PENNELEC CONEMAUGH SCRUBBER

901

IB 6.2.8.7-1C

Installation/Maintenance Instructions

Medium-Voltage Vacuum Power Circuit Breakers

Types 5VHK350 and 15VHK1000
1200 and 2000 amperes (Model 05 only)
and All 3000 amp VHK breakers

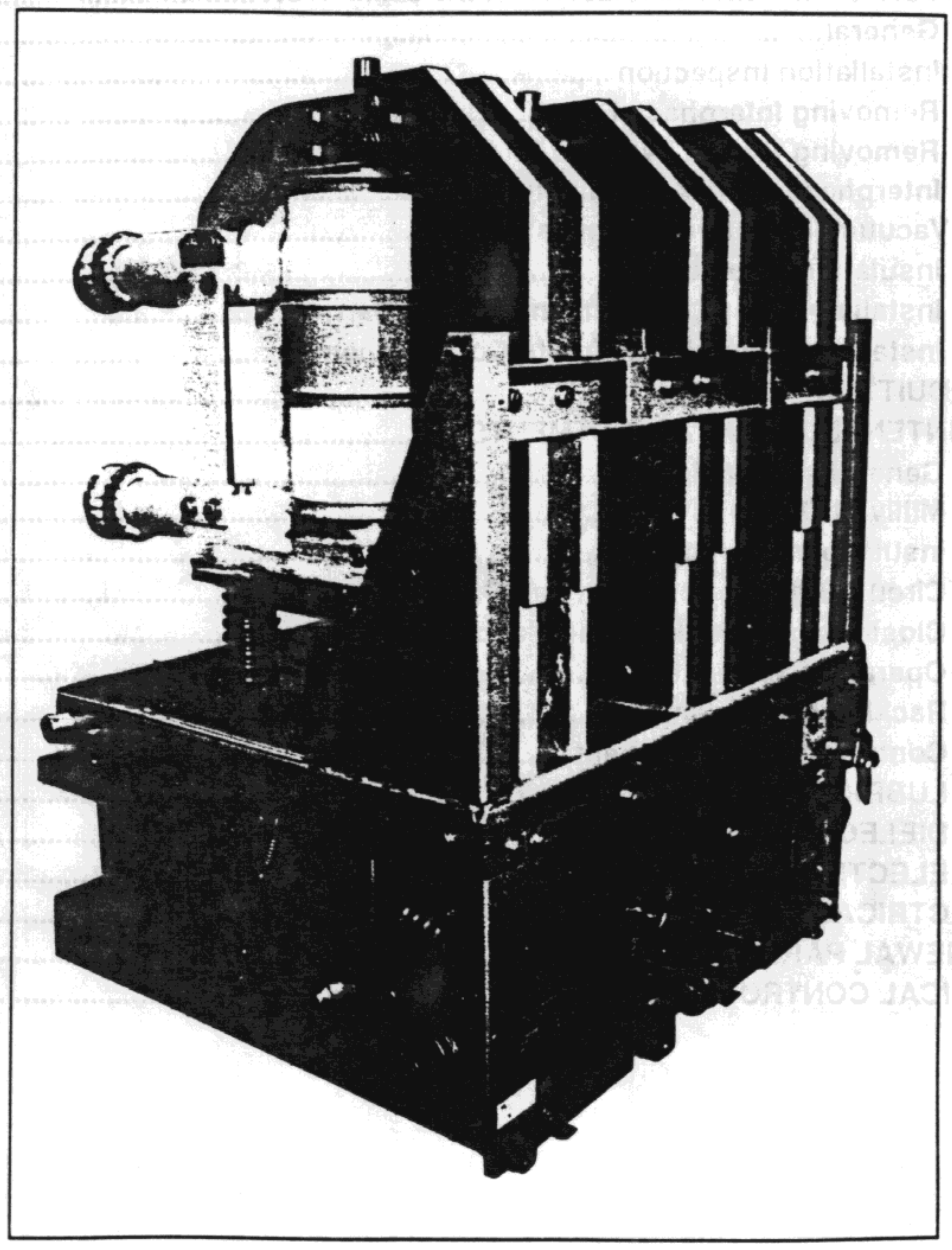


ABB Power Distribution, Inc.
Circuit Breaker Division

ABB
ASEA BROWN BOVERI

ASEA BROWN BOVERI

CONTENTS

INTRODUCTION

These instructions for installation, operation and maintenance of 15VHK1000 vacuum circuit breakers should be read carefully and used as a guide during installation and initial operation.

The specific ratings of each model circuit breaker are listed on the individual nameplates.

File these instructions in a readily accessible place together with drawings and descriptive data of the switchgear. These instructions should be used as a guide to proper maintenance of the equipment.

RECEIVING AND STORAGE

Immediately upon receipt of the circuit breakers, examine the cartons to determine if any damage or loss was sustained during transit. If injury or rough handling is evident, file a damage claim at once with the carrier and promptly notify the nearest ABB Office. The company is not responsible for damage of goods after delivery to the carrier, however, we will lend assistance if notified of claims.

Unpack the circuit breakers as soon as possible after receipt. If unpacking is delayed, difficulty may be experienced in making a claim for damages not evident upon receipt. Use care in unpacking in order to avoid damaging any of the circuit breaker parts. Check the contents of each carton against the packing list before discarding any packing material. If any shortage of material is discovered, promptly notify the nearest District Office. Information specifying the purchase order number and part numbers of the damaged or missing parts should accompany the claim.

Circuit breakers should be installed in their permanent location as soon as possible. If the breakers are not to be placed in service for some time, it is advisable to provide adequate means of protection. This may be done by keeping the breaker in its original shipping carton and storing in a warm, dry and uncontaminated atmosphere. If the circuit breaker cannot be stored properly as recommended it must be thoroughly checked before going into service to insure it has not absorbed moisture, rusted or become generally contaminated in any way.

CIRCUIT BREAKER INSTALLATION

General

Prior to initial installation of the circuit breaker into the switchboard, certain preliminary inspections should be made to insure proper operation. The inspection procedures for this are given in this section.

The circuit breaker is shipped with contacts closed, closing springs discharged and opening springs charged. If the circuit breaker is furnished with an undervoltage device, the device will be lockwired to allow closing of the breaker for shipment. A tag will identify the lock wire. To remove the wire, open the breaker and reach behind the control panel from the right hand side. Using wire cutters, cut and remove the tagged wire.

Referring to Fig. 1, if it is necessary to raise or move the breaker, attach a lifting yoke (5) at points (4) on both sides of the truck, or a fifth wheel at point (6) to transport the breaker as required.

Installation Inspection

Inspect condition of circuit breaker vacuum interrupters and electrical connections prior to installing the circuit breaker into the switchboard. Even though each circuit breaker is completely adjusted and tested at the factory, shipping and handling conditions could cause defects. The front cover and interphase barriers (2 & 3, Fig. 1) must be removed for access to and inspection of the vacuum interrupters, and their associated adjustments.

Removing Front Cover and Interphase Barrier (See Fig. 1)

The front cover can be removed after removing eight front cover screws (1). The interphase barriers can be removed by removing screw (7) from each barrier at the front and two sets of spacer bushings at the rear top and bottom of the barriers. The spacer bushings are retained by hairpin retainers (8) on each end of spacer bushing rods.

