01.4IB.65203
PowlVac 38™ Metal-Clad Switchgear

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 PowlVac 38™ Metal-Clad Switchgear:

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

B. **Purpose**

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

This instruction bulletin provides:

1. Safety guidelines
2. General descriptions of the operation and maintenance of the PowlVac 38 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.*

---

**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.

---

**NOTICE**

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

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.

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D. **Associated Instruction Bulletins**

- 01.4IB.65110A PowlVac 38™ CDS Circuit Breaker
- 01.4IB.65071 PowlVac 38™ CDS Grounding Device
- 01.4IB.65031 PowlVac 38™ CDS Manually Operated Test Device
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™ 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™ 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.**
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.

---

**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.

PowlVac 38™ Metal-Clad Switchgear equipped with vacuum circuit breakers is designed to comply with ANSI Standard C37.20.2.

PowlVac 38 metal-clad switchgear is characterized by removable interrupting devices, isolation of major circuit elements, grounded metal compartments, and insulated primary bus conductors. The metal-clad switchgear is a line-up of one or more switchgear vertical sections known as units, which are enclosed on all sides, top, and bottom except for the ventilation openings, lower unit cable penetrations, and view windows.

The metal-clad switchgear is used to protect and control medium voltage, alternating current power distribution systems. Each unit consists of a number of circuit breakers, plus auxiliary compartments containing accessory apparatus. The circuit breakers are used to control various types of circuits, such as incoming lines, bus ties, feeders, and motor starter. Also, special functions are provided in great variety and may be required for particular applications. Figure 1 illustrates a typical PowlVac 38 Metal-Clad switchgear line-up.

This instruction bulletin should be used in conjunction with the appropriate PowlVac 38 vacuum circuit breaker instruction bulletin, including any applicable supplement(s), separate instructions covering other components of the metal-clad switchgear, and applicable drawings because each metal-clad switchgear line-up is custom designed for a particular use and application. Separate instructions covering other components are not included in this publication, but are available upon request.

PowlVac 38 switchgear is available as indoor equipment only. For outdoor installations, the equipment is provided in a Power Control Room (PCR®).

1) One-High Construction

The basic one-high construction standard measurements are 92.38" high x 40" wide x 116.38" deep (Figure 1). The compartment holds one circuit breaker or auxiliary device. Each unit includes the primary and secondary compartments as shown in Figure 2.
Figure 1  PowlVac 38™ Switchgear Lineup
Figure 2  Typical Section View

Secondary Upper Compartment

Secondary Lower Compartment

Circuit Breaker Compartment

Primary Compartment

Cable Compartment

Main Bus

92.38

58.38

116.35

38.38

57.00

1.00

01.4IB.65203PowlVac 38™ Metal-Clad Switchgear
1200A & 2000A, 40kA
Figure 3  Inside View of 1200A Compartment Door

- **a. View Window**
- **b. Cam Door Latch**
- **c. Racking Access Port**
- **d. Locking Plate**
- **e. Manual Trip Actuator**

Figure 4  Inside View of 2000A Compartment Door

- **a. View Window**
- **b. Cam Door Latch**
- **c. Racking Access Port**
- **d. Vent Baffle**
- **e. Locking Plate**
- **f. Manual Trip Actuator**
B. **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. The primary enclosure contains control devices, current transformers, shutters, interlocks, and a ground bus. See Figure 2 for the location of the primary enclosure and see Figure 5 for the equipment’s devices.

C. **Secondary Compartment**

The secondary compartment (Figure 2) 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, and the mechanism operated cell switch (MOC) and the truck operated cell switch (TOC), are mounted in the lower compartment (Figure 5). Penetrations are provided to allow passage of control wiring between the compartments near the center of all units.

