Instructions for the operation and maintenance of Power Xpert™ XGIS gas insulated switchgear
Instructions for the operation and maintenance of Power Xpert™ XGIS gas insulated switchgear
Disclaimer of warranties and limitation of liability

This instruction booklet is published solely for information purposes and should not be considered all-inclusive. If further information is required, you should consult an authorized Eaton sales representative.

The sale of the product shown in this literature is subject to the terms and conditions outlined in appropriate Eaton selling policies or other contractual agreement between the parties. This literature is not intended to and does not enlarge or add to any such contract. The sole source governing the rights and remedies of any purchaser of this equipment is the contract between the purchaser and Eaton.

**NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, OR WARRANTIES ARISING FROM THE COURSE OF DEALING OR USAGE OF TRADE, ARE MADE REGARDING THE INFORMATION, RECOMMENDATIONS, AND DESCRIPTIONS CONTAINED HEREIN.**

In no event will Eaton be responsible to the purchaser or user in contract, in tort (including negligence), strict liability or otherwise for any special, indirect, incidental or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of power, additional expenses in the use of existing power facilities, or claims against the purchaser or user by its customers resulting from the use of the information, recommendations and description contained herein.
Contents

Section 1: Introduction ................................................................. 7
  1.1 Preliminary comments and safety precautions .......................... 7
    1.1.1 Safety precautions ...................................................... 7
    1.1.2 Switchgear identification ............................................. 7
  1.2 General information .......................................................... 8
  1.3 Power Xpert XGIS elements .................................................. 11
    1.3.1 Standard features ...................................................... 12
    1.3.2 Ground bus ............................................................... 17
    1.3.3 Bracing ................................................................. 18
    1.3.4 Arc resistant features ............................................... 18
    1.3.5 Optional features ..................................................... 18
    1.3.6 XGIS vertical section configurations ............................... 25
  1.4 Type XGIS gas insulated switchgear ratings (Tables 2 and 3) ....... 29
    1.5.1 1250 A vertical section ............................................. 31
    1.5.2 2000 A / 2500 A vertical section ................................... 32
  1.6 SSIS conductor system .......................................................... 33
    1.6.1 SSIS bus in XGIS gas insulated switchgear ......................... 33
    1.6.2 Power cable conductors in XGIS switchgear ....................... 34
  1.7 Voltage detection system .................................................... 36
    1.7.1 Connecting the voltage detection system cables to ground ....... 36
  1.8 SF₆ Gas handling ............................................................... 37

Section 2: Receiving, handling and storage ........................................ 37

Section 3: Safe practices ............................................................ 38
  3.1 Recommendations ............................................................. 38

Section 4: Description and operation ............................................... 39
  4.1 Introduction ..................................................................... 39
    4.1.1 Three-position disconnect switch ................................... 39
    4.1.2 Circuit breaker ......................................................... 39
    4.1.3 VT earthing switch ..................................................... 39
  4.2 Operation ........................................................................ 40
    4.2.1 Three position disconnect switch (3PDS) ......................... 41
    4.2.2 Circuit breaker ......................................................... 42
    4.2.3 Voltage transformer earthing switch ................................. 44

Section 5: Inspection, maintenance, and testing .................................. 46
  5.1 Logbook ......................................................................... 46
  5.2 Inspections ....................................................................... 46
  5.3 Maintenance .................................................................... 46
    5.3.1 SF₆ Gas handling ....................................................... 46
    5.3.2 Cleaning viewing ports ............................................... 47
  5.4 Testing ............................................................................ 47
    5.4.1 Typical test ............................................................. 47
    5.4.2 Voltage test .............................................................. 47
    5.4.3 Current test ............................................................. 48

Section 6: Renewal parts ............................................................... 49
  6.1 General ........................................................................... 49
  6.2 Ordering instructions ......................................................... 49

Notes: .................................................................................... 50
Notes: .................................................................................... 51
# List of Tables

Table 1.  3PDS status display table ...................................................... 16  
Table 2.  Vertical section dimensions ..................................................... 29  
Table 3.  Electrical data ............................................................... 29  
Table 4.  Relevant standards ........................................................... 30  
Table 5.  Operating conditions .......................................................... 30  
Table 6.  VDS LCD display performance .................................................. 36  
Table 7.  VDS relay output performance .................................................. 36  
Table 8.  Three-position disconnect switch/circuit breaker interlocking truth table .......... 44  
Table 9.  Recommended inspections .................................................... 46
Read and understand these instructions before attempting installation, operation, or maintenance of this equipment. This equipment must be installed and serviced only by qualified electrical personnel. Retain this document for future use.

**WARNING**
IMPROPERLY INSTALLING OR MAINTAINING THESE PRODUCTS CAN RESULT IN DEATH, SERIOUS PERSONAL INJURY, OR PROPERTY DAMAGE.

READ AND UNDERSTAND THESE INSTRUCTIONS BEFORE ATTEMPTING ANY UNPACKING, ASSEMBLY, OPERATION OR MAINTENANCE OF THE CIRCUIT BREAKERS.

INSTALLATION OR MAINTENANCE SHOULD BE ATTEMPTED ONLY BY QUALIFIED PERSONNEL. THIS INSTRUCTION BOOK SHOULD NOT BE CONSIDERED ALL INCLUSIVE REGARDING INSTALLATION OR MAINTENANCE PROCEDURES. IF FURTHER INFORMATION IS REQUIRED, YOU SHOULD CONTACT EATON.

**WARNING**
DO NOT ATTEMPT ANY WORK ON THIS EQUIPMENT SUCH AS INSTALLING COMPONENTS, PERFORMING ANY EXAMINATIONS, PERFORMING ANY ADJUSTMENTS, PERFORMING ANY SERVICING, OR PERFORMING ANY MAINTENANCE WHILE IT IS ENERGIZED. BEFORE PERFORMING ANY WORK, FOLLOW ALL APPROPRIATE HAZARD ASSESSMENT AND ENERGY CONTROL PRECAUTIONS AND PROCEDURES.

VERIFY NO VOLTAGES ARE PRESENT ON ALL INCOMING AND OUTGOING CONDUCTORS, AND ANY ENERGY SOURCES CONTAINED WITHIN THE EQUIPMENT PRIOR TO SERVICING, THEN GROUND (CONNECT TO EARTH) ALL INCOMING AND OUTGOING CONDUCTORS ATTACHED TO THIS EQUIPMENT AND TO ANY INTERNAL ENERGY SOURCES.

All possible contingencies which may arise during installation, operation or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of particular equipment, contact an Eaton representative.
Section 1: Introduction

1.1 Preliminary comments and safety precautions

This technical document is intended to cover most aspects associated with the installation and commissioning of Power Xpert™ XGIS gas insulated switchgear. It is provided as a guide for authorized and qualified personnel only. Please refer to the specific WARNING messages in paragraph 1.1.2 before proceeding past Section 1. If further information is required regarding a particular installation, application or maintenance activity, an Eaton representative should be contacted.

1.1.1 Safety precautions

All safety codes, safety standards and/or regulations must be strictly observed in the installation, operation and maintenance of this device.

---

**WARNING**

THE WARNINGS AND CAUTIONS INCLUDED AS PART OF THE PROCEDURAL STEPS IN THIS DOCUMENT ARE FOR PERSONNEL SAFETY AND PROTECTION OF EQUIPMENT FROM DAMAGE. AN EXAMPLE OF A TYPICAL WARNING LABEL HEADING IS SHOWN ABOVE TO FAMILIARIZE PERSONNEL WITH THE STYLE OF PRESENTATION. THIS WILL HELP TO ENSURE THAT PERSONNEL ARE ALERT TO WARNINGS, WHICH MAY APPEAR THROUGHOUT THE DOCUMENT. IN ADDITION, CAUTIONS ARE ALL UPPER CASE AND BOLDFACE AS SHOWN BELOW.

---

**WARNING**

COMPLETELY READ AND UNDERSTAND THE MATERIAL PRESENTED IN THIS DOCUMENT BEFORE ATTEMPTING INSTALLATION, OPERATION OR APPLICATION OF THE EQUIPMENT. IN ADDITION, ONLY QUALIFIED PERSONS SHOULD BE PERMITTED TO PERFORM ANY WORK ASSOCIATED WITH THE EQUIPMENT. ANY WIRING INSTRUCTIONS PRESENTED IN THIS DOCUMENT MUST BE FOLLOWED PRECISELY. FAILURE TO DO SO COULD CAUSE PERMANENT EQUIPMENT DAMAGE, BODILY INJURY OR DEATH.

---

**WARNING**

THE POWER XPERT XGIS SWITCHGEAR DESCRIBED IN THIS DOCUMENT ARE DESIGNED AND TESTED TO OPERATE WITHIN ITS NAMEPLATE RATINGS. OPERATION OUTSIDE OF THESE RATINGS MAY CAUSE THE EQUIPMENT TO FAIL, RESULTING IN DEATH, BODILY INJURY AND PROPERTY DAMAGE.

ALL SAFETY CODES, SAFETY STANDARDS AND/OR REGULATIONS AS THEY MAY BE APPLIED TO THIS TYPE OF EQUIPMENT MUST BE STRICTLY ADHERED TO.

1.1.2 Switchgear identification

A nameplate is located on the exterior door of each XGIS switchgear vertical section. Contained on this nameplate are the general order number, manufacturing shop order number, and all the necessary switchgear ratings. This information should be given to the Eaton sales office if a question should arise concerning the switchgear or if renewal parts are required. This information is sufficient for Eaton to find the manufacturing information for the switchgear.
1.2 General information

The purpose for this document is to provide instructions for operation and maintenance of Power Xpert XGIS gas insulated switchgear (referred to as Type XGIS gas insulated switchgear from this point forward). These switchgear vertical sections employ state-of-the-art gas insulation, shielded solid insulation, vacuum interrupters, and modular plug-in technologies. Combined with laser welding technology and a helium gas leakage testing process, this system provides high reliability and a small installation footprint. They provide reliable control and protection for electrical equipment and circuits, up to 38 kV.

