Vacuum Circuit Breaker Operator Module
Type 3AH
4.16kV to 38kV

Medium-Voltage Equipment
**DANGER**

Hazardous voltages and high-speed moving parts.

Will cause death, serious personal injury or equipment damage.

De-energize and ground the equipment before maintenance. Maintenance should be performed only by qualified personnel.

Unauthorized parts should not be used in the repair of the equipment.

Follow all safety instructions contained herein.

**IMPORTANT**

The information contained herein is general in nature and not intended for specific application purposes. It does not relieve the user of responsibility to use sound practices in application, installation, operation, and maintenance of the equipment purchased. Siemens reserves the right to make changes in the specifications shown herein or to make improvements at any time without notice or obligations. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary material or both, the latter shall take precedence.

**QUALIFIED PERSON**

For the purpose of this manual a qualified person is one who is familiar with the installation, construction or operation of the equipment and the hazards involved. In addition, this person has the following qualifications:

(a) **is trained and authorized** to de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.

(b) **is trained** in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.

(c) **is trained** in rendering first aid.

**SUMMARY**

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser’s purposes, the matter should be referred to the local sales office.

The contents of this instruction manual shall not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contacts the entire obligation of Siemens Industry, Inc. The warranty contained in the contract between the parties is the sole warranty of Siemens Industry, Inc. Any statements contained herein do not create new warranties or modify the existing warranty.
# Vacuum Circuit Breaker Operator Module

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Introduction and Safety

Introduction
The 3AH family of vacuum circuit breakers is designed to meet all the applicable ANSI, NEMA and IEEE standards. Successful application and operation of this equipment depends as much upon proper installation and maintenance by the user as it does upon the careful design and fabrication by Siemens.

The purpose of this Instruction Manual is to assist the user in developing safe and efficient procedures for the installation, maintenance and use of the equipment.

NOTE: IEEE Standards Requirements for Conversion of Power Switchgear Equipment (C37.59); Siemens has developed instruction manuals for particular replacement circuit breaker drawout vehicles, consult factory.

Contact the nearest Siemens representative if any additional information is desired.

Qualified Person
For the purpose of this manual a Qualified Person is one who is familiar with the installation, construction or operation of the equipment and the hazards involved. In addition, this person has the following qualifications:

- Training and authorization to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.
- Training in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses, face shields, flash clothing, etc., in accordance with established safety procedures.
- Training in rendering first aid.

Signal Words
The signal words “Danger,” “Warning” and “Caution” used in this manual indicate the degree of hazard that may be encountered by the user. These words are defined as:

**Danger** - Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

**Warning** - Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

**Caution** - Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Dangerous Procedures
In addition to other procedures described in this manual as dangerous, user personnel must adhere to the following:

1. Always work on de-energized equipment. Always de-energize a circuit breaker, and remove it from the switchgear before performing any tests, maintenance or repair.

2. Always perform maintenance on the circuit breaker after the spring-charged mechanisms are discharged.

3. Always let an interlock device or safety mechanism perform its function without forcing or defeating the device.

Field Service Operation
Siemens can provide competent, well-trained Field Service Representatives to provide technical guidance and advisory assistance for the installation, overhaul, repair and maintenance of Siemens equipment, processes and systems. Contact regional service centers, sales offices or the factory for details, or telephone Siemens Field Service at 1-800-241-4953.
Receiving, Handling and Storage

Introduction
This manual covers the Receiving, Handling and Storage instructions for Type 3AH vacuum circuit breakers shipped separately from the switchgear. This section of the manual is intended to help the user identify, inspect and protect the circuit breaker prior to its installation.

Receiving Procedure
Make a physical inspection of the shipping container before removing or unpacking the circuit breaker. Check for shipment damage or indications of rough handling by the carrier. Check each item against the manifest to identify any shortages.

Accessories such as the manual charging crank, the racking crank and the split plug jumper are shipped separately.

Shipping Damage Claims (when applicable) - Follow normal shipment damage procedures, which should include:

1. Check for visible damage upon arrival.

2. Visible damage must be noted on delivery receipt, and acknowledged with driver’s signature. Notation, “Possible internal damage, subject to inspection” must be on delivery receipt.

3. Notify the Siemens Sales office immediately of any shipment damage.

4. Arrange for carrier’s inspection. Do not move the unit from its unloading point.

Handling Procedure
1. Carefully remove the shipping carton from the circuit breaker. Keep the shipping pallet for later use if the circuit breaker is to be stored prior to its installation.

2. Inspect for concealed damage. Notification to carrier must take place within 15 days to assure prompt resolution of claims.

3. Each circuit breaker should be appropriately lifted to avoid crushing the side panels of the circuit breaker, or damaging the primary disconnect subassemblies.

Circuit breaker weights (Table A-4).

4. The palleted circuit breaker can also be moved using a properly rated fork-lift vehicle. The pallets are designed for movement by a standard fork-lift vehicle.

Storage Procedure
1. When the circuit breaker will be placed on its pallet for storage, be sure the unit is securely bolted to the pallet and covered with polyethylene film at least 10 mils thick.

Indoor Storage - Whenever possible, store the circuit breaker indoors. The storage environment must be clean, dry and free of such items as construction dust, corrosive atmosphere, mechanical abuse and rapid temperature variations.

Outdoor Storage - Outdoor storage is not recommended. When no other option is available, the circuit breaker must be completely covered and protected from rain, snow, dirt and all other contaminants.

Space Heating - Space heating must be used for both indoor and outdoor storage to prevent condensation and corrosion. When stored outdoors, 250 watts per circuit breaker of space heating is recommended.

WARNING
Heavy weight. Can cause death, serious injury, or property damage.
Use of a qualified rigger to hoist the circuit breaker.
Installation Checks and Initial Functional Tests

Introduction
This section provides a description of the inspections, checks and tests to be performed on the circuit breaker module only.

Inspections, Checks and Tests without Control Power
Vacuum circuit breakers are normally shipped with their primary contacts open and their springs discharged. However, it is critical to first verify the discharged condition of the spring-loaded mechanisms after de-energizing control power.

Spring Discharge Check (Figure 1)
Perform the Spring Discharge Check before removing the circuit breaker from the pallet or removing it from the switchgear.

The spring discharge check consists of simply performing the following tasks in the order given. This check assures that both the opening and closing springs are fully discharged.

1. Press red Open pushbutton.
2. Press black Close pushbutton.
3. Again press red Open pushbutton.
4. Verify Spring Condition Indicator shows DISCHARGED.
5. Verify Main Contact Status Indicator shows OPEN.

Manual Spring Charging Check
1. Insert the manual spring charging crank into the manual charge handle socket as shown in Figure 1. Turn the crank clockwise until the spring condition indicator shows the closing spring is Charged.
2. Repeat the Spring Discharge Check.
3. Verify that the springs are discharged and the circuit breaker primary contacts are open by indicator positions.

As-Found and Vacuum Check Tests - Perform and record the results of both the As-Found insulation test and the vacuum check high-potential test. Procedures for these tests are described in the Maintenance Section of this manual.

Automatic Spring Charging Check
Note: A temporary source of control power and test leads may be required if the control power source has not been connected to the switchgear. Refer to the specific wiring information and rating label for your circuit breaker to determine the voltage required and where the control voltage signal should be applied. When control power is connected to the circuit breaker, the closing spring should automatically charge.

The automatic spring charging features of the circuit breaker must be checked. Control power is required for automatic spring charging to take place.

1. Open control power circuit by opening the control power disconnect device.
2. Energize (close) the control power circuit disconnect.
3. Use the Close and Open controls (Figure 1) to first Close and then Open the circuit breaker contacts. Verify contact positions visually by observing the Open/Closed indicator on the circuit breaker.
4. De-energize control power by repeating Step 1. Disconnect the plug jumper from the switchgear first and next from the circuit breaker.
5. Perform the Spring Discharge Check again. Verify that the closing spring is discharged and the primary contacts of the circuit breaker are open.

Final Mechanical Inspections without Control Power
1. Make a final mechanical inspection of the circuit breaker. Verify that the contacts are in the open position, and the closing spring is discharged.
2. Verify mechanical condition of springs.
3. Check for loose hardware.
Introduction
The Type 3AH vacuum circuit breaker operator is intended for application in a drawout truck for use in medium voltage metal-clad switchgear. The 3AH circuit breaker conforms to the requirements of ANSI Standards, including C37.20.2, C37.04, C37.06, C37.09 and C37.010.

The circuit breaker consists of three vacuum interrupters, a stored energy operating mechanism, necessary electrical controls and interlock devices, disconnect devices to connect the circuit breaker to both primary and control power and an operator housing. In a typical installation in a drawout truck, insulating barriers are located between the vacuum interrupters and along the sides.

This section describes the operation of each major subassembly as an aid in the operation, installation, maintenance and repair of the circuit breaker.

