Instruction Bulletin - 01.4IB.26264C
FlexGear™ Low Voltage Arc Resistant Switchgear

Equipped with GE EntelliGuard, Siemens WL, or Eaton Magnum DS Circuit Breakers

Up to and including 635V
Contact Information

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Signal Words

As stated in ANSI Z535.4-2007, the signal word is a word that calls attention to the safety sign and designates a degree or level of hazard seriousness. The signal words for product safety signs are “Danger”, “Warning”, “Caution” and “Notice”. These words are defined as:

- **DANGER** indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

- **WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

- **CAUTION** indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

- **NOTICE** is used to address practices not related to personal injury.

Qualified Person

For the purposes of this manual, a qualified person, as stated in NFPA 70E®, is one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved. In addition to the above qualifications, one must also be:

1. trained and authorized to energize, deenergize, clear, ground, and tag circuits and equipment in accordance with established safety practices.
2. trained in the proper care and use of personal protective equipment (PPE) such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.
3. trained in rendering first aid if necessary.
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Ch 1 General Information

⚠️ WARNING

The equipment described in this document may contain high voltages and currents which can cause death or serious injury.

The equipment is designed for use, installation, and maintenance by knowledgeable users of such equipment having experience and training in the field of high voltage electricity. This document and all other documentation shall be fully read, understood, and all warnings and cautions shall be abided by. If there are any discrepancies or questions, the user shall contact Powell immediately at 1.800.480.7273.

⚠️ WARNING

Prior to adjustments, servicing, maintenance, or any act requiring the operator to make physical contact with the equipment, the power source must be disconnected and the equipment grounded. Failure to do so may result in death or serious injury.

NOTICE

The information in this instruction bulletin is not intended to explain all details or variations of the Powell equipment, nor to provide for every possible contingency or hazard to be met in connection with installation, testing, operation, and maintenance of the equipment. For additional information and instructions for particular problems, which are not presented sufficiently for the user’s purposes, contact Powell at 1.800.480.7273.

NOTICE

Powell reserves the right to discontinue and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.
A. **Scope**

The information in this instruction bulletin describes the Powell FlexGear™ low voltage arc resistant metal-enclosed switchgear assemblies equipped with any of the following:

- GE EntelliGuard - 800-5000A Continuous Current rating
- Siemens WL - 800-5000A Continuous Current rating
- Eaton Magnum DS - 800-5000A Continuous Current rating

The equipment described is indoor type switchgear for applications up to and including 635 Volts.

Standard construction details are provided in the appropriate sections. The circuit breaker operation and maintenance instructions can be found in its instruction manual provided with each circuit breaker. Any special switchgear construction details are provided in supplementary documentation.

B. **Purpose**

The information in this instruction bulletin is intended to provide details required to properly operate and maintain the low voltage arc resistant switchgear with either GE EntelliGuard, Siemens WL, or Eaton Magnum DS circuit breakers.

This instruction bulletin provides:

1. Safety guidelines
2. General descriptions of the operation and maintenance of the low voltage arc resistant switchgear
3. Instructions for installation of the switchgear.
4. Information for ordering renewal parts
5. Illustrations, photographs, and description of the switchgear. Refer to the instruction manual provided with the circuit breaker for details on the circuit breaker operation.

The illustrations contained in this document may not represent the exact construction details of each particular type of switchgear section. The illustrations in this document are provided as general information to aid in showing component locations only.

**WARNING**

Follow the appropriate safety precautions while handling any of the equipment. Failure to do so may result in death or serious injury.

To the extent required, the products described herein meet the applicable ANSI, IEEE, and NEMA Standards; however, no such assurance is given with respect to local codes and ordinances which may vary greatly.

C. **Instruction Bulletins Available Electronically**

**NOTICE**

Changes to the instruction bulletin may be implemented at any time and without notice. Go to powellind.com to ensure use of the current instruction bulletin for Powell equipment.

For more information visit powellind.com. To contact the Powell Service Division call 1.800.480.7273, or email info@powellservice.com.

For specific questions or comments pertaining to this instruction bulletin email documents@powellind.com with the IB number in the subject line.
### Ch 2 Safety

#### A. Safe Work Condition

The information in Section A is quoted from NFPA 70E 2018 - Article 120, 120.5 Establishing an Electrically Safe Work Condition.

**120.5 Process or Establishing and Verifying an Electrically Safe Work Condition.** Establishing and verifying an electrically safe condition shall include all of the following steps, which shall be performed in the order presented, if feasible:

1. Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.

2. After properly interrupting the load current, open the disconnecting device(s) for each source.

3. Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected position.

4. Release stored electrical energy.

5. Release or block stored mechanical energy.

6. Apply lockout/tagout devices in accordance with a documented and established procedure.

7. Use an adequately rated portable test instrument to test each phase conductor or circuit part to verify it is de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the test instrument is operating satisfactorily through verification on any known voltage source.

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**N** Exception No. 1: An adequately rated permanently mounted test device shall be permitted to be used to verify the absence of voltage of the conductors or circuit parts at the work location, provided it meets the all following requirements: (1) It is permanently mounted and installed in accordance with the manufacturer’s instructions and tests the conductors and circuit parts at the point of work; (2) It is listed and labeled for the purpose of verifying the absence of voltage; (3) It tests each phase conductor or circuit part both phase-to-phase and phase-to-ground; (4) The test device is verified as operating satisfactorily on any known voltage source before and after verifying the absence of voltage.

**N** Exception No. 2: On electrical systems over 1000 volts, noncontact test instruments shall be permitted to be used to test each phase conductor.

Informational Note No. 1: See UL 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements, for rating, overvoltage category, and design requirements for voltage measurement and test instruments intended for use on electrical system 1000 volts and below.

