Instruction Bulletin - 01.4IB.65241
PowlVac-ND® Metal-Clad Switchgear

27kV - 1200A & 2000A - 25kA
29.8kV - 1200A & 2000A - 25kA
36” Wide Design
Contact Information

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Signal Words

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

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

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

- **CAUTION**: 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-ND® Metal-Clad Switchgear:

- 27kV / 1200A & 2000A / 25kA
- 29.8kV / 1200A & 2000A / 25kA
- all ratings are 36" wide design

B. Purpose

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

This instruction bulletin provides:

1. Safety guidelines
2. General descriptions of the operation and maintenance of the PowlVac-ND 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.

C. Instruction Bulletins Available Electronically

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

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

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

D. Associated Instruction Bulletins

- 01.4IB.65140 PowlVac-ND® Series 4 Vacuum Circuit Breaker
- 01.4IB.65220 Lifting Devices
Ch 2  Safety

A.  Safe Work Condition

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

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

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

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

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

4. Release stored electrical energy.

5. Release or block stored mechanical energy.

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

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

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

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

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

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

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

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

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

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

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**B. SAFETY GUIDELINES**

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

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

The 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-ND® 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-ND® Metal-Clad Switchgear is designed to operate with the access doors to high voltage compartments closed. If a circuit breaker or auxiliary component is removed for any reason, the door must be re-closed and properly secured.

D. Specific

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

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

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

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

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

6. **ALL COMPONENTS SHALL BE DISCONNECTED BY MEANS OF A VISIBLE BREAK AND SECURELY GROUNDED FOR SAFETY OF PERSONNEL PERFORMING MAINTENANCE OPERATIONS ON THE SWITCHGEAR.**
7. Closed-door operation features on the PowlVac-ND® allow circuit breakers to be connected to or disconnected from the power circuit with the compartment door closed. Maintenance functions will require opening the compartment door to remove the device. **Personal Protective Equipment (PPE) suitable for the potential exposure hazard must be worn if the operator opens any high voltage compartment door while the equipment is energized.** Maintenance operations, such as fuse replacement on the auxiliary device, require opening the compartment door. While it is common practice to replace fuses in auxiliary devices with the equipment energized, this practice is not recommended.

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

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.

---

**WARNING**

**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-ND® Metal-Clad Switchgear with vacuum circuit breakers is designed to comply with ANSI Standard C37.20.2. 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 lineup 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 breaker compartments, 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 starters. Also, special functions are provided in great variety and may be required for particular applications. Figure 1 illustrates a typical PowlVac-ND Metal-Clad Switchgear lineup.

This instruction bulletin should be used in conjunction with the appropriate instructions for vacuum circuit breakers, including any applicable supplements, separate instructions covering other components of the metal-clad switchgear, and applicable drawings because each metal-clad switchgear lineup 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-ND is available as indoor equipment only. For outdoor installations, the equipment is provided in a Power Control Room (PCR®).

B. Construction

The standard construction measurements are 105” high x 36” wide x 110” deep (Figure 5). The compartment holds one circuit breaker or auxiliary device. Each unit includes a primary and secondary compartment.

1) One Major Circuit Component in Lower Compartment

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

2) Two Major Circuit Components

In this configuration, components may be stacked in a single vertical section as follows:

a. An auxiliary rollout device over a circuit breaker (Figure 2).

b. An auxiliary rollout device (VT) over an auxiliary rollout device (fuse only for CPT) (Figure 3).
Figure 1  PowlVac-ND® Metal-Clad Switchgear Lineup
Figure 2  Typical Section View - PT Rollout Over Breaker
Figure 3  Typical Section View - PT Rollout Over CPT Fuse Rollout with CPT in Rear
Figure 4  Typical Section View - Breaker Over Breaker
Figure 5  Typical PowlVac-ND Metal-Clad Switchgear Dimensions
C. PRIMARY COMPARTMENT

The primary compartment contains the high voltage equipment and connections arranged in compartments to offer increased safety by minimizing personnel exposure and limiting the effects of faults.

D. SECONDARY COMPARTMENT

The secondary compartment is located at the front of the construction. It consists of two or three compartments, upper, lower, and middle in two high equipment configurations. It has hinged doors or panels, which are mounted with the necessary instruments, controls, and protective devices. The terminal blocks, fuse blocks, and some control devices are mounted inside the compartment on the side sheets and barriers. Circuit breaker control accessories, such as the secondary disconnecting device, the mechanism operated cell switch (MOC) and the truck operated cell switch (TOC) are mounted in the lower compartment (Figure 6). Penetrations are provided to allow passage of control wiring between the compartments near the center of all units.

E. RATINGS

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

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

<table>
<thead>
<tr>
<th>Table A: Ratings for PowlVac-ND® Metal-Clad Switchgear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Maximum Voltage (kV, rms)</td>
</tr>
<tr>
<td>27</td>
</tr>
<tr>
<td>29.8</td>
</tr>
</tbody>
</table>

F. BASIC IMPULSE LEVEL

- 125kV for both 27kV and 29.8kV class switchgear

G. FIELD DIELECTRIC TEST

Field Power Frequency Withstand tests are 75% of (ANSI C37.20.2) rating of 60kV for 27kV and 29.8kV class switchgear. The recommended test voltage is 45kV ac rms.

