

Metropolitan Washington Airports Authority
PROCUREMENT AND CONTRACTS DEPT.
AMENDMENT OF SOLICITATION

Metropolitan Washington Airports Authority Procurement and Contracts Dept., MA-29 2733 Crystal Drive Arlington, VA 22202	1A. AMENDMENT OF SOLICITATION NO. IFB-19-13327	1B. DATED June 27, 2019
	2A. AMENDMENT NO. Two (0002)	2B. EFFECTIVE DATE August 5, 2019

The solicitation identified in Block 1A is amended as set forth in Block 3. Hour and date specified for receipt of offers is extended, is not extended. Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) by completing Block 4 and returning copy of the amendment; (b) by acknowledging receipt of this amendment on the Solicitation Offer and Award Sheet, Block 13. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER.

3. DESCRIPTION OF AMENDMENT

The Metropolitan Washington Airports Authority Solicitation IFB-19-13327, entitled "5kV South Distribution Center Relocation and Replacement Project at Ronald Reagan Washington National Airport" is amended as follows:

1. Section X, Attachment 01, Specifications, **Table of Contents** is revised with the attached Table of Contents dated July 26, 2019.
2. Section X, Attachment 01, Specifications, **Section 007300 - Supplementary Conditions** is revised with the attached Section 007300 dated July 26, 2019.
3. Section X, Attachment 01, Specifications, **Section 260513 – Medium-Voltage Cables** is revised with the attached Section 260513 dated July 26, 2019.
4. Section X, Attachment 01, Specifications, **Section 260543 - Underground Ducts and Raceways for Electrical Systems** is revised with the attached Section 260543 dated July 26, 2019.
5. Section X, Attachment 01, Specifications, **Section 260591 – Integrated Power Assembly – 5KV Switchgear** is revised with the attached Section 260591 dated July 26, 2019.
6. Section X, Attachment 01, Specifications, **Section 261301 – Medium Voltage Metal-Clad Switchgear** is revised with the attached Section 261301 dated July 26, 2019.
7. Section X, Attachment 01, Specifications, **Section 262416 – Panelboards** is provided for incorporation into Section X, Attachment 01, Specifications, Section 262416 dated July 26, 2019.
8. Section X, Attachment 02, Drawings, Replace Drawings **EL00.02, EL00.03, EL00.04, EL02.03, EL04.01, EL05.01 and EL06.01** with the attached Drawings. The drawings were revised to clarify references to specifications and drawings based upon the questions received.
9. Deadline for bid submission is unchanged and remains 2:00 P.M. August 15, 2019.

All other terms and conditions of the solicitation remain unchanged.

Except as provided herein, all terms and conditions of the document referenced in Block 1A, as heretofore changed, remain unchanged and in full force and effect.

4A. NAME AND TITLE OF OFFEROR	4B. SIGNATURE	4C. DATE

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SECTION 007300 — SUPPLEMENTARY CONDITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Provisions, Special Provisions, and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. The articles and paragraphs of this Section represent supplements or additions to the Contract Provisions or the Special Provisions. The requirements of this section are the sole responsibility of the contractor. No additional payment will be made to the contractor to fulfill these requirements.

1.3 WORK UNDER OTHER CONTRACTS

- A. During the period of this Project, the Authority anticipates that no other construction contracts will be underway at or near the site of work of this Contract.

1.4 PERMITTING

- A. Comply with all requirements set forth in the latest edition of the Authority's "Building Codes Manual". This manual describes Building Codes organization, Building Code inspection process, Construction permitting process, Certificate of Occupancy requirements, and information regarding elevators, escalators, and moving walks. The Authority will file for and provide the construction permit.

1.5 MAINTENANCE OF PEDESTRIAN AND VEHICULAR TRAFFIC

- A. Maintain adequate pedestrian and vehicular traffic flow and safety along the service roads, sidewalks, parking lots and other roadways on Airport property. In addition, this requirement applies to crossroads, approaches, and entrances affected by or made necessary by the Work. Coordinate activities throughout the project in a manner that allows emergency access, without delays to emergency response vehicles, to all areas of the Project that are occupied by employees.
- B. Prior to starting construction operations affecting pedestrian, vehicular, or aircraft traffic movement, submit and obtain the COTR's written approval of a Traffic Maintenance Plan. Develop plan in accordance with the safety requirements of the FAA, Airport Operations, and the Commonwealth of Virginia Department of Transportation's "Manual of Uniform Traffic Control Devices". Utilize the form indicated in the latest edition of the Virginia Department of Transportation's "Virginia Work Area Protection Manual – Standards and Guidelines".

- C. Provide and maintain temporary signage, "Jersey barriers," and such other traffic control devices or personnel as required complying with approved Traffic Maintenance Plan.
- D. Maintain the construction operations affecting pedestrian, vehicular, or aircraft traffic movement from the beginning of construction operations until final acceptance of the project. The maintenance shall constitute continuous and effective work prosecuted day by day with adequate equipment and forces to the end of project to ensure that roadways and structures are maintained in satisfactory condition at all times, including barricades and warning signs as necessary for performance of the work.
- E. Keep the portions of the project being used by public, pedestrian, aircraft, and vehicular traffic, whether it is through or local traffic, in such condition that traffic will be adequately accommodated. Remove snow and control all ice within the project boundaries. Removal of snow and ice for the benefit of the traveling public will be performed by the Authority. Bear all cost of maintenance work during construction and before the project receives a Certificate of Occupancy for constructing and maintaining approaches, crossings, intersections and other features as may be necessary.
- F. Keep the portions of the road and aircraft pavement surfaces being used by the public free from irregularities, obstructions, mud, dirt, snow, ice, and any characteristic that might present a hazard or annoyance to traffic in such condition that traffic will be adequately accommodated. Maintain a vacuum/sweeper and flusher truck at the site at all times to clean roadway and aircraft surfaces affected by construction traffic at the request of Airport Operations or the COTR.

1.6 NOT USED

1.7 ENVIRONMENTAL PROTECTION

- A. Comply with all Federal, state and local laws and regulations controlling pollution of the environment. Take necessary precautions to prevent pollution of streams, rivers, lakes, ponds, and reservoirs with fuel, oils, bitumens, chemicals, or other harmful materials and to prevent pollution of the atmosphere from particulate and gaseous matter.
- B. Notify COTR immediately in the event that abnormalities, discolorations, odors, oil or other signs of potential contamination by hazardous materials are encountered during construction activities. Follow with written notice within 24 hours, indicating date, time, and location of potential contaminants encountered. The COTR will provide further direction to Contractor regarding disposition of materials encountered.
- C. Petroleum contaminated soils and water may be encountered during the construction of this project. Petroleum impacted soils range from saturated to 1.0 ppm. Petroleum impacted water ranges from free product to "non-detect." Maintain the necessary health and safety requirements for all personnel in accordance with OSHA regulations.
- D. Do not use petroleum-contaminated soils as backfill around new piping or utilities. Transport petroleum contaminated soils to a location identified by the COTR. Place the contaminated soils on two layers of reinforced 6 mil plastic sheeting, install and maintain sediment and erosion controls, and adequately cover the stockpile to prevent water infiltration.

- E. De-watering manholes and water runoff during excavation shall be as specified under “Erosion and Sediment Control Notes” shown on the drawings.

1.8 DAMAGES AND PRE-EXISTING CONDITIONS

- A. Be responsible for all damages caused by Contractor’s construction activities. Provide all labor, materials, etc. to return any damaged areas, systems or equipment to their original condition at no additional cost to the Authority.
- B. Perform a survey of pre-existing conditions in the vicinity of Contractor’s construction activities, utilizing photographs and other means as necessary to document existing damage or conditions. Submit two copies of this survey to the Contracting Officer within 21 calendar days after Notice-to-Proceed. This survey will assist in resolving any damage claims against the Contractor during and after construction.
- C. Preserve all roadways, pedestrian and directional signage. Deliver all signs removed and not required for reinstallation to the Authority as directed by the COTR.
- D. Replace or repair lost or damaged signs at no cost to the Authority.

1.9 SECURITY DURING CONSTRUCTION

- A. Maintain the integrity of the Airport Security fence. Maintain the integrity of doors and walls between public areas and Air Operations Area (AOA) at all times. Comply with “Airport Order and Instructions attached as part of the Contract, as amended, any issued Airport Security Bulletins, and Title 49 Code of Federal Regulations, Parts 1500, 1540, 1542 and 1544.
- B. NOT USED
- C. NOT USED
- D. Establish and maintain the security of Contractor’s staging areas, equipment and materials.
- E. NOT USED
- F. Do not park within 300 feet of a terminal building unless specifically authorized by Airport Operations.
- G. No firearms or weapons of any type are allowed on the airport.
- H. No cartridge style nail guns, nor any tools that use a cartridge or any explosive charge, are allowed without prior written approval of the COTR and the Airport Security Coordinator. Obtain the written approval from the COTR before bringing such tools on the project.
- I. NOT USED

1.10 MATERIAL HAULING

- A. Access and egress to and from the Airport for hauling operations requiring access to the project site shall be as shown on drawings. Conduct hauling operations during hours indicated in the plans.
- B. The designated haul routes for hauling operations will not require vehicles utilizing existing taxi lanes or taxiways. Under no conditions shall the Contractor plan use of taxiways and taxi lanes for hauling equipment. Haul routes for this project are as indicated in the plans.
- C. Include all work associated with establishing, maintaining, signing, lighting and marking haul routes and taxiway crossings.
- D. Use load covers on all dump trucks. Load dump trucks so that no spillage occurs during transit on the State, municipal, or Airport roadways, taxiways, and aprons. Clean wheels of trucks leaving the Project construction site of all soil and rocks. Provide a truck washing rack on the Project site to minimize the tracking of soil onto paved surfaces.
- E. Be responsible for the cost of the immediate cleaning of earth tracking and spills on paved surfaces resulting from the Contractor's operations.
- F. NOT USED

1.11 PORTABLE LIGHTING

- A. Portable lighting: If used for Contractor operations, aim and shield portable lighting at all times to eliminate glare that could impair runway, taxiway, apron, ground operations, and Airport Traffic Control Tower operations. Equip portable lighting with reflectors and glare shields to prevent spillover of light into operational areas.

1.12 RADIO COMMUNICATIONS

- A. Cellular telephones are an acceptable alternative for two-way radio communications at Ronald Reagan Washington National Airport.

1.13 SAFETY

- A. Comply with all requirements set forth in MWAA Construction Safety Manual, Revision 18, dated June 11, 2019 except as modified in the following 1.13 paragraphs.
- B. Construction Safety Manual Chapter 2, paragraph 2.0.: Delete Contractor's Safety Manager (CSM) and Contractor's Industrial Hygienist (CIH).
- C. Construction Safety Manual Chapter 2, paragraph 2.0.: Replace Contractor Safety Manager with Contractor Safety Engineer.
- D. Construction Safety Manual Chapter 2, paragraph 2.1.: Replace Contractor Safety Manager with Contractor Safety Engineer. Delete references to Certified Industrial Hygienist (CIH).
- E. Construction Safety Manual Chapter 2, paragraph 2.1.2.: Delete paragraph.

- F. Construction Safety Manual Chapter 2, paragraph 2.1.5.: Delete paragraph.
- G. Construction Safety Manual Chapter 2, paragraph 2.2.: Replace Contractor Safety Manager with Contractor Safety Engineer.
- H. Construction Safety Manual Chapter 2, paragraph 2.3.: Replace Contractor Safety Manager with Contractor Safety Engineer.
- I. Construction Safety Manual Chapter 2, paragraph 2.5.: Replace Contractor Safety Manager with Contractor Safety Engineer

1.14 HEIGHT LIMITATION

- A. For all demolition and construction within the Airport, limit the height of Contractor's equipment to a maximum of 20 feet.
- B. Prior to beginning any work coordinate with the COTR the height of all cranes, boom trucks, scaffolds or similar vehicles of construction. Properly mark all construction equipment with safety flags and warning lights in accordance with current FAA and Airport Operations requirements. Submit FAA Form 7460, provided by COTR, for all variations on approved crane heights.