**N** Informational Note No. 2: For additional information on rating and design requirements for voltage detectors, refer to IEC 61243-1, Live Working - Voltage Detectors - Part 1: Capacitive type to be used for voltages exceeding 1kV a.c., or IEC 61243-2, Live Working - Voltage Detectors - Part 2: Resistive type to be used for voltages of 1kV to 36kV a.c., or IEC 61243-3, Live Working - Voltage Detectors - Part 3: Two-pole voltage type.
8. Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment in accordance with the following:

a. **Placement.** Temporary protective grounding equipment shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to a shock hazard (i.e., hazardous differences in electrical potential). The location, sizing, and application of temporary protective grounding equipment shall be identified as part of the employer's job planning.

b. **Capacity.** Temporary protective grounding equipment shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.

**N** Informational Note: ATSM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment*, is an example of a standard that contains information on capacity of temporary protective grounding equipment.

c. **Impedance.** Temporary protective grounding equipment and connections shall have an impedance low enough to cause immediate operation of protective devices in case of unintentional energizing of the electric conductors or circuit parts.

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**B. SAFETY GUIDELINES**

Study this instruction bulletin and all other associated documentation before installing the switchgear.

Each user has the responsibility to instruct and supervise all personnel associated with usage, installation, operation, and maintenance of this equipment on all safety procedures. Furthermore, each user has the responsibility of establishing a safety program for each type of equipment encountered.

The low voltage circuit breakers used in the metal-enclosed switchgear described in this instruction bulletin are operated by a high-energy, high-speed mechanism that is interlocked to provide specific operating sequences. It is mandatory that the following rules be observed to ensure the safety of personnel associated with usage, installation, operation, and maintenance of these circuit breakers.

*The safety rules in this instruction bulletin are not intended to be a complete safety program. The rules are intended to cover only some of the important aspects of personnel safety related to Powell FlexGear™ low voltage arc resistant switchgear.*
C. General

1. Only qualified personnel trained in the usage, installation, operation, and maintenance of the circuit breaker shall be allowed to work on this equipment. It is mandatory that this instruction bulletin, the applicable circuit breaker manual, any supplements, and service advisories be studied, understood, and followed.

2. Maintenance programs must be consistent with both customer experience and manufacturer’s recommendations, including service advisories and instruction bulletin(s). A well planned and executed routine maintenance program is essential for the equipment’s reliability and safety.

3. Service conditions and circuit breaker applications shall also be considered in the development of safety programs. Variables include ambient temperature; humidity; actual continuous current; thermal cycling; number of operations; interrupting duty; and any adverse local conditions including excessive dust, ash, corrosive atmosphere, vermin and insect infestations.

D. Specific

1. DO NOT WORK ON ENERGIZED SWITCHGEAR. If work must be performed on the switchgear, remove it from service and place it in an electrically safe condition.

2. DO NOT WORK ON THE SWITCHGEAR WITH THE CONTROL CIRCUIT ENERGIZED.

3. EXTREME CARE MUST BE EXERCISED TO KEEP ALL PERSONNEL, TOOLS, AND OTHER OBJECTS CLEAR OF MECHANISMS WHICH ARE TO BE OPERATED, DISCHARGED, OR RELEASED. These circuit breakers utilize stored energy mechanisms. These mechanisms must be serviced only by skilled and knowledgeable personnel capable of releasing each spring load in a controlled manner. Detailed information regarding these mechanisms is found in the appropriate circuit breaker instruction bulletin.

4. DO NOT ATTEMPT TO CLOSE THE CIRCUIT BREAKER MANUALLY ON AN ENERGIZED CIRCUIT.

5. DO NOT USE AN OPEN CIRCUIT BREAKER AS THE SOLE MEANS OF ISOLATING A HIGH VOLTAGE CIRCUIT. For complete isolation, the circuit breaker shall be in the disconnected position or shall be withdrawn completely.

6. ALL COMPONENTS SHALL BE DISCONNECTED BY MEANS OF A VISIBLE BREAK AND SECURELY GROUNDED FOR SAFETY OF PERSONNEL PERFORMING MAINTENANCE OPERATIONS ON THE SWITCHGEAR.

E. Safety Labels

The equipment described in this document has DANGER, WARNING, CAUTION, and instruction labels attached to various locations. All equipment DANGER, WARNING, CAUTION, and instruction labels shall be observed when the circuit breaker is handled, operated, or maintained.

**NOTICE**

Warning and Caution labels are located in various places. Do NOT remove or deface any of these warning/caution labels.
Ch 3  Equipment Description

A. General

NOTICE

Powell is committed to continuous product improvement. It is possible that improvements occurred between revisions to this document and therefore, may not be described in these instructions. If the equipment does not resemble the photographs and descriptions contained herein, do not attempt to perform the actions. Contact the Powell Service Division.

Powell FlexGear™ Low Voltage Arc Resistant Metal-Enclosed Switchgear described in this bulletin is designed to comply with IEEE Standard C37.20.1 (Standard for Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear) and IEEE C37.20.7 (Guide for Testing Metal-Enclosed Switchgear for Internal Arcing Faults). The metal-enclosed switchgear is a lineup of one or more switchgear vertical sections, which are enclosed on all sides, top, and bottom except for the ventilation openings, lower unit cable penetrations, and view windows. The switchgear sections consist of full depth structural frames and components providing separate compartments for circuit breakers, buses, cable and auxiliary components.

