Switchgear & Instrumentation

**PowlVac**\(^{100}\)™
Circuit Breaker User Guide

Issue Date: August 2012

Document Revision 0.2
STD/CUS/035

*Powered by Safety*®
This page intentionally left blank
The Design and Development Department is responsible for the data contained in this standard document. The relevant departmental managers and team leaders are responsible for ensuring the correct use of this data within their departments. The Engineering Manager is responsible for the correct use of the data within the Contract Engineering department.

AUTHORISED BY
SD&D Manager ____________________________ DATE 30th August 2012

P Dale
# Contents

1 Getting Started .................................................................................................................. 7  
  1.1 About this User Guide .................................................................................................... 7  
  1.2 How to Use this Installation and Maintenance Guide .................................................. 7  
  1.3 Application Notes .......................................................................................................... 8  

2 Introduction ......................................................................................................................... 9  

3 Specifications ....................................................................................................................... 10  
  3.1 Mechanical Specifications ............................................................................................. 10  
    3.1.1 Enclosure ................................................................................................................. 10  
    3.1.2 Special Climatic Operating Conditions ................................................................. 10  
    3.1.3 Dimensions ............................................................................................................. 10  
    3.1.4 Weights ................................................................................................................... 13  
  3.2 Electrical Specifications ................................................................................................. 14  
  3.3 Product Code Details ..................................................................................................... 15  

4 Circuit Breaker ..................................................................................................................... 16  
  4.1 Construction .................................................................................................................. 16  
    4.1.1 Fascia/Front Cover .................................................................................................... 16  
    4.1.2 40kA/1600A and 50kA/2000A Circuit Breakers ...................................................... 17  
    4.1.3 50kA/3150A and 63kA/3150A VCBs ...................................................................... 19  
    4.1.4 Internal Components .............................................................................................. 21  
  4.2 Electrical Connections .................................................................................................... 24  
    4.2.1 Primary Disconnects ................................................................................................. 24  
    4.2.2 Secondary Disconnect ............................................................................................... 24  
    4.2.3 Ground Connection ................................................................................................. 24  
  4.3 Operation .......................................................................................................................... 25  
    4.3.1 Mechanical ............................................................................................................... 26  
    4.3.2 Electrical .................................................................................................................. 28  

5 Dispatch and Storage .......................................................................................................... 29  
  5.1 Dispatch .......................................................................................................................... 29  
  5.2 Condition on Delivery .................................................................................................... 29  
  5.3 Handling ......................................................................................................................... 29  
  5.4 Storage ............................................................................................................................ 29  

6 Installation ............................................................................................................................ 30  
  6.1 Pre-Installation Checks .................................................................................................. 30  
    6.1.1 High Voltage Insulation Integrity Check ................................................................. 30  
    6.1.2 Vacuum Integrity Check .......................................................................................... 31  
    6.1.3 Control Voltage Insulation Integrity Check ............................................................ 31  
    6.1.4 Mechanical Operation Check ................................................................................. 31  
    6.1.5 Electrical Operation Check ...................................................................................... 32  
    6.1.6 Circuit Breaker and Compartment Physical Checks ................................................. 32  
  6.2 Inserting the Circuit Breaker into the Cubicle ................................................................. 33  
    6.2.1 Racking Mechanism Check ...................................................................................... 33
6.3 Removing the Circuit Breaker from the Cubicle ................................................................. 34

7 Maintenance ................................................................................................................................. 35

7.1 Overview .................................................................................................................................. 35

7.2 Routine Maintenance .................................................................................................................. 35

7.2.1 Inspection and Cleaning ......................................................................................................... 35

7.2.2 Vacuum Interrupter Check ..................................................................................................... 36

7.3 Lubricants and Cleaning Agents ............................................................................................... 36

7.3.1 Cleaning Agents ..................................................................................................................... 36

7.3.2 Lubricants ............................................................................................................................... 36

Appendix 1: Abbreviations/Glossary of Terms ............................................................................. 37

List of Figures

Figure 1 PowlVac™Vacuum Circuit Breaker .................................................................................. 9
Figure 2 Dimensioned Drawing - 700mm Wide Circuit Breaker .................................................... 11
Figure 3 Dimensioned Drawing – 50kA/3150A Circuit Breaker ..................................................... 12
Figure 4 Dimensioned Drawing - 63kA/3150A Circuit Breaker ....................................................... 13
Figure 5 Fascia/Front Cover .............................................................................................................. 16
Figure 6 Side View – 40kA/1600A and 50kA/2000A VCBs ............................................................. 17
Figure 7 Bottom View – 40kA/1600A and 50kA/2000A VCBs ......................................................... 17
Figure 8 Rear View – 40kA/1600A and 50kA/2000A VCBs ............................................................ 18
Figure 9 Side View – 50kA/3150A and 63kA/3150A VCBs ............................................................. 19
Figure 10 Bottom View – 50kA/3150A and 63kA/3150A VCBs ..................................................... 19
Figure 11 Rear View – 50kA/3150A and 63kA/3150A VCBs ............................................................ 20
Figure 12 Internal Components ....................................................................................................... 21
Figure 13 Internal Components – Isometric View .......................................................................... 22
Figure 14 Secondary Disconnect Socket ....................................................................................... 24
Figure 15 Sequence of Operation Flowchart .................................................................................. 25
Figure 16 Racking Boss Retainer .................................................................................................... 26
Figure 17 Release Knob .................................................................................................................... 26
Figure 18 Shutters ............................................................................................................................ 27
Figure 19 Electrical Schematic ........................................................................................................ 28

List of Tables

Table 1 Mechanical Enclosure Specifications .................................................................................. 10
Table 2 Circuit Breaker Dimensions ............................................................................................... 10
Table 3 Standard Weights of Loose Mechanical Items (kg) ............................................................ 13
Table 4 Electrical Specifications ..................................................................................................... 14
Table 5 Product Code Details ......................................................................................................... 15
Table 6 Internal Components ......................................................................................................... 23
Table 7 Vacuum Interrupter Measurements .................................................................................... 36
1 Getting Started

IMPORTANT NOTICE – READ THIS FIRST

This User Guide does not purport to cover every detail of the installation and operation of the PowlVAC\textsuperscript{100}TM (PV100) circuit breaker. Requests for further guidance or information on this or any other product should be directed to Powell UK.

