



# **Instruction Bulletin - 01.4IB.25002B**

## **Low Voltage Metal-Enclosed**

### **Type NDC<sup>®</sup> DC Switchgear**

*Equipped with Brush  
Type NDC Circuit Breaker*

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## Signal Words

As stated in ANSI Z535.4-2011 (2017), 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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## Contents

<b>Ch 1</b>	<b>General Information .....</b>	<b>1</b>
A.	SCOPE .....	2
B.	PURPOSE .....	2
C.	INSTRUCTION BULLETINS AVAILABLE ELECTRONICALLY .....	2
<b>Ch 2</b>	<b>Safety .....</b>	<b>3</b>
A.	SAFE WORK CONDITION .....	3
B.	SAFETY GUIDELINES .....	4
C.	GENERAL .....	5
D.	SPECIFIC .....	5
E.	SAFETY LABELS .....	5
<b>Ch 3</b>	<b>Equipment Description .....</b>	<b>6</b>
A.	GENERAL .....	6
B.	VERTICAL SECTIONS (UNIT) .....	6
1)	Control Compartment .....	8
2)	Primary Enclosure .....	8
C.	SWITCHGEAR RATING .....	8
D.	CIRCUIT BREAKER: THE REMOVABLE ELEMENT .....	9
E.	CIRCUIT BREAKER RACKING MECHANISM .....	9
1)	Disconnected/Test Position .....	9
2)	Connected Position .....	10
F.	SECONDARY DISCONNECT OPERATION .....	10

## Contents

<b>Ch 4 Installation .....</b>	<b>11</b>
A. GENERAL .....	11
B. RECEIVING .....	11
C. HANDLING .....	11
1) Lifting the Switchgear .....	13
D. STORAGE .....	13
E. PREPARATION OF SUBSTATION FLOOR .....	13
F. POSITIONING THE METAL-ENCLOSED DC SWITCHGEAR AND ANCHORING .....	14
1) Drawings and Diagrams .....	14
2) Positioning the Switchgear .....	14
3) Anchoring .....	14
G. GROUNDING .....	15
1) High Resistance Grounding .....	15
2) Low Resistance Grounding .....	15
H. CONNECTIONS .....	15
I. BUS CONNECTIONS AT SHIPPING SPLITS .....	19
1) Main Bus .....	19
2) Continuity Bus .....	21
J. POWER CABLES .....	21
K. CONTROL CABLES .....	21
L. INSERTING AND REMOVING THE CIRCUIT BREAKER FROM THE CIRCUIT BREAKER COMPARTMENT .....	21
M. INSPECTION AND TESTING .....	21
1) Inspection .....	22
2) Testing .....	22
<b>Ch 5 Maintenance .....</b>	<b>23</b>
A. GENERAL DESCRIPTION .....	23
1) Introduction .....	23
2) Cleaning .....	24
B. MAINTENANCE PROCEDURES .....	24
1) Switchgear Condition .....	24
2) Mechanisms and Wear Points .....	24
3) Abnormal Wear .....	24
4) Control Contacts .....	24
5) Secondary Wiring .....	24
6) Mechanical Parts .....	24
7) Ventilation .....	25
8) Battery and Charging Equipment .....	25
9) Anchor Bolts .....	25
10) Heaters .....	25
11) Records .....	25
12) Abnormal Conditions .....	26
<b>Ch 6 Recommended Renewal Parts and Replacement Procedure .....</b>	<b>27</b>
A. ORDERING INSTRUCTIONS .....	27



## Figures

<b>Figure 1</b>	<b><i>Typical DC Switchgear Line-Up .....</i></b>	<b><i>7</i></b>
<b>Figure 2</b>	<b><i>Equipment Key Components .....</i></b>	<b><i>9</i></b>
<b>Figure 3</b>	<b><i>Chain/Cable Sling Installation .....</i></b>	<b><i>12</i></b>
<b>Figure 4</b>	<b><i>Typical (UNIT) Dimensions .....</i></b>	<b><i>16</i></b>
<b>Figure 5</b>	<b><i>Switchgear Anchoring Detail .....</i></b>	<b><i>17</i></b>
<b>Figure 6</b>	<b><i>Typical Bolted Assembly .....</i></b>	<b><i>18</i></b>
<b>Figure 7</b>	<b><i>Main Bus Access Covers and Continuity Bus .....</i></b>	<b><i>20</i></b>

## Tables

<b>Table A</b>	<b><i>Ratings of Low Voltage Metal Enclosed Type NDC DC Switchgear .....</i></b>	<b><i>8</i></b>
<b>Table B</b>	<b><i>Type NDC Switchgear Unit Dimensions .....</i></b>	<b><i>16</i></b>
<b>Table C</b>	<b><i>Anchoring Detail Parts List .....</i></b>	<b><i>17</i></b>
<b>Table D</b>	<b><i>Bolt Torque Values for Powell Low Voltage Metal-Enclosed Switchgear .....</i></b>	<b><i>18</i></b>

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## Ch 1 General Information

### **WARNING**

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

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

### **WARNING**

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

### **NOTICE**

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

### **NOTICE**

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

**A. SCOPE**

The information in this instruction bulletin describes Powell low voltage metal-enclosed Type NDC® DC Switchgear assemblies equipped with the following:

- Brush NDC Circuit Breakers

The equipment described is indoor type switchgear for 1600V applications.

Standard construction details are provided in the appropriate sections. The circuit breaker operation and maintenance instructions can be found in *Brush Type NDC Operation and Maintenance Manual (55/4190)*. Any special switchgear construction details are provided in supplementary documentation.

**B. PURPOSE**

The information in this instruction bulletin is intended to provide details required to properly operate and maintain the low voltage metal-enclosed Type NDC DC switchgear equipped with Brush Type NDC circuit breakers.

This instruction bulletin provides:

1. Safety guidelines
2. General descriptions of the operation and maintenance of the low voltage metal-enclosed Type NDC DC switchgear
3. Instructions for installation of the switchgear.
4. Information for ordering renewal parts.
5. Illustrations, photographs, and description of the switchgear. For circuit breaker information see the *Brush Type NDC® Operation and Maintenance Manual (55/4190)*.

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

*All illustrations and photos are shown using deenergized equipment.*

 **WARNING**

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

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

**C. INSTRUCTION BULLETINS AVAILABLE ELECTRONICALLY** **NOTICE**

***Changes to the instruction bulletin may be implemented at any time and without notice. Go to [powellind.com](http://powellind.com) to ensure use of the current instruction bulletin for Powell equipment.***

For more information visit [powellind.com](http://powellind.com). To contact the Powell Sales, Parts, and Service call 1.800.222.6234 or 330.966.1750, or email [ncdsalesinfo@powellind.com](mailto:ncdsalesinfo@powellind.com).

