SECTION 261300.01 - PAD MOUNTED MEDIUM VOLTAGE DISTRIBUTION SWITCHGEAR

PART 1 - GENERAL

1.1 This specification applies to liquid-insulated, 25kV 60Hz Class, single phase pad mounted load interrupting and vacuum fault interrupting assemblies with maximum continuous ratings of 200A for use on underground distribution systems utilizing dead front equipment.

1.2 The switchgear shall be in accordance with the project one-line diagram and shall conform to the following specification.

1.3 DEFINITIONS

A. AISI: American Iron and Steel Institute.

B. ASTM: American Society for Testing and Materials

C. ANSI: American National Standards Institute.

D. BIL: Basic Impulse Insulation Level.

E. Bus (as used in this specification): A three-phase junction common to two or more ways.

F. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

G. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted switchgear and to provide a fully insulated connection. Also called an "elbow connector."

H. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or non-load break, separable insulated connector (bushing).

I. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).

J. Dead Front Padmounted Switchgear: An assembly in which all energized parts are insulated and completely enclosed within a grounded shield system when separable connectors are in place.

K. Fault Interrupter: A self-controlled mechanical switching device capable of making, carrying, and automatically interrupting an alternating current. A fault interrupter always consists of a switching device, a control unit, and sensors for current and/or voltage sensing. Only vacuum fault interrupters and vacuum load break switches are to be used.

L. Hotstick: An insulated stick, usually made of fiberglass, that is used to work energized overhead conductors and operate electrical equipment that is overhead, underground, and compartmentalized.

M. IEC: International Electrotechnical Commission.

N. IEEE: Institute of Electrical and Electronics Engineers.

O. NEMA: National Electrical Manufacturers Association.

P. NETA ATS: InterNational Electrical Testing Association, Acceptance Testing Specification.

Q. SCADA: Supervisory control and data acquisition.

R. Switched Way: A way connected to the bus through a three-pole gang operated switch.

S. Tapped Way: A way solidly connected to the bus.

T. Way: A three-phase or single-phase circuit connection to the bus that may contain combinations of switches and protective devices or may be a solid bus.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Time-current characteristic curves for overcurrent protective devices.

B. Shop Drawings: For pad-mounted switchgear.

1. Include a tabulation of installed devices with features and ratings.
2. Include dimensioned plans and elevations, showing dimensions, shipping sections, and weights of each assembled section. Elevations shall show major components and features, and they will mimic bus diagram.
3. Include a plan view and cross section of equipment base showing clearances, manufacturer's recommended work space, and locations of penetrations for grounding and conduits. Show location of anchor bolts.
4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, and location and size of each field connection.
5. Include list of materials.
6. Include single-line diagram.
7. Include control power wiring diagrams.

8. Include copy of nameplate.
9. Switchgear Ratings:

    a. Voltage.
    b. Continuous current.
    c. Short-circuit rating.
    d. BIL.

10. Interface data with monitoring or control network.
11. Wiring Diagrams: For each switchgear assembly, include the following:

    a. Power, signal, and control wiring.
    b. Three-line diagrams of current and future secondary circuits, showing device terminal numbers and internal diagrams.
    c. Schematic control diagrams.
    d. Diagrams showing connections of component devices and equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency

B. Source quality-control reports.

C. Field quality-control reports

D. Warranty Information:

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in "Field Quality Control" Article.

1.7 MANUFACTURERS

A. The pad mounted switchgears shall be as follows: Two (2) ways, Three (3) ways, or Four (4) ways, with 200 amp load interrupter switches, and 200 amp fault interrupter switches, as manufactured by:

1. Trayer Engineering Corporation
2. S&C Vista Underground Distribution Switchgear
3. Eaton/Cooper Power Series
4. Approved Equal

1.8 GENERAL DESCRIPTION

A. The pad mounted switchgear shall consist of vacuum interrupted, FR3 liquid filled design. In lieu of FR3, SF6 gas is also acceptable. Load-interrupter switches with in-series visible disconnect switches, and resettable vacuum fault interrupters, current sensing, low-voltage compartment/enclosure, microprocessor-based overcurrent control for the fault interrupters. Load-interrupter switch terminals shall be equipped with bushings rated 200 amperes continuous, and fault-interrupter terminals shall be equipped with bushing wells rated 200 amperes continuous to provide for elbow connection.