Our switchgear is manufactured in accordance with IEC standards. Powell UK cannot provide any assurances that this product will comply with the wide variety of local codes, regulations or ordinances that apply in different areas of the world.

1.1 About this User Guide

This guide provides user installation and maintenance instructions for the PV100 Vacuum Circuit Breaker (VCB).

The purpose of this installation and maintenance guide is to familiarize the user and maintenance personnel with the basic capabilities of the VCB. Only proven safe installation techniques are covered.

This guide was not prepared for inexperienced maintenance personnel. It is not intended to constitute a training program or to provide sufficient background for personnel, not experienced with this type of electrical system, to install the system described in this user guide.

The end user is responsible for ensuring that no persons should be authorised to install or carry out maintenance work on the system without having read this guide.

All rights reserved. Reproduction of any part of this user guide, in any form whatsoever without the written permission of Powell UK is forbidden. Additional copies can be obtained from the After Sales Services Dept. of Powell UK, Bradford, United Kingdom. The information contained within this user guide is confidential and cannot be transferred to a third party without the written consent of Powell UK.

All efforts have been made to ensure the accuracy of the contents of this user guide. However should any errors be detected, Powell UK would greatly appreciate being informed of them.

The above notwithstanding Powell UK can assume no responsibility for any errors in this guide or the consequences thereof.

The policy of Powell UK is one of progressive improvement in design, construction and operation. Systems and equipment referred to in this user guide are subject to changes in keeping with this policy. The manufacturer, therefore, reserves the right to make any changes without prior notice.

1.2 How to Use this Installation and Maintenance Guide

This installation and maintenance guide is arranged and subdivided to provide useful information with a minimum of searching.

The key to easy reference is the Table of Contents. Every subject, in the Table of Contents, is listed with a reference number and the page on which the item can be found. Each subject is numbered by Chapter, Paragraph and Sub-paragraph, for example:
4.1.2. "4" - Chapter number.
"1" - Main paragraph topic.
"2" - Breakdown of Main paragraph topic.

The page number, along with the number of pages in this user guide, is located in the outside corner of each page.

For convenience, all illustrations and tables are numbered in sequential order.

Familiarity with the Table of Contents will facilitate locating particular information easily.

Personnel responsible for the system should review all of the Table of Contents for future reference and an overall understanding of the guide. Then read the installation and maintenance guide and study the illustrations thoroughly.

1.3 Application Notes

Warranty
Powell UK warrant the switchgear against defects in material or workmanship under normal use for a period of 18 months from the date of shipment from our premises or 12 months from the date the equipment is put into service, whichever occurs first.

In the event of a failure arising during the warranty, Powell UK will undertake to repair or replace the switchgear at our option, provided always that it is found to be defective. The warranty obligations of Powell UK will not extend to defects caused by wrong or negligent operation, accident, overloading, unsuitable operating conditions, or by failure of the End User to comply with any instruction given by Powell UK with regard to its operation or installation.

Powell UK is not liable under any circumstances for special, economic, financial, indirect or consequential damages (including loss of profit, loss of use, loss of production, loss of contracts) or for expenses sustained as a result of switchgear malfunction or incorrect application.

Safety at Work.
The voltages present in certain parts of the switchgear are capable of inflicting a severe electric shock and may be lethal. It is the responsibility of the owner and / or the End User to ensure that the installation of the switchgear and the way in which it is operated and maintained complies with the requirements of the Health and Safety at Work Act in the United Kingdom, and with other applicable legislation and regulations and codes of practice in the UK or elsewhere.

The manufacturer accepts no liability for any consequences resulting from inappropriate or incorrect installation of the equipment.

Training
If additional training is required then contact Powell UK or their designated agent.

Type of operating environment
The intended operating environment is limited to being housed within an electrical switchroom or substation that is suitable for protecting the equipment. Access to the switchroom and switchgear must be prevented except by trained and authorised personnel.

General Operating Requirements
Users must have electrical experience and be able to interpret control circuit diagrams, electrical schematics and general arrangement drawings.
Minimum age (years). Eighteen (18), or minimum permissible age required by End User’s national law.
2 Introduction

The Powell UK PowlVac™ (PV100) Vacuum Circuit Breaker (VCB) is an automatically operated electrical switch incorporating the use of Vacuum Interrupters (VI).

These VCBs are designed to be incorporated within the Powell UK Type 298 range of Medium Voltage IEC Switchgear and Motor Control Centres. Please refer to the Powell UK MV298 User Guide for Circuit Breaker Cubicles incorporating PV100 Circuit Breaker (Document Reference STD/CUS/030) for further details.

When PV100 breakers are incorporated into our MV switchgear, service trolleys are also provided to aid insertion into and withdrawal from the switchgear cubicles. A compatible earthing truck can also be supplied as required by the contract.
3 Specifications
3.1 Mechanical Specifications

3.1.1 Enclosure

<table>
<thead>
<tr>
<th>IEC Publication</th>
<th>Description</th>
<th>Min</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 62271</td>
<td>Maximum ambient temperature</td>
<td>-20°C</td>
<td>+40°C</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td>Maximum 24 hour average temperature</td>
<td>-20°C</td>
<td>+35°C</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td>Storage temperature</td>
<td>-5°C</td>
<td>+55°C</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td>Maximum 24 hour average storage temperature</td>
<td>-5°C</td>
<td>+70°C</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td>Average relative humidity over 24 hours</td>
<td>95%</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>Average value of water vapour over 24 hours</td>
<td>2.2 kPa</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average relative humidity over 1 month</td>
<td>90%</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>Average value of water vapour over 1 month</td>
<td>1.8 kPa</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maximum Site Altitude</td>
<td>1000 M</td>
<td></td>
<td>M</td>
</tr>
<tr>
<td>IEC 62271-1</td>
<td>High Voltage switchgear and controlgear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Common specifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEC 62271-100</td>
<td>High Voltage switchgear and controlgear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alternating Current Circuit Breakers</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 Mechanical Enclosure Specifications

3.1.2 Special Climatic Operating Conditions
For any operating conditions other than those described above, Powell UK must be contacted in advance. Examples of these are as follows:

- At site altitudes above 1000m the effects of the reduction in dielectric strength of the air on the insulation level need to be taken into account.
- Increased ambient temperatures must be compensated for in the design on the busbars and tee-off conductors, otherwise the current carrying capacity will be limited. Heat dissipation can be assisted by fitting additional ventilation facilities.
- If the switchgear is to be operated in areas with high humidity and/or major rapid temperature fluctuations, there is a risk of dew deposits. This situation can be exacerbated with low primary currents as internal heating is not achieved.