![Diagram of vacuum circuit breaker module](image)

Figure 2. Vacuum Circuit Breaker Module
Vacuum Interrupters
The operating principle of the vacuum interrupter is simple. Figure 3 is a cutaway view of a typical vacuum interrupter. The entire assembly is sealed after a vacuum is established. The vacuum interrupter stationary contact is connected to the pole head of the circuit breaker. The vacuum interrupter movable contact is connected to the pole bottom and driving mechanism of the circuit breaker. The metal bellows provide a secure seal around the movable contact, preventing loss of vacuum while permitting vertical motion of the movable contact.

When the two contacts separate, an arc is initiated which continues conduction up to the following current zero. At current zero, the arc extinguishes and any conductive metal vapor which has been created by and supported the arc condenses on the contacts and on the surrounding vapor shield. Contact materials and configuration are optimized to achieve arc motion and to minimize switching disturbances.

Primary Disconnects (Figure 4)
Figure 4 illustrates the pad provision to accept the primary disconnects. Each circuit breaker has three upper and three lower primary disconnect pad provisions, to perform the connection to the switchgear.

Bolting hardware is M12 x 1.75 grade 8. Torque M12 bolts to 52 ft/lbs (70 Nm).

Phase Barriers
Plates of glass polyester insulating material are attached to the circuit breaker and provide suitable electrical insulation between the vacuum interrupter primary circuits and the cubicle.

Stored Energy Operating Mechanism
The stored energy operating mechanism of the circuit breaker is an integrated arrangement of springs, coils and mechanical devices designed to provide a number of critical functions. The energy necessary to close and open the contacts of the vacuum interrupters is stored in powerful opening and closing springs. These springs are normally charged automatically, but there are provisions for manual charging. The operating mechanism that controls charging, closing and tripping functions is fully trip-free, i.e., spring charging does not automatically change the position of the primary contacts, and the closing function may be overridden by the tripping function at any time.

Vacuum Interrupter/Operator Module
The vacuum interrupter/operator module consists of the three poles, each with its vacuum interrupters and primary insulators, mounted on the common motor or manually charged spring stored energy operating mechanism housing. This module is shown in Figure 4.
Vacuum Interrupter/Operator Description

Construction (Figures 1, 2, 5, 6a and 6b)
Each of the circuit breaker poles are fixed to the rear of the operating mechanism housing by two cast-resin insulators. The insulators also connect to the upper and lower pole supports which in turn support the ends of the vacuum interrupter. The pole supports are aluminum castings (1200A and 2000A) or copper castings (3000A). Primary stud extensions may be attached directly to the upper and lower pole supports.

The energy-storing mechanism and all the control and actuating devices are installed in the mechanism housing. The mechanism is of the spring stored energy type and is mechanically and electrically trip free.

The close-open indicator, closing spring charge indicator, and the operation counter are located on the front of the mechanism housing.

The control connector for the control and signalling cables is a multi contact plug.

Current-Path Assembly (Figure 5)
The current-path assembly consists of the pole head, the stationary contact, and the moving contact, which is connected to the pole bottom by a terminal clamp and a flexible connector.

Vacuum Interrupter (Figure 5)
The moving contact motion is aligned and stabilized by a guide bushing. The metal bellows follows the travel of the contact and seals the vacuum interrupter against the surrounding atmosphere.

Switching Operation (Figures 5 and 6a)
When a closing command is initiated, the closing spring (62), which was previously charged by hand or by the motor, actuates the moving contact through the jack shaft (63), lever, contact pressure spring (49), insulating coupler (48), and angled lever.

The forces that occur when the action of the insulating coupler (48) is converted into the vertical action of the moving contact are absorbed by the guide link, which pivots on the pole bottom and the eye bolt.

During closing, the opening spring (64) (Figure 6a) and the contact pressure springs (49) are charged and latched by pawl (64.2) (Figure 6b). The closing spring (62) (Figure 6a) of the motor-operated circuit breaker is recharged immediately after closing.

In the closed state, the necessary contact pressure is maintained by the contact pressure spring (49) and the atmospheric pressure. The contact pressure spring automatically compensates for arc erosion, which is very small.

When a opening command is given, the energy stored in the opening and contact pressure springs (49) is released by pawl (64.2) (Figure 6b). The opening sequence is similar to the closing sequence. The residual force of the opening spring arrests the moving contact in the open position.

Operating Mechanism
The operating mechanism is comprised of the mechanical and electrical components required to:

1. Charge the closing spring with sufficient potential energy to close the circuit breaker and to store opening energy in the opening and contact pressure springs.


3. Means of transmitting force and motion to each of three pole positions.

4. Operate all these functions automatically through electrical charging motor, cutout switches, antipump relay, close coil, open coil, and auxiliary switch.

5. Provide indication of the circuit breaker status (open/closed), spring condition (charged/discharged), and number of operations.

Figure 5. Pole Assembly

Circuit Breaker Pole (Figure 5)
The vacuum interrupter is rigidly connected to the pole head by its post insulator. The lower part of the vacuum interrupter is stabilized against lateral forces by a centering ring on the pole bottom. The external forces due to switching operations and the contact pressure are absorbed by the struts.
50.2 Charging mechanism gear box
50.3 Charging flange
50.3.1 Driver
50.4 Spring charging motor 88
50.4.1 Limit switches
50.5 Manual spring charging port
53 Close pushbutton
53.1 Close coil 52SRC
54 Open pushbutton
54.1 Trip coil 52T
55 Closing spring charge indicator
55.1 Linkage
55.2 Control lever
58 Close-open indicator
59 Operation counter
60 Operator housing
61.8 Shock absorber
62 Closing spring
62.1 Charging shaft
62.2 Crank
62.3 Cam disc
62.5 Lever
62.5.1 Pawl roller
62.5.2 Close latch pawl
62.6 Drive lever
62.8 Trip free coupling rod
62.8.1 Spring return latch
62.8.3 Trip free coupling lever
63 Jack shaft
63.1 Lever - phase C
63.5 Lever - phase B
63.7 Lever - phase A
64 Opening spring
68 Auxiliary switch
68.1 Auxiliary switch link

Figure 6a. Stored Energy Operating Mechanism (Circuit Breaker Shown in Open Position)
Vacuum Interrupter/Operator Description

Figure 6b. Stored Energy Operating Mechanism (Circuit Breaker Shown in Closed Position)

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Vacuum Interrupter/Operator Description

Construction
The essential parts of the operating mechanism are shown in Figures 6a and 6b. The control and sequence of operation of the mechanism is described in Figure 8.

Motor Operating Mechanism (Figure 6a)
The spring charging motor (50.4) is bolted to the charging mechanism (50.2) gear box installed in the operator housing. Neither the charging mechanism nor the motor require any maintenance.

Mode of Operation
The operating mechanism is of the stored-energy trip free type, i.e., the charging of the closing spring is not automatically followed by the contacts changing position, and the closing function may be overridden by an opening command at any time.

When the stored-energy mechanism has been charged, the instant of operation can be chosen as desired.

The mechanical energy for carrying out an “open-close-open” sequence for auto-reclosing duty is stored in the closing and opening springs.

Charging
The details of the closing spring charging mechanism are shown in Figure 6a. The charging shaft is supported in the charging mechanism (50.2), but is not coupled mechanically with the charging mechanism. Fitted to it are the crank (62.2) at one end, and the cam (62.3), together with lever (62.5), at the other.

When the charging mechanism is actuated by hand with a hand crank (Figures 9a and 9b) or by a motor (50.4), the flange (50.3) turns until the driver (50.3.1) locates itself in the cutaway part of the cam disc (62.3), thus causing the charging shaft to follow. The crank (62.2) charges the closing spring (62). When the closing spring has been fully charged, the crank actuates the linkage (55.1) via the control lever (55.2) for the “closing spring charged” indicator (55), and actuates the limit switches (50.4) for interrupting the motor supply. At the same time, the lever (62.5) at the other end of the charging shaft is securely locked by the latching pawl (62.5.2). When the closing spring is being charged, cam disc (62.3) follows idly, i.e., it is brought into position for closing.

Closing (Figures 6a, 6b and 7a - 7d)
If the circuit breaker is to be closed locally, the closing spring is released by pressing the CLOSE button (53). In the case of remote control, the close coil 52SRC (53.1) unlatches the closing spring (62).

As the closing spring discharges, the charging shaft (62.1) is turned by crank (62.2). The cam disc (62.3) at the other end of the charging shaft actuates the drive lever (62.6), with the result that jack shaft (63) is turned by lever (63.5) via the trip free coupling rod (62.8). At the same time, the levers (63.1), (63.5) and (63.7) fixed on the jack shaft operate the three insulating couplers (48) (Figure 5) for the circuit breaker poles. Lever (63.7) changes the Open-close indicator (58) over to Open. Lever (63.5) charges the opening spring (64) during closing, and the circuit breaker is latched in the closed position by lever (64.3) with pawl roller (64.3.1) and by pawl (64.2). Lever (63.1) actuates the auxiliary switch (68) through the linkage (68.1).

