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DIVISION 26 - ELECTRICAL

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SF6 INSULATED SWITCHGEAR

04/06

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SF6 INSULATED SWITCHGEAR
04/06

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 within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- ANSI C37.60 (1986; R 1992) Requirements for Overhead, Pad-mounted Dry-Vault and Submersible Automatic Circuit Reclosers and Fault Interrupters for AC Systems
- ANSI C37.71 (1997) Standard for Three Phase, Manually-Operated Subsurface and Vault Load-Interrupting Switches for Alternating-Current Systems
- ANSI C37.72 (1987) Standard for Manually-Operated Dead-Front Pad Mounted Switchgear with Load Interrupting Switches and Separable Connections for Alternating-Current Systems
- ANSI C57.12.29 (1999) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

ASTM INTERNATIONAL (ASTM)

- ASTM A 167 (1999; R 2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- ASTM D 2472 (2000; R 2006) Standard Specification for Sulphur Hexafluoride

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

- IEEE C2 (2007; Errata 2007; INT 2008) National Electrical Safety Code
- IEEE C57.12.29 (2005) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
- IEEE C62.11 (2005; Amendment A 2008) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
- IEEE Std 386 (2006) Standard for Separable Insulated Connector Systems for Power Distribution

Systems Above 600V

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (2003) Acceptance Testing Specifications

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 62271-111 (2005) High Voltage Switchgear And Controlgear Part 111: Overhead, Pad-Mounted, Dry Vault, And Submersible Automatic Circuit Reclosers And Fault Interrupters For Alternating Current Systems Up To 38 Kv

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2007; AMD 1 2008) National Electrical Code - 2008 Edition

NFPA 70B (2006; Errata 2007) Electrical Equipment Maintenance

UNDERWRITERS LABORATORIES (UL)

UL 467 (2007) Standard for Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL apply to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

1.3.1 Switched Way

A switched way is considered a three-phase circuit entrance to the bus through a switch.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Provide shop drawings for Switchgear Drawings; G including the following:

Nameplate Diagram; G

Single-Line Diagram; G for switch

Connection Diagram; G for overcurrent protection including CT/PT wiring, auxiliary power supplies, if any

Outline Drawing; G, showing plan and elevation views, with complete dimensions

Time-current coordination curves; G for all available trip settings, plotted on standard log-log coordination paper

SD-03 Product Data

Electronic Overcurrent Control Curves; G

SF6 Insulated Pad-mounted Switchgear; G

SF6 Insulated Vault-style Switchgear; G

Insulated High-Voltage Connectors; G

Air Termination Kit; G

Surge Arresters; G

Accessories; G

Vacuum Interrupters; G

Electronic Trip Units; G

Switch Enclosures; G, including material composition

Equipment Finish; G Paint Coating System - material and application description

Remote Operators

Each submittal shall include data on switches and associated accessories. Each submittal shall include manufacturer's information for each component, device and accessory provided with the equipment.

SD-06 Test Reports

Acceptance Checks and Tests; G

Design and production test reports for switches shall be submitted and shall be in accordance with ANSI C37.60 and ANSI C37.72.

Basic Impulse Level (BIL)

One Minute Withstand Rating

Momentary and Fault Closing Rating, Asymmetrical and Symmetrical

Mechanical Operational Check

Leak Tests

SD-07 Certificates

Paint Coating System; G

SD-09 Manufacturer's Field Reports

Switchgear Acceptance Checks and Tests; G

SD-10 Operation and Maintenance Data

O&M Data shall include
Wiring Diagrams
Maintenance and testing schedules
Recommended Spare Parts List

SF6 Insulated Pad-mounted Switchgear Operation and Maintenance; G

SF6 Insulated Pad-mounted Switchgear; G

Accessories; G

Vacuum Interrupters; G

Electronic Trip Units; G

SF6 Insulated Vault-Style Switchgear Operation and Maintenance; G

SF6 Insulated Vault-Style Switchgear; G

Installation Manual; G

Once equipment is approved and at least 30 days prior to field testing, request trip unit settings from the Government.

1.5 QUALITY ASSURANCE

1.5.1 Switchgear Drawings

Furnish drawings that include, but are not limited to, the following:

- a. Overall dimensions, weights, plan view, and front view
- b. Ratings
- c. Nameplate Diagram
- d. Single-Line Diagram for switch.
- e. Connection Diagram for overcurrent protection including CT/PT wiring, auxiliary power supplies, if any.
- f. Outline Drawing, showing plan and elevation views, with complete dimensions.
- g. Time-current coordination curves for all available trip settings, plotted on standard log-log coordination paper.

1.5.2 Paint Coating System

Submit IEEE C57.12.29 paint coating system performance requirement tests.

1.5.3 Electronic Overcurrent Control Curves

Provide time-current characteristic curves (on full size logarithmic paper) and instruction manuals for the electronic overcurrent control.