3.1.3 Dimensions
The table below details the overall dimensions of each breaker.

<table>
<thead>
<tr>
<th>Circuit Breaker Fault Rating</th>
<th>Circuit Breaker Current Rating</th>
<th>Cubicle Width</th>
<th>Breaker Width</th>
<th>Breaker Height</th>
<th>Breaker Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>40kA</td>
<td>1600A</td>
<td>700mm</td>
<td>545mm</td>
<td>710mm</td>
<td>632mm</td>
</tr>
<tr>
<td>50kA</td>
<td>2000A</td>
<td>700mm</td>
<td>545mm</td>
<td>710mm</td>
<td>632mm</td>
</tr>
<tr>
<td>50kA</td>
<td>3150A</td>
<td>1000mm</td>
<td>850mm</td>
<td>820mm</td>
<td>632mm</td>
</tr>
<tr>
<td>63kA</td>
<td>4000A</td>
<td>1000mm</td>
<td>850mm</td>
<td>930mm</td>
<td>744mm</td>
</tr>
</tbody>
</table>

Table 2 Circuit Breaker Dimensions

The following drawings show more detailed information regarding the dimensions of each breaker.
3.1.3.1 40kA/1600A and 50kA/2000A Circuit Breakers

Figure 2 Dimensioned Drawing - 700mm Wide Circuit Breaker
3.1.3.2 50kA/3150A Circuit Breaker

Figure 3 Dimensioned Drawing – 50kA/3150A Circuit Breaker
3.1.3.3 63kA/3150A Circuit Breaker

Figure 4 Dimensioned Drawing - 63kA/3150A Circuit Breaker

3.1.4 Weights

<table>
<thead>
<tr>
<th>Description</th>
<th>&lt;2000A</th>
<th>&lt;3150A</th>
<th>&lt;3150A</th>
</tr>
</thead>
<tbody>
<tr>
<td>40kA Circuit Breaker</td>
<td>245</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50kA Circuit Breaker</td>
<td>245</td>
<td>310</td>
<td></td>
</tr>
<tr>
<td>63kA Circuit Breaker</td>
<td></td>
<td></td>
<td>415</td>
</tr>
<tr>
<td>Service Trolley</td>
<td>100</td>
<td>120</td>
<td>105</td>
</tr>
<tr>
<td>Busbar Earth Truck</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earth Switch Operating Handle</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Earth Switch Extension Handle</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Racking Handle</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>CB Spring Charging Handle</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Table 3 Standard Weights of Loose Mechanical Items (kg)
3.2 Electrical Specifications

The specifications detailed below are based on normal operating conditions as detailed in Section 3.1. If these conditions should differ (e.g. the site is at an altitude greater than 1000m or there is an increased ambient temperature) then Powell UK should be consulted in advance as it may have an impact on the specifications detailed below.

<table>
<thead>
<tr>
<th>Specification</th>
<th>&lt;1600A</th>
<th>&lt;2000A</th>
<th>&lt;3150A</th>
<th>&lt;3150A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Circuit Fault Rating</td>
<td>40kA</td>
<td>50kA</td>
<td>50kA</td>
<td>63kA</td>
</tr>
<tr>
<td>Short Circuit Fault Duration</td>
<td>3 secs</td>
<td>3 secs</td>
<td>3 secs</td>
<td>3 secs</td>
</tr>
<tr>
<td>Rated Voltage</td>
<td>12kV</td>
<td>12kV</td>
<td>12kV</td>
<td>12kV</td>
</tr>
<tr>
<td>Rated Frequency</td>
<td>50Hz</td>
<td>50Hz</td>
<td>50Hz</td>
<td>50Hz</td>
</tr>
<tr>
<td>Continuous Current Rating</td>
<td>1600A</td>
<td>2000A</td>
<td>4000A(1)</td>
<td>4000A(1)</td>
</tr>
<tr>
<td>Basic Impulse Level (BIL)</td>
<td>75kV</td>
<td>75kV</td>
<td>75kV</td>
<td>75kV</td>
</tr>
<tr>
<td>Voltage Range Factor (K)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Peak Making Current</td>
<td>100kA</td>
<td>125kA</td>
<td>125kA</td>
<td>158kA</td>
</tr>
</tbody>
</table>

**Control Circuit Supply Voltage (U)**

<table>
<thead>
<tr>
<th>Voltage Range Factor</th>
<th>Control Circuit Supply Voltage (U)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% U</td>
<td>48Vdc</td>
</tr>
<tr>
<td>100% U</td>
<td>110Vdc</td>
</tr>
<tr>
<td>100% U</td>
<td>125Vdc</td>
</tr>
<tr>
<td>100% U</td>
<td>240Vdc</td>
</tr>
<tr>
<td>100% U</td>
<td>120Vac</td>
</tr>
<tr>
<td>100% U</td>
<td>240Vac</td>
</tr>
<tr>
<td>100% U</td>
<td>120Vdc</td>
</tr>
<tr>
<td>100% U</td>
<td>240Vdc</td>
</tr>
<tr>
<td>100% U</td>
<td>120Vdc</td>
</tr>
<tr>
<td>100% U</td>
<td>240Vdc</td>
</tr>
</tbody>
</table>

**Control Circuit Load**

<table>
<thead>
<tr>
<th>Control Circuit Load</th>
<th>Trip Coil</th>
<th>Close Coil</th>
<th>Motor Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>400VA</td>
<td>400VA</td>
<td>150VA</td>
</tr>
<tr>
<td></td>
<td>400VA</td>
<td>400VA</td>
<td>150VA</td>
</tr>
<tr>
<td></td>
<td>150VA</td>
<td>150VA</td>
<td>150VA</td>
</tr>
</tbody>
</table>