1.9 RATINGS

The ratings for the integrated switchgear shall be as designated below:

- Frequency, Hz: 60
- Short-Circuit Current, Amperes, RMS, Symmetrical: 12,500
- Voltage Class, kV: 25
- BIL Voltage, kV: 125
- Main Bus Continuous Current, Amperes: 200
- Three-Pole Load-Interrupter Switches. Continuous Current, Amperes: 200
- Load Dropping Current, Amperes: 200
- Fault Closing Current, Duty-Cycle, Three-Time, Amperes, RMS, Symmetrical: 12,500
- Number of fault interruptions at 12.5kA: 65
- Only vacuum loadbreak interrupters with switch mechanisms that have a minimum life of 10,000 operations at a full load without need for service, replacements or adjustments shall be provided.
- Only vacuum fault interrupters with mechanisms that have a minimum life of 8,000 load break operations without need for service, replacements or adjustments shall be provided.

1.10 CERTIFICATION OF RATINGS

A. The manufacturer of the switchgear shall be completely and solely responsible for the performance of the load-interrupter switch and fault interrupter as well as the complete integrated assembly as rated.

B. The manufacturer shall furnish, upon request, certification of ratings of the load-interrupter switch, fault interrupter, and the integrated switchgear assembly consisting of switches and fault interrupters in combination with the gas-tight tank.

1.11 COMPLIANCE WITH STANDARDS AND CODES:

The switchgear shall conform to or exceed the applicable requirements of the following standards and codes:

A. The applicable portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment, and ANSI C57.12.29, covering enclosure integrity for pad-mounted equipment in Coastal Environments

B. The applicable portions of ANSI C37.71, ANSI C37.72, ANSI C37.73, IEC 56, and IEC 265-1 (Class A), which specify test procedures and sequences for the load-interrupter switches, fault interrupters, and the complete switchgear assembly.

PART 2 - CONSTRUCTION REQUIRMENTS

2.1 TANK CONSTRUCTION FLUID INSULATION (not applicable to switchgear containing SF_6 gas)

A. The entire assembly shall be constructed of AISI type 304L stainless steel and shall be fully welded, including the bushings, using AISI type 308 filler material to maintain the corrosion resistant properties. No bolted/gasketed tank construction shall be allowed. Bolted/gasketed viewing windows will be acceptable.

B. The tank body shall be constructed with a minimum material thickness of AISA 7 ga.

C. Lifting lugs shall be welded to the tank so that the switch will remain level when being lifted. Lifting lugs shall have a rounded contour to limit damage to lifting slings.

D. All bushings and bushing wells to be welded to make them an integral part of the tank. No bolted/gasketed bushings shall be allowed.

E. Bushings shall be arranged horizontally or diagonally to allow for easy cable training.

F. The entire switch tank shall be hermetically sealed and be fully submersible with all tank penetrations being double o-ring sealed.

G. No external portion of the tank or its accessories shall trap water.

H. Lifting lugs shall be welded to the tank so that the switch will remain level when being lifted. Lifting lugs shall have a rounded contour to limit damage to lifting slings.

I. Parking stands shall be provided and located to allow each way to be parked with a minimum elbow and cable movement distance (for parking stand dimensions see ANSI C57.12.26-1975, Fig 5[2]).

J. One grounding provision with a 1/2″ 13 NC stainless steel nut, 7/16″ (11.1mm) deep, shall be provided for each way and shall be located to allow easy access for grounding each way. The grounding provision shall be welded to the switch tank.

K. A liquid level indicating device shall be provided to positively identify a low liquid level condition. This device shall display, in white letters on a red background, the words "LOW OIL" when the liquid level drops below prescribed limits. This device shall be static with no moving parts and shall be unaffected by the environmental conditions for the life of the switchgear assembly.

2.2 TANK CONSTRUCTION SF_6-GAS INSULATION (not applicable to switchgear containing less flammable fluid)

A. The entire assembly shall be constructed of AISI type 304 stainless steel and shall be fully welded using AISI type 308 filler material to maintain the corrosion resistant properties. No bolted/gasketed tank construction shall be allowed. Bolted/gasketed viewing windows and wire penetrations shall be allowed.

B. The tank body shall be constructed with a minimum material thickness of AISI 7 ga.

C. All bushings and bushing wells to be welded to make them an integral part of the tank. No bolted/gasketed bushings shall be allowed.

D. Bushings shall be arranged in a slanted vertical fashion to allow for easy cable training.

E. The entire switch tank shall be hermetically sealed and be fully submersible with all tank penetrations being double o-ring sealed.