Interphase Barrier Examination

All barrier hardware should be securely tightened. There should be no through holes or apparent missing hardware on the barriers. Also, dust or dirt should be removed by wiping with a clean lintless cloth saturated with an oil-free solvent.

Vacuum Interrupter Examination (See Fig. 2)

ASEA BROWN BOVERI

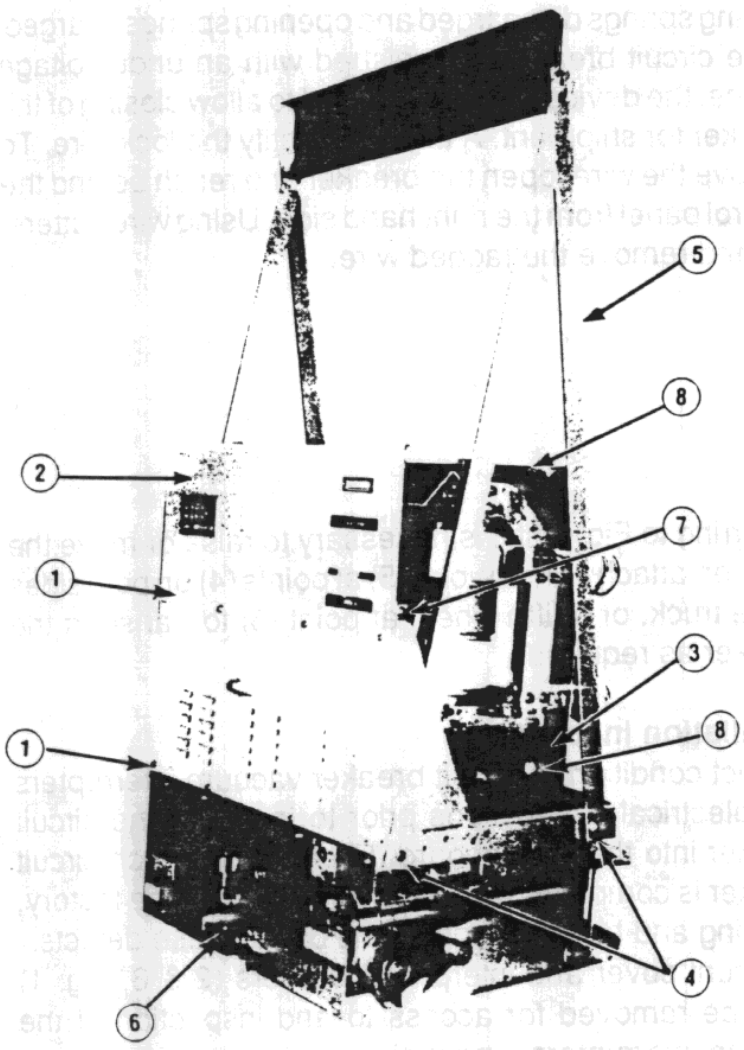


Fig. 1 — Circuit Breaker Assembly with Lifting Yoke Installed

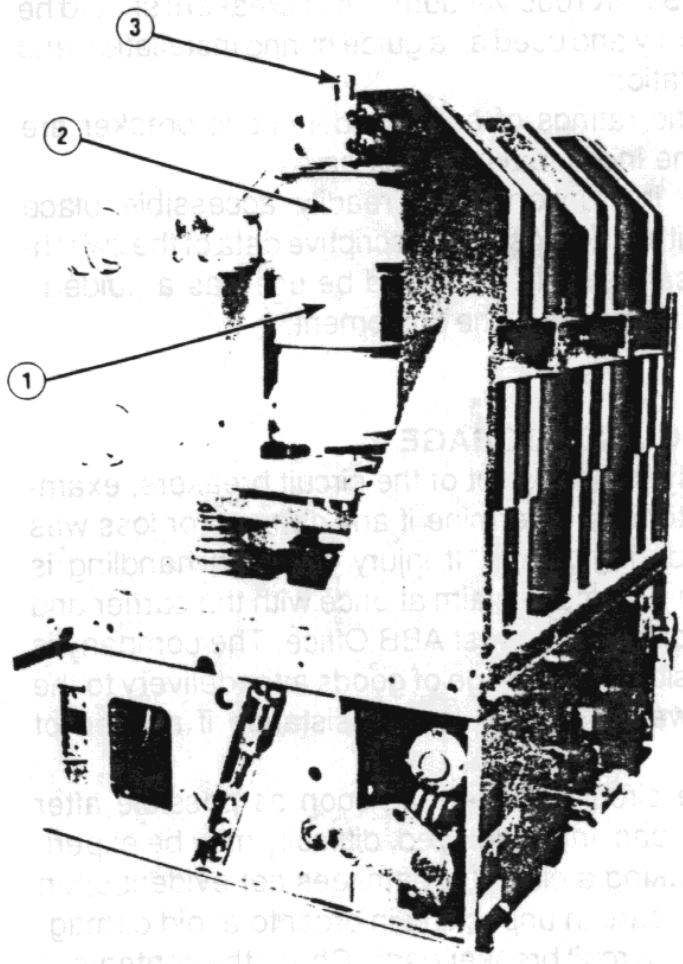


Fig. 2 — Circuit Breaker with Front Cover & Interphase Barrier Assembly Removed

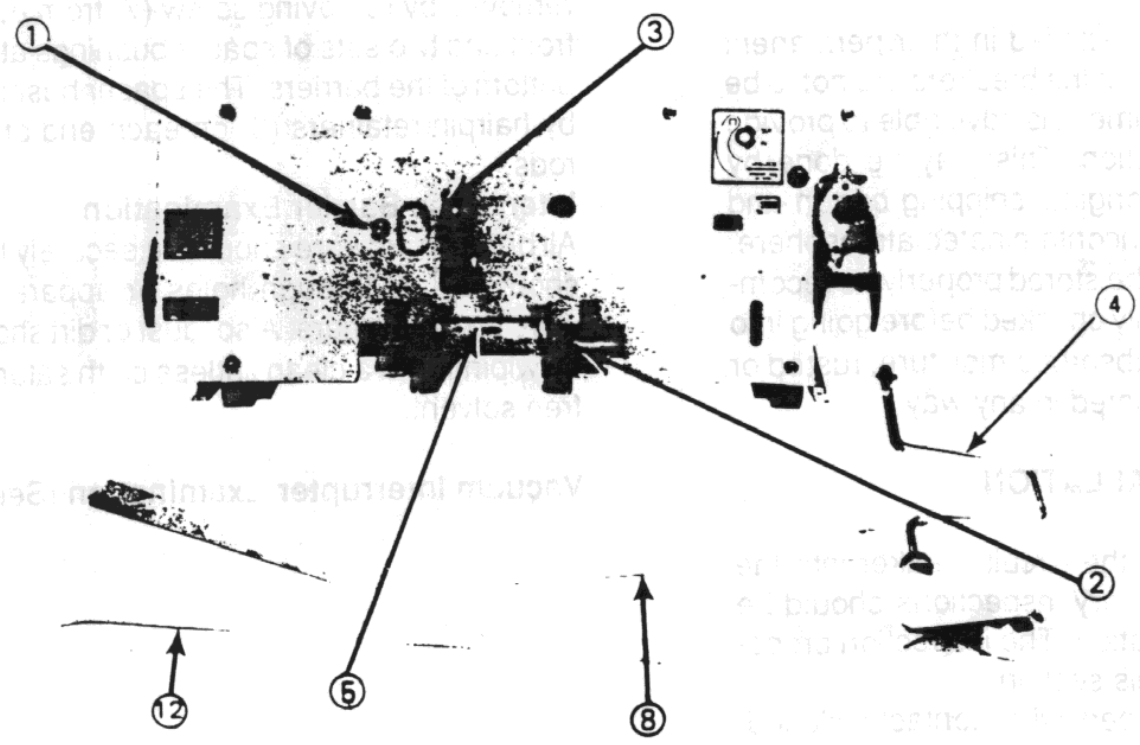


Fig. 3 — Front Circuit Breaker Panel & Accessories

The insulated vacuum envelope (2) should be examined carefully for cracks in the area of the metal-to-insulation seals on both ends and around the mid-band ring. Since a certain amount of transmitted light is usually required to detect cracks, the inspection should be done in a well lighted area. If the mid-band ring, when so equipped, has been bent by an accidental impact, that area should be specially scruntinized for seal damage. Small external chips, however, will not impair the useful life of the interrupter.

