Conductors: 4 pair, 24 AWG, copper, solid.

.4 Insulation: Polypropylene.

.5 Operating temperature: -40°C to 85°C.

.6 Installation temperature: -40°C to 85°C.

.7 c(UL)us, CMG, RoHS compliant.

.8 Traction stress maximum: 100 N.

.9 Minimum bending radius: 24mm single bend / 40 mm multiple bends.

**2.6 Ethernet Cable - Shielded – 600V – Non-Armored**

.1 Requirements:

.1 Cable: Industrial Grade Cat 6, 600V, Shielded.

.2 Shield Design: 100 percent coverage Foil Shielded.

.3 Conductors: 4 pair, Bonded pair, 23 AWG, copper, solid.

.4 Insulation: Polypropylene.

.5 Operating temperature: -40°C to 75°C.

.6 Installation temperature: -25°C to 75°C.

.7 Flame test: CSA FT4.

.8 cUL, CMR, RoHS compliant.

.9 Traction stress maximum: 177.928 N.

.10 Minimum bending radius: 101.600 mm.

**2.7 Ethernet Cable Unshielded – 300V – Armored**

.1 Requirements:

.1 Cable: Industrial Grade, Enhanced Cat 6 Cable, 300V, Solid, Unshielded, Aluminum Interlocked Armor.

.2 Conductors: 4 Pair, Bonded pair, 23 AWG, copper, solid.

.3 Conductor insulation: PO-Polyolefin.

.4 Outer jacket: Industrial Grade PVC.

.5 Temperature rating: -40°C to 75°C.

.6 Flame test: CSA FT4.

.7 Approvals: CMG, CSA or equivalent.

## 3. EXECUTION

### 3.1 General

.1 Install and rate power cables in accordance with the Canadian Electrical Code requirements.

.2 Install in accordance with manufacturer’s recommendations, observing requirements for minimum bending radius and pulling tensions.

.3 Minimum power conductor including luminaire drops to be #12 AWG.

.4 Minimum conductor size #14 AWG for all discrete control cables.

.5 Minimum conductor size #18 AWG for twisted pair analog signal cables.

.6 At each end of the run leave sufficient cable length for termination.

.7 Protect all conductors against moisture during and after installation.

.8 Protect wiring against damage from welding spatter and other construction activity by suitable means.

.9 If available blockouts through slabs or walls are insufficient in size or location, enlarge, chip or drill additional openings in accordance with Divisions 3 and 4.

.10 Protect metallic cable connectors in process areas with heat-shrinkage sleeves. Sleeve length to extend 75 mm past the connector and to provide a tight fit around connector and cable.

.11 Do not use TC cable in areas classified as hazardous locations.

.12 Arrange wiring in process area such that motor connection boxes and other field mounted devices are entered at the side or bottom of the connection box or enclosure.

.13 Provide sufficient length of "free" cable for motors mounted on slide rails to permit the motor to travel the full length of the rails.

.14 Install reducing bushings where threaded entry in a motor connection box is larger than the hub size of the cable connector.

.15 In-line splices are not acceptable unless done in a junction or splice box.

.16 At the discretion of the Engineer damage to a cable jacket may be repaired in accordance with the manufacturer's recommendation. If requested by Engineer, replace the entire length of a damaged cable.

.17 Arrange cable supports such that maintenance work or removal of the equipment served by the cable, will not cause any damage to the cable.

.18 Feeder cables exiting duct banks exposed into buildings and tunnels are to be run to their final termination point in conduit or covered cable tray if not of armored construction.

**3.2 Terminations and Splices**

.1 Wire nuts are permitted only in the following circuits:

.1 Lighting circuits.

.2 Receptacle circuits.

.2 Exercise care in stripping insulation from wire. Do not nick conductors.

.3 Strictly follow manufacturer's instructions with regards to tool size and application methods of terminations and compounds.