**Operating Time**

<table>
<thead>
<tr>
<th>Operating Time</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25ms</td>
<td>25ms</td>
<td>25ms</td>
</tr>
<tr>
<td></td>
<td>15ms</td>
<td>15ms</td>
<td>15ms</td>
</tr>
<tr>
<td></td>
<td>40ms</td>
<td>40ms</td>
<td>40ms</td>
</tr>
<tr>
<td></td>
<td>40ms</td>
<td>40ms</td>
<td>40ms</td>
</tr>
<tr>
<td></td>
<td>2 Cycles</td>
<td>2 Cycles</td>
<td>2 Cycles</td>
</tr>
<tr>
<td></td>
<td>3 Cycles</td>
<td>3 Cycles</td>
<td>3 Cycles</td>
</tr>
<tr>
<td></td>
<td>45ms</td>
<td>45ms</td>
<td>45ms</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>&lt;3.3ms</td>
<td>&lt;3.3ms</td>
<td>&lt;3.3ms</td>
</tr>
<tr>
<td></td>
<td>&lt;5ms</td>
<td>&lt;5ms</td>
<td>&lt;5ms</td>
</tr>
<tr>
<td></td>
<td>&lt;3.3ms</td>
<td>&lt;3.3ms</td>
<td>&lt;3.3ms</td>
</tr>
<tr>
<td></td>
<td>&lt;5ms</td>
<td>&lt;5ms</td>
<td>&lt;5ms</td>
</tr>
<tr>
<td></td>
<td>70ms</td>
<td>70ms</td>
<td>70ms</td>
</tr>
<tr>
<td></td>
<td>95ms</td>
<td>95ms</td>
<td>95ms</td>
</tr>
<tr>
<td></td>
<td>15 secs</td>
<td>15 secs</td>
<td>15 secs</td>
</tr>
</tbody>
</table>

Table 4 Electrical Specifications

Notes

(1) Forced cooling required in order to achieve this rating. Otherwise a rating of 3150A can be applied.
### 3.3 Product Code Details

<table>
<thead>
<tr>
<th>Voltage (KV)</th>
<th>12 (63kA not available at 12KV)</th>
<th>15 (40kA Not available at 15KV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device</td>
<td>PV100</td>
<td></td>
</tr>
<tr>
<td>Fault Level (kA)</td>
<td>40</td>
<td>63</td>
</tr>
<tr>
<td>Thermal Rating</td>
<td>06 (= 630A)</td>
<td>12 (= 1250A)</td>
</tr>
<tr>
<td></td>
<td>16 (= 1600A)</td>
<td>20 (= 2000A)</td>
</tr>
<tr>
<td></td>
<td>25 (= 2500A)</td>
<td>31 (= 3150A)</td>
</tr>
<tr>
<td></td>
<td>40 (= 4000A)</td>
<td></td>
</tr>
<tr>
<td>Close Coil Voltage (V)</td>
<td>048DC 110DC 125DC 240DC 120AC 240AC</td>
<td></td>
</tr>
<tr>
<td>Trip Coil Voltage (V)</td>
<td>048DC 110DC 125DC 240DC 120AC 240AC</td>
<td></td>
</tr>
<tr>
<td>Double Trip Coil</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Auto Spring Discharge</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Service Position Indicator</td>
<td>S</td>
<td></td>
</tr>
</tbody>
</table>

= Options

Example Configurations:

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-PV100-40-06-110DC-048DC</td>
<td>12kV, 40kA PV100 VCB rated at 630A c/w 110Vdc close coil and 48Vdc trip coil.</td>
</tr>
<tr>
<td>15-PV100-63-40-240DC-240DC-D-A-S</td>
<td>15kV, 63kA PV100 VCB rated at 4000A c/w 240Vdc close coil and 240Vdc trip coil. Fitted with double trip coils, auto spring discharge and a service position indicator.</td>
</tr>
</tbody>
</table>

Table 5 Product Code Details
4 Circuit Breaker
4.1 Construction

4.1.1 Fascia/Front Cover

Figure 5 Fascia/Front Cover
4.1.2 40kA/1600A and 50kA/2000A Circuit Breakers
4.1.2.1 Side View

4.1.2.2 Bottom View

Figure 6 Side View – 40kA/1600A and 50kA/2000A VCBs

Figure 7 Bottom View – 40kA/1600A and 50kA/2000A VCBs
4.1.2.3 Rear View

Figure 8 Rear View – 40kA/1600A and 50kA/2000A VCBs
4.1.3 50kA/3150A and 63kA/3150A VCBs

4.1.3.1 Side View

Figure 9 Side View – 50kA/3150A and 63kA/3150A VCBs

4.1.3.2 Bottom View

Figure 10 Bottom View – 50kA/3150A and 63kA/3150A VCBs
4.1.3.3 Rear View

Figure 11 Rear View – 50kA/3150A and 63kA/3150A VCBs
4.1.4 Internal Components
The figures below shows a 40kA/1600A circuit breaker with the front cover removed.

Figure 12 Internal Components
Figure 13 Internal Components – Isometric View
The table below details the main components shown in Figure 12 and Figure 13 and the functionality of each of those components.