To prevent loss of vacuum care should be exercised so as not to damage the interrupter's plastic cover vacuum Pinch-off tube (3).

Insulation Structure

All insulated parts should be checked for damage. Any dust or dirt should be removed by air or wiped with a clean lintless cloth saturated with an oil-free solvent. This is important because dirt and dust can accumulate and, with moisture. can place the circuit breaker in jeopardy, dielectrically.

Installing Front Cover and Interphase Barriers (See Fig. 1)

Install the interphase barriers first with one screw (7) for each barrier. Next install the front cover and fasten with eight front cover screws(1).

NOTE: It is recommended that a dielectric withstand test be made prior to initially putting this or any type vacuum circuit breaker into service. Refer to Dielectric Tests, in the Maintenance, Adjustments and Tests section of this bulletin, for the correct test procedure.

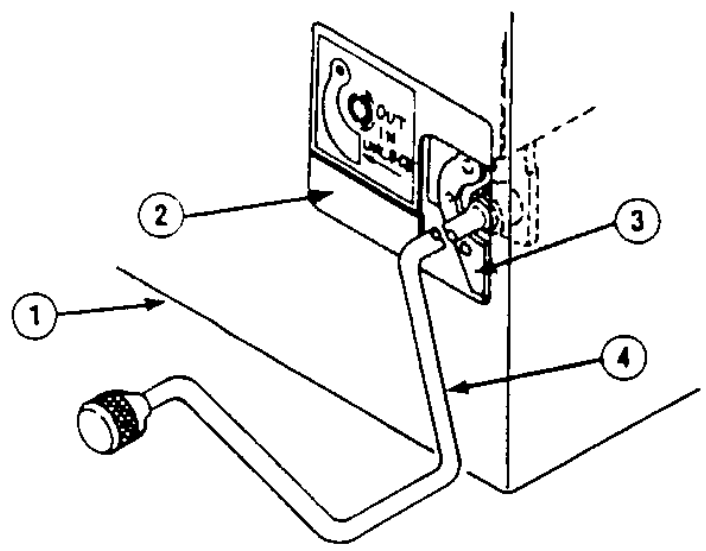


Fig. 4 — Method of Racking Circuit Breaker

Installing Circuit Breaker into Compartment (See Figs. 3&4)

NOTE: CLOCKWISE ROTATION of racking crank for inserting breaker. COUNTERCLOCKWISE rotation of racking crank for removal of breaker.

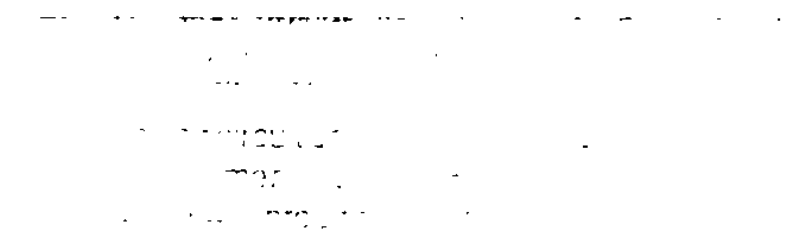
Turn motor disconnect switch (1, Fig. 3) to "OFF" position.

Engage racking crank (4, Fig. 4) and push racking unlocking lever (3) to left, then rotate racking crank counterclockwise only until resistance to motion is felt (DO NOT FORCE). If closing springs were left in the "charged" condition, they will automatically discharge.

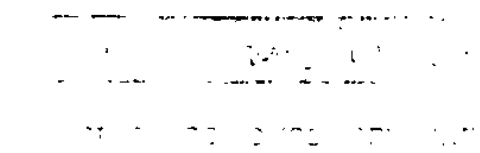
For installing the circuit breaker into the lower compartment, the fifth wheel is used to position the breaker so that it is lined up with the switchgear. Engage the fifth wheel (12, Fig. 3) with hole (5, Fig. 3). The lift device is required to lift and position the breaker for installation into the upper compartment. Guide and push circuit breaker into compartment until stopped. Again engage racking crank and rotate clockwise until racking mechanism automatically stops at "DISCONNECT" position. (Breaker is now held captive in compartment.)

To rack circuit breaker to "TEST" position, push racking unlocking lever (3, Fig. 4) to left, rotate racking crank approximately 1/4 turn clockwise, then release unlocking lever. Continue cranking until racking mechanism automatically stops at "TEST" position.

With the circuit breaker racked to "TEST" position, it should be checked for proper operation by operating all possible means of opening and closing, this includes control switches, relays, etc. Turn motor disconnect switch (1, Fig. 3) to "ON" position to charge the closing springs, and operate the breaker as required.



Push unlocking lever (3) to left and turn racking crank (4) approximately 1/4 turn clockwise, then release unlocking lever. Continue cranking until racking mechanism automatically stops at "CONNECTED" position.



The circuit breaker may now be put in service and be operated as required.

CIRCUITBREAKER REMOVAL(SeeFig.4)

To remove circuit breaker from "CONNECTED" position, open the breaker as required.

Open sliding door (2) in front compartment door (1). Engage racking crank (4) and push racking unlocking lever (3) to left. Rotate racking crank (4) counterclock-

wise approximately 1/4 turn, then release unlocking lever. Continue cranking counterclockwise until racking mechanism automatically stops at "TEST" position.
Repeat same operation for "DISCONNECT" position.
The circuit breaker can now be positioned for withdrawal.
If in the upper compartment (1200 and 2000A breakers) the lift device must first be located in the correct position.
For withdrawal from the switchboard, again push the racking unlocking lever to the left and turn the racking crank counterclockwise only until resistance to motion is felt. (Approximately 2-3 turns - DO NOT FORCE) The closing springs, if charged, will automatically discharge when the circuit breaker is moved to the withdrawn position. The circuit breaker can now be removed from the compartment by pulling on the handle located on the front barrier.