F. No external portion of the tank or its accessories shall trap water.

G. Lifting lugs shall be welded to the tank so that the switch will remain level when being lifted. Lifting lugs shall have a rounded contour to limit damage to lifting slings.

H. Parking stands shall be provided and located to allow each way to be parked with a minimum elbow and cable movement distance. (For parking stand dimensions see ANSI C57.12.26-1975, Fig 5[2])

I. One grounding provision with a 1/2″ 13 NC stainless steel nut, 7/16″ (11.1mm) deep, shall be provided for each way and shall be located allowing easy access for grounding each way. The grounding provision shall be welded to the switch tank.

2.3 ELECTRICAL

A. The switchgear shall be of total dead front design. All energized parts shall be sealed behind a welded ground plane to avoid the possibility of exposure to electrical shock when separable connectors are in place.

B. The load interrupter switch shall be a single phase device of a quick- make, quick-break design that operates at a speed independent of the speed of the external operating handle and shall utilize vacuum contacts rated at 200A continuous and 20,000A asymmetrical momentary. The mechanism shall have a minimum life of 10,000 operations at a full load without the need for service, replacements, or adjustments.

C. The fault interrupters shall be a single phase device of a quick-make, quick-break design that operates at a speed independent of the speed of the external operating handle and shall utilize vacuum contacts rated 200A continuous, 12,500A RMS symmetrical fault interrupting, 20,000A asymmetrical momentary, and shall have a minimum life of 8,000 load break operations at a full load without the need for service, replacements, or adjustment. The fault interrupter trip

mechanism shall be solenoid actuated and shall have capacitor energy storage devices to provide trip power.

D. The three position visible disconnect device shall be a single phase three position gang operated open-blade switch device of a quick-make, quick-break design that operates at a speed independent of the speed of the external operating handle and shall be rated at 200A continuous and 20,000A asymmetrical momentary, to be used in series with a fault interrupter switch or a load interrupter switch to establish a visible open or visible ground on the circuit. The contacts of the visible disconnect device shall be clearly visible in the open and closed positions through a window located on the tank face adjacent to the operating handles. The visible disconnect can be locked in any position. There is a manually operated interlock to prevent moving the handle from the closed position to the grounded position or from the grounded position to the closed position.

2.4 VIEWING WINDOWS

A. Each load-interrupter switch shall be provided with a viewing window to allow visual verification of the switch-blade position (closed, open, and grounded) while shining a flashlight on the blades.

2.5 HIGH-VOLTAGE BUS

A. Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the switchgear.

B. All internal bus shall be of copper bar or copper ribbon; no braid shall be used and no aluminum shall be used. All internal electrical clearances shall be a minimum of 2.25″ to maintain a 125kV BIL rating for the bus work. All bushing connections shall be double nut secured to maintain connection integrity.

2.6 PROVISIONS FOR GROUNDING

A. Provide a ground rod extending along both sides of the switchgear.

2.7 CONNECTIONS

A. Load-interrupter switches shall be equipped with 200-ampere busing wells, and fault interrupters shall be equipped with 200-ampere bushing wells.

B. All operating mechanisms shall be capable of manual operation with a hot stick. The operating handles will be parallel and flush to the tank face when closed and extended from the tank face when open.

2.8 BUSHINGS AND BUSHING WELLS

A. Bushings and bushing wells shall conform to ANSI/IEEE Standard 386.

PART 3 - BASIC COMPONENTS

3.1 DIELECTRIC (Liquid)

A. Unit shall utilize a liquid dielectric to insulate all internal components. Load and fault interruption shall take place in sealed vacuum contact bottles to protect the liquid insulation from exposure to arcing during load or fault interruption.

B. Provisions for adding liquid insulation shall be provided by means of a 1" NPT fill port located on the front face of the unit within the high-voltage compartment and provisions for draining or sampling shall be made available as an optional feature.

C. A liquid level indicating device shall be provided to positively identify a low liquid level condition. This device shall display, in white letters on a red background, the words "LOW OIL" when the liquid level drops below prescribed limits. This device shall be static with no moving parts and shall be unaffected by the environmental conditions for the life of the switchgear assembly.

3.2 DIELECTRIC (SF6 Gas)

A. Unit shall utilize SF_6 gas dielectric to insulate all internal components. Load and fault interruption shall take place in sealed vacuum contact bottles to protect the insulation from exposure to arcing during load or fault interruption.

B. Provisions for adding SF_6 insulation shall be provided by means of a stainless steel Dillo type valve located on the front face or top of the switchgear tank adjacent to the pressure gauge.

