

**SECTION 26 11 16  
SECONDARY UNIT SUBSTATIONS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies the furnishing, installation, and connection of the secondary unit substation, complete and ready for operation.
- B. The secondary unit substation shall consist of primary equipment, transformer and secondary equipment as specified below. The manufacturer of the unit substation shall furnish and coordinate all major components of the substations, including incoming primary equipment section, transformer and low-voltage section, as well as circuit breakers, fusible switches, and metering components. Provide a single warranty covering all substation assemblies, transformers and components.

**1.2 RELATED WORK:**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlet boxes.
- C. Section 26 05 13, MEDIUM-VOLTAGE CABLES: High voltage cables.
- D. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW: Cable and wiring.
- E. 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.
- F. Section 26 24 11, DISTRIBUTION SWITCHBOARDS: Secondary distribution switchboards.

**1.3 FACTORY TESTING:**

- A. Substations shall be thoroughly tested at the factory to assure that there are no electrical or mechanical defects. All tests shall be in accordance with the latest version of ANSI and NEMA standards. Factory tests shall be certified.

**1.4 SUBMITTALS:**

Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:

- A. Shop Drawings:

1. Include sufficient information, clearly presented, to determine compliance with drawings and specifications.
  2. Include electrical ratings, dimensions, mounting details, winding materials, required clearances, terminations, fuses (if required), safety features, weight, decibel rating, temperature rise, nominal impedance, regulation, no load and full load losses, wiring and connection diagrams, front, side and rear elevations, sectional views, coordination curves, accessories and nameplate data.
- B. Manuals:
1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts. It shall also include installation, operating instructions, maintenance, trouble shooting and repair procedures and technical literature pertaining to all components or instruments provided.
  2. Two weeks prior to final inspection, submit four copies of the final up-dated maintenance and operating manuals to the COTR.
- C. Certificates:
1. Two weeks prior to final inspection, submit four copies of the following to the COTR:
    - a. Certification by the Contractor that the substations have been properly installed, adjusted, and tested, including final circuit breaker settings.
    - b. Certified copies of all of the factory design and production tests, field test data sheets and reports for the substations.
- D. Manufacturer Seismic Qualification Certification: Submit certification that the switchgear, overcurrent protective devices, accessories, and components will withstand seismic forces at location being installed. Include the following:
1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term “withstand” means “the unit remain in place without separation of any parts from the equipment when subjected to the seismic forces as per specification Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS, and the unit will be fully operational after the seismic event”.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

#### **1.5 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 318-02..... Building Code Requirements for Structural Concrete.
- C. American Society for Testing and Materials (ASTM):  
  
D3487-00..... Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus.
- D. Institute of Electrical and Electronic Engineers (IEEE), National Electrical Manufacturers Association (NEMA), American National Standards Institute(ANSI):  
  
NEMA SG4, SG5; ANSI C37 - MV Metal-Enclosed Switchgear  
NEMA SG4, SG5; ANSI C37 - MV Load Interrupter Switchgear –  
NEMA 210, IEEE 100, ANSI C57 - Secondary Substation Transformers  
ANSI C37, UL 1558 - LV Metal-Enclosed Switchgear –  
C62.11-99..... Metal Oxide Surge Arresters for AC Power Circuits  
  
C62.41-95.....Surge Voltage in Low Voltage AC Power circuits
- E. National Fire Protection Association (NFPA):  
  
70..... National Electrical Code (NEC)

## **PART 2 - PRODUCTS**

### **2.0 MANUFACTURERS**

- A. Eaton / Cutler-Hammer
- B. General Electric
- C. Square D

Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

### **2.1 GENERAL REQUIREMENTS:**

- A. Unit substations shall be in accordance with ASTM, ANSI, IEEE, NEC, and as shown on the drawings.
- B. The substations shall be complete, grounded, continuous-duty, unitized integral assembly, metal clad, dead-front, dead-rear types, with liquid-immersed transformers.
- C. 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 maximum short circuit currents available, where the substation is being installed, as shown on the drawings.
- D. Provide substations that conform to the arrangements and details shown on the drawings and to the space designated for installation.