MAINTENANCE, ADJUSTMENTS AND TESTS

General Information

The 15VHK1000 circuit breakers are designed for minimum maintenance and tested to insure that minimum maintenance will be required. The few adjustments that are noted are required only when an operational check indicates a problem. Of course, during the maintenance checks, all accessible bolts, nuts and screws should be routinely checked to insure that they are tight.
It is recommended that the circuit breaker be inspected after the first 1000 operations and on a yearly basis unless environmental considerations and operating experience indicate that more frequent inspections are appropriate. These operations can be either no-load mechanical, load current switching, capacitor or reactor switching operations, or for motor starting applications.
Vacuum interrupters, as used on the 15VHK1000 circuit breakers, have an inherently long contact life and will provide trouble free service under varied applicaiton conditions, as long as the circuit breaker is applied within its rating. The wear condition of the individual vacuum interuupters will vary, depending on circuit conditions and such variables as single phase versus three-phase interuption, X/R ratio (asymmetry) and relay delay times. Of course, interrupting high short-circuit current will cause contact erosion to occur faster than load current interruptions. The interrupters for the 15VHK1000 Circuit Breakers have been tested for 2000% KSI minimum. It is unlikely that a circuit breaker will be subjected to this much duty during the life of the breaker and it is not expected that the interrupters will have to be replaced due to excessive erosion of contacts. However an erosion indicator is incorporated and the remaining erosion can be checked during maintenance. For the check on contact erosion, see section on contact wipe on page 7.

If, however after the first inspection period there is no indication of any problems, actual operating experience with specific circuits will indicate the future amount of maintenance needed for the various circuit breakers and the procedure can be modified as required.
Of course, where unusual service conditions exist, as covered by ANSI Standard C37.04, it must be presumed that these conditions were considered at the time of order; that the equipment supplied was designed for the special application; and that an appropriate supplemental maintenance program has been developed. These maintenance instructions only cover circuit breakers used under the standard service conditions.
At the selected maintenance period, the following tests and adjustments should be made:
NOTE: The following tabulated tests and adjustments are all that are normally necessary for proper maintenance and operation of the 15VHK1000 circuit breaker. The remaining portions of the breaker — close coil assembly, shunt trip device, control relay, auxiliary switch and motor — require no maintenance during the standard life of the circuit breaker regardless of the operating duty.

D.C. Millivolt Drop Test

During maintenance periods, the condition of the breaker current circuit can easily be determined by performing a millivolt drop test. This test should be performed regardless of whether the circuit breaker had interrupted low or high currents or has minimum operations.
The following table lists the millivolt drop and resistance values for the circuit breakers covered by this instruction book from terminal to terminal, exclusive of the primary disconnects.

Curcuit Breaker	Maximum MV Drop*	Maximum Micro-Ohms
15 VHK1000, 1200 Ampere	6.5	32.5
15 VHK1000, 2000 Ampere	5.5	27.5
15 VHK1000, 3000 Ampere	5.0	25.0
Millivolt drop with 200 amperes DC flowing.		

Insulation Cleaning

Any dirt, dust or grease should be removed from the surfaces of the entire current carrying structure, vacuum interrupter*, base insulation sheet and interphase barrier assembly. Wiping the surface with an oil-free solvent on a clean cloth or industrial wiper is normally sufficient for this purpose.

*Remember to discharge mid-band ring on interrupters.

CIRCUIT BREAKER OPERATION AND CONTACTS

1. To check breaker operation, the breaker should be withdrawn from the switchboard, the fron cover and barrier removed and the racking screw turned two to three turns clockwise until the racking unlocking lever snaps into the first position corresponding to the disconnect position.

2. Fully closed breaker (See Fig 3). Charge the closing springs and turn the motor switch (1) off. Close the breaker. Engage manual charge handle (8) with charging lever (3). During the intial portion of the downward stroke of the handle check to see which direction the closing spring guides (2) move. If this spring guides start to move out then the breaker did fully close originally. Excess contact pressure or friction can cause this condition and if it cannot be relieved then the factory should be consulted.

3. Contact wipe (contact pressure) (See Fig. 5). The contact air gap and contact wipe is set at the factory by setting the vertical position of the interrupter (1) and the vertical position of the pusrod (2). These parts should not be repositioned in the field unless a pushrod change is required to correct contact sequence as described elsewhere. Contact wipe is set at the factor at .11 minimum. Contact erosion and wear in mechanical parts will cause a reduction in contact wipe over the life of the breaker and a check should be made to insure that the wipe is not less than .020". The measurement is made as follows for the three poles:

a. Open the breaker and discharge the closing springs.
b. Using a thin 6" scale measure from the spring base to pivot pin 3. Record dimension X2.
c. Close the breaker and again measure between the spring base and pivot pin 3. Record Dim. X.
d. The measurement with the breaker open should be at least .020" greater than when the breaker is closed.
e. When contact wipe is less than the .020" and it has been determined that the breaker closes fully and there is not a mechanical problem, then the interrupter should be replaced due to contact erosion.

4. Contact Air Gap (See Fig. 5). The contact air gap is set at the factory at the nominal dimension of .35 This value will normally increase as the contacts erode. A check of the contact air gap checks that the breaker does open fully and that the gap is suffient to withstand the applied voltage. The measurement is made as follows for the three poles.

a. Open the breaker and discharge the closing springs.
b. Measure and record dim Y_2
c. Close the breaker, measure and record dim. Y_1
d. The air gap is the difference between the two measurements. The acceptable limits are .30 -- .50, with the upper limit being approached as contact wipe approaches the minimum.

5. Contact sequence (See Fig. 5). All three poles should touch within 2 millisecond at normal closing speeds. An oscilloscope, oscillograph or other timing method may be used to establish the 2 millisecond timing.

Before checking contact sequence, check that the contact wipe and air gaps are correct. It is not expected that the contact sequence should exceed the 2 millisecond limit; therefore, before attempting to readjust, checkthat the test equipment and procedure are correct. Also consider, expecially when testing with electronic equipment, that .002 seconds vacuum interrupter contact bounce is permissible during normal closing and this bounce is permissible during normal closing and this bounce can influence the contact measurements. if it is determined that the contact sequence is not within the 2 milliseconds, then adjustment is required. Usually, readjustment of one pole should be sufficient so that all three poles to be changed should be decreased if the contacts of that pole are touching after the other two poles, or increased if the contacts are touching before the other two poles, or increased if the contacts are touching after the two poles, or increased if the contacts are touching before the other two poles. The air gap is dcreased by turning pushrod (2) clockwise, viewing from the top of the breaker, and increased by turning counterclockwise.

Before the pushrod can be turned, the breaker must be open, closing springs discharged and pin (3) removed. With the breaker open, the vacuum in the interrupter maintains a constant upward force. of approx. 25 lbs. on the moving contact and pushrod (2). Therefore, before removing pin (3), the contact must be held down in the open position by temporary spacers at location (z). After removing retaining ring (4) and pin (3), rotate pushrod (2) as required. 1/4 turn of the pushrod (2) will change the air gap by approx. .019. After rotating the pushrod, carefully reposition the moving contact and pushrod vertically to align the pin holes. Replace the pin and retainer and remove the temporary spacer. During the readjustment procedure note that the contact wipe and air gap dimensions, specified previously, must be maintained. Also, that no more than 1/2 turn total of the pushrod should be required when readjusting for contact sequence.

After completing the contact sequence procedure, recheck the contact wipe and air gaps.

ASEA BROWN BOVERI

solvents to evaporate prior to any mechanical operations. It is mandatory that the breaker undergo thorough lubrication with Anderol 757 at the next maintenance interval. Use of solvents to free contaminated lubricant is strictly forbidden without immediate relubrication using Anderol 757. Note that bearing surfaces must be repacked and this will require disassembly of the mechanism. Do not operate the circuit breaker without completing this procedure.