C. A pressure gauge shall be provided for confirmation of the internal dielectric pressure. The gauge shall be color coded to show safe operating limits, and a temperature conversion chart shall be provided near the pressure gauge.

3.3 MANUAL OPERATING PROVISIONS

A. Manual operating handles shall move in to close and out to open. The direction of operation shall be apparent.

B. Switch, VFI, and visible disconnect device operating handles shall be designed to be easily operated with standard live line tools. The handles shall be of a channel shape and formed from AISI type 304 stainless steel, with the lower edge of sufficient width to support the hook end of standard live line tools, and assist in guiding the hook into the handle opening for live line tool operation. They shall be located where they can be operated either to open or to closed positions

with standard live-line tools. The force required to operate the handle shall be such that one average strength person in a standing position can readily operate it.

C. Switch, VFI, and visible disconnect operating handles shall be capable of being padlocked in both the open and closed positions, and shall be labeled to clearly indicate switch position.

3.4 LOAD BREAK SWITCH, FAULT INTERRUPTER, AND VISIBLE DISCONNECT SWITCH OPERATIGN MECHANISM

A. The switch, fault interrupter, and visible disconnect switch mechanism shall be designed so that operation does not require any special skills, and the closing and opening speeds of the contacts are independent of the speed at which the operating handle is operated.

B. The switch, fault interrupter, and visible disconnect switch shall be of a gang operated, three-phase design so that all contacts of the three phases shall be operated simultaneously with no possibility of single phasing due to teasing of switch handle.

C. The switch, fault interrupter, and visible disconnect switch shall be quick-make, quick-break type. Contacts shall be stable in open and closed positions without use of mechanical latches, sear pins, or detents.

D. The fault interrupter mechanism shall be a single phase trip-free device. The trip mechanism shall reset and be trip-ready when the fault interrupters operating handle is moved to the open position. The trip mechanism shall function independently of the fault interrupters contact opening/closing mechanism such that if the device is closed into a fault the device will trip open and the tripping action will not be felt in the operating handle.

3.5 POSITION INDICATORS

A. Switch, fault interrupter, and visible disconnect switch handles shall act as position indicators that clearly and positively indicate the open and closed positions of the switch mechanisms. Nameplates of a corrosion resistant material shall be fixed to the switch tank adjacent to the operating handle to assist in identifying switch position.

B. Visible disconnect switch contact positions shall be clearly visible though a viewing window located near the operating handle.

C. Fault interrupters shall have an additional indicator to show a tripped condition. The indicator shall be of a mechanical design linked directly to the trip mechanism of the fault interrupter. Electronic or electrical devices will not be used. The indicator shall consist of a yellow indicator rod within a clear sight glass mounted adjacent to the fault interrupter's operating handle. The indicator shall be up within the sight glass and clearly visible during a tripped condition of the fault interrupter, and down, out of the sight glass, and concealed during a trip-ready condition of the fault interrupter.

3.6 MOTOR OPERATING PROVISIONS

A. Provisions for motor operators shall be standard and supplied with every unit. In general, motor operators are required on all load interrupter switches.

3.7 TERMINATIONS

A. The switch bushings shall accommodate cable terminations in accordance with ANSI/IEEE std. 380-1977.

3.8 BUSHING DESIGNATION

A. The switch bushings shall be identified and legibly marked adjacent to each bushing with the appropriate phase designation, using a nameplate of stainless steel or other corrosion resistant material.

3.9 OVERCURRENT PROTECTION AND CONTROL

A. A microprocessor-based protection and control relay shall be provided to initiate fault interruption. This relay shall be SEL 451 for up to two (2) tap ways, and SEL 487E for more than two (2) tap ways, no exceptions are acceptable. Relay shall have the Capability to:

1. Provide both phase and residual overcurrent protection with inverse, very inverse, or extremely inverse curves all available in the one relay. All applicable IEC and ANSI curves are preprogrammed into the relay and any custom curve can be added.
2. Provide monitoring of load with instantaneous and demand currents with 2% accuracy at nominal input.
3. Have a count of trip operations and accumulation of interrupter current on a pole-by-pole basis.
4. Have a time delay on pick-ups adjustable from 0-16,000 cycles to help in coordination and also in cold load pick-up situations.
5. Make a 15-cycle event report for each time the relay picks up on fault. The report to contain detailed current, relay element, and input and output data associated with the event.
6. Store summaries of the 20 latest events and full length reports for the 12 latest events.
7. Provide interface with future SCADA remote terminal units.
8. Protect from unauthorized relay setting changes with a pass-code system

B. The relay shall be mounted in the low voltage compartment/enclosure.

C. Power and sensing for the relay shall be supplied by integral current transformers and an integral potential transformer.

