50/75/150DH-VR
Replacement Circuit Breaker

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Powering Business Worldwide
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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, BODILY INJURY AND PROPERTY DAMAGE.

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, CAN RESULT FROM FAILURE TO FOLLOW THE PROCEDURES OUTLINED IN THIS MANUAL.

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 8
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 THE INTERRUPTER ASSEMBLY 12
4.1.2 CONTACT EROSION INDICATOR 12
4.1.3 CONTACT WIPE AND STROKE 13
4.2 PHASE BARRIERS 13
4.3 BUSHINGS AND DISCONNECTING CONTACT ASSEMBLIES 13
4.4 STORED ENERGY MECHANISM 13
4.4.1 CLOSING SPRING CHARGING 14
4.4.2 CLOSING OPERATION 14
4.4.3 TRIPPING OPERATION 14
4.4.4 TRIP-FREE OPERATION 14
4.5 CONTROL SCHEMES 14
4.5.1 TIMING 16
4.6 SECONDARY CONNECTION BLOCK 16
4.7 INTERLOCKS 16
4.7.1 RACKING-IN INTERLOCK 16
4.7.2 ANTI-CLOSE INTERLOCK 16
4.7.3 RACKING SYSTEM TRIP AND CLOSING SPRING RELEASE INTERLOCKS 16
4.8 MISCELLANEOUS ITEMS 16
4.8.1 GROUNDING CONTACT 16
4.8.2 MOC AND TOC OPERATIONS 16
4.8.3 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 INTENSITY 22
5.5 LOW FREQUENCY WITHSTAND TEST (INSULATION CHECK) 22
5.6 CONTACT EROSION AND WIPE 22
5.7 PRIMARY CIRCUIT RESISTANCE 22
5.8 ELECTRICAL OPERATIONS CHECK 22
5.9 CELL POSITION DESCRIPTION 23
5.10 INSERTION PROCEDURE 24
5.11 REMOVING BREAKER FROM CELL 25

## SECTION 6: INSPECTION & MAINTENANCE 27

6.1 INSPECTION FREQUENCY 27
6.2 INSPECTION AND MAINTENANCE PROCEDURES 27
6.3 VACUUM INTERRUPTER INTEGRITY TEST 28
6.4 CONTACT EROSION AND WIPE 28
6.5 INSULATION 29
6.6 INSULATION INTEGRITY CHECK 29
6.7 PRIMARY CIRCUIT RESISTANCE CHECK 30
6.8 MECHANISM CHECK 30
6.8.1 CLOSURE™ TEST 30
6.9 LUBRICATION 33

## SECTION 7: REPLACEMENT PARTS 35

7.1 GENERAL 35
7.2 ORDERING INSTRUCTIONS 35
SECTION 1: INTRODUCTION

The purpose of this book is to provide instructions for receiving and handling, storage, installation, operation and maintenance of type DH VR-Series circuit breaker. The Vacuum Replacement Circuit Breakers (also referred to as VR-Series) are designed to be used in existing Westinghouse type DH metal-enclosed switchgear and provide equal or 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 are interchangeable with each other.

This book is intended to be used in conjunction with the technical information provided with the original equipment order which includes, but is not limited to electrical control schematics and wiring diagrams, outline diagrams, installation plans, and procedures for installation and maintenance of accessory items.

Satisfactory performance is dependent upon proper application, correct installation, and adequate maintenance. It is strongly recommended that this instruction book be carefully read and followed in order to realize optimum performance and long useful life of the circuit breaker.

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 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.

Figure 1.1. Quick Response Code

VR-Series QR Code

⚠ WARNING

SATISFACTORY PERFORMANCE OF THESE BREAKERS IS CONTINGENT UPON PROPER APPLICATION, CORRECT INSTALLATION AND ADEQUATE MAINTENANCE. THIS INSTRUCTION BOOK 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 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>Breaker Type</th>
<th>Nominal Voltage Class</th>
<th>Existing Breaker Rating</th>
<th>Existing Breaker Rated Continuous Current at 60 Hz</th>
<th>VR-Series Breaker Rating</th>
<th>Rated Voltage Factor</th>
<th>Rated Withstand ANSI Test Voltage</th>
<th>Rated Short-Circuit Maximum Sym. Interrupting Capability</th>
<th>Closing and Latching / Momentary Capabilities</th>
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<tbody>
<tr>
<td>50DH-VR</td>
<td></td>
<td></td>
<td></td>
<td>50DH150U</td>
<td>1.24</td>
<td>19</td>
<td>60</td>
<td>29 / 36</td>
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<tr>
<td></td>
<td>4.16</td>
<td>150</td>
<td>1200 / 2000</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>4.16</td>
<td>250</td>
<td>1200 / 2000</td>
<td>50DH250</td>
<td>1.24</td>
<td>19</td>
<td>60</td>
<td>29 / 36</td>
</tr>
<tr>
<td></td>
<td>4.16</td>
<td>350</td>
<td>1200 / 2000</td>
<td>50DH250U</td>
<td>1.19</td>
<td>19</td>
<td>60</td>
<td>41 / 49</td>
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<tr>
<td></td>
<td>4.16</td>
<td>350</td>
<td>1200 / 3000</td>
<td>50DH350</td>
<td>1.19</td>
<td>19</td>
<td>60</td>
<td>41 / 49</td>
</tr>
<tr>
<td>75DH-VR</td>
<td>7.2</td>
<td>500</td>
<td>1200 / 2000</td>
<td>75DH500</td>
<td>1.25</td>
<td>36</td>
<td>95</td>
<td>33 / 41</td>
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<td></td>
<td></td>
<td>150DH500</td>
<td>1.30</td>
<td>36</td>
<td>95</td>
<td>18 / 23</td>
</tr>
<tr>
<td></td>
<td>13.8</td>
<td>500</td>
<td>1200 / 2000</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>13.8</td>
<td>750</td>
<td>1200 / 2000</td>
<td>150DH500U</td>
<td>1.30</td>
<td>36</td>
<td>95</td>
<td>28 / 36</td>
</tr>
<tr>
<td></td>
<td>13.8</td>
<td>1000</td>
<td>1200 / 2000</td>
<td>150DH500UXU</td>
<td>1.30</td>
<td>36</td>
<td>95</td>
<td>37 / 48</td>
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<tr>
<td></td>
<td>13.8</td>
<td>750</td>
<td>1200 / 2000</td>
<td>150DH750</td>
<td>1.30</td>
<td>36</td>
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<td>28 / 36</td>
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<td>95</td>
<td>37 / 48</td>
</tr>
<tr>
<td></td>
<td>13.8</td>
<td>1500</td>
<td>1200 / 3000</td>
<td>150DH1500U</td>
<td>1.00</td>
<td>36</td>
<td>95</td>
<td>63 / 63</td>
</tr>
</tbody>
</table>

① All circuit breakers have a 3 second short time rating.
## Table 2. DH-VR (5kV, 250 MVA Rating Shown) Nominal Dimensions

