Instruction Bulletin - 01.4IB.65202D
PowlVac 38-AR™ Arc Resistant Metal-Clad Switchgear

Equipped with CDS Circuit Breakers
38kV, 1200A & 2000A, 40kA
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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**: Used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **CAUTION**: Used without the safety alert symbol, is used to address practices not related to personal 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 following PowIVac 38-AR™ Arc Resistant Metal-Clad Switchgear:

- 38kV, 40kA Interrupting Current, 1200 and 2000A Continuous Current equipped with a CDS (Closed Door Standard) Circuit Breaker

B. **Purpose**

The information in this instruction bulletin is intended to provide details required to properly operate and maintain the PowIVac 38-AR Arc Resistant Metal-Clad Switchgear described in Ch 1 General Information, A. Scope.

This instruction bulletin provides:

1. Safety guidelines
2. General descriptions of the operation and maintenance of the PowIVac 38-AR Arc Resistant Metal-Clad Switchgear
3. Instructions for installation and placing the switchgear into service
4. Instructions for part replacement
5. Information for ordering renewal parts
6. Procedure for critical adjustments
7. Illustrations, photographs, and description of the switchgear

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

All illustrations and photos are shown using deenergized equipment.

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**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**

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.

To contact the Powell Service Division call 1.800.480.7273 or 713.944.6900, or email info@powellservice.com.

For specific questions or comments pertaining to this instruction bulletin email documents@powellind.com with the Instruction Bulletin number in the subject line.

D. **Associated Instruction Bulletins**

- 01.4IB.65110B PowIVac 38™ CDS Circuit Breaker
- 01.4IB.65071 PowIVac 38™ CDS Grounding Device
- 01.4IB.65031A PowIVac 38™ CDS Manually Operated Test Device
- 01.4IB.65220 Lifting Devices
- 01.SUP.65202B Supplement PowIVac 38-AR™ Switchgear Accessibility Type 2C
**Ch 2  Safety**

**A. Safe Work Condition**

The information in Section A is quoted from NFPA 70E 2012 - Article 120, 120.1 Establishing an Electrically Safe Work Condition.

**120.1 Process of Achieving an Electrically Safe Work Condition**

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. Apply lockout/tagout devices in accordance with a documented and established policy.
5. Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are deenergized. Test each phase conductor or circuit part both phase-to-phase, and phase-to-ground. Before and after each test, determine that the voltage detector is operating satisfactorily.

**Informational Note:** See ANSI/ISA-61010-1 (82.02.01)/UL 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements, for rating and design requirements for voltage measurement and test instruments intended for use on electrical systems 1000 V and below.

6. 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 deenergized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.

**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 circuit breakers used in the metal-clad 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 PowlVac 38-AR™ Arc Resistant Metal-Clad Switchgear.*
C. General

1. Only supervised and qualified personnel trained in the usage, installation, operation, and maintenance of the switchgear shall be allowed to work on this equipment. It is mandatory that this instruction bulletin, 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 switchgear'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.

4. PowlVac 38-AR™ Arc Resistant Switchgear is designed to operate with the access doors to high voltage compartments closed. If a circuit breaker or auxiliary component is removed for any reason, the door must be re-closed and properly secured.

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 or discharging each spring load in a controlled manner. Detailed information regarding these mechanisms is found in circuit breaker instruction bulletin.

4. DO NOT ATTEMPT TO CLOSE THE CIRCUIT BREAKER MANUALLY ON AN ENERGIZED CIRCUIT. Without control power to operate the trip function, if the circuit breaker experiences a fault of some type, there is no reliable means to operate the circuit breaker before damage or personnel injury could occur.

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.
7. Closed-door operation features on the PowlVac 38-AR™ allow circuit breakers to be connected to or disconnected from the power circuit with the compartment door closed. Maintenance functions will require opening the compartment door to remove the device. **Opening the compartment door with the bus energized removes the arc resistant features of the design.**  

Personal Protective Equipment (PPE) suitable for the potential exposure hazard must be worn if the operator opens any high voltage compartment door while the equipment is energized. Maintenance operations, such as fuse replacement on the auxiliary device, require opening the compartment door. While it is common practice to replace fuses in auxiliary devices with the equipment energized, this practice is not recommended.

8. Interlocks are provided to ensure the proper operating sequences of the PowlVac 38-AR Arc Resistant Switchgear, circuit breakers and for the safety of the user. If for any reason an interlock does not function as described, **do not make any adjustments, modifications, or deform the parts. Do not force the parts into position. Contact Powell for further instructions.**

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**E. X-Rays**

When high voltage is applied across the contacts of a vacuum interrupter, there is the possibility of generation of X-rays. The intensity of the X-radiation is dependent on the peak voltage and the contact gap. At the normal operating voltage for this type of equipment, the radiation levels are negligible. At the voltages specified for testing, test personnel shall be in front of the circuit breaker such that the two layers of steel used in the frame and front cover construction are between the test personnel and the vacuum interrupters, and that the test personnel be no closer than one meter (3’) from the front of the circuit breaker. **THE CIRCUIT BREAKER SHALL BE EITHER FULLY OPEN, OR FULLY CLOSED WHEN MAKING HIGH POTENTIAL TESTS. DO NOT TEST WITH CONTACTS PARTIALLY OPEN.**

**F. 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.

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**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.

PowrVac 38-AR™ Arc Resistant Switchgear is defined as switchgear that is designed to withstand an internal arcing fault and able to direct the flow of the resulting gases and debris away from operating personnel. The result is increased operator safety.

PowrVac 38-AR™ Arc Resistant Switchgear is available as indoor equipment only. For outdoor installations, the equipment is provided in a Power Control Room (PCR®).

B. Construction

The basic one-high construction standard measurements are 105” high x 40” wide x 116½” deep (Figure 1). The compartment holds one circuit breaker or auxiliary device. Each unit includes a primary and secondary compartment.

1) One Major Circuit Component in Lower Compartment

A circuit breaker or auxiliary rollout can be placed in the lower compartment with a full height instrument compartment above (Figure 2).

2) Two Major Circuit Components

An auxiliary rollout device may be placed in an upper compartment above either a circuit breaker or auxiliary rollout (Figures 3 & 4).

C. Primary Compartment

The primary compartment contains the high voltage equipment and connections arranged in compartments to offer increased safety by minimizing personnel exposure and limiting the effects of faults.
Figure 1  PowlVac 38-AR™ Arc Resistant Switchgear Lineup
Figure 2  Typical Section View - Breaker Only
Figure 3  Typical Section View - Rollout Over Breaker
Figure 4  Typical Section View - Rollout Over Rollout

- Plenum
- Rollout Compartment
- Instrument Compartment
- Rollout Compartment
- Main Bus
- Cable Compartment

Dimensions:
- 105.00
- 66.38
- 58.37
- 123.38
- 128.38
- 38.62
Figure 5  Inside View of 1200A Compartment Door

- View Window
- Racking Access Port
- Shutter Interlock Actuator
- Manual Trip Actuator

Figure 6  Inside View of 2000A Compartment Door

- View Window
- Racking Access Port
- Blast Shield
- Shutter Interlock Actuator
- Manual Trip Actuator
D. Secondary Compartment

The secondary compartment is located at the front of the construction. It consists of two compartments, upper and lower, with a hinged door or panels, which is mounted with the necessary instruments, controls, and protective devices. The terminal blocks, fuse blocks, and some control devices are mounted inside the compartment on the side sheets and barriers. Circuit breaker control accessories, such as the secondary disconnecting device, the mechanism operated cell switch (MOC) and the truck operated cell switch (TOC) are mounted in the lower compartment (Figure 7). Penetrations are provided to allow passage of control wiring between the compartments near the center of all units.

E. Doors

All doors covering access to the primary circuit components are constructed with arc resistant features. These doors MUST remain closed when the equipment is energized to maintain the assigned Internal Arcing Accessibility Type shown on the equipment nameplate. These doors vary in size and construction based on compartment application. View windows are provided as a standard on the front compartment door.

1) Circuit Breaker Compartment Doors

These doors are essentially identical with respect to latching and physical size. The doors are single step latching; rotate the handle to the latched position and the door meets the requirements for the Internal Arcing Fault rating assigned. No additional operations or specialized tools are required to operate the door.

All circuit breaker compartment doors are equipped with interlocks to prevent misoperation. Details of these interlocks are described in Ch 5 Operation of this bulletin. The following interlocks are provided as standard equipment.

a. Closed-Door Racking Interlock - prevents racking the circuit breaker with the compartment door open

b. Safety Shutter/Door Interlock - prevents opening the compartment door if the safety shutters are not closed. This interlock also provides visual indication of the shutter position on front of the compartment door.

These two interlocks are interconnected such that a padlock or other locking means may be used to block breaker insertion into the compartment.

2) Auxiliary Device Compartment Doors

Auxiliary compartment doors are essentially the same as the circuit breaker compartment doors with similar latching components.

3) Rear Doors

Rear doors may be full height or split (two doors) based on device isolation requirements in the rear compartments. The doors rated 40kA and below operate from a single handle with latching that is similar to the front doors.
F. Ratings

PowlVac 38-AR™ Metal-Clad Switchgear is available in the standard voltage ratings listed in Table A, Ratings for PowlVac 38-AR™ Arc Resistant Metal-Clad Switchgear.

Note: Certain nonstandard ratings are available for special applications. Consult the manufacturer for details. Refer to the specific job drawings for detailed voltage ratings applicable to the particular switchgear lineup.

Table A  Ratings for PowlVac 38-AR™ Arc Resistant Metal-Clad Switchgear

<table>
<thead>
<tr>
<th>Rated Maximum Voltage (kV, rms)</th>
<th>Rated Short Circuit Current (kA) (K Factor = 1.0)</th>
<th>Rated Continuous Current @ 60Hz Amps, rms</th>
<th>Rated Internal Arcing Fault Accessibility Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>40</td>
<td>1200 &amp; 2000</td>
<td>2B</td>
</tr>
<tr>
<td>38</td>
<td>31.5</td>
<td>1200 &amp; 2000</td>
<td>2C*</td>
</tr>
</tbody>
</table>

Note: * See Supplement for specific information on Type 2C switchgear.

G. Basic Impulse Level

- 150kV for 38kV class switchgear

H. Factory Dielectric Test

Power Frequency Withstand (ANSI C37.20.2) is 80kV for 38kV class switchgear.

Note: If required, Field Dielectric Tests should be limited to 75% of Factory Dielectric Test values. Direct current dielectric testing is NOT recommended. If DC testing is required, see Ch 5 Operation, O. Testing and Inspection for values to be used.

I. Circuit Breakers

PowlVac 38-AR switchgear is designed to house the many different types of components required to distribute and control electricity. The primary component in this distribution system is the circuit breaker. The PowlVac 38™ circuit breaker is a vacuum type circuit breaker. It is designed to meet all the requirements for use in metal-clad switchgear and as such it has all the necessary interlocks and grounding to interface with the switchgear. It is a removable device, designed with wheels that make insertion and removal from the compartment a simple operation. All circuit breakers with equal ratings are interchangeable.

For detailed description of the circuit breaker and its operation refer to the appropriate instruction bulletin for PowlVac 38 CDS vacuum circuit breakers.
Figure 7  Inside View of the Compartment

a. Secondary Disconnect Device  
b. Shutters  
c. Primary Disconnect Bushings  
d. Shutter Operating Mechanism / Racking Arms  
e. TOC Switch & Operating Mechanism  
f. MOC Switch & Operating Mechanism  
g. MOC Test Position Lever  
h. Shutter Position Interlock  
i. Ground Bus  
j. Centering Block  
k. Closed Door Interlock  
l. Interference Plate  
m. Anti Rollout Device  
n. Manual Push To Trip / Circuit Breaker Trip Free Interlock  
o. Floor Pan  
p. Control Cable Entry
J. **Safety Interlocks and Provisions**

**NOTICE**

*Warning and Caution labels are located in various places. Do not remove or deface any of these warning/caution labels.*

1) **Key Interlocks**

Key interlocks are often supplied in conjunction with disconnecting switches, removable elements, and special compartments where access is dependent on other actions. The operation of key interlock schemes is generally described by a note or key chart on the specific work order drawings.

**NOTICE**

*Before placing the equipment with key interlocks into operation, the key scheme must be carefully checked and only proper keys left in the locks.*

All extra keys must be removed and discarded or secured where they are accessible only in an emergency.

2) **Circuit Breaker Compartment Safety Provisions**

The PowlVac 38™ circuit breaker is equipped with a positive mechanical interlock that prevents moving the breaker unless the primary contacts are open. To rack the circuit breaker in any direction, the circuit breaker must first be opened. The interlock then interfaces with an actuator located in the circuit breaker compartment of the switchgear to hold the circuit breaker in a “trip-free” condition while the circuit breaker is being racked into or out of the connected position.

Safety shutters (*Figure 7, b*) open and close over the stationary primary disconnect devices in response to the movement of the circuit breaker racking mechanism. A spring discharge interlock is provided to discharge the main closing spring when a circuit breaker is inserted into or withdrawn from the compartment. This interlock is activated by unplugging the secondary disconnect plug or the disconnect override device accessory.

A circuit breaker compartment interference plate is provided which is designed to hinder insertion of an incorrect type or rating circuit breaker into the compartment.

