

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 OF WORK AND NOTES TO DESIGNER

- A. Section includes cables and related cable splices, terminations, and accessories for 5 kV and 15 kVA prated shielded power cables, terminations and accessories.
- B. All or a portion of the work covered by this Section is to be conducted within the Air Operations Area (AOA) at Sea-Tac International Airport. Restrictions and conditions necessary to maintain airfield and aircraft safety as required by FAA regulations, and as required to maintain efficient airport operations, may impose limitations upon the Contractor's methods and procedures. Section 01140, Operational Safety on Airports lists the applicable conditions, limitations and regulations.
- C. It is desirable to provide a service loop of MV cable in all vaults and manholes to provide slack cable in the event of future splices. However, some manholes and vaults have space restrictions that prevent the ability to provide a full 360 degree loop. The designer should evaluate the space in each vault or manhole during design and include a service loop in the design in all vaults and manholes where possible.
- D. Design involving medium voltage cables work shall include a one-line drawing detailing cable identification for each cable. Labels shall be generated for each cable ID. Follow the labeling guidelines below:
 - 1. Labels shall be provided for phase A, B, and C for all medium voltage cables from source equipment to end equipment. Designer shall request cable identification numbers from F&I for labels. Below are sample cable ID where XXXX is a number provided by F&I.
 - a. Phase A cable – "AXXXX"
 - b. Phase B cable – "BXXXX"
 - c. Phase C cable – "CXXXX"
 - 2. A medium voltage cable without any splices shall have the same cable ID from source equipment to end equipment.

- a. Where two cables are joined by a non-separable splice, the two cables shall be identified by one cable ID
 - b. Where two cables are joined by a separable splice, the two cables shall be identified by two different cable IDs.
- 3. Cable labels for each cable shall be provided (with no exception) at source equipment, end equipment, and at all intermediate junction boxes, pull boxes, manholes, handholes, and vaults.
- E. Designs involving medium voltage cables in manholes, handholes, pull boxes, junction boxes, and/or cable vaults shall include design drawings of the foldouts for each pulling structure. Foldout designs shall clearly depict the demolition work and the new work with existing and new feeder cables clearly identified.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 DEFINITIONS

- A. Jacket: A continuous nonmetallic outer covering for conductors or cables.
- B. NETA ATS: Acceptance Testing Specification.
- C. Sheath: A continuous metallic covering for conductors or cables.

1.04 SUBMITTALS

- A. Qualification Data: For firms and persons specified in "Quality Assurance" article to demonstrate their capabilities and experience.
 - 1. Splicer must be qualified by Elastimold, 3M or Cooper Medium Voltage
- B. Electrical Contractor Experience:
 - 1. Minimum of one person on crew must have worked on at least five medium voltage installations. Crewmember with experience on five medium voltage projects must be present on site at all times while work is being performed.
 - 2. Include list of completed projects with project names, addresses, names of Engineers and Owners, and other contact information such that verification can be made. Provide qualification data for Independent Testing Agency.
- C. Product Data: For cables and cable accessories, including splices and terminations
- D. Material Certificates: For each type of cable and accessory, signed by manufacturer that products comply with specified requirements.

1. Contractor shall submit certificate that terminations are suitable for use with specified cable.
 2. Provide 40 year design life statement as specified in "Quality Assurance".
- E. Product Test Reports: Certified reports of Manufacturers' design and production tests indicating compliance of cable and accessories with referenced standards. Cables with the manufacturing date exceeding 12 months prior to the date of delivery to the Project site will not be accepted.
- F. Diagram of set-up area and submittal of pulling product and installation data including:
1. Shims
 2. Pulleys
 3. Take-up Reels
 4. Traffic Clearance
 5. Dynamometer Calculations
 6. Lubricant – type and quantity
 7. Clean-up Plan
- G. Submit switchover and outage plan.
1. Ductwork and cable must be installed before switch to new cable. Outage for switchover must be kept to a minimum (4 hour outage is the minimum that STIA has experienced for cable cutover)
- H. Schedule of cable pulls showing calculated pulling tension and sidewall pressure values and a summary showing maximum allowable pulling tension.
- I. Schedule of inspection during work, witnessed by POS electrical shop. Items inspected include the following:
1. Die crimp to connector
 2. Megger Readings
 3. Dynamometer Red Line before reset.
- J. Field test reports indicating and interpreting test results relative to compliance with performance requirements specified. Include certified copies of field test records.
- K. Maintenance data for cables and accessories to include in Operations and Maintenance Manual.