H. CIRCUIT BREAKERS

PowlVac-ND 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-ND 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-ND 27kV and 29.8kV vacuum circuit breakers.
Figure 6  Inside View of the Compartment

a. MOC Switch & Operating Mechanism  
b. Secondary Disconnect Device  
c. TOC Switch & Operating Mechanism  
d. Shutters  
e. Primary Disconnect Bushings (Location)  
f. Shutter Operating Mechanism / Racking Arms  
g. Shutter Position Interlock  
h. Cable Wireway  
i. Ground Bus  
j. Door Interlock  
k. Interference Plate  
l. Floor Pan  
m. Manual Push To Trip / Circuit Breaker Trip Free Interlock
I. 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.


The PowlVac-ND® 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 6, d)* open and close over the stationary primary disconnect devices in response to the movement of the circuit breaker racking mechanism. A spring discharge interlock is provided to discharge the main closing spring when a circuit breaker is inserted into or withdrawn from the compartment. This interlock is activated by unplugging the secondary disconnect plug or the disconnect override device accessory.

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

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

### WARNING

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

An anti-rollout stop block is provided to deter the removal of the circuit breaker from the compartment until the rollout latch on the circuit breaker is depressed.
J. **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.

K. **Primary Disconnect Devices and Bushings**

The stationary primary disconnecting devices are round silver-plated copper bar located within the primary disconnect bushings (Figure 6, e). The primary disconnect bushing is a capacitance graded design that is grounded to the switchgear frame at its mounting points. 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.

L. **Circuit Breaker Racking Mechanism**

*Figure 7  PowIVac-ND® Series 4 Circuit Breaker*

**Notice**

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

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

- Disconnected Position
- Test Position
- Connected Position

The secondary disconnect plug is an umbilical cord device. This multi-pin plug is located at the end of a cord attached to the top of the compartment. In order to rack the breaker into the compartment this plug must be inserted in the secondary disconnect receptacle. Once the plug is inserted and the breaker is racked past the “test position”, the plug is held captive and cannot be removed from the breaker.
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 primary stationary connections preventing the circuit breaker disconnects from coming into contact when in the disconnected and test positions.

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 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 primary contacts are open. The interlocks prevent the closing of the breaker between the disconnect/test and connected positions.

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

---

**NOTICE**

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

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**M. Auxiliary Compartments**

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

- Bus transitions to transformers
- Cable or bus duct entrance compartments
- Relay and metering compartments
- Instrument transformer compartments
- Control power transformer compartments
- Utility metering compartments

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**N. Unit Space Heaters**

Unit space heaters are provided in all outdoor equipment, and in indoor equipment when specified, in order to facilitate drying and prevent condensation. It is recommended that heaters be energized at all times; accordingly, no switch or thermostat is provided in the heater circuit unless specified. Two heaters are furnished for each vertical section of switchgear.
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 circuit breaker compartments and auxiliary units equipped with rollouts, it will be necessary to remove the circuit breaker or lower rollout to gain access to the heater.

O. 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 metallic grounded 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. The auxiliary compartments are equipped with doors and interlocks that are similar to the circuit breaker doors. The auxiliary rollout device is racked through the closed front door using the same procedure and racking tool as the circuit breaker. Interlocks related to racking position prevent opening the compartment door unless the rollout is fully racked to the disconnected position and the unit is grounded.

Figure 8  Voltage Transformer Auxiliary Rollout Carriage

To access the fuses, rotate the t-handle at the top of the device to allow the front cover to hinge downward.

For proper fuse installation/removal, see Ch 4 Installation, R. Auxiliary Device Rollout Carriages, 4) Changing Primary Fuses.

CAUTION

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

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

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

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

Q. Primary Disconnect Devices and Supports

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

R. 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 see 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 email info@powellservice.com.

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

A. General

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

B. Receiving

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

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

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

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

C. Handling

It is always preferable to handle a PowlVac-ND switchgear lineup with an overhead crane utilizing the lifting means provided on the switchgear. Never attempt to move more than two sections at a time, even when a crane is available.

Do not attempt to move the switchgear by opening the doors to attach straps or insert the forks of a forklift as the accessible surfaces are not designed to support the weight of the switchgear.

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.

CAUTION

Do not lift the switchgear by any means other than the lifting angles on the front and rear of the equipment. Failure to do so could result in equipment damage or personnel injury.
If roller or heavy-duty pipe is used to move the switchgear, the following precautions must be taken:

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

D. Storage

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

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

2. Equipment designed for outdoor exposure may be stored either in indoor or outdoor storage locations. The equipment must be protected from airborne external 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.

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 9 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 $\frac{1}{8}"$ (the two planes defined by the highest point and the lowest point of the leveling channels must be within $\frac{1}{8}""). The overall floor slope should not exceed $\frac{1}{8}"$ 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 $\frac{1}{8}"$ total thickness, may be used for final leveling.
Care should be taken to provide a smooth, hard and level floor surface in front of the units to facilitate installation and removal of the circuit breakers. The floor in front of the circuit breaker compartments should be level with, or slightly below, the base of the switchgear to facilitate inserting and withdrawing the circuit breakers. The step up from the floor into the circuit breaker compartment should be no more than the two metal thicknesses that make up the compartment floor and breaker pan. Critical components on the circuit breaker may be damaged if the step is larger. Should there be a gap between the concrete floor and the top of the floor leveling channel at the front of the lineup, the floor must be leveled relative to the circuit breaker compartments for approximately 36” extending away from the switchgear. This will assure the circuit breaker enters its compartment with a step up of no more than ¼”.