For specific questions or comments pertaining to this instruction bulletin email [documents@powellind.com](mailto:documents@powellind.com) with the instruction bulletin number in the subject line.



## Ch 2 Safety

### A. SAFE WORK CONDITION

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

#### **120.5 Process or Establishing and Verifying an Electrically Safe Work Condition.**

Establishing and verifying an electrically safe condition shall include all of the following steps, which shall be performed in the order presented, if feasible:

1. Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
2. After properly interrupting the load current, OPEN the disconnecting device(s) for each source.
3. Wherever possible, visually verify that all blades of the disconnecting devices are fully OPEN or that drawout type circuit breakers are withdrawn to the fully disconnected position.
4. Release stored electrical energy.
5. Release or block stored mechanical energy.
6. Apply lockout/tagout devices in accordance with a documented and established procedure.
7. Use an adequately rated portable test instrument to test each phase conductor or circuit part to verify it is de-energized.

Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the test instrument is operating satisfactorily through verification on any known voltage source.

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

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

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

**N** Informational Note No. 2: For additional information on rating and design requirements for voltage detectors, refer to IEC 61243-1, *Live Working - Voltage Detectors - Part 1: Capacitive type to be used for voltages exceeding 1kV a.c.*, or IEC 61243-2, *Live Working - Voltage Detectors - Part 2: Resistive type to be used for voltages of 1kV to 36kV a.c.*, or IEC 61243-3, *Live Working - Voltage Detectors - Part 3: Two-pole voltage type*.

8. Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment in accordance with the following:

- a. *Placement*. Temporary protective grounding equipment shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to a shock hazard (i.e., hazardous differences in electrical potential). The location, sizing, and application of temporary protective grounding equipment shall be identified as part of the employer's job planning.
- b. *Capacity*. Temporary protective grounding equipment shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.

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

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

## **B. SAFETY GUIDELINES**

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

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

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

*The safety rules in this instruction bulletin are not intended to be a complete safety program. The rules are intended to cover only some of the important aspects of personnel safety related to Powell low voltage metal-enclosed Type NDC® DC switchgear.*

**C. GENERAL**

1. Only supervised and qualified personnel trained in the usage, installation, operation, and maintenance of the switchgear shall be allowed to work on this equipment. It is mandatory that this instruction bulletin, any supplements, and service advisories be studied, understood, and followed.
2. Maintenance programs must be consistent with both customer experience and manufacturer's recommendations, including service advisories and instruction bulletin(s). A well planned and executed routine maintenance program is essential for circuit breaker's reliability and safety.
3. Service conditions and circuit breaker applications shall also be considered in the development of safety programs. Variables include ambient temperature; humidity; actual continuous current; thermal cycling; number of operations; interrupting duty; and any adverse local conditions including excessive dust, ash, corrosive atmosphere, vermin and insect infestations.

**D. SPECIFIC**

1. **DO NOT WORK ON ENERGIZED SWITCHGEAR.** If work must be performed on the switchgear, remove it from service and place it in an electrically safe condition.
2. **DO NOT WORK ON THE SWITCHGEAR WITH THE CONTROL CIRCUIT ENERGIZED.**
3. **EXTREME CARE MUST BE EXERCISED TO KEEP ALL PERSONNEL, TOOLS, AND OTHER OBJECTS CLEAR OF MECHANISMS WHICH ARE TO BE OPERATED, DISCHARGED, OR RELEASED.**

These circuit breakers utilize stored energy mechanisms. These mechanisms must be serviced only by skilled and knowledgeable personnel capable of releasing each spring load in a controlled manner. Detailed information regarding these

4. **DO NOT ATTEMPT TO CLOSE THE CIRCUIT BREAKER MANUALLY ON AN ENERGIZED CIRCUIT.**
5. **DO NOT USE AN OPEN CIRCUIT BREAKER AS THE SOLE MEANS OF ISOLATING A HIGH VOLTAGE CIRCUIT.** For complete isolation, the circuit breaker shall be in the disconnected position or shall be withdrawn completely.
6. **ALL COMPONENTS SHALL BE DISCONNECTED BY MEANS OF A VISIBLE BREAK AND SECURELY GROUNDED FOR SAFETY OF PERSONNEL PERFORMING MAINTENANCE OPERATIONS ON THE SWITCHGEAR.**

**E. SAFETY LABELS**

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

**NOTICE**

*Warning and Caution labels are located in various places 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

#### NOTICE

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

The Powell Type NDC® DC Switchgear is designed to comply with IEEE Standard C37.20.1-2002. Powell Type NDC DC Switchgear design also complies with the following international standards: BS EN 50123-1:2003 and BS EN 50123-6:2003.

The metal-enclosed switchgear is a line-up of one or more vertical sections which are enclosed on all sides, top, and bottom except for the ventilation openings, lower unit cable penetrations, and view windows. The switchgear is used to protect and control direct current power distribution systems. Each unit typically consists of a circuit breaker compartment, plus auxiliary compartments containing accessory apparatus. The circuit breakers are used to control various types of circuits, such as incoming lines, bus ties and feeders. Also, special functions are provided in great variety and may be required for particular applications. [Figure 1](#) illustrates a typical Powell Type NDC DC Switchgear line-up.

The Powell Type NDC DC switchgear vertical sections are available in two voltage classes, 0-900 Volt construction and 901-1800 Volt construction. Each voltage class has been specifically designed for use with the Brush Type NDC circuit breakers.

Because of the multitude of configuration requirements in traction power substation design, Powell has many different construction configurations available in each voltage class of its Type NDC DC switchgear design. **Refer to [Table B](#) and [Figure 4](#) for typical dimensions of the units supplied on the work order being installed.** In addition to the information supplied in [Table B](#), always consult the installation drawings supplied with the work order for any special requirements.

### B. VERTICAL SECTIONS (UNIT)

Each individual vertical section known as a unit, is typically constructed with a Control Compartment and a Primary Enclosure.

#### ⚠ WARNING

***All compartments can contain live conductors at system voltage. Interlocking is provided on the circuit breaker door to link with the operation of the circuit breaker. All other compartments are accessed via bolted or hinged covers and should only be accessed by qualified personnel.***



**Figure 1**     *Typical DC Switchgear Line-Up*



### 1) Control Compartment

The control compartment incorporates a hinged door which is mounted with the necessary instruments, controls, and protective devices. The terminal blocks, disconnect devices, and other control devices are mounted inside the compartment on the side sheets and barriers. A raceway is provided to carry the control and instrumentation wiring between units near the top of all vertical sections.

