DH-VR+
VR-Series+ Replacement Circuit Breaker

50DH-VR+ 250 1200A Shown

EATON
Powering Business Worldwide
DH-VR+
VR-Series® Replacement Circuit Breaker

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITY

The information, recommendations, descriptions and safety notations in this document are based on Eaton’s experience and judgment and may not cover all contingencies. If further information is required, an Eaton sales office should be consulted. Sale of the product shown in this literature is subject to the terms and conditions outlined in appropriate Eaton selling policies or other contractual agreement between Eaton and the purchaser.

THERE ARE NO UNDERSTANDINGS, AGREEMENTS, WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, OTHER THAN THOSE SPECIFICALLY SET OUT IN ANY EXISTING CONTRACT BETWEEN THE PARTIES. ANY SUCH CONTRACT STATES THE ENTIRE OBLIGATION OF EATON. THE CONTENTS OF THIS DOCUMENT SHALL NOT BECOME PART OF OR MODIFY ANY CONTRACT BETWEEN THE PARTIES.

In no event will Eaton be responsible to the purchaser or user in contract, in tort (including negligence), strict liability or otherwise for any special, indirect, incidental or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of power, additional expenses in the use of existing power facilities, or claims against the purchaser or user by its customers resulting from the use of the information, recommendations and descriptions contained herein. The information contained in this manual is subject to change without notice.

⚠️ DANGER

IMPROPERLY INSTALLING OR MAINTAINING THESE PRODUCTS MAY CAUSE THE EQUIPMENT TO FAIL, RESULTING IN DEATH, SEVERE PERSONAL INJURY, EQUIPMENT DAMAGE AND/OR IMPROPER OPERATION.

READ AND UNDERSTAND THESE INSTRUCTIONS BEFORE ATTEMPTING ANY UNPACKING, ASSEMBLY, OPERATION OR MAINTENANCE OF THE CIRCUIT BREAKERS.

INSTALLATION OR MAINTENANCE SHOULD BE ATTEMPTED ONLY BY QUALIFIED PERSONNEL. THIS INSTRUCTION BOOKLET SHOULD NOT BE CONSIDERED ALL INCLUSIVE REGARDING INSTALLATION OR MAINTENANCE PROCEDURES. IF FURTHER INFORMATION IS REQUIRED, YOU SHOULD CONSULT EATON’S ELECTRICAL SERVICES & SYSTEMS.

THE CIRCUIT BREAKERS DESCRIBED IN THIS BOOK ARE DESIGNED AND TESTED TO OPERATE WITHIN THEIR NAMEPLATE RATINGS. OPERATION OUTSIDE OF THESE RATINGS MAY CAUSE THE EQUIPMENT TO FAIL, RESULTING IN DEATH, SEVERE PERSONAL INJURY, EQUIPMENT DAMAGE AND/OR IMPROPER OPERATION.

ALL SAFETY CODES, SAFETY STANDARDS AND/OR REGULATIONS AS THEY MAY BE APPLIED TO THIS TYPE OF EQUIPMENT MUST BE STRICTLY ADHERED TO.

THESE VACUUM REPLACEMENT CIRCUIT BREAKERS ARE DESIGNED TO BE INSTALLED PURSUANT TO THE AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI). SERIOUS INJURY, INCLUDING DEATH, SEVERE PERSONAL INJURY, EQUIPMENT DAMAGE AND/OR IMPROPER OPERATION.

This product was manufactured by Eaton at the Power Breaker Center (PBC): 310 Maxwell Avenue, Greenwood, SC 29646.

All possible contingencies which may arise during installation, operation or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of particular equipment, contact an Eaton representative.
Table of Contents

SECTION 1: INTRODUCTION 4
  1.1 VISUAL INSTRUCTION BOOKLET ESSENTIALS 4
  1.2 QUICK RESPONSE CODE 4
  1.3 AVAILABLE DH-VR+ CIRCUIT BREAKERS 4

SECTION 2: SAFE PRACTICES 7

SECTION 3: RECEIVING, HANDLING, AND STORAGE 8
  3.1 RECEIVING 8
  3.2 HANDLING 9
  3.3 STORAGE 9
  3.4 APPROXIMATE WEIGHT BY TYPE 9

SECTION 4: DESCRIPTION AND OPERATION 12
  4.1 VACUUM INTERRUPTER 12
  4.1.1 VACUUM INTERRUPTER ASSEMBLY 12
  4.1.2 CONTACT EROSION INDICATOR 12
  4.1.3 CONTACT WIPE AND STROKE 13
  4.2 LINE AND LOAD CONDUCTOR ASSEMBLIES 13
  4.3 STORED ENERGY MECHANISM 13
  4.3.1 CLOSING SPRING CHARGING 13
  4.3.2 CLOSING OPERATION 13
  4.3.3 TRIPPING OPERATION 14
  4.3.4 TRIP-FREE OPERATION 14
  4.4 CONTROL SCHEMES 14
  4.4.1 TIMING 14
  4.5 SECONDARY DISCONNECT CONTACT BLOCK 14
  4.6 INTERLOCKS 16
  4.6.1 RACKING-IN INTERLOCK 16
  4.6.2 ANTI-CLOSE INTERLOCK 16
  4.6.3 AIR CIRCUIT BREAKER REJECTION BAR 16
  4.7 MISCELLANEOUS ITEMS 16
  4.7.1 GROUNDING CONTACT 16
  4.7.2 MOC AND TOC OPERATIONS 16
  4.7.3 OPERATIONS COUNTER 16

SECTION 5: INSPECTION & INSTALLATION 21
  5.1 EXAMINATION FOR DAMAGE 21
  5.1.1 NAMEPLATE VERIFICATION 21
  5.2 SURE CLOSE MECHANISM ADJUSTMENT 21
  5.3 MANUAL OPERATION CHECK 22
  5.4 VACUUM INTERRUPTER INTEGRITY 22
  5.5 INSULATION 22
  5.6 CONTACT EROSION AND WIPE 22
  5.7 PRIMARY CIRCUIT RESISTANCE 22
  5.8 ELECTRICAL OPERATIONS CHECK 22
  5.9 CIRCUIT BREAKER COMPARTMENT POSITION DESCRIPTION 23
  5.10 RACKING CIRCUIT BREAKER INTO CIRCUIT BREAKER COMPARTMENT 24
  5.11 REMOVING CIRCUIT BREAKER FROM CIRCUIT BREAKER COMPARTMENT 25

SECTION 6: INSPECTION & MAINTENANCE 26
  6.1 INSPECTION FREQUENCY 26
  6.2 INSPECTION AND MAINTENANCE PROCEDURES 26
  6.3 VACUUM INTERRUPTER INTEGRITY TEST 27
  6.4 CONTACT EROSION AND WIPE 27
  6.5 INSULATION 28
  6.6 INSULATION INTEGRITY CHECK 28
  6.7 PRIMARY CIRCUIT RESISTANCE CHECK 28
  6.8 VR-SERIES+ CIRCUIT BREAKER ELEMENT MECHANISM CHECK 28
  6.8.1 CLOSURE™ TEST 28
  6.9 MAINTENANCE RECOMMENDATION 32

SECTION 7: REPLACEMENT PARTS 34
  7.1 GENERAL 34
  7.2 ORDERING INSTRUCTIONS 34
SECTION 1:  INTRODUCTION

This instruction booklet provides information on receiving and handling, storage, installation, operation and maintenance of the DH VR-Series+ vacuum replacement circuit breaker. The Vacuum Replacement circuit breakers (also referred to as VR-Series+) are designed to be used in existing Westinghouse type DH metal-clad switchgear. The VR-Series circuit breakers provide superior electrical and mechanical performance as compared to the design ratings of the original circuit breaker. VR-Series+ Circuit breakers provide reliable control, protection and performance, with ease of handling and maintenance. Like ratings of the VR-Series+ circuit breakers are interchangeable with each other.

The VR-Series+ circuit breaker element offers:

- 10-year or 10,000 operation scheduled maintenance intervals. When applied in “usual service conditions” as defined by IEEE C37.04-1999, the VR-Series+ circuit breaker element requires maintenance only once every ten years or ten thousand operations, which ever comes first.  
  
  Note:  See Inspection & Maintenance section in this booklet for details.

- Increased mechanical endurance. Circuit breakers in repetitive duty applications offer 50% more operations over conventional vacuum circuit breaker elements before parts replacement may be needed.

- Increased short circuit capability. The VR-Series+ circuit breaker short circuit capability can be increased to 41 kA, provided a bus bracing study is performed and the switchgear is adequately braced to meet the requirements per IEEE C37.59.

Use this instruction bulletin in conjunction with the technical information provided with the original equipment order which includes electrical control schematic and wiring diagrams, outline diagrams, installations plans, and procedures for installation and maintenance of accessory items.

Satisfactory performance is dependent on proper application, correct installation, and adequate maintenance. It is very important that this installation and maintenance instruction booklet be read and followed closely to achieve optimum performance and a long useful circuit breaker life in its application.

1.1 VISUAL INSTRUCTION BOOKLET ESSENTIALS

Eaton provides additional documentation designed to enhance the technical information provided in this instruction booklet for the VR-Series+ circuit breakers. The Visual Instruction Booklet Essentials (VIBE) is a digital supplemental booklet featuring user interactive content and informative videos intended to assist with the maintenance of the VR-Series+ circuit breaker. The VIBE document is available for immediate download at www.eaton.com/VR-Series.

1.2 QUICK RESPONSE CODE

VR-Series+ circuit breakers have a quick response code (QR Code) on the escutcheon of the circuit breaker front cover. This QR Code is a matrix barcode that provides direct access to download VR-Series+ specific documentation, such as product instruction booklets and the VIBE documentation. See Figure 1.1 for the featured VR-Series+ QR Code.

Note: A smart phone with an adequate QR Code Scanner application must be used. Downloading content may incur data charges from the mobile service provider.

WARNING

SATISFACTORY PERFORMANCE OF THESE CIRCUIT BREAKERS IS CONTINGENT UPON PROPER APPLICATION, CORRECT INSTALLATION AND ADEQUATE MAINTENANCE. THIS INSTRUCTION BOOKLET MUST BE CAREFULLY READ AND FOLLOWED IN ORDER TO OBTAIN OPTIMUM PERFORMANCE FOR LONG USEFUL LIFE OF THE CIRCUIT BREAKERS. IT IS FURTHER RECOMMENDED THAT THE INSTALLATION BE PERFORMED BY AN EATON TRAINED ENGINEER OR TECHNICIAN.

VR-SERIES+ CIRCUIT BREAKERS ARE PROTECTIVE DEVICES, AS SUCH, THEY ARE MAXIMUM RATED DEVICES. THEREFORE, THEY SHOULD NOT UNDER ANY CIRCUMSTANCE BE APPLIED OUTSIDE THEIR NAMEPLATE RATINGS.

ALL POSSIBLE CONTINGENCIES WHICH MIGHT ARISE DURING INSTALLATION, OPERATION, OR MAINTENANCE, AND ALL DETAILS AND VARIATIONS OF THIS EQUIPMENT ARE NOT COVERED BY THESE INSTRUCTIONS. IF FURTHER INFORMATION IS DESIRED BY THE PURCHASER REGARDING A PARTICULAR INSTALLATION, OPERATION, OR MAINTENANCE OF THIS EQUIPMENT, THE LOCAL EATON REPRESENTATIVE SHOULD BE CONTACTED.