XGIS switchgear is designed for reliable performance, ease of handling and simplified maintenance. In addition, XGIS switchgear is tested to IEC standards for application around the world.

The XGIS switchgear has been tested to the seismic requirements contained in the IEEE 693 standard, the International Building Code (IBC 2015), and the California Building Code (CBC 2016). For more information, refer to Seismic Certificate Number SA022006EN.

XGIS gas insulated switchgear vertical sections incorporate technology intended to make the XGIS system smaller in size, easier to install, more reliable and easier to maintain than air-insulated switchgear.

XGIS vertical sections come in five configurations. Options are available to customize the equipment for each application. The five configurations are:

- Feeder/incoming
- Bus tie
- Bus sectionalizer
- Disconnector
- Cable connector

The XGIS switchgear vertical sections come with standard and optional features. All of the vertical sections include a pressurized tank filled with SF₆ (sulfur hexafluoride).

All XGIS vertical sections are designed for bottom entry of the power cables. All XGIS vertical sections are designed for top or bottom entry of low-voltage power and control wiring.

An option of the XGIS design is available that is certified to IP4X requirements.

The XGIS design is not rated for outdoor service.

**Figure 1** shows an XGIS vertical section exterior with its primary elements. **Figure 2** shows the details of the medium voltage power components and control elements.

**Figure 3** and **Figure 4** show XGIS system power components for a 1250 A standard section and a 1250 A bus tie section.

**Figure 5** shows an XGIS vertical section with front and interior control components.
Figure 3. XGIS 1250 A cable connection section, side view
Figure 4. XGIS 1250 A bus tie section, side view
1.3 Power Xpert XGIS elements

Figure 5. XGIS components.
1.3.1 Standard features

XGIS switchgear includes a three-position disconnect switch for circuit isolation, and a vacuum interrupter circuit breaker.

The three-position disconnect switch and circuit breaker can each be operated electrically or manually. The circuit breaker can be charged, closed or opened locally or remotely. The circuit breaker trip operation is initiated by external protective relays or other control devices. The three-position disconnect switch is interlocked with the circuit breaker.

SF₆ gas as an insulating medium

Sulfur Hexafluoride is an odorless, colorless, inert, non-toxic, non-corrosive and non-flammable gas. It is thermally stable and must be heated to more than 500º Celsius (932º F) before it will decompose. The symmetry of the atoms in its molecular structure makes it extremely stable, with a very high dielectric strength. Its dielectric capability is approximated three times that of air at atmospheric pressure. This means that equipment insulated with SF₆ can be much more compact than air-insulated equipment.

Power Xpert XGIS vertical section characteristics

An XGIS vertical section is divided into two functional areas: low- and medium-voltage.

1.3.1.1 Low-voltage area

The XGIS vertical section front door is used to access the low-voltage section. This section houses low-voltage control and operating mechanisms for the three-position disconnect switch and vacuum interrupter circuit breaker.

The vertical section door has control devices mounted on it for:
- Circuit breaker open/closed switch and status indicating lights.
- Three-position disconnect switch status indicator lights and push-buttons for three-position disconnect switch ground, open, and close operations.
- Three-position disconnect switch (grounding function) status indicators and pushbuttons for three-position disconnect switch grounding open and close.
- Customer specific control devices.
- Customer specific protective device(s).

The XGIS switchgear three-position disconnect switch operating mechanism is mounted on the gas tank front panel, located below the low-voltage control area. It is mechanically coupled to the three-position disconnect switch through a gas-tight tank fitting. It has electrical and manual modes of operation. It is mechanically and electrically interlocked with the circuit breaker to assure that the breaker is open prior to operation of the three-position disconnect switch for closing, isolation, or grounding.

The operating mechanism includes a rotary cam limit switch array, linkages for manual operation, and mechanical front panel switch status indicators. The motor propels a chain drive that moves the three-position disconnect switch from one position (closed, open, or grounded) to another. The cam and limit switches provide positive three-position disconnect switch position feedback to the operating mechanism.

The three-position disconnect switch normal operation mode is electric, but it also has a front access cover for manual operation.

Three-position disconnect switch manual operation is performed by opening the manual mode access cover when the circuit breaker is open, inserting a tool and rotating the recessed socket. Turning the manual operation socket with the manual operation tool moves the switch connector smoothly through each position. The three-position disconnect switch has a clutch that slips when the switch reaches the next position. The tool must then be removed and reinserted to continue moving the switch to the next position.

The vacuum interrupter circuit breaker operating mechanism is also mounted on the gas tank front panel, below the three-position disconnect switch’s operating mechanism. The circuit breaker mechanism includes stored energy springs for breaker closing and opening. The springs are charged either by an electric drive (normal mode) or using a manual charging handle mounted in the circuit breaker operating mechanism front cover.

The circuit breaker operating mechanism includes mechanical indicators for spring charged/discharged status and circuit breaker open/closed status. These indicators are visible through cutouts in the circuit breaker mechanism front cover.

The circuit breaker can be operated mechanically by buttons located on its front cover or electrically by pushbuttons mounted on the vertical section door, or remotely.

The three-position disconnect switch and circuit breaker are both mechanically and electrically interlocked to prevent improper operation during normal (electrical) and manual (mechanical) operation.

Low-voltage control wiring is routed from the internal vertical section terminal boards to an Eaton blue colored top hat, above the low-voltage compartment. Control wiring from vertical section to vertical section in a lineup is routed through these top hats.

SF₆ tank gauge

The SF₆ tank has a pressure gauge mounted on the tank upper left front face, with a color-coded scale indicating safe, caution and danger pressure values. In addition, the gauge includes pressure sensors with three contact outputs, 1.3 bar absolute (Normal), 1.2 bar (Alarm) and 1.1 bar (Block).

Figure 6. Tank pressure gauge.

SF₆ Tank filling fitting

To the right of the tank pressure gauge, a second pressure fitting is available for filling and evacuating the tank.

Figure 7. Tank filling fitting.
SF6 Three-position disconnect switch position viewing port
To the right of the tank charging fitting, a viewing port is available to observe the three-position disconnect switch position. This port is available for mounting a camera if desired.

Figure 8. Tank viewing port.

The viewing port provides a view of all three of the three-position disconnect switch mechanisms, and shows the ground, open and closed positions and armature poles. Figure 6 shows view port images of all three disconnect switch poles.

Figure 9. 3PDS pole positions as seen from the viewing port.

Circuit breaker cycle counter
The 1250 A XGIS circuit breaker is rated for 10,000 load or no-load operations. The 2000 A and the 2500 A XGIS circuit breakers are rated for 2,000 load or no load operations. Each closing spring charging operation is recorded on the cycle counter mounted on the left side of the circuit breaker frame, and viewable through a window in the front cover.

Figure 10. Circuit breaker cycle counter.

1.3.1.2 Medium-voltage area
SSIS conductor system
Power input and output circuits between XGIS vertical sections are connected to the XGIS using shielded solid insulation system (SSIS) conductor and termination elements. These elements are designed for medium voltage application and provide excellent insulation and current carrying features when properly installed using their mating bus joints.

Figure 11. Main bus compartment bus cones (SSIS).

The outer layer of each insulating component of the SSIS conductor system is shielded and grounded to the tank. The entire exterior of the SSIS conductor is at ground potential when properly installed.

Gas tank
Behind the low-voltage panel and above the output cable compartment, the gas tank is the heart of the XGIS switchgear. The tank is pressurized to slightly over atmospheric pressure with SF₆ gas, to insulate the MV components inside the tank.
The tanks are laser-welded to be gas tight. They have bushings on their top surface for main bus connections. Tanks for cable connections have bushings on the bottom front tank surface. Tanks for bus tie connections have bushings on the tank bottom surface. These bushings accommodate connections for main bus, cables or sectionalizing bus. The tank faces have gasketed ports for three-position disconnect switch and circuit breaker mechanical drive mounting. If repairs are needed, a rear access panel can be removed to access the devices inside the tank. If repairs inside the tank are required, an Eaton service representative should be contacted.

The gas tank includes a fitting and gauge for gas pressure monitoring, and another fitting for filling or evacuating the tank. Both fittings are viewable in the low-voltage area, below the low-voltage control DIN rails and wire channels.

A viewing port is mounted on the gas tank front face, beside the tank pressure gauge and charging fitting, for viewing the three-position disconnect switch position. This port can be fitted for a mounted camera. From there the three-position disconnect switch open, ground and closed positions can be seen.

The tank has an overpressure relief fitting mounted on the lower part of the tank rear vertical face. The overpressure relief fitting will rupture at 2 bar absolute.

For the 2000 A and 2500 A vertical section designs, a heat sink assembly is mounted on the rear of the tank, with fins extending out into the back portion of the vertical section. This heat sink provides additional cooling for the busbar connections within the tank.

Medium-voltage connections

The gas tank top has bushings for interface with main SSIS busbars. The main horizontal bus conductors can be fitted with optional CTs.

The gas tank lower front surface has bushings for output conductors, connecting either power cables or SSIS busbar, and can be fitted with optional CTs.

Conductors connecting the input bushings to the three-position disconnect switch are contained within the gas tank. When the switchgear is furnished with a three-position disconnect switch only, conductors from the three-position disconnect switch output terminals to the output bushings are contained within the tank. Since the three-position disconnect switches are not interlocked with other panels, it is recommended that access to the three-position disconnect switch panel and tie breaker panels be controlled and restricted using a Kirk key, padlock, or similar lockout system, so that only trained personnel can access them.

When a vacuum circuit breaker is furnished in the vertical section, the three-position disconnect switch is mounted and connected to the top of the circuit breaker assembly in the tank, and conductors run from the breaker’s output terminals to the tank output bushings.

