CITY OF FORT WAYNE MASTER UPDATED: 11/16/18

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

NTS: Building wires and cables and associated splices, connectors, and terminations for wiring systems rated 600 v and less.

1. GENERAL
	1. DESCRIPTION
		1. Scope:
			1. Contractor shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install low-voltage conductors and cabling.
			2. Types of cabling required include:

NTS: Edit paragraphs “a” through “d”, below, to suit the project.

* + - * 1. Insulated cable for installation in raceways.
				2. Cable for installation in cable trays.
				3. Direct-burial cable.
				4. Direct-burial cable duct.
		1. Related Sections:

NTS: List at (--1--) below only sections covering products, construction, and equipment specifically identified in this section and specified in another section and directly referenced in this specification. Do not list administrative and procedural Division 01 Sections.

* + - 1. Section 26 05 53, Identification for Electrical Systems.
			2. Section 31 00 05 Trenching and Earthwork
			3. Section (--1--).
	1. REFERENCES

NTS: Retain applicable standards and add others as required.

* + 1. Standards referenced in this Section are:
			1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
			2. ASTM B3, Specification for Soft or Annealed Copper Wire.
			3. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
			4. ASTM D3485, Specification for Smooth-Wall Coilable Polyethylene (PE) Conduit (Duct) for Preassembled Wire and Cable.
			5. ASTM F2160, Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD).
			6. NEMA TC 7, Smooth Wall Coilable Electrical Polyethylene Conduit.
			7. UL 44, Thermoset-Insulated Wires and Cables.
			8. UL 1277, Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

NTS: Edit article “1.3” below to suit the Project. DO NOT DELETE (NOT USED) ITEMS.

* 1. SUBMITTALS
		1. Action Submittals: Submit the following:
			1. Product Data
				1. Manufacturer’s literature, specifications, and engineering data for low voltage insulated cable proposed for use.
			2. Shop Drawings (NOT USED)
			3. Samples (NOT USED)
		2. Informational Submittals: Submit the following:
			1. Certificates
				1. Certification by the manufacturer that the conductors and cables conform to the requirements of the drawings and specifications.
				2. Certification by the Contractor that the conductors and cables have been properly installed, adjusted, and tested.
			2. Delegated Design Submittal (NOT USED)
			3. Test and Evaluation Reports (NOT USED)
			4. Manufacturers’ Instructions (NOT USED)
			5. Source Quality Control Submittals (NOT USED)
			6. Field Quality Control Submittals
				1. Written results of field insulation resistance tests.
			7. Manufacturer Reports (NOT USED)
			8. Sustainable Design Submittals (NOT USED)
			9. Special Procedure Submittals (NOT USED)
			10. Qualifications Statements (NOT USED)
		3. Closeout Submittals. (NOT USED)
			1. Maintenance Contracts
			2. Operation and Maintenance Data
			3. Bonds
			4. Warranty Documentation
			5. Record Documentation
			6. Sustainable Design Closeout
			7. Software
		4. Maintenance Material Submittals. (NOT USED)
			1. Spare Parts
			2. Extra Stock Materials
			3. Tools

NTS: Add requirements at (--1--) below if project requires special delivery methods.

* 1. QUALITY ASSURANCE

NTS: Retain applicable standards and add others as required.

* + 1. Items provided under this Section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).
			1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
			2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.
		2. Regulatory Requirements: Comply with the following:
			1. NEC Article 300, Wiring Methods.
			2. NEC Article 310, Conductors for General Wiring.
			3. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.
	1. DELIVERY, STORAGE, AND HANDLING
		1. Deliver wire and cable according to NEMA WC 26.
		2. (--1--)
1. PRODUCTS

NTS: Retain and edit applicable paragraphs under article “2.1”, below, to suit the project.

* 1. MATERIALS
		1. BUILDING WIRES AND CABLES
			1. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as required to meet application and NEC requirements.
			2. Wire and cable for 600 volts and below: Soft drawn, copper wire with 600 volt insulation.
				1. Conductors:

Annealed, copper in accordance with ASTM B33.

Stranding: Class B in accordance with ASTM B8.

* + - * 1. Insulations and Coverings:

Rubber: Conform to NEMA WC 3.

Thermoplastic: Conform to NEMA WC 5.

Cross-Linked Polyethylene: Conform to NEMA WC 7.

Ethylene Propylene Rubber: Conform to NEMA WC 8.

* + - 1. Feeders and service conductors: Single conductor Type XHHW-2.
			2. Branch Circuits:
				1. Single Conductor Type THHN/THWN: Above ground and underfloor conduits.
				2. Single Conductor Type XHHW-2: Duct bank conduit.
				3. No. 12 AWG minimum size (unless otherwise noted) for branch circuit wiring, including motor circuits.
				4. Size 120 v branch circuits for length of run on following basis.

