1.0 GENERAL

1.01 The switchgear shall be in accordance with the single-line diagram, and shall conform to the following specification.

1.02 The switchgear shall consist of a gas-tight tank containing SF_6 gas and load-interrupter switches with visible open gaps and integral visible grounds. Load-interrupter switch terminals shall be equipped with bushings rated 600 amperes continuous to provide for elbow connection. Manual operating mechanisms and viewing windows shall be located on the opposite side of the tank from the bushings so that operating personnel shall not be required to perform any routine operations in close proximity to medium-voltage elbows and cables.

1.03 Ratings

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

Frequency, Hz	50 or 60
Short-Circuit Current, Amperes, RMS, Symmetrical	40,000
Voltage Class, kV	12
Maximum Voltage, kV	15.5
BIL Voltage, kV	95
Main Bus Continuous Current, Amperes	600
Three-Pole Load-Interrupter Switches	
Continuous Current, Amperes	600
Load Dropping Current, Amperes	600
Fault Closing Current, Duty-Cycle Three-Time, Amperes, RMS, Symmetrical	40,000
Three-Time, Amperes, Peak	104,000

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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 as well as the complete integrated assembly as rated.

(b) The manufacturer shall furnish, upon request, certification of ratings of the load-interrupter switch and the integrated switchgear assembly consisting of switches 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 C37.74, which specify test procedures and sequences for the load-interrupter switches and the complete switchgear assembly.

2.0 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 (20° C).

(c) The gas-tight tank shall be evacuated before 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 (20° C).

(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 temperature or altitude at the installation site.

2.02 Gas-Tight Tank

(a) The tank shall be submersible and able to withstand up to 10 feet of water over the base.

(b) The tank shall be of welded construction and shall be made of 7-gauge mild steel or Type 304L stainless steel, as specified in Section 4.0.

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

2.03 Gas-Tight Tank Finish (for mild steel only)

(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 using 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 in. 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 in. 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 (152.4 mm by 304.8 mm) to allow visual verification of the switch-blade position (closed, open, and grounded) while shining a flashlight on the blades.

(b) 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 medium-voltage elbows and cables.

(c) 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 Medium-Voltage Bus

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

(b) Bus shall be copper.

2.06 Provisions for Grounding

(a) One ground-connection pad shall be provided on the gas-tight tank of the switchgear.

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

The following optional feature should be specified as required:

(c) One ground-connection pad per way shall be provided.

2.07 Connections

(a) Load-interrupter switches shall be equipped with 900-ampere bushings.

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

2.08 Bushings

(a) Bushings shall conform to ANSI/IEEE Standard 386.

(b) Bushings shall include a semiconductive coating.

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

3.0 BASIC COMPONENTS

3.01 Load-Interrupter Switches

(a) The three-phase, group-operated load-interrupter switches shall have a three-time fault-closing rating as specified under "Ratings." This rating defines the ability to close the switch the designated number of 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 medium voltage to ground the cable.

(c) The ground position shall have a three-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 medium voltage to establish a visible gap.

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

3.02 Operating Mechanisms

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

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

(c) A single, integrated operating mechanism shall fully operate each load-interrupter switch in a continuous movement so additional operations are not required to establish open or grounded positions.

(d) 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.

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

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

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

3.05 Optional Voltage Indication (Specify one of the following as required.)

(a) Voltage indication

(1) Voltage indication shall be provided for each load-interrupter switch by means of capacitive taps on the bushings, eliminating the need for cable handling and exposure to medium voltage to test the cables for voltage before grounding. This feature shall include a flashing liquid-crystal display to indicate the presence of voltage for each phase and a solar panel to supply power for testing the complete voltage-indication circuit.

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

(b) Voltage indication with provisions for low-voltage phasing

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

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

4.0 SWITCHGEAR STYLE (Select UnderCover™, wet-vault-mounted or dry-vault-mounted style.)

4.01 UnderCover Style

(a) The switchgear shall be suitable for subsurface installation.

(b) The switchgear shall be operable from grade level without exposure to medium voltage.

(c) Operating personnel shall be able to verify the positions (closed, open, and grounded) of the load-interrupter switches while standing.

(d) To guard against corrosion caused by extremely harsh environmental conditions, the gas-tight tank shall be made of Type 304L stainless steel.

(e) The tank shall be designed for use in typical subsurface electrical manholes and vaults that are subject to occasional flooding to a maximum head of 10 feet (3 m) above the base of the tank. The water in these vaults may also contain typical levels of contaminants, such as salt, fertilizer, motor oil, and cleaning solvents. Extreme environments, such as tidal waters, continuous submersion, abnormally high concentration of certain contaminants, or unusually high or low pH levels, should be evaluated on a case-by-case basis.

4.02 Wet-Vault-Mounted Style

(a) The switchgear shall be suitable for installation in a vault.

(b) To guard against corrosion caused by extremely harsh environmental conditions, the gas-tight tank shall be made of Type 304L stainless steel.