### 2) Primary Enclosure

The primary enclosure contains the high voltage equipment and connections. It is typically arranged into compartments to offer increased safety by minimizing personnel exposure and limiting the effects of faults.

- a. Breaker Compartment: Contains the circuit breaker, control devices, shutters and interlocks. For key features of the breaker compartment, see [Figure 2](#).
- b. Cable Termination Compartment: Is where the incoming cables are terminated.

- c. Main Bus Compartment: Is a metal enclosed compartment used to isolate the main bus from the feeder bus circuits and other high voltage components.
- d. HV Instrument Compartment: Is where high voltage fuses, transducers and load measuring circuit components are typically located.

**Note:** Refer to [Figure 4](#) for typical compartment arrangements.

## C. SWITCHGEAR RATING

The Powell low voltage metal-enclosed Type NDC® DC Switchgear has been constructed as required by IEEE C37.20.1-2002 (Standard for Low Voltage Metal-Enclosed Switchgear) and has been subjected to the series of proving tests required by IEEE C37.20.1-2002 achieving the following results.

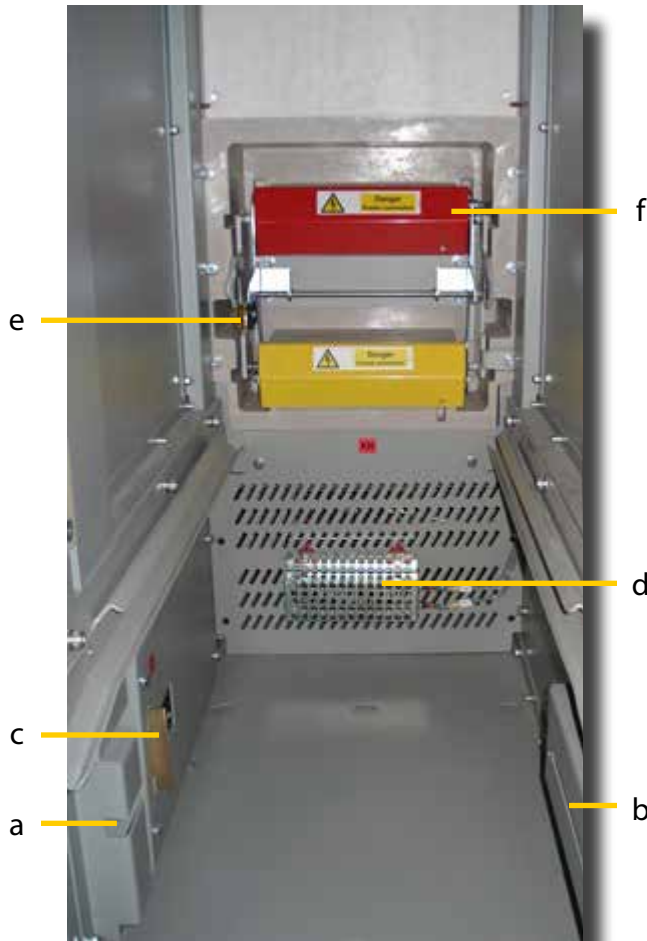
The switchgear described in this instruction bulletin meets the requirements for High Speed and Rectifier application.

**Table A Ratings of Low Voltage Metal Enclosed Type NDC DC Switchgear**

Rated Maximum Voltage	Rated Continuous Current Withstand	Short-Time Current Withstand Sustained	Duration	Short Circuit Current Withstand Peak	Dielectric 1-Minute Withstand
1600VDC	4000A	120kA	250ms	200kA	12.4kA
	6000A				
	8000A				



**Figure 2 Equipment Key Components**



- a. Breaker Coding Plate
- b. Breaker Door Interlock Mechanism
- c. TOC Assembly
- d. Anti-Condensation Heater (optional)
- e. Continuity Bus Connection Blade
- f. Primary Disconnect Shutter Assembly

breakers are equipped with wheels for easy insertion into and removal from the switchgear compartment. All circuit breakers furnished on a particular work order, and of like design and rating are interchangeable.

For a detailed description of the circuit breaker and its operation, refer to the *Brush Operations and Maintenance Manual* (55/4190).

#### **E. CIRCUIT BREAKER RACKING MECHANISM**

The circuit breaker racking mechanism enables moving the circuit breaker to one of two positions in the breaker compartment of the switchgear. **Disconnected/Test** and **Connected**.

##### *1) Disconnected/Test Position*

In the Disconnected/Test 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 breaker compartment. A metal shutter covers the openings of the stationary primary disconnect devices which prevents contact of the system voltage. In the disconnect position the circuit breaker control wiring is still connected to the circuit breaker through an umbilical cord device, which allows the circuit breaker control functions to be tested.

#### **D. CIRCUIT BREAKER: THE REMOVABLE ELEMENT**

Powell Type NDC® DC switchgear is designed to house the Brush Type NDC DC circuit breaker, which includes interlocks, primary disconnect devices, secondary disconnect devices, and a continuity bus connection. All circuit

## 2) *Connected Position*

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

Interlocks prevent the movement of a circuit breaker from one position to another, unless the circuit breaker is tripped open. The interlocks also prevent closing the circuit breaker between positions.

## **F. SECONDARY DISCONNECT OPERATION**

The secondary disconnect plug 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 breaker compartment. This plug must be inserted in the secondary disconnect receptacle on the circuit breaker. Once the plug is inserted and clamped, the breaker compartment door is closed and the breaker can be racked to the Connected position.

For complete instructions on inserting and withdrawing the circuit breaker in and out of the switchgear, refer to the *Brush Type NDC DC circuit breaker Operations and Maintenance Manual (55/4190)*.

### **CAUTION**

***Before inserting a removable element into the breaker compartment of a new switchgear installation, manually check the shutter mechanism, and the truck operated cell switch (TOC) for free movement. These checks should be made with all circuits deenergized. It is also recommended that these checks be performed during a periodic maintenance schedule when the circuits are deenergized.***



## Ch 4 Installation

Contact the Powell Service Division for installation, maintenance, and renewal parts assistance. To contact the Powell Service Division call 1.800.480.7273 or 713.944.6900, or email [serviceinfo@powellind.com](mailto:serviceinfo@powellind.com).

