01.4IB.78000A PowlVac-ND®
Metal-Clad Switchgear
5kV, 1200 & 2000A

Powered by Safety®
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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**
  
  "DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury."

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

- **CAUTION**
  
  "CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury."

- **CAUTION**
  
  "CAUTION, used without the safety alert symbol, is used to address practices not related to personal injury."

- **NOTICE**
  
  "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 serious injury or death.

The equipment is designed for use, installation, and maintenance by qualified 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

Before any adjustment, servicing, part replacement, or any other act is performed requiring physical contact with the electrical working components or wiring of this equipment, the power supply must be disconnected. Failure to follow this warning may result in injury or death.

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. This switchgear is either one (1) breaker compartment or two (2) breaker compartments per vertical section at 5kV, 1200A and 2000A circuit breakers, with sections of 26” wide, 95 1/8” high and 85” deep.

B. **Purpose**

The information in this instruction bulletin is intended to provide information 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 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 circuit breaker

The illustrations contained in this document may not represent the exact construction details of the PowlVac-ND Metal-Clad Switchgear. The illustrations in this document are provided as general information to aid in showing component locations.

All illustrations and photos are shown using deenergized equipment.
Ch 2 Safety

A. Safe Work Condition

The information in Section A is quoted from NFPA 70E 2004 - Article 120, 120.1 Establishing an Electrically Safe Work Condition.

120.1 Process of Achieving an Electrically Safe Work Condition

1. Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
2. After properly interrupting the load current, OPEN the disconnecting device(s) for each source.
3. Wherever possible, visually verify that all blades of the disconnecting devices are fully OPEN or that drawout type circuit breakers are withdrawn to the fully disconnected position.
4. Apply lockout/tagout devices in accordance with a documented and established policy.
5. Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are deenergized. Test each phase conductor or circuit part both phase-to-phase, and phase-to-ground. Before and after each test, determine that the voltage detector is operating satisfactorily.
6. Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being deenergized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.

B. Safety Guidelines

Study this instruction bulletin and all other associated documentation before uncrating the replacement circuit breakers.

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 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 metal-clad 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 circuit breaker’s reliability and safety.

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

D. Specific

1. **DO NOT WORK ON ENERGIZED METAL-CLAD SWITCHGEAR.** If work must be performed, the power supply must be disconnected and deenergized. The metal-clad switchgear must also be removed from service before any work is performed.

2. **DO NOT WORK ON AN ENERGIZED CIRCUIT BREAKER OR ON THE METAL-CLAD SWITCHGEAR. REMOVE THE CIRCUIT BREAKER FROM SERVICE AND REMOVE IT FROM THE METAL-CLAD SWITCHGEAR ENCLOSURE.**

3. **DO NOT WORK ON A CIRCUIT BREAKER WITH THE CONTROL POWER ENERGIZED.**

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

5. **DO NOT ATTEMPT TO CLOSE THE CIRCUIT BREAKER MANUALLY ON A LIVE CIRCUIT.**

6. **DO NOT USE AN OPEN CIRCUIT BREAKER BY ITSELF 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.**

7. All components should be disconnected by means of a visible break and should be securely grounded for the safety of personnel performing maintenance operations on the metal-clad switchgear, circuit breakers, or connected equipment.

8. Interlocks are provided to ensure the proper operating sequences of the metal-clad switchgear, circuit breaker, and for the safety of the user. If for any reason an interlock does not function as described, do NOT make adjustments, modifications, or deform the parts. Do NOT force the device into position. Contact Powell for more 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 during switchgear operation, handling, or maintenance.

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**NOTICE**

*Warning and Caution labels are located in various places in and on the switchgear and on the circuit breaker removable element. Always observe these warnings and caution labels. Do NOT remove or deface any of these warning/caution labels.*
Ch 3 Equipment Description

A. General

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 Metal-Clad Switchgear basic vertical sections are available in two basic designs: one-high construction and two-high construction.

1) One-High Construction

The basic one-high construction standard measurements are 95 1/8” high x 26” wide x 73” deep. The compartment holds one circuit breaker. For special use, a one-high construction with extended height, front, and rear sections is available.

2) Two-High Construction

The two-high basic construction standard measurements are 95 1/8” high x 26” wide x 85” deep. This construction can hold two circuit breakers; one in each compartment located one above the other.

Note: Each construction includes primary and secondary compartments, as shown in Figures 2 and 3. These instructions apply to both types of construction. Where significant differences exist between the two construction types, each is explained separately.
Figure 1  Typical Pow\lVac-ND® Metal-Clad Switchgear Lineup
Figure 2  One-High Basic Construction

Figure 3  Two-High Basic Construction
B. Secondary Compartment

The secondary compartment (Figure 2) is located at the front of the construction. It is a compartment with a hinged door or panels, which is mounted with the necessary instruments, controls, and protective devices. The terminal blocks, fuse blocks, and some control devices are mounted inside the compartment on the side sheets and barriers. Penetrations are provided to allow passage of control wiring between the compartments near the top of all vertical sections and near the center of the two-high construction.

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. The primary enclosure also contains control devices, current transformers, shutters, interlocks, and a ground bus. See Figures 2 and 3 for the location of the primary enclosure and Figure 4 for the equipment devices.

D. Voltage Ratings

PowlVac-ND® Metal-Clad Switchgear is available in the standard voltage ratings listed in Table A, Ratings for PowlVac-ND® Metal-Clad Switchgear. These ratings correspond to the ratings of the circuit breaker used.

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.

E. Lightning Impulse Withstand (BIL)

- 60kV for 4.76kV class switchgear

F. Factory Dielectric Test

Power Frequency Withstand (ANSI C37.20.2) is 19kV for 4.76kV class switchgear.

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

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G. Circuit Breaker: The Removable Element

PowlVac-ND Metal-Clad Switchgear is designed to house different types of removable elements for various functions and operations. One of these elements is the circuit breaker, which includes a stored energy operating mechanism, interlocks, primary disconnect devices, secondary disconnect devices, and a ground connection. All circuit breakers are equipped with wheels for easy insertion into and removal from the switchgear compartment. Refer to Figures 5 and 6 for a brief description and illustration of the exterior features of the circuit breaker. All circuit breakers furnished on a particular work order, and of a like design and rating are completely interchangeable.
For a detailed description of the circuit breaker and its operation, refer to the appropriate instruction bulletin and any applicable supplemental documents for PowlVac-ND® Vacuum Circuit Breakers.

H. SAFETY INTERLOCKS AND PROVISIONS

**NOTICE**

*Warning and Caution labels are located in various places in and on the switchgear and on the circuit breaker removable element. Always observe these warnings and caution labels. Do NOT remove or deface any of these warning/caution labels.*

1) Position Interlocks

Position interlocks (Figure 4, c) are often supplied in conjunction with disconnecting switches, removable elements, and special compartments where access is denied unless the removable element is withdrawn to the test position. The operation of key interlock schemes is generally described by a note or key chart on the specific work order drawings.

Figure 4  Interior Metal-Clad Switchgear (Lower Compartment)

![Diagram of Interior Metal-Clad Switchgear](Lower Compartment)

- **a.** Truck Operated Cell Switch (TOC) Assembly
- **b.** Mechanism Operated Cell Switch (MOC) Assembly
- **c.** Position Interlock (Location Only)
- **d.** Racking Cam Plates
- **e.** Shutters
- **f.** Current Transformers
- **g.** Ground Bus
- **h.** Circuit Breaker Compartment Interference Plate
- **i.** Secondary Disconnect Plug
- **j.** Anti-Rollout Stop Block
- **k.** Floor Pan
Before placing metal-clad switchgear with key interlocks in operation, the key scheme must be carefully checked and only proper keys left in the locks. All extra keys must be removed and destroyed, or secured where they are accessible only in an emergency.