1.05 QUALITY ASSURANCE

- A. Single-Source Responsibility: All medium-voltage cable and accessories shall be the product of a single manufacturer.
- B. Comply with the following standards:
1. NFPA 70 as adopted and administered by the Authority Having Jurisdiction.

- C. ANSI C2 "National Electrical Safety Code" for components and installation.
- D. Association of Edison Illuminating Companies (AEIC) for components and installation.
- E. ASTM for components and installation.
- F. Manufacturer Qualifications: Firm with 10 years' experience in manufacturing medium voltage cable with triple extrusion of EPR insulation and accessories similar to those indicated for this Project, with a record of successful in-service performance and having ISO 9000 approval certification.
- G. Identification: Cable shall be new and of recent manufacture (no more than 12 months old) and shall have label showing the name of cable manufacturer, size, plant location, insulation type, insulation thickness, voltage rating, insulation level, sequential footage, year of manufacture and UL designations. Marking shall be in contrasting color, i.e., white on black background.
- H. Installer: Engage an experienced and certified cable splicer to install terminations and connectors for medium voltage cable. Provide a list of personnel names including certifications. Significant projects they have worked in the past three years, and listing the approximate number and type of termination and connector installations they performed or assisted.
- I. Cable splicer shall have manufacturer's certification on specific cables used on project and shall have Puget Sound Electrical Joint Apprenticeship and Training Committee (PSE JATC) medium voltage cable splicing certification.
- J. Pulling Crew: Engage an experienced cable pulling crew to install medium voltage cable.
 - 1. Provide a list of personnel names and roles including significant projects they have worked in the past three years and listing the approximate number of pulls along with cable type and size and conduit size and length they have worked on.
- K. Testing Agency Qualifications: Member Company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- L. WARRANTY
 - 1. Manufacturer shall provide 40 year design service life statement.

1.06 DELIVERY STORAGE AND HANDLING

- A. Deliver medium voltage cable on factory reels conforming to NEMA WC 26.
- B. Store cables on reels on elevated platforms in a dry location. Comply with manufacturer's recommendations for proper cable storage. Cables found to be improperly stored on site will not be allowed to be installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Cables:
 - a. Okonite
 - b. BICC Cables/General Cable Co. Unishield Series
 - c. Kerite
 - d. Or F&I Approved Equal
 - 2. Cable Splicing and Terminating Products and Accessories:
 - a. 3M
 - b. Elastimold
 - c. Cooper
 - d. Or F&I Approved equal
- B. Source Limitations:
 - 1. Cables: All cables in single run shall be from the same manufacturer.
 - 2. Terminations and Accessories: Each type of cable termination or accessory product shall be of a single manufacturer.

2.02 CABLES

- A. Cable Type: Type MV 105 EPR.
- B. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74 and ICEA S-97-682.
- C. Conductor: Copper.
- D. Conductor Stranding: Compact round, concentric lay, Class B.
- E. Conductor Insulation: Ethylene-propylene rubber.
- F. Voltage Rating: 5 kV OR 15 kV.
- G. Insulation Thickness: 133 percent insulation level.
- H. Shielding: 5-mil uncoated copper tape, helically applied over semiconducting insulation shield with minimum 25% overlap.
- I. Cable Jacket: Chlorinated Polyethylene (CPE).
- J. Cable Pulling Eyes: on 15 kV pulls greater than 250 linear feet. Factory installed, one per phase.

- K. End Seals: Factory sealed ends.
- L. Lengths: add a minimum of 5% to True Tape measurements when ordering cable.