Powell FlexGear consists of multiple sections, fastened together as a single group (Figure 1). It is completely operational when installed and connected directly to the customers' power supply. Circuit breaker compartments (Figure 2, g) are provided with lift-off hinged access doors for installing or removing the circuit breakers. Auxiliary compartments (Figure 2, d) are provided with lift-off hinged access doors for mounting and maintenance of instruments, relays, and wiring. An overhead breaker lifting device (Figure 2, a) is provided as an option.

Powell FlexGear low voltage arc resistant switchgear is complex, high-current electrical equipment designed to operate within the voltage and current limitations shown on the equipment nameplate. Do not apply this equipment to systems with voltages and/or currents in excess of these limits.

The equipment has been designed to operate within the customers' specifications with regard to circuit capacity.
B. Ratings

<table>
<thead>
<tr>
<th>Maximum Voltage (Volts)</th>
<th>Continuous Current Rating (Amperes)</th>
<th>Arc Fault Current (kA)</th>
<th>Short Time Current</th>
<th>Short Circuit Current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Main Bus (kA)</td>
<td>Riser Bus (kA)</td>
</tr>
<tr>
<td>635</td>
<td>800-5000</td>
<td>85(.5s)</td>
<td>85</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>85</td>
<td>85</td>
</tr>
</tbody>
</table>

**Notes:** 1. For specific circuit breaker ratings refer to the appropriate manufacturer’s application guide.
Figure 1  Typical Powell FlexGear™ Low Voltage Arc Resistant Switchgear Lineup
The arc resistant rating is only valid when all doors are closed and properly latched or bolted, and components are installed and working properly. In addition, removal of any breaker from its compartment without reinstalling a circuit breaker maintenance cover will void the arc resistant rating.

**Note:** Circuit breaker maintenance covers for compartments not equipped with circuit breakers are not shown for illustrative purposes only.
**Ch 4 Installation**

Contact the Powell Service Division for installation, maintenance, and renewal parts assistance. To contact the Powell Service Division call 1.800.480.7273 or 713.944.6900, or email info@powellservice.com.

It is the responsibility of the purchaser to set or program components such as protective relays, meters, timers, etc., in accordance with the requirements of the particular installation, before placing the switchgear with vacuum circuit breakers into service. Programmable devices may be shipped with temporary programming, used to test the switchgear. Electromechanical relays may be shipped in a blocked position to avoid damage during shipment. Refer to separate instructions for these components for information on setting or programming.

**A. General**

This section contains information on receiving, handling, positioning, power cable termination, grounding, and checks to make the equipment ready for operation.

Once the assembly of the metal-enclosed switchgear is completed on site, all joints and hardware, including bus connections, structural assemblies, and control connections, should be checked for tightness and proper torque values. See Table C, **Bolt Torque Values for Powell FlexGear™**.

**B. Receiving**

Powell FlexGear™ is fabricated in rigid, floor-mounted, self-supporting steel vertical sections. The switchgear vertical sections are shipped in an upright position and when received should be kept upright.

When the switchgear is received, check for signs of damage. If damage is found or suspected, file claims as soon as possible with the transportation company and notify the nearest Powell representative.

Refer to the instruction bulletin furnished with the circuit breaker for receiving, handling, and storage instructions on the circuit breaker.

Some components such as top-mounted resistors or potential transformers, may be shipped separately. These components are identified by a number coinciding with that of the switchgear vertical section on which they are to be mounted.

**C. Handling**

Powell recommends the switchgear be handled or moved by means of an overhead crane. If an overhead crane is not available the switchgear may be moved on an even surface by the use of rollers or heavy duty pipes placed under the switchgear. The use of a forklift is not recommended, since the forks may damage the compartments or interior parts of the switchgear vertical sections. If no other method of handling is available, the forks must go completely under the switchgear base to avoid damage to the switchgear.

The switchgear is shipped with the circuit breakers installed unless other instructions are given. If the circuit breakers are shipped installed, they are done so in the open and fully connected position. Refer to the appropriate publication shipped with the device for removal instructions of the circuit breakers.
1) **Lifting the Switchgear**

The maximum shipping section width is 102 inches. The equipment should be lifted using an appropriately rated overhead crane. The equipment should be lifted one shipping section at a time or a maximum total weight of 10,000 lbs. Lifting rings are permanently attached at the front and rear corners of the center compartment of each section. Refer to Figure 6 for shipping height. Four lift points shall always be used when lifting the switchgear (Figure 3). If lifting a single section, then three lift points are available. It is important to note that when a spreader bar is not being used that each lift chain/cable when loaded maintain at least a 45° angle from the horizontal plane (Figure 4).

**Note:** At 45° the force on each lifting chain/cable is equal to the total load divided by four divided by 0.707 making each less efficient. Angles less than 45° can damage the switchgear.

**Note:** The customer is responsible for providing the spreader bar.
Figure 4  Chain/Cable Sling Installation
D. Storage

Shipping and storage of electrical equipment requires measures to prevent the deterioration of the apparatus over a long unused period. The mechanical and dielectric integrity must be protected. Electrical equipment is designed for use in a variety of environments. When the equipment is in transit and storage, these design considerations are not fully functional. In general, the following measures must be considered.

1. Equipment designed for indoor installation must be stored indoors in a climate controlled environment to prevent condensation of moisture. Exposure to rain and the elements, even for a short period, can permanently damage the equipment. Space heaters within the equipment should be energized, if so equipped. Humidity controlling desiccant materials should be utilized when space heaters are not provided or cannot be energized. The temperature should be kept above freezing (>33°F/1°C) and below (<140°F/60°C). The relative humidity should be kept below 60% or a dew point of 15°C/59°F. The equipment should be stored in such a manner as to leave all doors and panels accessible for inspection. The equipment must be inspected on a routine basis to assure operational integrity.