Three-position disconnect switch

XGIS switchgear includes a three-pole medium-voltage three-position disconnect switch (3PDS) in the tank. Each phase pole consists of a piston on a screw drive. This linear travel device is mechanically coupled to its operating mechanism through the tank wall. In the closed position, the three-position disconnect switch connects each phase of the main bus to incoming/outgoing power, through the vacuum circuit breaker (if furnished). If opened, the three-position disconnect switch disconnects each phase of the main bus from the incoming/outgoing power. If grounded, the 3PDS grounds the incoming/outgoing power through the vacuum circuit breaker (if furnished).

The grounded and closed (connected) position contacts are sockets, electrically connected respectively to the vertical section ground bus and to the incoming power bus. A center socket between the ground and main bus sockets is connected to the circuit breaker. The screw-driven connection piston moves to connect the circuit breaker to either ground or main bus. When the piston is not connected to either the grounded position or the closed position, but rests entirely within the circuit breaker connection socket, the three-position disconnect switch is in the open position, isolating the circuit breaker from the main bus or ground.

The three-position disconnect switch mechanical drive consists of a gear reduction, a chain drive and three sprockets. Each sprocket turns an output shaft, connected to a pole screw.

The three-position disconnect switch is a non-load break device, intended to connect downstream elements to the input source only under no-load (open circuit) conditions.

Instructions for the operation and maintenance of Power Xpert™ XGIS gas insulated switchgear

The three-position disconnect switch poles are propelled by screw drives, one for each pole. Normally the screws are driven by a dc motor. The gear output shafts which turn the pole screws pass through tank wall magnetic fluid seals.

Power and control for the three-position disconnect switch dc motor are provided by a dedicated controller mounted on the low-voltage panel.

The three-position disconnect switch has a second, mechanical drive means. If desired, a manual operation door in the front of the three-position disconnect switch operating mechanism can be opened to allow a T-handle to be inserted and turned to operate the screw drive. See the T-handle in Figure 14.
Figure 14. Three-position disconnect switch manual operation T-handle.

**NOTICE**

DURING MANUAL OPERATION, THE THREE-POSITION DISCONNECT SWITCH HAS NO SCREW DRIVE TRAVEL MECHANICAL LIMITS. IT CAN BE MOVED INTO OVERTRAVEL POSITIONS AT BOTH ENDS OF TRAVEL (GROUND AND CLOSED). DO NOT MOVE THE SCREW DRIVE BEYOND ITS END OF TRAVEL INDICATIONS, AS THAT CAN RESULT IN DAMAGE TO THE SCREW DRIVE MECHANISM. USE THE THREE-POSITION DISCONNECT SWITCH STATUS DISPLAY WINDOWS TO DETERMINE WHEN THE THREE-POSITION DISCONNECT SWITCH HAS REACHED THE DESIRED LOCATION.

Figure 15. Disconnect switch windows and label

In order to ground the output cables or coupling bus, the three-position disconnect switch must be put in the ground position and the circuit breaker must be closed.

The three-position disconnect switch screw drive also propels a cam limit switch mounted inside the operating mechanism. This cam limit switch has four contacts. The contacts are used in the electric control system to signal three-position disconnect switch status: closed, opened and grounded.

The three-position disconnect switch and circuit breaker are mechanically and electrically interlocked to prevent inappropriate operation.

Figure 16. Three-position disconnect switch chain drive.

A mechanical display provided on front of the three-position disconnect switch operating mechanism face plate indicates the switch position status as shown in Figure 17.

Figure 17. Three-position disconnect switch mechanism (normal operation).
The three-position disconnect switch mechanical status display uses symbols to indicate switch position. The display windows show the switch in its proper positions only when the symbols are in the center of their windows. See Figure 18. Refer to Table 1 for disconnect position associated with I and O symbols displayed in the status windows.

Table 1. 3PDS status display table

<table>
<thead>
<tr>
<th>Three-position disconnect switch position</th>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Open</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Closed</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

The 3PDS comes standard with locking means to prevent closing the switch or grounding the switch. These locking features consist of brackets for padlocks and Kirk lock fittings. Each bracket, whether for preventing closing or for preventing grounding, is labeled with their function. They are spring loaded so that the bracket tooth must be pushed into its 3PDS port before a padlock hasp or Kirk lock bolt can be inserted to secure the switch mechanism. See Figure 19.

Figure 19. _3PDS locking features - standard._

The circuit breaker assembly consists of three vacuum interrupters, one per phase, each housed in a molded frame. Input power connections from the 3PDS couple to top center input terminals mounted on each vacuum interrupter frame. The breaker outputs are bused to cable compartment bushings.

The circuit breaker vacuum interrupter poles are actuated by a stored-energy spring system, mounted in the breaker operating mechanism. Under normal conditions, an electric motor drive charges the springs with close and opening energy. For manual operation, the mechanism is charged using a lever with gear reduction. The charging lever is located on front of the circuit breaker operating mechanism.

The circuit breaker can be electrically or manually charged, and electrically or manually opened or closed.

Push buttons (I, O) provided on the circuit breaker front panel are used to trigger mechanical opening and closing of the breaker. Electrical charging, opening and closing can be initiated either locally or remotely via electrical controls as required for a given application.

The molded vacuum interrupter frame is attached to its operating mechanism. The operating mechanism is located outside the sealed tank. The molded vacuum interrupter frame assembly is located inside the sealed tank. The interrupter operating shafts are attached to the operating mechanism using sealed metal bellows that permit shaft travel without compromising the tank gas seal. See Figure 20.

The vacuum interrupter frame contains three vacuum interrupter poles, one for each phase. Each pole is a ceramic bottle with metal bellows and two pole pieces. One pole piece is fixed in the bottle, while the other pole is free to move. The movable pole is welded to the metal bellows so that the pole can move while retaining the necessary vacuum inside the bottle. See Figure 21.

Figure 22 shows the circuit breaker faceplate with status displays, a manual charging lever and manual control pushbuttons. The “PUSH TO OPEN” button is protected by a pad-lockable cover. The cover status is indicated by an electrical interlock block mounted on the breaker frame top.
Circuit breaker trip-free features

The Eaton XGIS vacuum circuit breaker incorporates electrical trip-free characteristics. That is, the contacts of the circuit breaker must return to the open position and remain there when an opening operation follows a closing operation, regardless of whether the closing signal is maintained.

A circuit breaker with “Electrically Trip-Free” features must be able to receive and respond to an electrical opening signal regardless of whether an electrical closing signal is applied.

Interlocking

The XGIS three-position disconnect switch and circuit breaker are extensively mechanically and electrically interlocked to prevent inappropriate operation.

1.3.2 Ground bus

XGIS vertical sections are equipped with a ground bus. This bus is intended as a grounding point for all cable grounds and the tank ground.
1.3.5 Optional features

Not every option can be furnished on every vertical section configuration. Following is a list of options. Whether any option can be included on a project will depend upon on the vertical section configuration applied.

3PDS locking features

In addition to the standard locking features that prevent switch closure or grounding, the 3PDS can be fitted with locking features to lock the switch in the closed position or lock the switch in the grounded position. These features include padlock and Kirk lock mechanisms and are mounted above and below the 3PDS faceplate.

Auxiliary Sections

XGIS vertical sections can be equipped with additional sections for custom equipment such as relays, power supplies, communications equipment, etc. These sections can be bolted to the end of an XGIS vertical section lineup, adjacent to the vertical section end sheet. Their top hats have extensions to accommodate the adjacent section end sheet. They are available in two widths: 600 mm and 800 mm. See Figure 25 and Figure 26.

Figure 25. 600 mm wide auxiliary section

Figure 26. 800 mm wide auxiliary section

An auxiliary section side wall is bolted to the end sheet of lineup end vertical sections. In addition, an angle is attached to the auxiliary section rear panel and to the side of the vertical section end sheet. See Figure 27.

1.3.4 Arc resistant features

The XGIS design is arc resistant and offers designs with attachment points for arc ducts at the sides or rear of the vertical section. If an XGIS vertical section is configured for arc resistance, exhaust flaps to integrate the vertical section into an arc resistant lineup prevent the use of top-mounted voltage transformers in the vertical section in which the arc duct attaches to the lineup.

Arc resistant lineups can be designed for arc gas exhaust from the lineup left end, lineup right end, or the rear of any vertical section. For more information, refer to IB022019EN

Figure 24. Cable cleats attached to cable compartment brackets.

1.3.3 Bracing

Incoming SSIS buses are inherently braced by their mechanical design. Output cables are clamped in place using cable cleats and vertical section braces.
Multiple auxiliary sections can be attached to a lineup.

**Figure 27.** Attached auxiliary panel, front view.

**Voltage transformers**

Bus side voltage transformers (non-fused or fused) are mounted in the XGIS vertical section in the voltage transformer compartment, behind the busbar compartment, and are equipped with a front panel accessible VT earthing switch. The VT earthing switch operator either connects the VTs or grounds the VTs.

Cable side voltage transformers (non-fused or fused) can be mounted in the XGIS vertical section in the voltage transformer compartment, behind the busbar compartment, only when bus VTs are not included in the same vertical section. These vertical sections are equipped with a front panel accessible VT disconnect switch. The VT disconnect switch operator either connects the VTs or grounds them. If bus VTs are included in the same vertical section, then the cable side VTs are mounted in the MV cable compartment on the vertical section rear base if the VTs are non-fused, or outside the vertical section in the cable vault if the VTs are fused.

**Note:** If the system utilizes a ducted arc exhaust (required to achieve an arc resistant rating), then a top mount VT cannot be installed in the same vertical section to which the arc duct connects.

**Figure 28.** Fused voltage transformer.

**Figure 29.** Unfused voltage transformer.

**Figure 30.** Fused remote voltage transformer (mounted in cable vault).

**Figure 31.** Unfused remote voltage transformer (mounted in cable vault).
Figure 32. Example input voltage transformers.