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto Discharge (optional)</td>
<td>Automatically discharges the main closing spring as the circuit breaker is removed from the cubicle.</td>
</tr>
<tr>
<td>Charging Motor</td>
<td>This is used to compress the main closing spring of the stored energy mechanism in order to close the breaker.</td>
</tr>
<tr>
<td>Charging Motor Cut-off Switch</td>
<td>This provides an electrical break in the charging motor control circuit when the main closing spring is fully charged and the stored energy mechanism is ready for a close operation.</td>
</tr>
<tr>
<td>Close Coil</td>
<td>This is a solenoid that operates the closing mechanism of the circuit breaker.</td>
</tr>
<tr>
<td>Close Coil Terminations</td>
<td>This is where the cables for the close coil are terminated.</td>
</tr>
<tr>
<td>Crank arms</td>
<td>These compress the main spring as the mechanism charges.</td>
</tr>
<tr>
<td>Damper</td>
<td>This controls the rebound of the vacuum interrupter contacts on a trip operation.</td>
</tr>
<tr>
<td>Indicator Plate</td>
<td>The manual close and trip buttons, close/open indicator and the breaker rating plate are mounted here.</td>
</tr>
<tr>
<td>Fundamental Linkage</td>
<td>This connects the stored energy mechanism to the jackshaft.</td>
</tr>
<tr>
<td>Latch Check Switch</td>
<td>Prevents the breaker being closed when the spring is half charged.</td>
</tr>
<tr>
<td>Left Jackshaft Flags</td>
<td>These flags engage the damper.</td>
</tr>
<tr>
<td>Main Closing Cam</td>
<td>Drives the fundamental linkage into the closed position</td>
</tr>
<tr>
<td>Main Closing Spring</td>
<td>Stores the energy required for a closing operation until the close command is issued.</td>
</tr>
<tr>
<td>Primary Trip Coil</td>
<td>This is a solenoid that operates the trip mechanism of the circuit breaker.</td>
</tr>
<tr>
<td>Primary/Secondary Trip Coil</td>
<td>This is where the cables for the primary and secondary trip coils are terminated.</td>
</tr>
<tr>
<td>Termination</td>
<td></td>
</tr>
<tr>
<td>Right Jackshaft Flags</td>
<td>These flags engage the jackshaft stop bolt.</td>
</tr>
<tr>
<td>Secondary Disconnect Plug</td>
<td>This is connected to the Secondary Disconnect Socket (located inside the circuit breaker compartment) in order to provide the control power to the circuit breaker.</td>
</tr>
<tr>
<td>Secondary Trip Coil (optional)</td>
<td>Redundancy for the Primary Trip Coil. This operates simultaneously with the Primary Trip Coil to protect against failure.</td>
</tr>
<tr>
<td>Stop Bolt</td>
<td>This bolt provides a positive stop for the rotation of the jackshaft.</td>
</tr>
<tr>
<td>Stored Energy Mechanism</td>
<td>Enables Open/Close operation of circuit breaker</td>
</tr>
<tr>
<td>Wormgear Assembly</td>
<td>Enables racking of breaker</td>
</tr>
<tr>
<td>Y relay</td>
<td>This prevents the circuit breaker from continuously re-closing following a trip signal.</td>
</tr>
</tbody>
</table>

Table 6 Internal Components
4.2 Electrical Connections
This section describes the way in which the breaker is connected to the switchboard electrical system.

4.2.1 Primary Disconnects
There are six primary disconnecting devices (arranged 2 per phase) on the circuit breaker. Each primary disconnecting device on the 40kA/1600A and 50kA/2000A circuit breakers have multiple contact fingers (see Figure 8) which will mate with the stationary primary disconnecting devices in the circuit breaker compartment. The 50kA/3150A and 63kA/3150A circuit breakers have multiple contact clusters (see Figure 11) to make the connection in the circuit breaker compartment. The multiple parallel paths of the contact finger and cluster assemblies keep the current density low.

4.2.2 Secondary Disconnect
Control power is transferred from the switchgear to the circuit breaker by means of the secondary disconnect plug (see Figure 12). This plug is attached to the top of the breaker via an umbilical and connects to a socket (see Figure 14 below) located on the underside of the top of the circuit breaker compartment.

![Figure 14 Secondary Disconnect Socket](image_url)

4.2.3 Ground Connection
The ground connection is an assembly of spring loaded fingers (earth shoe) that grounds the circuit breaker frame as it is inserted into the compartment. The earth shoe is located on the underside of the circuit breaker (see Figure 7 and Figure 8). An extension of the switchgear ground bus is secured to the circuit breaker compartment floor and engages the ground connection as the circuit breaker is placed into the test position.
4.3 Operation
PowlVac™ circuit breakers use sealed vacuum interrupters to control the primary circuit. The primary connections to the associated switchboard are made by parallel copper busbars terminating in the multiple contact fingers/clusters (depending on the size of the breaker). See Section 4.2.1 for further details) of the primary disconnecting devices. The primary disconnecting devices, busbars, and vacuum interrupter assemblies are supported by insulators specifically designed for the application.

The flowchart below details the sequence of operation of the circuit breaker. This flowchart also makes reference to the schematic wiring diagram detailed in Section 4.3.2.1.

![Sequence of Operation Flowchart](image-url)
4.3.1 Mechanical
This section details the various features of the PowlVac® circuit breaker and how they are operated.

4.3.1.1 Racking Mechanism
The racking mechanism is the mechanical assembly that facilitates moving the circuit breaker between the “Test/Isolated” position and the “In Service” position in the circuit breaker compartment.

It is rotation of the racking crank arms (see Figure 6 and Figure 9) that drive the circuit breaker into or out of the “In Service” position. This action also operates the compartment shutters (see Section 4.3.1.2 for further details). Stop Bolts on the side sheets are the means of positive stop for the racking crank arms rotation.

The circuit breaker position (Test/Isolated” or “In Service) is indicated by actuation of electrical limit micro-switches (located in the base of the circuit breaker compartment) via the rollers located on the underside of the circuit breaker (see Figure 7 and Figure 10). Connections to the micro-switches are terminated in the Low Voltage compartment within the circuit breaker cubicle.

Where Auto Discharge is fitted, this will operate to automatically discharge the main closing spring as the circuit breaker is completely removed from the switchgear cubicle. Please be aware that this goes off with a loud bang!

4.3.1.1.1 Racking Boss Retainer
With the circuit breaker compartment door closed, the racking boss retainer (located on the back of the compartment door – see Figure 16 below) automatically ‘locks’ the circuit breaker mounted racking boss in position.

This part interlocks with the racking boss on the circuit breaker

Racking Handle Access Hole

Door Mounted Release Knob Connected Here

Figure 16 Racking Boss Retainer

To release the racking boss as the door is opened, the release (knob located on the compartment door) should first be rotated in the clockwise direction.

Figure 17 Release Knob
4.3.1.1.2 Anti-Rollout Latch
The circuit breaker is equipped with an anti-rollout latch (see Figure 7 and Figure 10) which prevents inadvertent removal from the circuit breaker compartment by engaging a block within the compartment. To release the latch, push down on and hold the front of the mechanism.

4.3.1.2 Shutters
The circuit breaker travels between the “Test/Isolated” position and the “In Service” position as the crank arm roller engages the vertical slots of the racking hooks attached in the circuit breaker compartment. It is the action of the circuit breaker moving from the “Test/Isolated” position and the “In Service” position that drives the compartment shutters open. As the breaker moves to the “In Service” position the shutter rams on the breaker make contact with and thus drive the shutter operating mechanism within the circuit breaker cubicle. Opening the shutters allows the primary disconnecting devices to connect.