The circuit breaker rating should always be checked against the rating of the metal-clad switchgear. Under no circumstances should the interference plate be removed from the circuit breaker or the switchgear as this action may allow the installation of a circuit breaker not rated for the compartment.

**WARNING**

*Always verify the ratings and control scheme of a removable element before inserting into the equipment. Inserting an incorrectly rated element could result in death or serious injury.*

An anti-rollout stop block is provided to deter the removal of the circuit breaker from the compartment until the rollout latch on the circuit breaker is depressed.
K. **Main Bus, Main Bus Taps, Ground Bus, and Supports**

The main bus, main bus taps, and ground bus conductors are made of copper. The main bus, main bus joints, and taps are insulated. The bolted connections are silver-plated or tin-plated. The main bus supports are made of polyester fiberglass with epoxy inserts.

L. **Primary Disconnect Devices and Bushings**

The stationary primary disconnecting devices are tubular silver-plated copper bar ends located within the primary disconnect bushings (Figure 7, c). The tubular silver-plated copper bar forming the stationary primary disconnecting device is part of a continuous piece of tubular copper bus extending up to the main bus or the line-side bus. The stationary primary disconnecting devices are held in the primary disconnect bushings with spiral snap rings front and rear. These mate with the self-aligning fingers of the primary disconnect on the circuit breaker removable element. Contact pressure is ensured by garter springs around the exterior of the primary disconnect devices of the circuit breaker removable element. All mating surfaces are silver-plated to reduce contact resistance and prevent oxidation.

M. **Circuit Breaker Racking Mechanism**

**Figure 8  PowlVac 38 CDS Circuit Breaker**

**NOTICE**

When the circuit breaker closing spring is charged, attempting to insert or remove the circuit breaker from its compartment will discharge all operating springs.

The circuit breaker may be placed in three distinct positions within the circuit breaker compartment of the switchgear.

- Disconnected Position
- Test Position
- Connected Position
The secondary disconnect plug is an umbilical cord device. This multi-pin plug is located at the end of a cord attached to the top of the compartment. In order to rack the breaker into the compartment this plug must be inserted in the secondary disconnect receptacle. Once the plug is inserted and the breaker is racked past the “test position”, the plug is held captive and cannot be removed from the breaker.

3) **Connected Position**

In the “connected” position, the movable primary disconnecting circuits and stationary primary disconnecting circuits are engaged. The shutters are open and the secondary circuits and control contacts are completed.

Interlocks deter the movement of a circuit breaker from one position to another unless the circuit breaker is tripped open. The interlocks prevent the closing of the breaker between the disconnect/test and connected positions.

For complete instructions on inserting and withdrawing the circuit breaker in and out of the switchgear, see Ch 5 Operation of this bulletin and also refer to the appropriate circuit breaker instruction bulletin.

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**NOTICE**

When the control circuits are energized, the spring charging motor will operate to charge the breaker’s closing spring as soon as the control plug is inserted.

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**N. Auxiliary Compartments**

Many sizes of auxiliary compartments may be furnished in PowlVac 38™ lineups for various purposes. Consult the factory for special applications or requirements. Some examples are listed below:

1. Bus transitions to transformers
2. Cable or bus duct entrance compartments
3. Relay and metering compartments
4. Instrument transformer compartments
5. Control power transformer compartments
6. Utility metering compartments

---

**Note:** At this time the circuit breaker is in the same physical location as the “disconnected” position.
O. **Unit Space Heaters**

Unit space heaters are provided in all outdoor equipment, and in indoor equipment when specified, in order to facilitate drying and prevent condensation. It is recommended that heaters be energized at all times; accordingly, no switch or thermostat is provided in the heater circuit unless specified. Two heaters are furnished for each compartment.

Heaters in breaker units are located in the rear of the front compartment, below the lower primary disconnect devices, and in the rear cable compartment. Heaters in auxiliary units are placed in a similar location. In auxiliary units equipped with rollouts, it may be necessary to remove the lower rollout to gain access to the heater.

P. **Voltage Transformer Compartment**

The transformers are mounted on a removable element similar to the circuit breaker equipped with primary and secondary disconnecting devices. When the voltage transformers are disconnected, they are at a safe distance from all live parts of the switchgear and isolated by nonmetallic ungrounded safety shutters. In addition, a grounding device connects to the voltage transformer primary fuses when the voltage transformer auxiliary rollout is in the disconnected position. In this position, the transformer fuses may be removed and replaced (Figure 9). The auxiliary rollout device is equipped with an interlock that prevents accessing the fuses unless the unit is in the disconnected position.

![Figure 9 Voltage Transformer Auxiliary Rollout Carriage](image)

The removable element contains a spanner tool for removing the fuse holder plugs. It is located on the inside front of the device and clipped to the inside front cover.

When installing fuses:

a. Do not over tighten the plug. Hand tighten using the tool provided is sufficient.

b. The plug should be approximately flush with the mating threaded component of the fuse holder tube. If the plug surface extends out from the tube by more than 3/8”, recheck the placement of the fuse.

c. If the fuse has a blown fuse indicator device, place that end of the fuse such that the indicator will extend out the hole provided in the plug.

---

**CAUTION**

Failure to properly install the fuses correctly may prevent the fuses from interrupting fault current properly which will cause equipment damage.
Q. **Fuse Disconnecting Device**

Current limiting fuses with high interrupting rating are sometimes used in metal-clad switchgear to protect small transformers or circuits where circuit breakers cannot be economically or functionally justified.

The fuses are mounted on an auxiliary rollout carriage similar to a circuit breaker’s truck equipped with primary disconnecting devices only, but otherwise similar to the voltage transformer auxiliary rollout carriage.

When the fuses are disconnected, they are at a safe distance from all live parts of the switchgear and isolated by nonmetallic ungrounded safety shutters. In addition, a grounding device is provided which contacts the fuses after they are disconnected, effectively removing any static charge from the fuses. In this position, the fuses may be removed and replaced. It is recommended that the equipment be completely deenergized before attempting to remove the auxiliary fuse rollout. Under no circumstance should the unit ever be removed under load. Mechanical or key interlocks are applied to prevent operating the disconnecting device while under load. This is generally accomplished by interlocking so that the device’s secondary breaker must be locked in the open position before the disconnecting device can be opened or closed.

---

R. **Primary Disconnect Devices and Supports**

Window-type current transformers are positioned around the primary disconnect device bushings as required. They are removable from the front and may be located on upper and/or lower primary disconnect device bushings. If necessary, current transformers may be mounted outside the circuit breaker compartment of the primary enclosure.

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**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.*

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S. **Lighting**

Closed-door racking switchgear is equipped with a 120VAC interior light and a door mounted light switch. When the interior light is switched on in the circuit breaker compartment, the operator can read “breaker test/disconnect” or “breaker connected” on the circuit breaker position indicator through the view window.
**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.

B. **Receiving**

PowlVac 38-AR™ Metal-Clad Switchgear is fabricated in rigid, floor mounted, steel vertical sections. Indoor shipping assemblies are enclosed in a covering to protect the switchgear lineup from the weather. The switchgear vertical sections are shipped in an upright position, and when received should be kept upright.

When the switchgear lineup reaches its destination, the purchaser should check the material actually received against the shipping list to be sure that all parts have been received. If damage is found or suspected, file a claim as soon as possible with the transportation company and notify the nearest Powell representative.

The removable elements such as circuit breakers will be shipped separately for free standing switchgear. In a PCR®, the removable element may be shipped separately or in the switchgear using a shipping bracket. Refer to the appropriate instruction bulletin for a detailed description of the element and its receiving, storage, and handling instructions.

Some components such as top-mounted resistors or potential transformers, may also 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**

It is always preferable to handle a PowlVac 38-AR switchgear lineup with an overhead crane utilizing the lifting means provided on the switchgear. Because of the weight of the arc resistant equipment, it may be necessary to separate the shipping split into single vertical sections. This will increase the maneuverability and reduce the chances for damage while moving the switchgear. Never attempt to move more than two sections at a time, even when a crane is available.

Do not attempt to move the switchgear by opening the doors or pressure relief vents to attach straps or insert the forks of a forklift as the accessible surfaces are not designed to support the weight of the switchgear.
If a plenum is present, do not attempt to lift the unit by attaching straps or chains to or through the plenum shell or to the lifting angle on the plenum (it is provided to lift the plenum only). Further, when attaching chains or straps to the appropriate lifting points, use caution to prevent damage to the plenum. It is advisable to remove the plenum when possible.

Failure to follow these cautionary advisements may damage the equipment and reduce or negate its intended arc resistant function.

**CAUTION**

*Do not lift the switchgear by any means other than the lifting angles on the front and rear of the equipment. A spreader bar is required when a plenum is present. Failure to do so could result in equipment damage or personnel injury.*

The use of a forklift is not recommended on the switchgear. However, if no other method for handling is available, the forks must go directly under the bottom base to avoid damage to the switchgear. Caution must be exercised to avoid deforming the switchgear frame due to uneven weight distribution when lifting with a forklift.

If roller or heavy-duty pipe is used to move the switchgear, the following precautions must be taken:

1. If pipe is used, it must extend past the edges of the switchgear on both sides.
2. If rollers are used, they must be placed on the corners of the equipment.

**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 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 designed for outdoor exposure may be stored either in indoor or outdoor storage locations. The equipment must be protected from airborne external contaminate if stored outdoors. 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. PREPARATION OF FLOOR ANCHORING

The station floor must be strong enough to prevent sagging due to the weight of the switchgear structure and to withstand the impact stress caused by the opening of the circuit breakers under short circuit conditions. The impact loading is approximately 1½ times the static load.

It is essential that the floor be level to avoid distortion of the switchgear structure, and that the switchgear be completely aligned prior to final anchoring. This is accomplished by using floor leveling channels. The leveling channels should have a minimum web dimension of 4 inches. The required quantity and locations of the leveling channels and the spacing of the leveling channels, including the center channel, is shown on the drawings furnished with the order. Figure 10 shows the recommended orientation for the channels to be placed in the floor. The floor channels must be level and straight with respect to each other. The exposed top surface of the leveling channels must be flat and form a level surface plane for the entire switchgear assembly to rest upon. The surface plane of the leveling channels should be flat within 1/8” (the two planes defined by the highest point and the lowest point of the leveling channels must be within 1/8”). The overall floor slope should not exceed 1/8” across the front-to-back or end-to-end dimension of the switchgear lineup. In no case may the concrete floor rise above the level of the floor leveling channels.

The switchgear units must be placed on floor leveling channels in such a manner that the base of each unit rests directly on each of the floor channels. Even though the switchgear is not anchored to the center channel, its location is important to the proper support and alignment of the switchgear. Shims, not to exceed 1/8” total thickness, may be used for final leveling.
Care should be taken to provide a smooth, hard and level floor surface in front of the units to facilitate installation and removal of the circuit breakers. The floor in front of the circuit breaker compartments should be level with, or slightly below, the base of the switchgear to facilitate inserting and withdrawing the circuit breakers. The step up from the floor into the circuit breaker compartment should be no more than the two metal thicknesses that make up the compartment floor and breaker pan. Critical components on the circuit breaker may be damaged if the step is larger. Should there be a gap between the concrete floor and the top of the floor leveling channel at the front of the lineup, the floor must be leveled relative to the circuit breaker compartments for approximately 36” extending away from the switchgear. This will assure the circuit breaker enters its compartment with a step up of no more than ¼”.

When installing the switchgear on existing floors, it is recommended to pour a new layer of concrete with embedded channels, or to cut slots in the floor for embedding and leveling the supporting channels.

Encircling loops of reinforcing or building steel around single-phase conductors should be avoided in the areas for main cables when these circuits are rated at 600 amperes or above.

The user must provide suitable means for anchoring the switchgear to the floor. Recommended practice for anchoring the switchgear to the floor 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 painted to deter corrosion. If welding facilities are not available, the switchgear should be bolted to the floor channels. The switchgear must be in full contact with the leveling channel at the point of bolting to avoid distortion when tightening the hardware.

Provisions should be made in the floor for conduits for primary and secondary cables, located as shown on the floor plan drawing furnished for the particular order. If desired, the conduits may be installed before the switchgear. Positioning rollers, if used, should be high enough to allow the switchgear to pass over any conduits that might be required for future connections.
After all the equipment is located and fully installed, examine the bottom edge of the switchgear at the floor for gaps. Any gap greater than \(\frac{1}{8}\)" between the concrete floor and the switchgear must be filled. Silicone RTV is suitable for filling gaps \(\frac{1}{4}\)" or less. For gaps greater than \(\frac{1}{4}\)" it is recommended that concrete or mortar be used. Failure to fill these gaps may result in hazardous gas escape from under the switchgear in the event of an internal arcing fault.

**Figure 11  Anchoring with Channel Base**

**NOTICE**

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

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

Additional shipping members may have been installed in the bus or primary area to ensure against shipping damage. It is imperative that all shipping members are removed, and joints properly tightened and insulated before energizing the bus.

Mats, screens, railing, etc., which are external to the switchgear may be required to meet local codes, must be furnished by the purchaser. Be sure to discuss these items with the manufacturer prior to installation as they may affect the performance of the switchgear.