1.6 MAINTENANCE

Provide safety precautions, preventive maintenance plan and schedule, troubleshooting guides and diagnostic techniques, parts identification, warranty information, testing and performance data and contractor information for the following:

[SF6 Insulated Vault-Style Switchgear Operation and Maintenance](#)

[SF6 Insulated Pad-Mounted Switchgear Operation and Maintenance](#)

PART 2 PRODUCTS

2.1 SF6 INSULATED PAD-MOUNTED SWITCHGEAR

[ANSI C37.72](#)

2.1.1 Ratings and Test Requirements

The voltage rating of the switchgear shall be 15.5 kV. The corresponding ratings associated with the required switchgear voltage rating shall be as follows:

Rated Maximum Voltage, kV	15
Rated Withstand Impulse Voltage, kV BIL	110
Continuous and Load Interrupting Current, A	630
Momentary Current, kA asym	25
One second Current, kA sym	12
* Symmetrical interrupting rating, kA	12

Switched ways shall be rated for the required continuous and load interrupting current. * Short-circuit interrupting current rating applies to fault interrupting switched ways only.

2.1.2 Switchgear Construction

Switch contacts and cable entrance terminations shall be contained in an SF6 filled stainless steel tank. Switchgear shall be shipped factory filled with SF6 gas conforming to [ASTM D 2472](#). Switchgear shall be configured with load interrupting and fault interrupting switched ways as indicated. Switchgear shall have front accessible terminations suitable for cables entering from below with the manual operating provisions mounted on the rear. Switch contact positions for switched ways shall be visible through viewing windows in the SF6 tank located adjacent to the manual operating provisions. Provide gas pressure gage in viewable location from switch operating handle. Each switched way shall have three position switch; Open, Closed, Ground.

2.1.2.1 Pad-mounting Provisions

Provide enclosed switchgear suitable for installation on a concrete pad. Switchgear support frame enclosure base and enclosure shall be fabricated of [ASTM A 167](#) type 304 or 304L stainless steel. Enclosure base shall include any part of the switchgear enclosure that is within [75 mm](#) of concrete pad. Paint switchgear tank and support frame enclosure including base No. 70 light gray. Paint coating system shall have the manufacturer's standard [Equipment Finish](#) for highly corrosive areas and shall comply with [IEEE C57.12.29](#).

2.1.3 Load Interrupting Switched Ways

Load interrupter switched ways shall provide three-pole group operated switching.

2.1.4 Fault Interrupting Switched Ways

IEC 62271-111. Provide non-fused, non-reclosing, manual reset, Vacuum Interrupters consisting of vacuum bottles and a spring assisted operating mechanism. Each fault interrupting switched way shall utilize internally mounted current transformers and an electronic overcurrent control to provide three-pole ganged tripping and three-phase faults. The electronic overcurrent control shall have provisions for a wide variety of field selectable time-current characteristic curves with ten field selectable trip levels through a current range of 600 amperes.

2.1.5 Dead-Front High-Voltage Bushings

IEEE Std 386. 15 kV, 95 kV BIL. Provide 600 ampere one-piece deadbreak apparatus bushings for switched ways and 200 ampere bushing wells with bushing well inserts for fault interrupting switched ways as indicated.

- a. Parking stands: Provide a parking stand near each dead-front bushing. Provide insulated standoff bushings for parking of energized load-break connectors on each parking stands.

2.1.6 Insulated High-Voltage Connectors

IEEE Std 386. Provide corresponding connector for each switched way. Connectors shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

- a. 200 Ampere loadbreak connector ratings: Voltage: 15 kV, 95 kV BIL. Short time rating: 10,000 rms symmetrical amperes.
- b. 600 Ampere non-loadbreak connector ratings: Voltage: 15 kV, 95 kV BIL. Short time rating: 40,000 rms symmetrical amperes. Connectors shall have 200 ampere bushing interface for surge arresters as indicated.

2.1.7 Surge Arresters

IEEE C62.11, rated 10 kV, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap, suitable for plugging into inserts. Provide arresters on switched ways as indicated.

2.2 SF6 Insulated Vault-Style Switchgear

ANSI C37.71

2.2.1 Ratings and Test Requirements

The voltage rating of the switchgear shall be 15.5 kV. The corresponding ratings associated with the required switchgear voltage rating shall be as follows:

Rated Maximum Voltage, kV	15
Rated Withstand Impulse Voltage, kV BIL	110
AC 1 Min. Withstand, kV	35

DC 15 Min. Withstand, kV	53
Continuous and Load Interrupting Current, A	630
Momentary Current, kA asym	40
Fault close Current, kA asym (3 times)	40
1 Sec. Rating sym., kA	25

Switched ways shall be rated for the required continuous and load interrupting current.