Figure 33. VT earthing switch mechanism

**NOTICE**

DURING COMMISSIONING, IN ORDER TO PERFORM POWER FREQUENCY WITHSTAND VOLTAGE (PFWV) TESTING, IT WILL BE NECESSARY TO DISCONNECT THE VTS FROM THE CIRCUIT TO AVOID DAMAGE.

BECAUSE THE TWO POSITION SWITCH CAN ONLY CONNECT OR GROUND THE VT, IT WILL BE NECESSARY TO GROUND THE VT WITH THE TWO POSITION SWITCH, REMOVE ITS FUSE, AND RECONNECT THE VT WITH THE TWO POSITION SWITCH FOR PFWV TESTING.

VT earthing switch

XGIS switchgear can be fitted with one VT earthing switch mechanism.

Where main bus voltage transformers are furnished, whether fused or unfused, the VT earthing switch is a tank-mounted three-pole switch that connects each phase voltage transformer primary to its phase bus or to ground. The main bus VT is mounted in a compartment behind the main bus connection compartment, and connects to the earthing switch through bushings mounted in the tank top.

This switch can be operated either under load or no-load conditions. The earthing switch operator is located in the XGIS low voltage compartment, and connected by a linkage to the VT earthing switch mechanism located in the tank.

Cable side VTs can also be fitted for the VT earthing switch, but only when the VT is top mounted (in the compartment behind the main bus connection compartment), and connects to the switch using the same tank bushing. Figure 33 shows the VT earthing switch operator in the low voltage compartment, the linkage connecting it to the switch mechanism, and the bushing where a VT can be connected to the switch.

Current transformers

XGIS switchgear can be furnished with or field modified to include current phase current transformers for main bus phases or cable side phases.

XGIS optional current transformers are available to either ANSI (IEEE) or IEC standards, according to customer requirements.

The XGIS switchgear line can include single or multiple CTs per phase, depending upon the application. The maximum quantity of CTs possible on any phase depends upon the required CT standard, rating and design. In some cases, as many as three CTs can be mounted on either the main bus phases or the cable phases. In other cases, no more than one CT per phase can be furnished.

When furnished for the main bus side, the current transformers must be installed during the system installation and commissioning process, when the SSIS busbars are installed.

When furnished for the cable side, the current transformers can be installed on the cable bushings during fabrication. In either case, applied CTs are donut type sensors that encircle the main bus SSIS conductors or the cable connection bushings or bus tie cones.

XGIS uses mounting brackets to hold the optional CTs in place. These brackets differ with CT application, location, rating and type.

Since the XGIS switchgear can be furnished within two design ranges, 1250 A or 2000 A / 2500 A, the main bus side (insert mount) and the cable side (through mount) bracket designs will be different for each design range.

Main bus CTs

Main bus CTs can be furnished on the horizontal bus in the space above the gas tank, with the SSIS conductors passing through the CTs before terminating at the tank bushings. Main bus CT and bracket dimensions will differ depending upon the CT rating and applicable standards.
Main bus CTs are mounted using brackets attached to the SF₆ tank top surface. **Figure 34** shows an example of main bus CT brackets mounted on the tank top surface.

**Figure 34.** Main bus current transformers, shown surrounding through bus SSIS conductors.

**Figure 35** shows main bus CT mounting brackets.

**Figure 35.** Example main bus CT mounting brackets.

**Figure 36** shows a 1250 A ANSI main bus CT.

**Figure 37.** Example 2000 A / 2500 A main bus side CT
Instructions for the operation and maintenance of Power Xpert™ XGIS gas insulated switchgear

Figure 38. Main bus CT mounting brackets, both ratings.

Cable compartment CTs

Cable compartment CTs come in a variety of configurations, depending upon system requirements. They can be furnished for cable connections or bus connections.

Cable connections

In the 1250 A rated XGIS vertical section, cable connection CTs can be furnished as single or double CTs per phase. The CTs mount on an output bus horizontal bushing. Separable connectors connect cable(s) to the bushing. Shows an example of a cable connection bushing mounted on the tank front.

Figure 39 shows how a cable CT is mounted over the cable connection bushing, prior to making the cable connections.

Figure 39. Cable CT surrounding cable bushing.

Figure 40 and Figure 41 show examples of cable side current transformers. The 1250 A CT fits over one bushing per phase while the 2500 A CT fits over two bushings per phase.

Figure 40. Example 1250 A cable side CT.

Figure 41. Example 2500 A cable side CT.

Figure 42 shows 1250 A cable connection CTs mounted to the front of the tank.
Bus tie connections

XGIS sections can be configured for output bus connections, so that adjacent vertical section sectionalizing bushings are directly connected using SSIS bus. In that case, a different SF₆ tank is used, the output bushings are mounted vertically in the tank bottom, and connected to bus joints connecting SSIS bus sections.
Surge arresters can be mounted in the cable compartment. Each cable compartment bushing can accommodate up to three cable connectors. When surge arresters are included, they replace one of the power cable connectors, allowing a maximum of two power cable connections per phase. Figure 48 shows an example surge arrester designed for connection using tee type connectors.

Key interlocks
The XGIS design can be furnished with key interlocks.

Cable Grounding Kits
Cable grounding kits are available to facilitate grounding the cable connections in an XGIS vertical section. These kits are designed to provide grounding connections without disturbing the tee or companion connectors installed on the tank phase bushings. They include busbar connections to the vertical section ground bus.

There are three kits, each for a different cable connection configuration. They are:

- **67D3091** single cable connection grounding kit (see Figure 49),
- **67D3092** two cable connection grounding kit (see Figure 50),
- **67D3093** three cable connection grounding kit (see Figure 51).
1.3.6 XGIS vertical section configurations

The XGIS vertical sections come in five basic configurations, with options available to customize the equipment for each application. The configurations are:

- Feeder/incoming
- Bus tie
- Bus sectionalizer
- Disconnector
- Cable connector.

These configurations are defined and illustrated in the following pages.
1.3.6.1 Feeder/incoming
The feeder/incoming vertical section includes both the three-position disconnect switch and the vacuum interrupter circuit breaker. It includes SSIS main bus and cable connections. This section can be furnished with fused VTs with a disconnect switch, cable CTs, remote-mounted fused VTs or surge arresters.

1.3.6.2 Bus tie
The bus tie vertical section includes both the three-position disconnect switch and the vacuum circuit breaker. It is intended to connect two separate buses. It can be furnished with a set of VTs with the VT disconnect switch and bus CTs.

Figure 52. Feeder/incoming ANSI one-line.

Figure 53. Bus tie ANSI one-line.
1.3.6.3 Bus sectionalizer

The bus sectionalizer vertical section is intended to connect or isolate buses without circuit breaker protection. It includes the three-position disconnect switch, but no circuit breaker. It can be furnished with a set of VTs with the VT disconnect switch and bus CTs.

Figure 54. Bus sectionalizer ANSI one-line.

1.3.6.4 Disconnector

The disconnector vertical section includes only the three-position disconnect switch. It is intended to connect or isolate direct connections to the XGIS main bus. This section can be furnished with fused VTs with a disconnect switch, cable CTs, remote-mounted fused VTs or surge arresters.

Figure 55. Disconnector ANSI one-line.
1.3.6.5 Cable connector

The vertical section includes only a hard bus connection throughout the tank. It is intended to connect incoming or outgoing cable connections directly to the XGIS main bus. This section can be furnished with cable CTs, remote-mounted fused VTs or surge arresters.

Figure 56. Cable connector one-line.

Table 2, Table 3 and Table 4 list the vertical section dimensions, electrical data and relevant standards for Power XPert XGIS switchgear.

Table 5 lists the Power XPert XGIS switchgear rated operating conditions.
1.4 Type XGIS gas insulated switchgear ratings (tables 2, and 3)

Table 2. Vertical section dimensions

<table>
<thead>
<tr>
<th>Vertical section dimensions</th>
<th>1250 A</th>
<th>2000 A / 2500 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>600 mm (23.62 in)</td>
<td>800 mm (31.5 in)</td>
</tr>
<tr>
<td>Depth</td>
<td>1800 mm (70.87 in)</td>
<td>1800 mm (70.87 in)</td>
</tr>
<tr>
<td>Height</td>
<td>2700 mm (106.3 in)</td>
<td>2700 mm (106.3 in)</td>
</tr>
</tbody>
</table>

Table 3. Electrical data

<table>
<thead>
<tr>
<th>Electrical Data</th>
<th>Units</th>
<th>Value (1250 A / 2000 A / 2500 A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>kV</td>
<td>38 (60 Hz), 36 (50 Hz)</td>
</tr>
<tr>
<td>Lightning impulse withstand voltage</td>
<td>kV</td>
<td>170</td>
</tr>
<tr>
<td>Power frequency withstand voltage</td>
<td>kV</td>
<td>80</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>Hz</td>
<td>50/60</td>
</tr>
<tr>
<td>Internal arc class</td>
<td></td>
<td>AFLR</td>
</tr>
<tr>
<td>Loss of service continuity category</td>
<td></td>
<td>LSC2B</td>
</tr>
</tbody>
</table>

Accessibility of compartments

- Circuit breaker compartment: Interlock-controlled
- Busbar compartment: Tool-based/non-accessible
- Cable compartment: Tool-based or interlock-controlled
- External degree of protection: IP4X
- Primary live parts degree of protection: IP65
- Installation: Indoor
- Temperature classification: °C
- Relative humidity (max): %
- Phase busbars
  - Rated normal current | A     | 1250, 2000, 2500 |
  - Rated short-time withstand current, rms symmetrical | kA - 3 s. | 31.5 |
  - Rated peak withstand current | kA    | 82 |
- Ground bus
  - Rated short-time withstand current, rms symmetrical | kA - 3 s. | 31.5 |
  - Rated peak withstand current | kA    | 82 |