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

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

The user must provide suitable means for anchoring the switchgear to the floor. Recommended practice for anchoring the switchgear to the floor is to weld the switchgear structure to the floor channels using a tack weld at points indicated for anchoring on the drawing. After welding, any damaged paint should be removed and the weld and surrounding metal painted to deter corrosion. If welding facilities are not available, the switchgear should be bolted to the floor channels. The switchgear must be in full contact with the leveling channel at the point of bolting to avoid distortion when tightening the hardware.

Provisions should be made in the floor for conduits for primary and secondary cables, located as shown on the floor plan drawing furnished for the particular order. If desired, the conduits may be installed before the switchgear. Positioning rollers, if used, should be high enough to allow the switchgear to pass over any conduits that might be required for future connections.

After all the equipment is located and fully installed, examine the bottom edge of the switchgear at the floor for gaps. Any gap greater than ⅛” between the concrete floor and the switchgear must be filled. Silicone RTV is suitable for filling gaps ¼” or less. For gaps greater than ¼” it is recommended that concrete or mortar be used.

**Figure 10  Anchoring with Channel Base**

![Diagram of anchoring with channel base]({{site.base_url}}/resources/01.4IB.65241-Figure-10.png)
F. Positioning the Metal-Clad Switchgear

1) General

The recommended aisle space for the front and at the rear of the metal-clad switchgear is shown on the floor plan drawing furnished for the particular order. The space at the front must be sufficient to permit insertion, withdrawal, and transferring of the circuit breakers. The space at the rear must be sufficient for installation of cables, for inspection and maintenance, and on some switchgear to rollout voltage or control power transformers. The dimensions shown on the switchgear drawings are those required for proper operation of the switchgear. The space at the ends of the lineup can affect the function of the switchgear. There must be 36 inches from the right end (operator’s left while facing the switchgear) of the lineup to the wall or adjacent equipment to fully open the circuit breaker compartment door.

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

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

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

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

CAUTION

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

2) Assembly of Shipping Splits

The procedures for free-standing equipment and PCR® installed equipment are slightly different. When reassembling the shipping splits use the following guidelines:

a. Free-Standing Switchgear (Customer Building)

Refer to this section and Ch 4 Installation, C. Handling for instructions on moving the equipment into position.
Once in position, final alignment is based on the hardware locations. There are five (5) vertical rows of hardware to connect each vertical section to the adjacent section (Figure 11). Note that the front and rear rows are assembled with full hardware sets (nuts, bolts, and washers). The center locations may utilize either hardware sets or captive nuts in one section. If square holes are present in the equipment, use captive Tee-Nuts. Insert hardware in all holes and tighten to specification. Figure 1 shows a typical lineup with a fault current rating of \( \leq 25\text{kA} \).

b. **Switchgear Inside a Power Control Room**

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

Remove the main bus access covers in the rear compartment to gain access to the center set of mounting hardware holes.

i. **Assembly Without a Transition**

The adjacent sections of switchgear are already attached to the floor (and rear wall for wall-mounted gear). With the building components correctly aligned, the switchgear should also be aligned. From inside one of the two sections locate the attachment points between the adjacent vertical sections of switchgear. There are five (5) vertical rows of hardware to connect each vertical section to the adjacent section. See Figure 11 for locations. Note that the front and rear rows are assembled with full hardware sets (nuts, bolts, and washers). The center locations may utilize either hardware sets or captive nuts in one section (when square holes are present). Insert hardware in all holes and tighten to specification. Figure 1 shows a typical lineup with a fault current rating of \( \leq 25\text{kA} \).

ii. **Assembly With a Transition**

The adjacent sections of switchgear are already attached to the floor (and the rear wall for wall-mounted gear). The shipping split transition is 24” wide and is designed with slotted holes in the barriers to expand or contract to accommodate fluctuations in equipment size and alignment.

Prior to reassembly of the PCR, determine if the transition components are attached to the adjacent section of switchgear and if there are any components that should be placed in the equipment prior to reassembly to facilitate the process. The transition components mount to the switchgear at the same points shown in Figure 11. Assemble the transition right side components to the left side of the switchgear. Assemble the transition left side components to the right side of the switchgear. The main bus cut-out on each adjacent switchgear section is fitted with a collar that the bus barriers are installed to after the shipping split is assembled.
With the building components correctly aligned the switchgear should also be aligned.