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

### A. GENERAL

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

Once the assembly of the metal-enclosed switchgear is completed on site, all joints and hardware, including bus connections, structural assemblies, and control connections, should be checked for tightness and proper torque values. See [Table D Bolt Torque Values for Powell Low Voltage Metal-Enclosed Switchgear](#).

### B. RECEIVING

Powell low voltage metal-enclosed Type NDC® DC 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 switchgear is received, check for signs of damage. If damage is found or suspected, file claims as soon as possible with the transportation company and notify the nearest Powell representative.

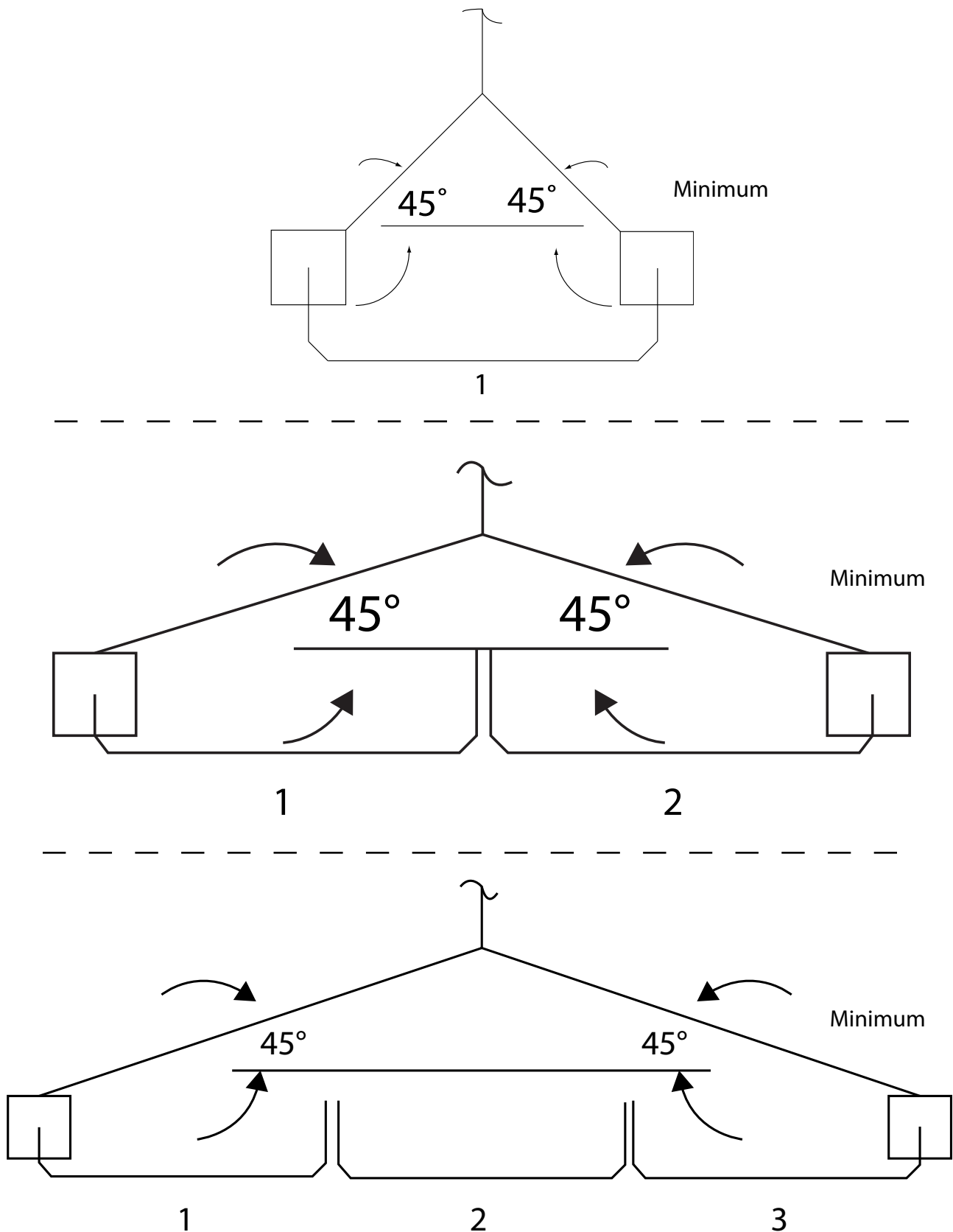
Refer to the *Brush Operations and Maintenance Manual (55/4190)* for receiving, handling, and storage instructions on the circuit breaker.

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

### C. HANDLING

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

**Figure 3** Chain/Cable Sling Installation





### 1) *Lifting the Switchgear*

The maximum shipping section width is 120 inches. The equipment should be lifted with an appropriately rated device. It should be assumed that each vertical section of equipment weighs 1200 lbs without the circuit breaker installed. The equipment should be lifted a single shipping section at a time. Four (4) lift points shall always be used when lifting the switchgear. It is important to note that when a spreader bar is not being used that each lift chain/cable when loaded maintains at least a 45 degree angle from the horizontal plane. See [Figure 3](#) for proper lifting instructions.

**Note:** *At 45 degrees the force on each lifting chain/cable is equal to the total load divided by four (4) divided by 0.707 making each less efficient. Angles less than 45 degrees can damage the switchgear.*

*The customer is responsible for providing the spreader bar.*

## D. STORAGE

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

1. Equipment designed for indoor installation must be stored indoors in a climate controlled environment to prevent condensation of moisture. Exposure to rain and the elements, even for a short period, can permanently damage the equipment. Space heaters within the equipment should be energized, if so equipped. Humidity controlling desiccant materials should be utilized when space heaters are not provided or cannot be energized. The temperature should be kept above 33°F/1°C and below 140°F/60°C. The relative humidity should be kept below 60% or a dew point of 59°F/15°C. 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. The auxiliary control devices, ship loose material and protective relays must also be protected. This includes items such as battery chargers, UPS systems, lighting, installation hardware and air conditioning. If prolonged storage is anticipated, humidity controlling desiccant materials should be utilized. Desiccant packets should be installed in all compartments and packing containers.

## E. PREPARATION OF SUBSTATION FLOOR

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 breaker under short circuit conditions. The short circuit impact load is approximately 1.5 times the static load weight of the switchgear.

Level foundations are desirable because 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 in three (3) feet. Care should be taken to provide a smooth, hard and level floor underneath and in front of the sections to facilitate installation and removal of the circuit breaker.

In most DC switchgear substation installations the switchgear is insulated from the floor. The insulation should extend a minimum of four feet around the perimeter of the switchgear. Prior to installation of the switchgear the insulation should be clean and dry and the resistance measured.