The crank (62.2) on the charging shaft (62.1) moves the linkage (55.1) by acting on the control lever (55.2). The closing spring charged indication is thus canceled, and the limit switches (50.4) switch in the control supply to cause the closing spring to recharge immediately.

Trip Free Operation (Figures 6a and 6b)
The trip free coupling rod (62.8) permits the immediate decoupling of the drive lever (62.6) and the jack shaft (63) to override closing action by trip command or by means of the racking interlocks.

The trip free coupling rod (62.8) forms a link between the drive lever (62.6) and the jack shaft (63). The rigidity of this link depends upon a spring return latch (62.8.1) carried within the coupling rod. The latch pivots within the coupling rod and is normally positioned to ensure the rigidity of the coupling rod. Trip free coupling link (62.8.2) and trip free coupling lever (62.8.3) cause the spring return latch position to be dependent upon the normal tripping components and the racking interlock. Thus, whenever a trip command is applied or the circuit breaker is not in the fully CONNECT or TEST position, the trip free coupling rod is no longer rigid, effectively decoupling the drive lever and jack shaft. Under these conditions the vacuum interrupter contacts cannot be closed.

Opening (Figure 6a)
If the circuit breaker is to be opened locally, the opening spring (64) is released by pressing the Open pushbutton (54). In the case of an electrical command being given, the trip coil 52T (54.1) unlatches the opening spring (64).

The opening spring (64) turns the jack shaft (63) via lever (63.5); the sequence being similar to that for closing.
Vacuum Interrupter/Operator Description

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<td>62.1</td>
<td>Charging shaft</td>
<td>62.8.3</td>
<td>Trip free coupling lever</td>
</tr>
<tr>
<td>62.2</td>
<td>Crank</td>
<td>62.8.5</td>
<td>Push rod &amp; cam assembly</td>
</tr>
<tr>
<td>62.2.2</td>
<td>Closing spring mounting</td>
<td>62.8.6</td>
<td>Interlock lever-push rod</td>
</tr>
<tr>
<td>62.8.1</td>
<td>Spring return latch</td>
<td>62.8.7</td>
<td>Interlock lever-actuator</td>
</tr>
<tr>
<td>62.8.2</td>
<td>Trip free draw bar</td>
<td>62.8.8</td>
<td>Trip free actuator</td>
</tr>
<tr>
<td>63</td>
<td>Jack shaft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>63.1</td>
<td>Lever-phase C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>63.5</td>
<td>Lever-phase B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>63.7</td>
<td>Lever-phase A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>Opening spring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64.2</td>
<td>Trip latch pawl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64.3</td>
<td>Lever</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64.3.1</td>
<td>Jack shaft pawl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64.5</td>
<td>Opening spring shaft</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 7a. Operating Mechanism Section Diagram
Operating Mechanism Open, Closing Spring Discharged
* Items changed from 7c on 'Trip' Operation) (Underlined items changed from 7b on 'Closed Spring Discharge' Operation)

Figure 7b. Operating Mechanism Section Diagram Operating Mechanism Open, Closing Spring Charged
* Items changed from 7d on 'Trip' Operation) (Underlined items changed from 7a on 'Closed Spring Charge' Operation)
Vacuum Interrupter/Operator Description

62.5.2 Close latch pawl
62.8.1 Spring return latch
62.8.2 Trip free draw bar
62.8.3 Trip free lever
62.8.5 Push rod & cam assembly
62.8.6 Interlock lever-push rod
62.8.7 Interlock lever-actuator
62.8.8 Trip free actuator
62.8.9 Interlock lever-actuator

64.2.1 Trip latch pin
64.2.2 Latching pawl release lever
64.3 Lever
64.3.1 Jack shaft pawl
64.5 Opening spring shaft
64 Opening spring
64.2.1 Trip latch pin
64.2.2 Latching pawl release lever
64.3 Lever
64.3.1 Jack shaft pawl
64.5 Opening spring shaft

Figure 7c. Operating Mechanism Section Diagram
Mechanism Closed, Closing Spring Discharged
(Callout items changed from 7b on 'Circuit Breaker Close' Operation)

Figure 7d. Operating Mechanism Section Diagram
Operating Mechanism Closed, Closing Spring Charged
(Callout items changed from 7c on 'Closing Spring Charge' Operation)
Rapid auto reclosing.

The closing spring is recharged automatically as described above. Therefore, when the circuit breaker is closed both its springs are charged. The closing spring charges the opening spring during closing. As a result, the circuit breaker is capable of an O-3s-CO-15s-CO operating cycle.

Anti-pumping feature (Device 52Y)
Care must be taken to see that a continuously applied closing command does not cause the circuit breaker to reclose after it has tripped out on a fault otherwise it may sustain damage by the “pumping” effect.

Figure 8. Operator Sequential Operation Diagram.
The circuit breaker may be operated only with the original hand crank (50), in order to avoid injuries as a result of the motor suddenly starting up.

Manually Charging the Closing Spring (Figures 9a and 9b).
Insert the hand crank (50) with the over running coupling pushed forward (50.6) through the opening (50.1) onto hand crank coupling (50.5) and turn it clockwise (about 48 revolutions) until the closing spring indicator (55) shows “Charged.” The hand crank is coupled with the charging mechanism via an over-running coupling; thus the operator is not exposed to any risk should the control supply recover during charging.

Rapid Auto-Reclosing
Since the closing spring is automatically recharged by the motor operating mechanism when the circuit breaker has closed the operating mechanism is capable of an open-close-open duty cycle as required for rapid auto-reclosing.

Manual Operation
Electrically operated vacuum circuit breakers can be operated manually if the control supply should fail.

Manual Closing (Figure 6a)
Press the close button (53). The close-open indicator (58) will then display “Closed” and the closing spring condition indicator (55) will now read “Discharged.”

Manual Opening (Figure 6a)
The opening spring (64) is charged during closing. To open the circuit breaker, press the Open pushbutton (54) and “OPEN” will be displayed by indicator (58).
Vacuum Interrupter/Operator Description

Elementary Diagram (Figure 10)
A typical elementary diagram is shown in Figure 10 for DC motor, close and trip operation.

Figure 10. Typical Elementary Diagram
Construction and Mode of Operation of Secondary
Shunt Release and Undervoltage Release (Figures 11, 12 and 13)

The release consists of a spring-power storing mechanism, a latching device, and an electromagnet. These elements are accommodated side by side in a housing (3), with a detachable cover and three through holes (5) for fastening screws. The supply leads for the trip coil are connected to a terminal block (33).

If operated with AC voltage, a rectifier is installed in the circuit breaker.

Indirect Releases (Secondary Shunt Release (Dual Trip) (52T1) or Undervoltage (27))

The indirect release provides for the conversion of modest control signals into powerful mechanical energy impulses. It is primarily used to open medium voltage circuit breakers while functioning as a secondary shunt release (dual trip) or undervoltage device.

These releases are mechanical energy storage devices. Their internal springs are charged as a consequence of the circuit breaker mechanism operation. This energy is released upon application or removal (as appropriate) of applicable control voltages. Refer to Figures 11, 12 and 13.

The Secondary shunt release and Undervoltage release mounts to the immediate right of the trip coil (54.1).

Secondary Shunt Release (52T1) (Figure 11)

A secondary shunt release (extra trip coil) is used for electrical opening of the circuit breaker by protective relays or manual control devices when more than one trip coil is required. The second trip coil is generally connected to a separate auxiliary supply (DC or AC) from the control supply used for the normal trip coil. Undervoltage Release (27) (Figures 12 and 13).

Undervoltage Release (27) (Figures 10 and 11)

The undervoltage release (3AX1103) is used for continuous monitoring of the tripping supply voltage. If this supply voltage falls excessively, the undervoltage release will provide for automatic tripping of the circuit breaker.

The undervoltage device may be used for manual or relay tripping by employing a contact in series with undervoltage device holding coil. Relay tripping may also be achieved by employing a normally open contact in parallel with the holding coil. If this scheme is used, a resistor must be provided to limit current when the normally open contact is closed.

Secondary shunt and undervoltage releases are available for all standard ANSI control voltages.
On the undervoltage release 3AX1103, the latch (25) is held by the locking pin (21) as long as the armature (9) is energized. If the circuit of the magnet coil (7) is interrupted, the armature (9) drops off, thus causing the latch (25) to lose its support and release the striker pin (23).

Following every tripping operation, the striker pin (23) must be reset to its normal position by loading the spring (31). This takes place automatically via the operating mechanism of the circuit breaker.

Since the striker pin of the undervoltage release 3AX1103 is latched only when the armature is energized, the undervoltage release is provided with a screw (29), for locking the striker pin (23) in the normal position for adjusting purposes or for carrying out trial operations during circuit breaker servicing. Position A (locked) disables the undervoltage release. Position B (unlocked) is the normal operating position.

**Capacitor Trip Device**

The capacitor trip device is an auxiliary tripping option (capacitor trip is a system that should be mounted on the drawout truck) providing a short term means of storing adequate electrical energy to ensure circuit breaker tripping.