As the circuit breaker is removed from the compartment, the shutters automatically close, preventing accidental access to the primary disconnects. A maintenance cradle is required to operate the shutters for maintenance purposes.

![Figure 18 Shutters](image)

4.3.1.3 Interlocks
Separate interlocks that operate in conjunction with the circuit breaker compartment to ensure the proper operation of the circuit breaker. The purpose of the interlocks is to:

- Prevent the circuit breaker being racked into the “In Service” position whilst the compartment door is open.
- Prevent the circuit breaker being racked into the “In Service” position whilst the circuit earth is applied.
- Prevent the circuit breaker being racked into or out of the “In Service” position unless the circuit breaker main contacts are open.
- Prevent the circuit breaker being racked if locked, i.e. for maintenance.
4.3.2 Electrical

The schematic below details the electrical operation of the circuit breaker.

4.3.2.1 Schematic

![Electrical Schematic](image)

**Figure 19 Electrical Schematic**
5 Dispatch and Storage

5.1 Dispatch
When a circuit breaker is supplied as part of a switchgear assembly, it will be shipped installed in the equipment. In these cases, the circuit breaker will be in the “In Service” position.

When a circuit breaker is supplied as a loose item, please ensure that a pole moulding shroud is fitted to avoid contamination of the pole moulding assemblies. It is important to remove this shroud prior to installing the circuit breaker in the switchgear.

5.2 Condition on Delivery
When the circuit breaker is received, check for any sign of damage. If damage is found or suspected, file all claims immediately with the transportation company and notify Powell UK.

5.3 Handling
After the circuit breaker has been removed from its shipping pallet it must be placed on the appropriate service trolley. This is the preferred way of handling the circuit breaker. When moving the circuit breaker around on the service trolley, it should be steered by the steel frame. The fascia / front cover should not be used to move the circuit breaker.

If necessary, the circuit breaker can be moved by an overhead crane using the two lifting eyes which have been provided for shackles (see Figure 6 and Figure 9). Please note the following:

- Damage to the lifting eye may result if hooks are used to lift the circuit breaker
- The centre of gravity of the circuit lies to the rear of the lifting eyes and as such when lifted the circuit breaker will tilt considerably. Ensure that persons and objects are clear of the breaker when lifting.
- Ensure all lifting devices are adequately rated for the loading of the circuit breaker.

5.4 Storage
It is recommended that the circuit breaker be placed into service immediately in its permanent location after completing the commissioning tests. If this is not possible, the following precautions must be taken to ensure the proper storage of the circuit breaker:

- The circuit breaker should be stored in a clean location free from corrosive gases or fumes.
- Unplated surfaces should be coated with grease/oil to prevent rusting.
- If the circuit breaker is stored for any length of time it should be inspected periodically to see that rusting has not started and to ensure good mechanical condition. If the circuit breaker is stored under unfavourable atmospheric conditions, it should be cleaned and dried before being placed into service.
6  Installation
6.1  Pre-Installation Checks
Before shipment from the factory, all circuit breaker functions are thoroughly checked. These checks must be performed on site prior to inserting the breaker into the cubicle. It is recommended that these checks are performed in the sequence stated below:

1. High Voltage Insulation Integrity Check
2. Vacuum Integrity Check
3. Control Voltage Insulation Integrity Check
4. Mechanical Operation Check
5. Electrical Operation Check
6. Circuit Breaker and Compartment Physical Checks

These tests are described in more detail in the following sections.

If the circuit breaker was shipped as a loose item, please ensure that the pole moulding shrouds are removed before these tests are carried out.

6.1.1  High Voltage Insulation Integrity Check
The primary circuit insulation on the circuit breaker should be checked phase-to-phase and phase-to-ground using a 2500V insulation resistance tester. Since definite limits cannot be given for satisfactory insulation values when testing with an insulation resistance tester, a record should be kept of the insulation resistance tester readings as well as the temperature and humidity readings. This record should be used to detect any weakening of the insulation system from one check period to the next.

Please note the following:

- When high voltage is applied across the contacts of a vacuum interrupter, there is the possibility of the generation of x-rays. The intensity of these x-rays is dependent on the peak voltage and the contact gap. At the normal operating voltage for this type of equipment, the radiation levels are negligible. At the voltages specified for testing, test personnel shall be in front of the circuit breaker such that the layer of steel used in the frame construction is between the test personnel and the vacuum interrupters. Please note the following:
  1. Test personnel shall be no closer than 1 metre from the front of the circuit breaker when performing high voltage tests
  2. The circuit breaker must be fully open or fully closed when performing high potential tests. Do not test the circuit breaker with the contacts partially open.

- High voltages across the open gaps of the vacuum interrupter can produce radiation. Personnel should stand at least one metre away from the circuit breaker with the covers in place when conducting high voltage tests. Test voltages should not exceed 28kV rms for the circuit breaker with a rated maximum voltage of 12kV rms and 36kV rms for the circuit breaker with a rated maximum voltage of 15kV rms.

- If DC high potential testing is performed, the DC high potential test machine must not produce instantaneous peak voltages exceeding 36kV rms.

- After the high potential is removed, an electrical charge may be retained by the vacuum interrupters. Failure to discharge this residual electrostatic charge could result in an electrical shock. All six primary disconnecting devices of the circuit breaker should be grounded and remain grounded for at least one minute to reduce this electrical charge before coming in to contact with the primary circuit.

- Remove all grounding conductors applied for this test before placing the circuit breaker back into service.

It is suggested that testing be carried out in accordance with IEC 62271-100.7.1 9 (see below).
Short-term Power-Frequency Withstand (IEC62271-100 7.1 Table 34)

<table>
<thead>
<tr>
<th>Breaker state</th>
<th>Voltage applied</th>
<th>Earth connected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed</td>
<td>Aa Cc</td>
<td>Bb Frame</td>
</tr>
<tr>
<td>Closed</td>
<td>Bb</td>
<td>Aa Cc Frame</td>
</tr>
<tr>
<td>Open</td>
<td>A B C</td>
<td>a b c Frame</td>
</tr>
</tbody>
</table>

Where A, B & C are the incoming breaker terminals and a, b & c are the outgoing breaker terminals

6.1.2 Vacuum Integrity Check
In order to reliably verify vacuum integrity, AC testing (rather than DC testing. See note below) must be performed. All PV100 circuit breakers must be tested with a minimum of 25kV rms applied across fully open contacts for 10 seconds. The test is deemed to be successful if no dielectric breakdown occurs during the test period.