1.3 AVAILABLE DH-VR+ CIRCUIT BREAKERS

Refer to Table 1.
### Table 1. DH-VR+ Availability and Interchangeability

<table>
<thead>
<tr>
<th>Existing DH Circuit Breaker Type</th>
<th>DH-VR+ Circuit Breaker Type</th>
<th>Maximum Voltage</th>
<th>Nominal 3-Phase MVA Class</th>
<th>Existing Circuit Breaker Rated Continuous Current at 60 Hz</th>
<th>Rated Voltage Factor</th>
<th>Rated Withstand ANSI Test Voltage</th>
<th>Rated Short-Circuit</th>
<th>Maximum Sym. Interrupting Capability</th>
<th>Closing and Latching / Momentary Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>50DH150</td>
<td>50DH-VR+150U</td>
<td>4.76</td>
<td>150</td>
<td>1200</td>
<td>1.24</td>
<td>19</td>
<td>60</td>
<td>29</td>
<td>36 / 58 / 97</td>
</tr>
<tr>
<td>50DH250</td>
<td>50DH-VR+250</td>
<td>4.76</td>
<td>250</td>
<td>1200</td>
<td>1.24</td>
<td>19</td>
<td>60</td>
<td>29</td>
<td>36 / 58 / 97</td>
</tr>
<tr>
<td>50DH250</td>
<td>50DH-VR+41</td>
<td>4.76</td>
<td>250</td>
<td>1200</td>
<td>1.00</td>
<td>19</td>
<td>60</td>
<td>41</td>
<td>41 / 78 / 132</td>
</tr>
</tbody>
</table>

1. All circuit breakers have a 3 second short-time and 3-cycle interrupting ratings.  
2. Non-standard rating.  
3. Requires bus bracing study and additional switchgear bracing.
Table 2. Available DH-VR+ Dimensions

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>50DH-VR+</td>
<td>1200</td>
<td>64.38</td>
<td>22.25</td>
<td>7.00</td>
<td>32.61</td>
<td>9.00</td>
</tr>
</tbody>
</table>
SECTION 2:  SAFE PRACTICES

VR-Series+ circuit breakers are equipped with high speed, high energy operating mechanisms. They are designed with several built-in interlocks and safety features to provide safe and proper operating sequences.

⚠️ DANGER

TO PROTECT THE PERSONNEL ASSOCIATED WITH INSTALLATION, OPERATION, AND MAINTENANCE OF THESE CIRCUIT BREAKERS, THE FOLLOWING PRACTICES MUST BE FOLLOWED:

- Only qualified persons, as defined in the National Electrical Safety Code, who are familiar with the installation and maintenance of medium voltage circuits and equipment, should be permitted to work on these circuit breakers.
- Read these instructions carefully before attempting any installation, operation or maintenance of these circuit breakers.
- Always remove the circuit breaker from the enclosure before performing any maintenance. Failure to do so could result in electrical shock leading equipment failure, resulting in death, severe personal injury, equipment damage and/or improper operation.
- Do not work on a circuit breaker with the secondary test coupler engaged. Failure to disconnect the test coupler could result in an electrical shock leading to death, severe personal injury, equipment damage and/or improper operation.
- Do not work on a closed circuit breaker or a circuit breaker with closing springs charged. The closing spring should be discharged and the main contacts open before working on the circuit breaker. Failure to do so could result in cutting or crushing injuries.
- Do not use a circuit breaker by itself as the sole means of isolating a high voltage circuit. Remove the circuit breaker to the ‘Disconnect’ position and follow all lockout and tagging rules of the National Electrical Code and any and all applicable codes, regulations and work rules.
- Do not leave the circuit breaker in an intermediate position in the circuit breaker compartment. Always have the circuit breaker either in the ‘Test’ or ‘Connect’ position. Failure to do so could result in a flash over causing the equipment to fail, resulting in death, severe personal injury, equipment damage and/or improper operation.
- Always remove the maintenance tool from the circuit breaker after charging the closing springs.
- Circuit breakers are equipped with safety interlocks. Do not defeat them. This may result in equipment failure, resulting in death, severe personal injury, equipment damage and/or improper operation.
SECTION 3: RECEIVING, HANDLING, AND STORAGE

VR-Series+ circuit breakers are subjected to complete factory production tests and inspection before being packed. They are shipped in packages designed to provide maximum protection to the equipment during shipment and storage and at the same time to provide convenient handling. Accessories such as the maintenance tool, code plate, (if applicable) etc. are shipped with the circuit breaker.

3.1 RECEIVING

Until the circuit breaker is ready to be delivered to the switchgear site for installation, DO NOT remove it from the shipping crate. If the circuit breaker is to be placed in storage, maximum protection can be obtained by keeping it in its crate.

Upon receipt of the equipment, inspect the crates for any signs of damage or rough handling. Open the crates carefully to avoid any damage to the contents. Use a nail puller rather than a crow bar when required.

When opening the crates, be careful that any loose items or hardware are not discarded with the packing material. Check the contents of each package against the packing list.

Examine the circuit breaker for any signs of shipping damage such as broken, missing or loose hardware, damaged or deformed insulation and other components. If damaged or loss is detected, file claims immediately with the carrier and notify an Eaton representative.

Tools and Accessories

Maintenance Tool (Style# 94C9506G01): This tool is used to manually charge the closing springs. One maintenance tool is provided with each vacuum replacement circuit breaker.

Racking Handle (Style# BT320G03): Optional racking handle used to drive the racking mechanism which moves the circuit breaker into and out of the circuit breaker compartment. The OEM racking handle will interface with the VR-Series+ replacement circuit breaker racking mechanism and is therefore not provided as part of the vacuum replacement circuit breaker.

Lifting Strap (Style# 94B1194G01): Optional item recommended for lifting the DH-VR+ circuit breaker.

Turning Dolly (Style# 94A9502G02): Optional item used to help maneuver circuit breaker when out of the circuit breaker compartment.
### 3.2 HANDLING

**WARNING**

DO NOT USE ANY LIFTING DEVICE AS A PLATFORM FOR PERFORMING MAINTENANCE, REPAIR OR ADJUSTMENT OF THE CIRCUIT BREAKER OR FOR OPENING, CLOSING THE CONTACTS OR CHARGING THE SPRINGS. THE CIRCUIT BREAKER MAY SLIP OR FALL CAUSING SEVERE PERSONAL INJURY. ALWAYS PERFORM MAINTENANCE, REPAIR AND ADJUSTMENTS ON A WORKBENCH CAPABLE OF SUPPORTING THE CIRCUIT BREAKER TYPE.

VR-Series+ circuit breaker shipping containers are designed to be handled either by use of an overhead lifting device or by a fork lift truck. If containers must be skidded for any distance, it is preferable to use roller conveyors or individual pipe rollers.

Once a circuit breaker has been inspected for shipping damage, it is best to return it to its original shipping crate until it is ready to be installed in the metal-clad switchgear.

When the circuit breaker is ready for installation, a lifting harness in conjunction with an overhead lift or portable floor lift can be used to move the circuit breaker. If the circuit breaker is to be lifted, position the lifting device over the circuit breaker and insert the lifting harness hooks into the circuit breaker side lifting points and secure (lifting straps should have at least a 1000lbs lift capacity). Be sure the hooks are firmly attached before lifting the circuit breaker. Stand a safe distance away from the circuit breaker while lifting and moving.

![Figure 3.2. Lifting the DH-VR+](image)

### 3.3 STORAGE

If the circuit breaker is to be placed in storage, maximum protection can be obtained by keeping it in the original shipping crate. Confirm that the circuit breaker is free from shipping damage and is in satisfactory operating condition before placing it in to storage.

The circuit breaker is shipped with its contacts open and closing springs discharged. The indicators on the front cover should confirm this. Insert the end of the maintenance tool into the manual charge socket opening and charge the closing springs by moving the handle up and down the full range of motion. When charging is complete the ratchet will no longer advance and the spring charged / discharged indicator displays 'Charged'. (Figure Set 3.3). Remove the maintenance tool. Push the "manual close" operator. The circuit breaker will close as shown by the circuit breaker contacts 'Closed' indicator. Push the "manual trip" operator. The circuit breaker will trip as shown by the circuit breaker contacts 'Open' indicator. After completing this initial check, leave the closing springs 'Discharged' and circuit breaker contacts 'Open'.

Outdoor storage is NOT recommended. If unavoidable, the outdoor location must be well drained and a temporary shelter from sun, rain, snow, corrosive fumes, dust, dirt, falling objects, excessive moisture, etc. must be provided. Containers should be arranged to permit free circulation of air on all sides and temporary heaters should be used to minimize condensation. Moisture can cause rusting of metal parts and deterioration of high voltage insulation. A heat level of approximately 400 watts for each 100 cubic feet of volume is recommended with the heaters distributed uniformly throughout the structure near the floor.

Indoor storage should be in a building with sufficient heat and circulation to prevent condensation. If the building is not heated, the same general rule for heat as for outdoor storage should be applied.

### 3.4 APPROXIMATE WEIGHT BY TYPE

<table>
<thead>
<tr>
<th>Type</th>
<th>Amperes</th>
<th>LBs</th>
</tr>
</thead>
<tbody>
<tr>
<td>50DH-VR+</td>
<td>1200</td>
<td>600</td>
</tr>
</tbody>
</table>
DH-VR+ VR-Series+ Replacement Circuit Breaker

Figure 3.3.a. Front External View of DH-VR+ (50DH-VR+ 250 1200A Shown)

1 Lifting Point
2 Lock Out Provision
3 Front Cover
4 Circuit Breaker Contact Status Indicator
5 Manual Charge Socket
6 Spring Charged / Discharged Indicator
7 Operations Counter
8 Push To Open Operator
9 Push To Close Operator
10 Racking Shaft
11 Racking Access Handle
12 Secondary Disconnect Slide
13 Turning Dolly Bracket

Front External View
Figure 3.3.b. Rear External View of DH-VR+ (50DH-VR+ 250 1200A Shown)

Rear External View

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lifting Point</td>
</tr>
<tr>
<td>2</td>
<td>Vacuum Interrupter</td>
</tr>
<tr>
<td>3</td>
<td>Racking Arm Mechanism</td>
</tr>
<tr>
<td>4</td>
<td>TOC Operator</td>
</tr>
<tr>
<td>5</td>
<td>Clear Phase Barrier</td>
</tr>
<tr>
<td>6</td>
<td>Primary Disconnect Contact</td>
</tr>
<tr>
<td>7</td>
<td>Ground Contact</td>
</tr>
<tr>
<td>8</td>
<td>Secondary Disconnect Contact Block</td>
</tr>
</tbody>
</table>

DH-VR+ VR-Series+ Replacement Circuit Breaker
SECTION 4: DESCRIPTION AND OPERATION

VR-Series+ vacuum replacement circuit breakers are designed to be used with existing installations of equivalent air-magnetic metal-clad switchgear circuit breakers. The front mounted spring type stored energy mechanism facilitates inspection and provides improved access to components for servicing. The long life characteristics of the vacuum interrupters and proven high reliability of spring-type stored energy mechanisms assure long, trouble-free service with minimum maintenance.

4.1 VACUUM INTERRUPTER

Vacuum interrupters offer the advantages of enclosed arc interruption, small size and weight, longer life, reduced maintenance, minimal mechanical shock, and elimination of contact degradation caused by environmental contamination.

In the closed position, current flows through the interrupter moving and fixed stems and the faces of the main contacts. As the contacts part, an arc is drawn between the contact surfaces. The arc is rapidly moved away from the main contacts to the slotted contact surfaces by self-induced magnetic effects. This minimizes contact erosion and hot spots on the contact surfaces. The arc flows in an ionized metal vapor and if the vapor leaves the contact area, it would condense into the metal shield which surrounds the contacts.

At current zero, the arc extinguishes and vapor production ceases. Very rapid dispersion, cooling, recombination, and deionization of the metal vapor plasma and fast condensation of metal vapor causes the vacuum to be quickly restored and prevents the transient recovery voltage from causing a restrike across the gap of the open contacts.

