CITY OF FORT COLLINS

LIGHT AND POWER DEPARTMENT

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FORT COLLINS, CO 80521

SPECIFICATION NO 367-303

TITLE

THREE PHASE DEADFRONT PAD-MOUNTED SF_6 INSULATED SWITCHGEAR WITH TWO SWITCHED WAYS AND TWO VACUUM INTERRUPTER PROTECTED TAPS

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I. General

1 01 General Description

The switchgear shall conform to this specification and shall consist of a gas-tight tank containing SF_6 gas, load-interrupter switches and resettable vacuum fault interrupters with visible open gaps and integral visible grounds, and a microprocessor-based overcurrent control Construction shall be deadfront Load-interrupter switch terminals and fault-interrupter terminals shall be equipped with 600 amp ANSI/IEEE 386 bushings to interface with conventional elbow style connectors Manual operating mechanisms and viewing windows shall be located on the opposite side of the tank from the bushings and bushing wells so that operating personnel will not be required to perform any routine operations in close proximity to high-voltage elbows and cables Switch shall be shipped factory filled with SF_6 gas conforming to ASTM D2472

1 02 Switch Configuration

Each switch shall be in accordance with Figure 1 and shall have two three-pole, three phase load/grounding switch ways and two vacuum interrupter tapped ways with field selectable single or three phase electronic trip The load interrupter/grounding switches associated with the vacuum interrupter tapped ways shall be configured for single-pole operation

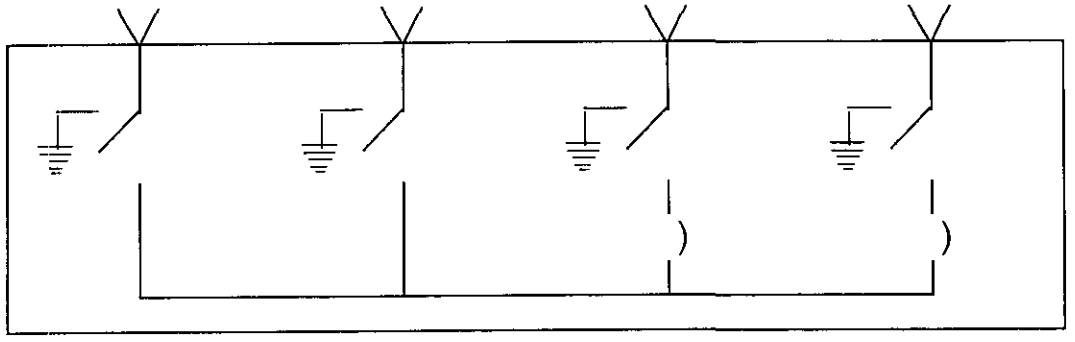

Figure 1 One-line Diagram

1 03 Ratings

The ratings for the integrated switchgear shall be as designated below

Frequency, Hz	60
kV, Maximum	15 5
kV, BIL	95
Main Bus Continuous, Amperes	600

Three-Pole Load-Interrupter Switches	
Continuous, Amperes	600
Load Dropping, Amperes	600
Ten-Time Duty-Cycle Fault-Closing,	
Amperes RMS Symmetrical	12,500
Amperes, Peak	32,500
Fault Interrupters	
Continuous, Amperes	600
Load Dropping, Amperes	600
Ten-Time Duty-Cycle Fault Interrupting,	
Amperes RMS Symmetrical	12,500
Ten-Time Duty-Cycle Fault-Closing,	
Amperes RMS Symmetrical	12,500
Amperes, Peak	32,500
Short-Circuit Rating	
Amperes, RMS Symmetrical	12,500

1 04 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 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 05 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

(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

II. Construction

2 01 SF_6-Gas Insulation

(a) The SF_6 gas shall conform to ASTM D2472

(b) The switchgear shall be filled with SF_6 gas to a pressure of 7 psig at 68° F

(c) The gas-tight tank shall be evacuated prior to filling with SF_6 gas to minimize moisture in the tank

(d) The switchgear shall withstand system voltage at a gas pressure of 0 psig at 68° F

(e) A gas-fill valve shall be provided

(f) A temperature-compensated pressure gauge shall be provided that is color coded to show the operating range The gauge shall be mounted inside the gas-tight tank (visible through a large viewing window) to provide consistent pressure readings regardless of the altitude at the installation site

2 02 Gas-Tight Tank

(a) The tank shall be submersible and shall be capable of withstanding a minimum of 15 psig internal pressure, 14 psig external pressure and 10 feet of water over the base