#### **F. POSITIONING THE METAL-ENCLOSED DC SWITCHGEAR AND ANCHORING**

##### *1) Drawings and Diagrams*

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

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

##### *2) Positioning the Switchgear*

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

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

When installing a unit substation where a rectifier is close coupled to the DC switchgear, the rectifier and the adjacent DC switchgear section should first be lined up and set in position in accordance with the dimensions on the base plan drawing for the installation. The additional sections should then be installed.

##### *3) Anchoring*

The recommended practice for anchoring the switchgear to the floor is shown in [Figure 5](#) and the typical unit anchor bolt locations are shown in [Figure 4](#). Because a switchgear line-up has many different configurations available, it is important to consult the installation drawings provided with the work order to ensure the correct number of anchors will be installed.

**Note:** *Depending on the geographic location of the switchgear installation, there can be special requirements associated to the anchoring of the switchgear. When required a detailed installation drawing will be furnished by Powell.*



## G. GROUNDING

To mitigate the risk of electric shock and the hazards associated with the internal arcing faults, two methods of grounding equipment operating above 250V have been developed.

### 1) High Resistance Grounding

Installations using high resistance ground techniques must incorporate several methods to achieve the desired results. Features such as floor insulation, conduit insulation collars, bus duct insulation collars and the use of a protective relay (ANSI Device Number 64) are required. All the insulation points must be able to withstand full system voltage should a fault occur between the internal bus bars and the enclosure. Additionally, the area around the equipment must be free of grounded surfaces. Personnel in contact with the equipment must be on an insulated floor and not have grounded surfaces in the proximity.

It is recommended that two (2) separate connections from the station ground be made directly to the 64 relay terminals. The other ends of the 64 relay are to be connected at the two opposite ends of the switchgear continuity bus bar (typically a factory connection).

### 2) Low Resistance Grounding

Installations using low resistance grounding is effectively grounded similar to AC equipment with the exception that the ground connection is made at a single point. This single point, usually a cable, is used as the monitoring point for fault currents. The installation requirements for the DC switchgear is similar to the high resistance system in that the switchgear must be insulated from ground so that all the ground current passes through the single monitoring point. The single point ground connection must be properly sized to carry the full fault current available.

***For cable sizing and connection details consult the installation drawing furnished by Powell.***

## H. CONNECTIONS

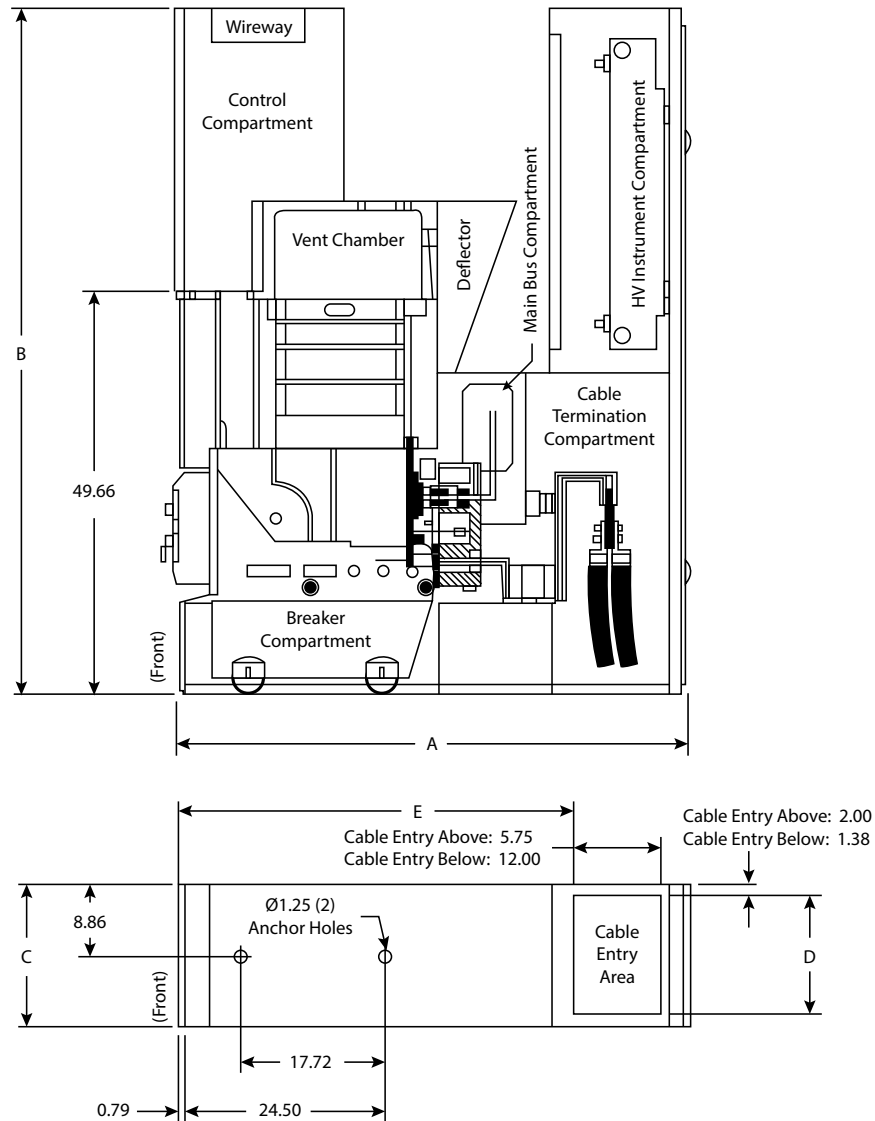
The primary conductors and other connection bars are copper. The connection surfaces are silver surfaced or equivalent. The silver plating used on bolted contact surfaces is approximately 0.0001" thick; plating on sliding contact surfaces are thicker. All field assembled joints in primary conductors,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