- E. 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.
- F. The substation equipment shall have the capability to withstand and interrupt fault currents supplied by the utility.
- G. Incorporate interlocking as shown on the drawings and as required for the safe operation of the substations.
- H. The substation shall be assembled and prewired by the manufacturer at the factory.
- I. Substation shall be thoroughly cleaned, phosphate treated and painted at the factory with rust-inhibiting paint and baked enamel or lacquer light gray finish.
- J. Coordinate the high and low voltage sections with their associated transformers. Sections shall be fabricated by a single manufacturer.
- K. Bolts, nuts and washers shall be rustproof metal, corrosion resistant (zinc chrome plated).

## **2.2 MEDIUM VOLTAGE SECTION:**

### **A. RATINGS**

- |    |                        |                                  |
|----|------------------------|----------------------------------|
| 1. | Nominal System Voltage | 12.47 kV, three-phase, four wire |
| 2. | System Grounding       | solid                            |
| 3. | Maximum Design Voltage | 15 kV                            |
| 4. | BIL                    | 95 kV                            |
| 5. | Continuous Current     | 600A                             |
| 6. | Momentary Current      | 40 kA rms Asymmetrical           |

- B. Housing shall be of indoor outdoor type.

### **C. Preformed Terminations:**

- 1. May be used for cables.
- 2. Shall conform to the requirements in Section 26 05 13, MEDIUM-VOLTAGE CABLES.
- 3. Independently support each cable by a clamp to a structural support within 152.4 mm (6 inches) of the termination to relieve any strain imposed by cable weight or movement.

### **D. High Voltage Fused Switches:**

- 1. Shall have the following features:
  - a. Air-break, gang-operated, rated load interrupter type.
  - b. Quick-make, quick-break, operating mechanisms.
  - c. Copper blades.

- d. A separate door for the fuse section. A mechanical interlock shall prevent opening the door unless the switch blades are open.
  - e. A manual operating handle with lock-open padlocking provisions.
  - f. When the switches are open, the fuses shall be de-energized.
  - g. Phase barriers for the full length of the blades and fuses for each pole.
  - h. A protective shield to cover the cable connections on the line terminals.
  - i. A safety window for viewing the switch blades.
2. Provide fuses of the current limiting power type.
- E. Interrupting ratings for the switches shall be not less than the maximum short circuit current available where the substation is being installed, as shown on the drawings.

## 2.3 DRY TYPE TRANSFORMER:

### A. RATINGS

The ratings of the transformer shall be as follows or as shown on the drawings:

kVA Rating	1000/1333	AA/FA
Impedance	5.75 %	ANSI Standard Tolerance
HV	12.47	kV Delta
HV BIL	95	kV
HV De-energized Taps	+/- 2 - 2-1/2%	full capacity
LV	480	Volts Wye
LV BIL	1	kV

### B. CONSTRUCTION

1. Forced air (FA) units all necessary components and wiring, including fans, for automatically increasing the kVA rating by 33%. The (FA) package shall include an electronic temperature monitor and fan control unit. The temperature monitor and fan control shall include digital readout, GREEN – power on, YELLOW – fan on, RED – high temperature indicating lights; audible high temperature alarm with alarm silence pushbutton; maximum temperature memory with read and reset switch; auto/manual fan control switch, system test switch; temperature sensing in all three low-voltage coils. Auxiliary alarm contact and means for remote control and temperature monitoring shall be provided. Control power shall be provided from a control power transformer in the secondary equipment.
  - a. The electrical insulation system shall utilize Class H material in a fully rated 220 degrees C system. Transformer design temperature rise shall be based on a 30 degrees C average ambient over a 24-hour period with a maximum of 40 degrees C. Solid insulation in the transformer shall consist of inorganic materials such as porcelain, glass fiber, electrical grade glass polyester,

electrical grade epoxy, or Nomex. All insulating materials must be rated for continuous 220 degree C duty. The insulation between the high- and low-voltage coils shall be more than sufficient for the voltage stress without the need of a varnish.