4.1.1 VACUUM INTERRUPTER ASSEMBLY

Each vacuum interrupter assembly (also referred to as pole unit) is assembled at the factory as a unit to assure correct dimensional relationships between working components. Three interrupter assemblies are used per circuit breaker. Each vacuum interrupter assembly consists of a molded insulator frame and includes the vacuum interrupter, its lead assembly, bell crank, operating rod, stand-off insulator, and contact load spring. The vacuum interrupter is mounted vertically with the stationary vacuum interrupter stem upward and the moving interrupter stem downward. The pole units are fastened to the circuit breaker’s stored energy mechanism frame. Silver-plated copper laminated shunts transfer current from the moving interrupter stem to the upper primary bushings via a Holm-free, non-sliding conical current transfer. A silver-plated copper casting is attached to the stationary stem, completing the primary circuit to the lower disconnect assemblies. The operating rod, loading spring, and bell crank transfer the mechanical motion from the circuit breaker’s stored energy mechanism to the moving stem of the vacuum interrupter.

4.1.2 CONTACT EROSION INDICATOR

The purpose of the contact erosion indicator is to monitor the erosion of the vacuum interrupter contacts, which is very minimal over time with Eaton vacuum interrupters utilizing copper-chrome contact material. The VR-Series+ vacuum interrupter assembly incorporates both the original vacuum interrupter erosion indicator and the contact-spring wipe into one all-encompassing indicator. The adequacy of the remaining contact erosion and wipe can easily be determined by observing the moving end of the vacuum interrupter assembly on a closed circuit breaker. The procedure to determine the adequacy of the “T” cutout on the vacuum interrupter assembly is depicted in Figures 6.1 and 6.2. If the wipe is inadequate (no part of the “T” cutout is visible) then the vacuum interrupter assembly must be replaced. Field adjustment is not possible.
4.1.3 CONTACT WIPE AND STROKE

The circuit breaker mechanism provides a fixed amount of motion to the operating rods connected to the moving stem of the vacuum interrupter. The first portion of the motion, the stroke, is used to close the vacuum interrupter contacts; the remainder of that motion, the wipe, is used to further compress the pre-loaded wipe spring. Contact stroke and wipe are related; contact wipe is the indication of the force holding the vacuum interrupter contacts closed as well as the energy available to hammer the contacts open with sufficient speed for interruption. Stroke is the gap between the stationary and moving contact of the vacuum interrupter when the circuit breaker is open. As the stroke increases due to contact erosion inside the vacuum interrupter, the wipe decreases. Although these changes are taking place as operations accumulate on the vacuum interrupter, field adjustment of the wipe or stroke are not necessary during the lifetime of the vacuum interrupter.

4.2 LINE AND LOAD CONDUCTOR ASSEMBLIES

Multiple finger type primary disconnecting contacts at the ends of the conductors provide means for connecting and disconnecting the circuit breaker to the bus terminals in the circuit breaker compartment of the metal-clad switchgear.

4.3 STORED ENERGY MECHANISM

The spring-type stored energy operating mechanism is mounted on the circuit breaker frame and in the front of the circuit breaker. Manual closing and opening controls are at the front cover (Figure Set 3.3). They are accessible while the circuit breaker is in any of its basic installation positions. (See Section 5 in this manual)

The mechanism stores the closing energy by charging the closing springs. Spring charging is automatically accomplished when control power is applied to the circuit breaker secondary disconnect contact. When released, the stored energy closes the circuit breaker, charges the wipe and resets the opening springs. The mechanism may rest in any one of the four positions shown in Figure 4.8 as follows:

a. Circuit breaker open, closing springs discharged.

b. Circuit breaker open, closing springs charged.

c. Circuit breaker closed, closing springs discharged.

d. Circuit breaker closed, closing springs charged.

The mechanism is a mechanically “trip-free” design. Trip-free is defined in Section 4.3.4 (Trip-Free Operation).

In normal operation the closing spring is charged by the spring charging motor, and the circuit breaker is closed electrically by the switchgear control circuit signal to energize the spring release coil. Tripping is caused by energizing the trip coil through the control circuit.

For maintenance inspection purposes the closing springs can be charged manually by using the maintenance tool and the circuit breaker can be closed and tripped by pushing the “Push to Close” and “Push to Open” operators on the front cover.

4.3.1 CLOSING SPRING CHARGING

Figure 4.7 shows schematic section views of the spring charging parts of the stored energy mechanism.

The major component of the mechanism is a cam shaft assembly which consists of a shaft to which are attached two closing spring cranks (one on each end), the closing cam, drive plate, and a free-wheeling ratchet wheel.

The ratchet wheel (6) is actuated by an oscillating ratchet lever (12) and drive pawl (10) driven by the motor eccentric cam. As the ratchet wheel rotates, it pushes the drive plates which in turn rotate the closing spring cranks and the closing cam on the cam shaft. The motor will continue to run until the limit switch “LS” contact disconnects the motor.

The closing spring cranks have spring ends connected to them, which are in turn coupled to the closing springs. As the cranks rotate, the closing springs get charged.

The closing springs are completely charged, when the spring cranks go over dead center and the closing stop roller (9) comes against the spring release latch (1). The closing springs are now held in the fully charged position.

The closing springs may also be charged manually as follows: Insert the end of the maintenance tool into the manual charge socket opening and charge the closing springs by moving the handle up and down the full range of motion. When charging is complete the ratchet will no longer advance and the spring charged / discharged indicator displays ‘Charged’. (Figure Set 3.3). Any further motion of the maintenance tool will not result into advance of charging.

4.3.2 CLOSING OPERATION

Figure 4.8 shows the positions of the closing cam and tripping linkage for four different operational states. In Figure 4.8.a the circuit breaker is open and the closing springs are not charged. In this state, the trip latch (8) is disengaged from the trip “D” shaft (9) (unlatched). After the closing springs become charged, the trip latch snaps into the fully reset or latched position (Figure 4.8.b).

When the spring release clapper (Figure 4.7, Item 13) moves into the face of the spring release coil (electrically or manually), the lower portion of the clapper pushes the spring release latch (1) downward. When the spring release latch moves, the cam shaft assembly is free to rotate. The force of the closing cam (Figure 4.8.b, Item 5), moving the main link (2), rotating the pole shaft (4) (which charges the opening spring). This moves the three operating rods (3), closes the main contacts and charges the contact loading springs (not shown). The operational state immediately after the main contacts close but before the spring charging motor recharges the closing springs is illustrated in Figure 4.8.c. Interference of the trip “D” shaft with the trip latch prevents the linkage from collapsing, and holds the circuit breaker closed.
4.3.3 TRIPPING OPERATION

When the trip bar "D" shaft (Figure 4.8.b, Item 9) is turned by movement of the shunt trip clapper (11), the trip latch will slip past the straight cut portion of the trip bar shaft and will allow the banana link and main link roller to lower. The energy of the opening spring and contact loading springs is released to open the main contacts. The mechanism is in the state illustrated (Figure 4.8.b) after the circuit breaker is tripped open.

4.3.4 TRIP-FREE OPERATION

When the manual trip button is held depressed, any attempt to close the circuit breaker results in the closing springs discharging without movement of the pole shaft or vacuum interrupter stem.

4.4 CONTROL SCHEMES

There are two basic control schemes for the VR-Series circuit breaker elements, one for dc control and one for ac control voltages (Figure 4.4). Specific customer order wiring schematics and diagrams are included with each circuit breaker.

There may be different control voltages or more than one tripping device, but the principal mode of operation is as follows:

As soon as the control power is applied, the spring charging motor automatically starts charging the closing spring. When the springs are charged, the motor cut off LS1/bb switch turns the motor off. The circuit breaker may be closed by closing the control switch close (CS/C) contact. Automatically upon closing of the circuit breaker, the motor starts charging the closing springs. The circuit breaker may be tripped any time by closing the control switch close (CS/C) contact. Automatically upon closing of the circuit breaker, the motor starts charging the closing springs. The circuit breaker may be tripped any time by closing the control switch close (CS/C) contacts.

Note the position switch (PS1) contact in the spring release circuit in the scheme. This contact remains closed while the circuit breaker is being racked between the 'Test' and 'Connect' positions for VR-Series circuit breakers. Consequently, it prevents the circuit breaker from closing automatically, even though the control close contact may have been closed while the circuit breaker is racked to the 'Connect' position.

When the CS/C contact is closed, the SR closes the circuit breaker. If the CS/C contact is maintained after the circuit breaker closes, the Y relay is picked up. The Y/a contact seals in Y until CS/C is opened. The Y/b contact opens the SR circuit, so that even though the circuit breaker would subsequently open, it could not be reclosed before CS/C was released and remade. This is the anti-pump function.

4.4.1 TIMING

The opening and closing times for the circuit breakers vary depending upon the control voltage, power rating, environment and test equipment. Differences in timing are expected between initial factory measurements and field inspections. Circuit breaker timing can be measured by service personnel using available equipment before installation and in conjunction with regular maintenance periods to assist in tracking the general health of the circuit breaker. Typical ranges as observed using nominal control voltages are listed in Table 4.

### Table 4. Time Per Event

<table>
<thead>
<tr>
<th>Event</th>
<th>Milliseconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closing Time (From Initiation of Close Signal to Contact Make)</td>
<td>45 - 60</td>
</tr>
<tr>
<td>Opening Time (Initiation of Trip Signal to Contact Break)</td>
<td>30 - 38</td>
</tr>
<tr>
<td>Reclosing Time (Initiation of Trip Signal to Contact Make)</td>
<td>140 - 165</td>
</tr>
</tbody>
</table>

**Note:** Values are typical at nominal rated control voltage(s).

4.5 SECONDARY DISCONNECT CONTACT BLOCK

The circuit breaker control wiring is arranged for draw-out disconnecting by means of a 18 point male plug arranged to connect to a female receptacle mounted in the rear of the existing DH circuit breaker compartment. The secondary disconnect contact block is mounted on a movable bracket on the left side of the circuit breaker truck (Figures 4.3). This permits it to be extended to the rear while the circuit breaker is in the 'Test' position to connect with the stationary receptacle in the circuit breaker compartment so that the control circuits are completed. Control wiring terminal blocks are located behind the front cover at the top of the circuit breaker element mechanism.

Normally the secondary disconnect contact is held stationary relative to the circuit breaker chassis with a release pin.

To engage the secondary disconnect contact while the circuit breaker is in the 'Test' position, pull release pin and push slide several inches until the secondary disconnects mate.

**Note:** If control power is present in the circuit breaker compartment, the charging motor will start once the secondary disconnects mate.

Figure 4.3. Secondary Disconnect Contact Block (Extended Position)
**Figure 4.4. Typical ac/dc Schematic**

**VR-Series + Circuit Breaker dc Control Schematic**

**VR-Series + Circuit Breaker ac Control Schematic**

**OPERATION**
- **C** and **‘NO’**: Closed until springs are fully charged
- **C** and **‘NC’**: Open until springs are fully charged
- **C** and **‘NO’**: Closed until springs are fully charged
- **C** and **‘NC’**: Open until mechanism is reset
- **C** and **‘NO’**: Open in all except between ‘Test’ and ‘Connect’ positions
- **C** and **‘NC’**: Not available when second trip coil option is chosen
- **C** and **‘NO’**: Closed in all except between ‘Test’ and ‘Connect’ positions

**SWITCH TERMINAL**
- **‘C’ and ‘NO’**: Brown Switch
- **‘C’ and ‘NC’**: Black Switch
- **‘C’ and ‘NO’**: Black Switch
- **‘C’ and ‘NC’**: Brown Switch

---

**CS – Circuit Breaker Control Switch - close**
**C – Circuit Breaker Control Switch - trip**
**Y – Anti Pump Relay**
**SR – Spring Release Coil (Close Coil)**
**M – Spring Charging Motor**
**ST – Shunt Trip Coil**
**PR – Protective Relay**
**O – Terminal Block or Accessible Terminal**
**PS1 – Position Switch 1**
**PS2 – Position Switch 2**
4.6 INTERLOCKS

**DANGER**

INTERLOCKS ARE PROTECTIVE DEVICES FOR PERSONNEL AND EQUIPMENT. DO NOT BYPASS, MODIFY, OR DISABLE ANY INTERLOCKS. DOING SO COULD CAUSE DEATH, SEVERE PERSONAL INJURY, EQUIPMENT DAMAGE AND/OR IMPROPER OPERATION.