3. The charging motor is sealed and no lubrication is required.

DIELECTRIC TESTS

It is recommended that dielectric withstand tests be made prior to use and then at routine maintenance periods to verify the integrity of vacuum interrupters. If, during the dielectric withstand test, the required test voltage cannot be sustained across the open contacts of the vacuum interrupter, the interrupter is faulty and must be replaced. Always insure that the contact air gap is correct before conducting primary circuit dielectric tests.

1 . The internal shield of a vacuum interrupter can acquire an electrical charge which is usually retained even after the voltage is removed. On certain types of interrupters, this shield is attached to the exposed mid-band ring and a grounding stick should be used to discharge the ring before working on the device.

2. Dielectric test voltages higher than rated voltage, applied across open contacts, may cause a vacuum interrupter to emit some X-radiation which could be a health hazard on prolonged exposure at close range. Accordingly, even though the emission is low and on for such a short period of time, it is considered appropriate to exercise caution.

Therefore, do not run any primary circuit dielectric withstand tests on isolated interrupters with open contacts, above rated voltage unless test personnel are adequately shielded or they are no less than six feet from the test unit.

Regarding complete breakers, it is noted that NO hazardous X-radiation is produced with closed contacts at any test voltage or with open contacts at rated voltage and there should be no cause for concern. Further, if the breaker is tested in its switchgear compartment, the enclosure steel provides sufficient shielding to protect personnel from X-radiation at the test voltages recommended below at the normal distances maintained for electrical safety.

The following test values should be used for dielectric testing the complete breaker and are to be applied for a one-minute period.

DIELECTRIC TESTS	60Hz
Primary Circuit	36.0kV
Secondary Circuit (Control)	1100Vk

* If it is desired to make a dielectric test on the secondary control wiring, turn the spring charging motor disconnect switch (1, Fig. 3) to the "OFF" position. Apply test voltage (1100V-AC) for one minute to each of the secondary

TABLE 1 — OPERATING VOLTAGE RANGE

				Undervoltage	
Nominal Control Voltage	Spring Charging Motor	Close Coil	Trip Coil	Pick-up Maximum	Drop-out
24 V dc	—	19-28	14-28	21	7-14
48 V dc	38-56	38-56	28-56	41	15-29
125 V dc	100-140	100-140	70-140	105	38-75
250 V dc	200-280	200-280	140-280	212	75-15
120 V ac	104-127	104-127	104-127	102	36-72
240 V ac	208-254	208-254	208-254	204	74-144

The front cover and interphase barriers can now be reinstalled. Return the racking screw to its original position by turning it counterclockwise approx. two to three turns until it stops.

Closing and Opening Times and Speeds
After the operation intervals noted previously, the closing and opening times are recommended to be checked by use of a cycle counter, travel recorder, oscillograph, etc. to monitor the time from energizing to contacts touch or part.
*A potentiometerwith mounting support, used in conjunction with an oscilloscope or oscillograph, and instructions are available on special order for specifically checking opening and closing speeds.
The circuit breaker closing and opening times should be within the following time ranges for normal operation.

Closing Time Range — MS	Opening Time Range — MS
40-60	25-35

NOTES:
1. Below 0°C, the closing times will increase (but with no reduction in closing force); and opening times will be within the limits.
2. Adjustments to correct speeds, if found to be outside limits, are critical and the nearest District Office should be contacted for recommendations.

Operating Mechanism (See Fig. 6)
The operating mechanism is adjusted at the factory for proper operation and should not be disturbed unless the circuit breaker does not close electrically on reclosing duty.
This condition is caused when the latch check switch (when used) is not actuated. Circuit breaker should not close before trip latch (4) has reset.
Adjustments should be made with latch (4) against reset stop pin (3). Turn in adjusting screw (1) until contacts of switch (2) "break" (as indicated by an audible click or check with bell ringer). Retract adjusting screw until switch contacts "make", then rotate adjusting screw one turn more. (Adjusting screw is self-locking.)

Racking Mechanism (See Fig. 7)
The circuit breaker racking mechanism is adjusted for proper operation and should not be disturbed unless it becomes possible to close the breaker during a racking operation.
It may be possible that interlocked blocking members are not positioned properly, which should be corrected as follows:

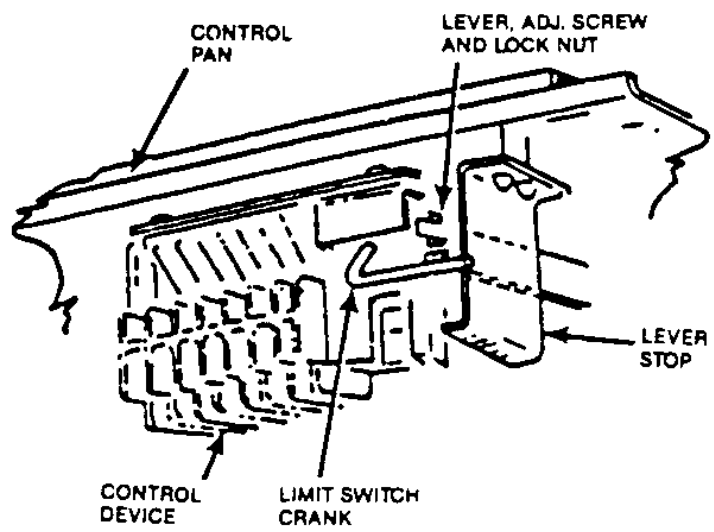


Fig 8 - Control Relay

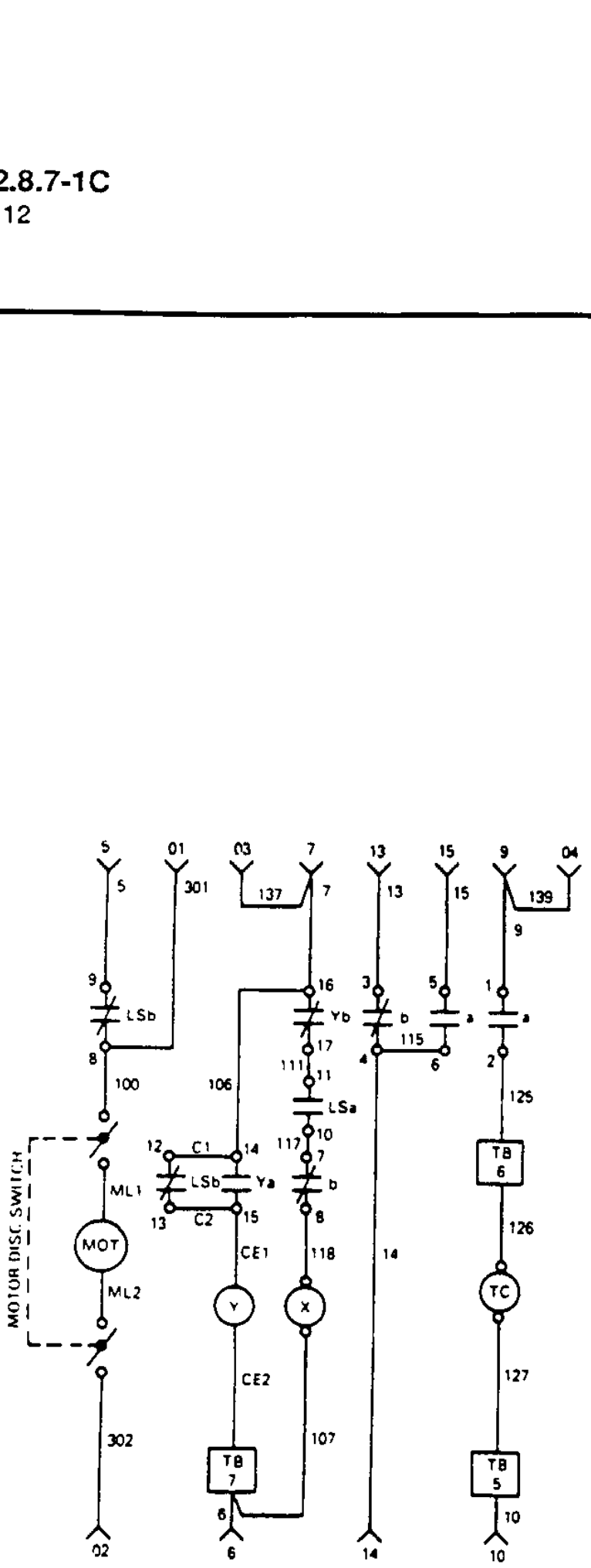
Remove the lower front mechanism coverplate and with the circuit breaker closed, make adjustments by regulating the length of connecting rod (1) for 1/32 inch minimum to 3/32 inch maximum clearance of "A" between trip link (3) and blocking lever (2). The maximum adjustment at point "A" should not exceed 3/32 inch.