2. The transformer shall be designed for a temperature rise of 150 degrees C and shall be capable of operating at 0 % above base nameplate kVA capacity continuously without any loss of life.
3. The transformer shall be designed to meet the sound level standards for dry-type transformers as defined in NEMA TR1. The measurement procedure shall be as specified in ANSI C57.12.90.
4. The transformer shall be UL labeled.
5. The transformer shall be of explosion-resistant, fire-resistant, air-insulated, ventilated dry-type construction, and cooled by the natural circulation of air through the windings.
6. High-voltage and low-voltage windings shall be copper. Insulation between layers of the windings shall be by Insuldur paper or equal.
7. The high- and low-voltage coil assembly shall be Vacuum Pressure Impregnated (VPI) polyester.
8. The transformer shall be supplied in a knockdown case design, for ease in fitting through limited openings, and shall be of heavy gauge sheet steel construction, equipped with removable panels for access to the core and coils. Front and rear panels shall incorporate lowered ventilating grills.

C. ACCESSORIES:

Transformer shall include:

1. Diagram instruction plate
2. Provisions for lifting and jacking
3. Removable center panel for access to high-voltage strap-type connector taps for de-energized tap changing
4. Two ground pads with continuous ground bus.

## 2.4 SECONDARY EQUIPMENT

### A. MANUFACTURERS

1. Cutler-Hammer
2. Schneider Electric
3. General Electric
4. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

### B. RATINGS

1. Voltage rating shall be as indicated on the drawings. The entire assembly shall be suitable for 600 volts maximum AC service.

2. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of 65,000.
3. The bus system shall have a minimum ANSI 4-cycle short-circuit withstand rating of 100,000 amperes symmetrical.
4. All circuit breakers shall have a minimum symmetrical interrupting capacity of 65,000 amperes. To ensure a fully selective system, all circuit breakers shall have 30 cycle short-time withstand ratings equal to their symmetrical interrupting ratings, regardless of whether equipped with instantaneous trip protection or not.
5. All ratings shall be tested to the requirements of ANSI C37.20.1, C37.50 and C37.51 and UL witnessed and approved.

### C. CONSTRUCTION

1. The switchgear shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide ventilators located on the top of the switchgear over the breaker and bus compartments to ensure adequate ventilation within the enclosure.
2. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills providing the floor is level to 1/8 inch per 3-foot distance in any direction. Provisions shall be made for jacking of shipping groups, for removal of skids or insertion of equipment rollers. Base of assembly shall be suitable for rolling directly on pipes without skids.
3. Each vertical steel unit forming part of the switchgear line-up shall be a self-contained housing having one or more individual breaker or instrument compartments and a centralized bus compartment. A front cable access compartment shall be provided as part of, or beside each breaker structure. Each individual circuit breaker compartment shall be segregated from adjacent compartments and sections by means of steel barriers to the maximum extent possible. It shall be equipped with drawout rails and primary and secondary disconnecting contacts. Removable hinge pins shall be provided on the breaker compartment door hinges. Current transformers for feeder instrumentation, where shown on the plans, shall be located within the appropriate breaker cells and be front accessible and removable.
4. The circuit breaker door design shall be such that the following functions may be performed without the need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.
5. The removable power circuit breaker element shall be equipped with disconnecting contacts and interlocks for drawout application. It shall have four positions, "connected," "test," "disconnected" and "removed." The breaker drawout element shall contain a worm gear levering "in" and "out"

mechanism with removable lever crank. Levering shall be accomplished via the use of conventional tools. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering "in" or "out" of the cell. The breaker shall include an optional provision for key locking open to prevent manual or electric closing. Padlocking shall provide for securing the breaker in the connected, test, or disconnected position by preventing levering.