F. **POSITIONING THE METAL-CLAD SWITCHGEAR**

1) **General**

The recommended aisle space for the front and at the rear of the metal-clad 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, and on some switchgear to rollout voltage or control power transformers. The dimensions shown on the switchgear drawings are those required for proper operation of the switchgear. The space at the ends of the lineup can affect the function of the switchgear. There must be 40 inches from the right end (operator’s left while facing the switchgear) of the lineup to the wall or adjacent equipment to fully open the circuit breaker compartment door.
CAUTION

All exposed primary bus and cable joints and connections must be insulated to the system insulation rating.

2) Assembly of Shipping Splits

Much of the arc resistant functions come from proper assembly of the switchgear. The procedures for free-standing equipment and PCR® installed equipment are slightly different. When reassembling the shipping splits use the following guidelines:

a. Free-Standing Switchgear (Customer Building)

Refer to this section and Ch 4 Installation, C. Handling for instructions on moving the equipment into position.

Once in position, final alignment is based on the hardware locations. There are five (5) vertical rows of hardware to connect each vertical section to the adjacent section (Figure 13). Note that the front and rear rows are assembled with full hardware sets (nuts, bolts, and washers). The center locations may utilize either hardware sets or captive nuts in one section. If square holes are present in the equipment, use captive Tee-Nuts. Insert hardware in all holes and tighten to specification. Figure 1 shows a typical lineup with a fault current rating of ≤ 40kA.

b. Switchgear Inside a Power Control Room

Generally, the equipment provided in a PCR is located in its proper place and fully assembled except for the sections on the shipping split. There is often a transition compartment provided at the split to serve as an easily accessible point to break the bus or to clear the wall and ceiling beams of the PCR.

Remove the main bus access covers in the rear compartment to gain access to the center set of mounting hardware holes. Figure 16 shows the main bus exposed after removing the front covers. It is not necessary to remove both sets of covers to access the bus, but this may make the assembly easier. Note the main bus support insulators in Figure 16 are only partially assembled. Use the bottom half to support the bus during installation. Follow the instructions in Ch 4 Installation, J. Connections, 1) Main Bus Assembly and Insulation to complete the support assembly and installation. These covers should remain off until after the bus is installed. See Ch 4 Installation, F. Position the Metal-Clad Switchgear, 1) General and Figures 13-16 for information on the aligning the switchgear.
Figure 12  Vent Duct Assembly

Notes:
1. This figure is for reference only.
2. The 24h x 34w wall cutout at a height of 102.83" (103.33"-5") is required for an arc duct ≤5’. The height of the cutout for arc ducts ≥5’ is 102.33" (103.33"-1”).
3. 103.33” is for 92” high switchgear. Special height configurations should have layout drawings with the correct dimensions to mount the duct.
i. **Assembly Without a Transition**

The adjacent sections of switchgear are already attached to the floor (and rear wall for wall-mounted gear). With the building components correctly aligned, the switchgear should also be aligned. From inside one of the two sections locate the attachment points between the adjacent vertical sections of switchgear. There are five (5) vertical rows of hardware to connect each vertical section to the adjacent section. See Figure 13 for locations. Note that the front and rear rows are assembled with full hardware sets (nuts, bolts, and washers). The center locations may utilize either hardware sets or captive nuts in one section (when square holes are present). Insert hardware in all holes and tighten to specification. *Figure 1* shows a typical lineup with a fault current rating of ≤ 40kA under construction. The exposed end is ready for the next shipping split to be located and attached.

ii. **Assembly With a Transition**

The adjacent sections of switchgear are already attached to the floor (and the rear wall for wall-mounted gear). The shipping split transition is 24” wide and is designed with slotted holes in the barriers to expand or contract to accommodate fluctuations in equipment size and alignment. Prior to reassembly of the PCR®, determine if the transition components are attached to the adjacent section of switchgear and if there are any components (such as bus bar and transition plenum components) that should be placed in the equipment prior to reassembly to facilitate the process. The transition components mount to the switchgear at the same points shown in *Figure 13*. Assemble the transition right side components to the left side of the switchgear. Assemble the transition left side components to the right side of the switchgear. The main bus cut-out on each adjacent switchgear section is fitted with a collar that the bus barriers are installed to after the shipping split is assembled.

With the building components correctly aligned the switchgear should also be aligned.

To assemble the transition, attach the inside main bus barrier assembly. Then attach the top assembly followed by the front and rear assemblies.
Figure 13  Side View of Typical Shipping Split

a. Five Rows of Hardware
Figure 14  Front View of Typical Shipping Split
Figure 15  Rear Compartment Shipping Split Assembly
Figure 16  Bus Installation
c. Bus Assembly

i. Follow the recommended torque instructions found on labels inside the rear compartment and Table B, Bolt Torque Values for Powell Medium Voltage Metal-Clad Switchgear.

ii. Cover bus joints with appropriate boot or other insulating material provided. See Ch 4 Installations, J. Connections for details on all appropriate insulation methods and assemblies.

iii. Connect the ground bus located in the bottom rear of the cable compartment. Refer to Ch 4 Installation, J. Connections.

3) Plenum Assembly

The preferred method of controlling the by-products of an internal arcing fault is to channel these gases out of the room where the gear is located. This task is accomplished by use of a plenum located above the switchgear and venting ducts which carry the gases from the plenum to a desired location.

In site erected buildings it may be desirable to contain the arc fault by-products within the building. This arrangement would have been discussed during the equipment design and the building requirements provided as part of the negotiation.

A shroud plenum designed with louvers in some or all sections will be provided and there will be no exhaust duct assembly or external building vent.

**WARNING**

It is critical to the performance of the switchgear protective scheme that the plenum and ducting be properly assembled and supported. Failure to follow the assembly instructions could result in death or serious injury.

a. Plenum and Barrier Assemblies

Every installation is examined for suitability of a specific plenum design as part of the engineering design process.

The following types of plenum and barrier constructions are offered, based on the application and room design:

i. For the Powell PCR® - A plenum made from barrier plates mounted around the perimeter of the equipment and tied directly to the building's ceiling or a plenum made from modular shrouds that cover the top of one or two vertical sections for the lineup and are tied together to create an assembly. The ends are sealed to protect the adjacent aisleways. For some installations, a plenum may be made from modular shrouds as described below.

ii. For Customer Buildings - A plenum made from modular shrouds that cover the top of one or two vertical sections for the lineup and are bolted together to create an assembly. The ends are sealed to protect the adjacent aisleways.
b. **Assembly of Plenum or Barrier in a PCR®**

Reassembly of the equipment, including the plenum, is required at the PCR shipping split for all equipment crossed by the split. The components for the shipping split transition plenum assembly will be shipped as a separate item.

i. **Barrier Assembly** - Connect the front vertical barriers (and rear if the switchgear is not mounted against an outside wall) using the hardware provided and attach the barrier to the PCR ceiling.

ii. **Modular Shroud** - Typically, a transition is used to span the shipping split. The transition is designed to expand or contract to accommodate variations in manufacturing tolerances and the reassembly process. The plenum is also designed to expand or contract to fit the open space between the adjacent switchgear sections. Once the transition components are reassembled, the plenum components may be installed.

   - Attach the left and right side components to the respective switchgear plenums and install the covering piece(s).

   - Attach the plenum components across the front and rear to the top of the transition assembly using the hardware provided.

c. **Assembly of Plenum in an Open Building**

For installation in a customer building, PowlVac 38-AR™ is typically split into two vertical sections. The plenum may be attached to the switchgear during shipment. If the plenum is attached to the switchgear the following precautions must be taken when handling the equipment:

i. If the equipment is to be lifted via overhead crane, a spreader bar must be used to avoid damaging the plenum.

ii. The path to the installation location must be evaluated for adequate overhead clearance.

iii. The equipment must never be lifted by the plenum. The plenum is not designed or attached to the equipment in a manner capable of supporting the equipment weight.

If the plenum shrouds are shipped separately:

i. Attach the plenum to the top of the switchgear using the sets of holes at the back of the instrument compartment and the middle of the cable compartment. Use the \( \frac{3}{8}'' \) captive nuts and \( \frac{1}{2}'' \) weld nuts provided.
ii. Connect the adjacent plenum components across the front, top, and rear using the hardware provided.

**Note:** One side is a round hole and the mating piece will be slotted to aid in alignment.

iii. The ends are sealed with plates that attach to the edge of the plenum to the top of the switchgear and across the side of the switchgear.

When the arc fault by-products are to be vented into the building, the following additional steps and precautions are required:

i. Clear space above the louvered plenum sections is based on the available fault level. For 38kV, 40kA designs the space above the plenum is required to be a minimum of 48 inches.

ii. There can be no obstructions above a louvered plenum assembly. This includes light fixtures, cable trays, bus duct, HVAC duct, etc.

iii. Where such items cross the switchgear, arrange the plenum such that non-louvered plenum components are below the obstructions.

iv. In cases where all the plenum components are louvered or the room layout has changed, Powell can assist in designing barriers to prevent undesirable fault gas deflection.

---

**WARNING**

*Failure to provide adequate clearance above the designs that allow venting into the equipment room can compromise the internal arcing fault accessibility type and possibly reflect hot gases capable of causing serious injury or death.*

---

4) Exhaust Duct Installation

All plenum assemblies require a method to vent the fault gases from the plenum to a designated area away from other equipment and personnel; typically out of the room.

In a PCR® installation, the exhaust vent(s) are built into the walls of the PCR and all necessary precautions have been included in the design and installation.

When the exhaust duct is provided and field installation is required, the following rules apply:

a. The duct must slope away from the equipment. A drop of 0.5 inches over a 5 foot length of duct is sufficient. For longer ducts, a drop of 1 inch over the total length is recommended. *(Figure 12).*
Figure 17  Plenum Overview

Figure 18  Plenum End View
b. The duct must be adequately supported. Do not omit any of the provided mounting brackets. It is recommended by Powell to keep the duct length to less than 10 feet. In this case, the connection to the switchgear and wall provide the required support. Where longer ducts are necessary, support should be provided approximately every 10 feet, typically at the connection between sections. Standard duct weighs approximately 45lbs/linear foot.

c. The exit point for the duct must be sealed to the building wall, weather-tight, and secured to the duct.

5) Access

All plenum assemblies will have an access point to facilitate initial assembly and maintenance. This access point is typically located in one of the panels along the front of the equipment, but may be located on an exposed end (if an end is exposed in the lineup). Figures 17 & 18 show a typical access point with cover panel partially open.

6) Placement of Equipment Near Exhaust Ducts

When a plenum and ducting system is utilized to control the by-products of an arcing fault, several site considerations must be made with respect to where the gas will be vented. Because the gas release is at an elevated temperature and pressure and contains metallic particles and toxic components, the location of the vent must be isolated from personnel and sensitive equipment. Further, when the gas is vented into the building the structural capability of the building to withstand the overpressure and the effects of the smoke and toxic gas in a closed area must also be evaluated.

Due to the circuitous route the arc blast takes through the switchgear, the plenum, and the duct system, a large part of the fault energy is attenuated inside the switchgear system. There is still a significant amount of energy that leaves the exhaust port and, depending on the speed of the protective scheme, a significant level of toxic gas and smoke may be released.

Pressure measurement in the switchgear during testing reveals significant drops in value as the gas works its way to the exit point of the duct. A typical 40kA three phase fault in a circuit breaker compartment sees a average peak pressure in that compartment of 12psi. The pressure is reduced to approximately 2psi when it reaches the exhaust duct external cover. At this point the gas has traveled at least 8 feet and the drop in pressure reflects the loss of energy that occurs.
The gas temperature also drops exponentially as it moves from the source. The temperature of the fault gases exiting the duct in the typical test sample are around 200°C and will continue to cool as it moves from the vent. The toxic nature of this gas does not decrease based on distance traveled and for that reason it is preferred to vent the gases outside of the building.

Additional precautions, beyond those concerned with the temperature of the gases, will be required when the gas is released in a confined space or building. These precautions include evaluation of the effect of an overpressure on the structure and the availability of light and fresh air.

The isolation area for the exhaust duct to vent into can be visualized as a 5 foot diameter cylinder around the center line of the exhaust duct that extends 7 feet out from the exhaust duct opening. While the actual flow of gas resembles an ellipsoid within the borders of the described cylinder and will vary in intensity based on fault current level and proximity to the vent opening, using the cylinder dimensions as the borders of the isolation area provides a simple and effective method to define the space. This space must be free of personnel, sensitive equipment, and physical impediments to gas flow when the equipment is energized.

**Figure 19   Exhaust Duct Gas**

G. **Door Alignment**

If for any reason it is necessary to realign the doors of the switchgear during installation, perform the following:

1. After checking that the switchgear is level and plumb, start at either end of the switchgear lineup and realign each door individually as required.
2. The top of each door should be level with the adjacent doors; the sides of each door plumb; the surface of each door flush with adjacent doors; and the space between adjacent doors equalized to permit their free swing and present a neat appearance.
3. Door may be raised or lowered vertically, moved left or right horizontally, or rotated to plumb them, by loosening the mounting screws which attach the door to the moveable half of the hinge assembly. These screws are located on the inside of the door. The door assembly may then be adjusted as allowed by the holes in the door, which are slightly oversized.
4. **PCR® Rear Doors** - When properly aligned, the rear doors of the switchgear (exterior doors of the PCR) should be tightly seated on the gasket that surrounds the door opening. After aligning the door as described above, close and latch the door and check the seal by inspecting the gasket for compression.