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

### **CAUTION**

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

**Figure 4** Typical (UNIT) Dimensions

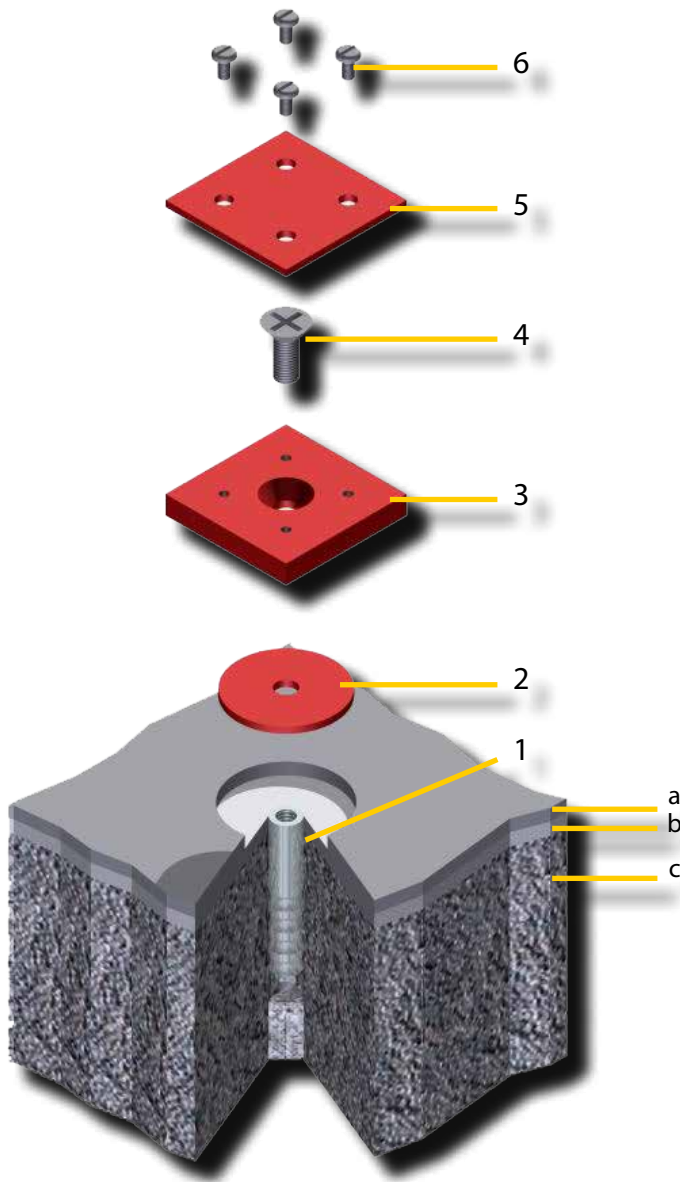


**Table B Type NDC Switchgear Unit Dimensions**

Voltage Class (V)	Unit Depth A (inches)	Unit Height B (inches)	Unit Width C (inches)	Cable Area Width D Below (inches)	Cable Area Width D Above (inches)	Cable Area Begin E Below (inches)	Cable Area Begin E Above (inches)
0-900	62.00	84.25/90.00	17.71	14.96	13.56	47.00	47.50
0-900	62.00	84.25/90.00	23.97	21.21	19.81	47.00	47.50
0-900	68.00	84.25/90.00	17.71	14.96	13.56	47.00	53.25
0-900	68.00	84.25/90.00	23.97	21.21	19.81	47.00	53.25
901-1800	68.00	84.25/90.00	17.71	14.96	13.56	47.00	53.25
901-1800	68.00	84.25/90.00	23.97	21.21	19.81	47.00	53.25



**Figure 5 Switchgear Anchoring Detail**



**Installation Notes:**

- 1) Drill a ½" diameter hole through the epoxy floor and concrete to the depth shown (3.25")
- 2) Fill the hole with adhesive epoxy to ½ hole depth. Recommend using McMaster-Carr Plastic dispenser kit (7498A125) which includes 5oz adhesive cartridge, mixing nozzle, and 5oz plastic dispenser. This kit will install sixteen ½" diameter rods at an embedded depth of 4-½". If additional epoxy is needed purchase McMaster-Carr 5oz adhesive cartridge (7598A11).
- 3) Hammer anchor into hole until level with epoxy floor.

- a. DC Switchgear Foot Plate (1)
- b. Epoxy Floor
- c. Concrete Base

**Table C Anchoring Detail Parts List**

Part Number	Quantity	Item Number	Description
93980A150	1	1	Anchor, Internal Thread, Adhesive Grip
21900P00009003	1	2	Insert, Tie Down, DC Cell
21900P00009001	1	3	Base, Tie Down
W1419	1	4	Screw FHMS, 3/8-16 UNC X1
21900P00009000	1	5	Cap, Tie Down
Pan Head, Slotted, 10-32 UNF x 0.375	4	6	Pan Head, Slotted, 10-32 UNF x 0.375

2. Join the clean contact surfaces by using the hardware provided.

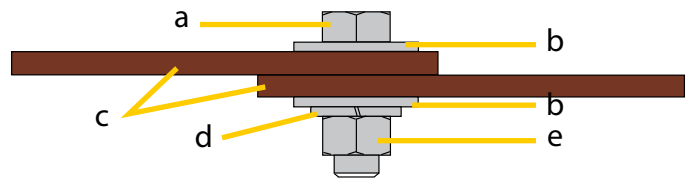
The correct length of bolt must be used in each joint to ensure that electrical clearances at bolt locations are maintained. As a general rule, when using ½ inch diameter bolts, the bolts should be 1 inch longer than the combined thickness of the copper bars being bolted together.

For example, if three (3) ¼ inch thick copper bars are to be connected, the bolt should be 1-¾ inch long. In addition to proper bolt length, the bolted assembly must include flat washers, split ring lock washers, and nuts. All bus joint hardware is zinc-plated, dichromate treated, high strength steel (SAE Grade 5). See [Figure 6](#) for proper hardware assembly.

**Note:** Once the connection is torqued, it is recommended that 3 threads should be exposed beyond the hex-nut.

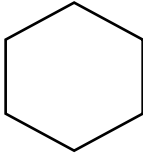
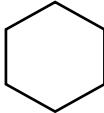


3. In some cases, external connections are made to metal-enclosed switchgear bus by bars. The metal-enclosed switchgear bars are normally silver-plated. Unplated bars, either copper or aluminum, should not be used to connect to plated bars.

**Figure 6 Typical Bolted Assembly**



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

**Note:** All hardware should be tightened to the torque values listed in [Table D Bolt Torque Values for Powell Low Voltage Metal-Enclosed Switchgear](#).

Table D Bolt Torque Values for Powell Low Voltage Metal-Enclosed Switchgear			
Bolt Dimensions (inches)	Bolt Head	Torque	
		Ft-Lbs	Kg-M
5/8		55-70	7.6-9.7
1/2		35-50	4.8-6.9
3/8		20-30	2.8-4.2
1/4		5-7	0.7-0.97

**Note:** Bolt heads are not actual size.



## **I. BUS CONNECTIONS AT SHIPPING SPLITS**

Before shipping the switchgear from the factory, sometimes it will be necessary to split the line-up of switchgear into smaller sections due to transportation or installation limitations. Typically when this occurs the main bus and continuity bus will have to be reconnected in the field.