.4 Where screw-type terminals are provided on equipment and instrumentation, terminate field wiring with insulated fork tongue terminals.

.5 Do not make splices in any of the instrumentation cable runs.

.6 All instrumentation and control equipment supplied shall be equipped with terminal blocks to accept conductor connections.

.7 Instrumentation conductors, where terminated at equipment terminals other than clamping type terminal blocks, shall be equipped with self-insulated, locking type terminators, sized as required to fit conductors and screw terminals.

**3.3 Re-Use of Existing Wiring**

.1 Except where specifically identified or approved, reuse of existing wiring is not permitted.

.2 Ensure all existing wiring is tagged prior to disconnection of equipment.

.3 Tag spare wires as “Spare” and indicate the location of the other end of the wire.

**3.4 Workmanship**

.1 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type. Do not pull wires into incomplete conduit runs.

.2 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with the Manitoba Electrical Code. Submit data sheet with values measured.

.3 Do not install any power conductor smaller than #12 AWG, except where specifically indicated otherwise, i.e., for fire alarm system station circuits, P.A. wiring, etc.

.4 Provide conductors as shown on Drawings. Minimum conductor sizes are indicated. Voltage drop from lighting panels to farthest outlet must not exceed 2% at full load in any case. Advise Engineer if problem is foreseen.

.5 Exercise care in stripping insulation from wire. Do not nick conductors.

**3.5 Identification, Coding and Balancing**

.1 Provide wiring identification in accordance with Section 40 90 00.

.2 Connect single phase equipment to minimize imbalance on feeders. Adjust branch circuiting shown as required for optimum balancing. Record all changes on As-Constructed Drawings.

.3 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc. Use two wraps of 3M #471 plastic film tape 48 mm wide.

.4 Conductors sized No. 10 and smaller are required to be factory coloured or numbered, not taped on Site.

.5 For direct current wiring use red for positive and black for negative.

.6 Install cable tags at both ends of cable.

.7 Identify each instrumentation conductor with wire numbers using a machine printed heat shrink wire marker.

**3.6 Physical Checkout**

.1 General Procedures:

.1 Conduct physical checkout of the fiber optic data highway network.

.2 Physical checkout shall be performed prior to functional testing.

**3.7 Check Procedures: Testing**

.1 Test all conductors for opens, shorts, or grounds.

.2 Perform an insulation-resistance test on each conductor, prior to termination, utilizing a megohmmeter with a voltage output of 1000 volts DC on all conductors.

.3 Individually test each conductor with all other conductors and shields grounded.

.4 The test duration shall be one minute.

.5 Investigate resistances less than 50 megaohms, or deviations between parallel conductors.

.6 Resistance values shall be as recommended by the cable manufacturer.

.7 Conductors with insulation resistance values, at one minute, less than 25 megaohms, or that deviate from other similar conductors by more than 50 percent will be rejected.

.8 All wire test results shall be properly tabulated, signed, dated, and submitted to the Engineer.

.9 Ethernet cable testing:

.1 Test for the following:

.1 Continuity.

.2 Pair placement and polarity.

.3 DC resistance.

.4 Characteristics at highest contemplated frequency:

.1 Attenuation - data cable.

.2 Mutual Capacitance - data cable.

.3 Near-end crosstalk (NEXT) - data cable.

.5 Run length.

.2 Tests to be conducted to Cat 6 standards.

.3 Reconnect or re-install and retest as necessary to correct excessive variations.

**3.8 Contract Closeout**

.1 Provide in accordance with Section 01 77 00.

**END OF SECTION**

# ELECTRICAL IDENTIFICATION

## 1. GENERAL

### 1.1 Summary

.1 Section Includes:

.1 Identification of electrical materials, equipment, and installations.

### 1.2 References

.1 American Society of Mechanical Engineers (ASME):

.1 A13.1: Scheme for the Identification of Piping Systems.