5. Check alignment of door shutter position interlock. With the equipment deenergized and the circuit breaker removed, enter the breaker compartment and close the door until the shutter position interlock actuator on the door contacts the upper linkage on the interlock. Verify that there is proper engagement and that the actuator will not move enough to miss the linkage. Verify that with the door fully closed, the lower linkage of the interlock will operate the latch so that the safety shutters are free to move.

### H. Removable Element

The removable element (circuit breaker) or auxiliary rollout device may be shipped loose in its own protective box or inserted in the switchgear when the equipment is installed in a PCR®. If the circuit breaker is in the switchgear, it will be locked in place by a special bracket designed to prevent movement during shipment. This bracket must be removed and discarded in order to move the circuit breaker.

Before installing or operating a removable element, such as the circuit breaker, ground and test device, or dummy removable element, refer to the appropriate instruction bulletin for a detailed description of the element and its operation, maintenance, and renewal parts.

### CAUTION

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

Removable elements may be rolled into the vertical section of the switchgear from the floor.

See *Ch 5 Operation* for specific details on inserting the removable element into the compartment. Installation of the auxiliary devices is covered in *Ch 4 Installation, S. Auxiliary Device Rollout Carriages.*

### I. Grounding

The switchgear assembly must be grounded before power connections are made.

External power connections should be installed after the equipment is placed in its permanent location and the grounding connections are completed. Temporary safety grounding cables must be connected to the equipment ground bus and all high voltage terminals that are handled or touched during power connection and installation.
A ground bus is furnished with lugs at each end for connection to the station grounding system.

The ground 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.

Assemble the ground bus joints as outlined in Ch 4 Installation, J. Connections. 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 if short circuits or other abnormal occurrences take place and to ensure that all parts of the equipment, other than live parts, are at 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 exist. 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 solution.

The 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.

J. 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 installation, 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 1/2 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 1/4 inch thick copper bars are to be connected, the bolt should be 1 3/4 inch long. In addition to proper length bolts, the bolt assembly must include flat washers, split ring lock washers, and nuts. All hardware must be SAE Grade 5 or better. See Figure 20 for proper hardware assembly.
3. In some cases, external connections are made to metal-clad switchgear bus by bars. The metal-clad 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 B, Bolt Torque Values for Powell Medium Voltage Metal-Clad Switchgear.

1) Main Bus Assembly and Insulation

The main and riser bus structure of PowlVac 38-AR™ Metal-Clad Switchgear is made up of tubular copper bus sections, flattened at the end to allow joints to be made with flat copper splice plates. This bus structure is supported by conical cast epoxy bus support inserts mounted on a polyester-glass barrier.

The insulation system of the main bus has been designed to minimize electrical stress on the insulation while maintaining the minimum practical size of the bus structure. It is very important to the successful operation and long life of this equipment that the main bus assembly and insulation be done very carefully, following these instructions step by step.

The main bus of the metal-clad switchgear may be reached through access covers both in front of and behind the bus. See Figure 2. The front bus access cover may be removed from inside the circuit breaker compartment, while the rear bus access cover may be removed from the cable entry compartment.

2) Installing and Connecting Main Bus Conductors

The installation and connections of the main current carrying conductors must be done correctly to ensure compliance with equipment basic impulse level (BIL) and factory dielectric test (Hi-Pot) requirements. By performing the following series of instructions, maximum operator safety and equipment integrity can be expected.

a. Remove the compartment covers.
b. Loosen the splice plate bolts at the bolted joints in the equipment, where the bus conductors being installed will be connected.
c. 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.
d. Carefully remove the upper half of the conical bus support by removing the three nylon hex head bolts securing the support to the glass polyester sheet support.
e. Each main bus conductor which must be field installed is furnished with a flat silicone rubber cushion. The cushion should be laid in the lower half of the conical bus support so that both ends are exposed.

f. RTV silicone supplied with the equipment should be applied to the inside and outside surfaces of the flat silicone rubber cushion to remove all trapped air voids.

g. Position the horizontal main bus conductor in the prepared bus support assembly and between the cleaned splice plates and secure the hardware to prevent shifting. Care must be taken at this time to ensure the bus conductors are properly oriented in relationship to each other.

h. Apply RTV silicone to half of the conical bus support along the bolting surface, bus contact surface, and parting surfaces as shown in Figure 21 to remove any trapped air voids.

i. Mount the upper half of the conical bus support against the glass polyester support with the 3/8 - 16 nylon bolts, flat washers, and hex nuts provided, tightening until snug (approximately 10lbs-ft; do not overtighten). Take care to fold the flat silicone rubber cushion around the tubular bus bar (Figure 22).

j. Tighten the bus bar splice plate bolts properly. See Table B, Bolt Torque Values for Powell Medium Voltage Metal-Clad Switchgear.
### Table B Bolt Torque Values for Powell Medium Voltage Metal-Clad Switchgear

<table>
<thead>
<tr>
<th>Bolt Dimensions (inches)</th>
<th>Bolt Head</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ft-Lbs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kg-M</td>
</tr>
<tr>
<td>5/8</td>
<td><img src="image" alt="Bolt 5/8" /></td>
<td>55-70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.6-9.7</td>
</tr>
<tr>
<td>1/2</td>
<td><img src="image" alt="Bolt 1/2" /></td>
<td>35-50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.8-6.9</td>
</tr>
<tr>
<td>3/8</td>
<td><img src="image" alt="Bolt 3/8" /></td>
<td>20-30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.8-4.2</td>
</tr>
<tr>
<td>1/4</td>
<td><img src="image" alt="Bolt 1/4" /></td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.7-0.97</td>
</tr>
</tbody>
</table>

**k.** Add additional RTV silicone as needed to displace all air between the tubular bus conductor, conical bus support, and the flat silicone rubber cushion. Also use RTV silicone to fill any voids in the conical bus support to glass polyester joint surfaces (*Figure 23*). Trapped air voids in the insulation/support system can lead to partial discharge problems over extended time periods.

**l.** Wipe any excess RTV silicone off the bus support assembly and tubular bus conductor, leaving a smooth finished bus support assembly free of entrapped air and secure the tie wrap (*Figure 24*).

---

3) **Main Bus Joint Insulation**

Main bus joints are insulated with either a custom fitted boot or with hand applied insulating tape. *Ch 4 Installation, J. Connections, 4) Wrapping of Joints* will describe the procedure for hand applied insulating tape wrapped joints. After installing main bus conductors as described in *Ch 4 Installation, J. Connections, 2) Installing and Connecting Main Bus Conductors* the joints must be insulated as follows.

- **a.** Tighten the bus bar splice plate bolts properly. See *Table B, Bolt Torque Values for Powell Medium Voltage Metal-Clad Switchgear*. Once the joints are insulated, it will not be possible to retorque the bolts without removing the boot.
- **b.** Place the boot over the joint (*Figure 25*).
c. Install brackets on both sides of the boot using nylon hardware (Figure 26).
d. Secure tie wraps around the bus bar (Figure 27).

Figure 25 Placing Boot over the Joint

Figure 26 Installing Brackets on the Boot

Figure 27 Boot Installation Complete

4) Wrapping of Joints

Wrapping of joints with insulating tape is an acceptable alternative to booting the bus conductor joints. For some complex or unusual joints, the formed bus boots described above may not be available. Bus conductor joints to be tape wrapped must use the following procedure to maintain proper insulation characteristics within the switchgear (Figure 28).

Table C Bus Wrapping Components

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0282A3529 P004</td>
<td>2&quot; wide tape</td>
</tr>
<tr>
<td>0282A3529 P005</td>
<td>4&quot; wide tape</td>
</tr>
<tr>
<td>0282A3529 P008</td>
<td>Electrical grade rubber based (RB) putty</td>
</tr>
</tbody>
</table>

Note: Electrical grade RB putty will be used only when required to grade voids and smooth out sharp edges of joints and pothead, terminator or entrance bushing connections.
**Figure 28  Insulation of Bus Bar**

- 0.48 (1.2) Approximate Dimension (Tape Tension)
- 1 Layer; 1/2 LAP = 2 Thicknesses
- 0.096 (2.4) Approximate Dimension (Tape Tension)

Circular or Square Tubes are taped in the same manner as Rectangular Bars

HV Tape - 2” (50.8) or 4” (101.6) Wide Rolls X 30’ (9144) ft Long - 0282A3529P004 or P005

Diagram of 1/2 LAP Starting with 1 Full Turn - Apply with Mastic Side Down

**Approximate Tensioned Dimensions**

- 1.75 (44.4) or
- 3.5 (88.9)

**Begin Taping at**

'A' + 1/4"  "A" = Contact Surface

**Table D Insulation of Bus Bar**

<table>
<thead>
<tr>
<th>Insulation Range (volts)</th>
<th>Number of Layers</th>
<th>Tape Width (inches)</th>
<th>Approx. Footage of Tape Required to Insulate 1 Linear Foot of Bus Bar (2&quot; &amp; 4&quot; Wide Rolls are 30’ Long)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bar Sizes (inches)</td>
</tr>
<tr>
<td>34.5</td>
<td>4 Layer + 1/2 Lap*</td>
<td>2 14 18 19</td>
<td>28 29 36 37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 7 9 9 14 15</td>
<td>18 19</td>
</tr>
</tbody>
</table>

**Note:** Apply tape at medium tension to produce a void-free uniform build-up of tape. A medium tension stretches a 0.030"x2" tape down to 0.024"x1 3/4" and 0.030"x4" down to 0.024"x3 1/2". Apply with mastic side down.

* Apply 3 layers - 1/2 lap for conductors passing through CT’s.

**Table E Insulation of Single Bus Bar Connection Joint**

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler &quot;A&quot;</th>
<th>Outer Wrap &quot;B&quot;</th>
<th>“C” (inches)</th>
<th>Approx. Number Rolls per Joint of HV Tape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RB Putty* &amp; 4 Layers</td>
<td>HV Tape</td>
<td>5 Layers</td>
<td>7</td>
</tr>
<tr>
<td>34.5</td>
<td>4 Layers</td>
<td>HV Tape</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** * Electrical grade rubber base putty 0282A3529 P008 in roll form will be used to grade voids and smooth out sharp edges of joints. This putty has no insulation value. 1 roll is ½" x 1½" x 5’ long.

Δ High voltage insulating tape 0282A3529 P004 - Roll is .030 x 2” x 30’ long. Apply with mastic side down.
Table F  Insulation of Double Bus Bar Connection Joint

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler “A”</th>
<th>Outer Wrap “B”</th>
<th>“C” (inches)</th>
<th>Approx. Number of Rolls per Joint of HV Tape Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.5</td>
<td>RB Putty* &amp; 4 Layers HV Tape Δ</td>
<td>5 Layers HV Tape Δ</td>
<td>7</td>
<td>1 Roll RB Putty* &amp; 3 Roll HV Tape Δ</td>
</tr>
</tbody>
</table>

Note:  
* Electrical grade rubber based putty 0282A3529 P008 in roll form will be used to grade voids and smooth out sharp edges of joints

# HV Tape 0282A3529 P005 roll is .030” x 4” x 30’ long.

Δ HV Tape 0282A3529 P004 roll is .030” x 2” x 30’ long. Apply with mastic side down.

Table G  Insulation of Tee Connection Joint

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler “A”</th>
<th>Outer Wrap “B”</th>
<th>“C” (inches)</th>
<th>Approx. Number of Rolls per Joint of HV Tape Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.5</td>
<td>RB Putty* &amp; 4 Layers HV Tape Δ</td>
<td>5 Layers HV Tape Δ</td>
<td>7</td>
<td>1 Roll RB Putty* &amp; 3 Roll HV Tape Δ</td>
</tr>
</tbody>
</table>

Note:  
* Electrical grade rubber based putty 0282A3529 P008 in roll form will be used to grade voids and smooth out sharp edges of joints. This putty has no insulation value.

1 roll is 1/8” x 1 1/2” x 5’ long.

Δ HV Tape 0282A3529 P004 roll is .030” x 2” x 30’ long. Apply with mastic side down.
Figure 32  Dead End Bus Joint Insulation

Pre-Insulation Epoxy Insulation
Thermoplastic Sleeving or Tape Insulation

Apply RB Putty Sparingly to Grade-Out and Round Off

Crissscross Tape in a Figure Eight Pattern to Fully Cover End

1) Cut and Apply 1-Strip of Tape to Form a Boot Over End

2) Apply RB Putty Sparingly to Round Off End of Bar

3) Continue with “A” Layer of HV Tape.

Table H  Insulation of Dead End Bus Joint

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler “A”</th>
<th>Outer Wrap “B”</th>
<th>“C” (inches)</th>
<th>Approx. Number of Rolls per Joint of HV Tape Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RB Putty* &amp; 4 Layers HV Tape Δ</td>
<td>5 Layers HV Tape Δ</td>
<td>7</td>
<td>1/2 Roll RB Putty* &amp; 1/2 Roll HV Tape Δ</td>
</tr>
<tr>
<td>34.5</td>
<td></td>
<td></td>
<td></td>
<td>5 Layers HV Tape Δ</td>
</tr>
</tbody>
</table>

Note: * Electrical grade rubber based putty 0282A3529 P008 in roll form will be used to grade voids and smooth out sharp edges of joints. This putty has no insulation value. 1 roll is 1/8” x 1 1/2” x 5’ long.