3.10 LOW-VOLTAGE COMPARTMENT/ENCLOSURE AND COMPONENTS

A. All electronic controls, relays, capacitor trip modules, and backup power capacitors shall be housed in a stainless steel enclosure outside and separate from the switch tank and the high voltage cable compartment.

B. The low-voltage compartment/enclosure shall be a separate, grounded structure, and shall allow maintenance without exposure to medium voltage.

C. All wire penetrations into the switch tank shall be grouped and potted in a liquid-tight synthetic dielectric compound and the potted group shall be o-ring sealed to the tank.

D. To guard against unauthorized or inadvertent entry, the low-voltage compartment/enclosure shall not have any externally accessible hardware.

E. The low-voltage compartment/enclosure shall include appropriate vents to prevent moisture buildup. Vents shall be screened and filtered to prevent entry of insects and shall be mounted to prevent rain entry and to minimize entry of dust into the enclosure.

F. Low-voltage wiring, except for short lengths, such as connections to terminal blocks, shall be shielded for isolation for medium voltage.

G. The low-voltage compartment/enclosure shall be made of "304L" stainless steel.

H. Control power for operating relays, charging capacitor trip modules, and charging backup power capacitors shall be provided by an internally mounted and fuse protected potential transformer bussed to the common bus such that no external power supply is required once the source-side cables are energized. The potential transformer fuse shall be mounted internally and shall have an externally available disconnect switch for the purpose of high voltage testing of the switchgear. Capacitor discharge switches shall be included on all capacitor trip modules and backup power capacitors to allow safe inspection and maintenance inside a stainless steel relay/control enclosure.

I. Single-point grounding methods shall be used on cabling between the tank and the low-voltage enclosure to protect electronic components from damage under surge and transient conditions.

PART 4 - SWITCHGEAR ENCLOSURE CONSTRUCTION

4.1 PAD-MOUNTED SWITCHGEAR STYLE

A. The front and rear enclosures shall be constructed of AISI type 304 stainless steel and shall be welded using AISI type 308 filler material to maintain the corrosion resistant properties.

B. The enclosure body and doors shall be constructed of a minimum material thickness of AISI 11ga. The lift-up top shall be constructed of a minimum material thickness of AISI 14ga.

C. The enclosure shall have double doors at the front with lift-up top. Both doors shall have provisions to latch the doors in the open position to prevent unintentional closing. The right-hand door shall have a three-point locking system with padlock provisions on the operating handle. The lift-up top shall have a self-setting automatic latching device to hold the top in the open position. The latching device must be manually released to lower the top and must be hook stick operable.

D. The enclosure doors shall include a fully encased and padlockable pentahead security bolt.

E. No external portion of the enclosure or its accessories shall trap water.

F. Because of the corrosion resistant nature of AISI type 304 stainless steel, only the outside of the enclosure will be painted. Paint processes shall meet or exceed ANSI std. C57.12.28. Color shall be Munsell 7GY 3.29/1.5 Padmount Green unless otherwise specified.

PART 5 - LABELING

5.1 HAZARD-ALERTING SIGNS

A. The exterior of the pad-mounted enclosure shall be provided with "Warning-Keep Out-Hazardous Voltage Inside-Can Shock, Burn, or Cause Death" signs.

B. Each unit of switchgear shall be provided with a "Danger-Keep Away-Hazardous Voltage-Will Shock, Burn, or Cause Death" sign. The text shall further indicate that operating personnel must know and obey the employer's work rules, know the hazards involved, and use proper protective equipment and tools to work on this equipment.

5.2 NAMEPLATES, RATINGS LABELS, AND CONNECTION DIAGRAMS

A. Each unit of switchgear shall be provided with a stainless steel nameplate, securely welded to the tank. All letters, schematics, and numbers shall be photo engraved or stamped on the nameplate.