2. Equipment stored in outdoor storage locations must be protected from airborne external contaminates. Outdoor storage will also require additional care to maintain temporary covers over the openings and shipping splits. The equipment must be provided with control power to facilitate the energization of space heaters, as well as other temperature and humidity controlling equipment. The temperature should be kept above freezing (>33°F/1°C) and below (<140°F/60°C). The relative humidity should be kept below 60% or a dew point of 15°C/59°F. The equipment should be stored in such a manner as to leave all doors and panels accessible for inspection. The equipment must be inspected on a routine basis to assure its integrity.

3. The auxiliary control devices, ship loose material and protective relays must also be protected. This includes items such as battery chargers, UPS systems, lighting, installation hardware and air conditioning. If prolonged storage is anticipated, humidity controlling desiccant materials should be utilized. Desiccant packets should be installed in all compartments and packing containers.
E. **Positioning the FlexGear™**

1) **Drawings and Diagrams**

Before any installation work is started, consult and study all drawings and Bill of Materials furnished by Powell for the particular order. The drawings include arrangement drawings and wiring and schematic diagrams.

The recommended aisle space for the front and at the rear of the metal-enclosed switchgear is shown on the floor plan drawing furnished for the particular order. The space at the front must be sufficient to permit insertion, withdrawal, and transferring of the circuit breakers. The space at the rear must be sufficient for installation of cables, for inspection and maintenance. The dimensions shown on the switchgear drawings are those required for proper operation of the switchgear.

When three or more sections are to be arranged in one continuous line-up, the center section should be the first to be located. The other sections should be installed in successive order in each direction from the center of the structure.

When installing a unit substation or power center, the power transformer and the adjacent metal-enclosed switchgear line-up should first be lined up and set in position in accordance with the dimensions on the base plan drawing for the installation. The additional sections should then be installed.

Establish a base line located a few inches in front of the sections and parallel with the desired front of the structure. Equalize the distances from the front of the sections to the base line to make the face of the group parallel to the base line.

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**CAUTION**

*Applicable national or local codes or regulations may require greater aisle space than is needed for operation of the metal-enclosed switchgear. It is the purchaser's responsibility to comply with these codes and regulations.*

Additional shipping members may have been installed in the bus or primary area to ensure against shipping damage. All shipping members must be removed from the switchgear compartments. All joints must be properly tightened and insulated before energizing the bus.

Mats, railing, etc. that are external to metal-enclosed switchgear may be required to meet local code. These items must be provided by the purchaser.

F. **Preparation of Floor Anchoring for Indoor FlexGear™**

The station floor must be strong enough to remain rigid and not sag under the weight of the switchgear structure. The floor also must be able to withstand the impact stress caused by the opening of the circuit breakers under short circuit conditions.
**Figure 5  Base View**

**Note:** The Cable Space Width is only contingent on the frame size. It has no bearing on the equipment depth and will be one of two dimensions shown in Table B, FlexGear™ Dimensions, C Cable Space, Width.
Figure 6  Side View

Note: It is possible to remove the plenum and lifting eye for installation purposes. They must be re-installed prior to energizing the equipment.

Table B  FlexGear™ Dimensions

<table>
<thead>
<tr>
<th>A Equipment Depth (in/mm)</th>
<th>B Rear Compartment Depth (in/mm)</th>
<th>C Cable Space (in/mm) Width</th>
<th>C Cable Space (in/mm) Depth</th>
<th>D Equipment Width (in/mm)</th>
<th>E Front Compartment Depth (in/mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>74 / 1880</td>
<td>26.25 / 666.75</td>
<td>24.34 / 618.24</td>
<td>24 / 609.6 or 34 / 863.6</td>
<td>47.75 / 1212.85</td>
<td></td>
</tr>
<tr>
<td>80 / 2032</td>
<td>32.25 / 819</td>
<td>30.34 / 770.64</td>
<td>24 / 609.6 or 34 / 863.6</td>
<td>47.75 / 1212.85</td>
<td></td>
</tr>
<tr>
<td>86 / 2184</td>
<td>38.25 / 971.5</td>
<td>36.34 / 923.04</td>
<td>24 / 609.6 or 34 / 863.6</td>
<td>47.75 / 1212.85</td>
<td></td>
</tr>
<tr>
<td>92 / 2337</td>
<td>44.25 / 1124</td>
<td>42.34 / 1075.44</td>
<td>24 / 609.6 or 34 / 863.6</td>
<td>47.75 / 1212.85</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>47.75 / 1212.85</td>
</tr>
</tbody>
</table>
The purchaser must provide suitable means for anchoring the switchgear to the floor. The floor supporting the switchgear must be level in order to avoid distorting the switchgear structure and to align the switchgear properly. The switchgear must be correctly and completely aligned prior to applying final anchors. Level foundations are desirable since they automatically produce true, level, and plumb switchboard installations. However, the switchgear will operate satisfactorily on a true and flat foundation that has a uniform slope of no more than 1/8 inch in three feet. The switchgear units must be placed on the floor channels in such a manner that the base of each unit rests directly on each of the floor channels.

The floor channels should have a minimum web dimension of 4 inches. The required quantity and location of the floor channels is shown on the drawings furnished with the order. The spacing of the floor channels, including the center channel, must be as shown on the drawings. Even though the switchgear is not anchored to the center channel, its location is important to the proper support and alignment of the switchgear units. The floor channels must be level and straight with respect to each other. Brass shims should be placed under floor channels when leveling is needed.

Care should be taken to provide a smooth, hard and level floor underneath and in front of the sections to facilitate installation and removal of the circuit breaker.