D. **Ratings**

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

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<tr>
<td>Rated Maximum Voltage (kV, rms)</td>
<td>Rated Short Circuit Current (kA) (K Factor = 1.0)</td>
</tr>
<tr>
<td>38</td>
<td>40</td>
</tr>
</tbody>
</table>

E. **Basic Impulse Level**

- 150kV for 38kV class switchgear

F. **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, N. Testing and Inspection for values to be used.

G. **Circuit Breakers**

PowlVac 38 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 vacuum circuit breakers.
H. 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 5, 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 ensure the main closing spring is discharged 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.
**Figure 5  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
- **i.** Ground Bus
- **l.** Interference Plate
- **m.** Anti-Rollout Device
- **n.** Manual Push To Trip/Circuit Breaker Trip Free Interlock
- **o.** Floor Pan
- **p.** Control Cable Entry
I. **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.

J. **Primary Disconnect Devices and Bushings**

The stationary primary disconnecting devices are tubular silver-plated copper bar ends located within the primary disconnect bushings (Figure 5, 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.

K. **Circuit Breaker Racking Mechanism**

**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.
1) **Disconnected Position**

In the “disconnected position” the movable primary disconnects of the circuit breaker are disengaged and separated at a safe distance from the stationary primary disconnecting devices located in the compartment. A metal shutter covers the openings of the stationary primary disconnecting devices, preventing access. The secondary disconnect plug is also removed in the “disconnected” position to disconnect the secondary control circuits.

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.

**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.*

2) **Test Position**

In the “test position”, the primary disconnecting devices are disengaged and the shutters are closed. The secondary circuits are completed by inserting the secondary disconnect plug (switchgear) into the secondary disconnect receptacle of the circuit breaker. Now the circuit breaker may be electrically operated without affecting the primary circuit.

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

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.

L. **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

M. **Unit Space Heaters**

Unit space heaters are provided in all equipment 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, each providing 250 watts of heat, 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.

**N. 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 7). The auxiliary rollout device is equipped with an interlock that prevents accessing the fuses unless the unit is in the disconnected position.

![Figure 7 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 floor.

When installing fuses:

a. Do not over tighten the plug. Hand tight 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. **Warning - Failure to do so may prevent the fuse from interrupting fault current properly.**
O. 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 a 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. The primary disconnecting devices mounted on the rollout carriage are capable of interrupting transformer magnetizing current, but should not be used to interrupt load current. Mechanical or key interlocks are applied to prevent disconnecting the control power transformer by withdrawing the rollout carriage while the transformer load is connected. This is generally accomplished by interlocking so that the transformer secondary circuit breaker must be locked in the open position before the disconnecting device can be moved.

When the fuse or control power transformer rollout carriage is in the disconnected position the rear barrier of the carriage effectively deters access to the stationary primary disconnect devices mounted in the compartment behind the rollout carriage. These stationary primary disconnect devices may remain energized.

P. Current Transformers (Window-Type)

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.

Q. 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.

Once the assembly of the metal-clad switchgear is completed on site, all joints and hardware, including bus connections, structural assemblies, and control connections, should be checked for tightness and proper torque values. See Table B, Bolt Torque Values for Powell Medium Voltage Metal-Clad Switchgear.

B. Receiving

PowlVac 38™ Metal-Clad Switchgear is fabricated in rigid, floor mounted, self-supporting 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. Refer to the instruction bulletin furnished for receiving, storage, and handling instructions for circuit breakers.

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™ switchgear lineup with an overhead crane utilizing the lifting means provided on the switchgear. Because of the weight of the 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.

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 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 contaminates 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 weight of the switchgear.

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 8 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.

Figure 8 Recommended Indoor Floor Construction
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 finish floor 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.
F. POSITIONING THE METAL-CLAD SWITCHGEAR

1) General

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

The recommended aisle space for the front and at the rear of the metal-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.

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 three or more switchgear units are to be arranged in one continuous line-up, the center shipping unit should be the first located. The other shipping line-ups should then be installed in successive order in each direction from the center of the structure.

When installing a unit substation or power center, the power transformer and the adjacent 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.

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

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.

CAUTION

All exposed primary bus and cable joints and connections must be insulated to the system insulation rating.
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 as earlier described, 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. If the doors require further alignment, additional adjustments may be made to the stationary half of the hinge assembly, which is mounted by screws, located inside the flange of the switchgear side sheet.