Δ HV Tape 0282A3529 P004 roll is .030” x 2” x 30’ long. Apply with mastic side down.

Figure 33  Bar-Type Current Transformer Joint Insulation

Pre-Insulation Epoxy Insulation
Thermoplastic Sleeving or Tape Insulation

“D” “A” “B”

0.50 (12.7) Min

Table I  Bar-Type Current Transformer Joint Insulation

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler “A”</th>
<th>Outer Wrap “B”</th>
<th>“C” (inches)</th>
<th>“D” (inches)</th>
<th>Approx. No. of Rolls per Joint of HV Tape Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.5</td>
<td>RB Putty* &amp; 4 Layers HV Tape Δ</td>
<td>5 Layers HV Tape Δ</td>
<td>7</td>
<td>5</td>
<td>1 Roll RB Putty* &amp; 3 Roll HV Tape Δ</td>
</tr>
</tbody>
</table>

Note: * Electrical grade rubber base putty 0282A3529P008 in roll form will be used to grade voids and smooth out sharp edges of joints. This putty has no insulation value. 1 roll is 1/8” x 1 1/2” x 5’ long.

Δ HV Tape 0282A3529P004 roll is .030” x 2” x 30’ long. Apply with mastic side down.

Note: ‡ Insulate as far as possible. Do not cover polarity marks.

Δ HV Tape 0282A3529P004 roll is .030” x 2” x 30’ long. Apply with mastic side down.
5) **Incoming Power Connections**

Incoming power connections to the switchgear may be connected in various configurations depending on the equipment application. Review the elevation drawings delivered with the equipment for site specific connection details.

6) **Cleaning Bus Insulation**

Main bus bars are insulated with a high temperature thermoset material having excellent dielectric and mechanical properties. When cleaning is necessary, use a lint-free cloth or industrial wiper, or a vacuum cleaner to remove accumulated dust and dirt. Do not clean the bus by blowing with compressed air. Dust and dirt removed in this manner may be blown into operating parts of the switchgear and damage bearings or other mechanisms.

If wiping or vacuuming does not clean the bus adequately, only distilled water, denatured alcohol or isopropyl alcohol should be used to remove any foreign materials from the insulation surface. The use of other solvents may result in severe damage to the insulation system or other parts of the equipment.

**K. Primary Cables**

The primary cable connections in PowlVac 38-AR™ switchgear are reached by opening the rear hinged 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 motors will rotate in the proper direction and that the phase rotation is the same when interconnecting two different sources of power.

Normally compression terminals are used to terminate primary cable. When shielded cables are used, proper stress relief must be provided at the cable termination. This may be done by the use of a commercially available cable terminator, many types of which are available, or by the use of a stress cone, either hand-built or of the prepackaged type. In all cases, carefully follow the cable manufacturer’s recommendations for installation of the type of cable being used. No insulation or stress relief materials are normally furnished for cable terminations.

Potheads may be used when it is desirable to hermetically seal the end of the cable to make a moisture proof connection between the cable and switchgear bus. A pothead also prevents seeping of oil from the end of oil impregnated varnish cambric or paper insulated cable.

1) **Primary Cable Penetrations**

   **a. General**

All cable penetrations should be sealed to maintain the arc resistant integrity of the equipment. Small gaps will exist between the round cables when they are pulled through a bushing as a group. While these gaps are typically quite small and would be expected to release minimal by-products in the event of a fault, it is recommended that they be sealed with a material such as Bisco, or where the gaps are very small, a silicon based sealant like RTV once the cables are pulled and terminated.
The incoming cable must not block the pressure relief venting in the vertical section where the cable is entering or the adjacent vertical sections.

Top entry for both breakers in two-high construction should be avoided as it severely limits the area for exhausting gases in that section.

b. **Bottom Entry**

The entry point is located on the floor of the rear compartment of the switchgear. The opening is covered with a non-magnetic stainless steel (some applications use glass-polyester) cover. Remove the cover and punch it for the appropriate sized entry bushing. It is important that all of the hardware used to attach the cover to the floor of the compartment be used when reinstalling the cover.

c. **Top Entry**

Top entry may be accomplished in a number of ways, depending on how the equipment is configured and the type of plenum (if present). Refer to *Ch 4 Installation, F. Positioning the Metal-Clad Switchgear, 3) Plenum Assembly* for details on how to identify the plenum.

i. The modular plenum (see *Ch 4 Installation, F. Positioning the Metal-Clad Switchgear*) has a provision to top entry outside the plenum over the cable compartment only. Between the rear mounting point of the plenum and the rear door frame is a removable cover to facilitate top entry. Remove the cover and punch it for the appropriate sized bushing. Using this entry blocks the rear of the plenum for an exhaust duct on that individual section.

ii. The plenum made from multiple pieces is typically found in PCR® applications where top entry from cable tray will be utilized. This plenum design may be opened on either end for the tray to pass through. The top of the equipment is penetrated as required.

**Note:** Future capacity increases may not be possible with this design as the cable bend radius may not be possible in the confined area under the plenum.

L. **Insulating Primary Cable Terminations**

All field assembled joints for primary cable terminations must be insulated to maintain the dielectric ratings of the switchgear. These joints should be prepared as outlined in *Ch 4 Installation, J. Connections*. Upon completion of the cable termination, care must be exercised when taping the exposed termination.

1. All terminations must be prepared for insulation as outlined in *Ch 4 Installation, J. Connections*.
2. The instructions for application of the tape insulation are the same as outlined for wrapping of joints.
3. As an alternative to taping, heat-shrink or cold-shrink insulating systems rated for the system voltage may be used. Follow the instructions provided by the insulation system manufacturer when installing such material.
**Figure 34  Cable Termination Joint**

![Diagram of Cable Termination Joint](image)

Epoxy Insulation Thermoplastic Sleeveing or Tape Insulation

- **No. 6 Cable to Surge Suppressors or Lightening Arrestors Potential Transf., etc.**

- **.50 (12.7) Min**

- **Table J  Cable Termination Joint**

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler “A”</th>
<th>Outer Wrap “B”</th>
<th>“C” (inches)</th>
<th>Approx. No. of Rolls per Joint of HV Tape Δ</th>
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<tbody>
<tr>
<td>34.5</td>
<td>RB Putty* &amp; 3 Roll HV Tape Δ</td>
<td>5 Layers HV Tape Δ</td>
<td>7</td>
<td>1 Roll RB Putty* &amp; 3 Roll HV Tape Δ</td>
</tr>
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**Note:**
* Electrical grade rubber base putty 0282A3529P008 in roll form will be used to grade voids and smooth out sharp edges of joints. This putty has no insulation value. 1 roll is 1/6” x 1 1/2” x 5’ long.

Δ HV Tape 0282A3529 P004 roll is .030” x 2” x 30’ long. Apply with mastic side down.

Where armored cable is used, the armor must be terminated and grounded before the cable passes through the transformer. Armor clamps are furnished for this purpose when specified.

When lead or other conducting sheath cable, or cable with shielding tape or braid is used, it is recommended that the sheath or shield be grounded solidly to the switchgear ground bus. The ground lead should be bonded to the sheath or shield on the side of the current transformer away from the primary terminals. In cases where the ground cannot be applied before the cable passes through the transformer, bond the lead to the sheath or shield between the transformer and the primary terminals. The ground conductor must then be passed back along the cable path through the current transformer before being connected to the ground bus.

Where potheads are used in units provided with ground fault current transformers, the pothead mountings must be insulated from ground.

All cables should be kept as close to the center of the current transformer window as possible.

**M. GROUND FAULT CURRENT TRANSFORMERS (WINDOW-TYPE)**

Window-type current transformers are furnished where specified for sensitive protection against ground faults. These transformers are normally installed in a horizontal position directly above or below the primary cable terminals so that the primary cable or cables can pass through them. One transformer is required for each three-phase circuit.
N. CONTROL CABLES

Space is provided for control cables to enter the switchgear from either the top or the bottom of the units. See drawings furnished with the switchgear for detailed dimensions and location of the control cable entry space.

When control conduits enter the unit from below, entry space is located on each side of the unit near the front inside the secondary enclosure. The conduits should not extend more than 1” above the floor. The control cables may be pulled through the conduits before or after the switchgear is installed, whichever is more convenient. However, if the cables are pulled before the switchgear is installed, they must be threaded through the opening in the switchgear floor plate when setting the switchgear in place.

Connect the cables to the terminal blocks in accordance with the wiring diagrams furnished for the specific job.

If the control conduits enter from above, drill the top cover plate of the front enclosure to suit the conduits, being careful not to damage existing wire bundles. The top cover may be removed temporarily to facilitate drilling. Fasten the conduits to the cover with locknuts.

The cables from the control power source to the switchgear should be large enough to avoid excessive voltage drop when the circuit breakers are operated. See testing instructions.

Where units have been split for shipment, any control or other secondary leads which 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 of time will be required for reconnecting them.

O. FIELD ALTERATION AND CABLE CONNECTIONS

⚠️ WARNING
Prior to adjustments, servicing, maintenance, or any act requiring 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.

⚠️ WARNING
Do not route any control cables in any manner or in any location which may impede the function of the interlocks, pressure relief vents, or any other moving part of the assembly. Incorrect routing of control or power cables could result in death or serious injury.

1) Adding Control Cable

PowlVac 38-AR™ arc resistant switchgear conforms to ANSI requirements for metal-clad switchgear and all wiring must meet the requirements of ANSI C37.20.2. Additional precautions are required to maintain the integrity of the arc resistant features. The general guidelines for adding control cables to arc resistant switchgear are as follows:

a. All penetrations into arc resistant switchgear from external sources must be made through sealed conduit or protective bushings into the instrument compartment or designated entry point.

b. The preferred entry into the switchgear is through the top of a full height instrument compartment or into the side of the end unit instrument compartment.
c. All interconnections between vertical sections should be run internally through the openings between instrument compartments *(Figure 35)*.

*Figure 35* Instrument Compartment Interconnecting Opening

d. Internal penetrations from various compartments to the instrument compartment should be made through the wire way provided *(Figure 35)* by entering the way at the end openings located in the center compartment. When this is not possible and the entry must be made directly into the wire way near the instrument compartment opening the entry may be made with either sealed conduit, a CGB (compression type fitting) that is filled to capacity and thereby is effectively sealed, or with a through fitting that is filled with an appropriate barrier/sealant material. For small gaps in the wires, electrical grade silicon RTV may be used to seal the entry. For large gaps or wire ways, use a fire barrier material such as Chico.

e. Entry from compartment floor:
   i. Conduit penetrations may be made in the floor in the area between the circuit breaker floor pan and the side walls in either the front compartment or center compartment. This area measures 2 inches wide and is therefore limited to small conduit fittings. Two layers of 11 gauge steel must be penetrated to utilize this area *(Figure 7, p)*.

   ii. Front compartment penetration on the left side of the compartment is discouraged because of the close proximity to the MOC actuator. Front compartment penetration on the right side is limited due to the front door interlock assembly and TOC assembly.

*Note:* The MOC actuator pivots with the operation of the circuit breaker. Do not route any wires above the level of the floor pan side wall and directly under the MOC actuator.

Installation of a rear door interlock will limit the accessibility of this wire way as the interlock shares the available space. Contact Powell for specific instructions if the wires and interlock cannot be fitted in the available space.
iii. Penetrations in the area directly behind the circuit breaker beneath the primary disconnecting devices are the preferred method of entry into this compartment. This is accomplished by removing the cover box and making the appropriate conduit penetration openings in the cutout panel provided. The cables are shielded by replacing the cover box. Cables entering the compartment are routed through an opening in the left side of the breaker floor pan and in the wire way formed by this pan and the left side wall. A cover is provided to shield the wires in the wire way.

iv. All penetrations into the center compartment (circuit breaker compartment) must be routed into the front compartment through either the vertical side barriers or the shelf directly above the circuit breaker. No special precautions are required other than use of a bushing or similar device to protect the wires as they pass through the metal barrier.

v. Entry into the instrument compartment is made as described in Ch 4 Installation, O. Field Alteration and Cable Connections, 1) Adding Control Cable, d.

f. In all cases, the control cable and its shielding method must not compromise the safe distances between energized conductor and ground for the rating of the equipment. The recommended minimum distance is:

- 10½” for equipment rated 38kV

This value may be superseded by any local or national regulation or requirement specific to the job site and is given only as guidance in the absence of any other requirements.

P. Surge Protection

When surge arresters are furnished, the primary cable terminal will be insulated at the factory unless it must be disconnected for shipment. When this connection is completed in the field, it will be necessary to insulate the primary connection before the switchgear is energized. PVC boots will normally be supplied to insulate these connections.

When surge arresters are not furnished, it will be the responsibility of the user to provide suitable protection for switchgear from damage due to lightning or other surges.

Q. Roof Entrance Bushings

When assembling the connection bar end of roof entrance bushings inside of the switchgear and other terminations where porcelain insulators are used, refer to the specific drawings furnished with the equipment describing the specific installation instructions. In most applications, insulation should be applied as follows:

1. Prepare the connection bars for insulation as outlined in Ch 4 Installation, J. Connections.
R. Bus Duct Entry

Bus duct entry into the switchgear must penetrate the plenum (when a plenum is present).

1. The Standard Plenum has an alternate configuration that contains compartments designed to accommodate bus. Connections to the bus are made from the outside of the equipment as is typical with standard bus duct.