<table>
<thead>
<tr>
<th>Breaker Type</th>
<th>Rated Continuous Current at 60 Hz (Amps)</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 250</td>
<td>1200</td>
<td>64.70</td>
<td>22.25</td>
<td>7.00</td>
<td>32.87</td>
<td>9.00</td>
<td>26.81</td>
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<tr>
<td>50DH-VR 250/250U</td>
<td>2000</td>
<td>64.70</td>
<td>32.25</td>
<td>10.00</td>
<td>34.60</td>
<td>9.00</td>
<td>26.81</td>
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<tr>
<td>50DH-VR 350</td>
<td>1200</td>
<td>73.06</td>
<td>22.25</td>
<td>7.00</td>
<td>38.00</td>
<td>11.00</td>
<td>26.81</td>
</tr>
<tr>
<td>50DH-VR 350</td>
<td>3000</td>
<td>73.06</td>
<td>32.25</td>
<td>10.00</td>
<td>43.50</td>
<td>11.00</td>
<td>26.81</td>
</tr>
<tr>
<td>75DH-VR 500</td>
<td>1200 / 2000</td>
<td>73.06</td>
<td>32.25</td>
<td>10.00</td>
<td>46.12</td>
<td>9.00</td>
<td>26.81</td>
</tr>
<tr>
<td>150DH-VR 500/750 (also &quot;U&quot; &amp; &quot;XU&quot;)</td>
<td>1200 / 2000</td>
<td>73.06</td>
<td>32.25</td>
<td>10.00</td>
<td>46.12</td>
<td>9.00</td>
<td>26.81</td>
</tr>
<tr>
<td>150DH-VR 1000E</td>
<td>1200 / 3000</td>
<td>87.06</td>
<td>32.25</td>
<td>10.00</td>
<td>54.64</td>
<td>11.00</td>
<td>26.81</td>
</tr>
</tbody>
</table>
SECTION 2: SAFE PRACTICES

VR-Series 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.

⚠️ WARNING

TO PROTECT THE PERSONNEL ASSOCIATED WITH INSTALLATION, OPERATION, AND MAINTENANCE OF THESE 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 breakers.
• Read these instructions carefully before attempting any installation, operation or maintenance of these breakers.
• Always remove the breaker from the enclosure before performing any maintenance. Failure to do so could result in electrical shock leading to death, severe personnel injury or property damage.
• Do not work on a breaker with the secondary test coupler engaged. Failure to disconnect the test coupler could result in an electrical shock leading to death, personnel injury or property damage.
• Do not work on a closed breaker or a breaker with closing springs charged. The closing spring should be discharged and the main contacts open before working on the 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 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 breaker in an intermediate position in the cell. Always have the breaker either in the Test or Connected position. Failure to do so could result in a flash over and possible death, personnel injury or property damage.
• Always remove the maintenance tool from the breaker after charging the closing springs.
• Breakers are equipped with safety interlocks. Do not defeat them. This may result in death, bodily injury or equipment damage.
SECTION 3: RECEIVING, HANDLING, AND STORAGE

Type DH 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, cell code plate, (if applicable) etc. are shipped with the breaker (Figure 3.1).

3.1 RECEIVING

Until the breaker is ready to be delivered to the switchgear site for installation, DO NOT remove it from the shipping crate. If the 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 breaker for any signs of shipping damage such as broken, missing or loose hardware, damaged or deformed insulation and other components. File claims immediately with the carrier if damaged or loss is detected and notify the nearest Eaton’s Electrical Services & Systems office.

Tools and Accessories

Maintenance Tool: This tool is used to manually charge the closing spring. One maintenance tool is provided with each vacuum unit replacement breaker. (Style# 8064A02G01)

Racking Handle: The racking handle is used to drive the racking mechanism which moves the circuit breaker into and out of the cell. The original OEM racking handle will interface with the VR-Series replacement breaker racking mechanism and is therefore not provided as part of the vacuum replacement breaker.

Secondary Connection Block Extension Cable: The extension cable can be used to connect the circuit breaker to a “test cabinet” or to the switchgear cell’s secondary receptacle block so that the breaker can be electrically operated while not installed in the switchgear cell. This extension cable is the same one provided with the original Westinghouse circuit breaker and is therefore not included as part of the VR-Series circuit breaker.

Turning Dolly: Optional item used to help maneuver breaker when out of structure. (Style# 677C889G01)

Figure 3.1.a. Typical Manual Charge Handle

Figure 3.1.b. Rotary Racking Handle

3.2 HANDLING

WARNING

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

DH-VR breaker shipping containers are designed to be handled either by use of a rope sling and 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 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 a breaker is ready for installation, a lifting harness in conjunction with an overhead lift or portable floor lift can be used to move a breaker, if this is preferable to rolling the breaker on the floor using self contained wheels. If the breaker is to be lifted, position the lifting device (lifting straps should have at least a 1600 pound capacity) over the breaker and insert the lifting harness hooks into the breaker side openings and secure. Be sure the hooks are firmly attached before lifting the breaker. Stand a safe distance away from the breaker while lifting and moving.

Figure 3.2. Lifting DH-VR (150DH-VR Shown)
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. Before placing it in storage, checks should be made to make sure that the breaker is free from shipping damage and is in satisfactory operating condition.

The breaker is shipped with its contacts open and closing springs discharged. The indicators on the front panel should confirm this. Insert the maintenance tool in the manual charge socket opening (Figure 3.3, 3.5, & 3.7). Charge the closing springs by pumping the handle up and down about 36 times until a crisp metallic “click” is heard. This indicates that the closing springs are charged and is shown by the closing spring “charged” (yellow) indicator. Remove the maintenance tool. Push the “manual close” button. The breaker will close as shown by the breaker contacts “closed” (red) indicator. Push the “manual trip” button. The breaker will trip as shown by the breaker contacts “open” (green) indicator. After completing this initial check, leave the closing springs “discharged” and 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

Refer to Table 3.

Table 3. Approximate Weight by Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Amperes</th>
<th>LBs</th>
</tr>
</thead>
<tbody>
<tr>
<td>50DH-VR 250</td>
<td>1200</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>875</td>
</tr>
<tr>
<td>50DH-VR 350</td>
<td>1200</td>
<td>750</td>
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<tr>
<td></td>
<td>2000</td>
<td>850</td>
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<tr>
<td></td>
<td>3000</td>
<td>1150</td>
</tr>
<tr>
<td>75/150DH-VR 500</td>
<td>1200</td>
<td>900</td>
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<td></td>
<td>2000</td>
<td>1050</td>
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</tr>
<tr>
<td></td>
<td>3000</td>
<td>1475</td>
</tr>
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</table>
Figure 3.3. Front External View of 15kV DH-VR (150DH-VR 500 1200A Shown)
Figure 3.4. Rear External View of 15kV DH-VR (150DH-VR 500 1200A Shown)

Rear External View

1  Primary Disconnect  3  TOC Switch Operating Mechanism  5  Secondary Disconnect
2  SURE CLOSE  4  MOC Switch Operating Mechanism
SECTION 4: DESCRIPTION AND OPERATION

VR-Series vacuum replacement breakers are designed to be used with existing installations of equivalent air-magnetic metal-clad switchgear breaker. 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 as the vapor leaves the contact area, it condenses 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 THE INTERRUPTER ASSEMBLY