When installing metal-enclosed switchgear on existing floors, it will usually be desirable to pour a newly finished floor with embedded channels, or to cut slots in the floor for embedding and leveling the supporting channels.

The recommended practice is to weld the switchgear structure to the floor channels, using a tack weld at points indicated for anchoring on the drawing. After welding, any damaged paint should be removed and the weld and surrounding metal should be painted to deter corrosion. If welding facilities are not available, the switchgear should be bolted to the floor channels.
**G. Grounding**

Before power connections can be made, the switchgear vertical sections must be grounded. A ground bus is furnished with lugs at each end for connection to the station grounding system.

![WARNING]

**A permanent low-resistance ground is essential for adequate protection. Improperly grounded equipment may result in death, bodily injury or property damage.**

The ground bus is bolted to the rear of the vertical section near the bottom. It is arranged so that connections to the station ground can be made in any unit.

Where equipment is shipped in more than one group, the sections of ground bus must be connected by using the splice plates furnished with the equipment (Figure 7). Assemble the ground bus joints as outlined under Ch 4 Installation, H. Connections. Ground bus connections are made in the lower portion of the cable entrance compartment. The switchgear ground bus must be connected to the station ground bus by a conductor having a current carrying capacity equal to that of the switchgear ground bus. It is very important that the equipment be adequately grounded to protect the operator from injury when short circuits or other abnormal occurrences take place and to ensure that all non-live parts of the equipment are ground potential.

It is recommended that the connection to the station ground have a cross section of 500,000 circular mils (240mm²) or greater if the soil in which it is buried is of such character as to cause appreciable corrosion. This is especially true where electrolysis from stray currents or contact with dissimilar metals exists. The resistance of the soil surrounding a station ground depends on the condition of the soil as well as its chemical content. Dry, loose, sandy or frozen soils will have a high resistance as compared with moist soils or soils containing ashes, cinders or salt solutions. IEEE Standard 142 states that grounding impedance in the range of 1 to 5 ohms is generally acceptable for industrial substations. Ground resistance testing is recommended to verify that the ground resistance falls within this range.

**H. Connections**

The main bus bars and other connection bars are copper. The connection surfaces are silver surfaced or equivalent. The silver plating used on bolted contact surfaces is approximately 0.0001” thick. All field assembled joints in primary conductors, regardless of method of insulation, should be made as follows:

1. Wipe the surface clean with a lint-free cloth. Do not use sandpaper or any other abrasive material on the plated surface. Avoid handling of cleaned surfaces as much as possible. If the surface is tarnished, clean it with silver polish and then wash it with denatured alcohol.
2. Join the clean contact surfaces by using the hardware provided.

The correct length of bolt must be used in each joint to ensure that electrical clearances at bolt locations are maintained. As a general rule, when using ½ inch diameter bolts, the bolts should be 1 inch longer than the combined thickness of the copper bars being bolted together.
For example, if three ¼ inch thick copper bars are to be connected, the bolt should be 1-¾ inches long. In addition to proper length bolts, the bolt assembly must include flat washers, split ring lock washers, and nuts. All bus joint hardware is zinc-plated, dichromate treated, high strength steel. Cap screws are ½-13 SAE Grade 5. See Figure 7 for proper hardware assembly.

Figure 7 Ground Bus Splice Bolt Assembly

3. In some cases, external connections are made to metal-enclosed switchgear bus by bars. The metal-enclosed switchgear bars are normally silver-plated. Unplated bars, either copper or aluminum, should not be used to connect to plated bars.

4. All field assembled primary conductor joints and terminations must be insulated before the operating voltage is applied.

Note: All hardware must be tightened to the torque values listed in Table C, Bolt Torque Values for Powell FlexGear™.

Refer to Figure 8 for a typical main bus splice connection.

Figure 8 Typical Channel-Type Main Bus Splice Connection

CAUTION

The operating temperature of conductors in metal-enclosed switchgear may reach 105°C. Any insulating material used in the metal-enclosed switchgear must be suitable for this temperature.

CAUTION

All exposed primary bus, cable joints, and connections must be insulated to maintain system insulation and arc resistant ratings.
I. **MAIN BUS ASSEMBLY INSULATION**

To insulate the main bus assembly follow these instructions:

1. Remove the compartment covers.
2. Bolt the splice plates and bus bars together using directions in *Ch 4 Installation, H. Connections*.
3. Tighten the bolts properly. See *Table C, Bolt Torque Values for Powell FlexGear™*.

<table>
<thead>
<tr>
<th>Bolt Dimensions (inches)</th>
<th>Bolt Head</th>
<th>Torque</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Ft-Lbs</strong></td>
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<tr>
<td>5/8</td>
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</tr>
<tr>
<td>1/4</td>
<td>![Image]</td>
<td>5-7</td>
</tr>
</tbody>
</table>

1) **Applying PVC Boots**

a. Prepare all joints as outlined under *Ch 4 Installation, H. Connections*.
b. Place the PVC boot over the joint. The boot should fit tightly around all conductors and flanges must contact each other in a smooth joint.
c. Secure the boot with the furnished nylon wire ties. The joint insulation is now complete.

**Note:** The PVC insulation boots are furnished for standard configurations.

d. Replace all covers previously removed.

2) **Cleaning Bus Insulation**

The main bus bar is insulated with a high temperature thermoplastic or thermoset material that provides dielectric and mechanical properties. Clean the insulation to provide optimum insulation properties. Only use denatured alcohol or isopropyl alcohol to clean the insulation.

Wear protective gloves and goggles and clean the main bus bar in a well ventilated area.

Vacuum and wipe dirt or other foreign matter from the insulation with a clean cloth saturated with only denatured or isopropyl alcohol.