1.15 NOISE CONTROL

- A. The Authority recognizes and can tolerate a normal level of noise created by a majority of construction activity. However, in the interest of the Authority's neighbors, the maximum acceptable noise level between the hours of 5:00 pm and 7:00 am the following morning is limited to 55 decibels. During daytime hours of 7:00 am through 5:00 pm, the maximum acceptable noise level for sustained or repetitive noises is 72 decibels. Measure the noise level using an "A" scale at a point 4'-0" above ground at property line nearest noise source.
- B. Secure advance written approval from the COTR prior to scheduling any activity that is anticipated to produce a sustained or repetitive noise level higher than the decibel limits indicated above.
- C. NOT USED

1.16 EXAMINATION OF PLANS, SPECIFICATIONS AND SITE OF WORK

- A. The offeror is expected to examine carefully the site of the proposed work, the proposal, plans, specifications, solicitation provisions, contract provisions, special provisions and contract forms before submitting a proposal. The submission of a proposal will be considered conclusive evidence that the offeror has made such examination and is satisfied as to the conditions to be encountered in performing the work as to the requirements of the Contract.

1.17 NOT USED

1.18 EQUIPMENT SUBMITTAL AND RELIVERY REQUIREMENTS

A. Equipment shop Drawing Submittals: Contractor shall provide submittals of the major equipment within the specified time period after the Notice to Proceed as follows:

- | | | |
|----|---------------------------------------|---------|
| 1. | 4.16kV Metal-Clad Switchgear | 8 Weeks |
| 2. | 4.16kV -208/120V Dry Type Transformer | 6 Weeks |
| 3. | Integrated Power Assembly | 8 Weeks |

B. Shop Drawing Review: MWAA will perform shop drawing review and approval in the presence of the Contractor and Manufacturer's representative within three weeks after receipt of the shop drawings from the Contractor. The on-board review(s) will be conducted at the MWAA facility at Ronald Reagan Washington National Airport.

C. Equipment Delivery: Equipment shall be delivered within the specified time period after approval of the shop drawings as follows:

- | | | |
|----|---|----------|
| 1. | 4.16kV Metal-Clad Switchgear housed in an Integrated Power Assembly | 16 Weeks |
| 2. | 4.16kV - 208/120V Dry Type Transformer | 16 Weeks |

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 007300

SECTION 260513 – MEDIUM - VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes single conductor cables and splices, terminations, and accessories for electrical distribution systems nominally rated 5 KV.

1.3 SUBMITTALS

- A. Product data on cables and cable accessories including descriptions and detailed specifications.
- B. Shop drawings of splices and terminations.
- C. Product certificate signed by manufacturer that its products comply with the specified requirements.
- D. Installer certificates signed by manufacturer of cable splicing and terminating products that Installers comply with training requirements specified under "Quality Assurance."
- E. Installer certificates signed by Contractor certifying that the Installers of cable splices and terminations meet the experience qualifications specified under "Quality Assurance."
- F. Product Test Reports: Certified reports of manufacturers' factory production and final tests indicating compliance of cable and accessories with referenced standards and this specification.
- G. Report of Field Tests: Certified copies of field test records.
- H. Maintenance data for cables and accessories for inclusion in Operation and Maintenance manual specified in Division 01."

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer of medium-voltage electrical cable to perform the installation specified in this Section. Engage Installers who are experienced in cable splices and terminations for the specific types of cable and cable accessories specified in this Section. All persons engaged in preparing, splicing or terminating medium voltage cable shall be qualified. All splicers/terminators shall be approved by the COTR or have a certificate from a school which teaches splicing and terminating of solid dielectric cable with the types of splices and

terminations specified below. At the option of the COTR the splicer/terminator may be required to prepare a representative sample splice and/or termination prior being permitted to make permanent connections on the project. Refer to Division 01 Section "References" for definition of experienced Installer.

- B. Field Testing Organization Qualifications: To qualify for acceptance, an independent testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.
- C. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- D. IEEE Compliance: Comply with applicable IEEE standards including C2 "National Electrical Safety Code."
- E. UL Compliance: Cables and components shall be listed and labeled by UL.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver medium-voltage cable on factory reels conforming to NEMA Standard WC 26, "Wire and Cable Packaging."
- B. Store cables on reels on elevated platforms or on a hard surface in a clean, dry location. Stand reels vertically so that weight is supported by flanges.
- C. Prevent impact damage by: aligning reels flange to flange, using guards across flanges when different reel sizes are stored together, maintain adequate aisles and barricades to prevent equipment from hitting the cable. Protect cable from liquid spills. Advise splicers, installers and handlers of special instructions.
- D. Seal the ends of all cable stored outdoors with heat-shrinkable cable end caps and reseal both ends when a length is cut from the reel.
- E. Cable Inspection: 1) check for shipping damage prior to accepting cable, 2) confirm cable specified was received, and 3) reseal cable ends.
- F. Handling: 1) remove nails and staples from reel flanges, 2) calculate and observe recommended bending radii, 3) use swivels and avoid overruns when unreeling.

1.6 WARRANTY

- A. Special Project Warranty: Submit a written warranty, mutually executed by manufacturer and the principal Installer, and agreeing to repair or replace medium-voltage cables, splices, and terminations that fail in materials or workmanship within the special project warranty period specified below. This warranty shall be in addition to, and not a limitation of, other rights and remedies the Authority may have against the Contractor under the Contract Documents.

- 1. Special Project Warranty Period: 30 years beginning on the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
1. Cable:
 - a. The Kerite Co.
 - b. The Okonite Co.
 - c. Prysmian Cable Corp.
 - d. Southwire
 2. Cable Splicing and Terminating Products and Accessories:
 - a. Cooper Power Systems
 - b. Electrical Products Division 3M
 - c. Elastimold
 - d. Raychem Corp.
 3. Compression Connectors:
 - a. AMP
 - b. 3M Company
 - c. Burndy
 - d. Thomas & Betts
 - e. Anderson Electrical Connectors
 4. Arc Proofing Products:
 - a. 3M products
 - b. Scotch

2.2 MEDIUM-VOLTAGE CABLE

- A. General: Cable shall be single-conductor type, 5kV, 133% insulation level. Cable shall conform to UL Standard 1072 Type MV-105, AEIC CS.8, ICEA S-93-639, and ASTM B-8.
- B. Cable shall be ethylene propylene rubber (EPR) insulated.
- C. Conductor: Uncoated soft, Class B, stranded compressed concentric round. Copper shall conform to ASTM B-8. Electrical resistance shall meet requirements of ICEA S-93-639.
- D. Conductor Shield: Extruded layer of semi-conducting thermosetting compound. The shield shall be clean stripping from the conductor and bonded to overlying insulation.
- E. Insulation: Shall be flexible thermosetting dielectric based on an ethylene propylene elastomer. The insulation shall limit degree of susceptibility to treeing experienced by crystalline materials.

Insulation thickness at any cross-section of insulation shall not be less than 90% of the following minimum average thickness: 5 KV - 115 mil.

- F. Insulation Shield: Clean stripping extruded semiconducting compound applied over insulation. Electrical and physical requirements conforming to ICEA S-93-639, AEIC CS.8 and UL 1072.
- G. Metallic Shielding Metallic Shielding Copper shielding tape, 5 mil in thickness helically applied over the semi - conducting insulation shield, with 12-1/2% overlap.
- H. Jacket: Shall be black, sunlight resistant polyvinylchloride with minimum average thickness of 80 mils. Minimum thickness shall not be less than 64 mils.
- I. Strand Filling: Conductor interstices are filled with impermeable compound.
- J. Operating Temperature: 105 °C continuous, 140 °C emergency, 250 °C short circuit.
- K. Production Tests: The cable shall be subjected to the following tests:
 - 1. Conductor shall meet resistance requirements of ICEA-S-93-639,
 - 2. Insulation resistance shall be tested in accordance with ICEA S-93-639 to be not less than 50,000 megohms - 1,000 feet,
 - 3. High voltage AC and DC test performed per ICEA S-93-639,
 - 4. Full reel corona test performed per AEIC CS.8 (x-y recording graph shall be furnished showing test results).

2.3 SPLICING AND TERMINATING PRODUCTS

- A. General: Comply with the following standards:
 - 1. IEEE 48: "Standard Test Procedures and Requirements For High Voltage Alternating Current Cable Terminations 2.5 KV Through 765 KV."
 - 2. IEEE 400: "Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems".
 - 3. IEEE 404: "Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V".
 - 4. IEEE 592: "Exposed Semi-conducting Shields on High Voltage Cable Joints and Separable Insulated Connectors."
 - 5. UL 486A-486B: "Wire Connectors and Soldering Lugs for Use with Copper Conductors."
 - 6. IEEE 386: "Separable Insulated Connector Systems for Power Distribution Systems above 600 V".
- B. Types: Compatible with the cable materials. All current carrying components shall be copper.
- C. Connectors/Lugs: Compression type, two hole, long barrel, seamless, tin plated copper, listed per UL486A-UL486B.
- D. Splicing and Terminating Kits: As recommended by the manufacturer in writing for the specific sizes, ratings, and configurations of cable conductor, splices, and terminations specified. Kits shall contain all components required for a complete splice or termination including detailed instructions

and shall be the product of a single manufacturer. Completed splices and terminations shall provide insulation equivalent to the insulation class of the cable it connects.

- E. Splices: Comply with IEEE 404; shall be made with standard splicing kits as recommended by cable or splicing kit manufacturer for the application. Splice kits shall contain all necessary components to reinstate primary cable insulation, metallic shielding and grounding systems and overall jacket to the equivalent of the cable itself. The splice shall provide a permanent, fully-shielded, fully submersible cable joint with a continuous current rating equal to the rating of the cable used. Voltage rating of separable splice shall be 5KV for use on 5 KV systems. The splice kit shall be one of the following types:
1. Heat shrink splice kit of uniform cross-section polymeric construction with outer heat shrink jacket.
 2. Pre-molded, cold shrink rubber, in-line splice kit.
 3. Separable multiway insulated splice system, 900 amp, with capacitive test point on molded T-body and with all components for the required splice configuration. Voltage rating of separable splice shall be 5KV for use on 5 KV systems. All current carrying and mating components shall be copper.
- F. Dead break Junctions: Dead break junctions shall have four 900A dead break interfaces bused together with copper bus and encapsulated in a precision molded peroxide cured EPDM insulated rubber body with a semiconductive outer shield. Junctions shall meet the requirements of ANSI/IEEE 386, and be equipped with stainless steel mounted bracket with 2 parking stands. When mated with a compatible product, the junction shall provide a completely shielded, submersible threaded connection. Unused interfaces shall be covered with insulated protective caps of the same manufacturer as the junctions. All current carrying and mating components shall be copper.
- G. Shielded-Cable Terminations: Comply with Class 1, IEEE Standard 48. Insulation class shall be equivalent to that of the cable upon which they are installed. Terminations for shielded cables shall include a shield grounding strap. Include an effective moisture seal for the end of the insulation whether or not this item is included in termination kits. Seal shall be silicone rubber tape, cold shrink rubber sleeve, or heat shrink plastic sleeve as recommended by the kit manufacturer. Termination kits shall be performance tested for compliance with IEEE Standard 48 and shall be of the following types:
1. Class 1 Termination for Shielded Cable: Modular type, furnished as a kit, with stress relief tube, multiple molded silicone rubber insulator modules, shield ground strap, and compression type connector.
 2. Class 1 Termination for Shielded Cable: Heat shrinkable type with heat shrinkable inner stress control and outer non-tracking tubes, multiple molded non-tracking skirt modules, and compression type connector.
 3. Separable insulated elbow connectors: Modular system, complying with IEEE Standard 386. System shall consist of disconnecting, 900A, 3 phase rated, single pole, cable terminators and matching stationary, plug-in, dead front terminals. System components shall be designed for the system voltage and for sealing against moisture. Elbows shall include voltage test points on molded connector body. Voltage rating of separable elbow connectors shall be 5 KV. All current carrying and mating components of the separable connector shall be copper.