Each interrupter is assembled at the factory as a unit to assure correct dimensional relationships between working components. The interrupter assembly consists of a vacuum interrupter, a molded glass polyester stand-off insulator, upper and lower clamps, flexible shunts, bell crank, operating rod, and contact load spring. The vacuum interrupter is mounted vertically with the fixed stem upward and the moving stem downward. The upper and lower glass polyester stand-off insulator and clamps support the interrupter and are fastened to the breaker’s stored energy mechanism frame. Upper and lower flexible shunts provide electrical connections from each interrupter to the breaker’s primary bushings while providing isolation from mechanical shock and movement of the interrupter’s moving stem. The operating rod, loading spring, and bell crank transfer mechanical motion from the breaker’s operating mechanism to the moving stem of the interrupter. A vacuum interrupter contact erosion indicator is located on the moving stem of the interrupter. It is visible when the breaker is withdrawn and is viewed from the rear of the breaker. (See Figure 4.1 and Figure 4.2)

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 copperchrome contact material. A contact erosion indicator mark is located on the moving stem of the interrupter (Figure 6.1 and 6.2).

In order to determine if the contacts have eroded to the extent that the interrupter must be replaced, close the breaker and observe the erosion mark placed on each moving stem from the rear of the breaker. If the mark on the interrupter stem is visible, the interrupter is satisfactory. If the mark is no longer visible, the interrupter assembly must be replaced.

The erosion indicator is easily viewed from the rear on the 7.5 or 15kV designs. Because of the nature of the 5kV 20-WR element inverted design, the erosion indicator is not easily viewed, although it is possible with the use of a light and an inspection type mirror.
4.1.3 CONTACT WIPE AND STROKE

Contact wipe is the indication of (1) the force holding the vacuum interrupter contacts closed and (2) the energy available to hammer the contacts open with sufficient speed for interruption.

Stroke is the gap between fixed and moving contacts of a vacuum interrupter with the breaker open.

The circuit breaker mechanism provides a fixed amount of motion to the operating rods. The first portion of the motion is used to close the contacts (i.e. stroke) and the remainder is used to further compress the preloaded wipe spring. This additional compression is called wipe. Wipe and stroke are thus related to each other. As the stroke increases due to the erosion of contacts, the wipe decreases. A great deal of effort and ingenuity has been spent in the design of VR-Series breakers, in order to eliminate any need for field adjustment of wipe or stroke.

4.2 PHASE BARRIERS

Phase barriers are sheets of insulation located between the interrupter pole assemblies and on the sides of the breaker frame. The phase barriers are designed to isolate energized conductor components in each phase from the adjacent phase and ground.

4.3 BUSHINGS AND DISCONNECTING CONTACT ASSEMBLIES

The line and load bushing assemblies, which are the primary circuit terminals of the circuit breaker, consist of six silver plated conductors. Multiple finger type primary disconnecting contacts at the ends of the conductors provide means for connecting and disconnecting the breaker to the bus terminals in the switchgear compartment.

4.4 STORED ENERGY MECHANISM

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

The mechanism stores the closing energy by charging the closing springs. When released, the stored energy closes the breaker, charges the wipe and resets the opening springs. The mechanism may rest in any one of the four positions shown in Figure 4.9 as follows:

a. Breaker open, closing springs discharged.
b. Breaker open, closing springs charged.
c. Breaker closed, closing springs discharged.
d. Breaker closed, closing springs charged.
The mechanism is a mechanically “trip-free” design. Trip-free is defined later in this section.

In normal operation the closing spring is charged by the spring charging motor, and the 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 breaker can be closed and tripped by pushing the “Push to Close” and “Push to Open” buttons on the front panel.

**WARNING**

**KEEP HANDS AND FINGERS AWAY FROM BREAKER’S INTERNAL PARTS WHILE THE BREAKER CONTACTS ARE CLOSED OR THE CLOSING SPRINGS ARE CHARGED.**

The breaker should be closed mechanically only if there is positive verification that load side conditions permit. It is recommended that closing the breaker in the “CONNECTED” position always be done with the cubicle door closed. Failure to follow these directions may cause death, personal injury, or property damage.

**ELECTRICAL TRIPPING CAN BE VERIFIED WHEN THE BREAKER IS IN THE “TEST” POSITION.**

### 4.4.1 CLOSING SPRING CHARGING

Figure 4.8 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 maintenance tool in the manual charging socket. Move it up and down several times (about 36) until a clicking sound is heard and closing spring status indicator shows “charged” (Figure 3.3). A further motion of the maintenance tool will result in free wheeling of the ratchet wheel and will not result into advance of charging.

### 4.4.2 CLOSING OPERATION

Figure 4.9 shows the positions of the closing cam and tripping linkage for four different operational states. In Figure 4.9a the breaker is open and the closing springs are discharged. In this state, the trip latch is disengaged from the trip “D” shaft (unlatched). After the closing springs become charged, the trip latch snaps into the fully reset or latched position (Figure 4.9b).

When the spring release clapper (Figure 4.8, Item 13) moves into the face of the spring release coil (electrically or manually), the upper portion of the clapper pushes the spring release latch (1) upward. When the spring release latch moves, the cam shaft assembly is free to rotate. The force of the closing cam (Figure 4.9b, 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 4.9c. Interference of the trip “D” shaft with the trip latch prevents the linkage from collapsing, and holds the breaker closed.

Figure 4.9.d shows the breaker in the closed state after the closing springs have been recharged. The recharging of the spring rotates the closing cam one half turn. In this position the main link roller rides on the cylindrical portion of the cam, and the main link does not move out of position.

### 4.4.3 TRIPPING OPERATION

When the trip bar “D” shaft (Figure 4.9b, 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 rise. 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 4.9b) after the breaker is tripped open.

### 4.4.4 TRIP-FREE OPERATION

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

### 4.5 CONTROL SCHEMES

There are two basic control schemes for each series of Type VCP-WR breakers, one for DC control and one for AC control voltages (Figure 4.5). Specific wiring schematics and diagrams are included with each breaker.

There may be different control voltages or more than one tripping element, 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 cuts off LS1/bb switch turns the motor off. The breaker may be closed by making the control switch close (CS/C) contact. Automatically upon closing of the breaker, the motor starts charging the closing springs. The breaker may be tripped any time by making the control switch (CS/T) contacts.

Note the position switch (PS1) contact in the spring release circuit in the scheme. This contact remains made while the breaker is being racked between the TEST and CONNECTED positions for appropriately retrofitted breakers. Consequently, it prevents the breaker from closing automatically, even though the control close contact may have been made while the breaker is racked to the CONNECTED position.