### **1) Main Bus**

There are typically three main bus access covers in each vertical section.

The first access cover is located in the breaker compartment, and mounted directly above the shutter assembly ([Figure 7](#)). This cover assembly is made up of two parts. The first part is made from a non-metallic insulating material. The second part is made from sheet metal.

## **NOTICE**

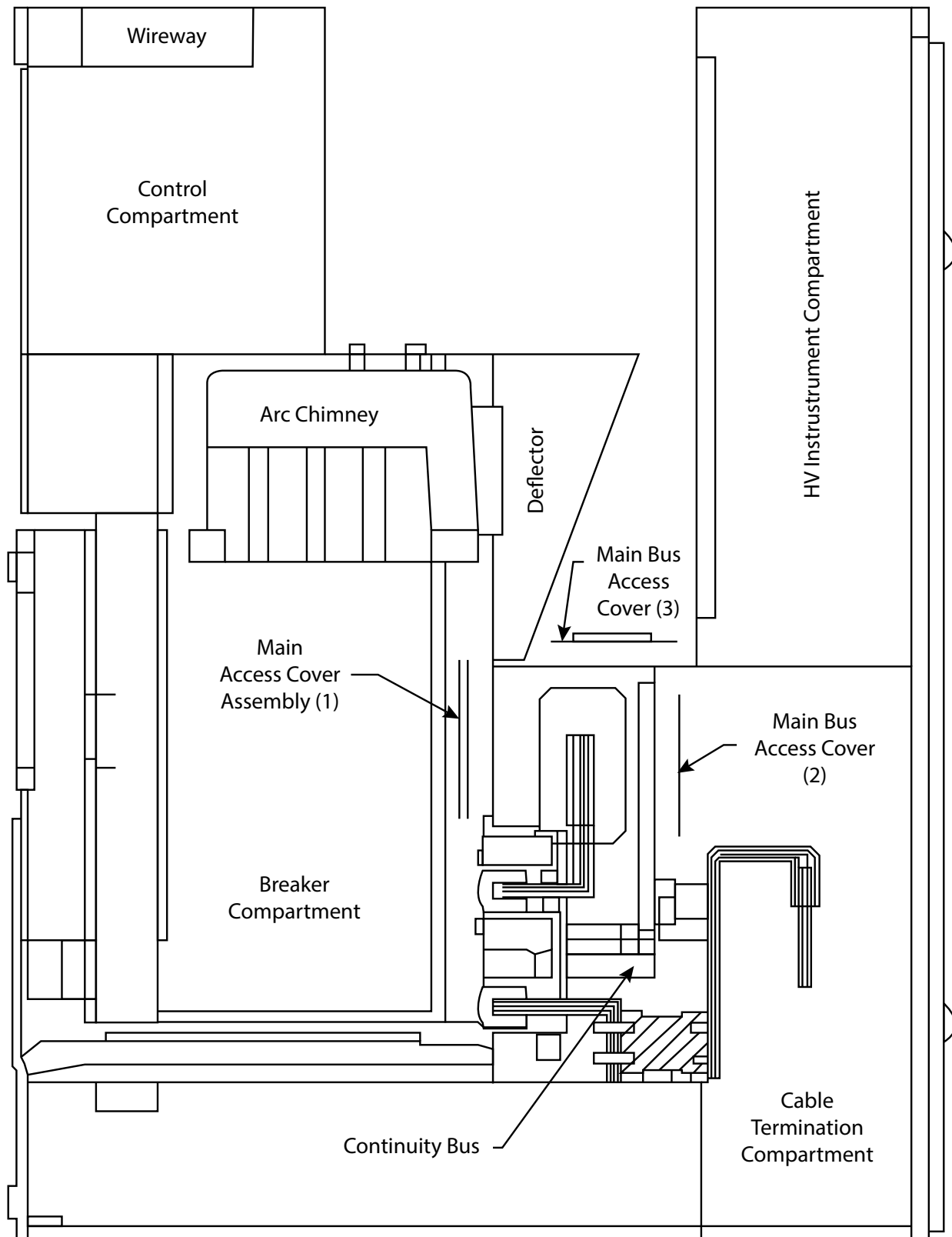
***When reassembling these covers ensure that the insulating cover is installed facing the circuit breaker compartment door.***

The second cover is accessed from the rear of the switchgear through the cable termination compartment ([Figure 7](#)). Depending on the configuration of the primary conductors located in this compartment, there may be no advantage to removing this cover for main bus access.

To access the third cover it will be necessary to remove the deflector assembly, being careful not to deform the film barrier located between the vent chamber and deflector ([Figure 7](#)).

*Note: Before installing the bus bars it is important to consult the installation drawings supplied with the switchgear for proper arrangement of the bus bars and splice assemblies. Be sure all bus connections are tight and torqued per the values given in [Table D Bolt Torque Values for Powell Low Voltage Metal-Enclosed Switchgear](#).*

**Figure 7** *Main Bus Access Covers and Continuity Bus*





## 2) Continuity Bus

The continuity bus is located in the cable termination compartment affixed to the exterior of the bottom cover of the main bus compartment (Figure 7). The bus bar is formed so that when the adjoining units are mated together the contact surfaces will be in contact. The connection is completed by using the 5/16" hardware provided in the ship loose material.

### **WARNING**

***It is of high importance that the continuity bus be reconnected properly to assure proper functioning of the ground structure relay (ANSI 64). Failure to do so can lead to an unsafe working environment.***

## J. POWER CABLES

Access the primary cable connections in the switchgear by opening the rear hinged doors. Before any cable connections are made, the cables should be identified to indicate their relationship with the switchgear connections. Normally compression type terminals are used to terminate the primary cables.

## K. CONTROL CABLES

Control cables typically enter from the top of the switchgear through a non-metallic conduit. The top covers will need to be drilled to suit the conduits, being careful not to damage existing wire bundles. Fasten the conduits to the cover using locknuts.

The cable from the control power source to the switchgear must be large enough to avoid excessive voltage drop when the circuit breakers are operated. Where units have

been split for shipment, any control or other secondary leads that must connect across the split will be arranged with terminal points 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 amount of time will be required for reconnecting them.

## L. INSERTING AND REMOVING THE CIRCUIT BREAKER FROM THE CIRCUIT BREAKER COMPARTMENT

Refer to the *Brush Operations and Maintenance Manual (55/4190)* for all installation and removal procedures.