2.03 SOLID TERMINATIONS

- A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Conductor materials shall be copper alloy. Include shield ground strap for shielded cable terminations.
- B. Class 1 Terminations: Suitable for Tape Shield MV-105 cable. Single piece, modular. Inside or outside rated as appropriate. Furnished as a kit with shield ground strap and compression type connector. Acceptable modules include but are not limited to Elastimold 16THG and PCT-1 and 35MTG, 3M Quick Term III 7600 Series and Raychem TFT-E-G/SG.

2.04 SEPARABLE INSULATED CONNECTORS

- A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture. All mating parts shall be compatible products of the same manufacturer. Conductor materials shall be copper alloy.
 - 1. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.
 - 2. Load-Break Cable Terminators: Elbow-type units with 200-A-load make/break and continuous-current rating. Coordinate with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled. Acceptable models include but are not limited to Elastimold 165/166LR and 167/168LR, and Cooper LE215.
 - 3. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled. Acceptable models include but are not limited to Elastimold 655LR and Cooper TP615
 - 4. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
 - 5. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
 - 6. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.

7. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
 8. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.
 9. Straight Plug Cable Terminators: In-line type units with 200 and 600 ampere continuous current rating. Dead-break, fully shielded, fully submersible. Pre-molded ethylene propylene diene monomer (EPDM) splicing body kit with cable joint sealed by interference fit of mating parts and cable. Acceptable models include but are not limited to Elastimold 151SP and K656.
- B. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool. Reference paragraph 2.11 below for product details.

2.05 SPLICE KITS

- A. Splice Kits: Comply with IEEE 404; cold shrink design type as recommended by cable or splicing kit manufacturer for the application.
- B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
1. See Separable Insulated Connectors Article.
- C. Combination tape and cold-shrink-rubber sleeve kit with re-jacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
- D. Premolded, cold-shrink silicone rubber, in-line splicing kit with EPDM rubber jacketing.
- E. Premolded, modular EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.
- F. Separable multiway splice system with all components for the required splice configuration.
- G. Non-separable splices shall not be used.

2.06 MEDIUM-VOLTAGE TAPES

- A. Linerless Rubber Splicing Tape. 3M Scotch 130C. Size per application requirements.
- B. Silicone rubber-based, Scotch 70 self-fusing electrical tape.
- C. Insulating-putty, 3M Scotchfil electrical insulation putty.

2.07 ARC-PROOFING MATERIALS

- A. Tape for First Course on Metal Objects: 10-mil- thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
- B. Arc-Proofing Tape: NRTL-listed fireproofing tape, flexible, conformable, intumescent to 0.03 inch thick, and compatible with cable jacket. Scotch No. 77 or approved equal.
- C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch wide.

2.08 FAULT INDICATORS

- A. Indicators: Automatic reset fault indicator, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.
- B. Instrument shall be submersible, self-calibrating, made of UV stabilized materials, have stainless steel hardware, large remote indicator and auxiliary contact.
- C. Temperature rating shall be -40° C to 85° C.
- D. Indicator shall have auxiliary contacts for remote monitoring and self-resetting upon current sensing.
- E. Indicator shall be E.O. Schweitzer Linam 1CRI or approved equal.
- F. Field Test Tool: Designed for use with fault indicators.

2.09 PHASE TAPE

- A. Premium grade, 7 mil, flame retardant, cold and weather resistant, 3/4 inch minimum width. Meets requirements of UL 510. Recommended for use on PVC jacketed cable.