When the CS/C contact is made, the SR closes the breaker. If the CS/C contact is maintained after the 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 breaker would subsequently open, it could not be reclosed before CS/C was released and remade. This is the anti-pump function.
Figure 4.5. Typical AC/DC Schematic

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

- **OPERATION**
  - Closed until springs are fully charged
  - Open until springs are fully charged
  - Closed until springs are fully charged
  - Open until mechanism is reset
  - Open in all except between ‘Test’ and ‘Connect’ positions
  - 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 ‘NO’ Brown Switch

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

- **OPERATION**
  - Closed until springs are fully charged
  - Open until springs are fully charged
  - Closed until springs are fully charged
  - Open until mechanism is reset
  - Open in all except between ‘Test’ and ‘Connect’ positions
  - 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 ‘NO’ Brown Switch

---

**Legend**

- CS - Breaker Control Switch - close
- CS - 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
4.5.1 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 heath of the 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 / Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closing Time</td>
<td>75</td>
</tr>
<tr>
<td>(From Initiation of Close Signal to Contact Make)</td>
<td></td>
</tr>
<tr>
<td>Opening Time</td>
<td>45</td>
</tr>
<tr>
<td>(Initiation of Trip Signal to Contact Break)</td>
<td></td>
</tr>
<tr>
<td>Reclosing Time</td>
<td>190</td>
</tr>
<tr>
<td>(Initiation of Trip Signal to Contact Make)</td>
<td></td>
</tr>
</tbody>
</table>

4.6 SECONDARY CONNECTION BLOCK

The breaker control circuit is connected to the switchgear control through secondary connection block, located at the lower left rear of the breaker. The contacts engage automatically when the breaker is racked into the “test” and “connect” positions. The socket half of the connection is located in the cubicle and a jumper of multiconductor cable can complete the control connections (for testing) when the breaker is withdrawn from the cell.

4.7 INTERLOCKS

**WARNING**

INTERLOCKS ARE PROTECTIVE DEVICES FOR PERSONNEL AND EQUIPMENT. DO NOT BYPASS, MODIFY, OR MAKE INOPERATIVE ANY INTERLOCKS. DOING SO COULD CAUSE DEATH, SERIOUS PERSONAL INJURY, AND/OR PROPERTY DAMAGE.

There are several interlocks built into the VR-Series vacuum replacement breakers. Each of these interlocks, though different in form, duplicate or exceed in function that of the original breaker. These interlocks exist to safeguard personnel and equipment. The basic premise behind the interlocking arrangement on the vacuum replacement breaker is that the 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 breaker should pose no greater risk than necessary to the operator in or out of the cell. In addition to the original interlocks, VR-Series breakers provide an anti-close interlock.

4.7.1 RACKING-IN INTERLOCK

The racking interlock prevents engaging the racking handle with the racking drive shaft when the breaker main contacts are closed (Figure 3.3). A metal bracket, or “flag”, moves in front of the racking mechanism drive shaft, blocking the access hole, preventing the crank from being inserted.

4.7.2 ANTI-CLOSE INTERLOCK

The anti-close interlock prevents discharging of the closing springs if the breaker is already closed (Figure 4.8, Item 11). When the breaker is closed, the interlock component moves away from the spring release clapper so that it cannot lift the spring release latch (9).

4.7.3 RACKING SYSTEM TRIP AND CLOSING SPRING RELEASE INTERLOCKS

The racking system tripping and spring release interlocks perform the following:

- Sets the breaker mechanically trip-free whenever the breaker is in the “withdrawn” position or between the “test” and “connect” position.
- Set the breaker in a safe condition (breaker open, springs discharged) when removed from the cell.
- Insert a mechanical trip signal to open a position switch preventing energization of the spring release coil whenever the breaker is in an intermediate position.
- Prevents inadvertent cycling (pumping) of the breaker between the “test” or “connect” positions.
- Prevents insertion of a closed and/or charged breaker into a cell.

The two shutter blades operate with a counterbalanced action. One blade moves up while the other moves down. This design requires a minimum of operating forces with smooth shutter operation. Blades are actuated through a common link bar and shutter roller by a guide on the right side of the circuit breaker frame.

**WARNING**

DO NOT FORCE THE BREAKER INTO THE CELL. DOING SO MAY DAMAGE PARTS THEREBY RISKING DEATH, PERSONAL INJURY, AND/OR PROPERTY DAMAGE.

4.8 MISCELLANEOUS ITEMS

4.8.1 GROUNDING CONTACT

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

4.8.2 MOC AND TOC OPERATIONS

The MOC operator located on the breaker frame is linked to the breaker main pole shaft. When the breaker closes, regardless of whether it is in the cubicle, the MOC linkage of the breaker will cause the exterior MOC operator to rapidly rise. Care should be exercised to avoid contact with this mechanism. Inside the cubicle, there is a lever system connected to a MOC switch. If the breaker is in the “test” (on some designs) or “connected” position the MOC switch contains contacts which are used to interlock the circuit breaker with other external devices and can provide breaker status indication.

**WARNING**

EXTREME CARE SHOULD BE TAKEN TO AVOID PERSONNEL OR EQUIPMENT CONTACT WITH THE MOC SYSTEM WHEN OPERATING THE BREAKER DUE TO THE ASSOCIATED MECHANICAL FORCE. CONTACT WITH THE MOC OPERATOR DURING OPERATION COULD RESULT IN INJURY.

The cell mounted Truck Operated Cell Switch (TOC) is operated by movement of the breaker truck into or out of the Connected position.

4.8.3 OPERATIONS COUNTER

All DH-VR breakers are equipped with a mechanical operations counter (Figures 3.3). As the breaker opens, the linkage connected to the pole shaft lever advances the counter reading by one.
Figure 4.6. 20WR Vacuum Element - Front Faceplate Removed

<table>
<thead>
<tr>
<th>Number</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LH Closing Spring</td>
</tr>
<tr>
<td>2</td>
<td>Motor Cutoff Switch</td>
</tr>
<tr>
<td>3</td>
<td>Latch Check Switch (Rear)</td>
</tr>
<tr>
<td>4</td>
<td>Operations Counter</td>
</tr>
<tr>
<td>5</td>
<td>Closing Cam</td>
</tr>
<tr>
<td>6</td>
<td>Spring Release Assembly</td>
</tr>
<tr>
<td>7</td>
<td>Shunt Trip Assembly</td>
</tr>
<tr>
<td>8</td>
<td>RH Closing Spring</td>
</tr>
<tr>
<td>9</td>
<td>Reset Opening Spring</td>
</tr>
<tr>
<td>10</td>
<td>Manual Charge Socket</td>
</tr>
<tr>
<td>11</td>
<td>Ratchet wheel</td>
</tr>
<tr>
<td>12</td>
<td>Charging Motor</td>
</tr>
</tbody>
</table>
**29WR Vacuum Element**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LH Closing Spring</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Motor Cutoff Switch</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Latch Check Switch (Rear)</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Operations Counter</td>
<td>8</td>
</tr>
</tbody>
</table>
Figure 4.8. Closing Cam and Trip Linkage