Control Relay Adjustment (See Fig. 8)
The control relay does not normally require any adjustment in the field. However, if necessary adjust the gap between the control device lever adjusting screw and the limit switch crank arm for a 1/64—1/32 gap with the closing springs charged. With the closing springs discharged, the gap between the lever stop and the lever should be 1/64" to 1/16".

LUBRICATION
The 15VHK1000 circuit breakers are lubricated during factory assembly as follows:
1 . All mechanism parts, bearings, pins, etc., have been lubricated with Anderol 757 manufactured by Nuodex, Inc. (formerly Tenneco Chemical, Inc.). (ABB No. 712994A, 4 oz. tube).
If the grease should become contaminated or unduly oxidized (hardened and darkened) or if parts are replaced, any relubrication should be done with the lubricants noted.

NOTES:
1 . The mechanism should be periodically inspected for lubrication contamination; frequency of inspection is dependent on operating environment.
2. Do not use light oil to lubricate any mechanism parts. In emergency situations, Anderol 732 may be used as a temporary lubricant. In these cases, allow time for the

ASEA BROWN BOVERI



LEGEND

a — Auxiliary Switch Contact Closed When Breaker Is Closed.
b — Auxiliary Switch Contact Open When Breaker Is Closed.
LSa — Limit Switch Contact Open When Springs Are Discharged. Closed When Springs Are Charged.
LSb — Limit Switch Contact Closed When Springs Are Discharged. Open When Springs Are Charged.
TC — Shunt Trip Coil.
X — Closing Latch Release Coil.
Y — Control Relay Lockout Coil.
Ya — Normally Open Control Relay Contact.
Yb — Normally Closed Control Relay Contact.
TB — Terminal Block Point.
ML — Motor Lead.
CE — Coil Lead End.
C1,C2 — Terminal Jumper (Control Device).
—< — Female Secondary Disconnect Contact.

Fig. 9 — Typical DC Schematic Diagram of Control Circuit

disconnect contacts at the rear of the circuit breaker.
If it is desired to make a dielectric test on the spring charging motor, turn the motor disconnect switch (1, Fig. 3) to the "ON" position. Apply test voltage (540V-AC) for one minute to the motor circuit.

ELECTRICAL CHARACTERISTICS OF CONTROL DEVICES

For operating voltage ranges for various nominal control voltages, refer to Table 1.
For average current values at various nominal control voltages, refer to Table 2. The current values given in this table are average steady state values - momentary inrush currents for all charging motors and AC coils are approximately six to eight times these values.

ELECTRICAL OPERATING SEQUENCE

Please refer to the specific schematic diagrams and other operational information furnished with your order. Fig. 9 is provided as a typical schematic for general information on electrical operation.

RENEWAL PARTS

We recommend only those renewal parts be stocked that will be required to insure proper and timely maintenance for normal operation of the 1 5VHK1000 circuit breakers. Copies of the applicable Renewal Parts Bulletin for specific circuit breakers will be furnished on request to the nearest District Office.
The minimum quantity of assemblies and items recommended in these bulletins are predicated on infrequent replacement of parts based on accumulated tests and operating experience. Total assemblies are recommended for fast replacement, when necessary, to return the breaker to service as quickly as possible. Then certain replaced assemblies can be returned to the factory for nominal reconditioning. The bulletins contain specific part ordering instructions, and if desired, specific instructions regarding replacement of those part assemblies recommended, that are not obvious, are also vailable if ordered.

Figure 2 - Average Currents Values

Nominal Control Voltage	Control Charging Motor	Close Coil	Trip Coil	Lockout Coil	Under Voltage	N.E.C. Fuse
24 V dc	-	22.0	22.0	0.30	0.9	30
48 V dc	25.0	10.7	10.7	0.15	0.5	30
125 V dc	10.0	5.0	5.0	0.06	0.2	30
250 V dc	5.0	2.2	2.2	0.03	0.1	30
120 V ac	10.0	4.5	4.5	0.40	0.2	30
240 V ac	5.0	2.3	2.3	0.20	0.1	30

ASEA BROWN BOVERI

ASEA BROWN BOVERI, INC.
ABB Power Distribution Inc.
Circuit Breaker Division
P.O. Box 100524
Florence, South Carolina 29501

Phone: (803) 665-4144
Telecopier: (803) 664-0520

Printed in U.S.A. 1M 1292

ASEA BROWN BOVERI

MS 3.2.1.9-2A

Maintenance and Surveillance

Medium-Voltage
Switchgear Equipment

HKII Switchgear
IB 3.2.4.7-1

5VHK250
IB 6.2.7.7-3

7.5VHK500 and 15VHK500/750
IB 6.2.7.7-2

5VHK350 & 15VHK1000
IB 6.2.8.7-1

RECOMMENDED MAINTENANCE & SURVEILLANCE 5VHK, 7.5VHK & 15VHK SWITCHGEAR EQUIPMENT

EQUIPMENT MAINTENANCE PROGRAM

This Bulletin augments the information and instruction provided in Instruction Bulletin 3.2.4.7-1.

Switchgear installation which requires exceptional dependability due to serious safety or economic consequences of operating problems should be given comprehensive maintenance and surveillance attention. This program recommendation has been developed specifically for use in Nuclear Power Generating Stations, but it is applicable to any installation where exceptional reliability is desired and a preventive maintenance program is to be implemented.

Some maintenance activities are considered essential, therefore ACTIVITIES WHICH ARE MOST IMPORTANT TO ASSURE AVOIDANCE OF PREDICTABLE PROBLEMS ARE UNDERLINED.