**CAUTION**

*Use alcohol in a well ventilated area to avoid inhaling vapors.*

**CAUTION**

*Do not use any commercial soap-based or detergent-based cleaner.*

*Do not use carbon tetrachloride.*

*Avoid prolonged exposure to solvent vapors.*

*Use solvents in a well ventilated area.*
J. **Power Cables**

Access the primary cable connections in Powell FlexGear™ by opening the hinged rear doors. Before any primary cable connections are made, the cables should be identified to indicate their phase relationship with the switchgear connections. This is necessary to ensure that the motors will rotate in the proper directions and that the phase rotation is the same when interconnecting two different sources of power. If parallel cables are used it is imperative to confirm phasing of each cable by test. Normally compression terminals are used to terminate primary cables.

Any connections to the power bus that will enter the instrument compartment must follow the guidelines found in *Ch 4 Installation, L. Field Wiring for Arc Resistant Equipment*.

The power bus in this equipment is insulated, however, air is the primary insulation medium. Do not place any object or add wiring in this air space as it may compromise the dielectric capability of the equipment.

![CAUTION]

**Do not place any object in this air space when energized. If done, it could result in equipment damage and/or minor or moderate injury to personnel.**

K. **Control Cables**

When control conduits enter the unit from below, the conduit should not extend more than 1 inch above the floor. The control cables may be pulled through the conduits before or after the switchgear is installed.

If the control conduits enter from above, drill the top cover of the front enclosure to suit the conduits, being careful not to damage existing wire bundles. Fasten the conduits to the cover with locknuts.

The cable from the control power source to the switchgear must be large enough to avoid excessive voltage drop when the circuit breakers are operated (see testing instructions that apply to a particular device). Where units have been split for shipment, any control or other secondary leads that must connect across the split will be arranged with terminal blocks in a convenient location so that the wires can be reconnected. The wires will be cut to length and formed before being folded back so that a minimum time will be required for reconnecting them. All entries should be sealed with duct seal to prevent gas transmission in case of a fault.

L. **Field Wiring Precautions for Arc Resistant Equipment**

Special precautions are required when adding or removing control wiring in arc resistant configurations of FlexGear as openings in the walls of the enclosure may allow the by-products of an arcing fault to escape from the unit in an undesirable manner. The overall rating of the equipment is IEEE Type 2B. This provides arc fault protection for the perimeter of the switchgear and specifically allows the instrument compartment to be open while the equipment is energized. The instrument compartment of arc resistant FlexGear is segregated from the power circuit with respect to venting gases produced by an internal arcing fault. This means there are precautions that must be followed when adding or removing control wiring that enters the instrument compartment to ensure compliance with the original design test requirements of the equipment.
1) Adding Control Cable

a. Penetrations in the exterior of the switchgear are only allowed in the areas designated at the top and bottom of the bus compartment (rear of the enclosure).
   i. A compression fitting, such as a CGB should be used to minimize the open area around the cable(s).
   ii. Where cable bundles leave small opening in the busing, a sealant such as silicone RTV should be used to fill the openings.

b. Do not route any control cables in any manner or in any location which may impede the function of the interlocks or pressure relief devices used in the arc resistant construction. Pressure relief devices are located on the top of the equipment (inside the plenum, if a plenum is provided). They must be free to operate to their full open position with no interference. Do not route cables or cable tray directly over the pressure relief vent.

c. Cables must not be bundles in such a way as to block or impede gases from an arcing fault from escaping through the intended vent areas.

d. The instrument compartment and front compartments with voltage transformers or control power transformers may be rated with a suffix B designation indicating the compartment is isolated from arc fault by-products in the power circuit.
   i. Penetrations into these compartments are made through an opening in the rear wall that is shrouded by a special cover.
   ii. All cables entering the compartment with connections to the power bus must be fuse protected.
   iii. The unprotected line side of the fuse must be shrouded by an insulated cover that prevents faults on these terminals from escalating and entering the compartment.

2) Removing Control Cable

Removing control cables from an arc resistant switchgear design requires that the opening created by the removal be blocked to prevent the transfer of products from an arcing fault into areas intended to be protected by the rated type of the equipment. Recommended methods for blocking the openings are as follows:

a. Partial removal of cables from a CGB fitting:
   i. For removal of small quantities of cable, the CGB may be tightened to further compress the gasket.
   ii. For removal of larger quantities of cable, the CGB may be fitted with a smaller size gasket or a smaller CGB must be installed. Small openings should be filled with a sealant such as silicone RTV.
   iii. Abandon the cable(s) in place.
      Disconnect and tie back both ends.

b. Partial removal from conduit or solid fitting:
   i. Abandon the cable in place.
      Disconnect and tie back both ends.

c. Complete removal of all cables from any fitting is accomplished as follows:
   i. Remove all cables and the fitting.
   ii. Fill the opening left by removal of the fitting with a steel cover plate (do not use aluminum). A minimum thickness of 11 gauge (0.119") is recommended. Smaller openings may be filled with the largest bolt which will fit in the opening, with flat washers on both sides of the wall.
iii. When a steel plate is used, its dimensions must extend past the boundaries of the opening by a minimum of 0.5 inches on all sides or 1 inch over the diameter. The plate must be mounted on the high voltage side of the wall.

iv. The plate may be welded or bolted in place. SAE Grade 5 hardware or better is required for bolting.

M. INSERTING AND REMOVING THE CIRCUIT BREAKER FROM THE CIRCUIT BREAKER COMPARTMENT

**CAUTION**

*Before inserting a removable element into the compartment, manually check the shutter mechanism, and the truck operated cell switch (TOC) for free movement. These checks should be made with all circuits deenergized.*

Refer to the instruction bulletin furnished with the removable element for all installation and removal procedures.