.2 Institute of Electrical and Electronics Engineers (IEEE):

.1 ANSI/IEEE C2: National Electrical Safety Code.

.3 Manitoba Hydro:

.1 Manitoba Electrical Code, most current adopted revision.

.2 Manitoba Hydro Inspection Notices.

.4 City of Winnipeg:

.1 Automation Design Guide.

.2 Electrical Design Guide.

.3 Identification Standard.

.4 Winnipeg Electrical By-Law.

.5 Information Bulletins.

### 1.3 Submittals

.1 Submit Shop Drawings and manufacturers' product data in accordance with the requirements of Section 40 90 00.

.2 Submit for each type of product specified.

.3 Miscellaneous: Schedule of identification nomenclature to be used for identification signs and labels.

## 2. PRODUCTS

### 2.1 Raceway and Cable Labels

.1 Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by the City of Winnipeg Electrical Design Guide.

.2 Components and installation shall comply with the Canadian Electrical Code.

.3 Conform to ASME A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.

.1 Color: Black legend on orange field.

.2 Legend: Indicates voltage.

.4 Adhesive Labels: Preprinted, flexible, self adhesive vinyl. Legend is over-laminated with clear, wear and chemical resistant coating.

.5 Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color coded, acrylic bands sized to suit diameter of line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.

.6 Colored Adhesive Tape: Self adhesive vinyl tape not less than 0.08 mm thick by 25 to 51 mm wide.

.7 Underground Line Warning Tape: Permanent, bright colored, continuous printed, vinyl tape with following features:

.1 Size: Not less than 152 mm wide by 0.102 mm thick.

.2 Compounded for permanent direct burial service.

.3 Embedded continuous metallic strip or core.

.4 Printed Legend: Indicates type of underground line.

.8 Tape Markers: Vinyl or vinyl cloth, self adhesive, wraparound type with preprinted numbers and letters.

.9 Aluminum, Wraparound Marker Bands: Bands cut from 0.4 mm thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

.10 Plasticized Card Stock Tags: Vinyl cloth with preprinted and field printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.

.11 Aluminum Faced Card Stock Tags: Wear resistant, 18 point minimum card stock faced on both sides with embossable aluminum sheet, 0.05 mm thick, laminated with moisture resistant acrylic adhesive, and punched for fastener. Preprinted legends suit each application.

.12 Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 51 by 51 mm by 1.3 mm.

.13 Comply with IEEE C2.

**2.2 Engraved Nameplates and Signs**

.1 Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by the City of Winnipeg Electrical Design Guide.

.2 Engraving stock, melamine plastic laminate, 1.6 mm minimum thick for signs up to 129 sq cm, 3.2 mm thick for larger sizes.

.1 Engraved Legend: Black letters on white face.

.2 Punched for mechanical fasteners.

.3 Baked Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for application. 6.4 mm grommets in corners for mounting.

.4 Exterior, Metal Backed, Butyrate Signs: Wear resistant, non-fading, preprinted, cellulose acetate butyrate signs with 1 mm, galvanized steel backing, with colors, legend, and size appropriate to application. 6.4 mm grommets in corners for mounting.

.5 Fasteners for Plastic Laminated and Metal Signs: Self tapping stainless steel screws or No. 10/32 stainless steel machine screws with nuts, flat washers and lock washers.

**2.3 Miscellaneous Identification Products**

.1 Cable Ties: Fungus-inert, self extinguishing, 1 piece, self locking, Type 6/6 nylon cable ties with following features:

.1 Minimum Width: 5 mm.

.2 Tensile Strength: 222 N minimum.

.3 Temperature Range: -40 to 85°C.

.4 Color: As indicated where used for color coding.

.2 Paint: Alkyd-urethane enamel. Primer as recommended by enamel manufacturer.

**3. EXECUTION**

**3.1 Installation**

.1 Install identification devices according to manufacturer's written instructions.

.2 Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

.3 Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and or designations used for electrical identification with corresponding designations used in Contract Documents or required by codes and standards. Use consistent designations throughout Project.

