

**SECTION 26 11 16**  
**SECONDARY UNIT SUBSTATIONS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing of the secondary unit substations, referred to as substation(s) in this section.

**1.2 RELATED WORK**

- A. Section 03 30 00, CAST-IN-PLACE CONCRETE: Requirements for concrete equipment pads.
- B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirement for seismic restraint for nonstructural components.
- C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- D. Section 26 05 13, MEDIUM-VOLTAGE CABLES: Medium-voltage cables.
- E. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- F. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- G. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.
- H. Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY: Short circuit and coordination study, and requirements for a coordinated electrical system.
- I. Section 26 23 00, LOW-VOLTAGE SWITCHGEAR: Switchgear for use in secondary unit substations.
- J. Section 26 24 13, DISTRIBUTION SWITCHBOARDS: Distribution switchboards for use in secondary unit substations.
- K. Section 26 25 11, BUSWAYS: Busways and fittings.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 FACTORY TESTS**

- A. Substations shall be thoroughly tested at the factory to assure that there are no electrical or mechanical defects. Tests shall be conducted per UL and ANSI Standards. Factory tests shall be certified. The following tests shall be performed:
  - 1. Transformer Section:
    - a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground.
    - b. Perform turns-ratio tests at all tap positions.

3. Low-Voltage Section: Refer to Section 26 23 00, LOW-VOLTAGE SWITCHGEAR, Section 26 24 13, DISTRIBUTION SWITCHBOARDS.
- B. Furnish four (4) copies of certified manufacturer's factory test reports to the COR prior to shipment of the substations to ensure that the switchgear has been successfully tested as specified.
- C. The Government shall have an option to witness the factory tests. All expenses of the Government Representative's trips to witness the testing will be paid by the Government. Notify the COR not less than 30 days prior to making tests at the factory.

#### 1.5 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
  1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Prior to fabrication of substations, submit the following data for approval:
      - 1) Complete electrical ratings, including primary and secondary voltage, decibel rating, temperature rise, nominal impedance, voltage regulation, and no load and full load losses.
      - 2) Nameplate data.
      - 3) Elementary and interconnection wiring diagrams.
      - 4) Technical data for each component.
      - 5) Dimensioned exterior views of the substations.
      - 6) Dimensioned section views of the substations.
      - 7) Floor plan of the substations.
      - 8) Foundation plan for the substations.
      - 9) Provisions and required locations for external conduit and wiring entrances.
      - 10) Approximate design weights.
    - c. Certification from the manufacturer that the substations have been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.
  2. Manuals:
    - a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
      - 1) Include three-line diagrams showing device terminal numbers.
      - 2) Include schematic signal and control diagrams, with all terminals identified, matching terminal identification in the substation.
      - 3) Include information for testing, repair, troubleshooting, assembly, and disassembly.

- b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
- 3. Test Reports:
  - a. Submit certified factory design and production test reports for approval.
  - b. Two weeks prior to the final inspection, submit certified field test reports.
- 4. Certifications: Two weeks prior to final inspection, submit the following:
  - a. Certification by the manufacturer that substations conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that substations have been properly installed, adjusted, and tested.

#### 1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata), form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. American Concrete Institute (ACI):
  - ACI 318-11 .....Building Code Requirements for Structural Concrete.
- C. American Society for Testing and Materials (ASTM):
  - D 117-10 .....Standard Guide for Sampling, Test Methods, and Specifications for  
Electrical Insulating Oils of Petroleum Origin
  - D 3487-09 .....Standard Specification for Mineral Insulating Oil Used in Electrical  
Apparatus.
- D. International Code Council (ICC):
  - IBC-12 .....International Building Code
- E. Institute of Electrical and Electronic Engineers (IEEE):
  - C37.121-89 .....American National Standard for Switchgear — Unit Substations —  
Requirements
  - C57.12.00-00 .....Standard General Requirements for Liquid-Filled Distribution, Power,  
and Regulating Transformers
  - C57.12.01-05 .....Standard General Requirements for Dry-Type Distribution and Power  
Transformers Including Those with Solid-Cast and/or Resin  
Encapsulated Windings
  - C62.11-05 .....Metal Oxide Surge Arresters for AC Power Circuits (> 1kV)
  - C62.41-91 .....Surge Voltage in Low Voltage AC Power Circuits
- F. National Electrical Manufacturers Association (NEMA):
  - LA 1-09.....Surge Arresters