- H. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.
- I. Tool Set: Provide shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.4 PROTECTIVE CABLE END CAPS

- A. Protect MV cables from water penetration on job site, before, during and after cable pulling. Seal cable ends with heat-shrinkable end cap. This cap shall remain in place until the actual time of termination. Sealing compounds and/or taping shall not constitute acceptable environmental protection. End sealing caps shall be as produced by Raychem Corporation, Type ESC, or approved equal.

2.5 ARC-PROOFING MATERIALS

- A. Arc-proofing tape shall consist of a UL-listed fire proofing tape. Tape shall be flexible, conformable, intumescent to 0.3-inches thick, and compatible with the cable jacket on which used. Tape shall be self-extinguishing and shall not support combustion.
- B. Glass cloth tape shall be pressure-sensitive adhesive type, 1-inch wide.

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to ICEA S-97-682 before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine raceways, cable trays, pull boxes, manholes, junction boxes, and other cable installation locations for cleanliness of raceways, minimum bending radii of cables, and conditions affecting performance of cable. Pull a mandrel of not less than 80% of the diameter of the inside of the duct and a bristle brush through raceways to check for suitable conditions. Do not proceed with cable installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Install cable accessory items in accordance with manufacturer's written instructions and as indicated.
- B. Notification: Notify COTR 24 hours prior to commencement of all cable pulls.

- C. Medium voltage cables shall be installed without any splices between terminations at equipment on both ends, except as indicated on the Contract Drawings.

3.3 INSTALLATION OF CABLES

- A. Pull conductors simultaneously where more than one cable is indicated in same raceway. Use UL listed and manufacturer approved pulling compound or lubricant where necessary. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values. Use dynamometer, capstan and two way communication to ensure this. Pulling shall not exceed 25 feet per minute. Never pull on middle of cable. Seal cable ends while pulling.
- B. Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceways. Do not use rope hitches for pulling attachment to cable.
- C. Do not install cable if ambient temperature is below -31°F. During cold weather installation, cable shall be pulled more slowly and trained in place the same day it is removed from storage. Do not impact, drop, kick or bend cable sharply in low temperatures.
- D. Feed cable into conduit using a guide tube or a conveyor sheave assembly. Use single sheaves for guiding cable only. Do not exceed bend radii while pulling over a sheave. Set up cable reels so that cable comes off reel with its natural curvature. Do no reverse bend cable.
- E. Install exposed cable parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- F. Bending Radii - Maintain 12X overall diameter or greater.
- G. Train cable to avoid dragging on edge of raceway.
- H. If using a basket grip, secure it in place with steel stripping and cut well behind the area it covers once the cable is in place.
- I. In manholes, handholes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag. However, redundant circuits shall be racked on opposite sides of the manhole or vault. Cables shall be secured with heavy duty cable ties to the cable rack arms. Provide additional cable racks where required.

3.4 INSTALLATION OF SPLICES AND TERMINATIONS

- A. Install splices at pull points and elsewhere using a standard kit. Conform to kit manufacturer's written instructions.
- B. Install terminations at ends of conductors using standard kits. Conform to manufacturer's written instructions. Comply with classes of terminations indicated.
- C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A-486B.

- D. When splicing and terminating medium voltage cable:
1. Keep cable and work area clean and dry.
 2. Do not cut insulation.
 3. Completely remove semi-conducting insulation shield, but do not lift it at cut-off point.
 4. Keep non-shielded conductors away from ground and other phase conductors.
 5. Ensure cable bends are smooth.
 6. Use skirted terminators outdoors or in contaminated areas.
 7. Use minimum amount of cleaning solvent.

3.5 INSTALLATION OF CABLE ACCESSORIES

- A. Arc-Proofing: Arc-proof medium-voltage cables individually in manholes and handholes. Apply as recommended by the manufacturer of the arc-proofing tape and the following:
1. Clean cable sheath.
 2. Apply arc-proofing tape in one half-lapped layer with the coated side toward the cable.
 3. Band the first and last applied wrap of the arc-proofing tape with two layers of 1-inch wide half-lapped, adhesive coated glass-cloth electrical tape.

3.6 GROUNDING

- A. 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 in accordance with manufacturer's written instructions. Use minimum of No. 4 AWG copper conductor and compression lugs.

3.7 IDENTIFICATION

- A. Identify cable in accordance with Division 26 Section "Identification for Electrical Systems." Identify voltage, feeder number and phase letter on each cable at each splice, termination and junction. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

PART 4 - CONTRACTOR QUALITY CONTROL

4.1 FIELD QUALITY CONTROL

- A. General: Comply with applicable standards of The InterNational Electrical Testing Association (NETA) including Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems."
- B. Preparation: Perform the following preparations in advance of independent tests:
1. Test cables' insulation resistance.
 2. Test circuits' continuity.

3. Furnish a set of Contract Documents and manufacturer's recommendations to test organization.
 4. Make power available at test locations.
- C. Schedule tests and notify COTR at least two weeks in advance of schedule for test commencement.
- D. Test procedure:
1. Independent Testing Organization: Arrange and pay for the services of an independent electrical testing organization in accordance with the requirements of Division 01 Section "Quality Requirements" to perform tests on medium-voltage cable. The testing firm shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems. The testing firm shall have at least five years of experience in the testing of electrical equipment of the type, rating, and voltage used on this Project. The testing firm shall be a current full-member company of the International Electrical Testing Association (<http://www.neta.org/>). This independent testing firm shall perform duties as required under the terms of this Contract.
 2. Test Objectives: To assure cable installation is operational within industry and manufacturer's tolerances, is installed in accordance with Contract Documents, and is suitable for energizing.
 3. Procedures: Comply with the INETA standard and IEEE 400. Upon satisfactory completion of tests, attach a label to tested components.
- E. Correct deficiencies and retest to demonstrate compliance.
- F. Reports: The testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit certified written reports to the COTR and Contractor, to include the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.
 4. Calibration records for the test instruments, meters and auxiliary equipment.

END OF SECTION 260513

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for concrete-encased duct banks.
 - 2. Manholes, handholes and boxes.

1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including end bells, bends, fittings, and solvent cement.
 - 3. Accessories for manholes, handholes, boxes, and other utility structures.
 - 4. Underground-line warning tape.
- B. Shop Drawings for Precast or Factory-Fabricated Manholes and other Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.
 - 3. Frame and cover design.
 - 4. Grounding details

1.5 INFORMATIONAL SUBMITTALS

- A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 2. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.
- C. Source quality-control test reports.
- D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: See section 011000 "Utility Outages" for requirements.

1.9 COORDINATION

- A. Coordinate layout and installation of ducts with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and as approved by COTR.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Listing and Labeling: Conduit and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- C. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. Cantex, Inc.
 - 4. CertainTeed Corp.; Pipe & Plastics Group.
 - 5. Condux International, Inc.
 - 6. ElecSys, Inc.
 - 7. Electri-Flex Company.
 - 8. IPEX Inc.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT; a division of Cable Design Technologies.
 - 11. Spiraduct/AFC Cable Systems, Inc.
- B. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Christy Concrete products.
 - 2. Oldcastle Precast Group
 - 3. Utility Concrete Products, LLC.
- B. Comply with ASTM C858 for design and manufacturing processes.
- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover securing bolts.
2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Select to suit system.
 - a. Legend: "MWAA ELECTRIC" for duct systems with power wires and cables for systems operating at 600V and less.
 - b. Legend: "MWAA COM" for communications, data and telephone duct systems.
4. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus and additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
5. Duct entrances in Handhole Walls: Cast end-bell or duct terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
6. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable rack and pulling-in irons installed before concrete is poured.

2.4 PRECAST CONCRETE MANHOLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Carder Concrete Products.
 2. Christy Concrete Products.
 3. Elmhurst-Chicago Stone Co.
 4. Oldcastle Precast Group.
 5. Riverton Concrete Products; a division of Cretex Companies, Inc.
 6. Utility Concrete Products, LLC.
 7. Utility Vault Co.
 8. Wausau Tile, Inc.
- B. Comply with ASTM C 858 and with interlocking mating sections, complete with accessories, hardware, and features:
 1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

- a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
- C. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.
- D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- E. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weather proof gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter 36 inches.
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 2. Cover Legend: Cast In. Select to suit system.
 - a. Legend: "MWAA ELECTRIC" for duct systems with power wires and cables for systems operating at 600V and less.
 - b. Legend: "MWAA COM" for communications, data, and telephone duct systems.
 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.

2.5 UTILITY STRUCTURE ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. McKinley Iron Works, Inc.
 2. Neenah Foundry Company.
 3. Underground Devices, Inc.
 4. American Polywater Corporation
- B. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- C. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch diameter eye, and 1-by-4-inch bolt
1. Working Load Embedded in 5000-psi Concrete: 13,000-lbf minimum tension.
- D. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- E. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: 316 stainless steel inserts indicated on the drawings.
1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- F. Expansion Anchors for Installation after Concrete is cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- G. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment.
 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.
- H. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 200 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- I. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Two required.

2.6 ELECTRICAL IDENTIFICATION PRODUCTS

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

1. Seton Name Plate Co.
 2. W.H. Brady, Co.
 3. 3M Company
- B. Underground-line Warning Tape: Provide Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility/feeder, compounded for direct-burial service. Overall thickness of 5 mils, foil core thickness 0.35 mil and weight of 28 lb/1000 sq. ft.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Underground ducts for Electrical Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Hand holes and Boxes, Including Telephone, Communications, and Data Wiring:
1. Units Located in Roadways and Other Deliberate Traffic Paths: Precast concrete. H-20 structural load rating according to AASHTO HB 17.
- B. Manholes: Precast concrete.
1. Units Located in Roadways and Other Deliberate Traffic Paths: H-20 structural load rating according to AASHTO HB 17.

3.3 EARTHWORK

- A. Excavation and Backfill: Comply with Section 310100 "Earthwork," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Sections 310100, 321216 and 321313.

3.4 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Manholes and Handholes:
 - 1. Core drill existing manholes to accommodate conduit entry into manhole.
 - 2. Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 3. Grout conduit into structure walls from both sides to provide watertight entrances.
- E. Sealing: Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- F. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares.
- G. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using non-magnetic tie wires.
 - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
 - 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks. Arrange reinforcing rods and ties as shown on the drawings
 5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 6. Minimum Space between Ducts: as shown on drawings
 7. Depth: Install top of duct bank at least 36 inches below finished grade.
 8. Warning Tape: Install detectable warning tape directly above all concrete-encased ducts and duct banks, 12 inches below finished grade. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of ductbank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.
- H. Separation between Utilities: Provide a radial separation of 12 inches minimum between electrical ductbanks or conduits and all other utilities or structures, except for water and sewer lines, unless otherwise indicated on drawings. For water or sewer lines, provide 18 inches vertical separation and 24 inches horizontal separation from electrical, unless otherwise indicated on drawings. Stacking of utilities shall not be permitted.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Precast Concrete Handhole and Manhole Installation:
1. Comply with ASTM C 891, unless otherwise indicated.
 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
 2. Manhole Frame: In paved areas and traffic ways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
 3. Install handholes with bottom below the frost line below grade.
 4. Handhole Covers: In paved areas and traffic ways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
 5. Where indicated, cast handhole cover frame integrally with handhole structure.
- C. Manhole Access: Circular opening in manhole roof; sized to match cover size.
1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- D. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

- E. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- F. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 INSTALLATION OF MANHOLE ACCESSORIES

- A. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, as required for installation and support of cables and conductors.
- B. Field-Installed Bolting Anchors in Manholes: Do not drill deeper than 3-7/8 inches for manholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems.

3.8 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove all foreign material.