2.2.2 Switchgear Construction

Switch contacts and cable entrance terminations shall be contained in an SF6 filled stainless steel tank. Switchgear shall be shipped factory filled with SF6 gas conforming to [ASTM D 2472](#). Switchgear shall be configured with load interrupting switched ways. Vault type switches shall be in accordance with ANSI C37.71. Switch contact positions for switched ways shall be visible through viewing windows in the SF6 tank located adjacent to the manual operating provisions. Provide gas pressure gage in viewable location from switch operating handle. Each switched way shall have three position switch; Open, Closed, Ground. Cable entrances shall be by means of open stud bushings as indicated. Switch configuration shall be as indicated.

2.2.3 Load Interrupting Switched Ways

Load interrupter switched ways shall provide three-pole group operated switching.

2.2.4 High Voltage Terminations

Provide [Air Termination Kit](#) for open stud bushings from switch manufacturer or approved equal.

2.2.5 EQUIPMENT FINISH

Each switch tank and enclosure shall have the manufacturer's standard finish for highly corrosive areas. The finish shall meet the requirements of [IEEE C57.12.29](#) and must be No. 70 light gray.

2.3 SF6 Refill Cylinders

Provide two SF6 refill cylinders, minimum size of 6 pounds of SF6; include regulator, valves, and hose for connection to the fill valve of the switch.

2.4 SOURCE QUALITY CONTROL

2.4.1 [Switchgear Acceptance Checks and Tests](#)

Furnish reports which include results of design and production tests performed according to [ANSI C37.72](#). Production tests shall be performed by the manufacturer on each switchgear assembly to ensure that design performance is maintained in production.

2.4.2 [Electronic Trip Units](#)

Electronic trip units shall be solid-state, powered from the current transformers used for sensing or by means of internal potential transformers (PTs). Use of cable fault indicators in lieu of electronic

trip units is not acceptable.

Trip units shall be capable of being set for true RMS single-phase or three-phase with neutral sensing capabilities. Trip units shall be capable of being set to provide protection curves including, but not limited to, standard "CO" type overcurrent relay curves and/or mimic the following fuse types: "E", "K", "KS", "QA", "EF", "T".

Trip settings shall be adjustable locally at the switch without requiring removal of the trip unit or the use of a computer or other external programming device. The trip settings shall be clearly visible from the front panel of the trip unit. The units shall not rely on volatile electronic memory to retain their trip settings.

The following trip functions shall be provided:

- Time overcurrent
- Instantaneous
- Ground Fault

Trip units shall provide visible trip indication by phase, which shall remain after a trip event, until the unit is manually reset.

Trip units shall be capable of operating satisfactorily in a coastal, humid climate with temperatures from minus 10 degrees C to 65 degrees C.

2.4.3 Switch Tank

The switch tank shall be a single tank, factory welded using a minimum 304L stainless steel. The switch tank shall be braced to withstand momentary and full load current duty. The following standard components shall be included:

- Filling valve with gauge.
- Lifting eyes.

- Viewing windows to permit inspection of the switch contacts and means of seeing visible status indication of the vacuum interrupters.

- Gas pressure gauge in viewable location from switch operating handle.

- One line diagram and stainless steel nameplate fastened with stainless steel mechanical fasteners.

- Provide a welded flange ready to accept a future gas pressure switch.
- Provide parking stands for each switched and interrupter way.

2.4.4 Accessories

Provide the following accessories for each switch.

2.4.5 Insulated Medium-Voltage Connectors

Insulated Medium-voltage connectors shall conform to [IEEE Std 386](#). Connector shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material. Provide connectors as indicated.

- a. 200 Ampere loadbreak connector ratings: Voltage: 15kV, 95 kV BIL. Short time rating: 10,000 amperes rms, symmetrical for a

time duration of 0.17 seconds.

- b. 600 Ampere deadbreak connector ratings: Voltage: 15 kV, 95 kV BIL. Short time rating: 27,000 amperes rms, symmetrical for a time duration of 4.0 seconds. Provide 200 Ampere interface connector (loadbreak reducing plug) for the indicated surge arrester.

2.4.6 Remote Operators

Each switch shall have provisions and equipment necessary to enable operating any way of the switch from a distance of no less than 25 feet, not necessarily in a straight line from the switch. This remote operation feature may be achieved by either manual operation or remote electrical operation.

2.4.7 Other Operational Features

Fittings, lifting eyes, insulators, and other required operational features or tools, shall be provided with the switch as necessary.

2.4.8 Auxiliary Contacts

Auxiliary contacts to indicate switch/interrupter position status (for future SCADA connection) shall be provided and wired to terminal blocks external to the SF6 enclosure, but enclosed within the overall enclosure.