PowlVac-ND® Metal-Clad Switchgear is provided with a positive mechanical interlock which is designed to deter moving a circuit breaker except when the primary contacts are open. It also prevents closing the primary contacts while the circuit breaker is being moved by blocking the operating mechanism mechanically and electrically.

Safety shutters 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 withdrawn from the compartment. This interlock is activated by unplugging the secondary disconnect plug (Figure 4, i) or the secondary disconnect override device accessory.

A circuit breaker compartment interference plate (Figure 4, h) is provided which is designed to hinder insertion of an incorrect type or rating circuit breaker into the compartment. The circuit breaker compartment interference plates for the metal-clad switchgear and the circuit breaker are designed to allow a circuit breaker with equal or higher voltage and current ratings to be inserted into the compartment and to hinder the insertion of a circuit breaker of a lower rating.

The circuit breaker rating should be checked against the metal-clad switchgear rating. Under no circumstances shall the breaker compartment interference plate be removed. Removing this plate allows an incorrect type of rating circuit breaker to be inserted into the compartment. For safety and since the interference plate does not coordinate control wiring, always refer to work order information, drawings, and schemes to make certain that the circuit breaker and metal-clad switchgear are coordinated for operation.

An anti-rollout stop block (Figure 4, j) is provided to deter the removal of the circuit breaker from the compartment until the anti-rollout latch (Figure 6, p) on the circuit breaker is depressed.

I. Circuit Breaker Racking Mechanism

The circuit breaker racking mechanism enables moving the circuit breaker to one of three positions in the secondary compartment of the switchgear: disconnected, test, and connected.

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 disconnects located in the compartment. A metal shutter covers the openings of the stationary primary disconnected devices which prevents contact. In this position, the secondary disconnect devices and control contacts are disengaged.
Figure 5  PowlVac-ND® Vacuum Circuit Breaker
Rear View

a. Lifting Point
b. Primary Disconnects
c. Vacuum Interrupter
d. Operating Pushrod
e. Wheel
f. Interference Plate
g. Ground Connection
Figure 6  PowlVac-ND® Vacuum Circuit Breaker  
Front View with Cover

- a. Mechanism Cell Switch (MOC) Actuator
- b. Circuit Breaker Position Indicator
- c. Racking Direction Indicator
- d. Padlockable Arm and Clip
- e. Racking Drive Shaft
- f. Nameplate
- g. Trip Cam
- h. Manual Trip Paddle
- i. Manual Charging Crank
- j. Handle
- k. Circuit Breaker Open/Close Indicator
- l. Secondary Disconnect Receptacle
- m. Manual Close Paddle
- n. Operations Counter
- o. Spring Charge Indicator
- p. Anti-Rollout Latch
2) **Test Position**

In the test position, the primary disconnect devices are disengaged and the shutters are closed. The secondary devices are completed, by plugging in the secondary disconnect plug into the secondary disconnect receptacle so that the breaker may be electrically or manually operated. However, the circuit breaker is in the same physical position as the disconnected position, with the exception of the secondary disconnect device.

3) **Connected Position**

In the connected position, the movable primary disconnects and stationary primary disconnects are engaged, the shutters are open, and the secondary devices and control contacts are completed.

Interlocks deter the movement of a circuit breaker from one position to another unless the circuit breaker contacts are open. The interlocks also deter closing the circuit breaker contacts between positions.

**J. Circuit Breaker Operation**

The circuit breaker is operated by a spring stored energy mechanism. A charging motor (Figure 7, g) is used to compress the main closing spring. During a closing operation, the energy stored in the main closing spring is used to close the vacuum interrupter contacts, compress the contact loading springs, and overcome frictional forces. When the circuit breaker is tripped, the energy stored in the contact loading springs opens the contacts at the correct speed. In an emergency the stored energy mechanism may be charged by a manual charging handle.

The secondary disconnect plug (Figure 4, i) is an umbilical cord device. A multi-pin plug is located at the end of a cord attached to the right side sheet of the secondary compartment. This plug must be inserted in the secondary disconnect receptacle (Figure 6, l) in the circuit breaker before the circuit breaker can be racked into the connected position. Once the plug is inserted and the circuit breaker is racked past the test position, the plug is held in place and cannot be removed while the circuit breaker is in the connected position or when moving between the connected and test position.

For complete instructions on inserting and withdrawing the circuit breaker in and out of the metal-clad switchgear refer to 01.4IB.77000A PowlVac-ND® Vacuum Circuit Breaker.

---

**CAUTION**

If the control circuits are energized, the spring charging motor will operate to charge the circuit breaker’s main closing spring as soon as the secondary disconnect plug is inserted into the secondary disconnect receptacle.

**CAUTION**

If the circuit breaker main closing spring is charged, withdrawing the secondary disconnect plug will cause the main closing spring to discharge and if closed the circuit breaker will trip.
K. **AUXILIARY ENCLOSURES AND COMPARTMENTS**

Many sizes of auxiliary enclosures and compartments are furnished for various purposes in PowlVac-ND® Metal-Clad Switchgear lineups. Some are listed below:

- Bus transitions to motor controllers
- Bus transitions to transformers
- Cable entrance compartments
- Starting reactor or autotransformer compartments
- Relay and metering compartments
- Instrument transformer compartments
- Control power transformer compartments

L. **ANTI-CONDENSATION HEATERS**

Anti-condensation heaters (Figure 20, f) are provided in all metal-clad switchgear in order to facilitate drying and to prevent condensation. It is recommended that heaters are energized at all times; accordingly, no switch or thermostat is provided in the heater circuit unless specified. Each one-high basic construction is furnished with a heater providing 125 watts of heat. Each two-high basic construction has two such heaters, for a total of 250 watts of heat.

Heaters in circuit breaker compartments are located at the back of the primary compartment, below the lower primary disconnect devices. Heaters in auxiliary compartments are located in a similar location. In auxiliary compartments equipped with rollouts, it may be necessary to remove the lower rollout to access the heater.

⚠️ **WARNING**

*If the rollout tray is removed from the switchgear compartment, the stationary primary disconnects mounted in the compartment may remain energized.*
M. Voltage Transformer (VT) Rollout Carriage

The voltage transformers are mounted on a rollout carriage 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 metal-clad switchgear. In addition, a grounding device is provided which contacts the fuses when the voltage transformers are disconnected, effectively discharging the transformers. In the disconnected position, the transformer fuses may be safely removed and replaced. When the voltage transformer rollout carriage is in the disconnected position the stationary primary disconnects mounted in the compartment behind the rollout carriage may remain energized.

N. Fuse Disconnecting Device Rollout Carriage

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 a rollout carriage equipped with disconnecting devices. Control power transformers of 5kVA and smaller may be mounted on the rollout with the fuses. For control power transformer types with greater than 5kVA, a separate power fuse rollout carriage assembly is provided (Figure 9).

Figure 8 Voltage Transformer and Rollout Carriage

Figure 9 Power Fuse Rollout Carriage
When fuses are disconnected they are at a safe distance from all live parts of the switchgear. A grounding device contacts the fuses after they are disconnected to effectively remove static charge from the fuses. In the disconnected position the fuses may be safely removed and replaced.

The disconnecting devices are capable of interrupting transformer magnetizing current but should not be used to interrupt load current. Mechanical or key interlocks (Figure 10) are applied to prevent operating the disconnecting device while the load is connected. This is generally accomplished by interlocking so that the transformer secondary breaker must be locked in the open position before the switchgear disconnecting device can be opened or closed.