2. The Barrier Type Plenum construction in a PCR® may also be configured with bus duct. The duct is not integral to the plenum. Here, standard bus duct is run inside the plenum assembly and sealed as it exits the perimeter wall of the plenum.

In all cases, there will be a fire barrier inside the duct at the point it exits the boundaries of the plenum.

S. Auxiliary Device Rollout Carriages

Rollout carriages will be shipped separately, marked with the unit number in which they are to be installed. Each rollout is equipped with its own wheels, and may be rolled on a smooth floor.

1) Installation

A lifting device is required to install/remove the auxiliary carriage in all positions. Follow the instructions found in the Instruction Bulletin for the specific lifting device required.

---

**Table K Pothead, Bushing, or Terminator**

<table>
<thead>
<tr>
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<th>Inner Filler &quot;A&quot;</th>
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<td>34.5</td>
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</tr>
</tbody>
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* Electrical grade rubber base putty 0282A3529P008 in roll form will be used to grade voids and smooth out sharp edges of joints. This putty has no insulation value.

1 roll is ½” x 1½” x 5’ long.

Δ HV Tape 0282A3529P004 roll is .030” x 2” x 30’ long. Apply with mastic side down.

---

**Figure 36 Roof Bushing**

POTHEAD

BUSHING

TERMINATOR

Wrap Over First Skirt Only

RB Putty * Wrap Over First Skirt Only

Note:**

Table K Pothead, Bushing, or Terminator

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1 roll is ½” x 1½” x 5’ long.

Δ HV Tape 0282A3529P004 roll is .030” x 2” x 30’ long. Apply with mastic side down.
2) Removal

To remove the auxiliary carriage from the switchgear, the carriage must first be racked to the “Disconnect” position. From this position, the auxiliary carriage can be removed from the racking mechanism and removed from the switchgear using the procedure found in the instructions for the lifting device.

3) Operational Checkout

![WARNING]

The equipment must be deenergized and grounded prior to performing any tests or checks of the safety interlocks described in this section. Failure to deenergize and ground the equipment prior to performing these tests or checks may result in death or serious injury.

a. All compartments are equipped with an anti-rollout latch. This is operated by a lever which projects from the front of the rollout at the lower left (Figure 37, b). The latch at the inner end of this lever operates in conjunction with a latching bar (Figure 37, c) located on the floor of the rollout compartment, to prevent the auxiliary carriage from accidentally coming out of the compartment during installation or removal of the carriage.

With the auxiliary carriage attached to the racking mechanism it is held captive. The compartment door may be closed and the auxiliary can be moved to the “Connect” position using the racking mechanism. To access the racking mechanism the interlock bar must be moved to the left, exposing the racking screw.

b. All rollouts are equipped with a fuse access door (Figure 37, a). This door is interlocked with the structure so that the door must be closed to move the rollout to the “CONNECT” position, and so that the door can only be opened in the “DISCONNECT” position.

All rollouts are equipped with a racking mechanism and position indication. Additionally, there is a racking access interlock bar that is equipped with a padlock hasp for lockout/tagout and an optional key lock. The key lock is mandatory on fuse rollouts.
c. All rollouts are equipped with a grounding switch, consisting of metal rods connected to ground and an operating mechanism. The mechanism is driven by a roller on the right side of the rollout carriage which engages a roller guide on the right side of the rollout compartment. When the rollout is in the “DISCONNECT” position, the live parts are automatically grounded and as the rollout is moved prior to reaching the “CONNECT” position this ground connection is removed by the operating mechanism.

d. Voltage transformer (VT) rollouts are equipped with a secondary disconnect device located under the rollout carriage on the left-hand side when facing the rollout, beneath the carriage. This connector mates with a stationary connector located on the floor of the rollout compartment. When the rollout is moved to the “CONNECT” position, the secondary disconnect is automatically engaged.

e. Fuse rollouts are equipped with a key interlock which prevents inserting and withdrawing the rollout unless the control power transformer secondary circuit breaker is in the “OPEN” position. If the fuses feed a control power transformer within the switchgear, the CPT secondary circuit breaker will be located in the switchgear secondary compartment. This circuit breaker will be equipped with a key interlock, with the key available only when the breaker is open. If the fuses feed an external transformer, the remote transformer secondary circuit breaker will have a similar key interlock. To insert or withdraw the rollout, open the transformer secondary circuit breaker and lock it open. Use the interlock key to release the interlock bar on the compartment. The key interlock is located on the left side of the racking shaft. Releasing this lock will allow the interlock bar to be moved to the left and expose access to the racking screw.

Using the 3/4” socket and racking tool, rack the carriage until the indicator flag shows the “Disconnect” position and the compartment door can be opened. The interlock key will remain captive until the interlock bar is moved to cover access to the racking screw. Locking the interlock bar to prevent access to the racking shaft will release the key and the secondary circuit breaker can be released and closed.
4) Changing Primary Fuses

On both styles of rollout, primary fuses are contained within horizontal insulating housings which also serve as the primary disconnecting devices for the rollout carriage. The fuses are held in place by silver-plated copper plugs screwed into the front of the insulating housing assembly.

To change a fuse, the auxiliary carriage must be in the “Disconnect” position. Moving the carriage to this position will release the compartment door interlock and the fuse access door interlock on the auxiliary rollout. Open the compartment door and then the fuse access door. The auxiliary carriage does not need to be removed to replace a fuse.

To access the fuses use the spanner tool to remove the silver-plated copper plugs. The spanner tool is located inside the auxiliary rollout and is attached to the inside of the front cover.
A. General

Compartment access shall be permitted ONLY to “Qualified Person”, as defined in NFPA 70E, using “approved safe work practice” and “appropriate PPE”. Failure to do so could result in death or serious injury.

All removable elements of the same type and rating which have duplicate control wiring may be interchanged.

During operation, all live parts are enclosed by barriers which permit the operator to perform work with maximum safety. Separate covers are provided over each different compartment, so that any compartment of an enclosure may be exposed without exposing other compartments.

All PowlVac 38™ circuit breakers are equipped for electrical operation. A manual charging handle is supplied as part of the accessories to permit manual operation of the circuit breaker during maintenance.

This device must not be used to close the circuit breaker on any energized circuit. If done, it could result in death or serious injury.

The control circuits may be checked by moving the circuit breaker to the test position where the main circuits are disconnected and the control circuits are completed.

B. Inserting the Removable Element into the Compartment

Opening the compartment door to install a circuit breaker defeats the arc resistant functionality of the compartment. The operator must wear the appropriate Personal Protective Equipment (PPE) for the level of flash hazard exposure indicated by the Arc Flash Studies. Failure to do so could result in death or serious injury.

Do not place the circuit breaker into the compartment until the switchgear lineup installation is complete. If the circuit breakers are placed into the switchgear lineup before the installation is complete, trouble may occur from foreign materials in the compartments and from a non-level foundation or from distortion caused during shipment or handling.

1. Verify that the circuit breaker open/closed indicator displays “BREAKER OPEN” and if not, press the manual trip operator to open the circuit breaker.
2. To insert the circuit breaker into the circuit breaker compartment, open the compartment door and align the wheels with the floor pan channels of the compartment. Verify that there are no locks or tags on the circuit breaker of the shutter interlock that would block operation or indicate an issue with the equipment and that the floor pan channels are free of debris prior to inserting the circuit breaker.
3. Roll the circuit breaker in the compartment until the racking crank arms make contact with the vertical slots in the compartment. The anti-rollout latch on the lower right side of the circuit breaker will engage the block in the compartment, preventing accidental removal of the circuit breaker from the compartment.

This is the disconnected position.

C. Racking Mechanism

The racking mechanism consists of two slotted cam plates mounted on each side of the compartment (located behind the shutter actuators shown in Figure 7) and the racking mechanism on the circuit breaker. The crank arm rollers at the ends of the racking crank arms of the circuit breaker will engage the cam plates in the compartment and the act of moving the circuit breaker from one position to another can be performed. The procedure that moves the circuit breaker from one position to another is known as “racking”. Arc resistant switchgear requires this procedure be performed with the compartment door closed for normal operation via one of the following options:

1) Closed-Door Racking

This is the standard for arc resistant switchgear. The front door of the circuit breaker compartment has an opening which enables the racking shaft of the circuit breaker to be accessed with the door closed and latched. The shaft is held captive and sealed to the door to maintain the arc resistant integrity. The opening is covered by a teardrop cover which automatically closes by gravity when the racking handle is removed. The door is also provided with a viewing window and the compartment light to allow viewing the position and condition of the circuit breaker without opening the door.

2) Remote Racking Device

The closed-door racking design allows the use of remote racking devices. The door is equipped with the appropriate connection points to mount an external remote racking device (contact Powell for appropriate device and instructions).

3) Onboard Racking

This design utilizes a circuit breaker equipped with an automatic racking system and requires no front door access. Mechanical operation of this racking method requires the compartment door be open and such operation should only be made in an emergency or with the switchgear deenergized.
D. Racking Procedure (Manual)

**CAUTION**

Use only the racking tools provided by Powell for inserting and removing the circuit breaker. The use of other tools such as electric drills, impact drills, etc., may damage the racking mechanism and render it inoperative.

**CAUTION**

Before inserting the circuit breaker into the compartment, be sure that the racking crank arms of the circuit breaker are in the fully withdrawn position, pointing towards the moveable primary disconnects. Otherwise, the primary disconnects, shutters, or the racking mechanisms may be damaged.

**CAUTION**

Before racking a circuit breaker in or out of the compartment, make sure that the key interlock is unlocked and in the opened position. Otherwise, the racking mechanism may be damaged.

**WARNING**

Opening the compartment door to install a circuit breaker defeats the arc resistant functionality of the compartment. The operator must wear the appropriate Personal Protective Equipment (PPE) for the level of flash hazard exposure indicated by the Arc Flash Studies. Failure to do so could result in death or serious injury.

All PowlVac 38-AR® designs are equipped with a closed-door racking feature that prevents moving the circuit breaker between the connected and disconnected positions with the door to the compartment open. This interlock may be defeated in emergencies.

1) Racking the Circuit Breaker to the Connected Position

a. Insert the circuit breaker compartment’s secondary disconnect plug into the circuit breaker’s secondary disconnect receptacle. Once the plug is fully inserted, move the secondary disconnect latch from left to right until it has engaged the housing of the secondary disconnect plug. When control power is present in the equipment, the spring charging motor will immediately begin to charge the closing spring after the secondary disconnect is inserted.

b. Ensure the telescoping racking shaft of the circuit breaker is pushed into the breaker (shaft is fully compressed) and close the compartment door by pushing the door tightly against the front of the compartment and rotating the latch handle of the door in a counter-clockwise direction approximately 90°.

This is the test position.

c. Rotate the racking access (teardrop) cover on the compartment door 180° to gain access to the racking shaft.

d. Insert the racking handle onto the racking drive shaft extension.
e. Turning the racking handle clockwise will begin to rack the circuit breaker into the compartment. When the circuit breaker is racked into the compartment, the force needed to rotate the racking handle will be low at the beginning of motion as the movement of the racking crank arms is only opening the shutters. Once the shutters are open, the circuit breaker begins to move toward the stationary primary disconnecting devices. When the movable primary disconnecting devices of the circuit breaker engage with the stationary primary disconnecting devices of the compartment, the force required to rotate the racking handle will increase appreciably. This force will decrease as the primary disconnecting devices spread and engage fully. Continuing rotation of the racking handle will cause the circuit breaker to travel further into the compartment ensuring wipe or overlap of the primary disconnecting devices. Continue racking until the breaker position indicator displays “BREAKER CONNECTED” as observed through the compartment door view window. This will be approximately 22 rotations from the starting point. When the circuit breaker reaches the end of the racking travel, the operator will notice an increased amount of force. If the user continues to apply force, a torque limiter on the racking handle will produce a sharp clicking sound indicting the torque limit is reached at 35-ft-lbs. Should the operator continue to apply force, the torque limiter will continue to operate with no further buildup of torque on the circuit breaker racking mechanism.

f. Once the circuit breaker has reached the connected position, remove the racking handle, close the teardrop cover on the compartment door, and operate the circuit breaker as required. This is the connected position.

2) Racking the Circuit Breaker to the Test Position

a. Verify that the circuit breaker open/closed indicator displays “BREAKER OPEN” and if not, operate the circuit breaker control switch to open the circuit breaker.

b. Open the teardrop cover on the compartment door and place the racking handle socket onto the racking drive shaft.

c. Turn the racking handle counterclockwise until the breaker position indicator displays “BREAKER TEST/DISCONNECTED”.

This is the test position.

d. The safety shutter position indicator on the compartment door should now be green and indicate the safety shutters are closed. This indication also releases the door latch interlock, allowing the compartment door to be opened.
E. **Racking Procedure (Electrical)**

This is an alternative to the manual racking procedures described above utilizing a motor driven mechanism and electric control, allowing the user to perform the racking function without being located in front of the circuit breaker compartment. The remote racking device mounts onto the compartment door. Refer to the instruction bulletin provided with the electric racking device for the proper operational procedure.

F. **Interlocks**

PowlVac 38-AR® utilizes a series of interlocks to prevent misoperation and maintain the arc resistant integrity of the switchgear. These interlocks operate in conjunction with the position of the safety shutters, the circuit breaker and the compartment door. Visual indication of operation is provided on the compartment door. Additionally, the interlocking system may be defeated for emergency operation through a series of steps that require tools.