To assemble the transition, attach the inside main bus barrier assembly. Then attach the top assembly followed by the front and rear assemblies.

c. **Bus Assembly**

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

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

iii. Connect the ground bus located in the bottom rear of the cable compartment. Refer to *Ch 4 Installation, J. Connections.*
Figure 11  Side View of Typical Shipping Split

a. Five Rows of Hardware
Figure 12  Front View of Typical Shipping Split
Figure 13  Rear Compartment Shipping Split Assembly
Figure 14  Bus Installation
G. Door Alignment

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

1. After checking that the switchgear is level and plumb, start at either end of the switchgear lineup and realign each door individually as required.
2. The top of each door should be level with the adjacent doors; the sides of each door plumb; the surface of each door flush with adjacent doors; and the space between adjacent doors equalized to permit their free swing and present a neat appearance.
3. Door may be raised or lowered vertically, moved left or right horizontally, or rotated to plumb them, by loosening the mounting screws which attach the door to the moveable half of the hinge assembly. These screws are located on the inside of the door. The door assembly may then be adjusted as allowed by the holes in the door, which are slightly oversized.
4. PCR® Rear Doors - When properly aligned, the rear doors of the switchgear (exterior doors of the PCR) should be tightly seated on the gasket that surrounds the door opening. After aligning the door as described above, close and latch the door and check the seal by inspecting the gasket for compression.
5. Check alignment of door shutter position interlock. With the equipment deenergized and the circuit breaker removed, enter the breaker compartment and close the door until the shutter position interlock actuator on the door contacts the upper linkage on the interlock. Verify that there is proper engagement and that the actuator will not move enough to miss the linkage. Verify that with the door fully closed, the lower linkage of the interlock will operate the latch so that the safety shutters are free to move.

H. Removable Element

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

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

CAUTION

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

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

See Ch 5 Operation for specific details on inserting the removable element into the compartment. Installation of the auxiliary devices is covered in Ch 4 Installation, 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. The IEEE Standard 142 states that grounding impedance in the range of 1 to 5 ohms is generally acceptable for industrial substations. Ground resistance testing is recommended to verify that the ground resistance falls within this range.

J. **Connections**

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

1. Wipe the surface clean with a lint-free cloth. Do not use sandpaper or any other abrasive material on the plated surface. Avoid handling of cleaned surfaces as much as possible. If the surface is tarnished, clean it with silver polish and then wash it with denatured alcohol.
2. Join the clean contact surfaces by using the hardware provided. The correct length of bolt must be used in each joint to ensure that electrical clearances at bolt locations are maintained. As a general rule, when using 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 ⅛ 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 15 for proper hardware assembly.

**Figure 15  Ground Bus Splice Bolt Assembly**

- a. Bolt
- b. Flat Washer
- c. Bus Bar
- d. Split Lock Washer
- e. Nut

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

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

**Note:** All hardware must be tightened to the torque values listed in Table B, Bolt Torque Values for Powell Medium Voltage Metal-Clad Switchgear.

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**Notice**

Failure to follow the guidelines for hardware length may cause failure of the insulation system due to partial discharge.

---

1) **Main Bus Assembly and Insulation**

The main and riser bus structure of PowlVac-ND® Metal-Clad Switchgear is made up of round edge rectangular copper bus bars joined with flat copper splice plates. This bus structure is supported by rectangular 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. The front bus access cover may be removed from inside the exhaust tunnel, while the rear bus access cover may be removed from the cable entry compartment.

2) **Installing and Connecting Main Bus Conductors**

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

- a. Remove the compartment covers.
- b. Loosen the splice plate bolts at the bolted joints in the equipment, where the bus conductors being installed will be connected.
c. Wipe the surface clean with a lint-free cloth. Do not use sandpaper or any other abrasive material on the plated surface. Avoid handling of cleaned surfaces as much as possible. If the surface is tarnished, clean it with silver polish and then wash it with denatured alcohol.

d. Install the silicone rubber bus cushion on the bus bar before installing in the switchgear.

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

f. Once the bus bar is positioned between the splice plates and secured on both ends, the silicone rubber bus cushion should be pushed into place inside the rectangular epoxy bus support. The final position of the bus cushion should be equidistant from either end of the epoxy support.

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

### Table B Bolt Torque Values for Powell Medium Voltage Metal-Clad Switchgear

<table>
<thead>
<tr>
<th>Bolt Dimensions (inches)</th>
<th>Bolt Head</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8</td>
<td><img src="image" alt="Hexagon" /></td>
<td>55-70</td>
</tr>
<tr>
<td>1/2</td>
<td><img src="image" alt="Hexagon" /></td>
<td>35-50</td>
</tr>
<tr>
<td>3/8</td>
<td><img src="image" alt="Hexagon" /></td>
<td>20-30</td>
</tr>
<tr>
<td>1/4</td>
<td><img src="image" alt="Hexagon" /></td>
<td>5-7</td>
</tr>
</tbody>
</table>
3) **Main Bus Joint Insulation**

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.

The following procedure applies for initial bus installation when connecting vertical sections at shipping splits and also after any maintenance procedures requiring exposing the main bus joint (checking torque). To achieve the dielectric performance for 27kV in the narrow design configuration, additional insulation is required under the boots to reduce the E-field gradient in air at certain connection points on the bus, specifically, the Main Bus Splice and Main Bus to Riser connections. The highlighted areas in *Figure 16* within the Main Bus Compartment require the addition of 3M Scotchfil putty followed by covering with vinyl backed mastic insulation pads and taping around the hardware at the splice to improve the E-field gradient in air.
Figure 16  Main Bus Compartment Bus Splice
a. Application Procedure

i. Clean area of dirt and debris
ii. Clean applied bus insulation with denatured alcohol
iii. Verify the correct hardware length (no more than 2 threads extending from the nut)
iv. Apply 3M Scotchfil Electrical Insulation Putty between the hardware on both sides of the joint and work material until there are no air pockets around the hardware and the gaps between the pre-applied bus insulation and the splice plates/riser are filled. Use a “cross-shaped” application to fill between the hardware and raise the insulation to at least half the height of the hardware.