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 motion 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, grounding or testing devices, or dummy removable element, consult the instruction bulletin for directions on installation, maintenance, and renewal parts for that particular element.

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.

For a detailed description of the circuit breaker and its operation, maintenance, and renewal parts, refer to the appropriate PowlVac 38™ circuit breaker instruction bulletin.

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, R. 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.
**WARNING**

*Ensure that the switchgear vertical sections are grounded prior to making power connections, if they are not it could result in death or serious injury.*

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. 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 ½ inch diameter bolts, the bolts should be 1 inch longer than the combined thickness of the copper bars being bolted together.

For example, if three ¼ inch thick copper bars are to be connected, the bolt should be 1⅜ 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 9 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. There are two methods of insulating the joints: Taping joints or applying boots where applicable. A detailed procedure for joint insulation is described in Ch 4 Installation, J. Connections, 3) Main Bus Insulation.

Note: All hardware must be tightened to the torque values listed in 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>
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<td><img src="https://example.com/circle.png" alt="Circle" /></td>
<td>5-7</td>
</tr>
</tbody>
</table>

Note: The bolt head drawings in Table B are not to scale. Locate the Bolting Torque label on the equipment for an accurate drawing of bolt sizes.
Figure 10  Side View of Typical Shipping Split
Figure 11  Front View of Typical Shipping Split
Figure 12  Rear Compartment Shipping Split Assembly
Figure 13  Bus Installation
1) **Main Bus Assembly and Insulation**

The main and riser bus structure of PowlVac 38™ 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 following the series of instructions below, 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. Clean contact surfaces of bus conductors as described previously in **Ch 4 Installation, J. Connections**.
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 between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice plates and between the cleaned splice planes.
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 14 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 15).

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

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 16). 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 17).
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 18).

Figure 17 **Conical Bus Support Installation Completed**

Figure 18 **Placing Boot over the Joint**

c. Install brackets on both sides of the boot using nylon hardware (Figure 19).
- d. Secure tie wraps around the bus bar (Figure 20).

Figure 19 **Installing Brackets on the Boot**

- b. **Boots**
- c. **Nylon Hardware**
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 21).

### 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” wide tape</td>
</tr>
<tr>
<td>0282A3529 P005</td>
<td>4” 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.

### Table D Insulation of Bus Bar

<table>
<thead>
<tr>
<th>Insulation Range (kV)</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” &amp; 4” Wide Rolls are 30’ Long)</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.5</td>
<td>4 Layer + ½ Lap *</td>
<td>2</td>
<td>14 18 19 28 29 36 37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>7 9 9 14 15 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”x1⅓/4” and 0.030”x4” down to 0.024”x3⅓/2”. Apply with mastic side down.

* Apply 3 layers - ½ lap for conductors passing through CT’s.
Figure 22  Single Bus Bar Connection Joint

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>&quot;C&quot; (inches)</th>
<th>Approx. Number Rolls per Joint of HV Tape ∆</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RB Putty* &amp; 4 Layers HV Tape ∆</td>
<td>5 Layers HV Tape ∆</td>
<td>7</td>
<td>1 Roll RB Putty* &amp; 1 Roll HV Tape ∆</td>
</tr>
</tbody>
</table>

34.5

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 1 ½” x 5’ long.

Δ High voltage insulating tape 0282A3529 P004 - Roll is .030 x 2” x 30’ long. Apply with mastic side down.

Figure 23  Double Bus Bar Connection Joint

Table F Insulation of Double 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>&quot;C&quot; (inches)</th>
<th>Approx. Number Rolls per Joint of HV Tape ∆</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RB Putty* &amp; 4 Layers HV Tape ∆</td>
<td>5 Layers HV Tape ∆</td>
<td>7</td>
<td>1 Roll RB Putty* &amp; 1 Roll HV Tape ∆</td>
</tr>
</tbody>
</table>

34.5

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.
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.

