

READ THIS FIRST

Notice to the Design Engineer, this document is part of Facilities and Infrastructure standards for Electrical Systems. Designers are advised to NOT use this template (*.doc) document as part of any project contract documents. Designers shall use the Port of Seattle MasterSpec specifications from the following link:

<https://www.portseattle.org/page/guide-specifications>.

Designers shall edit the corresponding Port's MasterSpec specification to meet the F&I Electrical Standard outlined in this specification. Note that Port's MasterSpec specifications contain specifications and languages for both Aviation and Maritime Divisions. F&I Standards are strictly for Aviation Division, and any Maritime related specs or languages should be removed from the project specifications.

PART 1 - GENERAL

1.01 SUMMARY AND NOTES TO DESIGNER

- A. Section Includes:
 - 1. Insulated copper conductors and cables for general power use rated 600 V and less, AWG sizes #14 through 750 kcmil.
 - 2. Connectors, splices, and terminations rated 600 V and less.
- B. 75°C is the standard design temperature for all conductors unless otherwise required by engineering considerations.
- C. Where lubrication appears necessary for installation, consider use of products with no-lube jacketing/insulation to reduce waste and labor.
- D. No cable splices are allowed in new construction without F&I approval.
- E. No feeder splices are allowed without F&I approval. If feeder cables must be extended, use compression splices in adequately sized pull-box.
- F. Where electrical panels are replaced in a new location and branch circuits are extended to a new panel location, terminal blocks are required in junction box in lieu of compression splices.
- G. Provide separate raceways for 480/277V feeders/circuits and 208/120V feeders/circuits.
- H. When engineering considerations dictate, control conductors may be routed in power raceway under the following conditions:
 - 1. All conductors must have a voltage rating for the highest voltage in the raceway.
 - 2. The largest power conductor in the raceway is #4 AWG.

- I. Aluminum wire is not allowed.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Requirements:
 - 1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.
 - 2. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2 and 3 control cables.
 - 3. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.03 SUBMITTALS

- A. Product Data: For each type of product.
- B. Qualification Data: For testing agency.
- C. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. All wire and cable shall be new and made of copper. No aluminum wire and cable allowed, unless otherwise noted.
- B. Listing and Labeling: Provide wire and cable that are Listed and Labeled as defined in NFPA 70, Article 100 and marked for specific types, sizes, and combinations of conductors and connected items.
- C. Comply with NFPA 70, as adopted and administered by F&I.
- D. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES

- A. General Requirements:

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1. Insulated conductors shall comply with NFPA 70 and be UL listed and labeled.
 2. All conductors shall be new.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Southwire Incorporated.
 2. American Insulated Wire
 3. Allied Wire and Cable
 4. Carol Cable
 5. Or approved equal.
- C. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658. All conductors #14 and larger shall be copper stranded. Use 600V rated cable for all 480V applications.
- D. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THW-2, Type THHN-2-THWN-2, Type XHHW-2, Type UF, Type USE, and Type SO.
- E. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for, mineral-insulated, metal-sheathed cable, Type MI, Type SO and, Type USE with ground wire.
- F. VFD Cable:
1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
 2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire. Sunlight- and oil-resistant outer PVC jacket, where required by environmental considerations.
 3. Comply with UL requirements for cables in Classes I and II, Division 2 hazardous location applications.
- G. 400 HZ AIRCRAFT CABLE:
1. The 400 Hz Aircraft Cable shall be of the single jacketed type suitable for nominal 200/115 Volt, 3-Phase, 4-Wire, 400 Hz power.
 2. Cables shall be an approved type Single Jacket Ground Support Cable for aircraft use.
 3. Cables shall have built-in thermal protection device to detect and disconnect output power in an overtemp situation.
 4. Components shall be as follows:
 - a. Power Conductors: 6-number 4 AWG Class M stranding
 - b. Neutral Conductor: 1-number 1 AWG Class M stranding.
 - c. Control Conductors: 18-number 18 AWG Class M stranding.
 - d. Outer Jacket: Pressure extruded rayon-reinforced black neoprene 0.17-inch nominal wall.
 - e. Minimum Bend Radius: 6.5-inches.
 - f. Temperature Range: Minus 65 degrees F to plus 130 degrees F.
 - g. Storage Temperature: Minus 65 degrees F to plus 130 degrees F.
 - h. Humidity: 0 to 100 percent.
 - i. Bundling: Single Jacket

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- j. Diameter: 1.65-inches
- k. Weight Per Foot: 2 lb. per foot
- l. Voltage Rating: 600 VAC
- m. Amperage Rating: 260 Amps

H. 400 HZ POWER SUPPLY CABLE

1. The 400 Hz Power Supply Cable shall be single jacketed multiplexed factory assembled type, rated 600 Volts and listed for 400 Hz service.
2. Conductors shall be # 2/0 stranded copper with type XHHW insulation. Number of conductors shall be provided as indicated on the cable schedule.
3. Type W, extra flexible cable shall be run in pantographs.