**Closing Cam and Trip Linkage**

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th></th>
<th>Description</th>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Spring Release (Close) Latch</td>
<td>6</td>
<td>Ratchet Wheel</td>
<td>11</td>
<td>Anti-Close Interlock</td>
</tr>
<tr>
<td>2</td>
<td>Pole Shaft</td>
<td>7</td>
<td>Spring Crank</td>
<td>12</td>
<td>Motor Ratchet Lever</td>
</tr>
<tr>
<td>3</td>
<td>Closing Spring Fixed End</td>
<td>8</td>
<td>Cam Shaft</td>
<td>13</td>
<td>Spring Release (Close) Clapper</td>
</tr>
<tr>
<td>4</td>
<td>Closing Spring</td>
<td>9</td>
<td>Spring Release Latch (Close Roller)</td>
<td>14</td>
<td>Spring Release (Close) Coil</td>
</tr>
<tr>
<td>5</td>
<td>Holding Pawl</td>
<td>10</td>
<td>Drive Pawl</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 4.9. Charging Schematic

4.9.a. Breaker Open and Closing Spring Not Charged

4.9.b. Breaker Open and Closing Spring Charged

4.9.c. Breaker Closed and Closing Spring Not Charged

4.9.d. Breaker Closed and Closing Spring Charged

### Charging Schematic

<table>
<thead>
<tr>
<th></th>
<th>Main Link Roller</th>
<th>5 Closing Cam</th>
<th>9 Trip Bar “D” Shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Main Link</td>
<td>6 Cam Shaft</td>
<td>10 Trip Latch Reset Spring</td>
</tr>
<tr>
<td>3</td>
<td>Operating Rod</td>
<td>7 Banana Link</td>
<td>11 Shunt Trip Lever</td>
</tr>
<tr>
<td>4</td>
<td>Pole Shaft</td>
<td>8 Trip latch</td>
<td>12 Shunt Trip Coil</td>
</tr>
</tbody>
</table>
SECTION 5: INSPECTION & INSTALLATION

⚠️ WARNING

BEFORE PLACING THE 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 BREAKER OPERATION LEADING TO DEATH, BODILY INJURY, AND PROPERTY DAMAGE.

When the breaker is first commissioned into service and each time the breaker is returned to service, it should be carefully examined and checked to make sure it is operating correctly.

5.1 EXAMINATION FOR DAMAGE

Examine the breaker for loose or obviously damaged parts. Never attempt to install nor operate a damaged 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 Electrical Services & Systems for resolution prior to proceeding.

5.2 SURE CLOSE MECHANISM ADJUSTMENT

⚠️ WARNING

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

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

The breaker has been factory adjusted to operate one mechanism operated cell (MOC) switch in the cell. 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 cell. 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 cell. 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 insure 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 breaker (Figure 4.5). The differential force of the assembly and the breaker should be a minimum of 10 lbs. with the breaker having the higher recorded force. Should the forces be less than that, proceed with the following steps to increase the breaker force:

⚠️ WARNING

MEASUREMENTS AND ADJUSTMENTS SHOULD NEVER BE ATTEMPTED IN AN ENERGIZED STRUCTURE. IF THE STRUCTURE CAN NOT BE DE-ENERGIZED, THEN PROPER PERSONAL PROTECTIVE EQUIPMENT PER NFPA 70E MUST BE WORN AT ALL TIMES WHILE GATHERING MOC SWITCH DATA, ADJUSTING OR SERVICING THE MOC SWITCH. FAILURE TO COMPLY WITH THIS WARNING COULD CAUSE SEVERE PERSONAL INJURY, DEATH, EQUIPMENT DAMAGE AND/OR IMPROPER OPERATION.

To adjust the SURE CLOSE drive spring for a specific number of MOC switches, proceed with the following steps:

Step 1: Locate the MOC drive spring (Figure 3.3). It is located in the left lower portion of the breaker as viewed from the rear of the breaker.

Step 2: From the factory, the drive spring comes set with adequate force to operate one MOC switch, however, more force can be generated. Refer to Figure 5.3 to see how that adjustment would look. Notice that there is a nut and a jam nut on the threaded rod to make the adjustment easy.

Step 3: With the breaker out of the cell, close the breaker and measure the output of the MOC switch with a spring gauge (Figure 5.6) immediately after force has been recorded, open the breaker. The MOC drive force should exceed the MOC cell force requirement by a minimum of 10lbs. If not, an adjustment is required.

Step 4: Loosen the jam nut on the SURE CLOSE spring and compress the spring an additional .25 inches. Close the breaker.

⚠️ WARNING

WITH THE BREAKER IN THE OPEN POSITION, THE SPRING COMPRESSION SHOULD NEVER BE SET TO A DIMENSION LESS THAN 3 INCHES AS MEASURED IN FIGURE 5.3.
5.3 MANUAL OPERATION CHECK

Manual operational checks must be performed before the breaker is connected to an energized circuit. Tests must be performed with the breaker withdrawn from the cell or in the disconnect position.

While the 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 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 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 BREAKER COULD CAUSE INJURY TO PERSONNEL AND/OR EQUIPMENT DAMAGE IF THE BREAKER WAS TO CLOSE.

Close and trip the breaker by pushing the close lever then the trip lever (Figure 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 LOW FREQUENCY WITHSTAND TEST (INSULATION CHECK)

Check breaker primary and secondary insulation per Section 6.

5.6 CONTACT EROSION AND WIPE

Manually charge the closing springs and close the 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 breaker is now ready to be operated electrically. It is preferred that this check be made with the breaker in the Test position in the 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 breaker compartment, refer to the original instruction books supplied with the assembly.

**WARNING**

EXAMINE THE INSIDE OF THE CELL BEFORE INSERTING THE BREAKER FOR EXCESSIVE DIRT OR ANYTHING THAT MIGHT INTERFERE WITH THE BREAKER TRAVEL.

**WARNING**

KEEP HANDS OFF THE TOP EDGE OF THE FRONT BARRIER WHEN PUSHING A BREAKER INTO A CELL. FAILURE TO DO SO COULD RESULT IN BODILY INJURY, IF FINGERS BECOME WEDGED BETWEEN THE BREAKER AND THE CELL. USE THE HANDLES PROVIDED ON THE FRONT OF THE BREAKER FACEPLATE, OR USE BOTH FULLY OPENED HANDS FLAT ON THE FRONT OF THE FACEPLATE.
These checks can be performed with the breaker in its withdrawn or disconnect position and connecting the breaker to a test cabinet or to the switchgear cell’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 BREAKER IN THE “CONNECT” POSITION BECAUSE OF THE POSSIBILITY OF CONNECTING DE-ENERGIZED LOAD CIRCUITS TO THE ELECTRICAL POWER SOURCE, RESULTING IN DEATH, PERSONNEL INJURY OR EQUIPMENT DAMAGE

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**5.9 CELL POSITION DESCRIPTION**

**Position A:** This is the “withdrawn” position. In the “withdrawn” position the breaker is out of the cell. The racking handle is not required for this position and the racking system interlocks are not automatic outside the cell. The breaker is held in a trip-free state and cannot be operated.

**Position B:** As the breaker is pushed into the cell it will reach a mechanical stop. This is the “disconnect” position and the breaker is still in the trip free state and cannot be operated. Although it is possible to engage the control block in this position, it SHOULD NOT BE engaged at this time.

**Position C:** The racking handle is inserted on the racking shaft and turned in a clockwise direction. The breaker starts advancing into the cell. The breaker remains in the trip-free state until position “D” is reached.