0 to 50 ft Run From Panelboard to first outlet: No. 12 AWG minimum.

51 to 100 ft Run: Increase one wire size, i.e., No. 12 AWG becomes No. 10 AWG.

101 to 150 ft Run: Increase two wire sizes, i.e., No. 12 AWG becomes No. 8 AWG.

151 ft and above: Wiring sized for 3% maximum voltage drop.

* + - * 1. For other branch circuits, voltage drop for branch circuits and feeder circuit combined shall not exceed requirements of the NEC 215.
			1. Control Circuits:
				1. Single conductor Type THHN/THWN: Above ground and underfloor conduits.
				2. No. 14 AWG stranded copper minimum size (unless otherwise noted).
				3. Multi-wire cable assembly: Duct bank conduits.
			2. Non-shielded Instrumentation, Graphic Indication, and Other Control Wiring Operating at Less Than 120 v: No. 14 AWG stranded copper except as otherwise indicated with same insulation as control circuits.
				1. Single conductor Type THHW/THWN, above ground and underfloor conduits.
				2. Multi-wire cable assembly: Duct bank conduits.
			3. Shielded instrumentation wiring, above ground and underfloor conduits:
				1. PVC insulation, tinned copper (19 by 27) stranded, No. 16 AWG, twisted pair or triplet cabled with aluminum mylar shielding, stranded, tinned, No. 18 AWG copper drain wire, and overall black FR-PVC, 90oC, 600 volt jacket.
				2. Multi-wire cable assembly: duct bank conduits.
			4. Telephone Wire, above ground conduits:
				1. Vinyl insulation, tinned copper, solid twisted pair, cabled conductors, and silver gray vinyl jacket.

Up to 4 conductors per cable: 22 AWG solid wire.

Over 4 conductors per cable: 24 AWG solid wire.

Duct Bank: High density polyethylene jacketed multi-wire cable assemblies.

* + - 1. Fire Pump Feeder: Type MI, 3-conductor copper.
			2. Multi-Wire Control and Instrumentation Cable Assemblies:
				1. Multi-conductor, color-coded cable with number and size of conductors indicated.
				2. Where spare conductors are not indicated provide 10% spare conductors. One pair minimum.
				3. Control and non-shielded instrumentation.

Bare soft stranded No. 14 or 12 AWG copper in accordance with ASTM B3.

Class B stranded in accordance with ASTM B8.

Type THWN insulation also meeting requirements of NEMA WC-5 with armor-nylon in accordance with UL 83-THHN/THWN.

Color coded or numbered in accordance with NEMA WC-5 Method I Table K-2.

Cabled with suitable fillers.

Overall black FR-PVC, 90°C, 600 volt sunlight resistant jacket.

UL listed for installation in cable trays in accordance with NEC Art. 318, Class I, Division 2 hazardous areas and in accordance with NEC 340 and for direct burial.

* + - * 1. Shielded Instrumentation:

Bare soft stranded No. 16 AWG copper in accordance with ASTM B3.

Class B stranded tinned copper in accordance with ASTM B8.

PVC with nylon armor insulation.

Twisted pairs color coded in accordance with NEMA WC-5 Method I Table K-2, and numbered.

Individual and overall aluminum mylar shields and seven strand tinned copper drain wires.

Overall black FR-PVC 90°C 600 volt sunlight resistant jacket.

UL listed for installation in cable trays in accordance with NEC 318, Class I, Division 2 hazardous areas in accordance with NEC 340 and for direct burial.

* + 1. Cable Connectors, Solderless Type:
			1. For wire sizes No. 4 AWG and above, use either compression type or bolted type with silver-plated contact faces.
			2. For wire sizes up to and including No. 6 AWG, use compression type. Alarm and control wire shall be terminated using forked type connectors at terminal boards.
			3. For wire sizes No. 1/0 AWG and larger, use connectors with at least two cable clamping elements or compression indents and provision for at least two carbon steel bolts with Belleville Washer Nut or approved equal bolts for joining to apparatus terminal.
			4. Properly size connectors to fit fastening device and wire size. Connectors shall be rated for 75 degree C, 600 volts.
		2. Cable Splices:
			1. For wire sizes No. 8 AWG and larger, splices shall be made up with compression type copper splice fittings. Splices shall be taped and covered with materials recommended by cable manufacturer to provide insulation equal to that on conductors.
			2. For wire sizes No. 10 AWG and smaller, splices may be made up with pre-insulated spring connectors.
			3. For wet locations, splices shall be waterproof. Compression type splices shall be waterproofed by sealant-filled, thick wall, heat shrinkable, thermoset­ting tubing or by pouring thermosetting resin into mold that surrounds the joined conductor. Spring connector splices shall be waterproofed with sealant filler.
			4. Splices shall be suitably sized for cable, rated 75 degrees C, and 600 volts.
			5. Splices shall be in accordance with NEC and UL.
		3. Wire and Cable Markers:
			1. Provide wire and cable markers in accordance with Section 26 05 53, Identification for Electrical Systems.
	1. SOURCE QUALITY CONTROL
		1. Factory Tests:
			1. Factory-test wire and cable in accordance with UL and/or NEMA standards.
1. EXECUTION
	1. INSTALLATION
		1. Install wires and cables as indicated, according to manufacturer's written instructions and NECA "Standard of Installation".
		2. Identification:
			1. Identify conductors in accordance with Section 26 05 53, Identification for Electrical Systems.
			2. Identify power conductors by circuit number and phase at each terminal or splice location.
			3. Identify control and status wiring using numeral tagging system.
		3. Color-code cables as follows:
			1. Colors for power:

| **System** | **Conductor** | **Color** |
| --- | --- | --- |
| All Systems | Equipment Grounding | Green |
| 240/120 VoltsSingle-Phase, Three-Wire | Grounded NeutralOne Hot LegOther Hot Leg | WhiteBlackRed |
| 208Y/120 VoltsThree-Phase, Four-Wire | Grounded NeutralPhase APhase BPhase C | WhiteBlackRedBlue |
| 240/120 VoltsThree-Phase, Four-WireDelta, Center TapGround on Single-Phase | Grounded NeutralPhase AHigh (wild) LegPhase C | WhiteBlackOrangeBlue |
| 480Y/277 VoltsThree-Phase, Four-Wire | Grounded NeutralPhase APhase BPhase C | GrayBrownOrangeYellow |

* + - 1. Colors for control wire
				1. AC hot conductor: Black.
				2. AC neutral conductor: White.
				3. Grounding conductor: Green.
				4. AC control conductor, powered from within panel: Red.
				5. AC control conductor, powered from remote source: Yellow.
				6. DC (+) power conductor, discrete signal: Blue.
				7. DC (-) power conductor, discrete signal: White with Blue Tracer.
				8. DC control conductor, discrete signal: Blue.
				9. Twisted pair cable (+) signal conductor, analog signal: White or Clear.
				10. Twisted pair cable (-) signal conductor, analog signal: Black.
				11. Twisted pair power, analog signal: Red
		1. Remove existing wire from raceway before pulling in new wire and cable.
		2. Bending Radius: Limit to minimum of six times cable overall diameter.

 Slack: Provide maximum slack at all terminal points.

* + 1. Run wire and cable in conduit unless otherwise indicated on Drawings. Pull conductors into raceway simultaneously where more than 1 is being installed in same raceway.
			1. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation.
			2. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
			3. Do not draw conductor into conduits until building is enclosed, watertight, and work causing cable damage has been completed.
		2. Install cable supports for vertical feeders in accordance with NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.
		3. For panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie cables in individual circuits.
		4. Seal cable and wire entering building from underground or exterior between wire and conduit, where cable exits conduit, with non-hardening approved compound.
		5. Install wire and cables in separate raceway systems as follows:
			1. .
			2. ac Control.
			3. dc control.
			4. Shielded instrumentation.
			5. Telephone cables.
			6. Network Cables.
			7. Fiber Optic Cables.
			8. Emergency system.
			9. Fire alarm system.
			10. As required by NEC.
		6. Where control or instrumentation cables are run in underground conduit and ducts provide multi-wire cable assemblies.
		7. Where power cables and instrument/signal cables enter and pass through same manhole, handhole, or distribution box, or steel barrier, separate raceways shall continue through box manhole or handhole to avoid magnetic interaction between power cables and instrumentation conductors. In manholes and handholes, provide Type C raceway outlet body with 3/16 in. holes drilled in bottom for drainage.
		8. Do not run instrumentation cables into control cabinets or MCC unless cables are terminated in cabinet or MCC.
		9. Wiring at Outlets: Install with at least 12 in. (300 mm) of slack conductor at each outlet.
		10. Do not use device as pass through for conductors. Pigtail conductors to device.
		11. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A.
		12. Drawings do not designate number of conductors in conduit nor does location of branch circuits and switch legs indicated on Drawings designate location or routing. Route branch circuits and switch legs as dictated by construction and these Specifications.
		13. Neutral conductors **SHALL NOT** be shared.
	1. TERMINATIONS AND SPLICES
		1. Terminate control, instrumentation, and communication cables on terminal strips in separate terminal cabinets located near conduit entrances of buildings or as shown on Drawings.
		2. Power Cable Splices (no splices in cables unless approved by Engineer):
			1. Provide continuous lengths of cable without splices in motor circuits and feeders unless otherwise noted. Splices may be installed in motor circuits and feeders with prior approval by ENGINEER.
			2. Install splices and taps that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
			3. Use splice and tap connectors that are compatible with conductor material.
			4. Where pre-insulated spring connectors are used for equipment connections, tape connector to wire to prevent loosening under vibration.
			5. Each tap, joint or splice in conductors No. 8 AWG and larger shall be taped with two half-lap layers of vinyl plastic electrical tape and finish wrap of color coding tape where required by code.
			6. Cable splices shall be made only in manholes, handholes, wireways, distribution boxes, and junction boxes. Splices below grade, in manholes, handholes, and wet locations shall be waterproof.
		3. Power Cable Terminations:
			1. Termination of wires with full compression type lugs installed with appropriate hand or hydraulic tool. Use proper dies to achieve the desired compression.
			2. For screw type terminal blocks, terminations for stranded conductors shall be made with T & B lock-on fork connector with insulated sleeves.
			3. Motor lead conductor terminations shall be made with a T & B or approved equal, full compression lug, full ring type, bolted, and taped as required. For connecting motor lead to service wiring fasten full ring lugs together with cadmium plated steel cap screws, and cover with a minimum of 2 layers 1/2 lap, 3M Scotch No. 33 tape; option: T & B "Motor Stub Splice Insulator".
	2. CONTROL CIRCUITS
		1. Control circuit home runs from same area for the same system returning to same panel, (e.g., LCP, DPC, etc.,) may be combined provided signal and voltage types are not mixed.
		2. Following types of home runs shall not be combined with other types:

* + - 1. 4-20 ma dc analog; Type 2 shielded cable.
			2. 24 vdc discrete (e.g., field or LCP powered dry contacts).
	1. BRANCH CIRCUITS
		1. Motor branch circuits and branch circuits for 3 phase circuits shall not be combined.
		2. Branch circuits for single phase equipment devices from same panel may be combined. Derating of conductors within conduit is not allowed.
	2. FEEDERS:
		1. Extend feeders at full capacity from origin to termination.
		2. Each conduit raceway shall contain only those conductors constituting single feeder circuit.
		3. Where multiple raceways are used for single feeder, each raceway shall contain conductor of each phase and neutral if used.
		4. Where feeder conductors run in parallel, conductors shall be of same length, material, circular-mil area, insulation type, and terminated in same manner.
		5. Where parallel feeder conductors run in separate raceways, raceways shall have same physical characteristics.
		6. On network systems, neutral shall be run with phase wires. Unbalanced neutral current shall not exceed normal or derated conductor capacity.
	3. MOTORS AND EQUIPMENT WIRING
		1. Provide motor circuits in accordance with diagrams and schedules on Drawings and code requirements, from source of supply to associated motor starter and starter to motor terminal box, including necessary and required intermediate connections.
		2. Do not include associated control conductors in same conduit with power conductors.
		3. Provide branch circuits to conform with NEC requirements and nameplate ratings. CONTRACTOR responsible for verification of ratings of motors and installing proper branch circuits.
		4. For VFD controlled motors, branch circuits and motor feeds shall be run in individual conduits for each motor.
	4. FIELD QUALITY CONTROL
		1. Site Tests:
			1. Test each electrical circuit after permanent cables are in place, to demonstrate that circuit and equipment are connected properly and will perform satisfactorily, free from improper grounds and short circuits.
			2. Individually test 600-volt cable mechanical connections after installation and before they are put in service, with calibrated torque wrench. Values shall be in accordance with manufacturer's recommendations.
			3. Individually test 600-volt cables for insulation resistance between phases and from each phase to ground. Test after cables are installed and before they are put in service, with Megger for one minute at voltage rating recommended by cable manufacturer or in accordance with ANSI/NETA ATS recommendations.
			4. Insulation resistance for each conductor shall not be less than value recommended by cable manufacturer. Cables not meeting recommended value or that fail when tested under full load conditions shall be replaced with a new cable for full length.
			5. Perform phase rotation test on all three-phase circuits.

NTS: Retain paragraph, below, when existing cables are spliced to new cables.

* + - 1. Where existing cables are spliced to cables provided under the Project, test existing cables prior to splicing. Test cables at 1,000 vdc for one minute. Entire spliced cable installation shall be re-tested after splice is completed. Existing cable that fails or has value less than two mega-ohms shall be brought to attention of Engineer and splicing shall not proceed until condition is acceptable.
	1. CABLES (LOW VOLTAGE)
		1. Inspect cables for physical damage and proper connection in accordance with single-line diagram.
		2. Test cable mechanical connections to manufacturer's recommended values using calibrated torque wrench.
		3. Check cable color coding with specifications and NEC standards.
		4. Electrical Tests:
			1. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 min.
			2. Perform continuity test to insure proper cable connection.
		5. Test Values:
			1. Evaluation results by comparison with cables of same length and type. Investigate any value less than 50 mega-ohms.

+ + END OF SECTION + +