(b) The tank shall be of welded construction and shall be made of 7-gauge mild steel

(c) A means of lifting the tank shall be provided

2 03 Gas-Tight Tank Finish

(a) To remove oils and dirt, to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion, mild-steel surfaces shall undergo a thorough pretreatment process comprised of a fully automated system of cleaning, rinsing, phosphatizing, sealing, drying, and cooling, before any protective coatings are applied By utilizing an automated pretreatment process, the mild-steel surfaces of the gas-tight tank shall receive a highly consistent thorough treatment, eliminating fluctuations in reaction time, reaction temperature, and chemical concentrations

(b) After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the mild-steel surfaces of the gas-tight tank To establish the capability to resist corrosion and protect the mild steel, representative test specimens coated by the manufacturer's finishing system shall satisfactorily pass the following tests

(1) 1500 hours of exposure to salt-spray testing per ASTM B 117 with

(i) Underfilm corrosion not to extend more than 1/32" from the scribe as evaluated per ASTM D 1645, Procedure A, Method 2 (scraping), and

(ii) Loss of adhesion from bare metal not to extend more than 1/8" from the scribe

(2) 1000 hours of humidity testing per ASTM D 4585 using the Cleveland Condensing Type Humidity Cabinet with no blistering as evaluated per ASTM D 714

(3) Crosshatch adhesion testing per ASTM D 3359 Method B with no loss of finish

Certified test abstracts substantiating the above capabilities shall be furnished upon request

(c) The finish shall be inspected for scuffs and scratches Blemishes shall be touched up by hand to restore the protective integrity of the finish

(d) The finish shall be indoor light gray, satisfying the requirements of ANSI Standard Z55 1 for No 61

2 04 Viewing Windows

(a) Each load-interrupter switch shall be provided with a large viewing window at least 6 inches by 12 inches to allow visual verification of the switch-blade position (open, closed, and grounded) while shining a flashlight on the blades

(b) Each fault interrupter shall be provided with a large viewing window at least 6 inches by 12 inches to allow visual verification of the disconnect-blade position (open, closed, and grounded) while shining a flashlight on the blades

(c) Viewing windows shall be located on the opposite side of the gear from the bushings and bushing wells so that operating personnel shall not be required to perform any routine operations in close proximity to high-voltage elbows and cables

(d) A cover shall be provided for each viewing window to prevent operating personnel from viewing the flash which may occur during switching operations

2 05 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) Before installation of bus, all electrical contact surfaces shall first be prepared by machine abrading to remove any oxide film Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant

2 06 Provisions for Grounding

(a) One ½-13 ground-connection per way plus one ½-13 tank ground shall be provided on the gas-tight tank of the switchgear

(b) The ground shall be constructed of stainless steel and welded to the gas-tight tank, and shall have a short-circuit rating equal to that of the switchgear

2 07 Terminations

(a) Terminals for load-interrupter switches shall have 600-ampere bushings

(b) Terminals for fault interrupters shall be equipped with 600-ampere bushings

(c) Bushings rated 600 amperes continuous shall be provided with a threaded stud

(d) Bushings shall be located on one side of the gear to reduce the required operating clearance

2 08 Bushings and Bushing Wells

(a) Bushings and bushing wells shall conform to ANSI/IEEE Standard 386 (ANSI Standard C119 2)

(b) Bushings and bushing wells shall include a semiconductive coating

(c) Bushings and bushing wells shall be mounted in such a way that the semiconductive coating is solidly grounded to the gas-tight tank

III. Basic Components

3 01 Load-Interrupter Switches

(a) The three-phase, gang-operated load-interrupter switches shall have a ten-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the switchgear This rating defines the ability to close the switch ten times against a three-phase fault with asymmetrical (peak) current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current Certified test abstracts establishing such ratings shall be furnished upon request

(b) The switch shall be provided with an integral ground position that is readily visible through the viewing window to eliminate the need for cable handling and exposure to high voltage to ground the equipment

(c) The ground position shall have a ten-time duty-cycle fault-closing rating

(d) The switch shall be provided with an open position that is readily visible through the viewing window to eliminate the need for cable handling and exposure to high voltage to establish a visible gap

(e) The open gaps of the switch shall be sized to allow cable testing through a feedthru bushing or the back of the elbow

3 02 Fault Interrupters

(a) Fault interrupters shall have a ten-time duty-cycle fault-closing and fault interrupting rating equal to or exceeding the short-circuit rating of the switchgear This rating defines the fault interrupter's ability to close ten times against a three-phase fault with asymmetrical (peak) current in at least one phase equal to the rated value and clear the resulting fault current, with the interrupter remaining operable and able to carry and interrupt rated current Certified test abstracts establishing such ratings shall be furnished