PART 4 - CONTRACTOR QUALITY CONTROL

4.1 FIELD QUALITY CONTROL

- A. General: Comply with applicable standards of The InterNational Electrical Testing Association (NETA) including Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems."
- B. Schedule tests and notify COTR at least two weeks in advance of schedule for test commencement.
- C. Test Instruments, Meters, and Auxiliary Equipment: Tested and calibrated within 6 months of use on this contract and provided by Contractor, independent testing companies and by manufacturers' field service personnel where required.
- D. Test procedure:

1. Independent Testing Organization: Arrange and pay for the services of an independent testing organization in accordance with the requirements of Division 01 Section "Quality Requirements" to perform tests.
 2. Procedures: Comply with the INETA standard and NFPA 70.
- E. Perform the following tests and inspections and prepare test reports:
1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts.
 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 3. Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Correct deficiencies and retest as specified above to demonstrate compliance.
- G. Reports: The testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit certified written reports to the COTR and Contractor, to include the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.
 4. Calibration records for the test instruments, meters and auxiliary equipment.

END OF SECTION 260543

SECTION 26 05 91 - INTEGRATED POWER ASSEMBLY - 5KV SWITCHGEAR

PART 1 - GENERAL

1.1 SCOPE

- A. The specification covers requirements applicable to the provision of Integrated Power Assembly (IPA) for the 5kV metal-clad switchgear and associated interior mounted equipment. The IPA shall be environmentally controlled, and shall consist of a coordinated grouping of electrical power and control equipment as indicated on any accompanying data sheets, and/or specifications and drawings. Any data sheets, drawings, or any other related documents accompanying this specification shall be considered a part of this specification.
- B. The supplier shall furnish, install, interconnect and test the equipment and materials specified herein, as well as any equipment specified in any related documents.
- C. Site conditions shall be shown on the data sheet(s). These conditions shall be considered and design requirements shown in Specification Section 26 13 01, "Medium Voltage Switchgear", when sizing and designing equipment and structures.

1.2 REFERENCES

- A. All materials, equipment and labor supplied by the supplier shall be in strict compliance with the statutes, codes and standards listed herein. Where conflicts exist between statutes, codes and standards, the more stringent requirement shall prevail. Applicable statutes, codes and standards are as listed below:
 - 1. American Institute of Steel Construction (AISC)
 - 2. American National Standard Institute (ANSI)
 - 3. American Society of Testing and Materials (ASTM)
 - 4. American Welding Society (AWS)
 - a. AWS D1.1 Structural Welding Code – Steel
 - 5. National Fire Protection Association (NFPA)
 - 6. National Electric Code (NEC)
 - 7. National Electrical Manufacturers Association (NEMA)
 - 8. Underwriters' Laboratories (UL)
 - 9. International Building Code (IBC)
 - 10. State Modular Building Code Programs where applicable

1.3 SUBMITTALS – FOR REVIEW/APPROVAL

- A. Provide the following submittals:
 - 1. Any quality plans, forms, or procedures deemed necessary by the customer.
 - 2. Structural drawings including:
 - a. General notes.

- b. Building plan view.
 - c. Building base skid detail.
 - d. Building elevations.
 - e. Stairs and landings details.
 - f. Certified structural calculations.
3. Electrical drawings including:
- a. Electrical notes.
 - b. Building electrical plan, showing conduit, cable tray, subfloor wireway, and any other means of wiring transit. Drawings shall also include conduit fill.
 - c. Building services wiring diagrams.
 - d. Grounding system plan.
 - e. Interconnection wiring diagrams.

1.4 SUBMITTALS – FOR CONSTRUCTION

- A. The following information shall be submitted for record purposes:
1. Final as-built drawings and information for items listed in Paragraph 1.3 shall incorporate all changes made during the manufacturing process
 2. Wiring diagrams
 3. Certified structural calculations
 4. Installation information including equipment anchorage provisions
 5. Seismic certification as specified

1.5 QUALITY REQUIREMENTS

- A. The IPA shall be manufactured under an established autonomous quality assurance program. The supplier shall have a designated quality assurance (QA) manager.
1. The successful bidder shall be prepared to submit for customer approval, any and/or all quality plans, forms, and procedures applicable to the manufacturer of the IPA

1.6 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- C. Provide Seismic tested equipment as follows:
1. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest International Building Code (IBC).
 2. The Project Structural Engineer shall provide site specific ground motion criteria to establish the SDS values required for the equipment. The CONTRACTOR shall

- evaluate the SDS values published on the Manufacturer's website to ascertain that they are "equal to" or "greater than" those required for the Project Site.
3. The IP rating of the equipment shall be 1.5.
 4. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
 - a. The CONTRACTOR shall employ and pay for the services of a licensed Civil or Structural engineer in the Commonwealth of Virginia location to provide equipment anchorage details and calculations, coordinated with the equipment mounting provision locations provided by the MANUFACTURER. Mounting recommendations based upon those used in actual testing shall be provided by the MANUFACTURER to verify the seismic design of the equipment.
 - b. The equipment MANUFACTURER shall certify that the equipment can withstand (IP = 1) and function (IP = 1.5) following a seismic event, including both vertical and lateral required response spectra as specified in the above codes. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

PART 2 - PRODUCTS

2.1 INTEGRATED POWER ASSEMBLY (IPA)

- A. The IPA shall be designed and constructed for outdoor use, under wind and seismic load conditions per the IBC or Commonwealth of Virginia guidelines for the job site.
- B. The building and all components mounted thereon shall be designed for, and anchored sufficiently for, transportation to the job site.
- C. The skid shall be of concrete or of welded construction.
 1. Welded construction shall utilize ASTM-A36 minimum structural steel members, sized and arranged for proper strength, and able to withstand the stress and loads which will result when lifting the complete factory fabricated and equipped assemblies. Welding shall be in accordance with the requirements of AWS D1.1. All welding shall be performed by welders certified for the work being performed. Suppliers shall be prepared to show welders' certificates.
 - a. Deflection shall be L/240. The building shall be suitable for installation on a concrete pad or on piers.
 - b. The skid shall be equipped with two (2) stainless steel ground pads located at opposite corners of the skid with provisions for NEMA hole pattern lug.
 - c. The skid shall be provided with a minimum of 8 mils mastic undercoating.
- D. The floor shall be a minimum of 1/4-inch H.R. ASTM-A36 minimum smooth steel plate, welded to the perimeter and longitudinal and/or transverse structural members of the skid. The floor loading shall be no less than 250 PSF.
 1. The floor shall be provided with gasketed floor cutouts where required for power and control cable entry/exit from the equipment. The cutouts shall be provided with 12 gauge galvanized or painted cover plates.

- E. Building construction:
1. Building walls, roof and ceiling shall be fabricated from properly reinforced 5000-PSI lightweight concrete or G90 galvanized steel. Exterior walls, exterior roof and interior ceiling shall be self-framing, interlocking design, with maximum panel width of 16-inch, or framed construction with maximum panel width of 36-inch.
 2. Exterior walls shall be properly reinforced 5000-PSI lightweight concrete or minimum of 18-gauge thickness for self-framing and interlocking design, or 24-gauge thickness framed construction design, but rated to withstand the loading requirements of the job site.
 3. Interior walls shall be constructed of six-inch “ribbed” panel construction, bolted to adjoining walls, that is properly reinforced 5000-PSI lightweight concrete or minimum 18-gauge thickness for self-framing and interlocking design, or 22-gauge thickness framed construction design, but rated to withstand the loading requirements of the job site.
 4. Exterior roof shall be properly reinforced 5000-PSI lightweight concrete or minimum of 18-gauge thickness for self-framing and interlocking design, or 24-gauge thickness framed construction design, but rated to withstand the loading requirements of the job site. The roof shall be sloped away from the personnel doors, where feasible. Gutters and downspouts shall be provided when the roof slope is directly over personnel or rear access equipment doors.
 5. Interior ceiling shall be properly reinforced 5000-PSI lightweight concrete or minimum of 18-gauge thickness for self-framing and interlocking design, or 22-gauge thickness framed construction design, but rated to withstand the loading requirements of the job site.
- F. For a building which must be shipped in multiple shipping sections, miscellaneous NEMA 1 junction boxes will be provided at the shipping splits for easy breakdown of the building wiring for shipment and reconnection at the job site. Prior to shipment the open end/sides of each shipping section will be crated (weatherproofed) for transit to the job site. The crating must be performed by a company recognized and experienced in the trade which includes the IPA manufacturer.
- G. Where wall bulkhead penetrations are required, the cutouts shall be completely framed with 1/4” aluminum cover plates with neoprene gasket.
- H. All fastening hardware shall be zinc plated, stainless steel or aluminum. Welding of galvanized steel and rivets shall not be the primary method of exterior fastening. Rivets can be used for mounting non-load-bearing trim members.
- I. The building shall be provided with a minimum of two (2) entrance doors. The doors shall be double wall construction, with brushed aluminum panic hardware with cylinder lock and thumb latch, brushed aluminum automatic closure with built-in hold open device, prime coat or stainless steel hinges, threshold, weather-stripping, drip shields/water flashing, “DANGER, HIGH VOLTAGE, KEEP OUT” sign, and a 12-inch removable transom above the equipment door, when required. The personnel door shall be 36-inch x 84-inch. The equipment door shall be 48-inch x 84-inch.

1. The supplier shall provide landings and stairs for the building. The stairs shall be built in compliance with the UBC code, and shall be hot-dipped galvanized after fabrication.
- J. For equipment requiring rear access, the supplier shall provide 14-gauge minimum galvanized steel, gasketed and hinged equipment rear access doors, with 3-point latching system with galvanized pad lockable handles, "DANGER HIGH VOLTAGE" sign, and drip shields/water flashing.
- K. The walls, roof and floor shall be fully insulated. The walls and roof shall be provided with fiberglass batt type insulation, minimum R-11. The floor shall be provided with polyurethane spray foam insulation, minimum R-6.
- L. The building shall be provided with a paint system per the following:
 1. The skid shall be prepared to the appropriate SSPC standard (SSPC-1, SSPC-2, SSPC-3) for removal of rust and scale prior to painting. A 2-3 mil application of Zinc rich primer shall be provided.
 2. The floor shall be provided with a 2-3 mil application of "Red" epoxy iron oxide primer, followed by a 2-3 mil application of ANSI-61 gray epoxy, with a non-skid finish.
 3. The exterior and interior of the building shall be provided with a 0.3-0.6 mil application of a vinyl wash primer, followed by a 2-3 mil application of white epoxy paint.
- M. The building shall be provided with a HVAC system, sized and provided by the supplier, considering the ambient site conditions, the dimensions of the building, the solar heating of the building, and the heat generated by the equipment within the building. The system shall be designed such that the sensible cooling capacity, NOT the total cooling capacity, will maintain an ambient temperature within the building of between 55°F winter and 80°F summer at design conditions. The system shall be provided with an electronic, automatic changeover thermostat.
- N. The building shall be provided with AC panelboard, remote breaker control cabinet, communication interface cabinet, and power factor control cabinet, as shown on the drawings. Furnish and install all wiring for the associated equipment.
- O. Coordinate the power and control wiring areas for conduits with the IPA floor plan.
- P. Design the IPA and switchgear with appropriate shipping spits for transit and rigging to the site.
- Q. The supplier shall furnish all electrical distribution equipment necessary for the proper operation of building services within and without the building. The operating voltage of all distribution equipment shall be 120/208, three-phase.
- R. The building shall be provided with twin tube, rapid start, fluorescent lighting fixtures, controlled via three-way wall switches to be located at each entry door.
- S. The building shall be provided with 125 V, 20 A duplex receptacles at each entry door.