There are several interlocks built into the VR-Series+ vacuum replacement circuit breakers. Each of these interlocks, though different in form, duplicate or exceed the function of the original circuit breaker’s interlocks. These interlocks exist to safeguard personnel and equipment. The basic premise behind the interlocking arrangement on the vacuum replacement circuit breaker is that the circuit breaker must not be inserted into or removed from a live circuit while the main contacts are closed. Also considered in the interlocking is that the circuit breaker should pose no greater risk than necessary to the operator in or out of the circuit breaker compartment.

4.6.1 RACKING-IN INTERLOCK

The racking-in interlock is designed to prevent moving the circuit breaker into or out of an operating position, if the circuit breaker contacts are closed. When the circuit breaker is in the closed position a mechanical interface is engaged to prevent operation of the racking access handle.

4.6.2 ANTI-CLOSE INTERLOCK

The anti-close interlock prevents discharging of the closing springs if the circuit breaker is already closed (Figure 4.7, Item 11). When the circuit breaker is closed, the interlock component moves away from the spring release clapper so that it cannot lift the spring release latch (9).

**DANGER**

DO NOT FORCE THE CIRCUIT BREAKER INTO THE CIRCUIT BREAKER COMPARTMENT. DOING SO MAY DAMAGE PARTS THEREBY RISKING DEATH, SEVERE PERSONAL INJURY, EQUIPMENT DAMAGE AND/OR IMPROPER OPERATION.

4.6.3 AIR CIRCUIT BREAKER REJECTION BAR

The DH-VR+ is classified as a non-interchangeable replacement circuit breaker as defined in IEEE C37.59-2007. The DH-VR+ does not utilize the existing 52X and 52Y control relays in the switchgear control scheme as required for the original DH air circuit breaker. The DH-VR+ circuit breaker has the 52X and 52Y functionality inside the circuit breaker mechanism and will require wiring jumpers installed in the switchgear to disable the 52X and 52Y circuitry. These jumpers are depicted on the DH-VR+ electrical schematic diagram and must be installed for DH-VR+ circuit breaker operation. An air circuit breaker rejection bar is provided to prevent the air circuit breaker from entering the circuit breaker compartment that no longer has functional 52X and 52Y relays. (Figure 4.5)

**DANGER**


4.7 MISCELLANEOUS ITEMS

4.7.1 GROUNDING CONTACT

The grounding contact is an assembly of spring loaded fingers which ground the circuit breaker frame (static ground) by engaging the switchgear grounding bus when the circuit breaker is racked into the circuit breaker compartment. The ground contact is located at the rear of the circuit breaker and visible from the back of the circuit breaker when out of the circuit breaker compartment. (Figure 3.3.b)

4.7.2 MOC AND TOC OPERATIONS

A mechanism attached to the right side of the DH-VR+ circuit breaker engages an operator that is linked to the Mechanism Operated Cell Switch (MOC) located in the circuit breaker compartment. This mechanism permits the contacts of the MOC Switch to be correlated with the circuit breaker’s contact position.

**NOTICE**

ALL TYPE DH-VR+ CIRCUIT BREAKERS UTILIZE THE DH-VR+ SURE CLOSE MECHANISM TO CONTROL MOC VELOCITY AND CLOSELY MIMIC THE DYNAMICS AND VELOCITIES OF OLDER CIRCUIT BREAKERS. IT IS IMPERATIVE THAT THIS MECHANISM BE ADJUSTED TO MATCH THE NUMBER OF MOC SWITCHES (FROM 0 TO 3) MOUNTED IN THE CIRCUIT BREAKER COMPARTMENT. ALWAYS CONFIRM THE MECHANISM IS PROPERLY ADJUSTED BEFORE ANY ATTEMPT IS MADE TO INSERT THE CIRCUIT BREAKER INTO THE CIRCUIT BREAKER COMPARTMENT.

IN ADDITION, THE MOC OPERATOR MUST BE CHECKED BEFORE ANY ATTEMPT IS MADE TO INSERT THE CIRCUIT BREAKER INTO THE CIRCUIT BREAKER COMPARTMENT. DETAILED PROCEDURES FOR EACH TEST ARE OUTLINED IN THE INSPECTION AND INSTALLATION SECTION OF THIS MANUAL.

The circuit breaker compartment mounted Truck Operated Cell Switch (TOC) is operated by movement of the circuit breaker truck into or out of the ‘Connect’ position. (Figure Set 3.3)

4.7.3 OPERATIONS COUNTER

All DH-VR+ circuit breakers are equipped with a mechanical operations counter (Figure Set 3.3). As the circuit breaker opens, the linkage connected to the pole shaft lever advances the counter reading by one.
**WARNING**

Interface Voltage

INSERTING OR OPERATING A SOLENOID-OPERATED CIRCUIT BREAKER IN A CELL CONVERTED FOR VACUUM REPLACEMENT CIRCUIT BREAKERS WITH STORED ENERGY MECHANISMS IS INCORRECT. THIS MAY LEAD TO DEATH, SEVERE BODILY INJURY, AND / OR EQUIPMENT DAMAGE.

THE CELL CONVERSIONS OF THE “X” RELAY AND THE “Y” ANTI-PUMP RELAY FOR A STORED ENERGY MECHANISM MUST BE REVERSED TO THEIR ORIGINAL CONFIGURATIONS PRIOR TO INSERTION OR OPERATION OF THE ORIGINAL SOLENOID-OPERATED CIRCUIT BREAKER.

---

**Figure 4.5. Air Circuit Breaker Rejection Bar**

- **NOTE:** DIM. TAKEN FROM FLOOR.
- **THIS VIEW IS LOOKING INTO THE CELL.**
- **THIS IS THE OPENING IN THE CELL.**
- **DRILL TWO 0.3125 HOLES FOR THE 1/4-20 HARDWARE LOCATED AS SHOWN – TYP FOR 250/350 MVA**

---

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Part Number</th>
<th>Item</th>
<th>Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rejection Bar (1)</td>
<td>94A1106H01</td>
<td>4</td>
<td>1/4-20 X 1 One Way Screw (2)</td>
<td>70001HXKBV</td>
</tr>
<tr>
<td>2</td>
<td>1/4 Standard Flat Washer (2)</td>
<td>70500BD30F</td>
<td>5</td>
<td>Conversion Warning Label (1)</td>
<td>94C9522H13</td>
</tr>
<tr>
<td>3</td>
<td>1/4-20 Nylon Locknut (2)</td>
<td>70220DPN16</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

NOTE: DIM. TAKEN FROM FLOOR.
Figure 4.6. VR-Series+ Circuit Breaker Element Mechanism - Front Cover Removed

VR-Series+ Circuit Breaker Element Mechanism

1. LH Closing Spring
2. Latch Check Switch (To Rear of Motor Cutoff Switch)
3. Motor Cutoff Switch
4. Closing Cam
5. Spring Release Assembly
6. Shunt Trip Assembly
7. RH Closing Spring
8. Reset / Opening Spring
9. Manual Charge Socket
10. Ratchet wheel
11. Operations Counter
12. Charging Motor
Figure 4.7. Closing Cam and Trip Linkage

Circuit Breaker Open, Springs Discharged

Circuit Breaker Closed, Springs Charged

<table>
<thead>
<tr>
<th>Number</th>
<th>Part Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Spring Release (Close) Latch</td>
</tr>
<tr>
<td>2</td>
<td>Pole Shaft</td>
</tr>
<tr>
<td>3</td>
<td>Closing Spring Fixed End</td>
</tr>
<tr>
<td>4</td>
<td>Closing Spring</td>
</tr>
<tr>
<td>5</td>
<td>Holding Pawl</td>
</tr>
<tr>
<td>6</td>
<td>Ratchet Wheel</td>
</tr>
<tr>
<td>7</td>
<td>Spring Crank</td>
</tr>
<tr>
<td>8</td>
<td>Cam Shaft</td>
</tr>
<tr>
<td>9</td>
<td>Spring Release Latch (Close Roller)</td>
</tr>
<tr>
<td>10</td>
<td>Drive Pawl</td>
</tr>
<tr>
<td>11</td>
<td>Anti-Close Interlock</td>
</tr>
<tr>
<td>12</td>
<td>Motor Ratchet Lever</td>
</tr>
<tr>
<td>13</td>
<td>Spring Release (Close) Clapper</td>
</tr>
<tr>
<td>14</td>
<td>Spring Release (Close) Coil</td>
</tr>
</tbody>
</table>
4.8.a. Circuit Breaker Open and Closing Spring Not Charged

4.8.b. Circuit Breaker Open and Closing Spring Charged

4.8.c. Circuit Breaker Closed and Closing Spring Not Charged

4.8.d. Circuit Breaker Closed and Closing Spring Charged

Charging Schematic

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Main Link Roller</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Main Link</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Operating Rod</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Pole Shaft</td>
<td>8</td>
</tr>
</tbody>
</table>
SECTION 5: INSPECTION & INSTALLATION

⚠️ DANGER

BEFORE PLACING THE CIRCUIT BREAKER IN SERVICE, CAREFULLY FOLLOW THE INSTALLATION PROCEDURE BELOW AND THE SAFE PRACTICES SET FORTH IN SECTION 2. NOT FOLLOWING THE PROCEDURE MAY RESULT IN INCORRECT CIRCUIT BREAKER OPERATION LEADING TO DEATH, SEVERE PERSONAL INJURY, EQUIPMENT DAMAGE AND/OR IMPROPER OPERATION.

When the circuit breaker is first commissioned into service and each time the circuit breaker is returned to service, it should be carefully examined and checked to confirm it is operating correctly per the guidelines in this instruction booklet.

5.1 EXAMINATION FOR DAMAGE

Examine the circuit breaker for loose or obviously damaged parts. Never attempt to install nor operate a damaged circuit breaker.

5.1.1 NAMEPLATE VERIFICATION

Verify the information on the new VR-Series® nameplate matches the information on the purchase order. If any discrepancies exist, notify Eaton’s Power Breaker Center for resolution prior to proceeding.

5.2 SURE CLOSE MECHANISM ADJUSTMENT

⚠️ DANGER

FOR ALL CIRCUIT BREAKER COMPARTMENTS EQUIPPED WITH MECHANISM OPERATED CELL (MOC) SWITCHES, THE STEPS OUTLINED IN THIS SECTION MUST BE PERFORMED BEFORE INSTALLING A VR-SERIES® REPLACEMENT CIRCUIT BREAKER. FAILURE TO COMPLY COULD CAUSE DEATH, SEVERE PERSONAL INJURY, EQUIPMENT DAMAGE AND/OR IMPROPER OPERATION.

All type DH-VR® circuit breakers utilize the SURE CLOSE mechanism to control kinetic energy transfer and closely mimic the dynamics and velocities of older circuit breakers. It is imperative that this mechanism be adjusted to compensate for the force of the MOC switch mounted in the circuit breaker compartment.

The circuit breaker has been factory adjusted to operate one mechanism operated cell (MOC) switch in the circuit breaker compartment. This means that for applications with either no MOC switch or one MOC switch, no field adjustments are required.