**Position D:** (Figure 5.8) Continue turning the racking handle in the clockwise direction for a total of about 4 turns. At this time, note that the breaker position mode indicator status will change from “trip-free” to “test/operator”. There is no click, stop or different feel to the racking handle at this point. Observe the shutter position indicator which is located inside of the cell structure. Continue turning the crank until the shutter indicator begins to move downward. Stop clockwise rotation at this point. Turn the racking handle counterclockwise to return the shutter to its fully closed position. The breaker is now in its “test” position. After reaching the test position, REMOVE the crank (this avoids damage to the racking handle interlock). In the “test” position, the breaker can be closed and tripped manually and electrically, thus allowing maintenance tests or checks. To operate the breaker electrically, the secondary control block must be engaged at this time. Release the secondary control block slider by pulling the release 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 block’s socket. The spring charging motor will begin to run and charge the closing spring as the contact block engages. The breaker is now in the “test” position, with control voltage applied, and ready for testing. The breaker is held captive in the cell via the racking system.

**Position E:** To continue installing the breaker to the connected position the racking handle will have to be reinserted onto the racking shaft (the breaker MUST be in the open position). Continue turning the racking handle in the clockwise direction and the breaker will continue advancing into the cell. The position mode indicator will change from “test/operator” to “trip-free”. The racking system cam will engage the trip release mechanism. The closing springs may be in the charged state but the internal PS switch will open circuit the close spring release coil (preventing an electrical close). At this point any attempt to mechanically close the breaker will cause a trip-free operation. As you continue to advance the breaker into the cell the primary voltage source shutters will open allowing the breaker stabs to engage with the source.

**Position F:** Continue clockwise cranking until a mechanical stop is reached. This is the fully engaged or connected position. At this position you will note the position mode indicator is again on “test/operator”, the trip and close cams have released the trip and close mechanisms, and the breaker can be operated. The racking handle MUST be removed before operating the breaker to prevent damage to the racking handle interlock and the breaker mechanism. The breaker is now ready for service.

**WARNING**

DO NOT USE ANY TOOL TO RACK THE BREAKER TO OR FROM THE CONNECTED POSITION OTHER THAN THE RACKING HANDLE. (FIGURE 3.1)

**Position G:** To remove the breaker from the cell it must be in the open position so that the racking interlock will allow the racking handle to be installed on the racking shaft. Turn the crank in the counterclockwise direction. The breaker will start coming out of the cell but before the main stabs are disconnected, the racking cam will raise the trip mechanism, putting the breaker into the trip-free state. Also, the secondary controls stabs will disengaged automatically. The position mode indicator will change from “test/op” to “trip-free”. The breaker is in a non-operate mode and will go through a trip-free operation if an attempt to close it were made.

**Position H:** Continue cranking in the counterclockwise direction, and the shutters will close after the main stabs have cleared, isolating the breaker from its source. Continue cranking until the position mode indicator re-centers on “test/operator”. At this time the breaker is in the test position and the trip cam is released, allowing the breaker to be operated either electrically or mechanically. If you desire to open or close the breaker in the test position the racking handle MUST be removed. To operate electrically, the secondary control block must be re-engaged.

**Position I:** To remove the breaker from the test position to the disconnected position, the breaker must be tripped if closed, and the secondary contact block should be disengaged and the manual open and close buttons cycled to render the breaker open and discharged. Continued cranking will force a trip-free condition leaving the breaker in the open position if the breaker were left closed in the test position. The breaker is in a non-operate state.

**Position J:** Once the racking mechanism is cranked counterclockwise until a mechanical stop is reached it is in the disconnected position. The racking handle should be removed at this point. The breaker is ready to be removed from the cell if desired.

**Position K:** The breaker is removed from the cell by manually pulling on the handle located immediately below the position mode indicator. The racking system is in the “disconnect” orientation. The breaker is in a trip-free status and in a non-operable state in the withdrawn position.
5.10 INSERTION PROCEDURE

a. Place the breaker in the withdrawn position out of the cell. The racking handle is not required for this position and the levering system interlocks are not automatic outside the cell. The 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 LEVER THE BREAKER TO OR FROM THE CONNECTED POSITION OTHER THAN THE DESIGNATED RACKING HANDLE.

b. From the withdrawn position, insure the breaker is open and the mechanism is completely discharged. Engage the racking crank and rotate the racking handle counterclockwise as far as possible and align the breaker wheel rails with the guide rails of the cell. (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 breaker as needed to obtain this status.

d. (Figure 5.7) Push the circuit breaker into the cell until all the wheels are on the cell floor and the breaker halts as the racking arm rollers meet the guide slots of the cell. This is the “DISCONNECT” position.
e. Engage the racking handle (Figure 5.9) and rotate clockwise. The breaker will start to move into the cell. The position indicator will show “TEST / OPERATE” before actually in the “test” position. This is a result of the incorporation of the two-stage closing spring discharge function added to the DH breaker line. The position indicator is attached to the trip cam on the racking mechanism. A valley has been added to the cam to trip, close, trip the breaker upon removal. This sequence decreases the amount of wear caused by “trip-free” operations. Continue racking until the position indicator moves from “TEST / OPERATE” to “TRIP-FREE” and then back to “TEST / OPERATE” (approx 1 or 2 turns). This is the “test” position. After reaching the test position, REMOVE the crank (this avoids possible damage to the passive interlock). In the test position, the breaker can be closed and tripped manually and electrically, thus allowing maintenance test or checks. To operate the 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.

5.10 DH-VR in Connect Position (150DH-VR Shown)

f. To advance from the test position, continue turning the racking handle clockwise. The 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 cell copper. The breaker will be considered in the “CONNECT” position when the position indicator reads “TEST / OPERATE”. This indicates that the trip linkage is released and the breaker is now ready for service.

Figure 5.10. DH-VR in Connect Position (150DH-VR Shown)

5.11 REMOVING BREAKER FROM CELL

a. To remove the breaker from the cell it must be in the open position. Insure the breaker is open and engage the levering crank. Move the breaker out by rotating the levering crank counter-clockwise. The breaker will start coming out of the cell.
cell before the main stabs or secondary control block are disconnected. The 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 breaker from its source. Continue racking out until the position mode indicator shows “test/operate” and the shutter indicator shows closed. The breaker is in the test position and the trip mechanism is released, allowing the breaker to be operated either electrically or mechanically. If you desire to electrically open or close the breaker in the test position, the secondary control block must be reengaged and the levering crank removed.

b. To remove the breaker from the test position to the disconnect position, the breaker must be tripped if closed, the levering crank re-inserted, and the secondary contact block should be disengaged. Rotate the levering crank counter-clockwise until the racking mechanism movement is halted by the racking mechanism stop. A two-stage closing spring discharge has been incorporated into the DH line of replacement breakers. Instead of forcing a trip-free condition the breaker will close momentarily then trips and remains open. This operation prevents excess wear to the breaker mechanism. The levering crank should be removed at this point. The breaker is ready to be withdrawn from the cell.

c. To remove the breaker from the disconnected to the withdrawn position, the breaker is pulled manually by the pull handle located immediately below the position mode indicator. The levering crank is not required between the withdrawn and disconnected positions.