**Figure 10  Switchgear Key Interlock**

- **a.** Locking Rod
- **b.** Transformer Secondary Circuit Breaker Switch
- **c.** Switchgear Key Interlock Mechanism
- **d.** Switchgear Compartment Interior Wall

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**WARNING**

Do NOT remove the rollout carriage from its rails without first deenergizing the primary circuit to which the rollout connects. Removing the carriage makes the stationary primary disconnect devices accessible and could result in serious injury or death.

---

**O. CURRENT TRANSFORMERS (CT) (THROUGH-TYPE)**

Ring-type current transformers (Figure 4, f) are positioned around the stationary primary disconnect devices. These current transformers are removable from the front and may be located on upper and/or lower primary disconnect supports. When necessary, special current transformers may be mounted in the cable compartment.

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**WARNING**

Before servicing or removing current transformers, deenergize the associated primary circuits. Failure to do so may result in serious injury or death.

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**P. MAIN BUS, MAIN BUS TAPS, AND GROUNDS**

The main bus, main bus taps, and ground bus conductors are made of copper. The main bus, main bus joints, and taps are insulated to protect against the propagation of faults. However, the insulation does NOT provide protection from shock hazards for personnel. The main bus and bus taps are silver-plated or tin-plated. The main bus supports of 5kV class metal-clad switchgear are constructed of polyester glass laminate.
Q. PRIMARY DISCONNECT DEVICES AND SUPPORTS

The primary disconnect devices have flat silver-plated copper contact bars located within the molded epoxy supports. The rear of the contact is bolted to the main bus riser or to the line-side bus. The contacts may be removed from the rear of the supports after the other bus connections have been disassembled.

The movable primary disconnects engage with the stationary primary disconnects in the primary compartment of the metal-clad switchgear. The removable element disconnect contacts are self-aligned fingers which will compensate for minor misalignment of up to approximately $\frac{1}{8}$".

R. LIGHTING

PowlVac-ND® metal-clad switchgear is equipped with a 120VAC interior light and a door-mounted light switch. When the light is switched on the user can read the circuit breaker position indicator messages through the view window of the compartment door. One of the following messages will appear: BREAKER TEST/DISCONNECTED or BREAKER CONNECTED. For an illustration of the interior view light switch and view window see Figure 19, h & i.
Ch 4 Installation

Before placing the metal-clad switchgear with vacuum circuit breakers in to service, the purchaser must set or program components such as protective relays, meters, timers, etc., in accordance with the requirements of the specific type of installation. Programmable devices may be shipped with temporary programming which was used to test the metal-clad switchgear. Electromechanical relays may be shipped in a blocked position to avoid damage during shipment. Refer to the separate instructions provided for these components for information on applying settings or programming.

A. General

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

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

B. Receiving

The PowlVac-ND® Metal-Clad Switchgear is fabricated in rigid, floor-mounted self-supporting steel vertical sections. The switchgear vertical sections are shipped in an upright position and when received, should be kept upright.

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

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

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

C. 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 contaminants 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.

**D. HANDLING**

It is always preferable to handle a PowlVac-ND® Metal-Clad Switchgear lineup with overhead cranes by the lifting means provided.

For an outdoor switchgear lineup, lifting channels are provided and are attached to the base of the vertical sections. Spreaders should be used in the slings above the vertical sections to prevent damage to the top edges of the switchgear. Do not attempt to lift the switchgear by using the angles installed on the sides. The angles are provided only to tie the vertical sections down during shipment which ensures that the unit will not tip over if it is top heavy.

If bases are furnished, the switchgear may be moved on an even surface by the use of rollers or heavy-duty pipes placed under the base. Any force to move or jack the switchgear must be applied to the base and not to the switchgear. The use of a forklift truck is not
recommended since the forks may damage the compartments or interior parts of the switchgear vertical sections. If no other method of handling is available, the forks must go completely under the switchgear base bottom to avoid damage to the switchgear.

E. Positioning the Metal-Clad Switchgear

1) Drawings and Diagrams

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

The recommended aisle space at 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 circuit breakers. The space at the rear must be sufficient for installation of cables, for inspection and maintenance. The dimensions shown on the switchgear drawings are those required for proper operation of the switchgear.

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

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

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

NOTICE

Applicable national or local codes or regulations may require greater aisle space than is needed for operation of the metal-clad switchgear.

It is the purchaser’s responsibility to comply with these codes and regulations.

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

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

F. Preparation of Floor Anchoring

1) Indoor Metal-Clad Switchgear

The station floor must be strong enough to remain rigid and not sag under the weight of the switchgear structure. The floor also must be able to withstand the impact stress caused by the opening of the circuit breakers under short circuit conditions. The short circuit impact load is approximately 1 1/2 times the static load weight of the switchgear.
The purchaser must provide suitable means for anchoring the switchgear to the floor. The floor supporting the switchgear must be level in order to avoid distorting the switchgear structure and to align the switchgear properly. The switchgear must be correctly and completely aligned prior to applying final anchors. Level foundations are desirable since they automatically produce true, level, and plumb switchgear installations. However, the switchgear will operate satisfactorily on a true and flat foundation that has a uniform slope of no more than 1/8" in three feet. The switchgear units must be placed on the floor channels in such a manner that the base of each unit rests directly on each of the floor channels. The recommended floor construction is shown in Figure 12.

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

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

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

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

2) Outdoor Metal-Clad Switchgear

Outdoor equipment is provided with a channel base that is usually 6" high. The switchgear may be installed on a flat concrete pad or on continuous piers running the length of the switchgear and located under the main longitudinal members of the base. If it is desired to install the switchgear on individual piers (not continuous for the length of the switchgear), consult with the factory for recommendations on the locations of piers.

The foundation must be level in order to prevent distortion of the equipment. Poor outdoor foundation leveling may be corrected by inserting brass shims at the points where the integral base frame is fastened to the concrete foundation. Level foundations are desirable since they automatically produce true, level, and plumb switchgear installations. However, the switchgear will operate satisfactorily on a true and flat foundation that has a uniform slope of no more than 1/8 inch over a distance of 3 feet.
When installing switchgear units on foundations of uniform slope, the floor of the units should be parallel to the foundation and the vertical center line of the units should be perpendicular to the floor instead of level and plumb. For pad mounted switchgear, power and control conduits should be installed prior to placement of the switchgear. For pier mounted switchgear, the conduits may be installed either before or after the switchgear is placed. The recommended method of anchoring an outdoor switchgear lineup is shown in Figure 13.

Grouting may be required to assure a good fit. An alternate method is to tack weld the channel base to leveling steel embedded in the concrete. It is not recommended that users attempt to embed anchor bolts in the concrete to penetrate predrilled holes in the channel base, as the accuracy required for this method of anchoring is very difficult to achieve under field conditions. When outdoor switchgear is shipped in more than one shipping section, care must be taken to weatherproof the shipping break.

The necessary gaskets, roof caps, trim pieces, and hardware are furnished with the switchgear. These must be carefully installed and caulked. If main cables enter at the bottom of any of the outdoor units, it will be necessary to remove the rear sheet and the rear floor sheet. The bottom rear cable entrance compartment will be completely open and the units may be moved over the projecting conduits.

**Figure 12  Floor Leveling Channels**

![Floor Leveling Channels Diagram](image1)

**Note:** It is imperative that the floor steel is even with the finished floor and that both are level. In NO case may the concrete floor rise above the level of the floor channels.

**Figure 13  Anchoring of Units with Channel Base**

![Anchoring of Units with Channel Base Diagram](image2)
G. Door Alignment

This section provides door alignment information in case it is necessary to realign the doors of metal-clad switchgear during installation. Before aligning doors, ensure the switchgear is level and plumb as described in Ch 4 Installation. Starting at either end of the switchgear lineup, realign each door individually as needed.