Finally, the SURE CLOSE mechanism provides an effective way to evaluate the condition of the MOC in the circuit breaker compartment. If the SURE CLOSE drive spring is properly adjusted, but the MOC does not fully open or close, it is time to maintain the MOC in the circuit breaker compartment. Maintenance usually means cleaning and lubricating the MOC mechanism. If the MOC has seen a large number of cycles, however, worn components may have to be replaced.

To insulate the proper operation of the SURE CLOSE mechanism, the MOC assembly should be cleaned and inspected for worn parts and then lubricated. A spring force gauge should be used to measure the forces needed to move the switch to the fully closed position prior to inserting the circuit breaker (Figure 5.5). The differential force of the assembly and the circuit breaker should be a minimum of 10 lbs. with the circuit breaker having the higher recorded force. Should the forces be less than that, proceed with the following steps to increase the circuit breaker force:

To adjust the SURE CLOSE drive spring proceed with the following steps:

Step 1: Charge and close VR+ circuit breaker

Step 2: Measure VR+ MOC operator closed position and output force. (Output force is the force measured when the MOC operator is Closed and is moved .01” to .09” in the open direction) (Figure 5.1)

Step 3: Go to circuit breaker compartment with highest number of MOC switches in the Lineup to be installed. Using the measured closed position acquired in step 2, Move the circuit breaker compartment moc operator to the respective position and measure required force. MAKE SURE THIS POSITION ADEQUATELY ACTUATES/ CENTERS MOC CONTACTS (Figure 5.2 and 5.3)

Step 4: Make sure the Force in step 2 exceeds force in step 3. Acceptable force differential is 7lbf - 13lbf. If adjustment is required to increase force continue to step 5.

Step 5: Make sure breaker is open and closing springs are discharged. Locate SURE CLOSE spring and increase spring tension .25” (be sure never to compress spring to a dimension less than 3.00”) (Figure 5.4 and 5.5)

Step 6: Charge and close circuit breaker and measure new output force. If more force is required to exceed the force measured in step 3. Go back to step 5. Once proper differential is achieved, the breaker is ready for service. (Figure 5.1)
5.3 MANUAL OPERATION CHECK

Manual operational checks must be performed before the circuit breaker is connected to an energized circuit. Tests must be performed with the circuit breaker withdrawn from the circuit breaker compartment or in the ‘Disconnect’ position. While the circuit breaker is withdrawn or in the ‘Disconnect’ position, place the maintenance tool into the manual charge socket opening and charge the closing springs with about 36 up and down strokes of the handle. When charging is complete, the closing crank goes over center toggle with an audible “click” and the Springs Charged / Discharged Indicator shows ‘Charged’. Remove the maintenance tool.

⚠️ NOTICE

IF THE SPRINGS ARE TO BE CHARGED ON A CLOSED CIRCUIT BREAKER, NO CLICK IS HEARD AT THE END OF CHARGING OPERATION. DISCONTINUE CHARGING AND REMOVE THE MAINTENANCE TOOL AS SOON AS ‘CHARGED’ FLAG IS FULLY VISIBLE. CONTINUE ATTEMPTS TO FURTHER CHARGE MAY RESULT IN DAMAGE TO THE MECHANISM.

⚠️ WARNING

ALWAYS REMOVE THE MAINTENANCE TOOL AFTER CHARGING THE SPRING. FAILURE TO REMOVE THE MAINTENANCE TOOL FROM THE CIRCUIT BREAKER COULD CAUSE INJURY TO PERSONNEL AND/OR EQUIPMENT DAMAGE IF THE CIRCUIT BREAKER WERE TO CLOSE.

Close and trip the circuit breaker by pushing the Push To Close Operator then the Push To Open Operator (Figure Set 3.3).

5.4 VACUUM INTERRUPTER INTEGRITY

Using a dry lint-free cloth or a paper towel, clean all the insulating surfaces of the pole units. Conduct a vacuum interrupter integrity check as described in Section 6.

5.5 INSULATION

Check circuit breaker primary and secondary insulation per Section 6.

5.6 CONTACT EROSION AND WIPE

Manually charge the closing springs and close the circuit breaker. Check contact erosion and wipe as described in Section 6.

5.7 PRIMARY CIRCUIT RESISTANCE

Check the primary circuit resistance as described in Section 6. The resistance should not exceed the values specified. Record the values obtained for future reference.

5.8 ELECTRICAL OPERATIONS CHECK

After going through the above steps, the circuit breaker is now ready to be operated electrically. It is preferred that this check be made with the circuit breaker in the ‘Test’ position in the circuit breaker compartment.

Since the Type DH-VR+ circuit breaker is for use in existing DH metal-clad switchgear, installation procedures are similar. If it is necessary to reference anything in the circuit breaker compartment, refer to the original instruction books supplied with the assembly.

Refer to Figure Set 3.3, depending upon the voltage rating of the circuit breaker, for any parts identification required during these installation procedures.

⚠️ WARNING

EXAMINE THE INSIDE OF THE CIRCUIT BREAKER COMPARTMENT BEFORE INSERTING THE CIRCUIT BREAKER FOR EXCESSIVE DIRT OR ANYTHING THAT MIGHT INTERFERE WITH THE CIRCUIT BREAKER TRAVEL.
**WARNING**

**KEEP HANDS OFF THE TOP AND SIDES OF THE FRONT COVER WHEN PUSHING THE CIRCUIT BREAKER INTO THE CIRCUIT BREAKER COMPARTMENT. FAILURE TO DO SO COULD RESULT IN BODILY INJURY, IF FINGERS BECOME WEDGED BETWEEN THE CIRCUIT BREAKER AND THE CIRCUIT BREAKER COMPARTMENT. USE THE HANDLE PROVIDED ON THE FRONT COVER OF THE CIRCUIT BREAKER, OR USE BOTH FULLY OPENED HANDS FLAT ON THE FRONT COVER.**

These checks can be performed with the circuit breaker in its 'Withdrawn' or 'Disconnect' position and connecting the circuit breaker to a test cabinet or to the switchgear circuit breaker compartment's secondary receptacle using the special extension cable designed for this purpose and described in Section 3.

Perform electrical operations checks. Close and trip the circuit breaker electrically several times to verify that the operation is reliable and consistent. Check that the operation of the spring charging motor is reasonably prompt and that the motor makes no unusual noise.

**WARNING**

**DO NOT PERFORM ELECTRICAL OPERATION CHECKS WITH THE CIRCUIT BREAKER IN THE 'CONNECT' POSITION BECAUSE OF THE POSSIBILITY OF CONNECTING DE-ENERGIZED LOAD CIRCUITS TO THE ELECTRICAL POWER SOURCE, RESULTING IN EQUIPMENT FAILURE, RESULTING IN DEATH, SEVERE PERSONAL INJURY, EQUIPMENT DAMAGE AND/OR IMPROPER OPERATION.**

5.9 CIRCUIT BREAKER COMPARTMENT POSITION DESCRIPTION

Position A ('Withdrawn Out'): In this position the circuit breaker is out of the circuit breaker compartment. Device can be manually Charged, closed and tripped. If the test jumper or test cabinet is available, the device can be electrically operated outside the circuit breaker compartment. Position indicator displays 'Withdrawn' position. (Figure Set 3.3)

Position B ('Withdrawn In'): Circuit breaker is pushed into the cell until it reaches a mechanical stop. Position indicator displays 'Withdrawn' position. Although it is possible to engage the secondary disconnect in this position, it SHOULD NOT be engaged at this time.

Position C ('Disconnect'): In the 'Disconnect' position the breaker is mechanically held/latched in the circuit breaker compartment, and the secondary disconnect is not engaged. The breaker must be racked from the 'Withdrawn In' position. Racking access handle must be actuated in order to gain access to racking shaft. Once racking shaft is engaged, turn the Handle clockwise until the position indicator fully displays 'Disconnect / Test' and the shutter indicator begins to move. Once the shutter indicator begins to move, reverse racking handle one half turn to make sure the shutter is closed. This is the 'Disconnect' position. The breaker can be manually operated in this position. Be sure to remove racking handle before attempting to close the breaker. An attempt to remove the circuit breaker with stored energy from the 'Disconnect' position will result in a single stage stored energy discharge/trip-free operation.

Position D ('Test'): The position indicator still displays 'Disconnect / Test', and the racking handle should not be installed. Release the secondary disconnect slide by pulling the release pin and push slide in several inches until the secondary disconnects mate. The spring charging motor will begin charging as soon as the disconnects are engaged. The circuit breaker is now in the 'Test' position. An attempt to remove the circuit breaker with stored energy from the 'Test' position will result in a single stage stored energy discharge/ trip-free operation.

Position E ('Trip-Free'): The 'Trip-Free' position is related to the space in between 'Disconnect / Test' and 'Connect'. The breaker should never be stopped or left in this position. This Position identifies the interlocked position which keeps the breaker from being closed unless it is in the 'Test' or 'Connect' position. The circuit breaker mechanism is mechanically and electrically unable to close in the 'Trip-Free' Position. 'Trip-Free' position is indicated on the position indicator.

Position F ('Connect'): To continue installing the circuit breaker to the 'Connect' position the racking handle will need to reengage the racking shaft. The Racking access handle must be actuated in order to gain access to racking shaft. (Open the breaker first) Once racking shaft is engaged, turn the Handle clockwise and the breaker will begin to advance toward the rear of the compartment. Do not stop in the 'Trip-Free' position. Continue racking until the "CONNECT at hard stop" portion of the label is observed and the end of travel is met by a mechanical stop. Once the 'Connect' position is reached, the racking handle MUST be removed before operating the circuit breaker. The circuit breaker is now ready for service.

Position G: To remove the circuit breaker from the circuit breaker compartment when it is in the 'Connect' position, the breaker must first be opened. Racking access handle must be actuated in order to gain access to racking shaft. Once racking shaft is engaged, turn the Handle anti-clockwise. The breaker primary and secondary disconnects will disengage and the breaker will travel towards the circuit breaker compartment door and will be in a trip-free state.

Position H: Continue rotation of the racking handle anti-clockwise until the shutter closes and the position indicator displays 'Disconnect / Test' position. The breaker is still latched in the circuit breaker compartment and considered in the 'Disconnect' position and can be manually charged, closed and opened as long as the racking handle is not installed. If electrical operation/ testing is needed, the secondary disconnect Will require engagement. Release the secondary disconnect slide by
pulling the release pin and push slide in several inches until the secondary disconnects mate. The spring charging motor will begin charging as soon as the disconnects are engaged. The circuit breaker is now in the 'Test' position and may be Closed and opened as long as the Racking handle is removed.

**Position I:** This position is the stored energy discharge position and is a non-operable position. It occurs between 'Disconnect / Test' and Withdrawn. To remove circuit breaker from the 'Disconnect / Test' position, the circuit breaker must be tripped if closed, and the secondary disconnect should be disengaged. Then manually cycle the "Push to Close" and "Push to Open" operators to render the circuit breaker open and discharged. Racking Access Handle must be actuated in order to gain access to racking shaft. Once racking shaft is engaged, turn the Handle anti-clockwise. If the breaker was not previously discharged of stored energy, racking the device will yield a trip-free single stage stored energy discharge before reaching the Withdrawn position on the indicator label.

**Position J ('Withdrawn In')**: Once the racking mechanism is racked anti-clockwise until a mechanical stop is reached, this is the Withdrawn position. The racking handle should now be removed. The circuit breaker is now ready to be withdrawn out of the circuit breaker compartment.

**Position K ('Withdrawn Out')**: The circuit breaker is removed from the circuit breaker compartment by manually pulling the handle on the front of the circuit breaker while the position indicator displays the 'Withdrawn' position.