(b) The fault interrupter shall be provided with a disconnect with an integral ground position that is readily visible through the viewing window to eliminate the need for cable handling and exposure to high voltage to ground the equipment

(c) The ground position shall have a ten-time duty-cycle fault-closing rating

(d) The disconnect shall be provided with an open position that is readily visible through the viewing window to eliminate the need for cable handling and exposure to high voltage to establish a visible gap

(e) The open gaps of the disconnect shall be sized to allow cable testing through a feedthru bushing or the back of the elbow

(f) An internal indicator shall be provided for each fault interrupter to show when it is in the tripped condition The indicator shall be clearly visible through the viewing window

3 03 Operating Mechanisms

(a) Load-interrupter switches and fault interrupters shall be operated by means of a quick-make, quick-break mechanism

(b) The manual handle shall charge the operating mechanism for opening, closing, and grounding of the switches and fault interrupters

(c) Operating mechanisms shall be equipped with an operation selector to prevent inadvertent operation from the closed position directly to the grounded position, or from the grounded position directly to the closed position The operation selector shall require physical movement to the proper position to permit the next operation

(d) Operating shafts shall be padlockable in any position to prevent operation

(e) The operation selector shall be padlockable to prevent operation to the grounded position

(f) The operating mechanism shall indicate switch position, which shall be clearly visible from the normal operating position

3 04 Overcurrent Control

(a) A microprocessor-based overcurrent control shall be provided to initiate fault interruption

(b) The control shall function correctly at temperatures of - 40°C to + 80°C

(c) The control shall be capable of single-pole or three-pole tripping of each fault interrupter

(d) Control settings shall be field programmable using a personal computer connected via a data port to the control Manual electronic tripping shall also be possible using a personal computer The data port shall be accessible from the exterior of the enclosure

(e) The control shall be mounted in a watertight enclosure and shall be removable in the field without taking the gear out of service

(f) Power and sensing for the control shall be supplied by integral current transformers

(g) The minimum total clearing time (from initiation of the fault to total clearing) for fault interruption shall be 40 milliseconds (2 4 cycles) at 60 hertz or 44 milliseconds (2 2 cycles) at 50 hertz

(h) The control shall feature time-current characteristic (TCC) curves including standard E-speed, coordinating-speed tap, and coordinating-speed main curves Coordinating-speed tap curves shall optimize coordination with load-side weak-link/backup current-limiting fuse combinations, and coordinating-speed main curves shall optimize coordination with tap-interrupter curves

(i) The standard E-speed curve shall have phase-overcurrent settings ranging from 25E through 200E The coordinating-speed tap curve shall have phase-overcurrent and independent ground-overcurrent settings ranging from 50 amperes through 400 amperes The coordinating-speed main curve shall have phase-overcurrent and independent ground-overcurrent settings ranging from 100 amperes through 800 amperes

(j) The control shall have instantaneous-trip (1 kA through 8 kA) and definite-time delay (32 ms through 96 ms) settings to allow tailoring of the coordinating-speed tap and coordinating-speed main curves to the application

3 05 Voltage indication with provisions for low-voltage phasing

(a) Voltage indication with provisions for low-voltage phasing for each load-interrupter switch and fault interrupter by means of capacitive taps on the bushings shall be provided to eliminate the need for cable handling and exposure to high voltage to test the cables for voltage and phasing This feature shall include a flashing LCD display to indicate the presence of voltage for each phase, and a solar panel to supply power for testing of the complete voltage-indication circuit and phasing circuit

(b) The voltage-indication feature shall be mounted on the covers for the viewing windows on the opposite side of the gear from the bushings and bushing wells so that operating personnel shall not be required to perform any routine operations in close proximity to high-voltage elbows and cables

IV. Switchgear Style

4 01 Pad-Mounted Style

(a) The gas-tight tank shall be made of 7-gauge minimum mild-steel

(b) Enclosure

(1) The switchgear shall be provided with a tamper resistant weatherproof pad-mounted enclosure suitable for installation of the gear on a concrete pad

(2) The pad-mounted enclosure shall be separable from the switchgear to allow clear access to the bushings and bushing wells for cable termination

(3) The basic material shall be 14-gauge minimum hot-rolled, pickled, and oiled steel sheet