#### D. BUS

1. All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on ANSI standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).
2. The vertical bus in each section shall be arranged so that the circuit breaker modules shall be easily and quickly inserted or withdrawn. The vertical bus bars in each section shall be copper. The vertical bus in each distribution section shall be extended to the maximum height available in the section. This shall allow for the future addition of feeder breakers without modification of the vertical bus.
3. Provide a full capacity neutral bus where a neutral bus is indicated on the drawings.
4. A copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear. The ground bus short-time withstand rating shall meet that of the largest circuit breaker within the assembly.

#### E. WIRING/TERMINATIONS

1. Small wiring, necessary fuse blocks and terminal blocks within the switchgear shall be furnished as required. Control components mounted within the assembly shall be suitably marked for identification corresponding to the appropriate designations on manufacturer's wiring diagrams.
2. Provide a front accessible, isolated vertical wireway for routing of factory and field wiring. Factory provisions shall be made for securing field wiring without the need for adhesive wire anchors.
3. Front access to all circuit breaker secondary connection points shall be provided for ease of troubleshooting and connection to external field connections without the need of removing the circuit breaker for access.
4. All control wire shall be type SIS. Wire bundles shall be secured with nylon ties and anchored to the assembly with the use of pre-punched wire lances or nylon non-adhesive anchors. All current transformer secondary leads shall first be connected to conveniently accessible shorting terminal blocks before connecting to any other device. Shorting screws with provisions for storage shall be provided. All groups of control wires leaving the switchgear shall be provided with terminal blocks with suitable numbering strips and provisions for #10 AWG field connections.



5. NEMA 2-hole mechanical-type lugs shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size indicated on the drawings.
6. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.

#### F. CIRCUIT BREAKERS

1. All protective devices shall be low voltage power circuit breakers, Cutler-Hammer type Magnum DS, similar or approved equal. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.
2. Breakers shall be provided in drawout configuration.
3. Power circuit breakers shall utilize a two-step stored-energy mechanism to charge the closing springs. The closing of the breaker contacts shall automatically charge the opening springs to ensure quick-break operation.
4. Breakers shall be manually operated (MO) unless electrically operated (EO) is indicated on the drawings.
5. Electrically operated breakers shall be complete with 120V AC motor operators. The charging time of the motor shall not exceed 6 seconds.
6. The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

#### G. TRIP UNITS

1. Each low voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip.
2. The trip unit shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.
3. The trip unit shall be provided with a display panel, including a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.
4. Trip unit shall have selectable thermal memory for enhanced circuit protection.
5. All circuit breakers shall have adjustments for long delay pickup and time, individual adjustments for short delay pickup and time, adjustable instantaneous pickup, and individually adjustable ground fault current pickup and time.

6. The trip unit shall have a 4-character LCD display showing phase, neutral, and ground current. The accuracy of these readings shall be +/- 2% of full scale.

#### H. ENCLOSURES

1. NEMA 1 Enclosure, fully front accessible.

#### I. NAMEPLATES

1. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16-inch high, minimum.
2. Furnish master nameplate giving switchgear designation, voltage ampere rating, short-circuit rating, and manufacturer's name.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION:

- A. Install the equipment in accordance with the NEC, as shown on the drawings and as recommended by the equipment manufacturer.
- B. Foundations:
  1. Provide foundations of reinforced concrete, Type C (3000 psi minimum, 28 day compressive strength), and comply with the ACI 318.
  2. Locate the top of the foundation pad 152.4 mm (6 inches) above the adjacent finished grade unless otherwise shown on the drawings. Refer to drawings for size, location, and structural steel reinforcing required.
  3. Grade the adjacent terrain so that surface water will flow away from the foundation.
  4. Anchor the unit with rustproofed bolts not less than 12.5 mm (1/2 inch). In seismic areas, substation shall be adequately anchored and braced to withstand the seismic forces at the location where installed.

#### 3.2 INSTRUCTIONS:

- A. Furnish the services of a competent instructor for two, 4 hour periods for instructing personnel in the operation and maintenance of the substation, on the date requested by the COTR.

END OF SECTION 26 11 16