Figure 17  Bus Splice Putty Installation

Apply putty in horizontal strips between the epoxy applied insulation and wrap strips around the bar to create a build-up in a cross-shaped pattern.

Work putty into gaps around hardware to force all the air out.
v. Apply 3M Scotch Vinyl Mastic Pad 2200 (6.5” x 4.5”) insulation over the hardware on both sides of the joint; covering the hardware. This material is cut to size from a roll. Work material until there are no air pockets around the hardware and no the gaps between the pad and the previously applied putty. There should be a minimum of 1/8” of material around all surfaces and hardware.

**Figure 18  3M Scotch Vinyl Mastic Insulation Pad**

**Figure 19  3M Scotch Vinyl Mastic Insulation Pad Applied Over Putty**

**Figure 20  Main Bus Tape Wrap**

1” overlap on epoxy bus insulation

0.06” minimum build-up of rubber tape across entire joint and epoxy bus insulation
vi. Apply HV Insulating tape 0282A3529P004 or Scotch Linnerless rubber splicing tape 130C (see Annex A of the Power Bus Design Guide) to cover the joint with 1” of overlap on all pre-applied insulation. The tape measures 0.03” x 2”. Apply with mastic side down. Apply the tape using ¼ - laps until there is a minimum of 0.06” thickness across all surfaces using the application technique discussed in PTB 01.4TB.127 and Figure 20 of this document.

vii. Place boot over taped joint. Close the boot with tie-wraps in the holes provided (Figure 21). Do not use tie-wraps containing any metal.

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 22).

<table>
<thead>
<tr>
<th>Table C Bus Wrapping Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Number</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>0282A3529 P004</td>
</tr>
<tr>
<td>0282A3529 P005</td>
</tr>
<tr>
<td>0282A3529 P008</td>
</tr>
</tbody>
</table>

Note: Electrical grade RB putty will be used only when required to grade voids and smooth out sharp edges of joints and pothead, terminator or entrance bushing connections.
**Figure 22 Insulation of Bus Bar**

- 1 Layer, 1/2 LAP = 2 Thicknesses
- 2 Layers, 1/2 LAP = 4 Thicknesses (Shown)
- 3 Layers, 1/2 LAP = 6 Thicknesses (Not Shown)
- 4 Layers, 1/2 LAP = 8 Thicknesses (Not Shown)

Circular or Square Tubes are Taped in the Same Manner as Rectangular Bars

<table>
<thead>
<tr>
<th>Insulation Range (volts)</th>
<th>Number of Layers</th>
<th>Tape Width (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 or 29.8</td>
<td>4 Layer + ½ Lap *</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

**Table D Insulation of Bus Bar**

<table>
<thead>
<tr>
<th>Insulation Range (volts)</th>
<th>Number of Layers</th>
<th>Tape Width (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 or 29.8</td>
<td>4 Layer + ½ Lap *</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler “A”</th>
<th>Outer Wrap “B”</th>
<th>“C” (inches)</th>
<th>Approx. Number Rolls per Joint of HV Tape ∆</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 or 29.8</td>
<td>RB Putty* &amp; 4 Layers</td>
<td>HV Tape ∆</td>
<td>5 LayersHV Tape ∆</td>
<td>7 1 Roll RB Putty* &amp; 1 Roll HV Tape ∆</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 Rolls RB Putty* &amp; 2 Rolls HV Tape ∆</td>
</tr>
</tbody>
</table>

**Note:**

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

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

---

**Figure 23 Single Bus Bar Connection Joint**

Epoxy Insulation Thermoplastic Sleeving or Tape Insulation

- “B” - 1/2 LAP
- “A”
- “C”
- RB Putty *

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler “A”</th>
<th>Outer Wrap “B”</th>
<th>“C” (inches)</th>
<th>Approx. Number Rolls per Joint of HV Tape ∆</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 or 29.8</td>
<td>RB Putty* &amp; 4 Layers</td>
<td>HV Tape ∆</td>
<td>5 LayersHV Tape ∆</td>
<td>7 1 Roll RB Putty* &amp; 1 Roll HV Tape ∆</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 Rolls RB Putty* &amp; 2 Rolls HV Tape ∆</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”x13/4” and 0.030”x4” down to 0.024”x31/2”. Apply with mastic side down.

* Apply 3 layers - 1/2 lap for conductors passing through CT’s.
### Figure 24  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</th>
<th>Outer Wrap</th>
<th>“C” (inches)</th>
<th>Approx. Number of Rolls per Joint of HV Tape △</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 or 29.8</td>
<td>RB Putty* &amp; 4 Layers HV Tape ∆</td>
<td>S Layers HV Tape ∆</td>
<td>7</td>
<td>1 Roll RB Putty*</td>
</tr>
</tbody>
</table>

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

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

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

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### Figure 25  Tee Connection Joint

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#### Table G  Insulation of Tee Connection Joint

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler</th>
<th>Outer Wrap</th>
<th>“C” (inches)</th>
<th>Approx. Number of Rolls per Joint of HV Tape △</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 or 29.8</td>
<td>RB Putty* &amp; 4 Layers HV Tape ∆</td>
<td>S Layers HV Tape ∆</td>
<td>7</td>
<td>1 Roll RB Putty*</td>
</tr>
</tbody>
</table>

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

- 1 roll is 1/8” x 1½” x 5’ long.

