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 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 13, MEDIUM-VOLTAGE CABLES: Medium-voltage cables.

C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

D. 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.

E. Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY: Short circuit, coordination and arc-flash study, and requirements for a coordinated electrical system.

F. Section 26 12 19, PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

A. Factory Tests shall be required.

B. Factory Tests shall be in accordance with Paragraph, MANUFACTURED PRODUCTS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirement:

1. 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:

   a. Transformer Section:

      1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground.

      2) Perform turns-ratio tests at all tap positions.

1.5 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

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.
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 318-14.....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 3487-16.....Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus.

D. International Code Council (ICC):

IBC-15.....International Building Code

E. Institute of Electrical and Electronic Engineers (IEEE):

C37.121-12 .....Guide for Switchgear - Unit Substations — Requirements

C57.12.00-15.....General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

C57.12.01-15.....General Requirements for Dry-Type Distribution and Power Transformers

C62.11-12.....Metal Oxide Surge Arresters for AC Power Circuits (> 1kV)

C62.41-91.....Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits

F. National Electrical Manufacturers Association (NEMA):
TR 1-13.....Transformers, Step Voltage Regulators and Reactors

G. National Fire Protection Association (NFPA):
70-17.....National Electrical Code (NEC)

H. United States Department of Energy
10 CFR Part 431.....Energy Efficiency Program for Certain Commercial and Industrial Equipment

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Unless otherwise specified, substations shall be in accordance with ANSI, ASTM, IEEE, NFPA, UL, 10 CFR Part 431, 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 liquid-filled transformer.

C. Substations shall be designed, manufactured, and rated for indoor installation and service. External doors shall have provisions for padlocking.

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. 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. Interrupting ratings shall be not less than the maximum short circuit current available, as shown on the drawings.

2.3 LIQUID-FILLED TRANSFORMERS

A. Shall have the following features:

1. Self-cooled by natural convection, with isolated windings.

2. Auto-transformers will not be accepted.
3. Ratings indicated are for continuous-duty without the use of cooling fans.
4. Temperature rises shall not exceed the following NEMA Standard test values for the respective insulation systems: 65 degrees C (149 degrees F) by resistance and 80 degrees C (176 degrees F) hottest spot.
5. Transformer insulating liquid shall be:
   a. Mineral oil: ASTM D 3487, Type II, tested in accordance with ASTM D 117
6. Nominal impedance shall be as shown on the drawings, but not less than 4-1/2 percent.
7. Sound levels shall conform to 3 dB below the NEMA standards.
8. Primary and secondary windings:
   a. Windings shall be copper.
   b. Primary windings shall be delta-connected.
   c. Secondary windings shall be wye-connected except where otherwise shown on the drawings.
   d. Leads shall be brought out through wet process, porcelain bushings, pressure-tight.
   e. Secondary windings shall have neutral bushings for transformers with wye-connected secondary windings.
   f. Terminals shall be the most suitable clamp or blade type as required for the circuit connections.
9. Provide four, 2-1/2 percent full capacity taps in the primary windings, with two taps above rated voltage and two taps below rated voltage.
10. Core and Coil Assemblies:
    a. Assemblies shall be rigidly braced to withstand the stresses caused by rough handling during shipment and the stresses caused by short circuit currents.
    b. Cores shall be grain-oriented, non-aging, silicon steel.
    c. Coils shall be continuous windings without splices except for taps.
    d. Coil loss and core loss shall be optimized for efficient operation.
    e. Primary, secondary, and tap connections shall be brazed or pressure type.

f. Coil windings shall have end fillers or tie downs.

11. Tanks, covers, and radiators shall be steel.

12. Features and accessories shall include the following:

a. Tap changer.

b. Lifting, pulling, and jacking provisions.

c. Globe type valves for filtering and draining.

d. Grounding pad.

e. Dial-type liquid thermometer with a maximum reading pointer and an external reset.

f. Liquid level gauge.

g. Pressure relief device.

h. Diagrammatic nameplate, including date of manufacture.

i. Auxiliary cooling equipment and controls.

1) Transformer shall be forced-air cooled. Forced-air cooling fans shall have cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm silencing relay.

13. Transformer energy efficiency shall comply with the United States Department of Energy’s 10 CFR Part 431.//

B. Transformer shall be rated 2,000kVA rating as shown on the drawings. 60kV BIL primary and 10 kV BIL secondary.

C. 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.

D. Provide four 2-1/2 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.

E. Features and accessories shall include the following:

1. Winding temperature indicator.

2. Auxiliary cooling equipment and controls.

a. Transformer shall be forced-air-cooled. Forced-air-cooling fans shall have automatic temperature control relay and winding temperature indicator with sequence contacts.

F. Transformer energy efficiency shall comply with the United States Department of Energy’s 10 CFR Part 431.

2.4 AUXILIARIES

A. Install additional components as shown on the drawings or otherwise required for the substations.

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. 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.

E. Substation Grounding:

1. Provide bare copper cable not smaller than No. 4/0 AWG, and not less than 610 mm (24 inches) below grade, interconnecting with the 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 on the drawings. 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 13, MEDIUM-VOLTAGE CIRCUIT BREAKER SWITCHGEAR.
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. 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.
   d. Verify correct liquid level in transformer tank.
   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.

3.3 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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