### 5.10 RACKING CIRCUIT BREAKER INTO CIRCUIT BREAKER COMPARTMENT

a. Place the circuit breaker in the ‘Withdrawn’ position out of the circuit breaker compartment. The racking handle is not required for this position and the racking system interlocks are not automatic outside the circuit breaker compartment. The circuit breaker can be operated in this position and extreme care should be exercised to avoid inadvertent operation and possible injury or equipment damage.

---

**WARNING**

DO NOT USE ANY TOOL TO RACK THE CIRCUIT BREAKER TO OR FROM THE ‘CONNECT’ POSITION OTHER THAN THE DESIGNATED RACKING HANDLE.

b. From the ‘Withdrawn Out’ position, insure the circuit breaker is open and the mechanism is completely discharged. Engage the racking handle and rotate counterclockwise as far as possible and align the circuit breaker wheel rails with the guide rails of the circuit breaker compartment. (See Figure 5.6)

c. Check that the closing spring status indicator reads ‘Discharged’ and that the main contact status indicator reads ‘Open’. Manually trip, close, and trip the circuit breaker as needed to obtain this status.

d. (Figure 5.8) Push the circuit breaker into the circuit breaker compartment until all the wheels are on the circuit breaker compartment floor and the circuit breaker halts as the racking arm rollers meet the guide slots of the circuit breaker compartment. This is the ‘Withdrawn In’ position.

---

**WARNING**

EXCESSIVE FORCE, APPLIED TO THE RACKING MECHANISM WHILE THE CIRCUIT BREAKER IS CLOSED, COULD SHEAR OFF THE PIN THAT THE RACKING HANDLE ENGAGES DURING OPERATION.

---

**WARNING**

WHILE RACKING THE CIRCUIT BREAKER, NOTE ANY SUDDEN RESISTANCE TO RACKING OR SIGNS OF BINDING, DETERMINE THE CAUSE OF INTERFERENCE AND CORRECT, AS APPROPRIATE, BEFORE PROCEEDING.

---

**e.** Engage the racking handle (Figure 5.90) and rotate clockwise. The circuit breaker will start to move into the circuit breaker compartment. The position indicator will fully display ‘Disconnect / Test’ when this position is reached. This is the ‘Disconnect / Test’ position. After reaching the ‘Disconnect / Test’ position, REMOVE the racking handle (this avoids possible damage to the passive interlock). In the ‘Disconnect / Test’ position, the circuit breaker can be closed and tripped manually and electrically, thus allowing maintenance test or checks. To operate the circuit breaker electrically, the secondary control block must be engaged at this time. Release the secondary connection block slider by pulling the catch pin and pushing the slider toward the rear several inches. The slider is located on the lower left hand area of the circuit breaker frame. Push on the front side flat surface of the slider until the contact block can be felt to be fully engaged in the secondary blocks socket.

---

**NOTICE**

ONCE THE SECONDARY DISCONNECT BLOCK IS ENGAGED IN THE ‘TEST’ POSITION, IT WILL REMAIN CONNECTED THROUGHOUT FURTHER INWARD MOVEMENT AS THE CIRCUIT BREAKER ADVANCES FROM THE ‘TEST’ TO THE ‘CONNECT’ POSITION.

THE SPRING CHARGING MOTOR WILL BEGIN TO RUN AND CHARGE THE CLOSING SPRING AS THE SECONDARY CONNECTION IS MADE AS LONG AS CONTROL POWER IS AVAILABLE. THE CIRCUIT BREAKER IS NOW IN THE 'TEST' POSITION, WITH CONTROL VOLTAGE APPLIED AND READY FOR ELECTRICAL OR MANUAL TESTING.

---

**Figure 5.8. Insertion of DH-VR+**
To advance from the ‘Test’ position, continue turning the racking handle clockwise. The circuit breaker will travel approximately 12.5”. Towards the end of travel, the rack-in torque will increase due to the additional resistance of the contact fingers interfacing with the circuit breaker compartment copper. The circuit breaker will be considered in the ‘Connect’ position when the position indicator displays ‘Connect’. (Figure 5.11) This indicates that the trip linkage is released and the circuit breaker is now ready for service.

5.11 REMOVING CIRCUIT BREAKER FROM CIRCUIT BREAKER COMPARTMENT

⚠️ NOTICE

THE CIRCUIT BREAKER MAY BE OPEN AND ITS CLOSING SPRING MAY DISCHARGE AS IT IS WITHDRAWN FROM THE CIRCUIT BREAKER COMPARTMENT. IT DEPENDS ON WHETHER THE CIRCUIT BREAKER WAS LEFT CLOSED OR OPEN, OR WHETHER THE SPRING WAS LEFT CHARGED OR DISCHARGED.

a. To remove the circuit breaker from the circuit breaker compartment it must be in the open position. Insure the circuit breaker is open and engage the racking handle. Move the circuit breaker out by rotating the racking handle counter-clockwise. The circuit breaker will start coming out of the circuit breaker compartment before the main stabs or secondary control block are disconnected. The circuit breaker will be in a non-operable mode and will go through a trip-free operation if any attempt to close it is made in the intermediate position. The shutters will close after the main stabs have cleared, isolating the circuit breaker from its source. Continue racking out until the position mode indicator shows ‘Disconnect / Test’ and the shutter indicator shows closed. The circuit breaker is in the ‘Test’ position and the trip mechanism is released, allowing the circuit breaker to be operated either electrically or mechanically. If you desire to electrically open or close the circuit breaker in the ‘Test’ position, the secondary control block must be reengaged and the racking handle removed.

b. To remove the circuit breaker from the ‘Test’ position to the ‘Withdrawn’ position, the circuit breaker must be tripped if closed, the racking handle re-inserted, and the secondary contact block should be disengaged. Rotate the racking handle counter-clockwise until the racking mechanism movement is halted by the racking mechanism stop. The racking handle should be removed at this point. The circuit breaker is ready to be withdrawn out from the circuit breaker compartment.

c. To remove the circuit breaker from the ‘Withdrawn In’ to the ‘Withdrawn Out’ position, the circuit breaker is pulled manually by the pull handle.
SECTION 6: INSPECTION & MAINTENANCE

⚠️ DANGER

DO NOT WORK ON A CIRCUIT BREAKER IN THE 'CONNECT' POSITION.

DO NOT WORK ON A CIRCUIT BREAKER WITH SECONDARY DISCONNECTS ENGAGED.

DO NOT WORK ON A CIRCUIT BREAKER WITH SPRINGS CHARGED OR CONTACTS CLOSED.

DO NOT DEFEAT ANY SAFETY INTERLOCKS.

DO NOT LEAVE MAINTENANCE TOOL IN THE SOCKET AFTER CHARGING THE CLOSING SPRINGS.

STAND AT LEAST ONE METER AWAY FROM THE CIRCUIT BREAKER WHEN TESTING FOR VACUUM INTEGRITY.

6.1 INSPECTION FREQUENCY

The scheduled maintenance interval for the VR-Series+ circuit breaker is once every ten years or ten thousand operations, whichever comes first when applied in normal applications as defined by IEEE C3704-1999. However, if the circuit breaker is operating in a high level of natural elements or in a corrosive environment, inspection should be performed twice each year. The circuit breaker should also be inspected and a vacuum interrupter integrity test performed (Section 6.3) any time the circuit breaker is transported to another physical location or switchgear assembly. In addition, the circuit breaker should have a full inspection if the circuit breaker interrupts a fault current.

Note: Refer to the table below for maintenance and inspection check points.

6.2 INSPECTION AND MAINTENANCE PROCEDURES

<table>
<thead>
<tr>
<th>NO. / SECTION</th>
<th>INSPECTION ITEM</th>
<th>CRITERIA</th>
<th>INSPECTION METHOD</th>
<th>CORRECTIVE ACTION IF NECESSARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Insulation</td>
<td>Stand Off Insulators, Operating Rods, Tie-Bars and Barriers</td>
<td>No dirt</td>
<td>Visual check</td>
<td>Clean with lint-free cloth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No cracking</td>
<td>Visual check</td>
<td>Replace cracked unit</td>
</tr>
<tr>
<td>Vacuum Integrity</td>
<td>Between main circuit with terminals ungrounded</td>
<td>Withstand 27kV 60Hz for 1 Minute</td>
<td>Hi-pot Tester</td>
<td>Clean and retest or replace</td>
</tr>
<tr>
<td>Insulation Integrity</td>
<td>Main circuit to ground</td>
<td>Withstand 15kV, 60Hz for 1 Minute (5kV Rating)</td>
<td>Hi-pot Tester</td>
<td>Clean and retest or replace</td>
</tr>
<tr>
<td></td>
<td>Control circuit to ground (Charging Motor disconnected)</td>
<td>Withstand 1125V, 60Hz for 1 Minute</td>
<td>Hi-pot Tester</td>
<td>Clean and retest or replace</td>
</tr>
<tr>
<td>2. Power Element</td>
<td>Vacuum Interrupter Assembly</td>
<td>Contact erosion visibility</td>
<td>Visual - Close the circuit breaker and look for &quot;T&quot; cutout on Vacuum Interrupter Assembly (See Figure 6.1 and 6.2)</td>
<td>If cutout is not visible, replace Vacuum Interrupter Assembly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contact wipe visible</td>
<td>Visual (Figure 6.1 and 6.2)</td>
<td>Replace Vacuum Interrupter Assembly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adequate vacuum</td>
<td>See Section 6.3</td>
<td>Replace Vacuum Interrupter Assembly If vacuum is not adequate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dirt on ceramic body</td>
<td>Visual check</td>
<td>Clean with dry lint-free cloth</td>
</tr>
<tr>
<td>Primary Disconnects</td>
<td></td>
<td>No burning or damage</td>
<td>Visual check</td>
<td>Replace if burned, damaged or eroded</td>
</tr>
<tr>
<td>3. Control Circuit Parts</td>
<td>Closing and tripping devices including disconnects</td>
<td>Smooth and correct operation by control power</td>
<td>Test closing and tripping of the circuit breaker twice</td>
<td>Replace any defective device - Identify per Trouble-Shooting Chart</td>
</tr>
<tr>
<td></td>
<td>Wiring</td>
<td>Securely tied in proper place</td>
<td>Visual check</td>
<td>Repair or tie as necessary</td>
</tr>
<tr>
<td></td>
<td>Terminals</td>
<td>Tight</td>
<td>Visual check</td>
<td>Tighten or replace if necessary</td>
</tr>
<tr>
<td></td>
<td>Motor</td>
<td>Smooth and correct operation by control power</td>
<td>Test closing and tripping of the circuit breaker twice</td>
<td>Replace brushes or motor</td>
</tr>
<tr>
<td></td>
<td>Tightness of hardware</td>
<td>No loose or missing parts</td>
<td>Visual and tightening with appropriate tools</td>
<td>Tighten or reinstate if necessary</td>
</tr>
<tr>
<td>4. Operating Mechanism</td>
<td>Dust or foreign matter</td>
<td>No dust or foreign matter</td>
<td>Visual check</td>
<td>Clean as necessary</td>
</tr>
<tr>
<td></td>
<td>Deformation or excessive wear</td>
<td>No excessive deformation or wear</td>
<td>Visual and operational</td>
<td>Remove cause and replace parts</td>
</tr>
<tr>
<td></td>
<td>Manual operation</td>
<td>Smooth operation</td>
<td>Manual charging closing and tripping</td>
<td>Correct per Trouble-Shooting Chart if necessary</td>
</tr>
<tr>
<td></td>
<td>CloSure™ Test</td>
<td>≥ 0.6 inch over travel</td>
<td>CloSure™ Test 6.8.1</td>
<td>If &lt; 0.6 Contact the PBC at 1-877-276-9379</td>
</tr>
</tbody>
</table>

Note: Contact Eaton for any mechanism maintenance other than adjustment or replacement of control components.