Circuit breaker ratings

- Rated normal current | A     | 1250 / 2000 / 2500 |
- Rated short-circuit breaking current, rms symmetrical | kA    | 31.5 |
- Rated short-circuit making current, peak | kA    | 82 |
- Rated short-time withstand current, rms symmetrical | kA - 3 s. | 31.5 |
- Class | E2, M2, C1 for 1250 A, C2 for 2000 A |
- Number of full short-circuit breaking operations | 30 |
- Rated operating sequence | 0 - 0.3S - CD - 15S - CO |
- Class | M2 |
- Number of operations - No-load or full load | > 10,000 / > 2,000 |

Three-position disconnect switch

- Number of operations | ≥ 2000 |

Heat Loss for representative sections

| 1250 A | 683 W |
| 2000 A | 905 W |
| 2500 A | 1554 W |
### Table 4. Relevant standards

<table>
<thead>
<tr>
<th>Relevant standards</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 62271-100 High-voltage switchgear and controlgear - Part 100: Alternating</td>
<td>current circuit breakers</td>
</tr>
<tr>
<td>IEC 62271-102 High-voltage switchgear and controlgear - Part 102: Hi-voltage</td>
<td>alternating current three-position disconnect switches and earthing switches</td>
</tr>
<tr>
<td>IEC 62271-200 High-voltage switchgear and controlgear - Part 200: AC metal-</td>
<td>enclosed switchgear and control gear for rated voltages above 1 kV and up</td>
</tr>
<tr>
<td></td>
<td>to and including 52 kV</td>
</tr>
<tr>
<td>IEC 60529 Degrees of protection provided by enclosures (IP code)</td>
<td></td>
</tr>
<tr>
<td>IEC 62271-1 High-voltage switchgear and controlgear - Part one: Common</td>
<td>specifications</td>
</tr>
</tbody>
</table>

### Table 5. Operating conditions

**Normal operating conditions, according to IEC 62271 – 1 for indoor switchgear**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient air temperature</td>
<td>≤ 40° C&lt;br&gt;≤ 35° C on average over 24 hours&lt;br&gt;≥ -5° C</td>
</tr>
<tr>
<td>Altitude</td>
<td>≤ 1000 m&lt;br&gt;Contact Eaton for applications above 1000 m.</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>No dust, smoke or corrosive or flammable gas or vapor, or salt (clean industrial air)</td>
</tr>
<tr>
<td>Storage conditions</td>
<td>To retain all of the functional qualities when stored for prolonged periods, we recommend that the equipment be stored in its original packaging, in well-ventilated, clean, and dry conditions, sheltered from the sun and rain, at a temperature ≥ -25° C and ≤ +55° C.</td>
</tr>
</tbody>
</table>

**Figure 57** shows outlines and dimensions for the 1250 A XGIS vertical section.

**Figure 58** shows outlines and dimensions for the 2000 A and 2500 A XGIS vertical section.
1.5 XGIS vertical section outlines and dimensions
1.5.1 1250 A vertical section

Figure 57  1250 A vertical section
1.5.2 2000 A / 2500 A vertical section

Figure 58. 2000 A / 2500 A vertical section dimensions.
1.6 SSIS conductor system

Solid Shielded Insulation System components provide modular shielded busbar conductors protected by solid insulation. The system includes shielded bus sections and coupling adapters that provide mechanically robust installation that is impervious to environmental conditions, and free from local electric field around the conductors.

The SSIS conductors and connecting adapters consist of three concentric layers:
- The live conductor
- The insulating layer over the conductor, and
- The conductive shield outer layer

Figure 59 shows some example SSIS components and their arrangement as bus sections and terminations. Bus sections start at bus connection bushings (fitted in the tank) coupled to end or cross bus joints, extend using SSIS busbar, and terminate at bus connection bushings connected to end or cross type bus joints.

Figure 59. Example SSIS components and assemblies.

1.6.1 SSIS bus in XGIS gas insulated switchgear

SSIS type busbars are installed as main bus conductors in XGIS switchgear.

Main busbars are installed and coupled to the bus connection bushings fitted on top of the sealed tank. Main horizontal busbars are enclosed in a separate compartment above the sealed tank.

The bus joints used to connect bus sections differ with the bus rating. There are two bus joint types and two connection types. The Type C bus joint serves 1250 A bus, and provides connections in either cross or end configurations. The Type F bus joint serves 2500 A bus, and also provides connections in either cross or end configurations.
SSIS cross adapters are used to extend the bus between the Bus joints are characterized by their bus size and by the bushing cones they can accommodate.

- A Type C bus joint has a top throat suitable for a Type C plug and a bottom throat suitable for a 1250 A bushing cone.
- A Type F bus joint has a top throat suitable for a Type C plug and a bottom throat suitable for a 2500 A bushing cone.
- Each bus joint uses a threaded rod to connect the bus with the tank cone. Type C and Type F bus joint rods are different.
- End bus joints use a cylindrical insert to balance the clamshell clamping force.

End bus joints use a cylindrical insert to balance the clamshell clamping force. See Figure 62, which shows the differences between Type C and Type F bus joints.

![Figure 62. Bus joint differences](image)

### 1.6.2 Power cable conductors in XGIS switchgear

The customer’s power cables terminate in XGIS by fitting separable cable connectors onto the XGIS tank bushings located in the power cable compartment. The installed cables are clamped in place using cable cleats mounted on the cable compartment cable brackets (see Figure 63).

The maximum number of cable connectors possible depends on the XGIS rating. Multiple connectors per phase are configured using tee or elbow type separable connectors (Figure 64). A surge arrester can be connected as the last connected device.

![Figure 63. 1250 A cable connectors in cable compartments.](image)
Note:
The Output Compartment can accommodate up to three connectors, or two connectors and a surge arrester.

Figure 64. Separable power cable connectors.

Figure 65. Cable separable connectors in 2000 A or 2500 A cable compartments.

The separable connectors include a shield layer that is used to ground the exterior of the connectors. The ground wires must be fastened to the compartment ground bus. This will ensure the outer surface of the separable connectors are at ground potential.
1.7 Voltage detection system

1.7.1 Connecting the voltage detection system cables to ground

**CAUTION**

FAILURE TO EFFECTIVELY GROUND VOLTAGE DETECTING CABLES L1, L2, L3 PRIOR TO POWER FREQUENCY WITHSTAND VOLTAGE TESTING OR VLF VOLTAGE TESTING COULD RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE.

The Voltage Detection System is equipped with four ports at the front of the device to measure the detected voltage from the bushings. Three ports are for L1, L2, and L3 voltages, and the fourth port is a ground connection.

The following procedure must be followed before performing any power frequency withstand voltage testing or VLF voltage testing:

- Ensure that the voltage detection cables and the ground wire are securely connected behind the VDS device.
- Using three wires that are terminated with banana jack at each end, connect the first wire between L1 port and the ground port, connect the second wire between L2 and the ground port and connect the third wire between L3 and the ground port as shown in Figure 66.
- After performing the voltage test and before energizing the switchgear for normal service, remove the three wires from the front of the voltage detecting device.

Since the cable compartment cable connectors include a capacitance test port for voltage detection, the VDS uses capacitance coupled voltage division to safely detect signals proportional to the high voltage present on the connected cables. In accordance with IEC 61243-5, the VDS will indicate voltage present when the input signal current corresponds to 45 - 120% of nominal voltage, and will indicate voltage absent for input current signals corresponding to line-to-earth voltage <10% of nominal voltage, where line-to-earth is defined as nominal voltage / √3.

While VDS is provided as standard on the cable side connections, it is also available as an option on other parts of the XGIS power circuitry.

The VDS LCD display shows, for each phase, voltage present or absent as follows:

**Table 6. VDS LCD display performance**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% x nominal &lt; Input ≤ 45% x nominal</td>
<td>display</td>
</tr>
<tr>
<td>Input &gt; 45% x nominal</td>
<td>display normally</td>
</tr>
<tr>
<td>Input &lt; 10% x nominal</td>
<td>no display</td>
</tr>
</tbody>
</table>

The VDS includes two interlock outputs that can be connected into permissive logic for operation of the three-position disconnect switch. These contacts perform as follows:

**Table 7. VDS relay output performance**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>phase voltage ≥ 0.1 x nominal voltage (control voltage present)</td>
<td>Relay 1 on</td>
</tr>
<tr>
<td>phase voltage &lt; 0.1 x nominal voltage (control voltage present)</td>
<td>Relay 2 on</td>
</tr>
<tr>
<td>control voltage absent</td>
<td>Relay 1 and Relay 2 off</td>
</tr>
<tr>
<td>Earth fault (asymmetry)</td>
<td>Relay 1 and Relay 2 on</td>
</tr>
</tbody>
</table>

The standard VDS for cable side voltage detection is the Peaks CVD10. Figure 67 shows the panel-mount instrument face of the VDS.

![Figure 66. VDS grounding.](image)

A voltage detection system is included as standard for detecting cable side voltages on all three phases. The voltage detection device is mounted on the XGIS front panel face and operates in accordance with IEC 61243-5 (integrated voltage detection systems). This system looks for the presence of voltage in each of the three phases and indicates the line status using LED display symbols on the device display.
1.8 SF₆ Gas handling

No SF₆ gas handling is required during general installation. If gas tank filling or evacuation is required, it should be done by specialists trained on SF₆ processing.

SF₆ removal and recharging will require a gas extraction pump and charging system suitable for restoring rated gas tank pressure during the refill. This equipment must meet the requirements dictated by the local jurisdiction.

Whenever SF₆ is removed from the tank, the tank desiccant must be replaced. This desiccant is specific to the XGIS switchgear. The desiccant catalog number is 87A1040H01. Figure 68 shows the desiccant placed in the tank bottom.

Section 2: Receiving, handling and storage

For information about receiving, handling and storage of XGIS switchgear, refer to the Installation and Commissioning manual, IB022018EN.

