SECTION 16430

SWITCHGEAR (600 VOLT AND LESS)

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A 167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 780/A 780M	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D 1535	(2008) Specifying Color by the Munsell System
ASTM D 709	(2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006 & 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48, 59 2009) National Electrical Safety Code
IEEE C37.20.1	(2002; Addenda A 2005; Addenda B 2006; R 2007) Standard for Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
IEEE C37.90.1	(2002; Errata 2003; Errata 2004) Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.12.29	(2005) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C57.13	(2008) Standard Requirements for Instrument Transformers
IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms

IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)Normal Measurements

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C12.1	(2008) Electric Meters; Code for Electricity Metering
NEMA ICS 6	(1993; R 2006) Standard for Industrial Controls and Systems Enclosures
NEMA LI 1	(1998) Industrial Laminated Thermosetting Products
NEMA ST 20	(1992; R 1997) Standard for Dry-Type Transformers for General Applications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

UNDERWRITERS LABORATORIES (UL)

UL 1558	(1999; Rev thru Jun 2009) Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
UL 467	(2007) Standard for Grounding and Bonding Equipment

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the County. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

B. Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

C. Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

D. Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.4 MAINTENANCE

A. Switchgear Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01340.

B. Assembled Operation and Maintenance Manuals

Manuals shall be assembled and bound securely in durable, hard covered, water resistant binders. The manuals shall be assembled and indexed in the following order with a table of contents. The contents of the assembled operation and maintenance manuals shall be as follows:

1. Manufacturer's O&M information required by the paragraph entitled "Operation and Maintenance Data".

2. Catalog data required by the paragraph entitled, "Product Data".

3. Drawings required by the paragraph entitled, "Shop Drawings".

4. Prices for spare parts and supply list.

5. Design test reports

6. Production test reports

1.5 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6 PROTECTIVE DEVICE COORDINATION

Include manufacturer's published Time-Current Curves (TCC) on 11 x 17 logarithmic paper. Submit TCCs that depict each protective device between (and including) the medium voltage cutouts supplying the building and the largest circuit protector in each panel. TCCs shall manufacturer specific curves of each fuse, relay, circuit breaker, transformer and conductors. Where a unique path is split between multiple TCCs provide overlap of the protective devices so that selectivity of both upstream and downstream devices will be indicated. Include a table of setpoints used in creating TCCs for each device represented in the TCCs including CT ratios, where applicable.

PART 2 PRODUCTS

2.1 SWITCHGEAR

IEEE C37.20.1 and UL 1558.

A. Ratings

The voltage rating of the switchgear shall be 480Y/277 volts AC, 4-wire 3 phase. The continuous current rating of the main bus shall be as indicated. The short-circuit current rating shall be as indicated. The switchgear shall be UL listed and labeled as service entrance equipment.

B. Construction

Switchgear shall consist of vertical sections bolted together to form a rigid assembly and shall be front and rear aligned. All circuit breakers shall be front accessible. Compartmentalized switchgear shall have vertical insulating barriers between the front device section, the main bus section, and the cable compartment with full front to rear vertical insulating barriers between adjacent sections. Where indicated, "space for future" or "space" shall mean to include bus, device supports, and connections. Provide insulating barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness. Apply moisture resistant coating to all rough-cut edges of barriers.

1. Enclosure

The switchgear enclosure shall be NEMA Type 12. Enclosure shall be bolted together with removable bolt-on side and rear covers, and sloping roof downward toward rear. Front doors shall be provided with stainless steel padlockable vault handles with a three point catch. Bases, frames and channels of enclosure shall be corrosion resistant and shall be fabricated of ASTM A 167 Type 304 or 304L

stainless steel. Base shall include any part of enclosure that is within 3 inches of concrete pad. Paint enclosure, including bases, ASTM D 1535 light gray No. 61 or No. 49. Paint coating system shall comply with IEEE C57.12.29 for stainless steel.