1) Door Alignment Conditions

When aligning doors, the following conditions apply:

- The top of each door should be level with the adjacent doors.
- The sides of each door should be plumb.
- The surface of each door should be flush with adjacent doors.
- The space between adjacent doors should be equalized to permit their free swing and present a neat appearance.
- The door stops permit a door swing of approximately 150°.

2) Aligning Switchgear Doors

The switchgear doors may be raised or lowered vertically, moved to the left or to the right horizontally, or rotated to make them plumb.

To align the doors perform the following steps:

a. Loosen the mounting screws which attach the door to the movable half of the hinge assembly. Mounting screws are located on the inside of the door.

b. With the screws in place, align the door assembly by repositioning the mounting screws in the slightly oversized holes.

c. With the mounting screws in the aligned position, tighten the screws to the proper torque. See Table B, Bolt Torque Values.

d. If the doors require further alignment, additional adjustments may be made to the stationary half of the hinge assembly, which is mounted by screws located inside the flange of the switchgear side sheet.

When properly aligned, the doors of outdoor switchgear should be tightly seated on the gasket all around the enclosure. After aligning doors, close and latch the door and check the seal by inspecting the gasket for impression or by running a 3” x 5” card around the edge of the door. If the card passes between the door and the gasket, the door is improperly adjusted and it should be readjusted until the card cannot pass between the door and the gasket.

H. The Removable Element

Before installing or operating a removable element, such as the circuit breaker, ground and test device, or dummy removable elements, consult the instruction bulletin for directions on installation, maintenance, and renewal parts for that particular element.

Removable elements, located in the one-high construction or in the lower compartment of the a two-high construction, may be rolled into place into the switchgear vertical section from the floor. Removable elements located in the upper compartments of two-high construction must be lifted into place using the optional lift truck or some other method of crane or hoist.
**CAUTION**

Do NOT attempt to lift a removable element which exceeds 50lbs without a lifting device. Failure to follow this caution may result in damage to the equipment or injury to the personnel.

The recommended lifting procedure is described in **Ch 5 Operations, A. GENERAL, 1) Inserting the Circuit Breaker Into the Compartment**.

For a detailed description of the PowlVac-ND® circuit breaker and its operation, maintenance, and renewal parts refer to 01.4IB.77000A PowlVac-ND® Vacuum Circuit Breaker.

I. **GROUNDING**

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

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

Where equipment is shipped in more than one group, the sections of ground bus must be connected by using the splice plates furnished with the equipment (Figure 14).

Assemble the ground bus joints as outlined under **Ch 4 Installation, J. CONNECTIONS**. Ground bus connections are made in the lower portion of the cable entrance compartment. The switchgear ground bus must be connected to the station ground bus by a conductor having a current carrying capacity equal to that of the switchgear ground bus. It is very important that the equipment be adequately grounded to protect the operator from injury when short circuits or other abnormal occurrences take place and to ensure that all parts of the equipment, other than live parts, are at ground potential.

**CAUTION**

The operating temperature of conductors in metal-clad switchgear may reach 221°F (105°C). Any insulating material used in the metal-clad switchgear must be suitable for this temperature.

It is recommended that the connection to the station ground have a cross section of 500,000 circular mils (240 mm²) 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 compared to 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 the 1 to 5 ohms range.

J. **CONNECTIONS**

The main bus bars and other connection bars are copper. The connection surfaces are silver plated or equivalent. The silver plating used on bolted contact surfaces is approximately 0.0001” thick; plating on sliding contact surfaces is thicker. All field assembled joints in primary conductors, regardless of method of insulation, should be made as follows:
• Wipe the surface clean with a lint-free cloth. Do not use sandpaper or any abrasive on the plated surface. Avoid handling of cleaned surface as much as possible. If the surface is tarnished, clean it with silver polish and then wash it with denatured alcohol.

• 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” diameter bolts, the bolt should be 1” longer than the combined thickness of the copper bars that are bolted together.

For example, if three ¼” thick copper bars are to be connected, the bolt should be 1¾” 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 14 for the proper assembly of hardware.

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.

• All field assembled primary conductor joints and terminations must be insulated for the operating voltage. There are two methods of insulating joints: taping joints or applying boots where applicable. A detailed procedure for joint insulation is described in Ch 4 Installation, K. Main Bus Assembly Insulation.

**Note:** All hardware must be tightened to the torque values listed in Table B, Bolt Torque Values.

<table>
<thead>
<tr>
<th>Bolt Dimensions (inches)</th>
<th>Bolt Head</th>
<th>Torque</th>
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</thead>
<tbody>
<tr>
<td>5/8</td>
<td></td>
<td>55-70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.6-9.7</td>
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<tr>
<td>1/2</td>
<td></td>
<td>35-50</td>
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<tr>
<td></td>
<td></td>
<td>4.8-6.9</td>
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<tr>
<td>3/8</td>
<td></td>
<td>20-30</td>
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<td></td>
<td></td>
<td>2.8-4.2</td>
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<tr>
<td>1/4</td>
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<td>5-7</td>
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<tr>
<td></td>
<td></td>
<td>0.7-0.97</td>
</tr>
</tbody>
</table>

**Note:** The bolt head drawings in the table above are not to scale. Locate the Bolting Torque label on equipment for an accurate drawing of bolt sizes.
CAUTION

All exposed primary bus, cable joints and connections must be insulated for the correct system operating voltage.

K. Main Bus Assembly Insulation

To insulate the main bus assembly, remove the compartment covers. Then bolt the splice plates and bus bars together, following the instructions from Ch 4 Installation, J. Connections. Tighten the bolts properly as stated in Table B, Bolt Torque Values.

To provide adequate bus joint insulation, use any of the following methods:

- Wrapping bus joints using tape or heat shrink material
- Applying PVC (polyvinyl chloride) boots

1) Wrapping Bus Joint

To wrap bus joints, perform the following steps:

a. Fill all cavities around the contact nuts and connection bars with the Solar Compounds Corporation Solarite KM1592 compound. Form a smooth surface for taping, thus preventing air voids.

Note: The compound is not an insulating medium and should not be used for that purpose.

b. Wrap the bus joint with 3 layers, $\frac{2}{3}$ lap, of Scotch Super 33+ black insulating tape, maintaining tension on the tape while wrapping. Where there are sharp angles, apply additional layers to obtain the equivalent of the insulation on the flat surfaces.

Note: One layer wound $\frac{2}{3}$ lap requires 3 turns around the bar in one width of the tape. One layer thickness is 3 times the tape thickness.

2) Applying PVC Boots

To apply PVC boots, perform the following steps:

a. Prepare all joints as outlined under Ch 5 Maintenance, J. Connections.

b. Place the PVC boot over the joint. The boot should fit snugly around all conductors, and flanges must contact each other in a smooth joint.

Note: The PVC insulation boots are furnished for standard configurations. Special configuration conditions must be taped.

c. Secure the boot with the furnished nylon wire ties. The joint insulation is now complete.

d. Replace all covers previously removed.
3) **Cleaning Bus Insulation**

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

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

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

---

**CAUTION**

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

Do not use any commercial soap-based or detergent-based cleaner because they may damage the insulation material.

Do not use carbon tetrachloride.

Avoid prolonged exposure to solvent vapors.

*Use solvents in a well ventilated area.*

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**L. PRIMARY CABLES**

Access the primary cable connections in PowlVac-ND® Metal-Clad Switchgear by opening the hinged rear doors. Before any primary cable connections are made the cables should be identified to indicate their phase relationship with the switchgear connections. This is necessary to ensure that 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 cables. When shielded cables are used, proper stress relief must be provided at the cable termination. A commercially available cable terminator or a hand-built or manufactured stress cone may be used to provide stress relief. In all cases, carefully follow the manufacturer’s recommendations for installation of the type of cable terminal to be used. Normally, no insulation or stress relief materials are 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.