Figure 68. XGIS gas tank desiccant.
Section 3: Safe practices

3.1 Recommendations

Type XGIS vacuum circuit breaker elements are equipped with high speed operating mechanisms. They are designed with several built-in interlocks and safety features to provide safe and proper operating sequences.

⚠️ WARNING

TO PROTECT PERSONNEL ASSOCIATED WITH INSTALLATION, OPERATION, AND MAINTENANCE OF THESE SWITCHGEAR ELEMENTS, THE FOLLOWING PRACTICES MUST BE FOLLOWED:

- Only qualified persons, as defined in the local electrical code, who are familiar with the installation and maintenance of medium-voltage circuits and equipment, should be permitted to work on switchgear.

- Read these instructions carefully before attempting installation or commissioning of this equipment.

- Do not work on a closed breaker or a breaker with closing springs charged. The closing spring should be discharged and the main contacts opened before working on the breaker. Failure to do so could result in injuries.

- Do not use a circuit breaker by itself as the sole means of isolating a high-voltage circuit. Open the three-position disconnect switch and follow good lockout and tagging rules, as well as all applicable codes, regulations and work rules.

- XGIS switchgear employs sulfur hexafluoride (SF₆) in the enclosure tank, at slightly higher than nominal atmospheric pressure. Special precautions must be followed if service is required on the SF₆ tank.

- SF₆ is heavier than air and will displace air in a confined space. This can present a suffocation hazard.

- Never allow only one person access to the XGIS tank to perform maintenance or service work.

- Always replace the tank desiccant after performing tank maintenance.

- Once XGIS tank service is completed, personnel must clean their hands, faces and exposed skin immediately. Tools and PPE must also be cleaned.

- SF₆ MUST NOT be discharged into the atmosphere. It should be collected and may be reused only after treatment and testing by qualified experts.
Section 4: Description and operation

4.1 Introduction

XGIS gas insulated switchgear is a 38 kV system with designs for main/feeder, bus tie, bus sectionalizing and disconnector units. It is configured for SSIS (solid shielded insulating system) main bus conductors and can accommodate power cables with tee connector terminations. The units are designed for 1250 A, 2000 A and 2500 A applications.

The XGIS switchgear includes arc-resistant features including arc plenum, seals and gaskets for containment, gas deflectors, arc flaps, and arc exhaust ducts.

Design options include:

- Current transformers,
- Voltage transformers (fused and unfused) with disconnect switch,
- Cable side voltage transformers, either internal or cable-connected remote voltage transformers,
- SSIS main bus connections, or
- Cable connections (to a cable vault), for single or multiple cables per phase,
- Surge arresters.

Each of the designs uses a sealed pressurized tank to house its power switching components and their connections. The tank contains SF₆ (sulfur hexafluoride) gas at 1.2 to 1.3 bar, as the insulating medium.

Each XGIS switchgear unit is composed of:

- A low-voltage compartment (instruments, relays and operating mechanisms compartment),
- A main bus compartment,
- A voltage transformer compartment,
- A pressurized sealed tank,
- A tank pressure gauge,
- A tank gas port,
- A tank pressure relief fitting,
- A power cable compartment.

Within the pressurized sealed tank, depending upon the configuration provided, there will be either a three-position disconnect switch (bus sectionalizing configuration), or a three-position disconnect switch and a vacuum circuit breaker assembly (incoming or feeder configuration).

4.1.1 Three-position disconnect switch

The three-position disconnect switch mechanism is driven by an electric motor, with manual backup. The switch assembly consists of three horizontal linear contacts, one for each phase, each with three-positions: grounded, open (isolated), and closed.

Mimic status for the switch position is mounted on the unit front door with three indicating lights. A mechanical display of the switch position consists of two display windows on the switch operating mechanism front face.

The switch operating mechanism with motor drive is mounted on the SF₆ tank front wall through a pressure seal, with the operating mechanism outside the tank and the switch assembly inside the tank. The three-position disconnect switch poles are each propelled by a rotating screw drive, with each switch drive shaft extending into the tank chamber through its own magnetic fluid seal. A cam limit switch assembly in the operating mechanism signal the three-position disconnect switch operating position.

4.1.2 Circuit breaker

The circuit breaker springs’ charging mechanism is driven by an electric motor, with manual backup. The vacuum circuit breaker consists of three horizontal vacuum interrupter bottles, propelled by a single mechanism. All normal operations are performed by first charging the open/close spring, then using spring force to open or close the breaker.

The circuit breaker status is indicated through a cutout window on the operating mechanism front cover (see Figure 22). This indicator can be viewed through a cutout on the vertical section front door (Figure 69, item 11). Breaker status is repeated electrically by indicating lights on the vertical section front door (Figure 69, items 12 and 13). Breaker positions are Open and Closed.

4.1.3 VT earthing switch

The VT earthing switch is furnished with voltage transformers. The VT earthing switch provides a means to connect its voltage transformer to a power circuit, or to disconnect and earth the VT primary.

For information on operating the VT earthing switch, see section 4.2.3.
4.2 Operation

Figure 69 shows a typical vertical section front panel devices layout. Actual layouts will depend upon customer custom features. Refer to the project drawings for installed details.

Legend

(Standard layout shown. Actual layout may have custom features).

1. Voltage detection system (VDS)
2. Protective relay
3. 3PDS closed indicating light
4. Tank gas pressure gauge viewing window
5. Three position disconnect switch (3PDS) open indicating light
6. 3PDS grounded indicating light
7. 3PDS mechanical status viewing window
8. Circuit breaker (CB) mechanical status viewing window
9. 3PDS close pushbutton
10. 3PDS open pushbutton
11. 3PDS ground pushbutton
12. 3PDS camera port (option)
13. CB open/close selector switch
14. CB open indicating light
15. CB closed indicating light

Figure 69. Typical vertical section front panel device layout
4.2.1 Three position disconnect switch (3PDS)

Normal operation

The 3PDS is normally operated electrically, using the operator control devices mounted on the vertical section front door (see Figure 69, items 9, 10 and 11). There is a pushbutton that initiates travel from an initial position to either the Ground, Open or Closed position. 3PDS status is displayed on the vertical section low voltage door by indicating lights (see Figure 69, items 1, 2 and 3).

The 3PDS is interlocked electrically with the circuit breaker to require that the circuit breaker be open before any disconnect switch operations are permitted. A rotary limit switch housed in the 3PDS operator enclosure requires that the 3PDS be in one of the three possible normal positions (Ground, Open or Closed) before movement to another position is permitted.

The 3PDS status may be viewed through the mechanical status viewing window (Figure 69 item 7).

Manual operation

3PDS manual operation may be required in the event of control power loss or failure of the switch electric drive controller.

The 3PDS operator enclosure has a front door that covers the manual operation port. This door is interlocked mechanically with the circuit breaker to require that the circuit breaker be open before opening the access door is permitted. In addition, a solenoid-driven pin, when energized by a circuit breaker control circuit, also prevents opening the manual access door. When the circuit breaker is open, this solenoid is de-energized and the access door may be opened. Also, if the cable side power circuit is de-energized, the solenoid is de-energized and manual operations are permitted.

Manual operation requires the use of the T-handle tool (see Figure 14.) When manual operations are performed, use the Switch Position indicator windows (see Figure 15 and Table 1) to determine when the target switch position has been reached.

With the circuit breaker open, 3PDS manual operations are performed as follows:

1. Open the manual operation cover and insert the provided T-handle tool.

2. Apply force until the tool is firmly engaged with the operating mechanism and rotate the tool in the desired direction.

3. Once the switch contacts have reached the next operating position, T-handle engagement will begin to slip and rotate freely.

4. Remove the tool from the manual operation port and reinsert. Repeat steps 2. and 3. to move the contacts to the next operating position. When the desired position has been achieved, as confirmed by the Switch Position indicator windows, remove the tool and close the manual operation cover.

NOTICE

IT IS POSSIBLE TO MANUALLY DRIVE THE THREE-POSITION DISCONNECT SWITCH PAST ITS FULLY GROUNDED OR FULLY CLOSED POSITIONS, RESULTING IN MECHANICAL DAMAGE TO THE SWITCH DRIVE TRAIN.

REFER TO THE THREE-POSITION DISCONNECT SWITCH DISPLAY WINDOWS TO THE RIGHT OF THE MANUAL ACCESS DOOR WHILE OPERATING IN THE MANUAL MODE. DO NOT TURN THE MANUAL DRIVE SHAFT FURTHER THAN FULLY GROUNDED OR FULLY CLOSED AS INDICATED BY THE THREE-POSITION DISCONNECT SWITCH POSITION DISPLAY WINDOWS.

FULLY GROUNDED POSITION IS INDICATED BY A “1” IN THE MIDDLE OF THE LEFT HAND (GREEN) WINDOW, AND A “0” IN THE MIDDLE OF THE RIGHT HAND (RED) WINDOW.

FULLY CLOSED POSITION IS INDICATED BY A “0” IN THE MIDDLE OF THE LEFT HAND (GREEN) WINDOW, AND A “1” IN THE MIDDLE OF THE RIGHT HAND (RED) WINDOW.

4.2.1.1 Three-position disconnect switch operation check performance

Confirm that the circuit breaker is open (check the Breaker Status indicator window for a green flag with “0 Open” indication).

Confirm that the 3PDS manual access door is fully closed.

Using local control devices on the unit door (if furnished) or temporary momentary pushbuttons wired to the remote inputs on the low-voltage customer terminal board (see the project schematics and wiring diagrams), initiate three-position disconnect switch position changes.

Test the three-position disconnect switch by commanding movement to all three possible positions (ground, open, closed).

Confirm that in each case a complete motion cycle is executed, with appropriate 3PDS status indicator lights illuminated on the section low voltage door and status flag indications in the 3PDS operator status display windows.
4.2.2 Circuit breaker

**Normal operation**

Circuit breaker electrical operation can be initiated locally or remotely. Locally, at the vertical section, a spring-return-to-center selector switch (Figure 69 item 16) triggers opening or closing operation.