2. Bus Bar

   Bus bars shall be copper with silver-plated contact surfaces. Plating shall be a minimum of 0.0002 inch thick. Make bus connections and joints with hardened steel bolts. The through-bus shall be rated at the full ampacity of the main throughout the switchboard. Provide minimum one-quarter by 2 inch copper ground bus secured to each vertical section along the entire length of the switchgear. The neutral bus shall be rated 100 percent of the main bus continuous current rating.

3. Main Section

   The main sections shall consist of an individually mounted drawout insulated-case circuit breaker.

4. Distribution Sections

   The distribution sections shall consist of individually mounted, drawout, insulated-case circuit breakers as indicated.

5. Auxiliary Sections

   Auxiliary sections shall consist of indicated instruments, metering equipment, control equipment, and current transformer compartments as indicated.

6. Handles

   Handles for individually mounted devices shall be of the same design and method of external operation. Label handles prominently to indicate device ampere rating, color coded for device type. Identify ON-OFF indication by handle position and by prominent marking.

C. Protective Device

   Provide main and branch protective devices as indicated on drawings.

1. Circuit Breakers

   UL listed, 100 percent rated, drawout, manually operated, low voltage, insulated-case circuit breaker, with a short-circuit current rating as indicated. Breaker frame size shall be as indicated.

D. Drawout Breakers

   Equip drawout breakers with disconnecting contacts, wheels, and interlocks for drawout application. The main, auxiliary, and control disconnecting contacts shall be silver-plated, multifinger, positive pressure, self-aligning type. Each drawout breaker shall be provided with four-position operation. Each position shall be clearly identified by an indicator on the circuit breaker front panel.

1. Connected Position: Primary and secondary contacts are fully engaged. Breaker must be tripped before racking into or out of position.

2. Test Position: Primary contacts are disconnected but secondary contacts remain fully engaged. Position shall allow complete test and operation of the breaker without energizing the primary circuit.

3. Disconnected Position: Primary and secondary contacts are disconnected.

4. Withdrawn (Removed) Position: Places breaker completely out of compartment, ready for removal. Removal of the breaker shall actuate assembly that isolates the primary stabs.

E. Electronic Trip Units

Equip main and distribution breakers with a solid-state tripping system consisting of three current sensors and a microprocessor-based trip unit that will provide true rms sensing adjustable time-current circuit protection. The ampere rating of the current sensors shall be as indicated. The trip unit ampere rating shall be as indicated. Ground fault protection shall be residual type sensing. The electronic trip units shall have the following features.

1. Breakers shall have long delay pick-up and time settings, and LED indication of cause of circuit breaker trip.

2. Main breakers shall have short delay pick-up and time settings and, instantaneous settings and ground fault settings as indicated.

3. Distribution breakers shall have short delay pick-up and time settings, instantaneous settings, and ground fault settings as indicated.

4. Breakers shall have provisions for communication via a network twisted pair cable for remote monitoring and control.

F. Electronic Trip Unit Central Monitor

Provide a microprocessor-based device designed to monitor and display parameters of the circuit breaker electronic trip units. The central monitor shall have the following features:

1. Alphanumeric display.

2. Indication of circuit breaker status; tripped, open, closed.

3. Cause of circuit breaker trip.

4. Phase, neutral, and ground current for each breaker.

5. Energy parameters for each breaker.

6. Provisions for communicating directly to a remote computer.

G. Meter Fusing

Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to voltage sensing meters. Size fuses as recommended by the meter manufacturer.

H. Terminal Boards

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

I. Wire Marking

Mark control and metering conductors at each end. Provide factory-installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Each sleeve shall contain a single letter or number, shall be elliptically shaped to securely grip the wire, and shall be keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Each wire marker shall indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.2 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.3 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each switchgear, equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Provide red laminated plastic label with white center core where indicated. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.4 SOURCE QUALITY CONTROL

A. Equipment Test Schedule

The County reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the County 30 calendar days before scheduled test date. Notify the County 15 calendar days in advance of changes to scheduled date.