2.10 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to ICEA S-93-639 before shipping.
 - 1. New Medium Voltage cables will have documentation of VLF and Insulation Resistance testing performed at the factory. Documentation will be delivered to the Port Construction Manager for review and acceptance prior to shipment to the Port.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Engage an experienced cable pulling crew to install medium voltage cable.
- B. Upon arrival at the Port facility, perform Insulation Resistance Testing on new medium voltage cable while cable is still on the reel.
- C. Verify protocols for shipping and handling of cables were performed. This includes end caps on cables, cable reels stored vertically, no sudden drops or laydowns of cable reels, or other careless handling that could result in damage to cable.
- D. Install cables according to manufacturer's written instructions and IEEE 576. Observe minimum bending radius of cable.
- E. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.
- F. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
- G. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.
- H. Perform True-Tape measurement for all installations in concealed and underground conduit. Note distance to elbows and bends as perceived by pulling resistance.
- I. Perform cable pull tension and side-wall calculations using true-tape measurement results from the engineer of record.
 - 1. For cable pull calculations, use a nominal coefficient of friction (COF) value of 0.5. If a lower COF number is used, provide documentation justifying the lower number.
 - 2. Include in pulling calculations any bends that the cable must traverse at the pulling location. Bends at the supply end do not normally need to be included in the calculations if the rotation of the cable reels will be assisted to relieve tension.
 - 3. Submit to the Port a schedule of cable pulls showing calculated pulling tension and sidewall pressure values.
 - 4. Provide to the Port a summary of pulling calculations including maximum pulling tension that can be used without exceeding cable manufacturer's tension or sidewall pressure ratings.
 - 5. Provide to the Port a jamming ration calculation for each combination of cable and conduit size in the project. Indicate compensatory action taken for all results between 2.5 and 3.0.
 - 6. Pulling calculation and summary sheet shall be present at the time of installation and shall be made available to the observer.

- J. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values. Pull conductors simultaneously where more than one cable is indicated in same raceway.
- K. Where necessary, use NRTL listed and manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation
- L. Pre-lubricate conduit using front-end packs or other means.
- M. Lubricate the cable throughout the pull using, as a minimum, the amount of lubricant recommended by the lubricant manufacturer.
- N. Where cable pull route passes through accessible enclosures, set up additional lubrication stations if calculations have shown a high pull tension (or near maximum sidewall pressure).
- O. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Pulling eyes attached to conductors are recommended as they have higher allowed pulling tension than basket-weave/cable grips. Do not use rope hitches for pulling attachment to cable.
- P. Use pulleys, sheaves, low-stretch rope and pulling equipment intended for medium voltage cable installation. Ensure bend radius limit of cable is not exceeded.
- Q. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
- R. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.
- S. Routing cable up through manholes and then back in intermediate manholes (looping) in order to obtain slack shall not be permitted.
- T. If cables are not to be immediately terminated, inspect protective waterproof caps on cable ends and replace if damaged. Water infiltration of cable will result in rejection of cable unless approved by engineer. Nitrogen purging of cable to remove water is not acceptable. Comply with manufacturer's recommendations for cable storage.
- U. Acceptable products include but are not limited to 3M EC# and Raychem HVES heat shrink cable end caps.
- V. Cable end caps shall be installed by a qualified cable splicer per "Quality Assurance" article.
- W. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- X. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

- Y. Install direct-buried cables on leveled and tamped bed of 3-inch-thick, clean sand. Separate cables crossing other cables or piping by a minimum of 2 inches of tamped earth, plus an additional 2 inches of sand. Install permanent markers at ends of cable runs, changes in direction, and buried splices.
- Z. Install "buried-cable" warning tape 12 inches above cables.
- AA. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; provide 360 degree service loop where not prevented by space constraints. Support cables at intervals adequate to prevent sag. In existing manholes, handholes and vaults with metal racks, install cables on insulated porcelain saddles with no direct contact to metal racks. Metal racks are not allowed in new manholes, handholes, vaults and pullboxes.
- BB. Arrange cables in manholes to avoid interference with duct entrances.
- CC. Add 2-hour fire protection wrap to emergency cables in manholes also occupied by non-emergency cables.
- DD. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.
- EE. Install cable splices at pull points and elsewhere as indicated; use standard kits. Use dead-front separable watertight connectors in manholes and other locations subject to water infiltration.