- △ HV Tape 0282A3529 P004 roll is .030” x 2” x 30’ long. Apply with mastic side down.
**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 Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 or 29.8</td>
<td>RB Putty* &amp; 4 Layers HV Tape Δ</td>
<td>5 Layers HV Tape Δ</td>
<td>7</td>
<td>1/2 Roll RB Putty* &amp; 1/2 Roll HV Tape Δ</td>
</tr>
</tbody>
</table>

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

1 roll is 1/8” x 1 1/2” x 5’ long.

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

**Table I  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>Approx. No. of Rolls per Joint of HV Tape Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 or 29.8</td>
<td>RB Putty* &amp; 4 Layers HV Tape Δ</td>
<td>5 Layers HV Tape Δ</td>
<td>7</td>
<td>1 Roll RB Putty* &amp; 3 Roll HV Tape Δ</td>
</tr>
</tbody>
</table>

**Note:** *Electrical grade rubber base putty 0282A3529P008 in roll form will be used to grade voids and smooth out sharp edges of joints. This putty has no insulation value.

1 roll is 1/8” x 1 1/2” x 5’ long.

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

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

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

6) **Cleaning Bus Insulation**

Main bus bars are insulated with a high temperature thermoset material having excellent dielectric and mechanical properties. When cleaning is necessary, use a lint-free cloth or industrial wiper, or a vacuum cleaner to remove accumulated dust and dirt. Do not clean the bus by blowing with compressed air. Dust and dirt removed in this manner may be blown into operating parts of the switchgear and damage bearings or other mechanisms. If wiping or vacuuming does not clean the bus adequately, only distilled water, denatured alcohol or isopropyl alcohol should be used to remove any foreign materials from the insulation surface. The use of other solvents may result in severe damage to the insulation system or other parts of the equipment.

K. **Primary Cables**

The primary cable connections in PowlVac-ND® switchgear are reached by opening the rear hinged doors.

Before any primary cable connections are made, the cables should be identified to indicate their phase relationship with the switchgear connections. This is necessary to ensure that motors will rotate in the proper direction and that the phase rotation is the same when interconnecting two different sources of power.

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

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

**Table J Cable Termination Joint**

<table>
<thead>
<tr>
<th>Insulation Level (kV)</th>
<th>Inner Filler “A”</th>
<th>Outer Wrap “B”</th>
<th>“C” (inches)</th>
<th>Approx. No. of Rolls per Joint of HV Tape Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 or 29.8</td>
<td>RB Putty* &amp; 4 Layers HV Tape Δ</td>
<td>5 Layers HV Tape Δ</td>
<td>7</td>
<td>1 Roll RB Putty* &amp; 3 Roll HV Tape Δ</td>
</tr>
<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 1/8” x 1 1/2” x 5’ long.*

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

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. See testing instructions.

Where units have been split for shipment, any control or other secondary leads which must connect across the split will be arranged with terminal blocks in a convenient location so that the wires can be reconnected. The wires will be cut to length and formed before being folded back so that a minimum of time will be required for reconnecting them.

O. 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*.
2. Tape the joint as outlined in *Ch 4 Installation, J. Connections, 4) Wrapping of Joints*.

**Figure 29  Roof Bushing**

<table>
<thead>
<tr>
<th>Table K Pothead, Bushing, or Terminator</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insulation Level (kV)</strong></td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td>27 or 29.8</td>
</tr>
<tr>
<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 1 1/2” x 5’ long.*

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

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 outside of the equipment as is typical with standard bus duct.

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**

A lifting device is required to install/remove the auxiliary carriage in upper compartments. Follow the instructions found in the Instruction Bulletin for the specific lifting device required. The same lifting device can be used for both auxiliary rollout devices and circuit breakers.
**Figure 30  Auxiliary Device Rollout Carriage**

![Figure 30  Auxiliary Device Rollout Carriage](image)

- a. Fuse Access Door
- b. Anti-Rollout Latch

2) **Removal**

To remove the auxiliary carriage from the switchgear, the carriage must first be racked to the “Disconnect” position. From this position, the auxiliary carriage can be removed from the racking mechanism and removed from the switchgear upper compartment using the lifting device instructions or rolled out directly from a lower compartment.

3) **Operational Checkout**

**NOTICE**

*Validate all interlocks prior to commissioning and energization.*

All rollouts are equipped with a racking mechanism and position indication. Additionally, there is a racking access interlock that is equipped with a padlock hasp for lockout/tagout and an optional key lock. The key lock is mandatory on fuse rollouts.

**WARNING**

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

a. All compartments are equipped with an anti-rollout latch. This is operated by a lever which projects from the front of the rollout at the lower right (Figure 30, b). The latch at the inner end of this lever operates in conjunction with a latching bar located on the floor of the rollout compartment, to prevent the auxiliary carriage from accidentally coming out of the compartment during installation or removal of the carriage.