N. INSPECTION AND TESTING

For assistance with testing and inspection contact the Powell Service Division at 1.800.480.7273 or email at info@powellservice.com.

After the equipment has been installed and all connections made, it shall be tested and inspected before putting in service. Although the equipment and devices have been completely tested at the factory, a final field test should be made to ensure the equipment has been properly installed. The primary equipment should be completely deenergized while the tests are in progress.

The directions for testing devices such as relays, instruments, and meters are given in the instruction bulletin furnished for each device.

1) Inspection

The following checks need to be made during inspection:

a. Power and secondary wiring connections are properly made.
b. Ground connections are properly made.
c. Circuit breakers prepared per manufacturer’s instruction manual.
d. All vent areas are clean and free of shipping or construction materials.
e. Verify plenum vents are in fully open position before equipment is energized.
f. All arc flash preventers (AFP) *(Figure 10)* are open and operate freely.
g. All tools are removed from the equipment and the area is free from debris.

*Figure 9 Plenum Vent*

- a. AR Slam Vent
- b. AR Slam Vent Latch
Figure 10  Arc Flash Preventers

Note: Section view of lower portion of typical switchgear showing AR Slam Vent. AR Slam Vent must be in open position as shown before equipment is energized.

2) Testing

The following tests shall be completed before placing the switchgear into operation:

a. A megger test shall be made to ensure all connections made in the field are free of undesirable grounds
b. A dielectric test shall be made on the high voltage circuit for one minute at the appropriate test voltage. (Voltage transformers, CPT’s, and surge arresters must be disconnected during this test).
c. For Start Up and Commissioning refer to powellind.com or contact Powell Service Department.
Ch 5 Maintenance

A. General

Contact Powell Service Division for assistance in performing maintenance or setting up a maintenance program. Email info@powellservice.com or call 1.800.480.7273.

A regular maintenance schedule should be established which obtains the best service and reliability from the switchgear. Plant operating and local conditions will dictate the frequency of inspection required. For specific information regarding the maintenance of devices, removable elements, such as circuit breakers, relays, motors, etc., refer to the separate instruction bulletin furnished with each device. Under normal conditions, the protective relays do not operate, therefore, it is important to check the operation of these devices regularly.

A permanent record of all maintenance should be kept, and the degree of detail depends on the operating conditions. In any event, it will be a valuable reference for subsequent maintenance, and for station operation. It is recommended that the record include the reports of tests made, the condition of the equipment, repairs, and any adjustments that were made. Test data from successive maintenance interval should be compared, to note any significant changes in the condition of the switchgear.

B. Overall Maintenance Procedures

The switchgear lineup and connections should be given the following overall maintenance at least once a year.

Powell offers a complete lubrication kit (Powlube-104) which contains all the lubricants required for maintaining Powell equipment. Powlube-104 consists of (1) A-grease, (1) B-grease, and (1) C-oil. Prior to March 2014, Powell provided Powlube-101 and Powlube-102 which contained (1) tube of Anderol 757 or Rheolube 368A, (1) tube of Mobilgrease 28, and (1) bottle of Anderol A456 oil.

A-grease should be lightly applied to those bearing surfaces that are accessible. Inaccessible surfaces, such as bearings, may be lubricated with a light synthetic machine oil such as C-oil. B-grease should be applied to the electrical contact surfaces.

For all previous lubrication requirements Powlube-104, A-grease replaces Anderol 757 and Rheolube 368A, B-grease replaces Mobilgrease 28, and C-oil replaces Mobil 1 and Anderol 456A.

⚠️ WARNING

When performing maintenance, the power source must be disconnected and the equipment grounded. Failure to do so may result in death or serious injury.
The switchgear lineup and connections should be given the following overall maintenance at least once a year:

**NOTICE**

*A periodic maintenance program is not intended to cover reconditioning or major repair, but should be used to determine if such service is required.*

**NOTICE**

*If optional shutters are included with the equipment, refer to the applicable section in the appropriate circuit breaker instruction bulletin to verify shutter operation.*

1) *Equipment*

   Clean the equipment thoroughly, removing all dust and other accumulations. Wipe the buses and supports clean. Refer to Ch 4 Installation for cautions about cleaning bus insulation. Inspect the buses and connections carefully for evidence of overheating or weakening of the insulation.

2) *Bus Insulation*

   The primary circuit bus bar is insulated with a high temperature thermoplastic or thermoset material that provides dielectric and mechanical properties. Clean the insulation to provide optimum insulation properties.

   Only use denatured alcohol or isopropyl alcohol to clean the insulation. Wear protective gloves and goggles and clean the main bus bar in a well ventilated area. Wipe dirt or other foreign matter from the insulation with a clean cloth saturated with only denatured or isopropyl alcohol.

3) *Mechanisms*

   Clean mechanisms and lubricate wear points. The application of lubricants should be held to a minimum to reduce the accumulation of dust and dirt.

   Refer to the instruction manual furnished with the removable device for lubrication instructions.

4) *Primary Disconnect Device Contacts*

   Check primary disconnecting device contacts for signs of abnormal wear or overheating. Discoloration of the silver surfaces is not ordinarily harmful unless atmospheric conditions cause deposits, such as sulfides on the contacts. Apply a thin coat of contact lubricant to the main contacts per the appropriate instruction manual before replacing the circuit breaker.

5) *Control Contacts*

   Contacts should be inspected and dressed or replaced when the surface becomes seriously pitted. Unless repetitive duty has been experienced, little attention should be required.
6) **Secondary Wiring**

Check all wiring connections for tightness, including those at the current and potential transformers and at the terminal blocks where circuits leave the switchgear. Ensure that the secondary wiring connections are properly connected to the switchgear ground bus.