TP 1-02.....Guide for Determining Energy Efficiency for Distribution Transformers

TR 1-00 .....Transformers, Regulators, and Reactors

G. National Fire Protection Association (NFPA):

70-11 .....National Electrical Code (NEC)

## **PART 2 - PRODUCTS**

### **2.1 GENERAL REQUIREMENTS**

- A. Substations shall be in accordance with ANSI, ASTM, IEEE, NEC, UL, and as shown on the drawings.
- B. Substations shall be a unitized integral assemblies, complete, grounded, continuous-duty, metal-clad, dead-front, dead-rear, with dry-type transformer.
- C. Substations shall be designed, manufactured, and rated for indoor installation and service, with ventilation openings.
- D. Substation ratings shall be not less than required by the NEC, and not less than shown on the drawings. Short circuit current ratings shall be not less than the available maximum short circuit currents as shown on the drawings.
- E. Substations shall conform to the arrangements and details shown on the drawings, and to the space designated for installation.
- F. Incorporate key-type mechanical interlock systems as required in Section 26 13 16, MEDIUM-VOLTAGE FUSIBLE INTERRUPTER SWITCHES, and Section 26 23 00, LOW-VOLTAGE SWITCHGEAR, Section 26 24 13, DISTRIBUTION SWITCHBOARDS, as shown on the drawings.
- G. Substations shall be assembled and prewired by the manufacturer at the factory. Substations shall be sub-assembled and shipped in complete sections ready for connection at the site. Where practical, a substation shall be shipped as one unit.
- H. Substations shall be thoroughly cleaned, phosphate treated, and painted at the factory with light gray rust-inhibiting paint or baked enamel.

### **2.2 MEDIUM-VOLTAGE SECTION**

- A. Medium-Voltage Fused Switch(es): Refer to Section 26 13 16, MEDIUM VOLTAGE FUSIBLE INTERRUPTER SWITCHES.
- B. Interrupting ratings shall be not less than the maximum short circuit current available, as shown on the drawings.

### **2.3 DRY-TYPE TRANSFORMERS**

- A. Shall comply with IEEE C57.12.01, and IEEE C57.12.50 for dry-type transformers rated up to 500 kVA, and IEEE C57.12.51 for dry-type transformers rated 501 kVA and larger.

- B. Provide a cast coil type transformer with primary and secondary windings individually cast in epoxy. Transformer shall have an insulation system rated 185 degrees C, with an 80 degree C average winding temperature rise above a 40 degrees C maximum ambient.
- C. Provide a vacuum pressure impregnated (VPI) type transformer with an insulation system rated 220 degrees C, and with an 80 degree C average winding temperature rise above a 40 degrees C maximum ambient.
- D. Transformer shall be rated kVA rating as shown on the drawings 9kV BIL primary and 10 kV BIL secondary.
- E. Primary and secondary windings:
  - 1. Windings shall be copper.
  - 2. Primary windings shall be delta-connected.
  - 3. Secondary windings shall be wye-connected except where otherwise shown on the drawings.
  - 4. Secondary windings shall have neutral bushings for transformers with wye-connected secondary windings.
  - 5. Terminals shall be the most suitable clamp or blade type as required for the circuit connections.
- F. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Locate tap adjustments on the face of the medium voltage coil. Adjustments shall be accessible by removing the front panel and shall be made when the transformer is de-energized.
- G. Features and accessories shall include the following:
  - 1. Winding temperature indicator.
  - 2. Auxiliary cooling equipment and controls.
    - a. Transformer shall have provisions for future addition of automatically controlled fans for forced-air-cooling.
    - b. Transformer shall be forced-air-cooled. Forced-air-cooling fans shall have automatic temperature control relay and winding temperature indicator with sequence contacts.
- H. Transformer energy efficiency shall comply with NEMA TP 1.

## 2.5 LOW VOLTAGE SECTION

- A. Refer to Section 26 23 00, LOW-VOLTAGE SWITCHGEAR.
- B. Refer to Section 26 24 13, DISTRIBUTION SWITCHBOARDS.

