



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

OMH/BELL, Inc. Suite 201 American Life Bldg. 137 Murray Blvd. Tel. (671) 477-1210 45002, Suite 10010 FAX (671) 477-5246		
Review is for conformance with information furnished and is based on concept expressed in the contract documents. No review is made of detailed dimensions or quantities. Conformance with the contract documents remains the contractor's responsibility.		
<input checked="checked" type="checkbox"/> APPROVED	<input type="checkbox"/> S	APPROVED
<input type="checkbox"/> REJECT	<input type="checkbox"/> D	AS NOTED
DATE 6-01-98	REVIEWED BY: CS	REJECTED RESUBMIT
REMARKS		

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 lubricated 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.

* 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.

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).

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.