**M. INSULATING PRIMARY CABLE TERMINATIONS**

All field assembled joints for primary cable terminations should be prepared as outlined under *Ch 5 Maintenance, J. CONNECTIONS.* Upon completion of the cable termination, care must be exercised when taping the exposed termination.

1. Primary cable terminations are made using pre-formed PVC insulating boots that are installed at the factory. If no boot is present or the switchgear configuration does not allow for one, then follow these steps to correctly tape the terminations.
2. All taping of roof bushing should be insulated as shown in Figure 16.
3. The instructions for application of the tape insulation are the same as outlined for wrapping of joints. See *Ch 5 Maintenance, J. CONNECTIONS.*
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 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 the units provided with ground fault current transformers, pothead mountings must be insulated from the ground. All cables should be kept as close to the center of the current transformer window as possible.

O. **Control Cables**

When control conduits enter the unit from below, the conduit 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.

If the control conduits enter from above, drill the top cover of the front enclosure to suit the conduits. Use care to avoid damage to existing wire bundles. Fasten the conduits to the cover with locknuts.

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**N. Ground Fault Current Transformers (Through Type)**

Through 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.
Connect the cables to the terminal blocks in accordance with the wiring diagrams furnished for the specific job. Control cables that must pass through any primary enclosure must be routed in the metal-enclosed wireways provided within the switchgear. All wireway covers must be replaced after cables are connected.

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

Q. Roof Entrance Bushing

When furnished, roof entrance bushings are frequently removed from the metal-clad switchgear for shipment, and the mounting openings are covered with shipping covers.

To install the roof entrance bushings, remove and discard the shipping covers and install the roof entrance bushings in their place. Use the gasket materials furnished with the roof entrance bushings to ensure a weatherproof installation. If the bushings have fixed terminals, which cannot be rotated in the field, be sure that the bushing terminal is aligned properly before bolting the bushing in place.

When assembling the connection bar end of the roof entrance bushings inside of the metal-clad switchgear and other terminations where porcelain insulators are used, insulation should be applied as follows:

1. Prepare the connection bars as outlined under Ch 4 Installation, J. Connections. Fill all cavities around the contact nuts and connection bars with Solarite KM1592 compound. Form a smooth surface for taping, thus preventing air voids.

   Note: Solarite KM1592 compound is not an insulating medium and should not be used for insulating purposes.

2. Wrap joint with insulating tape provided, maintaining tension on the tape while wrapping. Where there are sharp angles, apply additional layers of tape to obtain the equivalent of the insulation on the flat surfaces.

P. Surge Protection

It is the responsibility of the purchaser to provide suitable surge arrestors to protect the metal-clad switchgear from damage due to lightning or other electrical surges. When surge arrestors are furnished as part of the switchgear, the primary cable termination is insulated at the factory unless it must be disconnected for shipment. When this connection is completed in the field, it is necessary to insulate the primary connection before the switchgear is energized. Normally, PVC boots are supplied to insulate these connections.
R. Voltage Transformer (VT), Control Power Transformer (CPT), and Fuse Rollout Carriages

Rollout carriages will be shipped in a slightly open position, which are held in place by two angle shipping brackets bolted to the left and right support plates. Remove and discard the brackets and the hardware, which are used to attach them to the support plates. See Figure 17.

Close the rollout carriage carefully, ensuring that the primary and secondary disconnect devices align properly, and that the carriage closes completely. Also, confirm the operation of the interlocks provided, which control the power transformer and fuse rollouts. The rollout functions are described in the following sections.

Figure 17 Angle Shipping Bracket

1) Control Power Transformer Rollout

For control power transformers of 5kVA or smaller, the secondary circuit breaker is mounted inside the front cover of the rollout carriage, with its operating handle projecting through the cover. The interlock mechanism deters opening or closing of the rollout carriage unless the secondary circuit breaker is in the OFF position.

a. Closing the Rollout Carriage

To close the rollout carriage, perform the following steps:

i. Operate the secondary circuit breaker to the OFF position
ii. Lower the interlock slider, and turn the T-Handle counterclockwise. It should not be possible to close the secondary circuit breaker with the interlock in this position.
iii. Close the carriage in a smooth but brisk motion to reduce arcing between the contacts.
iv. Turn the T-Handle clockwise, raising the interlock slider.
v. Operate the secondary circuit breaker to the ON position.

With the interlock in the ON position, it should not be possible to turn the T-Handle counterclockwise far enough to unlatch the carriage, or to roll out the carriage (Figure 9, d).

b. Opening the Rollout Carriage

To open the rollout carriage, perform the following steps:

i. Operate the secondary circuit breaker to the OFF position
ii. Turn the T-Handle clockwise and lift the interlock slider. It should be possible to open the secondary circuit breaker with the interlock in this position.
iii. Withdraw the carriage in a smooth but brisk motion to reduce arcing between the contacts.
2) *Fuse Rollout*

Fuse rollouts are normally interlocked with the secondary circuit breaker of the transformer that the fuses protect using a key interlock system. The secondary circuit breaker is provided with a key interlock which releases a key only when the circuit breaker is locked in the OFF position. The rollout carriage is provided with a key interlock which deters opening or closing of the carriage unless the key is retained and the bolt is withdrawn.
Ch 5 Operation

A. General

Removable elements, such as the circuit breakers of the same type, rating, and duplicate wiring may be interchanged.

Separate covers are provided over each compartment so that any compartment or housing may be exposed without exposing other compartments.

All PowlVac-ND® vacuum circuit breakers are equipped for electrical operation. A manual charging handle is supplied as part of the accessories to permit manual operation of the circuit breaker during maintenance. **This device must not be used to close the circuit breaker on any energized circuit.**

The control circuits may be checked accurately and safely by moving the circuit breaker to the TEST/DISCONNECT position where the main circuits are disconnected and the control circuits are completed.

1) Inserting the Circuit Breaker Into the Compartment

Follow these steps to remove the circuit breaker from the upper compartment:

a. Release the lift truck brake and roll it into position in front of the lower compartment.
b. Open the upper compartment door of the switchgear unit.
c. Elevate the lift truck tray slightly above the upper compartment track level.
d. Position the lift truck tray onto the track level so that the slots at the edge of the tray will engage the hooks in the upper compartment.
e. Lower the lift truck until the tray latches to the compartment floor pan then set the lift truck brake.
f. Release the circuit breaker rollout latch and roll the circuit breaker into the lift truck tray until the rollout latch engages the tray.
g. When the circuit breaker is completely secured, disengage the lift truck and lower the circuit breaker to within 6 inches of the floor. Do not attempt to move the circuit breaker and truck with the circuit breaker elevated above 6 inches.
h. Move the lift truck and the circuit breaker to the required location.
i. To remove the circuit breaker from the lift truck, lower the lift truck tray to the

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**CAUTION**

When placing the circuit breaker on the lift truck, hold the lift truck firmly in place to prevent the truck from rolling away from the circuit breaker.

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**CAUTION**

Inserting the circuit breaker into the upper compartment is a two (2) person job. Do NOT attempt to perform this procedure alone, as it may result in personnel injury, damage to the circuit breaker, or damage to the lift truck.
When removing the circuit breaker from the lift truck, hold the lift truck firmly in place to prevent the truck from rolling away from the circuit breaker. Failure to do so may result in personnel injury or damage to the equipment.

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, from a non-level foundation or from distortion caused during shipment or handling.