(c) The tank shall be designed for use in typical subsurface electrical manholes and vaults that are subject to occasional flooding to a maximum head of 10 feet (3 m)

above the base of the tank. The water in these vaults may also contain typical levels of contaminants, such as salt, fertilizer, motor oil, and cleaning solvents. Extreme environments, such as tidal waters, continuous submersion, abnormally high concentration of certain contaminants, or unusually high or low pH levels, should be evaluated on a case-by-case basis.

4.03 Dry-Vault-Mounted Style

(a) The switchgear shall be suitable for installation in a vault.

(b) The gas-tight tank shall be made of 7-gauge mild steel.

The following optional features should be specified as required:

(c) To guard against corrosion caused by extremely harsh environmental conditions, the gas-tight tank shall be made of Type 304L stainless steel.

5.0 LABELING

5.01 Hazard-Alerting Signs

(a) 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.

(b) 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 current rating; short-circuit rating; and load-interrupter switch ratings, including duty-cycle fault-closing and short-time.

6.0 ANALYTICAL SERVICES

The following analytical services should be specified as required:

7.01 Short-Circuit Analysis

(a) The manufacturer shall provide a short-circuit analysis to determine the currents flowing in the electrical system under faulted conditions. Because expansion of an electrical system can result in increased available short-circuit current, the momentary and interrupting ratings of new and existing equipment on the system shall be checked to determine whether the equipment can withstand the short-circuit energy. Fault contributions from utility sources, motors, and generators shall be taken into consideration. If applicable, results of the analysis shall be used to coordinate overcurrent protective devices and prepare an arc-flash hazard analysis of the system.

(b) Data used in the short-circuit analysis shall be presented in tabular format and shall include the following information:

(1) Equipment identifications

(2) Equipment ratings

(3) Protective devices

(4) Operating voltages

(5) Calculated short-circuit currents

(6) X/R ratios

(c) A single-line diagram model of the system shall be prepared and shall include the following information:

(1) Identification of each bus

(2) Voltage at each bus

(3) Maximum available fault current, in kA symmetrical, on the utility source side of the incoming feeder or first upstream device

(4) Data for each transformer

(i) Three-phase kVA rating

(ii) Percent impedance

(iii) Temperature rise, 149° F and 131/149° F (65° C and 55/65° C)

(iv) Primary voltage

(v) Primary connection

(vi) Secondary voltage

(vii) Secondary connection

(iix) X/R ratio

(ix) Tap settings and available settings

(d) The manufacturer shall use commercially available PC-based computer software such as Power System Analysis Framework (PSAF-Fault) from CYME International, CYMDIST, and/or SKM Power Tools® for Windows with the PTW Dapper Module to calculate three-phase, phase-to-phase, and phase-to-ground fault currents at relevant locations in the electrical system, in accordance with ANSI Standards C37.010, C37.5, and C37.13. If applicable, an ANSI closing-and-latching duty analysis shall also be performed to calculate the maximum currents following fault inception.

7.02 Arc-Flash Hazard Analysis

(a) The manufacturer shall provide an arc-flash hazard analysis to verify that electrical equipment on the system is "electrically safe" for personnel to work on while energized. An arc flash is a flashover of electric current in air from one phase conductor to another phase conductor or from one phase conductor to ground that can heat the air to 35,000° F (19,426° C). It can vaporize metal and cause severe burns to unprotected workers from direct heat exposure and ignition of improper clothing. And the arc blast resulting from release of the concentrated radiant energy can damage hearing and knock down personnel, causing trauma injuries.

(b) The arc-flash hazard analysis shall include the following:

(1) Identification of equipment locations where an arc-flash hazard analysis is required

(2) Collection of pertinent data at each equipment location, including:

(i) Transformer kVA ratings, including voltage, current, percent impedance, winding ratio, and X/R ratio, plus wiring connections

(ii) Protective device ratings, including current, time-current characteristics, settings, and time delays

(iii) Switchgear data, including spacing, type of grounding, and appropriate working distances

(3) Preparation of a single-line diagram model of the system

(4) Preparation of a short-circuit study to determine the three-phase bolted fault current at each location

(5) Preparation of arc-flash calculations in accordance with NFPA 70E and IEEE 1584, including:

(i) Calculation of arc current in accordance with applicable guidelines

(ii) Determination of protective device total-clearing times based upon the time-current characteristics

(iii) Calculation of arc-flash incident energy level based on the protective device total-clearing times and appropriate working distance

(6) Determination of appropriate personal protective equipment in accordance with risk levels defined in NFPA 70E

(7) Calculation of the arc-flash protection-boundary distance

(8) Documentation of the results of the analysis, including:

(i) Preparation of a written report

(ii) Preparation of single-line diagrams

(iii) Preparation of arc-flash hazard labels to be affixed to the equipment

(9) The manufacturer shall use commercially available PC-based computer software such as the arc-flash module in SKM Power Tools® for Windows to calculate the incident energy category levels in accordance with IEEE 1584.

7.03 Analytical Service Site Visits

(a) The manufacturer shall perform a site walk-down to gather:

(1) Transformer ratings, including voltage, current, power, percent impedance, winding ratio, and X/R ratio, plus wiring connections

(2) Switchgear data, including conductor phase spacing, type of grounding, and appropriate working distances