3.02 CABLE TERMINATIONS AND CONNECTORS:

- A. Port electrical inspector will witness the first five terminations of each size and type on the project, or 10% of the project total, whichever is greater. A copy of the Inspection Instruction and Acceptance Criteria form, used by the Port for their inspections, is attached to this specification. After the first termination of each size and type has been inspected the contractor shall not perform any further terminations until written approval has been given by the Port.
- B. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.
- C. Install separable insulated-connector components as follows:
 - 1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
- D. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, fully enclosed cable tray (where not shared with other feeders), direct burial, or termination materials. Install per manufacturer's instructions.

- E. Seal around cables passing through fire-rated elements according to Section 078413 "Penetration Firestopping."
- F. Install fault indicators on each phase where indicated.

3.03 GROUNDING

- A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems".
- B. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

3.04 IDENTIFICATION

- A. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box.
- B. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.
- C. Install tags to be visible from grade level opening of manhole.
- D. Cable Tags
 - 1. Cable tags shall display a unique cable number for each phase of each section of cable. See the contract drawings for Cable Tag numbers.
 - 2. Cable tags shall be located at points of termination, and at least once in each accessible enclosure, i.e., manhole.
 - 3. Cable tags for each feeder shall be located adjacent to each other.
- E. Circuit Tags:
 - 1. Circuit tags shall display the feeder number, ex. "FDR 207".
 - 2. Circuit tags shall be located at points of termination, on either side of each splice, at the entry/exit of each manhole, and at least once in other accessible enclosures.
 - 3. Unless otherwise indicated on the drawings, one circuit tag shall be installed for each feeder bundle where feasible. Alternatively, each feeder cable may have a circuit tag installed.
- F. Tap/Load Tags:
 - 1. Tap/ Load tags shall be used in lieu of circuit tags on all taps from switches. See the drawing set for tap/load tag designations.
- G. Phase Tape:

1. Apply phase tape to exposed medium-voltage cable at each penetration of each manhole, vault, electrical room, or other enclosure. For utility tunnels and other situations with long runs of exposed medium-voltage cables, apply phase tape no farther than every 30 feet of cable length. Apply phase tape at each medium-voltage cable termination and splice. Helically wrap phase tape with 25% overlap for a length of 12 inches. Phase tape shall be applied over any arc-proofing tape, but not over identification labels.

3.05 CONDUCTOR COLOR CODING

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems".

3.06 EXISTING EQUIPMENT

- A. Dewatering:

1. Electrical enclosures, particularly below grade, are subject to flooding. See Section 312319 "Dewatering" for dewatering requirements.
2. Verify that manholes, vaults and hand holes are essentially dry. In the case where presence of water will prevent the continuation of work, pump the manhole, vault or hand hole dry and seal obvious leak points with epoxy grout or polyurethane-based water sealant. For plugging conduits, provide a removable plug capable of withstanding 20 psi hydrostatic pressure. Coordinate pumping discharge with the Resident Engineer and obtain the approval of the Port Environmental staff.

- B. Existing Cables:

1. Cables not included in work:
 - a. Existing cables are up to 40 years old and may be extremely brittle. Catastrophic failure may result from any attempt to adjust or move existing cables.
2. Existing cables shall not be relocated or otherwise disturbed without the approval of the Engineer.
3. Notify the Resident Engineer promptly if damaged or deteriorated wiring is discovered.
4. Where existing de-energized medium voltage cables are to be energized, or where existing medium voltage cables are to be modified, the cable shall be tested per existing cable requirements in "Field Quality Control" article.

3.07 FIELD QUALITY CONTROL

- A. Coordinate installation and final testing with Port Resident Engineer. Notify the Resident Engineer at least 48 hours in advance of testing. Provide the Resident Engineer the opportunity to witness all tests. Submit test results to the Resident Engineer within 36 hours of the test.

- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections. Test and inspections shall be performed for all shielded medium voltage cable installed or modified by this project.
- C. Perform the following tests and inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
 - a. If desired, cables may be tested prior to termination. However, such tests shall not replace the need to fully test the cable assembly after termination. Test voltages used prior to termination shall not exceed the manufacturer's recommended limits.
 3. Perform visual and mechanical inspection in accordance with NETA ATS 7.3.3.1 and at each end of cable and at any exposed transitional area.
 4. Perform "tug-test" at all splice locations. With cable de-energized, pull on cable sections on either side of splice to ensure termination is correctly bolted inside the splice cover.
 5. Perform VLF Withstand and VLF Tan-Delta test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.
 - a. VLF test shall be performed per IEEE 400.2.
 6. Perform electrical tests per NETA 7.3.3.2 and the following:
 - a. For all tests where voltage is applied, after the test set is removed, attach a shorting or drain device for the same duration that the voltage was applied in order to bleed off charge.
 7. Perform a Shield Continuity Test, NETA ATS 7.3.3.2.1 on each power cable.
 - a. Jumper the conductor to the shield drawing at the far end of the cable.
 - b. At the near end, measure the resistance of the shield drain to the conductor.
 - c. Deduct the conductor direct current resistance per NEC Table 8 if desired.
 - d. Shielding shall exhibit continuity of less than 10 ohms per 1000 feet of cable.
 - e. At the far end, remove the conductor to shield drain jumper.
 8. Where applicable, perform a Bolted Resistance Test on each power cable per NETA ATS 7.3.3.2.1.
 9. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
 10. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
 11. Tests shall be performed on terminated, unlanded cables only.
 12. Each end of the cable to be tested shall have had the solid termination, separable connector, or designed fitting permanently installed.
 13. Neither end of the cable to be tested shall be connected to any equipment except as required for performing the test.
 - a. For cables having terminations with built-in surge protection devices or similar, the protective devices shall be removed during testing to prevent damage.
 - b. Placing a plastic bag over a cable termination during testing to reduce corona is a standard testing practice.

14. Thermographic surveys of bolted connections are to be performed with cables energized and loaded. Where test conditions cannot be achieved, obtain Resident Engineer approval for deviation.
- D. Required calibrated test equipment includes an Ohmmeter, an Insulation Resistance Tester (Megger), Low-Resistance Meter, and thermographic imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C. Other needed equipment includes a tape measure, ambient thermometer, and ambient humidity indicator.
- E. Medium-voltage cables will be considered defective if they do not pass tests and inspections.
 1. Correct deficiencies and retest to demonstrate compliance.
 2. Prepare test and inspection reports. Complete one of the attached data sheets for each cable inspected or use an equivalent data sheet from a recognized testing authority.
- F. Provide completed High Potential test report and Terminations checklist.
- G. Where new cable is being connected to existing cable, perform the following tests:
 1. Perform insulation resistance test on new cable on reel.
 2. Perform VLF withstand and tan-delta test on existing cable where work is going to be done before beginning any work on existing cable.
 3. Perform VLF withstand and tan-delta test on cable after cable is pulled but prior to connection to existing cable.
 4. Perform VLF withstand and tan-delta test and insulation resistance tests on existing and new cable together at a voltage not to exceed the rating of the load break or the cable manufacturer's suggested voltage, whichever is lower.
 5. Perform final termination of cable to load.
 6. Do not exceed the operating voltage when testing existing cables and terminations.
 7. Perform the tan-delta test for a minimum of 30 minutes.
 8. Perform the withstand test for a minimum of 30 minutes.
 9. Use sinusoidal waveform for testing.

3.08 AUDIO VIDEO RECORDING

- A. Contractor Support: The Contractor shall support the audio-video recording of the cable pulling installation. The Port will conduct the recording or hire a third party contractor under a separate contract. The Contractor support required includes:
 1. Providing 120V power for the recording equipment.
 2. Incorporate the recording equipment and technician to operate the equipment into the space planning requirements at the feeding and pulling locations.
 3. Cooperating with the Recording Technician regarding camera angles and supplemental lighting.

END OF SECTION 260513

Except as noted below:

260513a - Medium Voltage Cable Test Report

260513b- Medium Voltage Cable Terminations Checklist