- T. The building shall be provided with LED exterior lights at each entry door, controlled via photocell and H-O-A switch.
- U. All wiring shall be type THWN, #12 AWG minimum for power circuits, minimum #14 AWG for control circuits. For all control interconnection wiring, both ends of the wire shall be provided with polyolefin sleeve type wire markers.
- V. EMT conduit shall be utilized for interior and exterior applications.
- W. Any cable-tray necessary shall be aluminum, 6-inch high with 9-inch rung spacing. All fittings shall have a minimum of 12-inch radius.
- X. 1/4-inch x 2-inch copper ground bar running the length of the building shall be provided, mounted approximately 6-inch above floor and connected to each end of the equipment ground bar. A #4/0 green insulated copper ground cable shall be provided from the ground bar to the exterior ground pads. A green insulated copper ground wire/cable will be provided from the ground bar to all auxiliary electrical equipment per NEC Table 250-95.

PART 3 - EXECUTION

3.1 TESTING AND INSPECTION

- A. The following testing and inspection shall be performed on the building:
 - 1. Perform continuity checks of all wiring installed by the supplier.
 - 2. Perform operational check of all supplier furnished and installed electrical apparatuses.
 - 3. Switchgear shipping sections' bus shall be re-spliced, torqued and resistance tested.
 - 4. A certified test report shall be provided by the supplier's Quality Assurance Manager.
- B. The switchgear shall be tested in the Field after installation per the manufacturer's instructions.
- C. The manufacturer shall perform startup and commissioning work at the site using their qualified Service Group. The Service Group shall have an office (non-home) within 50 miles of the site. The Service Group personnel shall be trained on the 33kV switchgear and relays used within the switchgear.

PART 4 - DATA SHEETS

4.1 Design Data-Service Conditions

- A. The following information must be included on the data sheets:
 - 1. Location: Country, State, City, & Seismic Zone
 - 2. External Environment: Industrial, Chemical, General Purpose, Hazardous, Class, Group, and Division
 - 3. Wind Load: 105 MPH Minimum
 - 4. Roof Load: As shown on the specifications

5. Maximum Building Size (see drawings:)): Ft. Deep, Ft. Long, Ft. High, Any Restrictions
6. Building Foundation: Slab, Piers
7. Cable Exiting from Building: Bottom, Upper Sidewalls for cable bus-cable by installing contractor

4.2 Electro/Center Design Options

A. The following information must be included on the data sheets:

1. Base: Galvanized Structural members, Galvanized Floor Plate
2. Exterior Walls & Roof: 14 ga Galvanized, roof slop ¼ inch per foot
3. Interior Ceiling: 14 ga Galvanized
4. Interior Walls: 14 ga Galvanized
5. Insulation: Walls and Ceiling – 3 ½ inch fiberglass R11
6. Doors: As shown on drawings
7. Cutout In Floor: Conduit Under Equipment for MV Enclosure, Cover plates – 12 ga Galvanized
8. Cutouts in Walls: Cover plates ¼ inch aluminum
9. Exterior Fasteners: Stainless Steel
10. Paint: Interior Walls, Roof, and Ceiling = 0.3 - 0.6 Mil Vinyl Washing Primer, Exterior to be decided by the City.
11. Climate Control: Electric heater only.
12. Building Services: From Internal Source 208Y/120V 60Hz.
13. AC Distribution Panel: Ac Distribution Panel with Circuits for Building Services.
14. Special Lighting: Unless otherwise indicated, provide following:
 - a) Emergency Lights(s)
 - b) Lighted Exit Sign (Each Door)
 - c) Photo Cell Control (Each Door)
 - d) By Pass Switch
15. Miscellaneous:
 - a) Rubber Floor Mats – Width as required
 - b) Fire Protective Equipment
 - c) ABC Fire Extinguishers (By Each Exit Door)
 - d) Smoke Detector
 - e) External Siren

END OF SECTION 265091

SECTION 26 13 01 – MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work performed under this contract shall include but not limited to furnishing, installing, testing and placing in satisfactory operation 5kV metal-clad switchgear and appurtenances as specified in the Contract Documents.
- B. All other associated equipment shall be furnished in accordance with these specifications or as indicated on the Contract Drawings.
- C. Provide services of a factory-trained service engineer, specifically trained to check connections; verify interwiring of all affected equipment; make adjustments as needed and assist in performing commissioning tests for placing equipment in satisfactory operation.
 - 1. Provide guidance during installation to check work of installing contractor.
 - 2. Provide thorough training to MWAA personnel in maintenance, care and operation of equipment. The training course content and schedule shall be submitted to the MWAA for prior approval.
 - 3. Test all equipment and insure proper setting and operation of 5kV metal-clad switchgear.
 - 4. Inspect installation and adjust as necessary when switchgear is ready to be energized and put into service.
 - 5. Certify that equipment has been inspected and is ready to be placed into continuous service.

1.2 COMPLIANCE

- A. The Contractor shall comply with standard specifications except as modified herein.

1.3 QUALITY ASSURANCE

- A. Comply with all MWAA, Federal and Commonwealth of Virginia laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below.
- B. Reference Standards, Codes and Specifications:
 - 1. ANSI: American National Standards Institute
 - 2. IEEE: Institute of Electrical and Electronic Engineers
 - 3. NEMA: National Electrical Manufacturer's Association
 - 4. UL: Underwriters Laboratories, Inc.
 - 5. NETA: Inter-National Electrical Testing Association
 - 6. NFPA: National Fire Protection Association

1.4 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00.
- B. Manufacturer's certified shop drawings shall include but not be limited to the following items:
 - 1. Outline and dimension drawings of the assembled switchgear, including a drawing of the base, location, arrangement, front view elevation, floor plan and top view coordinated conduit entry/exit location. Provide location of lifting eyes, jacking and pulling lugs. Provide weight of the equipment (switchgear for shipment parts and total for outline).
 - 2. Nameplate drawings and details, nameplate schedule.
 - 3. One-line and three-line drawings, schematics and wiring diagrams. Internal component arrangement drawings for the switchgear.
 - 4. Specification and description of all equipment including catalog cuts and drawings of all parts, devices, and components in each unit of the switchgear and complete descriptive literature and catalog cuts on the entire assembly with applicable selections duly highlighted for ease of reference. Any and all information necessary to prove that the proposed equipment meets all requirements of these specifications. Provide tabs and separators for ease of traceability of documents and literature included in each binder of submittals.
 - 5. Control diagrams of the two main breakers and feeder breakers.
 - 6. Certified test data, maintenance data, operating instructions and list of recommended spare parts as specified and recommended by manufacturer.
 - 7. Where standard data and catalog literature is supplied, all furnished options shall be carefully highlighted and options not being furnished shall be deleted or crossed out. Unclear information will cause rejection of the entire submittal.
 - 8. Clear and concise drawings and instructions for installation, operation, care and storage of the equipment. Non applicable portions of standard publications to be so marked, or crossed out.
 - 9. All submittals shall be clearly marked showing proper project identification, specification section number and component identification as shown on the drawings.
 - 10. Time-current curves on reproducible log paper and/or in electronic format for each type of protection relay, circuit breaker, and fuses as applicable. Curves or formulas for their derivation, as published in standard instruction books, are not acceptable as stand-alone documents.
- C. Provide a record of "as-built" drawings in accordance with "Closeout Submittals." The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes and deviations made during the manufacturing and installation process.
- D. Furnish service manuals in accordance with "Closeout Submittals" Section 01 78 00.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Comply with Section 01 60 00.
- B. Shipping:
 - 1. Ship materials complete with identification and quantity of items.

2. Pack spare parts and accessories in containers bearing labels clearly designating contents and pieces of equipment for which intended.
 3. Deliver spare parts and accessories at same time as pertaining materials. Delivery to the owner after completion of work.
- C. Receiving: Inspect all materials and equipment against approved shop drawings at time of delivery.
- D. Equipment or material damaged or not meeting the requirements of the approved shop drawing shall be immediately returned for replacement or repair.
- E. Carefully prepare for storage and label all equipment and materials after they have been inspected.
- F. Store all equipment and materials in a dry, covered, heated and ventilated location. Provide any additional measures in accordance with the manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 5KV METAL CLAD SWITCHGEAR

- A. Manufacturer:
1. Eaton-Electrical / Cutler-Hammer, Inc.
 2. General Electric Co.
 3. Siemens
 4. Contingent upon products' compliance with specifications, medium voltage switchgear, distribution control panels and components furnished under this Contract shall be standard products of the same manufacturer. Any deviation must be approved by the Engineer prior to manufacturing. The contractor shall guarantee the entire equipment for a minimum period of at least five years.
- B. 5kV Switchgear:
1. General
 - a. The switchgear, housed in an outdoor sheltered aisle metal enclosure, shall comprise of continuous lineup having metal clad circuit breaker sections coupled in a single lineup in accordance with applicable ANSI/IEEE C37 standards. The general arrangement of the switchgear shall be as indicated on the Contract Drawings. 5kV Metal Switchgear shall be mounted in Integrated Power Assembly (IPA) or equal as shown in Specification Section 26 05 91. The entire switchgear shall be rated same as vacuum circuit breakers.
 2. Buses
 - a. Provide A, B, and C type bus arrangement (from left to right, top to bottom and front to back when facing the front of the assembly).

- b. The bus bars shall be of uniform cross section throughout the length of the switchgear.
 - c. Buses shall have amperage ratings as indicated on the contract one-line Drawing, or as hereinafter specified. Use most stringent requirements in case of discrepancies. The bus material shall be copper. The bus bars shall be braced and capable of withstanding the short circuit current rating of the circuit breakers. All bus shall be insulated for entire length. Appropriate boots shall be provided at splice points and taps on busbars. Bus insulation and bracing materials shall have high dielectric strength, high tensile strength and a long creepage path. Bus temperature rise shall not exceed the rise as specified in IEEE and NEMA standards. Bus insulation shall be of molded material, designed for 5 kV. Bus supports shall be porcelain or epoxy as per manufacturer's standard design.
 - d. All bus bars shall be tin plated at splices and taps to a minimum thickness of 0.5 mils. All buses shall be securely bolted. Where splice plates are required, they shall be equal in cross-section to the main bus and shall be fully tin plated.
 - e. Each lineup shall be equipped with a full length copper ground bus tin plated over entire length to a minimum thickness of 0.5 mils. The ground bus shall be of the same short-circuit to withstand current rating as the main bus conductors and capable of carrying the rated short circuit current of the bus. The ground bus shall comply with all applicable codes and regulations.
 - f. All buses shall be permanently marked by stamping or painting the correct phase designation, i.e., phase A, phase B, or phase C.
 - g. Bus bar connections shall be with silicon bronze bolts and 2 conical bellville type pressure washers. Minimum 2 bolts per connection.
3. Outdoor Weatherproof Housing
- a. The outdoor walk-in type weatherproof 5kV switchgear housings shall consist of an assembly of dead-front, free standing metal-enclosed switchgear housing sections, metal-clad switchgear, and vacuum circuit breakers in a two-high arrangement as shown on drawings and specified herein.
 - 1) The switchgear housing and assembly shall be integrally designed and produced to assure a completely coordinated design and establish one source of responsibility for the equipment's performance in accordance with Section 26 05 91 and following:
 - a) Design Criteria
 - i. Roof
 - The roof snow load of the building shall be 30 lbs/sf.
 - The roof live load of the building shall be 30 lbs/sf.
 - ii. Building Dimensions are shown on the Contract Drawings.