FREQUENCY OF MAINTENANCE

Suggested time frames in the program are not absolute, they represent the best generalized advice of the manufacturer for equipment installed in a clean, uncontaminated environment such as may be found in a power generating station. If equipment is in a area where corrosive or conductive contaminants are present, or if large amounts of airborne contaminants will be experienced, the shortest interval of the range shown in the equipment maintenance program should be used. Further, in highly contaminated areas as described, circuit breaker servicing should be accomplished at a maximum of two year intervals.

If it becomes apparent after several maintenance cycles that certain activities are not needed as frequently as suggested, or that increased frequency would be prudent, the program should be adjusted to meet the specific needs of the installation.

RECORDS

Records are a key factor in a preventative maintenance program and can provide vital data for evaluating equipment condition, when necessary, if the recording system is consistent, thorough and available when needed. As a minimum the records would contain the data and, for circuit breakers, the number of operations at the last maintenance in addition to results of testing. If observations of equipment condition are recorded, a realistic basis for adjusting maintenance frequency will be available.

SPARE PARTS

A major factor in overall availability is downtime per failure or mean time to repair and although switchgear and associated components enjoy favorable reliability expectations, random failure of a component can cause downtime or reduced capability if inadequate attention is given to the spare parts inventory. A spare parts recommendation for the switchgear equipment can be provided to assist in selection of appropriate parts. Storage of spares should be in a clean, dry area. Part access and identification should permit prompt availability, when needed.

1. GENERAL

CAUTION: BE SURE THAT ALL ELECTRICAL SUPPLIES ARE OFF BEFORE PERFORMING ANY MAINTENANCE INSIDE EQUIPMENT.

a. The following lubricants are recommended:

LUBRICANTS	
Mechanisms (anti-friction)	ANDEROL 757 Tenneco Chem Inc.
Electrical Contact Compound	NO-OX-ID "A Special" Sanchem Chem Co.

Use of other lubricants risks incompatibility with original materials or unproven performance.

b. In tightening bolted conductor connections, use of a torque wrench is recommended. The following torque levels will assure good connections:

DRY THREAD TORQUE		
BOLT DIA.	TORQUE High Strength Steel	TORQUE Silicon Bronze
3/8"	15-25 ft. lb.	15-20 ft. lb.
1/2"	30-45 ft. lb.	25-35 ft. lb.
5/8"	50-75 ft. lb.	45-60 ft. lb.
3/4"	60-80 ft. lb.	65-75 ft. lb.

c. A clean and dry environment should be a continuing goal of the maintenance program for all electrical equipment.

d. Operating and maintenance personnel should be alert for unusual sounds (sizzling or crackling) and smells (ozone or burning) when in the vicinity of electrical equipment.

2. RECEIPT AND STORAGE

Environmental conditions during transit and storage can have a substantial effect on equipment reliability. Extended periods of storage with original shipping covers in place must be avoided.

a. Upon receipt, equipment should be put into a ventilated storage area protected from the weather. Temperatures should be maintained between 40°F and 120°F, humidity should be maintained at 50% relative* or below. Shipping covers and/or boxes should be removed.

*If relative humidity above 50% is anticipated, localized heat sources should be provided to maintain equipment temperature above the dew point. One means of accomplishing this is to energize internal equipment space heaters, if furnished, and store circuit breakers within the equipment enclosures. Note that equipment must be on a flat level surface to avoid floor distortion.

b. Under all conditions of transport and storage, equipment should be protected from direct impingement of water, flooding, and heavy contamination, such as construction dust and dirt.

3. AT INSTALLATION (Repetition of some factory activity is suggested due to uncertainties of shipping, handling, etc.)

CAUTION: TURN OFF ALL POWER BEFORE WORKING INSIDE.

a. Equipment mounting should be on level rails embedded flush with the finished floor per installation dwgs.

b. Removal of all shipping supports and installation of all bus conductors (main and ground) across shipping splits should be verified.

c. Check all bolted connections for proper torque.

d. Check circuit breaker contact penetration connection wipe by applying NO-OXID compound to stationary connection stabs and racking breaker into connected position, then out. Contact lines in compound verify contact.

e. Operate each circuit breaker (close and trip twice.)

f. Inspect primary conductor insulation system, remove contamination accumulated in storage and installation.

g. Check primary cable connections for tight hardware and proper stress relief. Check all primary connections to other electrical equipment.

h. Check control wire connections - See 6c.

i. Check trip/racking interlock to verify no racking with breaker closed and no closing unless breaker is latched in position.

j. Millivolt drop and timing measurements on each circuit breaker provide useful preoperation checks and valuable comparative data for future use.

4. TWELVE TO EIGHTEEN MONTH INTERVALS

CAUTION: TURN OFF ALL POWER BEFORE WORKING INSIDE.

a. Identify and service circuit breakers which are due. See CIRCUIT BREAKER SERVICING section, page 6 of this Bulletin.

b. Operate all circuit breakers which are not due for service.

c. Inspect primary interface connections with other equipment for signs of excessive heat (Cable and bus connection, usually in the rear of the equipment.) Discoloration or embrittlement of adjacent insulating materials and conductor corrosion or discoloration may indicate a hot joint. See HOT JOINT MAINTENANCE, Page 5.

d. Inspect primary cable for chafing at conduits or supports and loose or missing stress relief grounds.

e. Exercise the racking mechanism.

5. ONE TO THREE YEAR INTERVALS (Nuclear - Alternate refueling shutdowns.)

CAUTION: TURN OFF ALL POWER BEFORE WORKING INSIDE.

a. Clean contamination from all primary insulation with vacuum, distilled water or a solvent approved by NIOSH or local authority, as necessary. Inspect for discoloration or other evidence of excessive heat. If found, proceed per HOT JOINT MAINTENANCE, below.

b. Inspect control wiring bundles for discoloration due to heat, chafing or other damage to insulation.

c. Clean stationary breaker connection stabs in the enclosure with a solvent approved by NIOSH or local authority. Inspect for evidence of contact galling, excessive heat, arcing or corrosion. If found, proceed per HOT JOINT MAINTENANCE, page 5. Re-apply NO-OX-ID compound prior to reconnecting circuit breaker.

NOTE: Protective relays should typically be checked for accuracy of calibration at two to five year intervals, see manufacturers instructions for detail.

6. TEN YEAR MAXIMUM INTERVAL

CAUTION: TURN OFF ALL POWER BEFORE WORKING INSIDE.

CIRCUIT BREAKER REFURBISHMENT

a. Disassemble, inspect, clean, relubricate, readjust and recalibrate breaker mechanisms which have not been fully refurbished in ten years.

b. All primary conductor connection bolts should be retorqued to recommended values. (An alternative to retorquing may be use of infrared heat sensor (thermographic) techniques. These procedures are specialized, however, and require plans to overcome loading and safety difficulties.) See below.

c. Tighten all secondary control wire connections while checking for loose lug crimps and broken wire strands.

HOT JOINT MAINTENANCE - For primary joints which show evidence of excessive heat: (1) Open joint and inspect connection surfaces. (2) If surfaces appear reasonably smooth, with only minor pitting or corrosion, clean and dress contact surfaces minimizing removal of plating. (3) If surfaces are heavily pitted or corroded, or if there has been any melting of conductor material, the affected parts must be replaced. (4) Replace contact finger springs if breaker disconnects have been exposed to excessive heat. (5) Contact surfaces should be protected with NO-OX-ID before re-assembly. (6) Use recommended torque values in tightening bolted connections. (7) Before and after millivolt drop testing can provide some confidence that the problem has been corrected.