<table>
<thead>
<tr>
<th>BOLT SIZE</th>
<th>8 - 32</th>
<th>10 - 32</th>
<th>25 - 20</th>
<th>31 - 18</th>
<th>38 - 16</th>
<th>50 - 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>TORQUE Lbs. In.</td>
<td>24</td>
<td>36</td>
<td>72</td>
<td>144</td>
<td>300</td>
<td>540</td>
</tr>
</tbody>
</table>
6.3 VACUUM INTERRUPTER INTEGRITY TEST

Vacuum interrupters used in Type VR-Series+ circuit breakers are highly reliable interrupting components. Satisfactory performance of these devices is dependent upon the integrity of the vacuum in the interrupter and the internal dielectric strength. Both of these parameters can be readily checked by a one minute ac high potential test. (See Table 6.1 for appropriate test voltage.) During this test, the following warnings must be observed:

**WARNING**

APPLYING ABNORMALLY HIGH VOLTAGE ACROSS A PAIR OF CONTACTS IN VACUUM MAY PRODUCE X-RADIATION. THE RADIATION MAY INCREASE WITH THE INCREASE IN VOLTAGE AND/OR DECREASE IN CONTACT SPACING. X-RADIATION PRODUCED DURING THIS TEST WITH RECOMMENDED VOLTAGE AND NORMAL CONTACT SPACING IS EXTREMELY LOW AND WELL BELOW MAXIMUM PERMITTED BY STANDARDS. HOWEVER, AS A PRECAUTIONARY MEASURE AGAINST POSSIBILITY OF APPLICATION OF HIGHER THAN RECOMMENDED VOLTAGE AND/OR BELOW NORMAL CONTACT SPACING, IT IS RECOMMENDED THAT ALL OPERATING PERSONNEL STAND AT LEAST ONE METER AWAY IN FRONT OF THE CIRCUIT BREAKER.

**WARNING**

DC HI-POTENTIAL TESTS ARE NOT RECOMMENDED BY EATON. DO NOT APPLY DC AT ANY LEVEL TO VR-SERIES+ POWER CIRCUIT BREAKERS

With the circuit breaker open and securely sitting on the floor, connect all top/front primary studs (bars) together and the high potential machine lead. Connect all bottom/rear studs together and the high potential return lead. Do not ground them to the circuit breaker frame. Start the machine at zero potential, increase to appropriate test voltage and maintain for one minute.

Successful withstand indicates that all interrupters have satisfactory vacuum level. If there is a breakdown, the defective interrupter or interrupters should be identified by an individual test and replaced before placing the circuit breaker in service.

After the high potential is removed, discharge any electrical charge that may be retained, particularly from the center shield of vacuum interrupters. To avoid any ambiguity in the ac high potential test due to leakage or displacement (capacitive) current, the test unit should have sufficient volt-ampere capacity. It is recommended that the equipment be capable of delivering 25 milliamperes for one minute.

The current delivery capability of 25 mA ac applies when all three vacuum interrupters are tested in parallel. If individual vacuum interrupters are tested, current capability may be one third of this value.

**Table 6.1. Vacuum Interrupter Integrity Test Voltage**

<table>
<thead>
<tr>
<th>Circuit Breaker Rated Maximum Voltage</th>
<th>Vacuum Interrupter Integrity Test Voltage ac 60Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to and including 15.0 kV</td>
<td>27 kV</td>
</tr>
</tbody>
</table>

6.4 CONTACT EROSION AND WIPE

Since the contacts are contained inside the interrupter, they remain clean and require no maintenance. However, during high current interruptions, or high numbers of operations, it is possible for a minimal amount of erosion on the contact surfaces. It is also possible for further compaction of the conductor electrodes that has been known to reduce the amount of contact wipe. The VR-Series+ vacuum interrupter assembly incorporates both the original vacuum interrupter erosion indicator and the contact-spring wipe into one all-encompassing indicator. The adequacy of the remaining contact erosion and wipe can easily be determined by observing the vacuum interrupter side of the operating rod assembly on a closed circuit breaker. The procedure to determine the adequacy of the “T” cutout on the vacuum interrupter assembly is depicted in Figures 6.1 and 6.2. Some configurations may require the use of a small mirror and flashlight to clearly see the “T” cutout. As long as any part of the “T” cutout is visible on each pole unit, the contact surfaces and spring pressure are adequate for the circuit breaker to interrupt its full rated nameplate short circuit and carry continuous current without over-heating. If the wipe is inadequate (no part of the “T” cutout is visible) then the vacuum interrupter assembly must be replaced. Field adjustment is not possible.

**WARNING**

FAILURE TO REPLACE A VACUUM INTERRUPTER ASSEMBLY WHEN THE “T” CUTOUT IS NOT VISIBLE WILL CAUSE THE CIRCUIT BREAKER TO FAIL TO INTERRUPT AND THEREBY CAUSE PROPERTY DAMAGE OR PERSONAL INJURY.

Figure 6.1. The Arrow Shows The “T” Contact Wipe Indicator - (If the “T” or any portion of its visible as shown with the circuit breaker closed, the wipe is satisfactory) (See next figure for graphic of all possibilities)

Figure 6.2. Wipe Indication Procedure (Performed Only With Circuit Breaker Closed)

Any part of “T” Cutout Visible - “Wipe” Satisfactory

“T” Cutout Not Visible - “Wipe” Unsatisfactory
6.5 INSULATION

In VR-Series+ circuit breakers, insulation maintenance primarily consists of keeping all insulating surfaces clean. This can be done by wiping off all insulating surfaces with a dry lint free cloth or dry paper towel. In case there is any tightly adhering dirt that will not come off by wiping, it can be removed with a mild solvent or distilled water. But be sure that the surfaces are dry before placing the circuit breaker in service. If a solvent is required to cut dirt, use Isopropyl Alcohol or commercial equivalent. Secondary control wiring requires inspection for tightness of all connections and damage to insulation.

6.6 INSULATION INTEGRITY CHECK

PRIMARY CIRCUIT:

The integrity of primary insulation may be checked by the ac high potential test. The test voltage depends upon the maximum rated voltage of the circuit breaker. For the circuit breakers rated 4.76 kV the test voltage is 15 kV RMS, 60 Hz. Conduct the test as follows:

Close the circuit breaker. Connect the high potential lead of the test machine to one of the poles of the circuit breaker. Connect the remaining poles and circuit breaker frame to ground. Start the machine with output potential at zero and increase to the test voltage. Maintain the test voltage for one minute. Repeat for the remaining poles. Successful withstand indicates satisfactory insulation strength of the primary circuit.

Open the circuit breaker. Connect the high potential lead of the test machine to one of the terminals of the circuit breaker. Connect the remaining terminals and circuit breaker frame to ground. Start the machine with output potential at zero and increase to the test voltage. Maintain the test voltage for one minute. Repeat for the remaining poles. Successful withstand indicates satisfactory insulation strength of the primary circuit.

SECONDARY CIRCUIT:

Isolate the motor by disconnecting the two motor leads from the terminal block. Connect all points of the secondary disconnect contact pins with a shooting wire. Connect this wire to the high potential test. The test voltage depends upon the maximum rated voltage of the circuit breaker. (Refer to Table 6.2.) If the CloSure™ travel obtained is as specified, the mechanism performance is satisfactory. If the CloSure™ travel does not conform as shown in Figure 6.14, contact Eaton’s Electrical Services & Systems for further information. (See Step 13).

6.7 PRIMARY CIRCUIT RESISTANCE CHECK

The main contacts of the VR-Series+ circuit breaker are inside the vacuum chamber where they remain clean and require no maintenance at any time.

The dc electrical resistance of the primary circuit may be calculated by measuring the voltage drop across the circuit. This test should be performed with a low voltage, direct current (dc) power supply capable of delivering no less 100A dc.

- To check the primary circuit resistance:
  - Remove the circuit breaker from the circuit breaker compartment
  - Close the circuit breaker
  - Pass at least 100A dc from terminal to terminal of each pole unit in the closed position
  - Measure the voltage drop across the terminals.

The resistance can be calculated from Ohm’s Law and is expressed in micro-ohms. Repeat for the remaining two poles.

The resistance should not exceed the factory test levels more than 200% as stated in IEEE C37.09. Factory test levels are recorded on the circuit breaker test form, which is included with the circuit breaker. If measurements exceed 200%, contact the manufacturer.

**Resistance conversion for Temperature**

\[
R_{\text{conversion}} = R_{\text{Factory}} \left(1 + \frac{T_{\text{Field}} - T_{\text{Factory}}}{r}\right)
\]

- \(R_{\text{conversion}}\) = Resistance correction for temperature based from the factory resistance measurement.
- \(R_{\text{Factory}}\) = Resistance measurement from the factory.
- \(T_{\text{Field}}\) = Temperature measurement in the field.
- \(T_{\text{Factory}}\) = Temperature measurement from the factory.
- \(r\) = Copper resistivity temperature coefficient.

\[
\rho = 0.0039 \text{ Copper Resistivity Temperature Coefficient / Deg C}
\]

\[
\rho = 0.002167 \text{ Copper Resistivity Temperature Coefficient / Deg F}
\]

6.8 VR-SERIES+ CIRCUIT BREAKER ELEMENT MECHANISM CHECK

**Introduction:** The CloSure™ Test is a simple yet extremely effective means to determine and monitor the ability of the mechanism to close the circuit breaker contacts fully. It provides a quantitative measure of the extra energy available in terms of over travel in inches to close the circuit breaker contacts to their full extent. It may be used periodically to monitor the health of the mechanism.

**General Information:** The CloSure™ Test can be performed on all VR-Series+ circuit breakers. (Refer to Table 6.2.) If the CloSure™ travel obtained is as specified, the mechanism performance is satisfactory. If the CloSure™ travel does not conform as shown in Figure 6.14, contact Eaton’s Electrical Services & Systems for further information. (See Step 13).

**DANGER**

DO NOT ATTEMPT TO INSTALL OR PERFORM MAINTENANCE OR TESTS ON THE EQUIPMENT WHILE IT IS ENERGIZED. NEVER PUT YOUR HANDS NEAR THE MECHANISM WHEN THE CIRCUIT BREAKER IS IN THE CHARGED OR CLOSED POSITION. DEATH OR SEVERE PERSONAL INJURY CAN RESULT FROM CONTACT WITH ENERGIZED EQUIPMENT. ALWAYS VERIFY THAT NO VOLTAGE IS PRESENT BEFORE PROCEEDING WITH THE TASK, AND ALWAYS FOLLOW GENERALLY ACCEPTED SAFETY PROCEDURES.

**Safety Precautions:** Read and understand these instructions before attempting any maintenance, repair or testing on the circuit breaker. The user is cautioned to observe all recommendations, warnings and cautions relating to the safety of personnel and equipment.

**Note:** Hearing protection is recommended as the circuit breaker is opened and closed.

The recommendations and information contained herein are based on Eaton experience and judgment, but should not be considered to be all-inclusive or covering every application or circumstance which may arise. If further information is required, you should consult Eaton’s Electrical Services & Systems.

**Testing Procedures:** Assumining that the circuit breaker is safely removed from the circuit breaker compartment enclosure and positioned in an area outside the arc fault boundary, follow this procedure to perform the CloSure™ test. For further instructions on removal of the circuit breaker from the circuit breaker compartment, refer to the appropriate section of this manual.
**Step 1** - On the front cover, identify the status indicators. Confirm the closing spring status indicates 'Discharged' and the main contact indicator shows 'Open' (Figure 6.3).

**Step 2** - Remove the circuit breaker front cover. Be sure to save the original fasteners for reassembly.

**Step 3** - Charge the circuit breaker, close the circuit breaker, then open the circuit breaker. Alternately depress the Open and Close clappers a few times to ensure the circuit breaker is completely discharged.