- iii. Specific design considerations
 - Section installed on new foundation: Design structure base to allow forklift lifting or jacking to allow installation of shims for leveling in the event of settlement. Maximum predicted settlement is less than 0.1-inch.
 - Sections to be installed on existing vault: Design structure base to transfer housing and equipment loads to the existing vault walls.
- b) Components
 - i. Doors: In accordance with manufacturer's recommendations.
 - ii. Wall-mounted Heat Pump HVAC Units
 - Provide wall-mounted heat pump HVAC Units in accordance with manufacturer's recommendations.
 - Contractor to coordinate location of unit heaters with building manufacturer.
 - iii. Insulation
 - The walls, roof and floor shall be fully insulated. The walls and roof shall be provided with fiberglass batt type insulation, minimum R-11. The floor shall be provided with polyurethane spray foam insulation, minimum R-6.
- c) 5kV switchgear line-ups shall have a number of cubicles with interlocks as indicated on the drawings (a cubicle being a vertical section which is a self-supporting structure consisting of a bolted steel frame with reinforcing gussets).
- d) Each cubicle shall house vacuum circuit breakers, microprocessor-based metering, monitoring, and protective devices, breaker control devices, microprocessor based protective devices, space heaters, current and potential transformers, surge arresters, control switches, ground and test devices as indicated on drawings.
- e) Other equipment such as Remote breaker control cabinet, Annunciator Panels, AC Panelboard, Fire Alarm terminal cabinet, etc., shall be installed in the 5kV switchgear housings as shown on drawing and specified.
- f) Contractor shall provide space heaters, and air conditioning units in the outdoor enclosure of sufficient capacities and redundancy for reliable operation of the microprocessor

based relays, computer and associated accessories required by the manufacturers of these equipment.

- g) Enclosure doors shall be provided with quick release latch mechanism such that the doors can be open from inside, even when locked from the outside.

4. Circuit Breaker Sections

- a. The stationary structure of each unit shall be built of welded structural steel members, together with formed or fitted sections of smooth sheet steel. It shall form the compartments for the circuit breakers and auxiliary equipment. Adequate ventilation shall be provided for each unit. Major parts of the primary circuit including buses, potential transformers, and control power transformers shall be completely enclosed by grounded metal barriers.
- b. Each vertical section shall have hinged doors for mounting relays and instrumentation, and for removal of circuit breakers. The front mounted apparatus and devices shall be so arranged that the operating height is not less than 2'0" for the lowest device and is not more than 6'0" for the upper most mounted device. A full-height weather proof rear-hinged door with three-point lockable latches shall be provided for rear of each vertical section for access and for installation and maintenance of cables. All front doors shall be made of smooth surface, No. 11 gage thickness steel. Hinges shall be concealed removable pin type. Suitable gaskets shall be provided to make the outdoor unit completely weatherproof. The opening of a door shall not expose any primary circuit component.
- c. Each unit shall be provided with thermostat controlled front and rear compartment space heaters with separate thermostats for each side. The heaters shall be adequately sized. Tubular type heaters with thermostats operated at half voltage for long life shall be supplied. Individual circuit breaker shall be provided for each compartment's heaters. Circuit power shall be obtained from the distribution panel fed from control power transformers in each lineup with auto transfer switch as indicated on the Contract Drawings. Heater circuits and wiring shall be arranged such that external power can be applied for equipment heating during temporary storage.
- d. The stationary structure shall include insulated copper buses, the fixed portion of the primary disconnect devices, insulated connections, instrument transformers, control power transformers, control devices and fuses, automatic safety shutters to close the opening to the disconnected position, mechanical interlocks, secondary connections to devices within the units and to terminal blocks, and provision for connecting wiring. Guides shall be provided to assure alignment of all engaging parts during movement of the circuit breakers to the connected position.
- e. Each circuit breaker cell shall have provisions to attach motorized racking mechanism for racking the circuit breaker "in to" and "out of" its connected position from remote location within the switchgear enclosure.
- f. The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A shutter assembly shall automatically cover the stationary primary disconnecting contacts when the breaker is in the test position, disconnected position or out of the cell. Rails shall be provided to allow

withdrawal of each circuit breaker for inspection and maintenance without the use of a separate lifting device.

- g. Each stationary unit shall be grounded directly to the ground bus. Suitable terminals on the ground bus shall be provided and connected to the substation ground system on both ends of switchgear.
- h. The incoming and outgoing power and control cables shall enter the assembly from below if otherwise not shown on drawings. Cable terminals coordinated to specified load cable size shall be provided, unless otherwise specified or indicated.

5. Removable Elements – Vacuum Circuit Breakers

- a. The removable elements shall consist of stored-energy vacuum interrupter-type circuit breakers, complete with operating mechanism, operations counter, removable portion of the primary and control wiring. The control wiring shall be in conduit or other suitable enclosure. Circuit breakers shall be free standing when removed and shall have castors or wheels.
- b. Breakers:
 - 1) For 5kV switchgear, the breakers shall be suitable for nominal voltage class 4.16kV RMS, insulation levels rated to withstand test voltage 19kV RMS and 60kV impulse. Main and tie breakers shall be rated for 1,200 amperes or as indicated on the Contract Drawings, 3-phase nominal 250 MVA class, having a maximum symmetrical interrupting capability 36 kA RMS and momentary current rating of 58 kA RMS and standard operating duty of CO+15 seconds +CO.
- c. The circuit breakers shall be isolated from all other primary equipment and arranged so that they can be completely disconnected from the line and bus for test and inspection. The circuit breakers shall be equipped with mechanical interlocks which shall permit withdrawal of circuit breaker from the cubicle only when it is in “open” condition and with its mechanism springs fully discharged. It shall not be possible to close the circuit breaker either electrically or manually when the circuit breaker points between the test and operating positions, or while the interlock is engaged. Similarly, it shall not be possible to insert a closed circuit breaker from “test” to “connected” position and vice-versa. Isolation shall be accomplished by moving the circuit breaker to the disconnected position. Means shall be provided for padlocking the circuit breakers in the open, disconnect or test position.
- d. The removable elements shall be assembled in jigs which shall accurately locate the contacts, holding devices and interlocks. Similar jigs shall be used in construction of the stationary structure.
- e. Control connections between the stationary equipment and the removable breaker shall be made with self-aligning female and male multi contact devices.
- f. The circuit breakers shall be of the stored energy type utilizing AC power for charging, closing and tripping. In addition, under voltage release shall be provided on all breakers to block closing of an open circuit breaker if control supply is not available and to automatically trip a closed circuit breaker on loss of control supply to trip circuit. Detachable lever/operating handle shall

be provided for manually charging the springs in the event of failure of control power. Means shall be provided to automatically isolate the control power supply during manual spring charging, to avoid injury to operating personnel if control supply is restored during manual spring charging.

- g. Each breaker shall be furnished with all required closing and opening apparatus, operation counter, and mechanism operated auxiliary switches providing interlocking control and indication based on the main contact position (open and closed position of the circuit breaker) as shown on the Contract Drawings. The mechanism operated auxiliary switches shall have at least two spare sets of normally open (type a) and two spare sets of normally closed (type b) contacts, to indicate open, closed, and tripped status at the supervisory monitoring system. A truck operated cell switch shall be furnished for each circuit breaker to provide interlocking control and indication of the circuit breaker racking position as shown on the Contract Drawings with at least two spare sets each of normally open and normally closed contacts.
- h. Circuit breakers shall be furnished with all relays, switches and pilot lights as shown on the Contract Drawings. Each breaker shall be arranged for manual trip operation from switchgear front panel or from Remote Breaker Control cabinet. The following features shall be provided at minimum:
 - 1) When racked out to its 'Test' position, the breaker can be operated locally from its breaker control switch provided on the switchgear front only.
 - 2) All remote breaker controls associated with the breaker shall automatically be disabled when the breaker is either in its 'Test' or 'Disconnected' position.
 - 3) When racked in to its 'connected' position, all local breaker 'close' operations shall be automatically disabled.
 - 4) In 'connected' position the breakers shall be normally operated from remote breaker control cabinet located in the outdoor weatherproof switchgear housing itself.
 - 5) Suitable inputs shall be provided for supervisory system for monitoring circuit breaker status and metering parameters.
- i. Circuit breakers of the same rating shall be inter-changeable and shall fit any housing of the same rating in the switchgear line up.
- j. Feeder breaker shall be key interlocked with its associated transformer to permit operation of tap changer only when the transformer is disconnected from both sides (primary and secondary).
- k. All spare contacts specified in preceding clauses shall be wired to terminal blocks.
- l. Unless approved by owner/engineer for specific application(s) prior to manufacturing, devices, apparatus, terminal blocks, switches, etc. belonging to one cell shall not be mixed with those of any other cell.

C. Other Devices and Appurtenances

1. Potential Transformers

- a. Potential transformers shall be of the indoor, dry type, single phase, 60 Hertz, voltage rating as shown on drawing, having not less than 200 volt amperes on a metering accuracy basis, and equipped with current limiting fusible cutouts. Potential transformer shall be of GE, ITI, ABB Power T&D Company, or equal. All transformers shall be properly identified for polarity with standard markings and symbols. Necessary potential buses, if required between units, shall be installed. Medium voltage leads shall be braced for the switchgear rating.
 - b. Each set of potential transformers and their primary fuses shall be mounted in a separate steel compartment. Primary connections to the transformers shall be insulated and enter the compartment through approved porcelain bushings. Unless shown otherwise, set of potential transformers shall be mounted on a steel carriage which will be capable of disconnecting the transformers and fuses from their potential source and removing them from the structure. This removing mechanism shall be so arranged that full access to the transformers cannot be accomplished until they are disconnected and removed from the structure. When moved to a full draw-out position, the transformer fuses shall be automatically connected to a ground stud. Removal of the transformers shall disconnect their secondary wiring as well as the primary connections. Primary contacts shall be insulated from the structure by porcelain bushings or equal, shall be self-aligning and shall have silver-to-silver contact surfaces.
2. Current Transformers
- a. Current transformers shall be multi-ratio, dry type, epoxy cast resin insulated for applicable voltage rating and rated as indicated on the Contract Drawings. They shall have sufficient thermal and mechanical capacity to withstand the maximum momentary current rating of the breakers without being saturated. The secondary terminals shall be of the solderless clamp type. All current transformers shall be properly identified for polarity with standard marking symbols. The minimum acceptable accuracy class for metering and relaying shall be in accordance with the latest edition of ANSI standard C37.20.2 but not lower than 10C50. The design of CT adopted shall allow accurate measurement of low currents, down to at least 5% of primary rating.
 - b. Window-type current transformers shall be provided for ground sensor relaying, as shown on the Contract Drawings.
3. Instruments and Relays
- a. Protective relays and other devices for mounting on the switchgear panels shall be semi-flush-mounted with cases of similar design and attractive in appearance. They shall be of rectangular type, semi-flush mounted with only the bezel of these devices visible on exterior surface of the instrument compartment door. Extension collars or similar arrangements to gain extra depth for mounting the apparatus/devices are not acceptable.
 - 1) Protective Relays: Subject to compliance with requirements, or as acceptable to The Authority provide one of the following:
 - a) GE Multilin (**Basis of Design**)
 - b) SEL

c) Square D

- 2) The protective relay types shall be as shown on the drawings and ranges and characteristics shall be provided as defined by coordination study based on Section 26 05 73, and protection system requirements, and this section. Protective relays, except as otherwise noted, shall be microprocessor based, with self test features and test simulation provisions incorporated in the relay unit. Exposed metal surface of relays and instruments shall have a dull black lacquer finish. Integrated test devices or current shorting provisions do not eliminate the need for test switches as shown on the Contract Drawings. Remote communications shall be provided either Ethernet or RS 485 ports. A front panel port shall be provided for local PC access. The latest programming software modules shall be provided with the relays. The relays shall be fully setup, configured, and programmed to provide the protective functions shown on the single line diagram and schematics.
- 3) Furthermore, it shall be easily possible to enable and utilize all other functions available in the multifunction relays at any time in future without any extra cost to buyer. Further, any latest firmware/software necessary for upgrading the relays shall either be available as cost free download from safe and secure internet site or be provided in any usable electronic form by the contractor for the entire life span of the relays. All - The microprocessor based protective relays provided under this section shall be manufactured by one manufacturer unless otherwise noted and approved by the Owner or required as part of interface with the local utility.
- 4) Whether shown in the contract drawings or not, it shall be Contractor's responsibility to utilize built-in monitoring and alarm functions of the microprocessor-based relays, such as trip circuit monitoring, internal relay failure alarm, circuit breaker status (ON/OFF) monitoring, etc. It shall also be possible to bypass these functions at the option of the owner. Schematic drawings submitted for review/approval prior to manufacturing, shall reflect utilization of such functionalities. The protective and interlocking functionality as shown in one line diagram and schematics shall be achieved by use of single multifunction relay or a combination of relays meeting the requirements of specifications, accommodated in the available space in low voltage instrument compartment(s) and shall be subject to Owner's approval.
- 5) The Contractor shall provide all required contacts which will be determined by the equipment manufacturer based on the operation of the system and approval by the Engineer prior to preparation of shop drawings and minimum of two spare pairs of normally open and normally closed contacts.
- 6) Relays shall conform to ANSI/IEEE C37.90.
- 7) Provide one complete set of test blocks current and voltage test switches for each type of relay in the switchgear, as applicable.
- 8) Controls, relays and protective functions shall be provided completely assembled and wired.