Applying abnormally high voltage across a pair of contacts in a vacuum may produce X-radiation (X-rays). The radiation levels may increase with increased voltage and/or decreased contact spacing. X-rays produced during this test with the voltage specified in Section 6.1.1 and normal contact spacing is extremely low and well below the maximum permitted by standards. Do not apply voltage that is higher than the recommended value. Do not use contact separation that is less than the normal open position separation of the circuit breaker contacts.

Note:
Powell UK recognises the widespread use of DC high potential equipment in the field and the desire to use this equipment to verify vacuum integrity. However, the capacitive component of the vacuum interrupter during DC testing may yield false negative test results, which are often misinterpreted as vacuum interrupter failure. When DC testing is performed, a test set providing a full wave rectified 50kVDC high potential voltage can be applied for 5 seconds as a “go - no go” test.

Recording the leakage readings is not necessary, as a dielectric breakdown will trip all portable DC high potential test sets. If a DC test breakdown occurs, the test must be repeated after reversing the DC high voltage test supply connection across the vacuum interrupter. A vacuum interrupter should be questioned only if it has failed both tests.

6.1.3 Control Voltage Insulation Integrity Check
This test should be done with a 500V or 1000V insulation resistance tester or with an AC high potential tester. The AC high potential test should be made at 1125V, 50 or 60 Hz for one minute. The charging motor must be disconnected prior to testing the control circuit. The charging motor itself may be similarly tested at a voltage not to exceed 675V, 50 or 60 Hz. Be sure to remove any test jumpers and reconnect the charging motor when the tests are complete.

6.1.4 Mechanical Operation Check
This is to check the manual charge, close and trip functionality of the breaker.

To check the manual charge, insert the charging handle and charge until the spring charge indicator shows “Closing Spring Charged”. This requires around 60 operations of the handle. Remove the handle.

Once fully charged, push the manual close button on the circuit breaker and the circuit breaker should close. The circuit breaker open/closed indicator will now display “Breaker Closed”.

Once closed, push the manual trip button on the circuit breaker and the circuit breaker should open. The open/closed indicator will now display “Breaker Open”.
6.1.5 **Electrical Operation Check**
To check the basic electrical operation of the circuit breaker all normal control supplies must be applied in the sequence described below. This is most easily achieved by making the appropriate connections to the secondary disconnect connector of the circuit breaker.

- Apply an electrical supply to pins 3 (+ve) & 2 (-ve) to energise the close coil and close the circuit breaker.
- The circuitry is arranged to cause the charging motor to operate after circuit breaker closure and recharge the main closing spring. Check this occurs.
- Apply an electrical supply to pins 7 (+ve) & 6 (-ve) to energise the trip coil and trip the circuit breaker.

6.1.6 **Circuit Breaker and Compartment Physical Checks**
Prior to inserting the circuit breaker into the cubicle, perform the checks detailed below:
- Check that the circuit breaker is the correct one for the designated compartment. Please note that the circuit breakers are designed such that it is not possible to insert a breaker of one rating into a cubicle of a different rating.
- Examine the primary disconnecting devices for any signs of damage or contamination. If any of the primary disconnecting devices are damaged, make no attempt to repair them, but contact Powell UK for further information.
- Examine the circuit breaker compartment to see that it is clean and clear of debris.
- Where a circuit breaker has been shipped separately to the switchboard, ensure that the pole moulding shroud has been removed.
6.2 Inserting the Circuit Breaker into the Cubicle

The circuit breaker is inserted into the switchgear cubicle with the use of a service trolley (a service trolley is provided for each cubicle width). The procedure for inserting the circuit breaker is as follows:

- Unlock and open the compartment door.
- Position the service trolley (with the breaker on) at the correct height facing the panel front. The height of the trolley may need some adjustment and this can be done by winding the trolley adjusters up or down the threaded bar as required.
- Move the trolley up to the cubicle and ensure that it automatically latches to the cubicle such that it can’t be moved away.
- Operate the anti-rollout lever to release the breaker from the trolley.
- Move the breaker forwards until it is fully inside the cubicle and the anti-rollout lever has latched onto the anti-rollout bracket on the compartment mid pan.
- The breaker is now inserted into the compartment and is in the “Test/Isolated” position.
- Remove the breaker control wiring plug (secondary disconnect) from the storage position on the breaker and connect it to the socket on the top of the compartment above the breaker.
- Detach the trolley from the cubicle by moving the lever on the trolley (at the front and underneath the bench top) to the right and pulling the trolley away.
- Close and lock the compartment door. The breaker can now be racked into the “In Service” position using the provided racking handle assuming all other interlocks will allow it.

6.2.1 Racking Mechanism Check

This check must be performed with the circuit breaker inside the compartment as the circuit breaker interlocks prevent racking of the breaker when outside of the cubicle.

- Ensure the breaker is inserted into the designated cubicle and is in the “Test/Isolated” position as described above.
- Fit the hexagonal spigot of the racking handle to the racking boss through the access hole in the compartment door.
- To rack the breaker into the “In Service” position, turn the racking handle clockwise until the stop is reached. It will take approximately 20 turns to achieve this. NOTE: The circuit breaker must not be stopped at any position in the travel range between the “Isolated” position and the “In Service” position.
- To rack the breaker from the “In Service” position to the “Test/Isolated” position, turn the handle anti-clockwise until the stop is reached. It will take approximately 20 turns to achieve this. NOTE: The circuit breaker must not be stopped at any position in the travel range between the “In Service” position and the “Isolated” position.
6.3 Removing the Circuit Breaker from the Cubicle

The circuit breaker is removed from the switchgear cubicle with the use of a service trolley (a service trolley is provided for each cubicle width). The procedure for withdrawal of the circuit breaker is as follows:

- Ensure that the breaker is open and in the "Test/Isolated" position.
- Unlock and open the compartment door ensuring that the door retaining catch is disengaged before opening.
- Disconnect the breaker control wiring plug (secondary disconnect) from the socket on the top of the compartment above the breaker and attach it to the storage position on the breaker.
- Position the service trolley at the correct height facing the panel front. The height of the trolley may need some adjustment and this can be done by winding the trolley adjusters up or down the threaded bar as required.
- Move the trolley up to the cubicle and ensure that it automatically latches to the cubicle such that it can’t be moved away.
- Operate the anti-rollout lever to release the breaker from the cubicle.
- Move the breaker backwards until it is completely on the service trolley and the anti-rollout lever latches on the trolley.
- Detach the trolley from the cubicle by moving the lever on the trolley (at the front and underneath the bench top) to the right and pulling the trolley away.
- The breaker is now completely removed from the compartment.