## 2.6 AUXILIARIES

- A. Install additional components as shown on the drawings or otherwise required for the substations.
- B. Provide 120-volt heaters in incoming section, dry-type transformer section. Heaters shall be of sufficient capacity to control moisture condensation in the compartments, shall be 250 watts minimum, and shall be controlled by a thermostat and humidistat located in each section. Thermostat shall be industrial type, high limit, to maintain compartments within the range of 15.5 to 32.2 degrees C (60 to 90 degrees F).

Humidistat shall have a range of 30 to 60 percent relative humidity. If heater voltage is different than substation secondary voltage, provide transformer rated to carry 125 percent of heater full load rating. Transformer shall have 220 degrees C insulation system with a temperature rise not exceeding 115 degrees C and shall conform to NEMA ST 20. Energize electric heaters while the substation is in storage or in place prior to being placed in service. Provide method for easy connection of heater to external power source.

## **PART 3 – EXECUTION**

### **3.1 INSTALLATION**

- A. Install substations in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.
- B. Coordinate the components of the substations and their arrangements electrically and mechanically. Coordinate all circuit entrances into the substations, including methods of entrance and connections.
- C. Anchor substations with rustproof bolts, nuts, and washers not less than 13 mm (1/2 inch) diameter, in accordance with manufacturer's instructions, and as shown on the drawings.
- D. In seismic areas, substations shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed.
- E. Interior Location. Mount substations on concrete slab. Unless otherwise indicated, the slab shall be at least 100 mm (4 inches) thick. The top of the concrete slab shall be approximately 100 mm (4 inches) above finished floor. Edges above floor shall have 15 mm (1/2 inch) chamfer. The slab shall be of adequate size to project at least 100 mm (8 inches) beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm (3 inches) above slab surface. Concrete work shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- F. Substation Grounding:
  - 1. Provide bare copper cable not smaller than No. 4/0 AWG not less than 610 mm (24 inches) below grade, interconnecting the indicated ground rods.
  - 2. Surge arresters (if applicable) and neutral shall be bonded directly to the transformer enclosure, and then to the grounding electrode system with bare copper conductors, sized as shown. Lead lengths shall be kept as short as practical with no kinks or sharp bends.

### **3.2 ACCEPTANCE CHECKS AND TESTS**

- A. Perform tests in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Medium-Voltage Section Tests:
    - a. Refer to Section 26 13 16, MEDIUM-VOLTAGE FUSIBLE INTERRUPTER SWITCHES.

2. Transformer Inspection and Tests:
  - a. Compare equipment nameplate data with specifications and approved shop drawings.
  - b. Inspect physical and mechanical condition. Check for damaged or cracked insulators and liquid leaks.
  - c. Verify that cooling fans operate correctly and that fan motors have correct overcurrent protection.
  - d. Inspect all field-installed bolted electrical connections, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey after energization under load.
  - e. Perform specific inspections and mechanical tests as recommended by manufacturer.
  - f. Verify correct equipment grounding.
  - g. Verify that the tap-changer is set at specified ratio.
  - h. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.
3. Low-Voltage Section Tests:
  - a. Refer to Section 26 23 00, LOW VOLTAGE SWITCHGEAR Section 26 24 13, DISTRIBUTION SWITCHBOARDS.

### 3.3 FOLLOW-UP VERIFICATION

- A. Upon completion of acceptance checks, settings, and tests, the Contractor shall demonstrate that the substations are in good operating condition and properly performing the intended function.

### 3.4 TEMPORARY HEATING

- A. Apply temporary heat to substations, according to manufacturer's written instructions, throughout periods when the environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

### 3.5 ONE LINE DIAGRAM AND SEQUENCE OF OPERATION

- A. At final inspection, an as-built one line diagram shall be laminated or mounted under acrylic glass, and installed in a frame mounted in the substation room or in the outdoor substation enclosure.
- B. Furnish a written sequence of operation for the substation and connected line side/load side electrical distribution equipment. The sequence of operation shall be laminated or mounted under acrylic glass, and installed in a frame mounted in the substation room or in the outdoor substation enclosure.
- C. Deliver an additional four copies of the as-built one line diagram and sequence of operation to the COR.

### 3.6 INSTRUCTION

- A. Furnish the services of a factory-trained technician for one 4-hour training period for instructing personnel in the maintenance and operation of the substations, on the dates requested by the COR.

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