JOINT COVERS - During surveillance it may be necessary to remove joint covers. It is possible that the cover may crack when it is flexed for removal or replacement due to embrittlement from loss of plasticizer. An isolated incidence of such cracking indicates that the joint has been operating at higher temperatures than normal. A cracked cover should not be reused. An embrittled cover which has not cracked will provide insulating capabilities at least as long as it took to embrittle. Generalized embrittlement of joint covers is not expected for twenty years or more. If the cover is cracked, its part number may be located in the inside part of the cover . Please contact the customer service group at the ABB Sanford facility for replacement.

CIRCUIT BREAKER SERVICING

Circuit breakers require inspection and servicing periodically to assure operability. Servicing should be accomplished based on number of operations since last serviced, with an elapsed time limit. The appropriate frequency of servicing depends on the duty of the circuit breaker. As experience warrants, the recommended frequency of servicing shown below should be adjusted on specific breakers to account for more/less severe duty than initially expected, based on the breaker condition when serviced. Variations in actual in-service duty will cause these intervals to change. These intervals should be used as a general guideline only.

Recommended service frequency is shown for three general categories of duty:

LOAD CURRENT SWITCHING, UP TO RATED CONTINUOUS CURRENT ENVIRONMENT NORMAL, MINIMAL CONTAMINATION.

Service breaker every five (5) years or upon accumulating the number of operations shown below since last serviced, whichever comes first.

5VHK-250, 7.5VHK-500, 15VHK-500/750 - 2000 operations.

5VHK-350, 15VHK-1000 - 1000 operations.

MOTOR START, CAPACITOR & REACTOR SWITCHING OR ANY DUTY IN A CONTAMINATED ENVIRONMENT.

Service breaker every two years or upon accumulating the number of operations shown below since last serviced, whichever comes first.

5VHK-250, 7.5VHK-500, 15VHK-500/750 - 750 operations.

5VHK-350, 15VHK-1000 - 400 operations.

FAULT INTERRUPTION

Service a breaker which has interrupted short circuit current as soon as possible.

MECHANICAL OPERATING LIFE

This service program qualifies a circuit breaker for the total number of mechanical operations shown below before replacement or factory refurbishment is required. The limit is suggested to provide margin.

5VHK-250, 7.5VHK-500, 15VHK-500/750 - 750, Total Operations - 10,000, Suggested Limit - 9,000.

5VHK-350, 15VHK-1000, Total Operations - 5,000, Suggested Limit - 4,500.

The following should be accomplished at each service interval:

CLEAN, INSPECT & LUBRICATE PRIMARY DISCONNECTS.

INSULATION CLEANING.

OPERATION CHECK

CONTACT PRESSURE CHECK**

MILLIVOLT DROP TEST

Instructions follow which clarify the above.

In addition, the hardware (bolts, nuts, screw and pin retainers) should be checked with a thorough inspection to be sure that they are in place and secure. There are other adjustments which may be required due to the operating or test abnormalities below:

TIMING TEST*

Recommended as a pertinent periodic test to evaluate breaker condition

CONTACT PRESSURE ADJUSTMENT**

Required if contact pressure check indicates a problem.

RACKING MECHANISM ADJUSTMENT**

Required if interlock fails to block closing while breaker is being racked in or out or racking latch is not blocked with breaker closed.

LATCH CHECK SWITCH ADJUSTMENT**

Required if circuit breaker fails to latch closed on reclosing.

LUBRICATION

The VHK circuit breakers are lubricated during factory assembly as follows:

All mating surfaces of moving current carrying joints have been lubricating with NO-OX-ID Special Grade "A" grease.

All other mechanism parts, bearings, pins, etc. have been lubricated with ANDEROL 757.

The circuit breaker mechanism does not ordinarily require lubrication in the usual moderate service environment expected.

However, if operating difficulties are experienced, if grease becomes contaminated or if parts are replaced, relubrication with ANDEROL grease may be required. Extensive disassembly is required to properly relubricate the mechanism. Contact the nearest ABB Power Distribution district office for field assistance or factory refurbishing arrangements.

Primary disconnect fingers should be cleaned with a solvent approved by NIOSH or local authority, inspected for corrosion or evidence of arcing and lubricated with NO-OX-ID grease at each servicing.

NOTES:

Do not use light oil to lubricate mechanism parts.

The spring charging motor is sealed, lubrication is not recommended.

INSULATION CLEANING

Any dirt, dust or grease should be removed from the surfaces of the entire current carrying structure, vacuum interrupter, base insulation sheet and interphase barrier assembly. Wiping the surface with an oil-free solvent on a clean cloth or industrial wiper is normally sufficient for this purpose.

* Remember to discharge mid-band ring on interrupters so equipped.

CAUTION: FOR SAFETY, KEEP CLEAR OF ALL MOVING PARTS.

OPERATIONS CHECK

During servicing it is desirable to verify breaker operability. It is recommended that this be done at the minimum expected control voltage level. (Typically 80% of nominal).

* Specific guidance on the timing test is included in the following instructions:
5VHK-250, 350 - IB 6.2.7.7-3, 7.5VHK-500, 15VHK-500/750 - IB 6.2.2.7-2 and 15VHK-1000 - IB 6.2.8.7-1.

** Consult the circuit breaker Instruction Bulletin for guidance in making the contact pressure check and adjustments.

MILLIVOLT DROP TEST

During servicing, the resistance of the circuit breaker current carrying parts can be checked with a millivolt drop test. This test should be performed regardless of circuit breaker duty or number of operations.

The following table lists millivolt drop and resistance values for the circuit breakers, from terminal to terminal, exclusive of the primary disconnects.

If the millivolt drop does not exceed 150% of the values, shown in the table on breakers with light loading, no contact maintenance is necessary. If the millivolt drop does exceed 150% of the values, contact the factory.

If breaker loading is 75% or more of rated current, it is recommended that the listed values be used as limits.

CURRENT RATING	MAXIMUM MV DROP (1)	MAXIMUM MICRO-OHMS
5VHK250 (26") 1200 Amp 2000 Amp	 8 6	 40 30
5VHK250 (36"),7.5VHK500 15VHK 500/750 MODEL 20 1200 2000	 7 6	 35 30
5VHK350, 15VHK1000 MODEL 05 1200 2000 3000	 6.5 5.5 5.0	 32.5 27.5 25.0

(1) Millivolt drop with 200 Amperes Flowing

TIMING TEST

Periodically, if functional check is desired, the closing and opening times should be checked by use of a time-travel analyzer*, oscillograph or cycle counter to monitor the time from energizing the control to the contacts being fully closed or fully open.

The circuit breaker closing and opening times should be within the following time ranges for normal operation.

NOTES: Below 0° C, the closing times will increase, opening times will be within the limits.

If timing is outside the limits, the factory should be contacted for recommendations.

CIRCUIT BREAKER	CLOSING TIME RANGE - MS**	OPERATING TIME RANGE - MS**
5VHK250 (26") 1200 Amp 2000 Amp	40-60	25-35
5VHK250 (36"), 7.5VHK500 15VHK 500/750 MODEL 20 1200 2000	40-60	25-35
5VHK250, 15VHK1000 MODEL 05 1200 2000 3000	40-60	25-35
** With 125VDC Control, timing may vary slightly at other control voltages.		

* Analyzer mounting support and instructions available on special order.