The circuit breaker can be inserted into the lower compartment of the switchgear unit by first aligning the circuit breaker wheels with the compartment floor pan channels. The circuit breaker is now ready to be inserted into the TEST position and then racked to the CONNECTED position. This procedure is fully described in the circuit breaker instruction bulletin.

The procedure for inserting a circuit breaker into the upper compartment of a two-high construction varies, because the procedure depends on the design of the lift truck used.

The standard lift truck is used when adequate aisle space (68” minimum) is available. Perform the following steps to insert a circuit breaker in the upper compartment:

a. Lower the lift truck tray to the lowest position and set the brake.
b. While holding the lift truck in place, roll the circuit breaker onto the tray so that the front cover of the circuit breaker faces toward the lift mechanism of the truck.
c. Push the circuit breaker onto the tray until the circuit breaker latches onto the tray.
d. Open the upper compartment door of the switchgear unit.
e. To operate the lift truck, raise breaker 1 inch off the floor for easy movement.
f. Release the brake and roll the lift truck to the position in front of the lower compartment.
g. Elevate the circuit breaker slightly above the upper compartment track level.
h. Position the lift truck tray onto the track level so the slots at the edge of the tray engage the hooks in the upper compartment.
i. Lower the circuit breaker until the tray latches into the compartment floor pan, then set the lift truck brake.
j. Release the circuit breaker rollout latch from the slot of the tray and roll the circuit breaker into the compartment until the rollout latch engages the rollout stop block in the compartment.
k. Disengage and remove the lift truck once the circuit breaker is completely secured in the compartment.

2) Removing the Circuit Breaker from the Upper Compartment

Removing the circuit breaker from the upper compartment is a two (2) person job. Do NOT attempt to perform this procedure alone, as it may result in personnel injury, damage to the circuit breaker, or damage to the lift truck.
When placing the circuit breaker on the lift truck, hold the lift truck firmly in place to prevent the truck from rolling away from the circuit breaker.

Follow these steps to remove the circuit breaker from the upper compartment:

a. Release the lift truck brake and roll it into position in front of the lower compartment.
b. Open the upper compartment door of the switchgear unit.
c. Elevate the lift truck tray slightly above the upper compartment track level.
d. Position the lift truck tray onto the track level so that the slots at the edge of the tray will engage the hooks in the upper compartment.
e. Lower the lift truck until the tray latches to the compartment floor pan then set the lift truck brake.
f. Release the circuit breaker rollout latch and roll the circuit breaker into the lift truck tray until the rollout latch engages the tray.
g. When the circuit breaker is completely secured, disengage the lift truck and lower the circuit breaker to within 6 inches of the floor. Do not attempt to move the circuit breaker and truck with the circuit breaker elevated above 6 inches.
h. Move the lift truck and the circuit breaker to the required location.
i. To remove the circuit breaker from the lift truck, lower the lift truck tray to the lowest position and set the brake.
j. While holding the lift truck in place, roll the circuit breaker off of the tray into the required position.

3) Electrical Operation

a. General: A one-line or three-line diagram, and a schematic diagram are prepared for each metal-clad switchgear lineup. All diagrams shall be thoroughly studied and completely understood by the user before the metal-clad switchgear is placed into service.
b. 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 to be in synchronism as indicated by the synchroscope before the circuit breaker is CLOSED.
c. 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 4, e) cover the primary disconnect contacts when the removable element is withdrawn from the compartment.
Shutter operating cam plates (Figure 20, b) 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 is operated past the disconnected position, the crank arm rollers will move the cam plates backward and open the shutters before the circuit breaker starts its forward travel to the connected position. When the circuit breaker is racked to the disconnected position, the shutters are returned to their closed position by springs attached to the cam plates. Provisions for padlocking the shutters in the closed position are furnished on each of the two cam plates. Padlocking either of the two cam plates deters opening of the shutters.

5) Racking Mechanism

![CAUTION]

**CAUTION**

Before attempting to rack a circuit breaker in or out of the compartment, ensure that the key interlock, if present, is unlocked and in the opened position. Failure to do so may result in damage to the racking mechanism.

![CAUTION]

**CAUTION**

Before inserting the circuit breaker into the compartment, ensure that the racking crank arms of the circuit breaker are in the fully withdrawn position, pointing towards the movable primary disconnects. Failure to do so may result in damage to the primary disconnects, shutters, or the racking mechanisms.

The racking mechanism access opening of a circuit breaker, or other removable element is located on the switchgear front door (Figure 18, b). Since the racking mechanism can be operated through the switchgear front door, the process is called closed door racking (Figure 18).

Figure 18 Manual Closed Door Racking with Racking Handle

The racking mechanism (Figure 19, f) moves a removable element, such as a circuit breaker, within the switchgear compartment. Manual and power racking are the two methods available for racking circuit breakers or other removable elements within the switchgear compartment. Manual racking is performed using a racking handle (Figure 18, a). Power racking is performed using an electric racking device. Racking methods incorporate a torque-limiting device that prevents damage to the racking mechanism.
Note: Refer to appropriate instruction bulletins and applicable supplements for full details on PowlVac® Vacuum Circuit Breakers racking mechanism procedures.

Figure 19 Typical Switchgear Compartment Door

![Figure 19](image1.png)

- a. Circuit Breaker Control Switch
- b. Test Switches
- c. Ammeter
- d. Handle
- e. Racking Mechanism Access Opening
- f. Circuit Breaker Racking Mechanism (location only)
- g. Pull to Trip Paddle
- h. Compartment Internal Light Switch
- i. Compartment Interior View Window
- j. Compartment Door

The switchgear compartment door (Figure 19, j) features a pull to trip paddle (Figure 19, g) which operates the circuit breaker tripping mechanism. The trip paddle enables the user to manually trip the circuit breaker with the compartment door closed.

An internal compartment light switch (Figure 19, h) and a viewing window (Figure 19, i) enable the user to view the circuit breaker inside the switchgear compartment.

During the racking procedures the circuit breaker racking mechanism moves the circuit breaker or other removable element on two slotted cam plates mounted on each side of the switchgear compartment (Figure 20, b).

Figure 20 Lower Right Side Compartment

![Figure 20](image2.png)

- a. Mechanism Operated Cell Switch (MOC)
- b. Shutter Operating Cam Plate
- c. Racking Cam Plate
- d. Manual Trip Mechanism
- e. Pull to Trip Paddle
- f. Anti-Condensation Heater
Before attempting to rack a removable element in or out of a compartment equipped with a removable element key interlock, ensure that the interlock is unlocked and is in the open position. Failure to do so may result in damage to the racking mechanism.

6) Floor Pan

The bottom of each switchgear compartment has a floor pan (Figure 4, k) that is designed to contain and align a circuit breaker or other removable element within the compartment. Floor pan channels and top flanges are provided on the left and right sides of the floor pan. When the removable element is rolled onto the floor pan, the wheels are guided within the floor pan channels to align the circuit breaker in the proper connecting position. Top flanges on the channels deter tipping or vertical movement of the circuit breaker as it travels within the compartment. The floor pan channels with top flanges align the circuit breaker laterally as it is rolled onto the floor pan into the anti-rollout locked position. An anti-rollout stop block (Figure 4, J), welded to the floor pan is designed to engage the removable element anti-rollout latch to deter the removal of the circuit breaker. When removing the circuit breaker, the anti-rollout latch must be depressed to release it from the anti-rollout stop block on the floor pan.

8) Removable Element Position Interlock (Optional)

The removable element position interlock is a mechanical, manually operated assembly designed to deter movement of the removable element from one position to another. This interlock may be secured either by padlocks or by key interlocks. The interlock consists of a moveable steel angle bracket with a welded steel interference pin, a fixed pivot pin, and a support bracket where a padlock can be used.