This device is applied in circuit breaker installations lacking independent auxiliary control power or station battery. In such installations, control power is usually derived from the primary source. In the event of a primary source fault or disturbance the capacitor trip device will provide short term tripping energy for circuit breaker opening due to relay operation.

The capacitor trip converts 120 or 240 VAC control voltage to a DC full wave voltage which is used to charge a large capacitor to the peak of the converted wave. (Figure 14).

**Shock Absorber**

Circuit breakers are equipped with a hydraulic shock absorber (61.8) (Figure 6a). The purpose of this shock absorber is to limit overtravel and rebound of the vacuum interrupter movable contacts during the conclusion of an opening operation. The shock absorber action affects only the end of an opening operation.

**Auxiliary Switch (52a/b)**

Figure 6a shows the circuit breaker mounted auxiliary switch (68). This switch provides auxiliary contacts for control of circuit breaker closing and opening functions. Contacts are available for use in relaying and external logic circuits. This switch is driven by linkage (68.1) connected to the jack shaft (63). The auxiliary switch contains both ‘b’ (Normally Closed) and ‘a’ (Normally Open) contacts. When the circuit breaker is open, the ‘b’ contacts are closed and the ‘a’ contacts are open.

**Spring Charging Motor (88)**

Spring charging motors (50.4) (Figure 6a) are available for both AC and DC operation. If operated with AC voltage, a rectifier is installed in the circuit breaker.
Introduction and Maintenance Intervals
Periodic inspections and maintenance are essential to obtain safe and reliable operation of the circuit breaker.

**DANGER**
Hazardous voltages and high-speed moving parts.
Will cause death, personal injury, and property damage.
De-energize before working on this equipment. Read instruction manuals, observe safety instructions, and limit use to qualified personnel.

When circuit breakers are operated under “Usual Service Conditions,” maintenance and lubrication is recommended at ten year intervals or at the number of operations indicated in Table 2. “Usual” and “Unusual” service conditions for Medium Voltage Metal-Clad Switchgear (includes Circuit Breaker Module) are defined in ANSI C37.20.2, section 8.1. Generally, “usual service conditions” are defined as an environment in which the equipment is not exposed to excessive dust, acid fumes, damaging chemicals, salt air, rapid or frequent changes in temperature, vibration, high humidity, and extremes of temperature.

The definition of “usual service conditions” is subject to a variety of interpretations. Because of this, you are best served by adjusting maintenance and lubrication intervals based on your experience with the equipment in the actual service environment.

Regardless of the length of the maintenance and lubrication interval, Siemens recommends that circuit breakers should be inspected and exercised annually.

For the safety of maintenance personnel as well as others who might be exposed to hazards associated with maintenance activities, the safety related work practices of NFPA 70E, parts II and III, should always be followed when working on electrical equipment. Maintenance personnel should be trained in the safety practices, procedures and requirements that pertain to their respective job assignments. This manual should be reviewed and retained in a location readily accessible for reference during maintenance of this equipment.

The user must establish a periodic maintenance program to ensure trouble-free and safe operation. The frequency of inspection, periodic cleaning, and preventive maintenance schedule will depend upon the operation conditions. NFPA Publication 70B, “Electrical Equipment Maintenance” may be used as a guide to establish such a program. A preventive maintenance program is not intended to cover reconditioning or major repair, but should be designed to reveal, if possible, the need for such actions in time to prevent malfunctions during operation.

**Recommended Hand Tools**
Metric hardware is used on these circuit breakers. Following list of hand tools describes those normally used in disassembly and re-assembly procedures.

- Open end wrenches: 7, 8, 10, 13, 17 and 19 mm
- Open end wrench: 55 mm used to exchange shock absorber (Qty: 2 pcs are required for the task).
- Sockets: 7, 8, 10, 13 and 17 mm
- Socket: 36 mm (used for replacing post insulators)
- Deep Sockets: 19 and 24 mm
- Hex keys: 5, 6, 8 and 10 mm
- Torque wrench: 0-150Nm (0-100ft-lbs)
- Screwdrivers: 0.032 x 1/4 in. wide and 0.55 x 7/16 in. wide
- Pliers
- Light Hammer
- Dental Mirror
- Flashlight
- Drift Pins: 1/8, 3/16, and 1/4 in.
- Retaining Ring Plier (external type, tip diameter 0.040 in.)

**Recommended Maintenance and Lubrication**
Periodic maintenance and lubrication should include all the tasks shown in Table 1. Recommended procedures for each of the listed tasks are provided in this section of the manual.

**WARNING**
Failure to properly maintain the equipment could result in death, serious injury or product failure, and can prevent successful functioning of connected apparatus.

Instructions should be carefully reviewed, understood, and followed.

The maintenance tasks in Table 1 must be performed regularly.
Maintenance

Table 1 — Maintenance Tasks

- Checks of the primary power path
  - Cleanliness check
  - Inspection of flexible connectors
- Checks of the stored energy operator mechanism
  - Maintenance and lubrication
  - Fastener check
  - Manual spring charging check
  - Contact erosion check
- Electrical control checks
  - Wiring and terminals check
  - Secondary disconnect check
  - Automatic spring charging check
  - Electrical close and trip check
- Vacuum integrity check
- High potential test
- Insulation test
- Contact resistance test
- Inspection and cleaning of circuit breaker insulation
- Functional tests

The list of tasks in Table 1 does not represent an exhaustive survey of maintenance steps necessary to ensure safe operation of the equipment. Particular applications may require further procedures. Should further information be desired or should particular problems arise which are not covered sufficiently for the Purchaser’s purposes, the matter should be referred to the local Siemens sales office.

DANGER

The use of unauthorized parts in the repair of the equipment, or tampering by unqualified personnel will result in dangerous conditions which will cause death, serious injury or equipment damage.

Follow all safety instructions contained herein.

Checks of the Primary Power Path

The primary power path consists of the three vacuum interrupters, the three upper and the three lower primary disconnects. These components are checked for cleanliness and condition. The vacuum interrupters are also checked for vacuum integrity.

Some test engineers prefer to perform the contact erosion check during the manual spring charging check of the operator, since charging of the springs is necessary to place the contacts in the closed position.

Also, the vacuum integrity check is usually performed in conjunction with the High Potential tests.

These instructions follow the recommendation that these tests (contact erosion/manual spring charging check, and vacuum integrity/high potential tests) will be combined as described.

Cleanliness Check

Figure 2 is a side view of the circuit breaker with the insulating barriers removed (if furnished) to show the vacuum interrupter, and the upper and lower connection pad.

All of these components must be clean and free of dirt or any foreign objects. Use a dry lint-free cloth. For stubborn dirt, use a clean cloth saturated with denatured alcohol (except for the vacuum interrupters). For stubborn dirt on a vacuum interrupter use a damp cloth and then thoroughly dry it using a dry lint-free cloth.

Inspection of Flexible Connectors

Inspect the flexible connectors that connect the bottom movable contacts of the vacuum interrupters to the lower connection pad for tightness and absence of mechanical damage, burning, or pitting.

Checks of the Stored Energy Operator Mechanism

The stored energy operator checks are divided into mechanical and electrical checks for simplicity and better organization. This first series of checks determine if the basic mechanism is clean, lubricated and operates smoothly without control power. The contact erosion check of the vacuum interrupter is also performed during these tasks.

Maintenance and Lubrication

Table 2 — Maintenance and Lubrication Intervals (ANSI C37.06) Usual Service Conditions Maintenance Based Upon Number of Circuit Breaker Closing Operations.

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Number of Years/Closing Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 kV 36kA (250MVA)</td>
<td>10 years/10,000 operations</td>
</tr>
<tr>
<td>15 kV 23kA (500MVA)</td>
<td>10 years/10,000 operations (See Note)</td>
</tr>
<tr>
<td>All Others</td>
<td>10 years/10,000 operations (See Note)</td>
</tr>
</tbody>
</table>

Note: For circuit breaker ratings other than 5kV - 250MVA and 15kV - 500MVA overhaul is required at 10,000 operations — reference Overhaul Section.

The vacuum interrupter operator mechanism is shown in Figure 15 with the front cover removed to show construction details. Both the opening spring and the closing spring are shown. The movable end of the closing spring is connected to a crank arm. The movable end of the opening spring is connected to the jack shaft by a pull rod.

Clean all components for evidence of excessive wear. Place special attention upon the closing spring crank and the insulating couplers and linkages.

Lubricate all non-electrical moving or sliding surfaces with a light coat of synthetic grease or oil. Lubricants composed of ester oils and lithium thickeners will be compatible.

Shell (drawn cup) needle bearings:


Pivots, sliding, and/or rolling surfaces and general lubrication:

Anderol 732 or Klueber Isoflex

Klueber Isoflex, Anderol 732 or Beacon #325

Figure 15. Operator Lubrication Points
**Fastener Check**
Inspect all fasteners for tightness. Both lock-nuts and retaining rings are used. Replace any fasteners that appear to have been frequently removed and replaced.