7) **Mechanical Parts**

Visually check and manually operate mechanical moving parts such as the shutter, TOC, and MOC assemblies. Also check hinged doors and per the appropriate circuit breaker instruction manual for the rollout features of the transformers and fuses. Examine mechanical mating parts such as the levering-in arms and the mating guide channels.

8) **Ventilation**

Check all labyrinths, grillwork, and air passages for obstructions and accumulations of dirt. The air space around the switchgear, which is necessary for the entrance of ventilating air, should be cleaned of possible debris.

9) **Battery and Charging Equipment**

The control battery is such an important accessory to the switchgear operation that it must be given special periodic attention if it is to have a long life of reliable service. Periodic inspections and tests are recommended in the battery supplier's instructions. During the same time that the battery is routinely checked, inspect the battery charger and remove any accumulations of dust and dirt.

10) **Hardware**

Check to see all anchor bolts and switchgear hardware are tightened to correct torque values. See Table C, Bolt Torque Values for Powell FlexGear™.

11) **Heaters**

If the switchgear is equipped with anti-condensation heaters, check to see that all heaters are energized and operating properly. This may be done by using a hook-on ammeter to measure the current drawn by the heater.
12) Records

The condition of each switchgear unit at the time of inspection should be listed in a permanent record to become a guide for anticipating the need for replacements or for special attention between the regular maintenance periods. Insulation resistance tests are suggested for checking the insulation. A series of these tests will indicate any tendency toward a reduction in dielectric strength of the insulation. Insulation resistance readings should be taken before and after cleaning the equipment and, insofar as possible, under similar conditions at successive periods. Records should include the insulation resistance reading, the temperature, and the humidity, either by definite reading or description. Acceptable limits vary with the extent and design of the bus structure. In contrast to a small installation, the longer switchgear assemblies have a more extensive bus structure with a greater number of insulators. Therefore, there are a larger number of parallel insulation resistance paths to ground, which tends to decrease insulation resistance readings. This variation in insulation resistance between different switchgear assemblies emphasizes the value of a series of readings which can be charted to establish a normal insulation level so that progressive weakening of the insulation can be recognized.

C. Abnormal Conditions

Local atmospheric conditions such as high humidity, salty atmosphere, corrosive gases, heavy dust, extreme heat, or severe operating conditions, are considered to be abnormal, and more frequent equipment inspections are required.

A series of quarterly inspections should be performed to analyze the effect of local abnormal conditions on equipment. Then an inspection and maintenance schedule can be established to maintain the equipment in a satisfactory condition.

If maintenance and inspection frequency in abnormal conditions interferes with operating and production schedules, consideration should be given to placing the equipment in a relatively tight room. Clean air can be pumped into the room to create positive air pressure and decrease exposure of the equipment to abnormal conditions. In areas where the ambient temperature is relatively high, cooling the air will improve equipment protection from extreme heat conditions. A less frequent maintenance schedule can be established when equipment is protected from abnormal conditions.
**A. ORDERING INSTRUCTIONS**

1. To order Replacements Parts from Powell, visit the website at powellind.com or call 1.800.480.7273.
2. Always specify the complete nameplate information including:
   - Circuit Breaker Type
   - Serial Number
   - Rated Voltage
   - Rated Amps
   - Impulse Withstand
   - Control Voltage (for control devices and coils)
3. Specify the quantity and description of the part and the instruction bulletin number. If the part is in any of the recommended renewal parts tables, specify the catalog number. If the part is not in any of the tables, a description should be accompanied by a marked illustration from this instruction bulletin or photo.
4. Standard hardware such as screws, bolts, nuts, washers, etc., should be purchased locally. Hardware used in bolted joints of conductors must be SAE Grade 5 or better to ensure proper clamping torque and to prevent the joints from overheating. The hardware should be plated to deter corrosion.

**B. RECOMMENDED RENEWAL PARTS**

A sufficient amount of renewal parts should be stored to enable the prompt replacement of any worn, broken or damaged part. A sufficient amount of stocked parts minimizes service interruptions caused by breakdowns and saves time and expense. When continuous operation is a primary consideration, a larger quantity of renewal parts should be stocked depending on the severity of the service and the time required to secure replacement parts.

Since parts may be improved periodically, renewal parts may not be identical to the original parts. *Table D, Accessories*, lists the recommended spare parts to be carried in stock by the user. As a minimum, it is recommended that one set of parts be stocked per ten circuit breakers or less.

Powell recommends that only qualified technicians perform maintenance on Powell FlexGear™. Refer to the **Qualified Person** section in the front of this instruction bulletin.
## Table D Accessories

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Part Number</th>
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<tr>
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<td>MS-664-c8</td>
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<td>Clevis</td>
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<td>Overhead Lift Hand Crank</td>
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<tr>
<td>Door Latch Mechanism</td>
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<tr>
<td>Swinghandle with Padlock Hasp</td>
<td>H3-50-220-050</td>
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<td>Linear Actuator</td>
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<td>4000A-5000A Circuit Breaker</td>
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</tbody>
</table>

**Notes:**
1. The numbers in the () indicate the number of pieces or the length of cable included.
2. One (1) Breaker Maintenance Cover is shipped with each line-up, contact Powell for additional covers.
Equipped with GE EntelliGuard, Siemens WL, or Eaton Magnum DS Circuit Breakers
Up To And Including 635V

01.4IB.26264C
FlexGear™ Low Voltage Arc Resistant Switchgear

Equipped with GE EntelliGuard, Siemens WL, or Eaton Magnum DS Circuit Breakers
Up To And Including 635V

March 2019