With the auxiliary carriage attached to the racking mechanism it is held captive. The compartment door may be closed and the auxiliary can be moved to the “Connect” position using the racking mechanism. To access the racking mechanism rotate the access cover over the racking drive shaft.

b. All rollouts are equipped with a fuse access door (Figure 30, 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.
c. All rollouts are equipped with a grounding switch, consisting of metal rods connected to ground and an operating mechanism. The mechanism is driven by a lever on the side of the rollout device that interfaces with a bracket inside the rollout compartment. When the rollout is in the “DISCONNECT” position, the live parts are automatically grounded and as the rollout is moved prior to reaching the “CONNECT” position this ground connection is removed by the operating mechanism.

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

e. The fuse only auxiliary device must never be racked in or out under load. Therefore, a circuit breaker is placed in series with the transformer secondary and interlocked with the auxiliary device position such that the device may only be racked with the transformer secondary circuit breaker open.

A key interlock on the auxiliary rollout compartment door and an interlock mounted on the transformer secondary circuit breaker provide the permissive coordination to block racking unless the secondary is open.

Procedure:

i. Open the secondary circuit breaker and move the interlock into position.

ii. Lock the interlock (circuit breaker is now blocked from closing) and remove the key.

iii. Use the key to release the auxiliary rollout device racking mechanism on the compartment door.

iv. Rack the device to the disconnected position.

The key is held captive in the door interlock. The door may now be opened and the fuses removed as described in Ch 4 Installation, S. Auxiliary Device Rollout Carriages, 4) Changing Primary Fuses.

v. Close the compartment door and rack the auxiliary device to the connected position.

vi. Lock the interlock and remove the key.

vii. Return the key to the secondary circuit breaker lock and operate it to release the circuit breaker.

viii. Close the circuit breaker to energize the secondary load circuit.

4) Changing Primary Fuses

On both styles of rollout, primary fuses are contained within the rollout in vertical isolating housings that consist of barriers and boots. It is imperative that the boot be correctly oriented when reinstalled so the automatic grounding switch makes contact on withdrawal of the carriage.

**WARNING**

*Failure to properly reinstall the boots on the auxiliary rollout fuse connections will result in misoperation of the grounding switch which can cause equipment damage and/or serious injury or death.*
Procedure

i. Move the rollout carriage to the disconnected position (Figure 31) using the appropriate procedure. The transformer carriage may be racked out. The fuse only carriage requires additional steps to isolate the transformer secondary described in previous section. The compartment door may not be opened.

Figure 31 Rollout in Disconnected Position

ii. Using a flashlight, look through the view window and verify the ground switch is closed on the lower terminal of the fuse connection.

iii. It is not necessary to remove the carriage from the switchgear to replace the fuses. Should one choose to remove the carriage, use the removal instructions state in Ch 4 Installation, R. Auxiliary Device Rollout Carriages, 2) Removal. Should one choose to complete this procedure in the compartment, verify that the anti-rollout latch is engaged.

iv. Open the access cover to the device (Figure 32).

Figure 32 Access Cover Open

v. Cut the tie-wraps on both the top and bottom boot assemblies to expose the fuse clips (Figure 33).

Figure 33 Cutting the Tie-Wraps

vi. Using a gloved hand or fuse puller, remove the fuse by pulling the top end of the fuse toward the access door, pivoting the fuse in the bottom clip (Figure 34).
vii. Lift the fuse up and out of the bottom clip, passing it over the racking shaft and through the access door.

*Figure 34 Removing the Fuse*

viii. To replace the fuse, carefully locate the bottom connection boot such that the opening for the ground switch allows the switch to fully make the connection (metal-to-metal) *(Figure 35).* Replace the tie-wraps.

*Figure 35 Bottom Connection with Switch*

ix. Carefully locate the upper boot such that the top opening is centered on the top of the fuse so there is no impediment to the Blown Fuse Indicator operation. Replace the tie-wraps.

x. Verify the ground switch is closed.

xi. Close and latch the access cover.

xii. If the rollout carriage was removed from the compartment, reinstall it in the compartment to the disconnected position.

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

This is the disconnected position.
C. **Racking Mechanism**

The racking mechanism consists of two slotted cam plates mounted on each side of the compartment (located behind the shutter actuators shown in Figure 6) 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”.

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 to 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).

D. **Racking Procedure (Manual)**

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

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

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

All PowIvac-ND® designs are equipped with a closed-door racking feature that prevents moving the circuit breaker between the connected and disconnected positions with the door to the compartment open. This interlock may be defeated in emergencies.
1) **Racking the Circuit Breaker to the Connected Position**

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

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

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

   d. Insert the racking handle onto the racking drive shaft extension.

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

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

   This is the connected position.
2) **Racking the Circuit Breaker to the Test Position**

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

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

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

   **This is the test position.**

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

2. **Racking Procedure (Electrical)**

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

3. **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.

4. **Shutters**

   Metal shutters (Figure 6, d) cover the primary disconnect contact when the removable element is withdrawn from the compartment.