B. The nameplates shall contain the following information at a minimum:

1. Date of manufacture (month and year, for example, 1-90)
2. Serial number
3. Model or style number
4. Rated maximum voltage
5. Rated impulse withstand voltage
6. Rated continuous current
7. Rated load interrupting current
8. Rated momentary current
9. Rated making current
10. A three-line bushing-oriented schematic diagram, using standard symbols (this may be put on a separate nameplate)

11. Total weight (including insulating medium)
12. Type of insulating medium

PART 6 - EXECUTION

6.1 EXAMINATION

A. Upon delivery of switchgear and prior to unloading, inspect equipment for damage.

1. Examine tie rods and chains to verify they are undamaged and tight and that blocking and bracing are tight.
2. Verify that there is no evidence of load shifting in transit and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
4. Compare switchgear and accessories received with the bill of materials to verify that the shipment is complete. Verify that switchgear and accessories conform to the manufacturer's quotation and Shop Drawings. If the shipment is not complete or does not comply with project requirements, notify the manufacturer in writing immediately.
5. Unload switchgear, observing packing label warnings and handling instructions.
6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:

1. Handle switchgear, according to manufacturer's recommendations; avoid damage to the enclosure, termination compartments, base, frame, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
2. Transport switchgear upright to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
3. Use spreaders or a lifting beam to obtain a vertical lift and to protect switchgear from straps bearing against the enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
4. Do not damage structure when handling switchgear.

C. Storage:

1. Switchgear may be stored outdoors. If possible, store switchgear at final installation locations on concrete pads. If dry concrete surfaces are not available, use pallets of adequate strength to protect switchgear from direct contact with the ground. Ensure switchgear is level.
2. Protect switchgear from physical damage. Do not store switchgear in the presence of corrosive or explosive gases.
3. Store switchgear with compartment doors closed.

D. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders have to cross section barriers to reach load or line lugs.

E. Pre-Installation Checks:

1. Verify removal of any shipping bracing after placement.

F. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at switchgear location.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

6.2 SWITCHGEAR INSTALLATION

A. Comply with NECA 1.

B. Equipment Mounting:

1. Install switchgear on cast-in-place concrete equipment base(s).

C. Install level and plumb, tilting less than 1.5 degrees when energized.

D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

6.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. For counterpoise, use tinned bare copper cable not smaller than No. 4/0 AWG, buried not less than 18 inches below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable with no kinks or sharp bends.
2. Equipment connections shall not be smaller than No. 4/0 AWG.
3. Make joints in grounding conductors and loops by exothermic weld or compression connector.
4. Terminate all grounding and bonding conductors on a common equipment grounding terminal on the switchgear enclosure.
5. Complete the switchgear grounding and surge protector connections prior to making any other electrical connections.

B. Terminate medium-voltage cables in incoming section of switchgear according to Section 260513 "Medium-Voltage Cables."

6.4 SIGNS AND LABELS

A. Comply with the installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with OSHA 29 CFR 1910.269 (by contractor)

6.5 FIELD QUALITY CONTROL (by Contractor)

A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections.

B. General Field Testing Requirements:

1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" chapter.
2. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
3. After installing switchgear but before primary is energized, verify that grounding system at the switchgear is tested at the specified value or less.
4. After installing switchgear and after electrical circuitry has been energized, test for compliance with requirements.

C. Medium-Voltage Switchgear Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect bolted electrical connections using calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
b. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
2) Make key exchange with devices operated in off-normal positions.

2. Electrical Tests:

a. Inspect bolted electrical connections using a low-resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
b. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the temperature of the bus is other than plus

or minus 20 deg C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.

1) Insulation-resistance values of bus insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
2) Do not proceed to the dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.

c. Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, according to manufacturer's published data. If manufacturer has no recommendation for this test, it shall be conducted according to NETA ATS, Table 100.2. Apply the test voltage for one minute.

1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

d. Perform system function tests according to "System Function Tests" Article.
e. Verify operation of space heaters.

D. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
b. Verify operation of light-emitting diodes, display, and targets.
c. Record passwords for each access level.
d. Clean the front panel and remove foreign material from the case.
e. Check tightness of connections.
f. Verify that the frame is grounded according to manufacturer's instructions.
g. Set the relay according to results in approved Coordination Study.
h. Download settings from the relay. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.

2. Electrical Tests:

a. Perform insulation-resistance tests from each circuit to the grounded frame according to manufacturer's published data.
b. Apply voltage or current to analog inputs and verify correct registration of the relay meter functions.
c. Functional Operation: Check functional operation of each element used in the protection scheme.
d. Control Verification:

1) Functional Tests:

a) Check operation of all active digital inputs.
b) Check output contacts or silicone-controlled rectifiers, preferably by operating the controlled device, such as circuit breaker, auxiliary relay, or alarm.
c) Check internal logic functions used in protection scheme.
d) Upon completion of testing, reset min/max recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.

6.6 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after "Field Quality Control" tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

END OF SECTION 2613.00.01