.4 Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

.5 Self Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.

.6 Install painted identification as follows:

.1 Clean surfaces of dust, loose material, and oily films before painting.

.2 Prime Surfaces: For galvanized metal, use single component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy duty, acrylic resin block filler. For concrete surfaces, use clear, alkali resistant, alkyd binder type sealer.

.3 Apply one (1) intermediate and one (1) finish coat of silicone alkyd enamel.

.4 Apply primer and finish materials according to manufacturer's instructions.

.7 Identify Raceways and Exposed Cables of Certain Systems with Color Banding: Band exposed and accessible raceways of systems listed below for identification.

.1 Bands: Pre-tensioned, snap around, colored plastic sleeves; colored adhesive tape; or combination of both. Make each color band 51 mm wide, completely encircling conduit, and place adjacent bands of two (2) color markings in contact, side by side.

.1 Fire Suppression Supervisory and Control System: Red and yellow.

.2 Combined Fire Alarm and Security System: Red and blue.

.3 Security System: Blue and yellow.

.4 Mechanical and Electrical Supervisory System: Green and blue.

.5 Telecommunications System: Green and yellow.

.8 Install Circuit Identification Labels on Boxes: Label externally as follows:

.1 Exposed Boxes: Pressure sensitive, self adhesive plastic label on cover.

.2 Concealed Boxes: Plasticized card stock tags.

.3 Labeling Legend: Permanent, water proof listing of panel and circuit number or equivalent.

.9 Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker located directly above line at 150 to 200 mm below finished

grade. Where multiple lines installed in common trench or concrete envelope do not exceed an overall width of 400 mm, use single line marker.

.1 Install line marker for underground wiring, both direct buried and in raceway.

.10 Color Code Conductors: Secondary service, feeder, and branch circuit conductors throughout secondary electrical system.

.1 Field applied, color coding methods may be used in lieu of factory coded wire for sizes larger than 10 AWG.

.1 Colored, pressure sensitive plastic tape in half lapped turns for distance of 150 mm from terminal points and in boxes where splices or taps are made. Apply last 2 turns of tape with no tension to prevent possible unwinding. Use 25 mm wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.

.2 Colored cable ties applied in groups of 3 ties of specified color to each wire at each terminal or splice point starting 76 mm from terminal and spaced 76 mm apart. Apply with special tool or pliers, tighten to snug fit, and cut off excess length.

.2 208/120 Volt System: As follows:

.1 Phase A: Black.

.2 Phase B: Red.

.3 Phase C: Blue.

.4 Neutral: White.

.5 Ground: Green.

.11 Power Circuit Identification: Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms.

.1 Legend: 6.4 mm steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.

.2 Fasten tags with nylon cable ties; fasten bands using integral ears.

.12 Apply identification to conductors as follows:

.1 Conductors to Be Extended in Future: Indicate source and circuit numbers.

.2 Multiple Power or Lighting Circuits in Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.

.3 Multiple Control and Communications Circuits in Same Enclosure: Identify each conductor by its system and circuit designation. Use consistent system of tags, color coding, or cable marking tape.

.13 Apply warning, caution, and instruction signs and stencils as follows:

.1 Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic laminated instruction signs with accepted legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.

.2 Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch (9 mm) high lettering for emergency instructions on power transfer, load shedding, and or emergency operations.

.14 Install identification as follows:

.1 Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide single line of text with 13 mm high lettering on 38 mm high label; where two (2) lines of text are required, use lettering 51 mm high. Use black lettering on white field. Apply labels for each unit of following categories of equipment.

.1 Panels.

.2 Racks

.3 Servers

.4 PLCs

.5 RIOs

.6 Wireways

.7 Network Switches

.8 Miscellaneous Panel Devices

.2 Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

## 3.2 Contract Closeout

.1 Provide in accordance with Section 01 77 00.

**END OF SECTION**