**Step 4** - Cut a piece of one inch wide drafting / masking tape approximately 8 to 10 inches long.

**Step 5** - Clean the far left cam with a mild solvent such as alcohol. Place the tape around the cam starting from the bottom up. Make certain that the tape adheres well to the cam surface. (Figure 6.4).

**Step 6** - Mount the transparent CloSure™ Test Tool (Figure 6.5.b) with two bolts and washers. Refer to Figure 6.5.a and Table 6.1 for approximate mounting holes. Hand tighten the bolts.

**Step 7** - Using a red Sanford® Sharpie® fine point permanent marker (or equivalent), place the marker tip in the proper hole ("C") located over the cam and make a heavy mark on the tape by moving the marker as described in Figures 6.7 and 6.11. Remove the marker from the hole.

**Step 8** - Charge the closing springs with the maintenance tool (Charging handle). Continue charging the closing springs until a "click" is heard and the status indicator shows 'Charged' (Figure 6.6).

**Step 9** - Place the marker back in the hole. While holding the marker tip against the tape, close the circuit breaker (Figure 6.8). Remove the marker from the hole.

**Step 10** - While closely observing the pole shaft at the left side of the circuit breaker (Figure 6.9), recharge the closing springs with the maintenance tool. As the circuit breaker is recharged, there should be no movement of the pole shaft. If there is movement of the pole shaft while recharging, this indicates a problem with the circuit breaker - stop the test and consult the factory.

**Step 11** - Open the circuit breaker, then close it, then reopen it. Verify that the mark made in Step 7 is aligned with the pen opening. If it is not aligned, this indicates a problem with the circuit breaker - stop the test and consult the factory.
Step 12 - Inspect the circuit breaker to assure it is in the open position and the closing springs are discharged. Alternately depress the Open and Close clappers a few times to ensure the circuit breaker is completely discharged. Remove the transparent CloSure™ Tool.

Step 13 - Remove the tape from the cam and place it on a sheet of paper that can be kept as a record of the test. Record the date of the test, person conducting the test, circuit breaker serial number, and the operations counter on the tape or paper (Figures 6.12 and 6.13).

Step 14 - Evaluate the CloSure™ performance by comparing the test tape with the illustration in Figure 6.14. Measure the over travel “X”. If “X” is greater than or equal to 0.6”, the circuit breaker performance is satisfactory. If “X” is less than 0.6”, this indicates a problem with the circuit breaker - consult the Power Breaker Center for technical support.

Step 15 - Reassemble the front cover onto the circuit breaker. Return the circuit breaker to its original configuration and setup.

Figure 6.8. With Marker in Hole “C”, While Closing Circuit Breaker

Figure 6.9. Pole Shaft Located On Left Side Of Circuit Breaker
Figure 6.10. Move the Sharpie® 15° Left and Right

Figure 6.11. Top view of Cam and Marker Interface

Figure 6.12. Evaluate the CloSure™ Performance

Figure 6.13. Determining the Distance Traveled

Figure 6.14. Illustrative Testing Tape Sample

*Figure not to scale

*Note: Use the center of the marker diameter to determine "X" distance

If "X" is > 0.6", then the performance is satisfactory.
6.9 MAINTENANCE RECOMMENDATION

The VR-Series+ circuit breaker is lubricated during assembly with a long lasting synthetic lubricant. When applied in “usual service conditions” as defined by IEEE C37.04-1999, the VR-Series+ circuit breaker element requires maintenance only once every ten years or ten thousand operations, which ever comes first.

After a ten year service interval or when ten thousand operations have been reached, contact your local Eaton representative to arrange for factory recertification.

During the ten year service interval, no supplemental lubrication with light machine oil is recommended. Machine oil may be incompatible with the advanced lubricant in the VR-Series+ vacuum replacement circuit breaker and will damage the components of the stored energy mechanism.
<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>INSPECTION AREA</th>
<th>PROBABLE DEFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FAILS TO CLOSE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closing Springs Not Charged</td>
<td>Control Circuit</td>
<td>• Control Power (Fuse blown or switch off)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Secondary Disconnect Contacts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Motor Cut-off Switch (Poor or burned contacts. Lever not operational.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Terminals And Connectors (Poor or burned contacts)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Motor (Brushes worn or commutator segment open)</td>
</tr>
<tr>
<td>Mechanism</td>
<td></td>
<td>• Pawls (Slipping or broken)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ratchet Wheel (Teeth worn or broken)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cam Shaft Assembly (Sluggish or jammed)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Oscillator (Reset Spring off or broken)</td>
</tr>
<tr>
<td>Closing Springs Not Charged</td>
<td>Control Circuit</td>
<td>• Control Power (Fuse blown or switch off)</td>
</tr>
<tr>
<td>Circuit Breaker Does Not Close</td>
<td>(Close Coil does not pick up)</td>
<td>• Secondary Disconnect Contacts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Anti Pump Relay (Y Relay N.C. contact open or burned or relay picks up)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Close Coil (Open or burned)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Latch Check Switch (Contact open - Bad switch or trip bar not reset)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Auxiliary Switch (B Contact open or burned)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Motor Cut-Off (Contacts open or burned)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Trip Coil Assembly (Clapper fails to reset)</td>
</tr>
<tr>
<td>Closing sound but no close</td>
<td></td>
<td>• Pole Shaft (Not open fully)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Trip Latch Reset Spring (Damaged or missing)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Trip Bar-D Shaft (Fail to remain reset)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Trip Latch-Hatchet (Fails to remain reset)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Trip Floor Tripper (Fails to remain reset)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Close Latch (Binding)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Close Latch Roller (Binding)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Trip Circuit Energized</td>
</tr>
<tr>
<td><strong>UNDESIRABLY CLOSES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Circuit</td>
<td></td>
<td>• Close Circuit (CS/C getting shorted)</td>
</tr>
<tr>
<td>Mechanism</td>
<td></td>
<td>• Close Release Latch (Fails to reset)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Close Floor Tripper (Fails to reset)</td>
</tr>
<tr>
<td><strong>FAILS TO CLOSE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Trip Sound</td>
<td>Control Circuit</td>
<td>• Control Power (Fuse blown or switch off)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Secondary Disconnect Contacts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Auxiliary Switch (A contact not making poor or burned)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Trip Coil (Burned or open)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Terminals and connections (Poor or burned or open)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Trip Clapper (Jammed)</td>
</tr>
<tr>
<td>Trip Mechanism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trip Sound But No Trip</td>
<td>Trip Mechanism</td>
<td>• Trip Bar, Trip Latch (Jammed)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pole Shaft (Jammed)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Operating Rod Assembly (Broken or pins out)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Vacuum Interrupter (One Or More Welded)</td>
</tr>
<tr>
<td><strong>UNDESIRABLY TRIPS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Circuit</td>
<td></td>
<td>• Control power (CS/T Switch, remains made)</td>
</tr>
<tr>
<td>Mechanism</td>
<td></td>
<td>• Trip Coil Clapper (Not resetting)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Trip Bar or Trip Latch (Poor engagement of mating or worn surfaces)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Trip Bar Reset Sprint (Loss of torque)</td>
</tr>
</tbody>
</table>
SECTION 7: REPLACEMENT PARTS

7.1 GENERAL

In order to minimize production downtime, it is recommended that an adequate quantity of spare parts be carried in stock. The quantity will vary from customer to customer, depending upon the service severity and continuity requirements. Each customer should develop his own level based on operating experience. However, when establishing a new operating record, it is a good practice to stock one set of control components for every six circuit breakers of the same control voltage. This quantity should be adjusted with time and frequency of operation of the circuit breakers.

<table>
<thead>
<tr>
<th>No.</th>
<th>Part Description</th>
<th>Control Components</th>
<th>Part Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANTI-PUMP (Y) RELAY</td>
<td></td>
<td>94C9525H01</td>
</tr>
<tr>
<td></td>
<td>(48Vdc)</td>
<td></td>
<td>94C9525H02</td>
</tr>
<tr>
<td></td>
<td>(125Vdc)</td>
<td></td>
<td>94C9525H03</td>
</tr>
<tr>
<td></td>
<td>(250Vdc)</td>
<td></td>
<td>94C9525H04</td>
</tr>
<tr>
<td></td>
<td>(120Vac)</td>
<td></td>
<td>94C9525H05</td>
</tr>
<tr>
<td>2.</td>
<td>RECTIFIER</td>
<td>Rectifier</td>
<td>94C9525G09</td>
</tr>
<tr>
<td>3.</td>
<td>SPRING CHARGING MOTOR</td>
<td></td>
<td>94C9525G10</td>
</tr>
<tr>
<td></td>
<td>(48Vdc)</td>
<td></td>
<td>94C9525G11</td>
</tr>
<tr>
<td></td>
<td>(125Vdc)</td>
<td></td>
<td>94C9525G12</td>
</tr>
<tr>
<td></td>
<td>(250Vdc / 240Vac)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>AUXILIARY SWITCH</td>
<td>Circuit Breaker Auxiliary Switch</td>
<td>94C9525G13</td>
</tr>
<tr>
<td>5.</td>
<td>POSITION SWITCH</td>
<td>Circuit Breaker Position Switch PS1</td>
<td>94C9525H06</td>
</tr>
<tr>
<td>6.</td>
<td>POSITION SWITCH</td>
<td>Circuit Breaker Position Switch PS2</td>
<td>94C9525H07</td>
</tr>
<tr>
<td>7.</td>
<td>LATCH CHECK SWITCH</td>
<td>Latch Check Switch (LC)</td>
<td>94C9525H08</td>
</tr>
<tr>
<td>8.</td>
<td>MOTOR CUTOFF SWITCHES</td>
<td>[LS]</td>
<td>94C9525G15</td>
</tr>
<tr>
<td>9.</td>
<td>SPRING RELEASE COILS / SHUNT TRIPS</td>
<td></td>
<td>94C9525G16</td>
</tr>
<tr>
<td></td>
<td>24Vac</td>
<td></td>
<td>94C9525G17</td>
</tr>
<tr>
<td></td>
<td>48Vdc</td>
<td></td>
<td>94C9525G18</td>
</tr>
<tr>
<td></td>
<td>125Vac / 120Vac</td>
<td></td>
<td>94C9525G19</td>
</tr>
<tr>
<td></td>
<td>250Vdc / 240Vac</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>CONTROL COMPONENTS KIT</td>
<td></td>
<td>94C9525G01</td>
</tr>
<tr>
<td></td>
<td>48Vdc</td>
<td></td>
<td>94C9525G02</td>
</tr>
<tr>
<td></td>
<td>125Vdc</td>
<td></td>
<td>94C9525G03</td>
</tr>
<tr>
<td></td>
<td>250Vdc</td>
<td></td>
<td>94C9525G04</td>
</tr>
<tr>
<td></td>
<td>120Vac-C/M 48Vac-T</td>
<td></td>
<td>94C9525G05</td>
</tr>
<tr>
<td></td>
<td>240Vac-C/M 48Vac-T</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>120Vac-C/M 120Vac-CT</td>
<td></td>
<td>94C9525G06</td>
</tr>
<tr>
<td></td>
<td>240Vac-C/M 240Vac-CT</td>
<td></td>
<td>94C9525G07</td>
</tr>
</tbody>
</table>

7.2 ORDERING INSTRUCTIONS

a. The style numbers in Table 7.1 should be sufficient to purchase control components for most applications. Some circuit breakers have special control schemes. Supply complete nameplate information for verification or if additional components are needed.

b. Specify the method of shipping desired.

c. Send all orders or correspondence to the nearest Eaton sales office or contact the PBC direct at 1-877-276-9379.

d. Include negotiation number with order when applicable.