2.5 SWITCH ENCLOSURES

2.5.1 Pad-Mounted Switch Enclosures

Enclosures shall be in accordance with ANSI C57.12.29 and shall be equipped with a ground bus capable of carrying the rated fault current for one second for each way. Enclosures shall be sized such that the centerline of the apparatus bushing shall be a minimum of 36 inches above the base of the enclosure. Further, there shall be a minimum depth of 24 inches for the interior of the cabinet housing cable terminations.

The overall switch enclosure shall be made of a minimum grade of 304L stainless steel with suitable stiffeners. All flanges shall overlap and interlock. Access to the switch and cable compartments shall be through hinged doors and a hood (if required). The door shall have stiffeners to prevent warping and miss alignment. The doors shall fit to the enclosure to provide a watertight seal. The roof of the enclosure shall be sloped from the center to the edge to prevent standing water.

Switch enclosures shall include:

- Recessed or removable lifting provisions.
- Padlocking provisions
- Mounting provisions internal to the enclosure for anchoring to the pad.
- Minimum 300 series stainless steel hardware.
- Door stops and stays to prevent accidental closing.

2.5.2 Vault-Style Switch Mounting Frames And Enclosures

Mounting frames of angle-iron construction shall be furnished for all vault type switches and shall be hot-dipped galvanized after fabrication in accordance with ASTM A123/A123M and ASTM A153/A153M.

Enclosure mounting frame with minimum 11 gauge galvanized sheet steel front panel and galvanized expanded metal back and side panels. After fabrication, all exposed ferrous metal surfaces of the enclosure shall be cleaned and painted.

Mounting frames shall be painted in accordance with ANSI C37.72.

PART 3 EXECUTION

3.1 INSTALLATION

Provide [Installation Manuals](#) for SF6 insulated switchgear. Electrical installations shall conform to [IEEE C2](#), [NFPA 70](#), and to the requirements specified herein.

3.2 GROUNDING

Grounding shall be as specified in Section [28 05 26.00 40](#), "GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY" and [NFPA 70](#) and [IEEE C2](#), except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms. 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.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section [28 05 26.00 40](#), "GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY" as indicated.

3.2.2 Switchgear Grounding

Connect #4/0 bare copper conductor ground loop, not less than [610 mm](#) below grade, to the upper end of the ground rods by exothermic welds or compression connectors. Provide #4/0 bare copper conductors connecting the switchgear grounding provisions to two different ground rods.

3.2.3 Connections

Make joints in grounding conductors and ground loop by exothermic weld. Exothermic welds shall be installed as specified in Section [28 05 26.00 40](#), "GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY".

3.2.4 Grounding and Bonding Equipment

[UL 467](#), except as indicated or specified otherwise.

3.3 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount switch on concrete slab. Slab shall be at least [300 mm](#) thick, reinforced with a [152 x 152 - MW19 x MW19](#) mesh, placed uniformly [100 mm](#) from the top of the slab. Slab shall be placed on a [150 mm](#) thick, well-compacted gravel base. Top of concrete slab shall be approximately [100 mm](#) above finished grade. Edges above grade shall have [15 mm](#) chamfer. Slab shall be of adequate size to project at least [200 mm](#) beyond equipment.

Stub up conduits, with bushings, [150 mm](#) into cable wells in the concrete pad. Coordinate dimensions of cable wells with switch cable training

areas. Concrete work shall be as specified in Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE.

3.4 FIELD QUALITY CONTROL

3.4.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS and referenced ANSI standards.

At least 30 days prior to field testing, request trip unit settings from the Government.

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.4.1.1 Switchgear

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate information with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Check for proper anchorage, physical damage, alignment, required area clearances, and grounding.
- (4) Inspect doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
- (5) Verify that insulating SF6 gas pressure is correct.
- (6) Inspect all indicating devices for proper operation.
- (7) Inspect connections for tightness of bolted joints.
- (8) Lubricate as required.

b. Electrical Tests

- (1) Perform contact-resistance tests.
- (2) Trip fault interrupters by operation of overcurrent.
- (3) Perform insulation-resistance tests.
- (4) Perform an over-potential test on each switched way pole with the switched way in the open position in accordance with the manufacturer's instructions.
- (5) Set fault interrupter overcurrent control in accordance with government provided settings. Request settings from government, in writing, a minimum of 30 days prior to scheduling electrical tests.
- (4) Perform resistance measurements through accessible bolted electrical connections with a resistance ohmmeter, if applicable.
- (5) Perform insulation-resistance tests on each pole,

phase-to-phase and phase-to-ground with switch closed and across each open pole for one minute. Test voltage shall be in accordance with manufacturer's published data or NETA ATS, Table 10.1.

(5) Verify open and close operation from control devices, if applicable.

3.4.1.2 Grounding System

a. Visual and Mechanical Inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

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.

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.

3.4.2 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that devices are in good operating condition and properly performing the intended function. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times for checks and tests.

-- End of Section --