(4) The enclosure shall be provided with removable front and back panels, and hinged lift-up roof sections for access to the operating and termination compartments Each roof section shall have a retainer to hold it in the open position Hinge pins shall be stainless steel

(5) Lift-up roof sections shall overlap the panels and shall have pentahead bolts and provisions for padlocking that incorporate a means to protect the padlock shackle from tampering

(6) The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad

(7) Panel openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between panels and panel openings to guard against water entry

(8) For bushings rated 600 amperes continuous, the termination compartment shall be of an adequate depth to accommodate 200 ampere loadbreak elbows or encapsulated surge arresters mounted on 600-ampere elbows having 200-ampere interfaces

(9) An instruction manual holder shall be provided

(10) Non-removable lifting tabs shall be provided

(c) Enclosure Finish

(1) All exterior welded seams shall be filled and sanded smooth for neat appearance

(2) To remove oils and dirt, to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion, all surfaces shall undergo a thorough pretreatment process comprised of a fully automated system of cleaning, rinsing, phosphatizing, sealing, drying, and cooling, before any protective coatings are applied By utilizing an automated pretreatment process, the enclosure shall receive a highly consistent thorough treatment, eliminating fluctuations in reaction time, reaction temperature, and chemical concentrations

(3) After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the steel enclosure To establish the capability to resist corrosion and protect the enclosure, representative test specimens coated by the manufacturer's finishing system shall satisfactorily pass the following tests

(i) 4000 hours of exposure to salt-spray testing per ASTM B 117 with

(a) Underfilm corrosion not to extend more than 1/32" from the scribe as evaluated per ASTM D 1645, Procedure A, Method 2 (scraping), and

(b) Loss of adhesion from bare metal not to extend more than 1/8" from the scribe

(ii) 1000 hours of humidity testing per ASTM D 4585 using the Cleveland Condensing Type Humidity Cabinet with no blistering as evaluated per ASTM D 714

(iii) 500 hours of accelerated weathering testing per ASTM G 53 using lamp UVB-313 with no chalking as evaluated per ASTM D 659, and no more than 10% reduction of gloss as evaluated per ASTM D 523

(iv) Crosshatch adhesion testing per ASTM D 3359 Method B with no loss of finish

(v) 160-inch-pound impact adhesion testing per ASTM D 2794 with no chipping or cracking

(vi) Oil resistance testing consisting of a 72-hour immersion bath in mineral oil with no shift in color, no streaking, no blistering, and no loss of hardness

(vii) 3000 cycles of abrasion testing per ASTM 4060 with no penetration to the substrate

Certified test abstracts substantiating the above capabilities shall be furnished upon request

(4) The finish shall be inspected for scuffs and scratches. Blemishes shall be touched up by hand to restore the protective integrity of the finish

(5) The finish shall be olive green, Munsell 7GY3 29/1 5

V. Labeling

5 01 Hazard-Alerting Signs

(a) The exterior of the pad-mounted enclosure (if furnished) 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—Hazardous Voltage—Failure to Follow These Instructions Will Likely Cause Shock, Burns, or 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

(c) Each unit of switchgear shall be provided with a "Danger—Keep Away—Hazardous Voltage—Will Shock, Burn, or Cause Death" sign

5 02 Nameplates, Ratings Labels, and Connection Diagrams

(a) Each unit of switchgear shall be provided with a nameplate indicating the manufacturer's name, catalog number, model number, date of manufacture, and serial number

(b) Each unit of switchgear shall be provided with a ratings label indicating the following voltage rating, main bus continuous rating, short-circuit rating, fault-interrupter ratings including interrupting and duty-cycle fault-closing, and load-interrupter switch ratings including duty-cycle fault-closing and short-time

(c) The pad-mounted enclosure (if furnished) shall be provided with a connection diagram showing load-interrupter switches, fault interrupters with integral disconnects, and bus along with the manufacturer's model number

VI. Accessories

6 01 Adapter Cable

An adapter cable for connecting an overcurrent control to a user-furnished personal computer (having a 25-pin or 9-pin serial communication port) in the field shall be provided

6 02 Software

Software necessary for programming the microprocessor-based overcurrent control shall be provided

VII. Factory Production Tests

7 01 The bulk SF_6 gas supply and each individual switch shall be tested for moisture content Each individual switch shall undergo a mechanical operation check and a leak test The switch shall be factory filled with SF_6 gas and AC hi-pot tested one minute phase-to-phase, phase-to- ground and across the open contacts Circuit resistance shall be checked on all ways Each vacuum interrupter shall be trip tested by injecting AC current through the switch