   Cam plates, located on each side of the compartment, are operated by the circuit breaker crank arm rollers which will then operate the switchgear shutters. As the circuit breaker mechanism is operated past the disconnected position, the crank arm rollers will move the cam plates downward and open the shutters before the circuit breaker starts its forward travel to the connected position. When the circuit breaker is racked to the disconnected position, the shutters are returned to their closed position by springs attached to the cam plates.
Provisions for padlocking the shutters in the closed position are furnished on each of the two cam plates and on the front of the shutter interlock (Figure 6, g). The interlock may also be fitted with a permanent key lock for this purpose. Padlocking either of the two cam plates or the interlock will deter opening of the shutters.

**H. Floor Pan**

Each compartment is equipped with a floor pan (Figure 6, l) 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 above the circuit breaker on the right side of the barrier separating the primary from the secondary compartments (Figure 6, c). 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 6, a). 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 MOC test position cam with the similar sized shaped disc without MOC strike pad used for the “connected” position only. This part may be obtained at the time of order or through the Powell Service Division.

**K. Secondary Disconnect Device**

The secondary disconnect device is a 32-point plug mounted at the lower end of an umbilical cord, which hangs at the right side of the compartment (Figure 6, b). The plug mates with the secondary control socket on the lower right front of the circuit breaker.
Interlocks are provided to ensure proper operating sequences of the device and for the safety of the operator. If, for any reason, an interlock does not function as described DO NOT MAKE ANY ADJUSTMENTS, MODIFICATIONS, OR DEFORM THE PARTS. DO NOT FORCE THE DEVICE INTO POSITION. CONTACT POWELL FOR INSTRUCTIONS. Failure to follow this warning could result in death or serious injury.

Interlocks are provided to deter improper operation of the circuit breaker. These interlocks function as follows:

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

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.

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

Key interlocks are applied to ensure that either the source of power is disconnected before the dummy element can be racked into or out of the “connected” position, or all loads are disconnected. For example, a dummy used as a substitute for a main breaker may be racked in and out if the source feeding the dummy is deenergized or if all load breakers and equipment fed by the dummy are locked open.
The interference stops provided on the dummy removable element deter insertion of an element of lower continuous current rating in a higher rated compartment. Further, these stops deter the insertion of any dummy removable element into any circuit breaker compartment. It may be possible to insert a circuit breaker element into a dummy compartment as far as the “DISCONNECT” position, but it cannot be racked into the compartment because there is no secondary plug to perform the necessary interlock functions.

M. Testing and Inspection

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

**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 45kV (75% of 60kV). 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.

---

**WARNING**

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

---

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

---

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

<table>
<thead>
<tr>
<th>Nominal Control Power Voltage</th>
<th>Voltage Range Required at Tripping Coil Terminals</th>
<th>Voltage Range Required (dc) at Closing Coil Terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>24VDC</td>
<td>14 to 28 VDC</td>
<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 intervals should be compared, to note trends as well as any significant changes in the condition of the switchgear.

![WARNING]

**WARNING**

*When performing maintenance the power source must be disconnected and the equipment grounded. Failure to do so may result in death or serious injury.*

The 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]

**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 buses and connections carefully for evidence of overheating or weakening of the insulation.

2) Bus Insulation

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

Only use denatured alcohol or isopropyl alcohol to clean the insulation. Wear protective gloves and goggles and clean the main bus bar in a well ventilated area. Wipe dirt or other foreign matter from the insulation with a clean cloth saturated with only denatured or isopropyl alcohol followed by wiping all surfaces with a dry, clean, lint-free cloth.

3) Mechanisms

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

4) Primary Disconnect Device Contacts

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

5) Disconnecting Contacts

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

6) Control Contacts

The contacts should be inspected and dressed or replaced when the surface becomes seriously pitted. Unless repetitive duty has been experienced, little attention should be required.
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 tests are recommended in the battery supplier’s instructions. During the same time that the battery is routinely checked, inspect the battery charger and remove any accumulations of dust and dirt.

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.

12) **Heaters**

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

The condition of each switchgear unit at the time of inspection, should be listed in a permanent record to become a guide for anticipating the need for replacements, or for special attention between the regular maintenance periods.

a. Insulation resistance tests are suggested for checking the insulation. A series of these tests will indicate any tendency towards a reduction in the dielectric strength of the insulation. Insulation resistance readings should be taken before and after cleaning the switchgear equipment, and in so far as possible, under similar conditions at successive periods. Records should include the insulation resistance reading, the temperature, and the humidity (either by definite reading or description).

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

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

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

14) Doors

Verify that all doors open without interference. Exterior doors utilizing tie-down bolts should have gasket material around the tie-down bolt holes. Confirm the presence and functionality of the gasket. If the gasket is damaged, replace it.

15) Interlocks

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

b. Shutter position interlock right side component:

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

ii. Inspect pivot points at top of racking hook and on both glass polyester linkages extending to the shutters for wear.
16) **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-ND® switchgear. Refer to the Qualified Person 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>51702G32</td>
<td>1</td>
<td><img src="image" alt="Secondary Disconnect Override" /></td>
</tr>
<tr>
<td>Manual Charging Handle</td>
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<td>Racking Handle</td>
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<td>PowlVac® Lubrication Kit</td>
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01.4IB.65241 PowlVac-ND®
Metal-Clad Switchgear

27kV - 1200A & 2000A - 25kA
29.8kV - 1200A & 2000A - 25kA
36” Wide Design

May 2020