**Manual Spring Charging and Contact Erosion Checks**
Perform the Manual Spring Charging Check contained in the section describing the Installation Check and Initial Functional Tests. The key steps of this procedure are repeated here:

1. Insert the hand charging crank into the manual charge socket at the front of the operator control panel. Turn the crank clockwise (about 45 revolutions) to charge the closing spring. Continue cranking until the Charged flag appears in the window of the spring indicator.

2. Press the Close (black) pushbutton. The contact position indicator on the operator control panel should indicate that the circuit breaker contacts are Closed.

3. Perform the contact erosion check. Contact erosion occurs when high fault currents are interrupted or when the vacuum interrupter is nearing the limit of its contact life. Determination of acceptable contact condition is checked by the visibility of the white contact erosion mark shown in Figure 16. The white contact erosion mark is located on the movable stem of the vacuum interrupter, near the plastic guide bushing.

The contact erosion check procedure is:
- a. Be sure the circuit breaker primary contacts are Closed.
- b. Observe the white contact erosion mark (Figure 16) of each pole. When any part of the white contact erosion mark is visible, contact wear is within acceptable limits.

4. Press the red Open pushbutton after completing the contact erosion check. Visually verify the Discharge condition of the closing spring and that the circuit breaker contacts are Open.

5. Press the black Close pushbutton. Nothing should happen. The manual spring check should demonstrate smooth operation of the operating mechanism.


Electrical Control Checks
The electrical controls of the circuit breaker should be checked during inspections to verify absence of any mechanical damage, and proper operation of the automatic spring charging and Close and Trip circuits.

Unless otherwise noted, all of these tests are performed without any control power applied to the circuit breaker.

Check of the Wiring and Terminals
1. Physically check all of the circuit breaker wiring for evidence of abrasion, cuts, burning or mechanical damage.

2. Check all terminals to be certain they are solidly attached to their respective device.

WARNING
Hazardous voltages and high-speed mechanical parts.
Will cause death, severe personal injury, or property damage.
De-energize before working on this equipment.

Read instruction manuals, observe safety instructions and limit use to qualified personnel.

Automatic Spring Charging Check (Control Power Required)
Repeat the automatic spring charging check described in the section entitled Installation Checks and Initial Functional Tests.

<table>
<thead>
<tr>
<th>Rated Max. Voltage</th>
<th>Interrupting Class</th>
<th>Rated Current</th>
<th>Curve Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.76kV 250MVA</td>
<td>36kA</td>
<td>A</td>
<td>3</td>
</tr>
<tr>
<td>4.76kV 350MVA</td>
<td>49kA</td>
<td>C</td>
<td>10</td>
</tr>
<tr>
<td>8.25kV 500MVA</td>
<td>41kA</td>
<td>C</td>
<td>8</td>
</tr>
<tr>
<td>15kV 500MVA</td>
<td>23kA</td>
<td>B</td>
<td>4</td>
</tr>
<tr>
<td>15kV 750MVA</td>
<td>36kA</td>
<td>A</td>
<td>3</td>
</tr>
<tr>
<td>15kV 1000MVA</td>
<td>48kA</td>
<td>C</td>
<td>9</td>
</tr>
<tr>
<td>38kV 1500MVA</td>
<td>35kA</td>
<td>D</td>
<td>13</td>
</tr>
<tr>
<td>4.76kV</td>
<td>31.5kA</td>
<td>B</td>
<td>6</td>
</tr>
<tr>
<td>4.76kV</td>
<td>40kA</td>
<td>C</td>
<td>7</td>
</tr>
<tr>
<td>4.76kV</td>
<td>50kA</td>
<td>C</td>
<td>11</td>
</tr>
<tr>
<td>8.25kV</td>
<td>40kA</td>
<td>C</td>
<td>7</td>
</tr>
<tr>
<td>15kV 20kA</td>
<td>20kA</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>15kV 25kA</td>
<td>25kA</td>
<td>B</td>
<td>5</td>
</tr>
<tr>
<td>15kV 31.5kA</td>
<td>31.5kA</td>
<td>B</td>
<td>6</td>
</tr>
<tr>
<td>15kV 40kA</td>
<td>40kA</td>
<td>C</td>
<td>7</td>
</tr>
<tr>
<td>15kV 50kA</td>
<td>50kA</td>
<td>C</td>
<td>11</td>
</tr>
<tr>
<td>38kV 31.5kA</td>
<td>31.5kA</td>
<td>D</td>
<td>12</td>
</tr>
</tbody>
</table>

Primary tasks of this check are:
1. The circuit breaker is energized with control power for this check.
2. Energize the control power source.
3. When control power is connected to the circuit breaker, the closing spring should automatically charge. Visually verify that the closing spring is charged.

Note: A temporary source of control power and test leads may be required if the control power source has not been connected to the switchgear. When control power is connected to the circuit breaker, the closing spring should automatically charge.
Figure 17. Typical Vacuum Interrupter Contact Life Curves
Maintenance

Electrical Close and Trip Check (Control Power Required)
A check of the circuit breaker control circuits shall be performed. This check is made with the circuit breaker energized by control power either from the switchgear or an external control power source.

1. Once the circuit breaker springs are charged, move the switchgear Close/Trip switch to the Close position. Verify by both the sound of the circuit breaker closing and by the main contact status indicator that the circuit breaker contacts are closed.

2. As soon as the circuit breaker has closed, the automatic spring charging process is repeated.

3. After a satisfactory close operation is verified, move the switchgear Close/Trip switch to the Trip position. Verify by both the sound of the circuit breaker opening and by the main contact status indicator that the circuit breaker contacts are open.

4. After a satisfactory open operation is verified, hold the circuit breaker manual Trip button and apply and maintain an electrical close signal. The circuit breaker should close, immediately trip, the close spring should charge, and the circuit breaker should not attempt to close.

Completion of these checks demonstrates satisfactory operation of auxiliary switches, internal relays and open and close coils.

Checks of the Spring Charging Motor (88)
No additional checks of the spring charging motor are necessary.

Vacuum Interrupters
The life expectancy of vacuum interrupters is a function of the number of interruptions and magnitude of current interrupted (Table 3 and Figure 17).

They must also be replaced before certain amount of mechanical operations (Table 2) or when the contacts have been eroded beyond allowed limits. Vacuum interrupter replacement procedures are detailed in the following maintenance instructions.

The vacuum interrupter contact life curves Figure 17 are offered as a guide to life expectancy.

Vacuum Integrity Check
(using Mechanical Test) (Figure 18)
Before putting the circuit breaker into service, or if a vacuum interrupter is suspected of leaking as a result of mechanical damage, check the vacuum either mechanically as described in this section or alternatively electrically using a high potential test set as described in the next section.

Open and isolate the circuit breaker and detach the insulating coupler (48) from lever (48.6) (Figure 18).

The atmospheric pressure will force the moving contact of a hermetically sealed vacuum interrupter into the “Closed” position, causing lever (48.6) to move into the position shown in Figure 18.

A vacuum interrupter may be assumed to be intact if it shows the following characteristics:

An appreciable closing force has to be overcome when lever (48.6) is moved to the “Open” position by hand (Figure 18). When the lever is released, it must automatically return to the “Closed” position with an audible sound as the contacts touch.

After checking the vacuum, reconnect the lever (48.6) to the insulating coupler (48) (Figure 18).

High-Potential Tests
The next series of tests (Vacuum Integrity Test and Insulation Tests) involve use of high voltage test equipment. The circuit breaker under test should be inside a suitable test barrier equipped with warning lights.

Vacuum Integrity Check (using Dielectric Test)
A high potential test is used to verify the vacuum integrity of the circuit breaker. The test is conducted on the circuit breaker with its primary contacts in the Open position.

| Hazardous voltages used in high potential tests. |
| Will cause severe personal injury and death. |
Follow safe procedures, exclude unnecessary personnel and use safety barriers. Keep away from the circuit breaker during application of test voltages.

Disconnect the plug jumper from between the circuit breaker and switchgear before conducting high potential tests.

After test completion, ground both ends and the middle portion of the vacuum interrupter to dissipate any static charges.

WARNING
Vacuum interrupters may emit X-ray radiation. Can cause personal injury.
Keep personnel more than six (6) feet away from a circuit breaker under test.

High Potential Test Voltages
The voltages for high potential tests are shown in Table 4.

<p>| Table 4. High Potential Test Voltages |</p>
<table>
<thead>
<tr>
<th>Equipment kV Rating</th>
<th>Max AC rms</th>
<th>Max DC Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.76kV</td>
<td>14kV</td>
<td>20kV</td>
</tr>
<tr>
<td>8.25kV</td>
<td>27kV</td>
<td>38kV</td>
</tr>
<tr>
<td>15kV</td>
<td>27kV</td>
<td>38kV</td>
</tr>
<tr>
<td>38kV</td>
<td>60kV</td>
<td>85kV</td>
</tr>
</tbody>
</table>
Note: Do not use DC high potential testers incorporating half-wave rectification. These devices produce high peak voltages. These high voltages will produce X-ray radiation. These devices also show erroneous readings of leakage current when testing vacuum circuit breakers.