I. FLEXIBLE METAL CLAD (MC) CABLE SHALL NOT BE USED FOR GENERAL WIRING PURPOSES.

2.02 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. Ilco; a branch of Bardes Corporation.
4. NSi Industries LLC.
5. O-Z/Gedney; a brand of the EGS Electrical Group.
6. 3M; Electrical Markets Division.
7. Tyco Electronics.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

1. For #14 AWG through #10 AWG wire sizes, use insulated spring wire connectors rated for use on stranded wire or insulated compression connectors.
2. For #8 AWG wire, use solderless pressure connectors with insulating sleeves.
3. For #6 AWG and larger cable, use split bolt connectors with manufactured insulation covers or tape sufficient to provide 150% insulation level. As an option, compression connectors are acceptable using compression dies designed for the exact connector being used. Provide insulating sleeves manufactured specifically for the connector being used.
4. No cable splices are allowed in new construction without F&I approval.

3.01 EXAMINATION

- A. Examine raceways and building finishes, to receive wire and cable for compliance with requirements for installation tolerances and other conditions affecting performance of wire and cable. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper, Stranded for No. 14 AWG and larger.
- B. Branch Circuits: Copper. Stranded for No 14 AWG and larger, except VFD cable, which shall be extra flexible stranded.

3.03 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. THHN/THWN stranded copper wire is standard for all wet and dry indoor locations.
- B. XHHW stranded copper wire is standard for all outdoor applications.
- C. Provide plenum and/or tray rated cable where required by the application.
- D. Provide lead-free jacketing and/or insulation where available.
- E. Grounding Conductors: #6 AWG and larger: stranded copper, bare, soft drawn. #8 AWG and smaller: stranded copper with green insulation.
- F. Service Entrance: Type SE or Type USE multiconductor cable.
- G. Exposed Feeders: SE, USE sunlight exposed rated conductors. In addition, F&I will review and approve all catenary systems for strain relief and wind resistance
- H. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.
- I. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway for indoor applications; Type XHHW-2, single conductors in raceway for outdoor locations; Underground feeder cable, Type UF in raceway.
- J. Feeders Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway.

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- K. Feeders in Cable Tray: Type THHN-2-THWN-2, single conductors in raceway. Type NM cable is not allowed. Type MC cable is not allowed.
- L. Provide LMFC for light fixture whips, in lengths not to exceed 6'.
- M. Exposed Branch Circuits, Including in Crawlspace: Type THHN-2-THWN-2, single conductors in raceway. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway for indoor applications, Type XHHW-2, single conductors in raceway for outdoor applications.
- N. Branch Circuits Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway. Branch Circuits in Cable Tray: Type THHN-2-THWN-2, single conductors in raceway. Underground lighting applications: RHW/USE stranded copper.
- O. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.04 INSTALLATION OF CONDUCTORS AND CABLES

- A. National Electrical Installation Standards (NEIS), published by the National Electrical Contractors' Association (NECA) shall be used as a reference to establish a standard for quality of installation workmanship.
- B. Make conductor lengths for parallel circuits equal by actual length comparison before installing in conduit.
- C. Smallest wire sizes allowed are #12 AWG for lighting and power and #14 AWG for controls. See section 260523 – "Control Voltage Electrical Power Cables".
- D. Provide dedicated neutrals for branch circuits. Shared neutrals will not be allowed.
- E. Control conductors shall be routed in separate raceways from power conductors.
- F. Provide separate raceways for 480/277V feeders/circuits and 208/120V feeders/circuits.
- G. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- H. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
 - 1. Exposed 400Hz cables shall be supported with insulated cable supports made from thermoplastic elastomer. The supports shall be flame retardant, and shall provide a layer of insulation to prevent cable from rubbing against the edge of the supports.

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- I. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- J. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- K. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- L. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- M. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.
- N. Restricted Conductors: Contractors in possession of aluminum conductors or solid copper conductors in their vehicles, storage or work areas may be removed from the site until such material is no longer on the premises.

3.05 CONNECTIONS

- A. No splices are allowed in raceways or inaccessible locations. Splice only in junction or outlet boxes.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
 - 1. For bolted connections in equipment, verify that, by applying a spot of red paint to each bolt head such that the paint will be visibly disturbed if the bolt is disturbed, connections have been properly. Use copper lugs only on main circuit breakers and feeder breakers. No CU/AL lugs allowed.
- C. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- D. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.06 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.07 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.08 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping" and Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.09 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative, if required:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with the following requirements.
 - a. Megger testing for one half minute is required for all 600-Volt insulated wire #2 AWG and larger using a 500-Volt Megger for 208-Volt systems and a 1000-Volt Megger for 480-Volt systems.
 - b. Test continuity between conductors and from each conductor to ground before initial energization of all service equipment, switchgear, switchboards, MCCs (including motors) and panelboards. Record test information for all cables tested on attached report.
 - c. Using a Volt/Ohm meter, test all power conductors below #2 AWG for continuity to ground.
 - d. Test circuits for motor rotation, phaser to phaser sequence.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

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- c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- D. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- E. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519