The breaker spring charging system status is displayed on the breaker operating mechanism front cover through a cutout window, also viewable through the vertical section door (item 11). Electrical (normal) spring charging operation is initiated by a selector switch (Figure 69 item 17). Charged status is indicated by an indicating light (item 14).

The circuit breaker operating mechanism includes an operation cycle counter, viewable from the breaker front cover (see Figure 22).

**Manual operation**

Circuit breaker manual operation can be initiated at any time using the circuit breaker front cover manual pushbuttons (see Figure 22), provided that the spring is charged. If control power is not available, spring charge status can be viewed through the Mechanism Status mechanical flag viewing cutout on the breaker front cover.

If manual charging of the circuit breaker spring is required, it can be done using the manual charging handle (see Figure 22). After confirming that the spring is discharged (Mechanism Status flag), cycle the manual charge handle approximately 25 times until the Mechanism Status flag indicates “Charged.” Then use the manual buttons on the breaker front cover to initiate breaker operation.

For typical application configurations, please see Figure 52, Figure 53, Figure 54, Figure 55 and Figure 56. The low-voltage compartment is at the front of the entire vertical section, the pressure-relief channel is behind the vertical section, and all 3-phase medium-voltage elements are enclosed in the sealed SF₆ tank.

The SF₆ tank is made of laser-welded stainless steel plates and contains the isolation and grounding three-position disconnect switch and may also contain a vacuum circuit breaker, depending on the application.

The cable compartment is located underneath the tank and contains separable (plug-in type) connectors for installing power cables and lightning arresters. The CTs are installed over the CT bushings.

**4.2.2.1 Manual operation check**

Turn off power to the circuit breaker by opening low voltage control power circuit breaker. Discharge any remaining spring energy in the circuit breaker mechanism by closing and opening the breaker. Refer to Figure 70 and proceed by pumping the charging handle. Charge the closing springs with about 25 up and down handle strokes. When charging is complete the closing crank goes over center with an audible CLICK and the springs charge status indicator shows that it is charged. Refer to Figure 71 for an enlarged view of the charge status window.

**4.2.2.2 Electrical operation check**

Ensure the low voltage control power is applied to the circuit breaker mechanism and close the low voltage control power circuit breaker if needed. Ensure the circuit breaker electrical control circuit is functioning by closing and opening the circuit breaker electrically. After the circuit breaker opens, the spring charge motor should automatically re-charge the circuit breaker mechanism spring and verify the charge status shows that the spring is charged.

**4.2.2.3 Interface interlocks / interlocking check**

The three-position disconnect switch and circuit breaker are extensively interlocked to prevent inappropriate operation. Following is Table 8 which indicates how the two devices’ status affects what operations are possible for each device. Refer to the project schematics and three-position disconnect switch controller program for details.
4.2.2.4 Typical feeder circuit operations

It is assumed that a feeder is in the energized condition and the operating sequences described below are of a general nature for gas insulated switchgear. In all cases applicable safety and specific operating rules shall be observed.

4.2.2.5 Sequence of operation for isolation of a feeder:

a. The feeder circuit breaker is switched to the open position. This enables the three-position disconnect switch.

b. The feeder three-position disconnect switch is switched to the open position. Verify this state by viewing.

c. The feeder circuit is now isolated on the cable side.

4.2.2.6 Sequence of operation for feeder grounding:

a. Isolate the feeder using 4.3.1, above.

b. Verify that the circuit is deenergized by means of an integrated voltage detector / indicator.

c. The three-position disconnect switch is switched to the ground position. Verify this state by viewing.

d. Close the circuit breaker.

e. Lock the circuit breaker in its closed position.

f. The feeder is now grounded through the circuit breaker on the line side.

4.2.2.7 Sequence of operation for main bus grounding on sectionalized bus arrangements

(a bus and b bus tied together using a bus tie breaker)

It is assumed that the tie circuit breaker is in the energized condition.

Sequence of operation for grounding of main bus section A:

a. Open all breakers connected to bus “A.”

b. Move all three-position disconnect switches on bus “A” to the open position and verify that state by viewing.

c. Disable closing of all bus “A” three-position disconnect switches.

d. Open the tie breaker between bus “A” feeder and bus “B” feeder.

e. Open bus “A” three-position disconnect switch of the bus tie circuit breaker. Verify this state by viewing.

f. Move the bus “B” three-position disconnect switch to the ground position (this is possible only if all three-position disconnect switches on the bus “A” feeders are in the open position). Verify this state by viewing.

g. Close the tie circuit breaker.

h. Lock the tie circuit breaker in the closed position.

i. Bus “B” is now grounded.

4.2.2.8 Circuit breaker trip free operation

The Eaton XGIS vacuum circuit breaker incorporates electrical trip-free characteristics. That is, the contacts of the circuit breaker must return to the open position and remain there when an opening operation follows a closing operation, regardless of whether the closing signal is maintained.

A circuit breaker with “Electrically Trip-Free” features must be able to receive and respond to an electrical opening signal regardless of whether an electrical closing signal is applied.
Table 8. Three-position disconnect switch/circuit breaker interlocking truth table

<table>
<thead>
<tr>
<th>Status</th>
<th>Electrical</th>
<th>Mechanical (manual)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CB springs charged</td>
<td>CB open</td>
</tr>
<tr>
<td>CB opened</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>CB closed</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>CB springs charged</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td>Disconnect switch</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>ground</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disconnect switch</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>closed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disc. in operation</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Disc. manual door</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>closed/locked</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disc. manual door</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>open</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disc. not at ground,</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>closed or open</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control power on</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Control power off</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unit low voltage door</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>open</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage present on</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>cable side</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 = permitted   0 = not permitted   N/A = does not apply

Conditions not covered by table

- Three-position disconnect switch must reach destination position for a cycle to be complete
- Three-position disconnect switch mechanism has physical travel limits at ground and open. DO NOT EXCEED these limits.
- Three-position disconnect switch position is displayed by mechanical indicator. Indicator displays correctly only at cardinal positions
- Three-position disconnect switch must be in open position before electrical operations are permitted (may be necessary to manually position)
- If unit control power is sourced from the cable side, and the cable is energized, the three-position disconnect switch cannot be moved to ground position
- If unit control power is sourced from the cable side, and the cable is energized, three-position disconnect switch manual operations are prevented
- If control power is lost, the circuit breaker cannot be closed (due to a lockout magnet). If the circuit breaker must be closed under this condition, remove the circuit breaker front cover, push the lockout magnet pin in, then close the breaker using the manual (mechanical) button.

4.2.3 Voltage transformer earthing switch

Operation of the VT earthing switch is the same no matter where in the power circuit the VT is connected.

Voltage transformers can be furnished in a variety of locations, both main bus side and cable side. When top-mounted VTs are supplied for either main bus or cable side applications (on top of the tank behind the main bus compartment), they can be equipped with VT earthing switches. These switches either connect the VT to its power circuit or connect it to ground.

The VT earthing switch can be operated under no-load or loaded conditions, and is operated as follows.

4.2.3.1 VT earthing switch operation

⚠️ WARNING
THE POWER XPERT XGIS SWITCHGEAR DESCRIBED IN THIS DOCUMENT ARE DESIGNED AND TESTED TO OPERATE WITHIN ITS NAMEPLATE RATINGS. OPERATION OUTSIDE OF THESE RATINGS MAY CAUSE THE EQUIPMENT TO FAIL, RESULTING IN DEATH, BODILY INJURY AND PROPERTY DAMAGE.

ALL SAFETY CODES, SAFETY STANDARDS AND/OR REGULATIONS AS THEY MAY BE APPLIED TO THIS TYPE OF EQUIPMENT MUST BE STRICTLY ADHERED TO.

⚠️ WARNING
ELECTROCUTION, SHOCK AND BURN HAZARD.
LOCK OUT VT DISCONNECT SWITCH IN THE GROUNDED POSITION BEFORE ENTERING UPPER VT COMPARTMENT FOR ANY REASON. FAILURE TO FOLLOW THIS WARNING MAY RESULT IN SERIOUS INJURY OR DEATH.

The VT earthing switch is located to the right and behind the three-position disconnect switch, and is operated by a cylindrical lever, topped with a phenolic ball. It has two positions, Connect and Ground, and must be in one of these two positions at all times.

When the VT earthing switch is in either the Connect or Ground position, it is held in place by a spring-loaded latch that must be unlatched to permit switch position changes. See Figure 72.

Note: When isolating VTs from an energized primary bus, it is recommended that the VT secondary (low voltage) circuit breaker be opened to interrupt current flow through the switch contacts prior to operating the VT disconnect to or from the connected position.
To move the VT earthing switch from the Connect position to the Ground position, **wearing all appropriate personal protective equipment**, follow these steps:

1. Grip the handle and apply a small amount of pressure away from center.
2. Pull the release arm out and begin rotating the handle (see Figure 73).
3. Let go of the release arm.
4. Continue to rotate the switch handle toward the desired position until the release arm locks back into place (see Figure 74).

**Figure 72.** VT earthing switch with latch lever

**Figure 73.** Grip the handle. Pull the release arm out.

**Figure 74.** Let go of the release lever and rotate switch handle to the Ground position.

**Figure 75.** VT earthing switch in Ground position.

**Figure 75** shows the VT earthing switch in its new (Ground) position. Follow the same procedure to move the switch from Ground to Connect.
Section 5: Inspection, maintenance, and testing

5.1 Logbook

The user should keep a logbook with data with regards to the installation, maintenance and repair of the XGIS switchgear. The information recorded should at least include the following:

- All important incidents occurring in and with the XGIS
- All faults
- All maintenance work carried out
- All repairs carried out
- Note of contact with Eaton with regards to instructions and permissions if required of any changes or modifications/repairs carried out.