Vacuum Integrity Test Procedure

1. Observe safety precautions listed in the danger and warning advisories. Construct the proper barrier and warning light system.

2. Ground each pole not under test.

3. Apply test voltage across each pole for one minute (Circuit Breaker open).

4. If the pole sustains the test voltage for that period, its vacuum integrity has been verified.

As-Found Insulation and Contact Resistance Tests

As-Found tests verify the integrity of the circuit breaker insulation system. Megger or insulation resistance tests conducted on equipment prior to installation provide a basis of future comparison to detect changes in the protection afforded by the insulation system. A permanent record of periodic As-Found tests enables the maintenance organization to determine when corrective actions are required by watching for significant deterioration in insulation resistance, or increases in contact resistance.

Insulation and Contact Resistance Test Equipment

In addition to the High Potential Test Equipment capable of test voltages as listed in Table 4, the following equipment is also required:

- AC High Potential tester with test voltage of 1500 volts, 60 Hz
- Test equipment for contact resistance tests.
Insulation and Contact Resistance Test Procedure

1. Observe safety precaution listed in the danger and caution advisories for the Vacuum Integrity Check tests.

2. Close the circuit breaker. Ground each pole not under test. Use manual charging, closing and tripping procedures.

3. Apply the proper AC or DC (Table 4) high potential test voltage between a primary conductor of the pole and ground for one minute.

4. If no disruptive discharge occurs, the insulation system is satisfactory.

5. After test, ground both ends and the middle of the bottle to dissipate and static charge.

6. The spring changing motor may be tested with the secondary control wiring (at the same voltage) without disconnecting per step 7 below.

7. To test secondary wiring and the spring charging motor. Ground the circuit breaker housing. Either:
   1. Connect all the secondary disconnects with a shorting wire, connect the shorting wire to the high potential lead of the voltage tester, starting with zero volts gradually increase the test voltage to 1500 volts rms, 60 Hz, and maintain test voltage for one minute, or,
   2. Apply 1800 volts rms, 60 Hz to each secondary disconnect point for 1 second.

8. If no disruptive discharge occurs, the secondary control insulation level is satisfactory.

9. Disconnect the shorting wire and re-attach the leads to the spring charging motor.

10. Perform contact resistance tests of the primary contacts. The resistance should be read between the lower and upper connection pads (Figure 18). Contact resistance should not exceed the values listed in Table 5.

Table 5. Maximum Contact Resistance

<table>
<thead>
<tr>
<th>Current Rating (Amps)</th>
<th>Contact Resistance (Micro-Ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200</td>
<td>35</td>
</tr>
<tr>
<td>2000</td>
<td>30</td>
</tr>
<tr>
<td>3000</td>
<td>30</td>
</tr>
</tbody>
</table>

Inspection and Cleaning of Circuit Breaker Insulation

1. Perform the Spring Discharge Check on the circuit breaker after all control power is removed. The Spring Discharge Check consists of 1) pressing the red Open pushbutton, 2) then pressing the black Close pushbutton, and 3) again pressing the red Open pushbutton. All of these controls are on the circuit breaker front panel (Figure 1). Visually verify the Discharge condition of the springs.

2. Remove any interphase and outerphase barriers if furnished (applicable for certain types only).

3. Clean barriers and post insulators using clean cloth and one of the following solvents:
   - Isopropyl or isobutyl alcohol

4. Replace all barriers. Check all visible fasteners again for condition and tightness.

Note: Do not use any cleaning compounds containing chlorinated hydrocarbons such as trichlorethylene, perchlorethylene or carbon tetrachloride. These compounds will damage the phenylene ether copolymer material used in the barriers and other insulation on the circuit breaker.

Functional Tests

Refer to the Installation Checklist in the Installation Checks and Initial Functional Tests section of this manual. Functional tests consist of performing at least three (3) Manual Spring Charging Checks and three (3) Automatic Spring Charging Checks. After these tests are complete, and the springs are fully discharged, all fasteners and connections are checked again for tightness and condition.
Overhaul

Introduction
For following procedures along with the troubleshooting charts at the end of this section, provide maintenance personnel with a guide to identifying and correcting possible malfunctions of the circuit breaker.

WARNING
Hazardous voltages and high speed moving parts.
Can cause death, severe personal injury, or property damage.
De-energize circuit breaker and discharge springs before working on circuit breaker.
Read instruction manual.

Circuit Breaker Overhaul

Table 6 lists the recommended overhaul schedule for 3AH circuit breakers operating under ANSI usual conditions. When actual operating conditions are more severe, overhaul periods should occur more frequently. The counter on the front panel of the circuit breaker records the number of operations.

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Number of Closing Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 kV 36kA (250MVA)</td>
<td>30,000</td>
</tr>
<tr>
<td>15 kV 23kA (500MVA)</td>
<td></td>
</tr>
<tr>
<td>All Others All Others</td>
<td>10,000</td>
</tr>
</tbody>
</table>

Table 6. Overhaul Schedule
ANSI Usual Conditions

Maintenance Based Upon Number of Closing Operations

Replacement at Overhaul
The following components are replaced during an overhaul of the circuit breaker, when required:
- Vacuum interrupters as determined by vacuum integrity test, contact erosion, or according to Overhaul Schedule - reference Table 6.
- Close Coil, 52SRC
- Trip Coil, 52T
- Trip Free Drive Bar Mechanism

When these parts are changed, locking devices must also be removed and replaced. These include lock washers, retaining rings, retaining clips, spring pins, cotter pins, etc.

1. Replace Vacuum Interrupter; instructions follow.

2. Close Coil (52SRC) and Trip Coil (52T).
   a. Remove two “push on” terminal connections
   b. Remove two M4 hex head screws and coils.
   c. Install replacement coils with new M4 x 10 hex head screws (Siemens part # 00-000-443-820) and new lock washers for M4 (Siemens part # 00-000-288-316).
   d. The coil mounting screws must be installed using thread locking adhesive (Loctite #222, Siemens part 15-133-281-007) and primer (Loctite primer T, Siemens part 15-133-281-005).
   e. Connect wires to coils with new wire terminals (Siemens part # 15-171-600-002)

3. Lubricate operating mechanism according to Maintenance Section.

4. When work is finished operate circuit breaker, close open, several times, and check that all screw connections are tight.

Replacement of Vacuum Interrupters
Replacement vacuum interrupters are furnished as a complete assembly. They have been completely tested and dielectrically and mechanically conditioned.

For 3000A circuit breaker with flexible current shunts which are electron-beam welded to the vacuum interrupters, the vacuum interrupters are not field replaceable. Contact the nearest Siemens representative.

It is recommended that one vacuum interrupter be removed and replaced completely rather than removing two or more vacuum interrupters at a time. The following procedure in checklist format describes the procedure for removing and replacing a vacuum interrupter. Components may be identified by reference to Figures 19 and 20.

1. Removing the Vacuum Interrupter

   Note: Special care needs to be exercised in removal or installation of hardware around the bottom, or movable contact end, of the vacuum interrupter.

   The movable contact uses metal bellows to maintain the vacuum seal while still permitting up and down motion of the contact. These bellows are rugged and reliable, and are designed to withstand years of vertical movement. However, care should be exercised to avoid subjecting the bellows to excessive torque during removal and replacement. Twisting the bellows through careless bolt removal or tightening may damage the vacuum interrupter.

   1.1 Before starting work, the circuit breaker should be isolated from all primary and control power sources and all stored energy discharged by opening, closing, and opening the circuit breaker by hand. Discharge any static charge by grounding all and center metal sections of the vacuum interrupter. Carefully remove exterior and interphase barriers.

   1.2 Loosen the lateral bolt(s) on terminal clamp (29.2). Refer to Figure 20 and employ the illustrated procedure to loosen clamp hardware.
Figure 19. Vacuum Interrupter Replacement Illustration

16.1 Post insulator  29.1 Flexible connector  40 Pole bottom
20 Pole head  29.2 Terminal clamp  48 Insulating coupler
27 Upper connection pad  30 Vacuum interrupter  48.5 Pin
28 Strut  31.2 Bolt assembly  48.6 Lever
28.1 Centering ring  36.1 Moving contact  48.6.5 Rod end
29 Lower connection pad  36.3 Eye bolt  48.9 Drive link
Overhaul

1.3 Withdraw pin (48.5) from insulating coupler (48) and levers (48.6).

1.4 Remove coupling pin from the eye bolt (36.3)

1.5 Free struts (28) from the pole head (20). Loosen the strut hardware on the pole bottom (40) and swing the struts forward and downward.

1.6 Loosen screws fastening the centering ring (28.1).

1.7 Remove bolt (31.2), lockwasher and large washer at stationary contact of the vacuum interrupter.

1.8 Using a deep socket, loosen and remove hex cap-screw fastening the pole head to the post insulator. Completely remove the pole head and set aside.