1) **Closed-Door Racking Interlock**

This interlock prevents racking the circuit breaker into the compartment with the door open. It is located on the right side wall of the circuit breaker compartment. A plunger contacts the door when the door is completely closed and latched, releasing the interlock and allowing the circuit breaker racking mechanism to enter the racking hooks mounted on the switchgear side walls. This interlock may also be equipped with a padlock or key lock, mounted on the interlock housing, for use as a compartment lockout.

This interlock may be defeated by actuating the interlock plunger and racking the circuit breaker into the connected position.

a. Place the circuit breaker in the compartment as described in the normal racking procedure but do not close the door.
b. Press the lower of the two plunger assemblies on the interlock toward the rear of the compartment until it stops. Hold the plunger there.
c. Begin racking the circuit breaker.
d. After a turn or two on the racking shaft, the second plunger will move back toward the rear of the compartment.
e. This indicates the safety shutters are open. Release the lower interlock plunger.

**Note:** The circuit breaker may only be moved out of the connected position if it is in the open condition. Moving the circuit breaker back to the test position and closing the door resets the interlock.

The racking shaft on the circuit breaker does not necessarily extend properly when the breaker is racked with the interlock defeated. Extending the shaft and closing the compartment door does not guarantee proper alignment of the door and racking shaft.

---

**WARNING**

If the door and racking shaft are misaligned, the equipment is no longer arc resistant. Removing the arc resistant features may result in death or serious injury.
2) Safety Shutter/Door Interlock

This interlock prevents opening the compartment door with the safety shutters open; i.e. the circuit breaker in any position except the test position. It is located on the right side wall of the circuit breaker compartment (Figure 7, h). A plunger on the interlock contacts a target on the door (Figures 5, c & 6, d) when the door is completely closed and latched, releasing the interlock and allowing the door to be opened. When the circuit breaker moves away from the test position, the safety shutters open, and the interlock is activated. This action is indicated by the safety shutter indicator flag changing from “green” to “red”.

Note: If the shutters are blocked open for maintenance activities and the compartment door is closed, this interlock must be defeated to reopen the door. Should the safety shutters misoperate and remain open during operation, the interlock will remain active and prevent access to the compartment.

Opening the circuit breaker compartment door to install a circuit breaker defeats the arc resistant functionality of the compartment. The operator must wear the appropriate Personal Protective Equipment (PPE) for the level of flash hazard exposure indicated by the Arc Flash Studies. Failure to do so could result in death or serious injury.

This interlock may be defeated by removing the hardware (Figure 38, b) and actuating the interlock by pushing a small screwdriver or center punch into the hole until the shutter position indicator flag (Figure 38, a) changes from “red” to “green”.

Figure 38  Defeating the Shutter Interlock

a. Shutter Position Indicator Flag
b. Hardware To Be Removed
3) **Special Precautions**

Several conditions exist which can cause misalignment issues with the interlock system for the front door. These conditions should not be encountered in normal operation, but may occur during the initial start up and commissioning of the equipment. These conditions can be avoided with minimum effort. The door is equipped with a removable panel that allows access to the internal mechanism, should these abnormal conditions occur.

a. Racking the circuit breaker partially into or out of the compartment with the front door open can leave the interlock system misaligned. Closing the door with this condition can create the following issues:

   i. The racking shaft or the circuit breaker may not align with the opening in the door and the latching mechanism may not close the shaft. This places the equipment in an unsafe condition as the gap between the handle and door is not arc resistant.

   ii. The shutter actuator and interlock actuator on the door may not align.

b. Lifting and closing the safety shutters with the front door open may cause the shutters to not fully close due to friction between the actuator and the interlock latch. Under normal conditions a closed door will hold the interlock latch open and the actuator may pass by it freely. If the latch is engaged (the door is open) the weight of the shutter assembly may not be enough to overcome the friction created by the spring loaded latch. Closing the door after this condition occurs can cause the shutter actuator on the compartment wall and the actuator on the door to bind. If the door is then latched, the binding may prevent operation of the interlock and prevent the door from opening. It may also make it difficult to perform the interlock defeat procedure. The following actions may help to reduce the friction and allow the door to open:

   i. Verify that the interlock shows “red” or partially “red” indicating the shutters are open. Attempt to defeat the interlock as described in Figure 38. If there is excessive resistance to pushing the screwdriver, try the following actions to break the bind:

      1) Use a small punch or rod in place of the screwdriver and strike it lightly with a hammer.

      2) Shake the door handle while pushing the screwdriver against the interlock.

      3) Push the door inward toward the switchgear while pushing the screwdriver against the interlock and shake the handle at the same time.

   ii. If the equipment is deenergized and there is a circuit breaker to the right or left of the compartment with the issue:

   ![WARNING]

   **WARNING**

   Do not attempt this action if the switchgear is energized as it exposes the operator to electric shock hazard and removes the arc resistant protection. Failure to comply with this warning could result in death or serious injury.
1) Enter the adjacent breaker compartment and open the pressure relief vents.
   a) PowlVac 38-AR™ metal-clad switchgear has venting that is hinged by U-bolts. These vent covers may be opened and access is gained to the shutter linkage.
   b) To enter the damaged compartment the vents must be opened. Vents located on top of the equipment and on top of the circuit breaker compartment are hinged and may be opened to access adjacent compartments of vent paths. Vertically mounted vents, such as those on the main bus compartment, may be unbolted or deformed to gain access. Vents that are deformed must be replaced.
   c) Access to the shutter linkage is now gained and the linkage may be moved to break the bind.

   If all suggested methods have failed contact Powell.

4) Rear Door Interlocks (Optional)

   This interlock prevents opening the rear compartment door(s) when the circuit breaker is in the connected position. The interlock consists of two components; the actuator, located in the left rear of the circuit breaker compartment, and the interlock, located just inside the door on the right of the compartment bottom flange of the rear compartment. A latch hook engages the rear door when the circuit breaker feeding that compartment is in the connected position and prevents the door from being opened.

   **Figure 39  Rear Door Interlock View from Inside Compartment**

   To access the rear compartment, the circuit breaker must be tripped and racked out.

   The interlock (Figure 39) is spring loaded to allow automatic resetting of the interlock function if the rear compartment door is to be closed after the circuit breaker is racked to the connected position.
This interlock may be defeated in an emergency using the following procedure:

a. If the rear door is equipped with tie-down bolts on the perimeter, remove these bolts. These bolts should be captive on the door. It is not necessary to completely remove them but they must be completely removed from their tapped insert to open the door.

b. Remove the $\frac{3}{8}$-16 hex head screw on the rear door lower right corner (Figure 40).

Figure 40 Rear Door Interlock View from Outside the Compartment

- Using a small flat blade screwdriver the interlock latch hook may be accessed directly through the opening.
  i. Insert the screwdriver approximately 2 inches until contact is made with the latch.
  ii. Rock the point of the screwdriver down to move the latch. There should be some resistance from the spring pushing up as this is being performed.
  iii. At the same time, rotate the door handle and pull gently on the door. The door should open.
The operator may be exposed to potentially lethal voltages and must check for the presence of voltage using an approved method prior to performing any action that requires entering the compartment. The operator must wear the appropriate PPE for the level of exposure indicated by the Arc Flash Studies (AFS) for the equipment.

**WARNING**

**Figure 41  Defeating the Rear Door Interlock**

**G. Electrical Operation**

1. A one-line or three-line diagram and a schematic diagram are prepared for each switchgear lineup. All diagrams shall be thoroughly studied and completely understood by the user before the switchgear is placed into service.

2. The reading of indicating, recording instruments, and meters is common knowledge to electrically trained personnel. The use of instrument, rheostat control, and governor motor control switches are also common. Synchronizing switches are usually provided on generator and incoming line units with a synchronizing switch contact which is wired in series with the circuit breaker control switch “close” contact. The synchronizing switch should always be turned “on” first and the circuits adjusted should be in synch as indicated by the synchroscope before the circuit breaker is closed.

3. A green light indicates that the circuit breaker is open and a red light indicates that the circuit breaker is closed. For the DC control schemes, the red light is also arranged to supervise the trip coil and indicate that the trip coil circuit has continuity.

**H. Shutters**

Metal shutters (Figure 7, b) cover the primary disconnect contact when the removable element is withdrawn from the compartment.

Cam plates, located on each side of the compartment, are operated by the circuit breaker crank arm rollers which will then operate the switchgear shutters. As the circuit breaker mechanism is operated past the disconnected position, the crank arm rollers will move the cam plates downward and open the shutters before the circuit breaker starts its forward travel to the connected position. When the circuit breaker is racked to the disconnected position, the shutters are returned to their closed position by springs attached to the cam plates.

Provisions for padlocking the shutters in the closed position are furnished on each of the two cam plates and on the front of the shutter interlock (Figure 7, h). The interlock may also be fitted with a permanent key lock for this purpose. Padlocking either of the two cam plates or the interlock will deter opening of the shutters.
I. **Floor Pan**

Each compartment is equipped with a floor pan which the removable element rolls on. Each side of the pan is designed with channels, which the wheels of the removable element rolls into. The width between the channels will align the removable element laterally as it is rolled in the compartment.

The top flanges of the channel deter any tipping or vertical movement of the removable element. A rollout stop block is mounted to the floor pan. When a removable element is rolled into the compartment, the rollout latch will drop behind this rollout stop block, and deter the removal of the removable element until this latch is manually depressed.

J. **Truck Operated Cell Switch (TOC) (Optional)**

The purpose of the TOC switch is to indicate whether or not the removable element is in the connected position. When required, the switch is mounted on the right side sheet of the secondary compartment about half way up from the floor (Figure 7, e). A pin on the right side of the removable element engages the operating arm of the TOC switch and operates the switch as the removable element moves from the “TEST” position to the “CONNECTED” position. When the removable element is withdrawn, the spring return mechanism of the switch returns to its original position.

K. **Mechanism Operated Cell Switch (MOC) (Optional)**

The mechanism operated cell switch actuator (MOC) is an auxiliary switch which provides contacts which change position when the circuit breaker closes or opens. It is operated by an arm which projects from the circuit breaker mechanism at the lower left side of the breaker. This arm rides above the arm of the MOC. When the breaker is closed, the arm moves downward, moving the lever. The lever is connected by a linkage to the switch, and the whole assembly is spring loaded to the open position.

The switch is mounted inside the secondary enclosure on the left side sheet above the switch operating mechanism (Figure 7, f). As supplied, the MOC actuator mechanism will operate with the circuit breaker in either the “CONNECTED” or “TEST” position. If it is desired that the switch operate in the “CONNECTED” position only, remove the small bolted on MOC test position lever that forms the bottom flange at the front of the pivoted lever (Figure 7, g).

L. **Secondary Disconnect Device**

The secondary disconnect device is a 24-point plug mounted at the lower end of an umbilical cord, which hangs at the right side of the compartment (Figure 7, a). The plug mates with the secondary control socket on the lower right front of the circuit breaker.

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**WARNING**

Interlocks are provided to ensure proper operating sequences of the device and for the safety of the operator. If, for any reason, an interlock does not function as described DO NOT MAKE ANY ADJUSTMENTS, MODIFICATIONS, OR DEFORM THE PARTS. DO NOT FORCE THE DEVICE INTO POSITION. CONTACT POWELL FOR INSTRUCTIONS. Failure to follow this warning could result in death or serious injury.
Interlocks are provided to deter improper operation of the circuit breaker. These interlocks function as follows:

1. The secondary disconnect plug must be inserted when the breaker is in the “DISCONNECT” position in order to move the breaker to the “TEST” position.
2. The secondary disconnect plug must be inserted to operate the breaker in the “TEST” position.
3. The secondary disconnect plug may be withdrawn with the breaker in the “DISCONNECT” position after the secondary locking bar is lifted. The removable element cannot be operated or racked into the enclosure with the secondary disconnect plug withdrawn.
4. The secondary disconnect plug must be inserted and locked in position to rack the breaker from the “TEST” position toward the “CONNECTED” position. The secondary disconnect plug is then held captive and cannot be withdrawn until the breaker is returned to the “DISCONNECT” position.

M. DUMMY REMOVABLE ELEMENTS

Dummy removable elements are used as a means of isolating circuits or bus sections, where operation is infrequent and a circuit breaker cannot be economically justified. The device consists of a framework to simulate the circuit breaker removable element with a set of six main disconnecting contacts similar to those on the circuit breaker. The front ends of the two primary disconnecting contacts of each phase are connected, top to bottom, by copper bars which are fully isolated. The stationary structure is the same as for the circuit breaker, except that no umbilical cord or control devices are provided. When the device is racked into position, it connects the upper set of primary disconnecting devices to the lower set. See the separate instruction book furnished with the dummy removable element for further information.

**WARNING**

Under no conditions may the dummy element be racked in or out when the circuit it is connected to is under load. This action could result in death or serious injury.

Key interlocks are applied to ensure that either the source of power is disconnected before the dummy element can be racked into or out of the “connected” position, or all loads are disconnected. For example, a dummy used as a substitute for a main breaker may be racked in and out if the source feeding the dummy is deenergized or if all load breakers and equipment fed by the dummy are locked open.