---

**Table G Insulation of Tee 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>&quot;C&quot; (inches)</th>
<th>Approx. Number of Rolls per Joint of HV Tape ∆</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.5</td>
<td>RB Putty* &amp; 4 Layers HV Tape ∆</td>
<td>5 Layers HV Tape ∆</td>
<td>7</td>
<td>1 Roll RB Putty*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 Roll RB Putty*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 Roll HV Tape ∆</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 Rolls HV Tape ∆</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 ⅛” x 1⅜” x 5’ long.

**Table H Insulation of Dead End Bus Joint**

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler &quot;A&quot;</th>
<th>Outer Wrap &quot;B&quot;</th>
<th>&quot;C&quot; (inches)</th>
<th>Approx. Number of Rolls per Joint of HV Tape ∆</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.5</td>
<td>RB Putty* &amp; 5 Layers HV Tape ∆</td>
<td>7 Layers HV Tape ∆</td>
<td>7</td>
<td>¼ Roll RB Putty*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>½ Roll HV Tape ∆</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1⅛ Rolls HV Tape ∆</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.

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

**Figure 24** *Tee Connection Joint*

**Figure 25** *Dead End Bus Joint Insulation*

---

**Table G Insulation of Tee 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>&quot;C&quot; (inches)</th>
<th>Approx. Number of Rolls per Joint of HV Tape ∆</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.5</td>
<td>RB Putty* &amp; 4 Layers HV Tape ∆</td>
<td>5 Layers HV Tape ∆</td>
<td>7</td>
<td>1 Roll RB Putty*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 Roll RB Putty*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 Roll HV Tape ∆</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 Rolls HV Tape ∆</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 ⅛” x 1⅜” x 5’ long.

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

There are several methods of making primary cable connections, two are discussed below:

1. Potheads are used when it is desired 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.

2. Prepackaged cable termination kits can be used if the sealing features of a pothead are not needed. These kits, which are available from several suppliers, usually include all the material necessary to terminate the cable and to provide stress relief at the termination.

No insulation materials are normally furnished for cable terminations. When potheads are supplied, insulation materials are furnished for the bar terminations to the pothead studs.

In all cases, carefully follow the cable manufacturer's recommendations for installation and termination of the type of cable being used.
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 26  Cable Termination Joint**

![Cable Termination Joint Diagram]

**Table I  Cable Termination Joint**

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler &quot;A&quot;</th>
<th>Outer Wrap &quot;B&quot;</th>
<th>&quot;C&quot; (inches)</th>
<th>Approx. No. of Rolls per Joint of HV Tape Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.5</td>
<td>1 Roll 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>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 Roll RB Putty* &amp; 6 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 ⅛" x 1½" x 5’ long.

- Δ HV Tape 0282A3529 P004 roll is .030” x 2” x 30’ long. Apply with mastic side down.
Figure 27  **Bar-Type Current Transformer Joint Insulation**

![Diagram of Bar-Type Current Transformer Joint Insulation](image)

**Table J  Bar-Type Current Transformer Joint Insulation**

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler &quot;A*&quot;</th>
<th>Outer Wrap &quot;B*&quot;</th>
<th>&quot;C*&quot; (inches)</th>
<th>&quot;D*&quot; (inches)</th>
<th>Approx. No. of Rolls per Joint of HV Tape ∆</th>
<th>2&quot; or 3&quot; Bars</th>
<th>4&quot; or 6&quot; Bars</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.5</td>
<td>RB Putty* &amp; 4 Layers HV Tape ∆</td>
<td>5 Layers HV Tape ∆</td>
<td>7</td>
<td>5</td>
<td>1 Roll RB Putty* &amp; 3 Roll HV Tape ∆</td>
<td>2 Roll RB Putty* &amp; 6 Roll HV Tape ∆</td>
<td></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 1½" x 5’ long.

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

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

---

**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.

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.
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.

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. 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.