1.9 Grasp the vacuum interrupter (30) and withdraw vertically. Assistance may be required to work the terminal clamp off the movable stem of the vacuum interrupter. **FORCIBLE TWISTING EFFORT IS NOT ALLOWED.** If the terminal clamp (29.2) cannot be easily removed, STOP!, check to be certain hardware is loose, and that the terminal clamp (29.2) is not binding.

2. Installing a Vacuum Interrupter

- **NOTE:** Replacement vacuum interrupter (30) will be received from the factory with an eyebolt (36.3) in place, adjusted and torqued to specific requirements. **DO NOT ALTER THE ADAPTER SETTING.**

2.1 Inspect all silver plated connection surfaces for cleanliness. Clean only with a cloth and solvent. Do not abrade.

2.2 Insert vacuum interrupter (30) into the lower pole support (40). Slip terminal clamp (29.2) into position on the movable stem.

2.3 Align vacuum interrupter and fasten “finger tight” using heavy flat washer, lock washer and bolt, (31.2).

---

**Figure 20. Technique for Tightening Vacuum Interrupter Terminal Clamp Hardware**
2.4 Fasten the pole head to the post insulator (16.1) “finger tight” using hex head bolt, lock washer and flat washer.

2.5 Attach struts (28) to the upper pole support (20), replace hardware (M10), but do not tighten at this time.

2.6 Couple levers (48.6) and drive link (48.9) to the eye-bolt (36.3), using the pin supplied. Apply retaining clips. Appropriate pin is modestly chamfered, not to be confused with pin for the insulating coupler.

2.7 Raise the terminal clamp (29.2) against the step or the spacer (if applicable) of the moving contact (36.1) of the vacuum interrupter (30) so that the radius of the movable contact faces the connecting surface of the flexible connector (29.1). Refer to Figure 20 and employ technique illustrated to fasten terminal clamp. Note opposing wrenches. Tighten the bolt(s) of the terminal clamp to a torque of 40 Nm (30 ft. lbs.), taking care to see that the terminal of the vacuum interrupter is not subjected to excessive bending movement.

3. Checking the Contact Stroke

3.1 Open the circuit breaker.

3.2 Free insulating coupler (48) by removing pin (48.5). The vacuum interrupter contacts must now close automatically as a consequence of atmospheric pressure.

3.3 Observe the terminal clamp (29.2) through the openings on each side of the pole bottom (40). Using vernier calipers (automatic circuit breaker test equipment preferable) measure the distance from the bottom surface of the terminal clamp to the bottom edge of the cutout opening. Measure carefully and record your result.

3.4 Connect the insulating coupler (48) using pin (48.5) and the retaining clips provided.

3.5 Repeat the measurement described in step 3.3 again with care to maximize accuracy. Record your result.

3.6 Determine difference between the measurements made under steps 3.3 and 3.5. Your results should be per Table 7.

3.7 If you fail to achieve the listed results, carefully repeat the entire procedure making certain of your measurements.

3.8 Loosen eyebolt locking nut on insulating coupler (48), and retain position of the eye. Make adjustments in one-half turn increments. After adjustment is completed, tighten eyebolt locking nut to 26-34 ft-lb. (35-45 Nm).

4. After eyebolt is tightened to proper torque, repeat all measurement procedures, making certain they are in agreement with values indicated in 3.6.

5. Complete all other maintenance procedures. Completely reassembled circuit breaker should pass high potential test before it is ready for service.

Hydraulic Shock Absorber

The mechanism is equipped with a hydraulic shock absorber that functions when the circuit breaker opens. See item 61.8 (Figure 6a). The shock absorber should require no adjustment. However, at maintenance checks, the shock absorber should be examined for evidence of leaking. If evidence of fluid leakage is found, the shock absorber must be replaced to prevent damage to the vacuum interrupter bellows.
Table 7. Vacuum Interrupter Stroke

<table>
<thead>
<tr>
<th>Voltage (Max kV)</th>
<th>MVA Rating</th>
<th>Vacuum Interrupter Type (2)</th>
<th>Stroke (1), (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.76 kV</td>
<td>250 MVA</td>
<td>VS17006</td>
<td>7 - 9 mm</td>
</tr>
<tr>
<td>4.76 kV</td>
<td>350 MVA</td>
<td>VS15052</td>
<td>8.4 - 9.2 mm</td>
</tr>
<tr>
<td>8.25 kV</td>
<td>500 MVA</td>
<td>VS15052</td>
<td>8.4 - 9.2 mm</td>
</tr>
<tr>
<td>15 kV</td>
<td>500 MVA</td>
<td>VS17006</td>
<td>7 - 9 mm</td>
</tr>
<tr>
<td>15 kV</td>
<td>750 MVA</td>
<td>VS15052</td>
<td>8.4 - 9.2 mm</td>
</tr>
<tr>
<td>15 kV</td>
<td>1000 MVA</td>
<td>VS15052</td>
<td>8.4 - 9.2 mm</td>
</tr>
<tr>
<td>38 kV</td>
<td>1500 MVA</td>
<td>VS30030</td>
<td>18 - 22 mm</td>
</tr>
</tbody>
</table>

Notes:
1. Stroke settings are applicable to both 1200A and 2000A continuous current rated circuit breakers.
2. The vacuum interrupter type designation is labeled on the vacuum interrupter. If vacuum interrupter does not match rating, contact the nearest Siemens representative.
3. If you need assistance achieving adjustments, contact the nearest Siemens representative.
## Table 8. Troubleshooting

<table>
<thead>
<tr>
<th>Problem</th>
<th>Symptoms</th>
<th>Possible Causes and Remedies</th>
</tr>
</thead>
</table>
| Circuit breaker fails to close | Closing spring will not automatically charge | 1. Secondary control circuit is de-energized or control circuit fuses are blown. Check and energize or replace if necessary.  
2. Secondary disconnect contacts A1 or D16 are not engaging. Check and replace if required.  
3. Damage to wiring, terminals or connectors. Check and repair as necessary.  
4. Failure of charging motor (88). Replace if required.  
5. Motor cut-off switch LS21 or LS22 fails to operate. Replace if necessary.  
6. Mechanical failure of operating mechanism. Refer to factory or authorized service shop. |
| Closing springs charge, but circuit-breaker does not close | • Close coil, (52SRC) fails to energize. No sound of circuit breaker closing. | 1. Secondary control circuit de-energized or control circuit fuses blown. Correct as indicated.  
2. No closing signal to secondary disconnect pin A2. Check for continuity and correct relay logic.  
3. Secondary disconnect contacts 13 or 15 are not engaging. Check and correct as required.  
4. Failure of anti-pump relay (52Y) contacts 21-22 or 31-32 or 13-14. Check and replace as required.  
5. Failure of close coil (52SRC). Check and replace as required.  
6. Auxiliary switch 52a/b NC contacts 41-42 are open when circuitbreaker contacts are open. Check linkage and switch. Replace or adjust as necessary.  
7. Spring charged switch LS9 NO contacts remains open after springs are charged. Check and replace as required. |
<p>| • Close coil energizes. Sound of circuit breaker closing is heard, but circuit breaker contacts do not close. | | 1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop. |</p>
<table>
<thead>
<tr>
<th>Problem</th>
<th>Symptoms</th>
<th>Possible Causes and Remedies</th>
</tr>
</thead>
</table>
| Nuisance or false close | Electrical problem                            | 1. Nuisance or false closing signal to secondary disconnect contact A2. Check relay logic. Correct as required.  
2. Close coil (52SRC) terminal A2 is shorted to ground. Check to determine if problems in wiring or coil. Correct as required. |
|                         |                                               | Mechanical Problem                                                                           |
|                         |                                               | 1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop. |
| Circuit breaker will not trip | Trip coil, (52T) does not energize. There is no tripping sound. | 1. Secondary control power is de-energized or control power fuses are blown. Correct as indicated.  
2. Damage to wiring, terminals or connectors. Check and repair as necessary.  
3. No tripping signal to secondary disconnect contact C2. Check for continuity and correct relay logic.  
4. Secondary disconnect contacts C2 or D2 are not engaging. Check and replace if required.  
5. Failure of trip coil (52T). Check and replace if necessary.  
6. Auxiliary switch 52a/b NO contacts 23-24 or 33-34 are open when circuit breaker is closed. Check linkage and switch. Replace or adjust as necessary. |
|                         |                                               | Trip coil (52T) energizes. No tripping sound is heard, and circuit breaker contacts do not open (i.e., they remain closed). |
|                         |                                               | 1. Failure of opening spring or its mechanical linkage. Check and replace if required. |
|                         |                                               | Trip coil (52T) energizes. Tripping sound is heard, but circuit breaker contacts do not open. |
|                         |                                               | 1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.  
2. One or more of the vacuum interrupters are held closed. Check and replace as necessary. |
| Nuisance or false trip  | Electrical problem                            | 1. Tripping signal remains energized on secondary disconnect contact C2. Check for improper relay logic. |
|                         |                                               | Mechanical problem                                                                           |
|                         |                                               | 1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop. |
Table A-1a
Type 3AH Circuit Breaker Ratings (Historic “Constant MVA” Rating Basis)