1. Test Instrument Calibration

a) The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

b) The accuracy shall be directly traceable to the National Institute of Standards and Technology.

c) Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.

d) Dated calibration labels shall be visible on all test equipment.

e) Calibrating standard shall be of higher accuracy than that of the instrument tested.

f) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

1) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

2) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

B. Switchgear Design Tests

IEEE C37.20.1 and UL 1558.

1. Design Tests

Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification.

a) Short-circuit current test

b) Enclosure tests

c) Dielectric test

2. Additional design tests

   In addition to normal design tests, perform the following tests on the actual equipment. Furnish reports which include results of design tests performed on the actual equipment.

   a) Temperature rise tests

   b) Continuous current

C. Switchgear Production Tests

IEEE C37.20.1 and UL 1558. Furnish reports which include results of production tests performed on the actual equipment for this project. These tests include:

1. 60-hertz dielectric tests

2. Mechanical operation tests

3. Electrical operation and control wiring tests

4. Ground fault sensing equipment test

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

A. Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

B. Equipment Grounding

Provide bare copper cable not smaller than No. 4/0 AWG not less than 24 inches below grade connecting to the indicated ground rods. When work in addition to that indicated or specified is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

C. Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector.

D. Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

A. Switchgear

IEEE C37.20.1.

B. Field Applied Painting

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

C. Galvanizing Repair

Repair damage to galvanized coatings using ASTM A 780/A 780M, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

D. Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Interior Location

Mount switchgear on concrete slab. Unless otherwise indicated, the slab shall be at least 4 inches thick. The top of the concrete slab shall be approximately 4 inches above finished floor. Edges above floor shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 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 3 inches above slab surface.

3.5 FIELD QUALITY CONTROL

Contractor shall submit request for settings of breakers to the County after approval of switchgear and at least 30 days in advance of their requirement.

A. Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

1. Switchgear

a. Visual and Mechanical Inspection

1) Compare equipment nameplate data with specifications and approved shop drawings.

2) Inspect physical, electrical, and mechanical condition.

3) Confirm correct application of manufacturer's recommended lubricants.

4) Verify appropriate anchorage, required area clearances, and correct alignment.

5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

6) Verify that circuit breaker sizes and types correspond to approved shop drawings.

7) Verify that current transformer ratios correspond to approved shop drawings.

8) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

10) Clean switchgear.

11) Inspect insulators for evidence of physical damage or contaminated surfaces.

12) Verify correct barrier installation.

13) Exercise all active components.

14) Inspect all mechanical indicating devices for correct operation.

15) Verify that vents are clear.

16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.

17) Inspect control power transformers.

b. Electrical Tests

1) Perform insulation-resistance tests on each bus section.

2) Perform overpotential tests.

3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.

4) Perform control wiring performance test.

5) Perform primary current injection tests on the entire current circuit in each section of assembly.

6) Perform phasing check on double-ended switchgear to ensure correct bus phasing from each source.

7) Verify operation of switchgear heaters.

2. Circuit Breakers
Low Voltage

a. Visual and Mechanical Inspection

1) Compare nameplate data with specifications and approved shop drawings.

2) Inspect circuit breaker for correct mounting.

3) Operate circuit breaker to ensure smooth operation.

4) Inspect case for cracks or other defects.

5) Inspect all bolted electrical connections for high resistance using low resistance ohmmeter, verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method, or performing thermographic survey.

6) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

1) Perform contact-resistance tests.

2) Perform insulation-resistance tests.

3) Perform Breaker adjustments for final settings.

4) Perform long-time delay time-current characteristic tests.

a. Determine short-time pickup and delay by primary current injection.

b. Determine ground-fault pickup and time delay by primary current injection.

c. Determine instantaneous pickup current by primary injection.

d. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.

3. Grounding System

a. Visual and Mechanical Inspection

1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

1) IEEE Std 81. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

B. Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and

properly performing the intended function. Circuit breakers shall be tripped by operation of each protective device. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, the County shall be given 5 working days advance notice of the dates and times for checks, settings, and tests.

END OF SECTION