The interlock is held by spring force in the open or non-interlock position. When the removable element is out of the compartment, rotating the interlock 45° counterclockwise and securing it will block the insertion of a removable element. When the removable element is in the compartment, rotating the interlock 45° counterclockwise and securing it will block the removal of a removable element by inserting a steel pin through a portion of the removable element top cover.

9) Mechanism Operated Cell Switch (MOC) (Optional)

The mechanism operated cell switch (Figure 4, b) is an auxiliary switch which operates in conjunction with the circuit test/disconnected position. When included, the TOC is mounted in the upper left corner of the switchgear secondary compartment (Figures 2 and 3).

The TOC actuator (Figure 7, a) is mounted on the upper left corner of the removable element. As the removable element is withdrawn from the compartment, the spring return mechanism of the TOC returns it to its original position.
breaker mechanism. The MOC is operated by linkages in the secondary compartment which operates in conjunction with the circuit breaker mechanism.

The MOC operating actuator (Figure 6, a), which projects from the top right surface of the circuit breaker mechanism, operates in conjunction with the MOC assembly in the secondary compartment. When the circuit breaker is CLOSED the plunger moves upward striking and lifting the operating lever of the compartment mounted MOC assembly.

The operating lever of the MOC assembly is directly connected to the operating arm of the MOC switch. The MOC switch operating lever is spring loaded to return to the OPEN position when engaged and operated by the circuit breaker plunger. In both one-high and two-high construction, the MOC switch assembly is mounted in the upper right corner of the secondary compartment. The MOC switch operates with the removable element in either the CONNECTED or the TEST position.

10) Secondary Disconnect Device

The metal-clad switchgear has a 24 point plug, secondary disconnect device which is mounted at the lower end of the umbilical cord and hangs from the right side of the compartment. The secondary disconnect plug (Figure 4, i) plugs into the secondary disconnect receptacle (Figure 6, l) on the lower right front of the circuit breaker.

Interlocks are provided to deter misoperation of the circuit breaker. Interlocks function as follows:

a. The secondary disconnect plug must be inserted into the secondary disconnect receptacle when the circuit breaker is in the disconnect position in order to rack the circuit breaker from the TEST position to the CONNECTED position.

b. The secondary disconnect plug must be inserted fully into the secondary disconnect receptacle and latched into place to operate the circuit breaker in the TEST position.

c. The secondary disconnect plug may be withdrawn with the circuit breaker in the TEST position by releasing the latch that holds the plug in place and pulling the plug handle straight out of the secondary disconnect receptacle. With the plug withdrawn, the circuit breaker cannot be operated or racked in either direction. **Removing the plug opens a closed circuit breaker and discharges the closing spring if it is charged.**

d. During racking procedures, the plug is locked in place and cannot be withdrawn until the circuit breaker returns to the TEST position or the DISCONNECT position.

11) Dummy Removable Element

 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 element consists of a framework and primary disconnects which simulates the circuit breaker removable element. The front ends of the primary disconnects 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 secondary disconnect device or control devices are provided. When the element is racked into position, it connects the upper set of the metal-clad switchgear primary disconnect devices to the lower set.

Key interlocks are applied to ensure that all sources of power are disconnected prior to operating the dummy removable element.

The interference plates provided on the dummy removable element will deter the insertion of an element of lower continuous current rating in a higher rated compartment. Further, these plates deter the insertion of any dummy removable element into any circuit breaker compartment. It may be possible to insert a circuit breaker removable element into a dummy removable compartment as far as the disconnected position but it cannot be racked into the compartment because there is no secondary disconnect device to perform the necessary interlock functions.

12) Ground and Test Device

The PowlVac-ND® manual ground and test device is a removable element which is mounted on a frame similar to the frame of a circuit breaker. It is equipped with a ground contact, primary disconnects, grounding cables, test ports, and wheels.

The ground and test device provides a means for obtaining access to the primary disconnect devices of the circuit breaker compartment for the purpose of grounding the primary circuits and conducting certain high voltage withstand tests (hipot).

B. Test and Inspection

For test and inspection instructions, refer to applicable instruction bulletins and any supplemental documents. For assistance with testing and inspection, contact the Powell Service Division by e-mailing info@powellservice.com or calling 1.800.480.7273.

After the equipment has been installed and all connections are made, it should be tested and inspected before being put into 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.

THE PRIMARY EQUIPMENT SHOULD BE COMPLETELY DEENERGIZED WHILE THE TESTS ARE IN PROGRESS.

The directions for testing devices such as relays, instruments, and meters are given in the instruction 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 purchaser. General instruction books are furnished for complicated automatic equipment, describing the sequence of operation of the devices required to perform the desired function.

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.
The voltage at the terminals of the breaker closing coils, when the breaker is being closed, should not be less than 43.2V for 48V coils, 112.5V for 125V coils, or 225V for 250V coils.

Check the engagement between all moving and stationary contacts in both the connected and disconnected (or grounded) positions. This contact engagement may be checked simply by “lighting-out” with a flashlight or “ringing-out” with a bell. Contact engagement is adjusted at the factory and under normal circumstances will check out properly.

After the switchgear, together with the apparatus it is to control has been installed and all interconnections made, a final check and test should be performed before putting the switchgear and apparatus into service. While preliminary tests are conducted, extreme care must be exercised to ensure that the equipment to be controlled is not connected to the system.

The testing equipment will depend on the size and type of installation. Portable voltmeters will be required. For large and complicated installations, ammeters should be available in case unexpected trouble develops. Simple portable device for lighting-out or ringing circuits are required for testing equipment.

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

The connections to the equipment apart from the switchgear, such as instrument transformers, remote control and interlock circuits, and auxiliary switches should be lighted out to make sure that they are also correct. The extent to which this will have to be done depends on the thoroughness of the installation work. There must be definite assurance that connections are correct before an attempt is made to operate the equipment.

The covers for meters, relays, and other devices, which have to be removed during the course of installation and testing, 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.

After the switchgear has been installed and put into operation, the drawings supplied with the equipment should be reviewed and any deviations made during the installation should be noted.

CAUTION

DC high potential testing is NOT recommended; however, if it is required, the voltage level appropriate for the equipment must be used. This is 20kV for equipment rated 4.76kV. The DC high potential test machine must not produce instantaneous peak voltages exceeding 50kV. For further information on DC high potential testing, refer to the separate instructions for PowlVac-ND® circuit breakers.

As a final check before energizing the equipment, the insulation integrity of the high voltage circuits should be verified with a high voltage (2500V or greater) megohmmeter. All portions of the high voltage circuits should be checked, both phase-to-phase and phase-to-ground. This check will verify that there is no major insulation damage due to shipping, handling, and installation.
Ch 6 Maintenance

Contact Powell Service Division for assistance in performing maintenance or for setting up a maintenance program. For more information visit www.powellind.com. To contact the Powell Service Division call 1.800.480.7273 or 713.944.6900, or e-mail info@powellservice.com.

A regular maintenance schedule should be established to obtain 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, such as circuit breakers, relays, meters, etc., refer to the separate instruction book furnished for each device. The inspection 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 protective relays regularly.

A permanent record of all maintenance work should be kept, the degree of detail needed depends on the operating conditions. A complete record will be valuable as a reference for subsequent maintenance work and for station operation. It is recommended that the record include reports of tests made, the condition of equipment, and repairs and adjustments that were made.

**CAUTION**

Before any covers are removed or any doors opened which permit access to the primary circuits, it is essential that the circuit or circuits be deenergized and breakers withdrawn to a disconnected position and tagged and locked out.