Please note that where Auto Discharge is fitted, this will operate to automatically discharge the main closing spring as the circuit breaker is racked out of the switchgear cubicle. Please be aware that this goes off with a loud bang!
7 Maintenance

7.1 Overview
Maintenance serves to preserve trouble-free operation and achieve the longest possible working life of the circuit breaker. It is recommended that routine maintenance be carried out after 2000 operations or at 12 monthly intervals (whichever is soonest) in order to reduce the number of repairs and the unplanned shutdown time.

Maintenance work may only be performed by trained personnel familiar with the characteristics of the individual circuit breaker, in accordance with all relevant safety regulations and with other overriding instructions. It is recommended that Powell UK service personnel carry out any servicing and repair work. Please contact the Site Services team for further information regarding maintenance personnel and activities.

Please note the following:
- If maintenance is performed at longer time intervals than one year, the vacuum integrity test (see Section 6.1.2) should be performed each time the circuit breaker is removed from the switchgear cubicle.
- If the breaker is known to have interrupted a fault current at or near its rating, it is recommended that the circuit breaker be inspected and any necessary maintenance carried out as soon as is practicable.

7.2 Routine Maintenance
It is recommended that the following maintenance is conducted after every 2000 operations or after each year of service, whichever occurs first:
- Inspection and Cleaning
- Mechanical Operation Check
- Lubrication

These activities are detailed in the following sections. Ensure that the breaker is open, in the “Test/Isolated” position and fully discharged prior to conducting this work.

7.2.1 Inspection and Cleaning
Remove the front cover and conduct the following activities:
- Visually check the circuit breaker for loose or damaged parts.
- Identify and replace any damaged parts.
- Remove any loose dust and dirt using a vacuum cleaner. Do not use compressed air to clean the circuit breaker as this may result in loose dirt or grit being blown into bearings or other critical parts, thus causing excessive wear.
- Clean the breaker including the primary insulation, vacuum interrupter supports and operating pushrods with a dry lint-free cloth or an industrial-type wiper. Do not use solvents, de-greasers, or any aerosol products to clean in the area of any mechanisms. If dirt adheres and cannot be removed by wiping, remove it with a mild solvent such as denatured alcohol. Be sure that the circuit breaker is dry before returning it to service. Do not use any type of detergent to wash the surface of the insulators as detergent may leave an electrically conducting residue on the surface as it dries.
7.2.2 Vacuum Interrupter Check
During assembly of the circuit breaker, the Vacuum Interrupters (VIs) are appropriately set up with the stroke set for each VI and the subsequent nut gap measured and recorded. When the circuit breaker is new, the measurements should be as follows:

<table>
<thead>
<tr>
<th>Circuit Breaker</th>
<th>Stroke (mm)</th>
<th>Nut Gap (mm)</th>
<th>Maximum Stroke Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>40kA and 50kA</td>
<td>7-9</td>
<td>≥ 8.4</td>
<td>2.5</td>
</tr>
<tr>
<td>63kA</td>
<td>11.7-13.7</td>
<td>≤ 5</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 7 Vacuum Interrupter Measurements

End of life is determined to have been reached when the initial stroke recorded when new has increased by 2.5mm (40kA and 50kA breakers) or 3mm (63kA breaker). When end of life has been reached, it indicates that the vacuum interrupter contacts have worn and the vacuum interrupters need replacing. Please contact Powell UK to make arrangements for this work to be carried out. Please note that the information detailed above is based on maximum values. Specific data recorded for each VI for should be used when performing routine maintenance.

7.3 Lubricants and Cleaning Agents

7.3.1 Cleaning Agents
The circuit breaker can be cleaned using the following cleaning agents:

- Contact Cleaner - Electrical Cleaner
  - RS Components Ltd – Part No 203-0750

- Insulation Cleaner - Electro Mech.
  - RS Components Ltd – Part No 268-2115

If RS Components Ltd products are not available locally, please contact the Site Services team for an approved equivalent supplier.

7.3.2 Lubricants
The following lubricants should be used:
- Lubricate all accessible mechanical parts using Rheolube 368A Grease.
- Inaccessible mechanical parts can be lubricated with a synthetic machine oil such as Anderol 456.
- Electrical contact surfaces should be lubricated using Mobilgrease 28.
Appendix 1: Abbreviations/Glossary of Terms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACH</td>
<td>Anti-Condensation Heater</td>
</tr>
<tr>
<td>BES</td>
<td>Busbar Earthing Switch</td>
</tr>
<tr>
<td>BIL</td>
<td>Basic Impulse Insulation Level</td>
</tr>
<tr>
<td>CB</td>
<td>Circuit Breaker</td>
</tr>
<tr>
<td>CT</td>
<td>Current Transformer</td>
</tr>
<tr>
<td>EPDM</td>
<td>Ethylene Propylene Diene Monomer (M-class rubber)</td>
</tr>
<tr>
<td>ES</td>
<td>Earthing Switch</td>
</tr>
<tr>
<td>HDHC</td>
<td>Hard Drawn High Conductivity</td>
</tr>
<tr>
<td>HV</td>
<td>High Voltage</td>
</tr>
<tr>
<td>IAC</td>
<td>Internal Arc Classification</td>
</tr>
<tr>
<td>IR</td>
<td>Insulation Resistance</td>
</tr>
<tr>
<td>LV</td>
<td>Low Voltage</td>
</tr>
<tr>
<td>MCB</td>
<td>Miniature Circuit Breaker</td>
</tr>
<tr>
<td>MV</td>
<td>Medium Voltage</td>
</tr>
<tr>
<td>VC</td>
<td>Vacuum Contactor</td>
</tr>
<tr>
<td>VCB</td>
<td>Vacuum Circuit Breaker</td>
</tr>
<tr>
<td>VT</td>
<td>Voltage Transformer</td>
</tr>
</tbody>
</table>