If it is desired to leave the breaker in the cell instead of moving it from the test position to the completely withdrawn position, rotate the racking handle counter-clockwise one rotation. This will place the breaker in a “trip-free” mode but will not discharge the closing springs. This prevents unnecessary wear to the breaker mechanism.
SECTION 6: INSPECTION & MAINTENANCE

WARNING

DO NOT WORK ON A BREAKER IN THE “CONNECTED” POSITION.

DO NOT WORK ON A BREAKER WITH SECONDARY DISCONNECTS ENGAGED.

DO NOT WORK ON A 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.

6.1 INSPECTION FREQUENCY

Inspect the breaker once a year when operating in a clean, non corrosive environment. For a dusty and corrosive environment, inspection should be performed twice a year. Additionally, it is recommended to inspect the breaker every time it interrupts 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.</td>
<td>Insulation</td>
<td>Stand Off Insulators, Operating Rods, Tie-Bars and Barriers</td>
<td>No Dirt</td>
<td>Visual Check</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No Cracking</td>
<td>Visual Check</td>
</tr>
<tr>
<td>Vacuum Integrity</td>
<td>Between Main Circuit With Terminals Ungrounded</td>
<td>Withstand 27k 60Hz For 1 Minute</td>
<td>Hipot 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 (15kV Rating) 27kV, 60Hz For 1 Minute (15kV Ratings)</td>
<td>Hipot 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>Hipot Tester</td>
<td>Clean And Retest Or Replace</td>
</tr>
<tr>
<td>2.</td>
<td>Power Element</td>
<td>Vacuum Interrupters</td>
<td>Contact Erosion Visibility Of Mark</td>
<td>Visual - Close The Breaker And Look For Green Mark On Moving Stem From The Rear Of The Breaker (See Figure 6.1 and 6.2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Contact Wipe Visible</td>
<td>Visual (Figure 6.3 and 6.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Adequate Vacuum</td>
<td>See Section 6.3</td>
</tr>
<tr>
<td></td>
<td>Primary Disconnects</td>
<td>Dirt On Ceramic Body</td>
<td>Visual Check</td>
<td>Clean With Dry Lint-Free Cloth</td>
</tr>
<tr>
<td>3.</td>
<td>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 Breaker Twice</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wiring</td>
<td>Securely Tied In Proper Place</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Terminals</td>
<td>Tight</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Motor</td>
<td>Smooth And Correct Operation By Control Power</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tightness Of Hardware</td>
<td>No Loose Or Missing Parts</td>
</tr>
<tr>
<td>4.</td>
<td>Operating Mechanism</td>
<td>Dust Or Foreign Matter</td>
<td>No Dust Or Foreign Matter</td>
<td>Visual Check</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lubrication</td>
<td>Smooth Operation And No Excessive Wear</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Deformation Or Excessive Wear</td>
<td>No Excessive Deformation Or Wear</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Manual Operation</td>
<td>Smooth Operation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CloSure™ Test</td>
<td>≥ 0.6 Inch Over Travel</td>
</tr>
</tbody>
</table>

BOLT SIZE

<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 Lb. In.</td>
<td>24</td>
<td>36</td>
<td>72</td>
<td>144</td>
<td>300</td>
<td>540</td>
</tr>
</tbody>
</table>

Warning

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

FAILURE TO FOLLOW ANY OF THESE INSTRUCTIONS MAY CAUSE DEATH, SERIOUS BODILY INJURY, OR PROPERTY DAMAGE. SEE SECTION 2 - SAFE PRACTICES FOR MORE INFORMATION.
6.3 VACUUM INTERRUPTER INTEGRITY TEST

Vacuum interrupters used in Type VR-Series circuit breakers are highly reliable interrupting elements. 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 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 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 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 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 VI’s are tested in parallel. If individual VI’s are tested, current capability may be one third of this value.

<table>
<thead>
<tr>
<th>Breaker Rated Maximum Voltage</th>
<th>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 there may be a minimal amount of erosion from the contact surfaces. To determine contact erosion, close the breaker and observe the vacuum interrupter moving stem from the rear of the breaker. If the mark on each stem is visible, erosion has not reached maximum value thus indicating satisfactory contact surface of the interrupter. If the mark is not visible, the vacuum interrupter assembly must be replaced (Figure 6.1 and 6.2).

The adequacy of contact wipe can be determined by simply observing the vacuum interrupter side of the operating rod assembly on a closed breaker. Figures 6.3 and 6.4 show the procedure for determining the contact wipe. It maybe necessary to use a small mirror and flashlight to clearly see the “T” shape indicator. If the wipe is not adequate, the vacuum interrupter assembly (Pole Unit) must be replaced. Field adjustment is not possible.

**WARNING**

**FAILURE TO REPLACE A VACUUM INTERRUPTER ASSEMBLY WHEN CONTACT EROSION MARK IS NOT VISIBLE OR WIPE IS UNSATISFACTORY, WILL CAUSE THE BREAKER TO FAIL TO INTERRUPT AND THEREBY CAUSE PROPERTY DAMAGE OR PERSONNEL INJURY.**
6.5 INSULATION

In VR-Series 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 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 breaker. For the breakers rated 4.76 kV, 8.25 kV and 15 kV, the test voltages are 15 kV, 27 kV and 27 kV RMS, 60 Hz respectively. Conduct the test as follows:

Close the breaker. Connect the high potential lead of the test machine to one of the poles of the breaker. Connect the remaining poles and 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 breaker. Connect the high potential lead of the test machine to one of the poles of the breaker. Connect the remaining poles and 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.

If a DC high potential machine is used, make certain that the peak voltage does not exceed the peak of the corresponding AC RMS test voltage.

SECONDARY CIRCUIT:

Isolate the motor by disconnecting the two motor leads from the terminal block. Connect all points of the secondary disconnect pins with a shooting wire. Connect this wire to the high potential lead of the test machine. Ground the breaker frame. Starting with zero, increase the voltage to 1125 RMS, 60 Hz. Maintain the voltage for one minute. Successful withstand indicates satisfactory insulation strength of the secondary control circuit. Remove the shooting wire and reconnect the motor leads.
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. Unlike most typical circuit breaker designs, the VR-Series design uses a highly reliable and unique flexible clamp design that eliminates the need for lubrication and inspection for wear.

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 switchgear
- Close the 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 breaker. If measurements exceed 200%, contact the manufacturer.

Resistance conversion for Temperature

\[ R_{\text{conversion}} = R_{\text{Factory}}(1 + (T_{\text{Field}} - T_{\text{Factory}})/\rho) \]

\[ R_{\text{conversion}} = \text{Resistance correction for temperature based from the factory resistance measurement.} \]

\[ R_{\text{Factory}} = \text{Resistance measurement from the factory.} \]

\[ T_{\text{Field}} = \text{Temperature measurement in the field.} \]

\[ T_{\text{Factory}} = \text{Temperature measurement from the factory.} \]

\[ \rho = \text{Copper resistivity temperature coefficient / Deg C} \]

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

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

6.8 MECHANISM CHECK

Make a careful visual inspection of the mechanism for any loose parts such as bolts, nuts, pins, rings, etc. Check for excessive wear or damage to the breaker components. Operate the breaker several times manually and electrically. Check the closing and opening times to ensure they are in accordance with the limits in Table 4.1.