- 9) The contractor shall perform protective coordination studies to determine appropriate ranges, characteristics and actual relay settings of the relays indicated on the drawings and specified herein.
 - 10) Microprocessor relays and meters shall be capable of operation in temperatures 10 degrees F to 122 degrees F ambient and shall be suitable for operation in corrosive environment prevalent in water treatment plants. Additional details of metering and protective devices are given on the drawings.
 - 11) Microprocessor-based relays shall be utility grade relays with communication and monitoring capabilities, either single function or multifunction and shall perform all the functions required as indicated on the drawings for the complete power monitoring, metering, protection, communication, and control systems.
 - 12) The switchgear manufacturer shall furnish, install and wire all auxiliary and timing relays necessary for the required control of the switchgear. Where possible, auxiliary and timing functions may be accomplished in the microprocessor relays via programmed or "Flex"-Logic; and outputted via relay contact I/O modules whose ratings and configuration are compatible with the control application. Where external devices are required, timing relays shall be of the solid state type with electromechanical outputs and adjustable timing range, simple adjustment and repetitive accuracy. Auxiliary relays shall be ABB type SG, timing relays shall be 328 Series Multi-Range TDR manufactured by Automatic Timing & Controls ATS, Lancaster, PA, or equal.
 - 13) Main contacts of all switching devices shall be silver-plated or equivalent. The contact surfaces of primary and secondary disconnecting devices and relays shall be silver-plated or equivalent. Contact backup springs shall be stainless steel.
4. Test Switches
- a. Panel-mounted test switches and one complete set of test plugs as required for testing draw-out relays or meters with suitable terminals and cables shall be supplied. All test switches shall be 10-pole test switches in Flexitest cases, ABB type FT-1 or equal. The switches shown on the Contract Drawings show only the required number of poles used for the specified circuitry.
 - b. All test switch wiring shall be plainly marked to indicate the respective circuits connected to each pole of the switch.
5. Control Power Transformers and Automatic Transfer Switch
- a. Control power transformer (CPT) shall be provided for each of two five (5) kV incoming lines to the switchgear, as shown on the drawings and recommended by the manufacturer. If the manufacturer's recommended CPT is higher than shown on the drawings, the Contractor shall provide higher capacity at no additional cost to the owner. Capacity of each transformer shall be large enough for operating connected loads and all switchgear accessories including integrated motorized remove racking system. In addition to above requirement, each transformer shall have minimum of 25

percent spare capacity in its nameplate kVA rating. Transformer shall have dual primary and secondary fuse protection. Primary current-limiting fuses shall be of the disconnecting type. Transformer shall have class 185 insulation system for 185°C total temperature on 80°C rise. Coils shall be wound of electric grade copper, with continuous wound construction. Core and coil assembly shall be completely encapsulated in resin. Sound level shall not exceed 45 DB. The transformer shall include 4 + 2-1/2% voltage adjustment taps, two above neutral and two below neutral. Transformers located as indicated on Contract Drawings. All auxiliary power circuits (120/208 volt) shall have individual circuit breakers with over current protection.

6. Control and Test Operating Switches and Indicating Lights

- a. Provide control switches and indicating lights on each switchgear section. All indicating lights shall be LED Cluster Type, Starled MB119-; or R. Stahl Inc. type 8415. Provide blue indicating lights for trip coil failure and transformer winding alarm, green, red and amber indicating lights for showing the OPEN, CLOSE, and TRIPPED position of the circuit breakers respectively. Breaker control switches shall be of the momentary contact type. All switches shall be Type SB-1 manufactured by General Electric; or equal. In addition to the equipment indicated on the Contract Drawings, any necessary relays, switches, resistors and other devices required to insure proper functioning of the equipment shall be furnished and installed.
- b. When inserted into its connected position, circuit breakers shall be operable from remote locations only.
 - 1) Normally all 5 kV breakers shall be operated from the Remote Breaker Control cabinet (located by the side of switchgear) placed at right angle to front/draw-out side of the line-up, and/or from Remote Control cabinet (located in a Control Room), as indicated on the Drawings. Remote Control switches shall be disabled when the circuit breakers are withdrawn to the test position. However, a local control switch shall be provided at the units to operate the circuit breakers when withdrawn to the test position. Withdrawing circuit breakers to test position shall automatically disable all remote control switches. The local control switches shall be wired so as not to allow closing the circuit breakers when in normal operating position, but shall allow tripping the circuit breaker in any position.

7. Wiring

- a. Each switchgear lineup shall be completely assembled, wired and tested at the factory, including all buses, connections, insulators, cleats, terminals and terminal blocks. No current-carrying parts shall be left uninsulated. All secondary wiring in high voltage compartments shall be run in conduit or metal-covered wiring troughs. Secondary wiring outside the high voltage compartments shall be firmly laced and secured, and terminated with compression type ring terminals on approved molded type terminal blocks which are conveniently located with respect to control wires termination.

- b. Terminal blocks shall have approved covers and shall be so mounted that the wires to them can be grouped and laced together in a neat and workmanlike manner. A sufficient number of terminal connections, including 15 percent spare terminals, shall be provided for all control and instrument wiring. All secondary wiring shall be copper No. 14 AWG or larger, 90-deg. C, 600 volt switchboard wire, or equal. Label each wire at all termination points by means of plastic, split-sleeve, non-adhesive wire marker.
8. Nameplates
- a. Each cubicle shall be provided with two lamicoïd nameplates, black with white lettering and with identification as specified and indicated on the Contract Drawings. The nameplates shall appear on front and rear of each cubicle.
 - b. Lamicoïd nameplate, black with white lettering, shall be provided for all indicating instruments, relays, control switches, test switches, pilot lights and other devices mounted on cubicle doors or swinging panels. The nameplates shall identify each item or function as appropriate. For relays, the device number shall be used, i.e. 50/51, for pilot lights, green – “open”, red – “closed”, etc. For test switches include description of each link, i.e., Phase A, 51 trip, etc.
 - c. Nameplates shall be mounted with stainless steel screws.
9. Ground and Test Devices
- a. Ground and test device(s) shall be provided as per manufacturer recommendations and as specified herein. Furthermore, the 5kV Ground and test devices shall also comply with all requirements of the Utility. Grounding and test devices shall be stored in designated cells in switchgear cubicle.
 - b. The ground and test device shall be a power-operated unit and shall incorporate the following features:
 - 1) It shall be designed such that it can be inserted in the switchgear units in place of and in the same manner as the circuit breaker removable elements, to permit grounding either the bus or feeder, or to make external connections to either the bus or feeder for test purposes. It shall include a solenoid-operated circuit closing device so arranged with a gang operated, 3-pole selector, disconnect switch to effectively ground either the bus or feeder when the device is inserted in the unit and closed.
 - 2) The device shall be electrically closed by means of a suitable remote control station connected to the device by 50 feet of flexible cable to permit the operator to stand well clear of the equipment.
 - 3) The ground device shall have a momentary and four-second current-carrying capacities at least equal to those of the circuit breakers.
 - 4) The grounding device shall connect solidly to the ground bus in the unit when in the operating position.
 - 5) No automatic tripping of the grounding device shall be provided.

- 6) The device shall be provided with suitable windows or transparent enclosures and barriers to permit visual observation of the position of all selector switch blades.
- 7) All locking and interlocking features shall be provided to prevent improper or unsafe operation of the equipment.

10. Accessories

a. The following accessories shall be furnished for the 5kV switchgear:

- 1) One each - maintenance tool for manually closing circuit breakers when not in housing, manually charging the breaker closing spring and manually opening the shutter.
- 2) One each - levering crank for moving circuit breaker between test and connected positions as back-up for motorized racking.
- 3) One each - set of test plugs for use with Flexitest relays and meters and for use with current and potential test switches.
- 4) One each - test cable for electrically operating the circuit breakers outside the housing.
- 5) One complete set of any special tools, rail extensions and clamps, wrenches or other equipment required for maintenance of each switchgear.
- 6) Maintenance test cabinet complete with pushbuttons and control relays, test plug jumper and cable that breaker can be operated outside its compartment with the switchgear control power or with the test cabinet in maintenance area.
- 7) 5 kV distribution class surge arresters shall be provided connected at the line/load side terminations as shown in drawings and securely grounded to the metal structure.
- 8) Spanner nut wrenches for removing, replacing or checking tightness of main disconnect contacts when de-energized.

11. Mimic Buses

a. The mimic buses shown on the panel shall be 1/2-in. wide by 1/8-in. thick red plastic securely fastened without screws. The mimic buses shall be arranged substantially as indicated on the Contract Drawings. Symbols of transformers, circuit breakers, etc., indicated on the Contract Drawings, may be revised to suit standard symbols furnished by a particular supplier. Details of arrangement and construction, equipment, and symbols shall be submitted for approval.

12. Annunciators

a. Provide UL listed, semi flush mounted micro-processor based alarm annunciators type AN-3100D of Panalarm make or approved equal having following features:

- 1) Bright LED illuminated window inscription having:

- a) Window legends printed on standard transparency film for ease of change/replacement of legends in the field.
 - b) Continuous internal monitoring of the condition of LEDs.
 - 2) Field configurable software for sequence of operation, flash rates, color sequence and relay outputs through externally accessible serial or Ethernet ports.
 - 3) Communication capability with RS-232/RS-485 serial or Ethernet ports and supporting Modbus, DNP and other user systems compatible protocols.
 - 4) Internal self-diagnostics for monitoring and reporting of internal faults.
 - b. Suitable for 120V, 60Hz AC control power.
 - c. Display windows minimum 1.5" H x 3" W, with minimum 2 LEDs per window.
 - d. Control functions including:
 - 1) Acknowledge, test, silence, and integral test push buttons on front panel.
 - 2) External push button inputs
 - 3) Configurable switch inputs
 - e. Output relays, software configurable dual relay per point.
13. Spare Parts
- a. The Contractor shall furnish the following spare parts for each switchgear:
 - 1) Two complete sets of primary and secondary potential transformer fuses and 1 complete set of current limiting fuses for every type furnished.
 - 2) One circuit breaker trip coil for breakers of each rating.
 - 3) One complete set of control power transformer fuses.
 - 4) One complete vacuum interrupter modular assembly.
 - 5) Spring charging motor.
 - 6) One vacuum contactor.
 - 7) Auto transformer.
 - 8) One microprocessor relay of each type with case.
 - 9) One microprocessor based power meter (MM).
 - 10) One set (3nos) of lightning arresters.
14. Painting
- a. The steel work of the switchgear structures shall be thoroughly cleaned and all surfaces given one primary coat of an approved zinc chromate primer. All interior surfaces shall then be given one shop finishing coat of lacquer of the nitro-cellulose enamel variety. All exterior surfaces shall be given three shop coats of the same lacquer. The color of finish coats shall be dark gray ANSI No. 24.