P. 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.
Figure 28  Roof Bushing

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

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler “A”</th>
<th>Outer Filler “B”</th>
<th>“C” (inches)</th>
<th>Approx. No. of Rolls per Joint of HV Tape</th>
<th>∆</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.5</td>
<td>RB Putty* &amp; 4 Layers HV Tape</td>
<td>5 Layers HV Tape</td>
<td>7</td>
<td>1 Roll RB Putty* &amp; 3 Rolls HV Tape</td>
<td>2 Rolls RB Putty* &amp; 6 Rolls HV Tape</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 1½” x 5’ long.

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

R. **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**

Rollout carriages may be installed in the bottom position of an auxiliary compartment by simply rolling into place. Align with the guide channels in the switchgear unit and roll the carriage into the unit until the position latch falls into place (Figure 29).

Figure 29  Auxiliary Device Rollout Carriage

Q. **Bus Duct Entry**

Bus duct entry into the switchgear must maintain metal-clad switchgear isolation and integrity. Connections to the bus are made from the outside of the equipment as is typical with standard bus duct.

In all cases, there will be a vapor barrier inside the duct at the point it exits the switchgear.

Rollout carriages to be installed in any other position in the switchgear equipment may require a lifting device. Refer to the appropriate lifting device instruction bulletin specific to the switchgear equipment.
2) Operational Checkout

All rollout carriages are equipped with certain operational and safety features. Most of these features are common to both VT and fuse rollouts, but each type also has some specific features which differ from the features of the other type. The proper operation of these features should be checked at installation.

**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 rollouts are equipped with a position latch. This is operated by a lever which projects from the front of the rollout at the lower left (Figure 29, b). The latch at the inner end of this lever operates in conjunction with a latching bar (Figure 29, c) located on the floor of the rollout compartment, establishing the “CONNECT” and “DISCONNECT” positions of the rollout.

When first installed, the rollout is pushed into the compartment until it reaches the “DISCONNECT” position. The position latch will ride up the front slope of the latching bar and drop into position in the notch in the bar. In normal operation of the switchgear, it should never be necessary to withdraw the rollout beyond the “DISCONNECT” position.

To move the rollout to the “CONNECT” position, depress the position latch lever and push the rollout in. Once the rollout begins to move, release the lever and allow the latch to ride on the cam. When the rollout reaches the “CONNECT” position, the latch will drop into position at the end of the cam. At this point, the rollout is in its operating position and all connections are made automatically. The latch should drop into place without being pushed, but there should be little or no movement of the rollout possible once the latch is in place. There should be no in-out movement more than 1/4”, once the carriage is latched into the “CONNECT” position.

b. All rollouts are equipped with a fuse access door (Figure 29, 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. To check operation of this interlock:

i. With the rollout in the “DISCONNECT” position, open the fuse access door. Attempt to move the rollout to the “CONNECT” position. It should not be possible to move the rollout completely in.

ii. Close the fuse access door. Move the rollout to the “CONNECT” position. Attempt to open the fuse access door. It should not be possible to open the door.
c. All rollouts are equipped with a grounding switch, consisting of three metal rods connected to ground and an operating mechanism. The mechanism is driven by a cam follower on the right side of the rollout carriage which engages a cam on the floor 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. To check the operation of the grounding switch, first with the rollout in the “DISCONNECT” position, open the fuse door and visually check that the grounding switch is in contact with all three of the fuse holders. Close and latch access door and move the rollout toward the “CONNECT” position. Verify through the view window that the grounding switch has opened prior to the rollout reaching the “CONNECT” position.

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. To check this engagement, move the rollout to the “CONNECT” position. At the VT secondary fuse block, which is normally located in the secondary compartment, remove the fuses and check for circuit continuity through the VT secondary winding, using a multimeter set on the ohms scale.

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 key to unlock the rollout and insert or withdraw it. Lock the rollout in place and the key is available to unlock the secondary circuit breaker.

3) 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, move the rollout to the “DISCONNECT” position and open the fuse access door. Refer to Ch 4 Installation, R. Auxiliary Device Rollout Carriages, 2) Operational Checkout, e. for more detail. Use the spanner wrench tool stored on the bottom pan of the rollout to unscrew the plug. Remove the blown fuse and replace it with a fuse of the same type and rating. Screw the plug back into place and store the spanner wrench in the clips provided.
Ch 5  Operation

A. GENERAL

⚠️ WARNING

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.