6.8.1 CLOSURE™ TEST

Introduction: The CloSure™ Test is a simple yet extremely effective means to determine and monitor the ability of the mechanism to close the breaker contacts fully. It provides a quantitative measure of the extra energy available in terms of over travel in inches to close the 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 6.1.) If the CloSure™ travel obtained is as specified, the mechanism performance is satisfactory. If the CloSure™ travel does not conform as shown in Figure 6.15, contact Eaton’s Electrical Services & Systems for further information. (See Step 13).

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>
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 6.6).

Step 6 - Mount the transparent CloSure™ Test Tool (Figure 6.7b) with two bolts and washers. Refer to Figure 6.7a 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 6.9, 6.11, and 6.12. 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 6.8).

Step 9 - Place the marker back in the hole. While holding the marker tip against the tape, close the breaker (Figure 6.10). Remove the marker from the hole.

Step 10 - While closely observing the pole shaft at the right side of the circuit breaker (Figure 6.11), 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 6.14 and 6.15).

Step 14 - Evaluate the CloSure™ performance by comparing the test tape with the illustration in Figure 6.16. 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 6.7a. Front View of CloSure™ Tool Showing Mounting / Testing Hole Locations (6352C49H01)
Figure 6.8. Manually Charging Closing Springs

Figure 6.11. Pole Shaft Located On Right Side Of Circuit Breaker

Figure 6.9. Make a Clear and Heavy Mark

Figure 6.12. Move the Sharpie® 15° Left and Right

Figure 6.10. With Marker in Hole “C”, While Closing Breaker

Figure 6.13. Top view of Cam and Marker Interface

Cam

CloSure™ Tool

Marker

15°
6.9 LUBRICATION

All parts that require lubrication have been lubricated during the assembly with molybdenum disulphide grease. Eaton No. 53701QB. Over a period of time, this lubricant may be pushed out of the way or degrade. Proper lubrication at regular intervals is essential for maintaining the reliable performance of the mechanism. The breaker should be relubricated once a year or per the operations table (Table 6.2), which ever comes first. The locations shown in Figure 6.17 should be lubricated with a drop of light machine oil.

After lubrication, operate the breaker several times manually and electrically.

Roller bearings are used on the pole shaft, the cam shaft, the main link and the motor eccentric. These bearings are packed at the factory with a top grade slow oxidizing grease which normally should be effective for many years. They should not be disturbed unless there is definite evidence of sluggishness, dirt or parts are dismantled for some reason.

If it becomes necessary to disassemble the mechanism, the bearings and related parts should be thoroughly cleaned, remove old grease in a good grease solvent. Do not use carbon tetrachloride. They should then be washed in light machine oil until the cleaner is removed. After the oil has been drawn off, the bearings should be packed with Eaton Grease 53701 QB or equivalent.

Table 6.2. Lubrication Per Number of Operations

<table>
<thead>
<tr>
<th>RATINGS</th>
<th>OPERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>29kA and below</td>
<td>750</td>
</tr>
<tr>
<td>Above 29kA</td>
<td>400</td>
</tr>
<tr>
<td>3000 Amp</td>
<td>400</td>
</tr>
</tbody>
</table>

![Figure 6.17. General Lubrication Areas](image)

- Apply one drop of non-synthetic light machine oil at locations shown.
### Table 6.3. Troubleshooting Chart

<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 Disconnects</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></td>
<td>Mechanism</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>Breaker Does Not Close</td>
<td>(Close Coil Does Not Pick Up)</td>
<td>• Secondary Disconnects</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>Control Circuit</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>UNDESIRABLY CLOSES</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control Circuit</td>
<td>• Close Circuit (CS/C Getting shorted)</td>
</tr>
<tr>
<td></td>
<td>Mechanism</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 Disconnects</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>UNDESIRABLY TRIPS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control Circuit</td>
<td>• Control Power (CS/T Switch, remains made)</td>
</tr>
<tr>
<td></td>
<td>Mechanism</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 Worm 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>7.2 ORDERING INSTRUCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. The style numbers in Table 7.1 should be sufficient to purchase control components for most applications. Some breakers have special control schemes. Supply complete nameplate information for verification or if additional components are needed.</td>
</tr>
<tr>
<td>b. Specify the method of shipping desired.</td>
</tr>
<tr>
<td>c. Send all orders or correspondence to the nearest Eaton sales office or contact the PBC direct at 1-877-276-9379.</td>
</tr>
<tr>
<td>d. Include negotiation number with order when applicable.</td>
</tr>
</tbody>
</table>

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Table 7.1 Common Replacement Parts - Descriptions and Style Numbers

| 1. ANTI-PUMP (Y) RELAY       | (48vDC) | 94C9525H01 |
|                             | (125vDC) | 94C9525H02 |
|                             | (250vDC) | 94C9525H03 |
|                             | (120vAC) | 94C9525H04 |
|                             | (240vAC) | 94C9525H05 |
| 2. RECTIFIER                | Rectifier | 94C9525G09 |
| 3. SPRING CHARGING MOTOR   | (48vDC) | 94C9525G10 |
|                             | (125vDC) | 94C9525G11 |
|                             | (250vDC / 240vAC) | 94C9525G12 |
| 4. BREAKER AUXILIARY SWITCH | Breaker Auxiliary Switch | 94C9525G13 |
| 5. BREAKER POSITION SWITCH  | Breaker Position Switch PS1 | 94C9525H06 |
| 6. BREAKER POSITION SWITCH  | Breaker Position Switch PS2 | 94C9525H07 |
| 7. LATCH CHECK SWITCH       | Latch Check Switch (LC) | 94C9525H08 |
| 8. MOTOR CUTOFF SWITCHES    | (LS) (20WR/29WR) | 94C9525G14 |
|                             | (LS) (18WR) | 94C9525G15 |
| 9. SPRING RELEASE COILS / SHUNT TRIPS | 24vDC | 94C9525G16 |
|                             | 48vDC | 94C9525G01 |
|                             | 125vDC | 94C9525G02 |
|                             | 250vDC | 94C9525G03 |
|                             | 120vAC-C/M 48vDC-T | 94C9525G04 |
|                             | 240vAC-C/M 48vDC-T | 94C9525G05 |
|                             | 120vAC-C/M 120vAC-CT | 94C9525G06 |
|                             | 240vAC-C/M 240vAC-CT | 94C9525G07 |
| 10. CONTROL COMPONENTS KIT  | 48vDC | 94C9525G01 |
|                             | 125vDC | 94C9525G02 |
|                             | 250vDC | 94C9525G03 |
|                             | 120vAC-C/M 48vDC-T | 94C9525G04 |
|                             | 240vAC-C/M 48vDC-T | 94C9525G05 |
|                             | 120vAC-C/M 120vAC-CT | 94C9525G06 |
|                             | 240vAC-C/M 240vAC-CT | 94C9525G07 |