- b. The underside of the switchgear housing shall be given a coating of 1/8-in. minimum rubberized sealing compound to prevent rusting.
15. Heater
- a. Provide in each breaker or auxiliary compartment and each cable compartment.
 - b. Heaters shall be supplied from 120 V, shall have sufficient capacity to control moisture condensation in the compartments, and shall be sized 250 watts at 240V.
 - c. Provide space heater switches and thermostat for each vertical section of the switchgear.
 - d. The space heaters in the 5 kV switchgear line-ups shall be fed from a new AC panel as indicated. Energize electric heaters in switchgear assemblies while the equipment is stored or in place prior to being placed in service.
16. Breaker Remote Control Cabinet
- a. The breaker remote control cabinet shall have internal terminal boards to accept the open-close and indicating light and interlock control wires from each breaker in the switchgear lineup.
 - b. On the front of the cubicle an open-close switch with associated indicating lights and a suitable nameplate shall be provided for each breaker in the switchgear lineup as depicted on contract drawings.
 - 1) When a breaker in switchgear is in connected position, the operator will use control switches provided on cabinet for open and close operation.
 - 2) The controls and indicating lights are in addition to the controls and indicating lights provided on each of the hinged panels containing circuit breakers in the switchgear lineup.
17. Integrated Remote Racking System
- a. Integrated remote racking system shall be motorized to provide a means for remotely racking any 5 kV draw out circuit breaker and/or auxiliary drawers in the 5 kV metal-clad switchgear.
 - b. The racking system shall be powered from an internal CPT.
 - c. The system shall have motor, logic controller, and safety interlocks built into the compartments.
 - d. The system shall track and log racking records to simplify the scheduling of equipment maintenance.
 - e. The “Operator” used for open and close breakers remotely shall be hand held and provide following: status display, breaker open/close controls, on/off button to activate the “Operator”, port for connecting cable to the switchgear, test, and connect/disconnect indicators.
18. Corrosion Protection
- a. Bases, frames, and channels of substations and switchgear exterior housing which come in contact with concrete shall be corrosion resistant and shall be

fabricated of hot-dip galvanized steel or stainless steel. The underside of the switchgear housing enclosure shall be provided with a coating of minimum 1/8 inch thick rubberized sealing compound to prevent rusting.

b. Galvanized Steel

- 1) ASTM A 123, ASTM A 525 G90 coating and ASTM A 153, as applicable.
- 2) Galvanize after fabrication where practicable.

c. Stainless Steel

- 1) ASTM A 167, Type 302 or 304.

19. Terminal Boards

- a. Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies.
- b. Terminal blocks associated with current transformers shall be short-circuiting type.
- c. Terminate conductors for current transformers with ring-tongue lugs.
- d. Terminal blocks identification shall be identical in similar units.
- e. External wiring shall be color coded consistently for similar terminal blocks.

20. Shipping Splits

- a. Metal-clad switchgear lineups should be in many vertical sections or stacks. These lineups should be broken down into shipping splits after the lineup is assembled and tested at the factory. Delivery of sections shall be closely coordinated with the special requirements including sequencing and scheduling of partial deliveries.
- b. These shipping sections must be reassembled, in the correct order, when received at the job site. The shipping splits shall be determined by the Contractor and approved by the WSSC.

21. Factory Tests

- a. 5kV Switchgear, shall be completely assembled, wired and tested at the factory.
- b. The Contractor shall notify the Engineer in writing at least 14 calendar days prior to the scheduled testing time. The owner reserves the right to witness the testing of the switchgear.
- c. Five certified copies of the test results, for the switchgear, shall be submitted to the owner for approval.
- d. Three copies of the final factory inspection tests shall be furnished to the owner.
- e. The Contractor shall provide, for Owner's approval, a factory witness testing plan. Factory tests shall include all tests required by ANSI, NEMA, and IEE for demonstrating compliance with the specifications including but not limited to the following:

- 1) Operate each drawout breaker manually and electrically, and check operation of shutters and interlocks.
- 2) Demonstrate interchangeability of drawout breakers in the switchgear assembly.
- 3) Operate each breaker manually and check operation of auxiliaries, interlocks, and contact gap clearances.
- 4) Operate all relays, sensors, and interlocking contacts manually to test operation of all circuits.
- 5) Operate ground and test devices.
- 6) Test insulation of control and relay circuits.
- 7) Test vacuum verification equipment and verify performance in accordance with the specifications.
- 8) Test insulation of each breaker phase-to-phase and phase-to-ground with a megohmmeter.
- 9) Test vacuum interrupters for high potential withstand capability.
- 10) Test each 5kV bus section for ac overvoltage (1-minute Hi-Pot test).
- 11) Verify microprocessor relay settings and perform protective device tests.
- 12) Perform electrical operational tests and verify functions and interlocks.
- 13) Demonstrate maneuverability of the breakers using the breaker lifter in the switchgear housing.

PART 3 - EXECUTION

3.1 FACTORY WITNESS TESTING

- A. After the equipment has been completely assembled, it shall be shop tested for general operating condition, circuit continuity, high potential, and other standard tests for the particular class of equipment, as defined by industry standards.
- B. The switchgears shall be subjected to all standard factory tests, including quality control tests. Four certified copies of test results shall be submitted to the Authority before the equipment is shipped to the project site.
- C. The owner reserves the right to witness all factory tests. Two weeks written notice shall be provided to the owner so arrangements can be made to witness tests. A sample copy of all factory tests to be performed shall be submitted to the owner with the two weeks advanced notice. The Authority shall bear the cost of transportation and lodging for two (2) MWAA representatives.
- D. The factory tests shall include, at minimum, all the vendor's standard set of tests which shall be listed in the proposal including testing of protection devices and controls by simulating operating conditions.

3.2 CONSTRUCTION REQUIREMENTS

- A. Installation
 1. Install all equipment in accordance with the manufacturer's recommendations.
 2. Install protective devices as shown on drawings and Specifications.

3. Make all necessary adjustments to equipment to provide complete operational unit substations upon completion of the project.
4. Set adjustable devices.
5. Set protective devices in accordance with the Section 26 05 73, "Overcurrent Protective Device Coordination and Arc Flash Study."
6. Install danger signs on all four sides of outdoor walk-in enclosure.
7. Steel channel sills:
 - a. The Contractor shall furnish and install hot-dipped galvanized-steel channel sills on which to mount all switchgear. The sills shall be cast in place and shall be lined up true and level.

B. Painting and Labeling

1. Paint color shall be ANSI #70 light gray unless otherwise required by the owner.
2. Identify each piece of equipment, including mechanical operators and electrical switches for equipment, with nameplates, to indicate the service or function.

3.3 FIELD QUALITY CONTROL

- A. The services of a qualified representative of the manufacturer of the switchgear shall be provided to inspect the installation of the equipment, make necessary adjustments, assist in testing equipment, and instruct the operating personnel about operation and maintenance.
- B. The manufacturer's representative shall utilize prepared comprehensive check sheets covering inspections, checks and tests required for assembly of the product. These check sheets shall be executed and signed by the manufacturer's engineering representative and copies of these documents shall be submitted to the owner/engineer upon completion.
- C. Coordinate with the construction sequence and other work as indicated on drawings and stated herein.
 1. All outages due to demolition of the existing switchgear and installation of the new switchgear shall be approved by the owner.
- D. The owner/engineer shall witness the field inspection testing of the switchgear. The Contractor shall provide two weeks advance notice to the owner/engineer for performing the field testing and shall organize the testing as follows:
 1. Preliminary Inspection:
 - a. The preliminary inspection shall demonstrate that each unit:
 - 1) Has not been damaged by transportation and installation.
 - 2) Has been properly installed.
 - 3) Has no mechanical defect.
 - 4) Is in proper alignment.
 - 5) Has been properly connected.
 2. Final Inspection/Test:

- a. Perform field acceptance and/or verification tests in accordance with the most recent Edition of NETA.
 - b. Test all breakers.
 - c. Test all relays for functionality and verification of configuration, setups and outputs by injecting secondary current and voltages as well as simulating the status of the inputs.
- E. Manufacturer shall certify in writing that the equipment has been installed and tested in accordance with the Contract documents and is ready to be placed into service.
- F. Provide a complete test report of all field tests to the owner, including but not limited to the test results, initial signature values of pertinent parameters, soft copy of relay settings of all protective devices according to the approved coordination study.

3.4 O & M TRAINING

- A. Provide thorough O&M Training in accordance with Section 01 79 00 and as specified herein. Training shall be from manufacturer's factory engineer or approved manufacturer's representative.
- B. Training Program Schedule, written material, and diagrams shall be submitted by contractor for Owner's approval and to allow maintenance personnel to get familiarized with equipment before training.

END OF SECTION 261301

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution Panelboards.
 - 2. Lighting and Appliance Branch-Circuit Panelboards

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.
 - 6. Structural calculations and design for panel supports to comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems".

1.4 INFORMATIONAL SUBMITTALS

- A. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. Include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.9 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 3. Finishes:
 - a. Panels and Trim: Galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel; same finish as panels and trim.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
 - 4. Identification: Laminated plastic nameplate for panelboard located at top of panelboard, plus directory card mounted on the inside of panelboard door in a transparent card holder.
- B. Incoming Mains Location: Top or bottom as required by field conditions.
- C. Phase, Neutral, and Ground Buses:
 - 1. Material for all buses: Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Compression type.
 - 3. Ground Lugs and Bus-Configured Terminators: Compression type.
 - 4. Branch Circuits: Compression type.
- E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Series rated breakers are not acceptable.

2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 - c. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in the “on” or “off” position.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.
- E. Install filler plates in unused spaces.
- F. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- G. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final designations. Obtain approval before creating nameplates.
- C. Panelboard Nameplates: Label each panelboard and each load circuit breaker with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

3.5 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.6 CLEANING

- A. Vacuum clean the interior of panels at the end of the project. Do not use compressed air to assist in cleaning.

PART 4 - CONTRACTOR QUALITY CONTROL

4.1 FIELD QUALITY CONTROL

- A. General: Comply with applicable standards of The InterNational Electrical Testing Association (NETA) including Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems."
- B. Preparation: Perform the following preparations in advance of independent tests:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Schedule tests and notify COTR at least two weeks in advance of schedule for test commencement.
- D. Test Instruments, Meters, and Auxiliary Equipment: Tested and calibrated within 6 months of use on this contract and provided by Contractor and independent testing companies.
- E. Test procedure:
 - 1. Independent Testing Organization: Arrange and pay for the services of an independent electrical testing organization in accordance with the requirements of Division 01 Section "Quality Requirements" to perform tests on panelboards.
 - 2. Test Objectives: To assure panelboard installation is operational within industry and manufacturer's tolerances, is installed in accordance with Contract Documents, and is suitable for energizing.
 - 3. Procedures: Comply with the INETA standard and IEEE 400. Upon satisfactory completion of tests, attach a label to tested components.
- F. Remove and replace malfunctioning units and retest as specified above.
- G. Reports: The testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit written reports to the COTR and Contractor, to include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.
 - 4. Calibration records for the test instruments, meters and auxiliary equipment.

- H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each panelboard.
1. Perform thermographic survey when the equipment is energized and operating under maximum load conditions.
 2. Remove all necessary covers prior to thermographic inspection. Use appropriate caution, safety devices and personal protective equipment.
 3. Test Parameters:
 - a. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1° C at 30° C.
 - b. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - c. Thermographic surveys should be performed during periods of maximum possible loading. Refer to ANSI/NFPA 70B, 2006 Edition, Section 21.17.
 4. Report: Provide a certified test report which includes the following.
 - a. Description of equipment being tested.
 - b. Discrepancies.
 - c. Temperature difference between the area of concern and the reference area.
 - d. Probable cause of temperature difference.
 - e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
 - f. Identify load conditions at time of inspection.
 - g. Provide thermograms and visible light images for all inspected components. The photographs and thermograms of the deficient components shall be clearly identified. Visible light images shall align with the thermal image as closely as possible.
 - h. Remedial action recommended/taken.
 - i. Observations after remedial action.
 - j. Calibration record for the imaging equipment.
 5. Corrective Actions:
 - a. Provide corrections in accordance with NETA ATS-2007, Table 100.18.
 6. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panel 11 months after date of Substantial Completion and submit test report as identified above.

END OF SECTION 262416