The interference stops provided on the dummy removable element deter insertion of an element of lower continuous current rating in a higher rated compartment. Further, these stops deter the insertion of any dummy removable element into any circuit breaker compartment. It may be possible to insert a circuit breaker element into a dummy compartment as far as the “DISCONNECT” position, but it cannot be racked into the compartment because there is no secondary plug to perform the necessary interlock functions.
N. **Grounding and Testing Devices**

The PowlVac 38™ grounding and testing devices are removable elements which are mounted on a frame similar to the frame of a circuit breaker. They are equipped with a ground contact, primary disconnects, test ports, wheels, and can be operated manually or electrically.

The grounding device provides a means for obtaining access to the primary disconnect devices for grounding the primary circuits. The testing device is used to conduct certain high voltage withstand tests (hipot). Insulation and isolation barriers between phases and between phase and ground are also provided where required.

Closed-door racking interlocks must be temporarily defeated for racking grounding or testing devices into the circuit breaker compartment. The use of grounding and testing devices requires access to the front of the devices to allow connection of remote electrical control to the grounding device or connection of test equipment to the testing device. To gain access to the front of these devices the breaker compartment door must remain open during use. Refer to *Ch 5 Operation, F. Interlocks, 1) Closed-Door Racking Interlock* for the procedure to defeat the interlock.

O. **Testing and Inspection**

For test and inspection instructions, refer to applicable instruction bulletins and any supplemental documents. For assistance with testing and inspection, contact Powell on our website at powellind.com, or call 1.800.480.7273.

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**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.*

After the equipment has been installed and all connections made, it should 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 that the equipment has been properly installed and that all connections are correct and have not become loose in transportation.

If users perform AC hipot testing on high voltage cables used to connect the switchgear to loads, the following testing practices are recommended:

1. AC hipot testing voltage must be limited to no more than 60kV (75% of 80kV). DC hipot testing is not recommended. If DC hipot testing must be performed, consult with Powell prior to testing.
2. Surge arrestors, if present, must be disconnected before hipot testing.
3. Voltage Transformers and Control Power Transformers must be moved to the “DISCONNECTED” position before AC hipot testing.
Directions for testing devices such as relays, instruments and meters are given in the instruction book furnished for each device. The settings of the protective relays must be coordinated with the other relays on the system and, therefore, these relays must be set by the user. General instruction books are furnished with the equipment, containing the instruction material for all individual devices used in the equipment.

When transformers are furnished to supply the control power, the primary taps should be selected so that the control voltage indicated on the wiring diagram is obtained on the secondary of the transformer. When a battery is used to supply the control power, the cables from the battery to the switchgear should be large enough to avoid excessive voltage drop. When supplied by a battery, the voltage at the terminals of the operating coils, shall not be less than the values listed in Table L, Rated Control Power Voltages and Ranges for Circuit Breakers.

Check continuity between all moving and stationary contacts of voltage transformer and fuse rollouts in both the connected and disconnected (or grounded) positions. The continuity may be verified with a multimeter or continuity tester by connecting one test lead to the bus phase that the stationary device is connected to and the second lead connected to the corresponding phase fuse holder cap. The fuses must be in place for continuity.

After the switchgear has been installed and all connections to the apparatus it is to control have been made, it should be given a final check and test before being energized.

The connections to the equipment apart from the switchgear, such as instrument transformers, remote control and interlock circuits, and auxiliary switches should be checked for continuity and phase relationship.

The covers for meters, relays, and other devices which have to be removed during the course of installation and test should be carefully handled when removed. The covers should be put back in place promptly to keep dust and dirt from collecting on the vital relay parts.

**CAUTION**

Wire connections, accessible bolted bus connections, and insulated joints should be examined to make sure they have not been loosened or damaged during shipment or installation.

**WARNING**

Do not attempt to energize the equipment until all connections are verified. Improper connections could result in death or serious injury.

After the switchgear has been installed and put into operation, the drawings supplied with the equipment should be reviewed and notations made on them of any changes made during the installation.

### Table L. Rated Control Power Voltages & Ranges for Circuit Breakers

<table>
<thead>
<tr>
<th>Nominal Control Power Voltage</th>
<th>Voltage Range Required at Tripping Coil Terminals</th>
<th>Voltage Range Required (dc) at Closing Coil Terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>24VDC</td>
<td>14 to 28 VDC</td>
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</tr>
<tr>
<td>48VDC</td>
<td>28 to 56 VDC</td>
<td>38 to 56 VDC</td>
</tr>
<tr>
<td>125VDC</td>
<td>70 to 140 VDC</td>
<td>100 to 140 VDC</td>
</tr>
<tr>
<td>250VDC</td>
<td>140 to 280 VDC</td>
<td>200 to 280 VDC</td>
</tr>
<tr>
<td>120VAC</td>
<td>104 to 127 VAC</td>
<td>104 to 127 VAC</td>
</tr>
<tr>
<td>240VAC</td>
<td>208 to 254 VAC</td>
<td>208 to 254 VAC</td>
</tr>
</tbody>
</table>
P. CONTROL CABLE REMOVAL

1) General

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 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.
   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. Example: from the circuit breaker compartment to the instrument compartment, the plate should mount on the circuit breaker compartment side of the wall.

iv. The plate may be welded or bolted in place. SAE grade 5 hardware or better is required for bolting.
Ch 6  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. The test cabinet, when furnished, provides a convenient means for maintaining the circuit breakers. 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 intervals should be compared, to note trends as well as any significant changes in the condition of the switchgear.

The primary circuits of the metal-clad switchgear are insulated in order to reduce the size of the equipment. However, this insulation, requires a certain amount of air gap between phases and to ground, which completes the insulation.

![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.

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.

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.
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 followed by wiping all surfaces with a dry, clean, lint-free cloth.

3) **Mechanisms**

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

4) **Primary Disconnect Device Contacts**

Check the primary disconnect device contacts for signs of abnormal wear or overheating. Clean the contacts with a silver polish. Discoloration of the silvered surfaces is not ordinarily harmful, unless the atmospheric conditions cause deposits, such as sulfides on the contacts. If necessary, the deposits can be removed with a good grade of silver polish. Before placing or replacing the circuit breaker into service, apply a thin coat of contact lubricant to main contacts for lubrication.

5) **Disconnecting Contacts**

Inspect all primary and secondary disconnecting devices (such as those on rollout transformers) for abnormal wear, fatigue, or overheating. Replace, if necessary, otherwise treat the same as primary disconnect device contacts.

6) **Control Contacts**

The 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.

---

**CAUTION**

Inhalation of vapor could result in minor or moderate injury.

**CAUTION**

Use only the cleaners recommended in this document. Failure to do so could result in equipment damage.
7) Secondary Wiring

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

On all chargers, having a manual transfer switch for setting the charging rate, carefully check and ensure that the selector switch is returned to the value appropriate for a floating charge at the end of the periodic inspection. Serious damage to the control battery can occur if the charger is left on a high charging rate for an extended period of time.

8) Mechanical Parts

Visually check and manually operate the mechanical moving parts such as the shutter, TOC, and MOC mechanism operated cell switch assemblies, the key interlock, hinged doors, and the rollout features of the transformers and fuses. Examine mechanical mating parts such as the circuit breaker racking crank arms and the switchgear guide rails.

Check to see all anchor bolts and switchgear hardware are tightened to correct torque values.

When using “clamp” style tubular bus support insulators (Figure 42), tighten fasteners to a torque value of 8-10lbs-ft; do not overtighten.

9) Ventilation

Check all labyrinths, grillwork, and air passages for obstructions and accumulations of dirt. The air space under the outdoor switchgear, which is necessary for the entrance of ventilating air, should be cleaned of leaves and other possible debris. Replace or clean dirty filters.

11) Hardware

Check to see all anchor bolts and switchgear hardware are tightened to correct torque values.

When using “clamp” style tubular bus support insulators (Figure 42), tighten fasteners to a torque value of 8-10lbs-ft; do not overtighten.

Figure 42 “Clamp” Style Tubular Bus Support

10) 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.
12) 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.

13) Testing

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.

a. Insulation resistance tests are suggested for checking the insulation. A series of these tests will indicate any tendency towards a reduction in the dielectric strength of the insulation. Insulation resistance readings should be taken before and after cleaning the switchgear equipment, and in so far 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).

b. Acceptable limits will vary with the extent and design of the bus structure. In contrast to a small installation, the longer switchgear lineups will have a more extensive bus structure with a greater number of insulators, and thereby, a larger number of parallel insulation resistance paths to ground, which will tend to decrease insulation resistance readings. This variation in insulation resistance between different switchgear lineups emphasizes the value of a series of readings that can be charted to establish a normal insulation level so that progressive weakening of the insulation can be recognized. Voltage transformers and control power transformers should be disconnected during these tests, as they may not be able to withstand the switchgear tests and they may provide direct paths to ground.

c. The resistance of bus connections may be checked by passing a measured DC current of 100A or more, through the joint and measuring the voltage drop (in millivolts) across the joint. An increase in the voltage drop indicates a joint requiring maintenance.

d. Tests on circuit breakers, removable elements, and other devices which are included in the switchgear should be performed in accordance with the instructions applicable to each device.

14) Pressure Vents

Verify that all pressure relief vents are functional and undamaged. Do not walk on pressure vents during inspection. All horizontal vents (top of gear and top of lower breaker/auxiliary compartments) can be accessed from the compartment they cover.

a. Horizontally mounted hinged vents should be checked for free movement around the hinge point. Interference fitting, where two vents are mated over an opening, is acceptable (i.e. the two covers over the circuit breaker compartment may bind slightly on each other as they are closed but they should close completely on to the top of the compartment. Further, they should move freely once clear of each other when opened).
b. Vertically mounted vents should be checked to assure they are still flush to the mounting surface and that no objects could potentially impede opening. Do not attempt to open these vents as they are designed to deform when called upon to operate and are rated for single operation. Attempts to open or otherwise move these vents could damage them. These types of vents should be inspected for damage that would cause them to open partially and potentially expose energized components. Repair or replace as necessary.

15) Doors

Verify that all doors open without interference.

a. The handle should rotate easily to open or close the latch pins (the latch pins should be cleaned and lightly lubricated with A-grease).

b. The rear frame of the door, including the protruding latch pins should clear the switchgear side door frame without contact. If there is contact, adjust the door in accordance with the instructions in Ch 4 Installation.

c. Both front and rear doors should seal with little or no “play” in the fit. Confirm that the latched door has 1/8” or less movement. When the rear door includes a gasket for a weather seal, verify that the gasket is contacted across all mating surfaces by confirming compression marks in the gasket.

d. Exterior doors utilizing tie-down bolts should have gasket material around the tie-down bolt holes. Confirm the presence and functionality of the gasket. If the gasket is damaged, replace it.

16) Interlocks

a. Shutter position interlock from door component - verify that the actuator on the opening side of the door slides freely and operates the shutter position flag. A small amount of A-grease should be used for lubrication. Close the door and verify the position flag changes from red to green. Rack the circuit breaker slightly toward the connected position and verify that the flag moves from green to red. Verify that the door cannot be opened.

b. Shutter position interlock right side component:

i. Inspect for wear on latch and spring assembly. Lubricate with A-grease as necessary.

ii. Inspect pivot points at top of racking hook and on both glass polyester linkages extending to the shutters for wear.

17) Actuators

Verify alignment of the push-to-trip actuator on the door to the mating actuator on the circuit breaker floor pan. Verify that there is no damage to the sliding actuator on the floor pan and that it slides freely. Lubricate with a small amount of A-grease if needed.
C. **Abnormal Conditions**

Local conditions such as high ambient temperature, high humidity, salt-laden atmosphere, corrosive gases, heavy dust, ash, severe circuit operating conditions, vermin, or insect problems are considered to be abnormal, and will require more frequent inspections.

A series of inspections should be made at quarterly intervals, until the local conditions can be analyzed to determine a schedule that will maintain the switchgear in satisfactory condition.

In some locations, local conditions may be so bad that the frequency of maintenance will interfere with operating and production schedules. In such cases, consideration should be given to the possibility of enclosing the switchgear lineup in a relatively tight room, and to use filtered air handling units to supply a sufficient quantity of clean air to maintain conditions, maintenance schedules may then be established on a more normal basis. Such an arrangement might also provide for cooling the air, where the ambient temperature is relatively high, thus further improving operating conditions. To add another level of reliability, chemical filtration may be used in addition to mechanical filtration.
Ch 7  **Recommended Renewal Parts and Replacement Procedures**

**A. ORDERING INSTRUCTIONS**

1. To order replacement 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
   - 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 M, Renewal Parts** lists the recommended spare parts to be carried in stock by the user with recommended quantity. 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 PowlVac 38-AR™ switchgear. Refer to the **Qualified Person** section in the front of this instruction bulletin.
<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number</th>
<th>Recommended Quantity</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary Disconnect Override</td>
<td>65759G16</td>
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<td><img src="secondary_disconnect_override.jpg" alt="Image" /></td>
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<tr>
<td>Manual Charging Handle</td>
<td>50235P01</td>
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<td>PowlVac® Lubrication Kit</td>
<td>Powlube-104</td>
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01.4IB.65202D PowlVac 38-AR™
Arc Resistant Metal-Clad Switchgear

Equipped with CDS Circuit Breakers
38kV, 1200A & 2000A, 40kA

November 2017