⚠️ WARNING

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 accurately and safely 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

⚠️ WARNING

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 mechanism may be damaged.

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) Inserting the Circuit Breaker Into the Circuit Breaker Compartment

⚠️ NOTICE

Use the appropriate circuit breaker or grounding or testing device instruction bulletin in conjunction with this section to insert/remove the element from the switchgear compartment.

a. Verify that the circuit breaker open/closed indicator displays “BREAKER OPEN” and if not, press the manual trip operator to open the circuit breaker.
b. 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.

c. Roll the circuit breaker in the compartment until the racking crank arms contact with the vertical slots in the compartment. The anti-rollout latch on the lower middle part of the circuit breaker front cover 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 5) 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 the circuit breaker. In PowlVac 38™ metal-clad switchgear there are three methods available; closed door racking, remote racking, and onboard racking. All racking methods incorporate a torque limiting device which prevents damage to the racking mechanism. Refer to appropriate instructions for PowlVac 38 vacuum circuit breakers, including any applicable supplement(s), for a further description of the full operating instructions for this racking mechanism.

**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 tools, 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.

A further option to closed door racking is closed door tripping. If this option is furnished, a mechanical trip button on the door operates a mechanism within the compartment, which trips the removable element.
1) **Closed-Door Racking**

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 by the latching mechanism on the door. 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**

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.

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 counterclockwise 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 indicating 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.
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 remote racking device for the proper operational procedure.

F. **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.

G. **Shutters**

Metal shutters (Figure 5, b) cover the primary disconnect contacts 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 rearward 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. Padlocking either of the two cam plates or the interlock will deter opening of the shutters.

H. **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.
I. **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 5, 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.

J. **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 5, 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 5, g).

K. **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 5, 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 “DISCONNECT” and “TEST” positions are physically the same location.
2. The secondary disconnect plug must be inserted to operate the breaker in the “TEST” position.
3. The secondary disconnect plug may be withdrawn to place the breaker in the “DISCONNECT” position after the secondary latch is opened. 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.
L. 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.

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.

M. 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, and wheels. The grounding device is operated manually and the testing device is operated 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.

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.

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.
N. Testing and Inspection

**WARNING**

*Do not connect primary cable/bus or control wiring of the switchgear assembly to an energized system until all preliminary tests have been made to the switchgear assembly.*

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 1.800.480.6900.

**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.

**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.*

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.

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**WARNING**

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

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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.

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**Table 1. 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>
<td>---</td>
</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>
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 interval 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.

**CAUTION**

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

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 bus 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.

---

**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.

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.
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.

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.

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.

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 test 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.

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.

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 30), tighten fasteners to a torque value of 8-10lbs-ft; do not overtighten.

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 reading 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 reading 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) Doors

Verify that all doors open without interference.

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

15) 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™ switchgear. Refer to the Qualified Persons section in the front of this instruction bulletin.
### Table M Renewal Parts

<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>
<td>1</td>
<td><img src="image1" alt="Image" /></td>
</tr>
<tr>
<td>Manual Charging Handle</td>
<td>50235P01</td>
<td>1</td>
<td><img src="image2" alt="Image" /></td>
</tr>
<tr>
<td>Racking Handle</td>
<td>50218G01</td>
<td>1</td>
<td><img src="image3" alt="Image" /></td>
</tr>
<tr>
<td>PT Secondary Disconnect Assembly</td>
<td>90422G01P</td>
<td>1</td>
<td><img src="image4" alt="Image" /></td>
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<tr>
<td>Umbilical Cord</td>
<td>65759G17</td>
<td>1</td>
<td><img src="image5" alt="Image" /></td>
</tr>
<tr>
<td>PowlVac® Lubrication Kit</td>
<td>Powlube-104</td>
<td>1</td>
<td><img src="image6" alt="Image" /></td>
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</tbody>
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01.4IB.65203 PowlVac 38™
Metal-Clad Switchgear

38kV, 1200A & 2000A, 40kA

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