**WARNING**

INSPECTIONS, CHECKS AND MAINTENANCE OPERATIONS SHOULD ONLY BE CARRIED OUT BY AUTHORIZED SPECIALIST PERSONNEL. BEFORE INSPECTIONS, CHECKS AND MAINTENANCE OPERATIONS ARE COMMENCED, ALL NECESSARY STEPS MUST BE TAKEN TO ENSURE SAFE WORKING. THIS MEANS, AMONG OTHER THINGS, THAT:

- ALL PARTS OF THE SYSTEM BEING INSPECTED MUST BE DE-ENERGIZED AND EARTHED.

- PROTECTIVE PLATES MUST ONLY BE REMOVED AFTER THE INSTALLATION HAS BEEN MADE COMPLETELY SAFE.

5.2 Inspections

The XGIS switchgear should be inspected using a visual inspection annually, a condition inspection every 5 years, and a maintenance inspection when the given number of cycles is reached or at 10 years, whichever occurs first, per the table below.

**Table 9. Recommended inspections**

<table>
<thead>
<tr>
<th>Annually</th>
<th>Every 6 years</th>
<th>Every 10 years or cycle based a,b</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>Check pressure gauge</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>Vacuum around bus, breaker &amp; three-position disconnect switch mechanisms, low-voltage cable compartment</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>Gas sample and quality check</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>Check for excess wear on operating mechanisms</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>Check for loose relay connections</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>Operate circuit breaker by performing opening and closing operations using manual and electric operations and lubricate as necessary.</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>Operate three-position disconnect switch using manual operation and electric operation, and lubricate as necessary.</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>Operate VT disconnect switch using manual operation.</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>Test all mechanical and electrical interlocks.</td>
</tr>
</tbody>
</table>

**Notes:**

a 6000 cycles for 1250 A circuit breaker and 2000 cycles for 2000 A and 2500 A circuit breaker
b 2000 cycles for 3 position disconnect switch and 500 for VT earthing switch
All low voltage components (relays, lights, heaters, etc.) should be inspected in accordance with the relevant instruction manuals.
Contact Eaton Engineering Systems and Services for additional information.

5.3 Maintenance

The XGIS is designed to be maintenance free for the service life of the switchgear. If an issue arises requiring maintenance of components in the SF₆ tank, work must be done by an Eaton representative.

Under normal operating conditions, the breaker and switch mechanisms should not require additional lubrication or maintenance for the rated service life of the equipment.

If lubrication is required, Eaton recommends using Kluber ISOFLEX TOPAS NB 52. Apply this lubricant to all bearing, sliding surfaces, joints, rollers, gearbox, sprockets, and interlocking mechanisms. Apply this lubricant to the Three-position disconnect switch and vacuum circuit breaker mechanism after 2000 cycles.

All low voltage components should be maintained in accordance with the relevant instruction manuals.

Contact Eaton Engineering Systems and Services for additional information.

5.3.1 SF₆ Gas handling

**WARNING**

SF₆ GAS CAN CAUSE SUF OCATION. GAS HANDLING SHALL BE PERFORMED BY QUALIFIED SF₆ GAS HANDLING SPECIALISTS ONLY.

The Power Xpert XGIS product is designed such that no SF₆ gas handling should be required during installation and commissioning of the gear. If gas tank filling or evacuation is required, it should be done by specialists trained on SF₆ processing.

SF₆ removal and recharging will require a gas extraction pump and charging system suitable for restoring rated gas tank pressure during the refill.

**Gas removal**

Whenever SF₆ is removed from the tank, the tank desiccant must be replaced. This desiccant is specific to the XGIS system and consists of a bag, catalog number 87A1040H01, and should be purchased as a spare part. Figure 68 shows bags of desiccant placed in the tank bottom.

The SF₆ removed should be weighed and its weight recorded in kilograms. All recovered SF₆ should be stored in a DOT approved cylinder.

**Gas refilling**

The weight of SF₆ gas refilled in the tank should be equal to the nameplate weight of SF₆ for that vertical section. The weight of SF₆ refilled should be recorded in kilograms. If new SF₆ is used to refill the tank, it must meet the performance requirements of IEC 60376.

An SF₆ leak detector should be used throughout all gas processes to ensure that there are no leaks in the equipment. The weight of all SF₆ cylinders should be recorded when they arrive at and leave the site.

Instructions for the operation and maintenance of Power Xpert™ XGIS gas insulated switchgear
5.3.2 Cleaning viewing ports
The XGIS SF₆ tank viewing port can be cleaned using the following procedure:

1. Rinse with lukewarm water.
2. Wash with a solution of mild soap or household detergent and lukewarm water using a soft cloth or sponge.
3. Rinse with cold water and dry with a soft cloth to prevent water spotting.
   DO NOT scrape, scrub, or use brushes or squeegees.
   DO NOT use abrasive or highly alkaline cleaners.

5.4 Testing
XGIS switchgear is filled with the SF₆ insulating gas in the factory and tested as a complete system.
Current and voltage tests may be conducted without removing cables or discharging the insulating gas.

5.4.1 Typical test
Prior to beginning any testing, confirm that the equipment is de-energized.

Below is a list of common tests that may be performed on the XGIS switchgear. Consult Eaton engineering services for more information.

XGIS test list:
- Voltage withstand test
- Main circuit contact resistance (section to section)
- CTs ratio and polarity
- PTs ratio and polarity
- VDS functionality
- Relay functionality
- Ground bus continuity check
- Camera operation if provided (optional equipment)

5.4.2 Voltage test
In addition to a standard AC power frequency withstand voltage test that can be performed on the XGIS switchgear, several different voltage withstand tests can be performed on XGIS switchgear cables. These include but are not limited to the following tests:
- DC voltage withstand test
- Very Low Frequency (VLF) withstand test

Prior to performing any voltage withstand tests the switchgear must be prepared for voltage withstand testing.

5.4.2.1 Preparation for voltage withstand test
Prior to beginning preparing the switchgear for voltage withstand testing, confirm that the equipment is de-energized.

The following procedure must be followed before performing any voltage withstand testing:

1. Ensure that the voltage detection cables and the ground wire are securely connected behind the VDS device.
2. Using three wires that are terminated with banana jack at each end, connect the first wire between L1 port and the ground port, connect the second wire between L2 and the ground port and connect the third wire between L3 and the ground port as shown in Figure 76.
3. After performing the voltage withstand test and before energizing the switchgear for normal service, remove the three wires from the front of the voltage detecting device.

Prior to performing any voltage withstand test, the voltage transformers and lightning arresters must be isolated.
When performing a voltage withstand test on the switchgear, the voltage transformer must be in one of the following states:

1. VT installed and VT disconnect switch grounded, thereby removing the VT circuit from the PFVV test.
2. VT is removed and an insulating plug is installed in the VT port with the VT disconnect switch connected (see below for information on how to plug the VT port).
3. VT installed, primary VT fuse is removed, low voltage VT secondary circuit open (fuse removed or breaker open), and VT disconnect switch closed. In this case, the PFVV cannot exceed the field test level for the given service voltage (cannot perform PFVV test at type test levels for this option).

Removing a fused VT and installing an insulating plug
In order to satisfy the conditions of item 2. above, it will be necessary to remove a fused VT from its VT port on top of the tank, then plug the port with an insulating dummy plug. To do this,

1. Confirm that the equipment is de-energized
2. Loosen the four bolts holding the fused VT assembly to the tank VT port.
3. Disconnect the fused VT signal cable plug from its VT receptacle.
4. Remove the VT from the VT port area.
5. Install an insulating dummy plug, Eaton Catalog Number 87A1025H01.
6. Secure the dummy plug to the VT port by tightening the bolts to 13 Nm (115 in.-lb.) See Figure 77, below.

**Note:** Any empty VT port or exposed cable terminations must be insulated by installing an insulated plug or insulating cap respectively.

### 5.4.2.2 Performing switchgear voltage test

Power frequency withstand voltage tests should be performed at an AC voltage not to exceed the field PFWV level. PFWV tests should be performed with adequately rated AC hipot equipment.

Power frequency withstand voltage tests can be performed directly on the XGIS switchgear by installing a voltage test cable (see Figure 78) onto an empty cable bushing or by installed a power test cable into the termination left for the lightning arrester (if applicable).

Any power cables connected to a load must be disconnected from the load prior to voltage withstand testing. Empty (unapplied) terminations of any power cables that are connected to the XGIS switchgear must insulated and/or isolated.

### 5.4.2.3 Performing cable voltage test

XGIS switchgear is designed to allow the dielectric testing of power cables while the power cables are connected to the switchgear. Any cables under test should be isolated from the main bus using the 3PDS. Once isolated, cable testing can be conducted with the main bus energized up to the rated nameplate value.

The power cables must be disconnected from any load prior to testing. After disconnecting the cable from the load, hi-pot test equipment can be used to perform the applicable voltage withstand test on the entire cable run.

Typical voltage tests that can be performed on the power cables are:

- Direct Current withstand voltage tests
- Very Low Frequency withstand voltage test

To avoid damage to the XGIS switchgear and PFWV test equipment, cable test voltages should not exceed the following values:

- DC PFWV Test - 80 kV
- VLF (very low frequency) PFWV Test - 56 kV

### 5.4.3 Current test

Contact Eaton engineering services for more information.
Section 6: Renewal parts

6.1 General
When ordering renewal or spare parts, include as much information as possible. In many cases, the style number of the new part can be obtained from identification on the old part. Always include a description of the part. Specify the rating, structure number, and shop order number of the switchgear housing in which the part is to be used. See technical document TD022003EN for a list of XGIS renewal parts.

Contact Eaton engineering services for more information.

6.2 Ordering instructions
For ordering details for XGIS switchgear renewal parts, refer to technical document TD022003EN.
Eaton is a registered trademark.
All other trademarks are property of their respective owners.