## M. INSPECTION AND TESTING

For assistance with testing and inspection contact Powell North Canton Division (NCD) at 1.800.222.6234 or email [ncdsalesinfo@powellind.com](mailto:ncdsalesinfo@powellind.com).

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

The directions for testing devices such as relays, instruments, and meters are given in the instruction bulletin furnished for each device. General instruction bulletins are furnished for complicated automatic equipment, describing the sequence of operation for the devices required to perform the desired functions.

### 1) *Inspection*

The following checks need to be made during inspection:

- a. Power and secondary connections are properly made.
- b. Connections to the continuity bus are properly made.
- c. Circuit breakers are prepared in accordance with the *Brush Operations and Maintenance Manual (55/4190)*.
- d. All vent areas are clean and free of shipping or construction materials.
- e. All tools are removed from the equipment and the area is free from debris.

### 2) *Testing*

The following test shall be completed before energizing any circuit of the switchgear:

- a. An insulation resistance test shall be made to ensure all connections made in the field are free of undesirable grounds.
- b. A dielectric test shall be made on the low voltage primary power circuit for one minute at the appropriate test voltage. [transducer, circuit breaker control modules (CBCM), and surge arrestors must be disconnected during this test].

**Note:** *Most equipment supplied by Powell will include a detailed field test plan. If the field test plan was not part of the contract, it becomes the responsibility of the equipment user to perform the necessary test to assure safe operation of the equipment.*



## Ch 5 Maintenance

Contact Powell Service Division for assistance in performing maintenance or setting up a maintenance program either by phone 1.800.480.7273, by email [ncdsalesinfo@powellind.com](mailto:ncdsalesinfo@powellind.com), or by visiting our website at [powellind.com](http://powellind.com).

### NOTICE

***Before attempting any maintenance work, it is important to study and fully understand the safety practices outlined in Ch 2 Safety of this instruction bulletin. If there is any reason to believe there are any discrepancies in the descriptions contained in this instruction bulletin, or if they are deemed to be confusing and/or not fully understood, contact Powell immediately.***

#### A. GENERAL DESCRIPTION

##### 1) Introduction

Periodic inspections and maintenance are essential. Powell low voltage DC switchgear is designed for use in typical service environments that do not expose the equipment to excessive dust, acid fumes, harmful chemicals, salt air, rapid or frequent temperature changes, vibration, high humidity, or extreme temperatures. The maintenance schedule should be adjusted based on experience and service environment.

### NOTICE

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

A permanent record of all maintenance work should be kept, the degree of detail depends upon the operating conditions. The record will be a valuable reference for subsequent maintenance work and for station operation. It is also recommended that the record include reports of tests performed, condition of the equipment, and any repairs or adjustments that were performed. This record should begin with tests performed at the time of installation and energizing, and all data should be graphed as a function of time to ensure a proper maintenance cycle is scheduled.

### CAUTION

***Prior to performing any maintenance on the switchgear, make sure all circuits are deenergized and the circuit breakers are withdrawn to the disconnected position and locked out.***

### CAUTION

***If work is to be done on remote equipment connected to a section of the switchgear, the circuit breaker must be placed in the disconnected position. The remote equipment should also be isolated from any other power sources.***

## 2) *Cleaning*

Primary bus supports should be cleaned. Wipe the supports clean with a dry, lint-free cloth or an industrial type wiper. If dirt adheres and cannot be removed by wiping, remove it with a mild solvent such as denatured alcohol. Do not use any type of detergent to wash the surfaces of the supports because detergent may leave an electrically conducting residue on the surface as it dries.

## 3) *Abnormal Wear*

Check primary disconnecting device contacts for signs of abnormal wear or overheating. Discoloration of the silver surface is not ordinarily harmful unless atmospheric conditions cause deposits, such as sulfides on the contacts. If deemed necessary, clean the contact surface with a good grade of silver polish. Apply a thin coat of contact lubricate to the main contacts before replacing the circuit breaker in to the breaker compartment.

## **B. MAINTENANCE PROCEDURES**

### **CAUTION**

***Prior to beginning any maintenance procedures, make certain that the equipment is deenergized and grounded.***

***Note: If the switchgear is configured in such a way that adjacent substation power sources are connected to the switchgear, those power sources must be deenergized also.***

## 1) *Switchgear Condition*

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

## 2) *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.

For breaker lubrication instructions refer to the *Brush Type NDC® Operations and Maintenance Manual (55/4190)*.

## 4) *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.

## 5) *Secondary Wiring*

Check all wiring connections for tightness, including those at the shunt and at the terminal blocks where circuits leave the switchgear. Ensure that the secondary wiring connections from any protective relays are properly connected to the continuity bus.

## 6) *Mechanical Parts*

Visually check and manually operate mechanical moving parts such as the shutters, TOC, and also check the hinged doors. Examine mechanical mating parts such as the levering-in arms and the breaker guide channels.



### 7) *Ventilation*

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

### 8) *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.

### 9) *Anchor Bolts*

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

### 10) *Heaters*

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

### 11) *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 regularly maintenance periods.

Although DC switchgear primary conductors are typically non-insulated, it is recommended insulation resistance tests are performed for checking the insulation material used to support the conductors.

A series of these tests will indicate any tendency toward a reduction in dielectric strength of the insulating material. 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 readings, 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 large number of parallel insulation resistance paths to ground, which tends to decrease insulation readings. This variation in 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.

## *12) Abnormal Conditions*

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

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

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



## **Ch 6 Recommended Renewal Parts and Replacement Procedure**

### **A. ORDERING INSTRUCTIONS**

1. To order Replacement Parts from Powell, email [ncdsalesinfo@powellind.com](mailto:ncdsalesinfo@powellind.com) or call 1.800.222.6234.
2. Always specify the complete nameplate information including:
  - Circuit Breaker Type
  - Serial Number
  - Rated Voltage
  - Rated Amps
  - Control Voltage (for control devices)
3. Specify the quantity and description of the part and the instruction bulletin number. If the part is in any of the recommended renewal parts tables, specify the catalog number. If the part is not in any of the tables, a description should be accompanied by a marked illustration from this instruction bulletin or photo.
4. Standard hardware such as screws, bolts, nuts, washers, etc., should be purchased locally. Hardware used in bolted joints of conductors must be SAE Grade 5 or better to ensure proper clamping torque and to prevent the joints from overheating. The hardware should be plated to deter corrosion.



**01.4IB.25002B**  
**Low Voltage Metal-Enclosed**  
**Type NDC® DC Switchgear**

*Equipped with Brush  
Type NDC Circuit Breakers*

April 2023