If work is to be done on remote equipment connected to a unit, the breaker for that unit shall be placed in the disconnected position and tagged and locked out. Also, the remote equipment shall be isolated from any other power sources connected to it.

The primary circuits of metal-clad switchgear are insulated in order to reduce the size of the equipment. However, this insulation, in most instances, requires a certain amount of air gap between phases and ground to complete the insulation. Inserting any object in this air space when equipment is energized, whether it be a tool or part of the body, may under certain conditions short circuit this air gap and cause a breakdown in the primary circuit to ground and cause serious damage to the equipment and/or injury to personnel.

Care should be exercised during maintenance and checking procedures to prevent accidental circuit breaker tripping or operation.

The switchgear structure and connections should be given the following overall maintenance at least annually:

**A. EQUIPMENT CONDITION**

Thoroughly clean the equipment, removing all dust and other accumulations. Wipe clean the buses and supports. Inspect the buses and connections carefully for evidence of overheating or weakening of the insulation.

**B. MECHANISMS AND WEAR POINTS**

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

Check primary disconnecting device contacts for signs of abnormal wear or overheating. Use a good grade of silver polish to remove deposits from the silver surfaced contacts. Discoloration of the silver surfaces is not ordinarily harmful unless atmospheric conditions cause deposits, such as sulfides, on the contacts. Apply a thin coat of contact lubricant to the main contacts before replacing the circuit breaker.

D. Other Disconnecting Contacts

Inspect all primary and secondary disconnecting contacts, such as those on the rollout transformer, for abnormal wear, fatigue, or overheating. Replace the contacts if necessary. Otherwise clean the main disconnecting contacts with a good grade of silver polish.

E. Control Contacts

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

F. Secondary Wiring

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

G. Mechanical Parts

Visually check and manually operate mechanical moving parts such as the shutter, TOC and MOC switch assemblies, the position interlock, hinged doors, and the rollout features of the transformers and fuses. Examine mechanical mating parts such as the levering in arms and the guide channels.

H. Ventilation

Check all labyrinths, grillwork, and air passages for obstructions and accumulations of dirt. The air space under 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.

I. Battery and Charging Equipment

Special attention should be given to the control battery because it is an important item for switchgear operation. To provide long life and reliable service for the battery, perform frequent inspections and tests recommended in the battery supplier's instructions. At the same time the battery is checked, inspect the battery charger and remove accumulations of dust and dirt.

J. Anchor Bolts

Check to see that all anchor bolts and bolts in the structure are secure.

K. Heaters

If the switchgear is equipped with heaters, check to see that all heaters are energized and operating properly.
L. Records

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

M. Abnormal Conditions

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

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

If maintenance and inspection frequency in abnormal condition interferes with operating and production schedules, consideration should be given to placing the equipment in a relatively tight room. Clean air can be pumped into the room to create positive air pressure and decrease exposure of the equipment to abnormal conditions. In areas where the ambient temperature is relatively high, cooling the air will improve equipment protection from extreme heat conditions. A less frequent maintenance schedule can be established when equipment is protected from abnormal conditions.
Ch 7  Recommended Renewal Parts and Replacement Procedures

A. Ordering Instructions

Order Renewal Parts from the Service Division of Powell on the website, www.powellind.com, or call 1.800.480.7273.

1. Always specify complete nameplate information, including:
   - Type
   - Serial Number
   - Rated Voltage
   - Rated Amperes
   - Impulse Withstand
   - Control Voltage (for control devices and coils)

2. 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, a photo, or a sketch showing the part needed.

3. 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 parts. A sufficient amount of stock 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 C Miscellaneous Parts lists the recommended spare parts to be carried in stock by the user. Based on how the equipment is to be used, the purchaser determines the quantity of replacement parts that may be needed.

Powell recommends that only qualified technicians perform maintenance on this equipment. Refer to the Qualified Person Section in the front of this instruction bulletin. If these circuit breakers are installed in a location where they are not maintained by a qualified technician, a spare circuit breaker should be on site ready for circuit breaker replacement. The malfunctioning unit can then be returned to the factory for reconditioning.
### Table C Miscellaneous Parts

<table>
<thead>
<tr>
<th>Catalog Number</th>
<th>Description</th>
<th>Model Number</th>
<th>Quantity per Installation</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Secondary Disconnect Override Device</td>
<td>77360G02</td>
<td>1</td>
<td>Image not available</td>
</tr>
<tr>
<td>2</td>
<td>Manual Charging Handle</td>
<td>50235-P1</td>
<td>1</td>
<td>Image not available</td>
</tr>
<tr>
<td>3</td>
<td>Racking Handle</td>
<td>50218G01</td>
<td>1</td>
<td>Image not available</td>
</tr>
<tr>
<td>5</td>
<td>CPT Secondary Disconnect</td>
<td>90421G01P</td>
<td>1</td>
<td>Image not available</td>
</tr>
<tr>
<td>6</td>
<td>PT Secondary Disconnect</td>
<td>90422G01P</td>
<td>1</td>
<td>Image not available</td>
</tr>
<tr>
<td>7</td>
<td>Umbilical Cord</td>
<td>77360G01</td>
<td>1</td>
<td>Image not available</td>
</tr>
<tr>
<td>8</td>
<td>Lubrication Kit</td>
<td>Powlube-102</td>
<td>1</td>
<td>Image not available</td>
</tr>
</tbody>
</table>
### Table D Troubleshooting Topics

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Cause</th>
<th>Reason &amp; Remedy</th>
</tr>
</thead>
</table>
| The circuit breaker will not fully engage into the compartment. | Wrong circuit rating | The circuit breaker interference plate on the compartment’s floor pan prevents the incorrect circuit breaker from being inserted into the incorrect compartment.  
*Ensure the correct circuit breaker’s current rating corresponds to the correct compartment’s current rating.* |
| | Debris, dirt, & foreign objects | Debris, dirt, and foreign objects are at the bottom of the compartment floor pan channels, and will not let the circuit breaker roll into the compartment.  
*Check and clean the compartment thoroughly and remove any debris, dirt, or foreign objects in the compartment floor pan channels.* |
| | Key interlock in the locked position | The key interlock is in the locked position.  
*Check and ensure that the key interlock is not in the locked position and if so, make sure all conditions are met before unlocking the key interlock.* |
| The circuit breaker will not fully rack into the compartment. | Debris or foreign objects in the compartment | Debris and foreign objects are in the switchgear primary disconnect devices.  
*Check and clean the devices thoroughly and remove debris and foreign objects.* |
| | Debris or foreign objects in/on the circuit breaker’s primary disconnects | Debris and foreign objects are in/on the upper and lower primary disconnects.  
*Check and thoroughly clean the upper and lower primary disconnects and remove any debris or foreign objects.* |
| | Key interlock in the locked position | The key interlock is in the locked position, which prevents the circuit breaker from being fully racked in.  
*Check and ensure that the key interlock is not in the locked position and if so, make sure all conditions are met before unlocking the key interlock.* |
| The circuit breaker will not rack out of the compartment. | Circuit breaker still in the closed position | The circuit breaker is still in the closed position.  
*Trip the circuit breaker.* |
| | Key interlock in the locked position | The key interlock is in the locked position, which prevents the circuit breaker from being fully racked in.  
*Check and ensure that the key interlock is not in the locked position and if so, make sure all conditions are met before unlocking the key interlock.* |
| The circuit breaker closes and instantly opens. | Protective or control devices | A trip signal is present.  
*Adjust protective devices parameters, and/or check control circuit operation and make corrections as needed.* |
| | Short circuit fault in the power circuit | There is a fault in the main bus.  
*Check the power circuit and remove the fault.* |
01.4IB.78000A
PowlVac-ND® Metal-Clad Switchgear

5kV, 1200 & 2000A

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