These ratings are in accordance with the following standards:

| ANSI C37.04-1979 | Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis |
| ANSI C37.06-1987 | AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities |
| ANSI C37.09-1979 | Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis |
| ANSI C37.010-1979 | Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis |

<table>
<thead>
<tr>
<th>Measured Parameter</th>
<th>Units</th>
<th>Circuit Breaker Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>5-3AH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>250</td>
</tr>
<tr>
<td>Nominal Voltage Class</td>
<td>kV</td>
<td>4.16</td>
</tr>
<tr>
<td>Nominal 3-Phase MVA Class</td>
<td>MVA</td>
<td>250</td>
</tr>
<tr>
<td>Maximum Design Voltage (V)</td>
<td>kV rms</td>
<td>4.76</td>
</tr>
<tr>
<td>Voltage Range Factor (K)</td>
<td>——</td>
<td>1.24</td>
</tr>
<tr>
<td>Withstand Voltage Levels</td>
<td>Power Frequency</td>
<td>19</td>
</tr>
<tr>
<td>Lightning Impulse (BIL)</td>
<td>kV crest</td>
<td>60</td>
</tr>
<tr>
<td>Continuous</td>
<td>A rms</td>
<td>1200</td>
</tr>
<tr>
<td>Short-Circuit (at rated maximum design voltage)</td>
<td>kA rms-sym</td>
<td>29</td>
</tr>
<tr>
<td>Interrupting Time</td>
<td>Cycles</td>
<td>5</td>
</tr>
<tr>
<td>Permissible Tripping Delay (Y)</td>
<td>Sec</td>
<td>2</td>
</tr>
<tr>
<td>Rated Maximum Design Voltage (V) divided by K (V/K)</td>
<td>kV</td>
<td>3.85</td>
</tr>
<tr>
<td>Max. Sym Interrupting (K x I)</td>
<td>kA rms-sym</td>
<td>36</td>
</tr>
<tr>
<td>Short-Time Current (K x I) (3 seconds)</td>
<td>kA</td>
<td>36</td>
</tr>
<tr>
<td>Asymmetrical (1.6 x K x I)</td>
<td>kA rms</td>
<td>58</td>
</tr>
<tr>
<td>Peak (2.7 x K x I)</td>
<td>kA peak</td>
<td>97</td>
</tr>
</tbody>
</table>

Footnotes
1. High close and latch (momentary) rating available for special application
2. Maximum voltage for which the circuit breaker is designed, and the upper limit for operation.
3. K is the ratio of the rated maximum design voltage to the lower limit of the range of operating voltage in which the required symmetrical and asymmetrical interrupting capabilities vary in inverse proportion to the operating voltage.
4. To obtain the required symmetrical interrupting capability of a circuit breaker at an operating voltage between 1/K times rated maximum design voltage and rated maximum design voltage, the following formula shall be used: Required Symmetrical Interrupting Capability = Rated Short-Circuit Current (I x K) / Operating Voltage
   For operating voltages below 1/K times rated maximum design voltage, the required symmetrical interrupting capability of the circuit breaker shall be equal to K times rated short-circuit current.
5. Within the limitations stated in ANSI C37.04-1979, all values apply to polyphase and line-to-line faults. For single phase-to-ground faults, the specific conditions stated in clause 5.10.2.3 of ANSI C37.04-1979 apply.
6. Current values in this row are not to be exceeded even for operating voltage below 1/K times rated maximum design voltage. For operating voltages between rated maximum design voltage and 1/K times rated maximum design voltage, follow footnote 5 above.
7. Current values in this row are independent of operating voltage up to and including rated maximum design voltage.
8. “Nominal 3-Phase MVA Class” is included for reference only - this information is not listed in ANSI C37.06-1987.
9. Standard duty cycle is CO - 15sec - CO
Appendix

Table A-1b
Type 3AH Circuit Breaker Ratings (New “Constant kA” Rating Basis)

<table>
<thead>
<tr>
<th>Rated Values</th>
<th>Units</th>
<th>Circuit Breaker Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Range Factor (K)</td>
<td>-- --</td>
<td>1.0</td>
</tr>
<tr>
<td>Withstand Voltage Levels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Frequency</td>
<td>kV rms</td>
<td>19</td>
</tr>
<tr>
<td>Lightning Impulse (BIL)</td>
<td>kV crest</td>
<td>60</td>
</tr>
<tr>
<td>Continuous</td>
<td>A rms</td>
<td></td>
</tr>
<tr>
<td>Short-Circuit (I)</td>
<td>kA rms-sym</td>
<td>31.5</td>
</tr>
<tr>
<td>Interrupting Time</td>
<td>ms</td>
<td>83</td>
</tr>
<tr>
<td>Permissible Tripping Delay (Y)</td>
<td>Sec</td>
<td>2</td>
</tr>
<tr>
<td>Max. Sym Interrupting (I)</td>
<td>kA rms-sym</td>
<td>31.5</td>
</tr>
<tr>
<td>% dc Component</td>
<td>%</td>
<td>47</td>
</tr>
<tr>
<td>Short-Time Current (I) (3 seconds)</td>
<td>kA rms</td>
<td>31.5</td>
</tr>
<tr>
<td>Closing &amp; Latching (Momentary) Asymmetrical (1.55 x I)</td>
<td>kA rms</td>
<td>49</td>
</tr>
<tr>
<td>Closing &amp; Latching (Momentary) Peak (2.6 x I)</td>
<td>kA peak</td>
<td>82</td>
</tr>
</tbody>
</table>

Footnotes
1. Maximum voltage for which the circuit breaker is designed, and the upper limit for operation.
2. K is listed for informational purposes only. For circuit breakers rated on a “kA basis”, the Voltage Range Factor is 1.0.
3. 3000FC indicates that fan cooling may be required in the switchgear structure to achieve this rating.
4. All values apply to polyphase and line-to-line faults.
5. Standard duty cycle is O - 0.3sec - CO - 15sec - CO.
### Table A-2
**Type 3AH Circuit Breaker Ratings**

<table>
<thead>
<tr>
<th>Control Voltages, ANSI C37.06</th>
<th>Spring Charging Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>Control Circuit Voltage</td>
</tr>
<tr>
<td></td>
<td>Close Coil Amperes *&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Close</td>
<td>Trip</td>
</tr>
<tr>
<td>24 VDC 19-28</td>
<td>14-28</td>
</tr>
<tr>
<td>48 VDC 36-56</td>
<td>28-56</td>
</tr>
<tr>
<td>125 VDC 100-140</td>
<td>70-140</td>
</tr>
<tr>
<td>250 VDC 220-280</td>
<td>140-280</td>
</tr>
<tr>
<td>120 VAC 104-127</td>
<td>104-127</td>
</tr>
<tr>
<td>240 VAC 208-254</td>
<td>208-254</td>
</tr>
</tbody>
</table>

1. Current at nominal voltage.
2. Capacitor trip.

### Table A-3
**Interrupting Capacity of Circuit Breaker Auxiliary Switch Contacts**

<table>
<thead>
<tr>
<th>Type of Circuit to Interrupt</th>
<th>Continuous Current Amperes</th>
<th>Control Circuit Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>120 VAC</td>
</tr>
<tr>
<td>Non-Inductive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inductive</td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>

1. 2 Contacts in series.

### Table A-4
**Circuit Breaker Weights**

<table>
<thead>
<tr>
<th>Maximum Voltage kV rms sym.</th>
<th>Interrupting Capability kA rms sym. (MVA)</th>
<th>Continuous Current, Amperes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1200 A</td>
</tr>
<tr>
<td>4.76</td>
<td>31.5 (250)</td>
<td>242 (110)</td>
</tr>
<tr>
<td>4.76</td>
<td>40 (350)</td>
<td>246 (112)</td>
</tr>
<tr>
<td>4.76</td>
<td>50</td>
<td>330 (150)</td>
</tr>
<tr>
<td>8.25</td>
<td>40 (500)</td>
<td>246 (112)</td>
</tr>
<tr>
<td>15.0</td>
<td>20 (500)</td>
<td>165 (75)</td>
</tr>
<tr>
<td>15.0</td>
<td>25</td>
<td>165 (75)</td>
</tr>
<tr>
<td>15.0</td>
<td>31.5 (750)</td>
<td>242 (110)</td>
</tr>
<tr>
<td>15.0</td>
<td>40 (1000)</td>
<td>246 (112)</td>
</tr>
<tr>
<td>15.0</td>
<td>50</td>
<td>330 (150)</td>
</tr>
<tr>
<td>38.0</td>
<td>31.5 (1500)</td>
<td>363 (165)</td>
</tr>
</tbody>
</table>

1. For shipping, add 100 lbs (45 kg).