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PROGRAM POLICY LETTER NO. P11-V-16

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SUBJECT: Suitability, Safety and Performance of Circuit Breakers

Scope
This program policy letter (PPL) is intended for Coal Mine Safety and Health Administration (MSHA) enforcement and Technical Support audit personnel, equipment manufacturers, repair facilities, coal mine operators, independent contractors, miners' representatives, and other interested parties.

Purpose
This PPL provides guidance on the examination, testing and maintenance requirements of circuit breakers under 30 C.F.R. §§ 75.900-3 and 77.900-1 regarding potentially dangerous conditions involving circuit breakers, including those that have been repaired or rebuilt. It also emphasizes that the mine operator must keep a record of such examinations.

Policy
Under 30 C.F.R. §§ 75.900-3 and 77.900-1, circuit breakers, including those that have been repaired or rebuilt, must be examined and tested monthly and properly maintained by a qualified person to assure that they are in safe operating condition. In addition, under § 75.512 and 77.502, during the weekly and monthly examination of electric equipment, when a potentially dangerous condition is found related to a circuit breaker, the circuit breaker must be removed from service until such condition is corrected.

Some characteristics that should be addressed during the examination or maintenance of circuit breakers, including those that have been repaired or rebuilt include: integrity

and strength of the housing; internal and external electrical insulation; all component parts must be present and in working condition; identification labeling; and cleanliness.

In addition, 30 C.F.R. §§ 75.900-4 and 77.900-2 require that a record of examinations, testing, repairs, and adjustments be kept in a secure book approved by the Secretary. When a circuit breaker is sent to a repair/rebuild facility for repairs and/or adjustments, a report of all repairs and adjustments should accompany the circuit breaker and the report should be included in the record book.

The attachment "Recommended Guidelines on Repair or Rebuild and Maintenance of Circuit Breakers" provides guidance for inspectors, auditors, mine operators, repair and rebuild shops, contractors, miners' representatives, and other interested parties in recognizing improperly repaired or rebuilt or inadequately maintained circuit breakers.

Background

MSHA has become aware of issues relative to circuit breakers that have not been adequately maintained or have been improperly repaired or rebuilt. These issues have been the cause of numerous serious accidents and at least one fatality. Some of the hazardous conditions caused by inadequately maintained or improperly repaired or rebuilt circuit breakers include:

- Circuit breakers are incorrectly labeled. The worst case is circuit breakers labeled for use at 1000 Volts, when in fact the circuit breaker was only rated for 600 Volts. This situation could cause the circuit breaker to flash across the phases, causing an arc blast, which could cause injury to any personnel close to the circuit breaker.
- Cases and components have been found shot blasted as part of the cleaning process. Shot blasting decreases the insulating characteristics of the case and may compromise the physical integrity of the case.
- Painted circuit breakers have been found in use in the mine. This decreases its insulating characteristics and can become a component of a plasma ball in the event of a catastrophic internal event, such as an arc blast. Painting the components inside of a circuit breaker, such as the arc chutes, have kept the component from performing its function, which allows internal damage to occur during normal operation.
- Damaged and modified cases have been found repaired with epoxy. Epoxy or other repair materials used for case repair do not have the strength or insulating characteristics of the original material. In the event a circuit breaker has to clear a bolted fault, these areas could give way and allow pieces of the case to become shrapnel. A case that is cracked or is missing pieces should be destroyed and discarded.

- Circuit breaker cases have been found with significant overheating signs. Overheating is an indication that something abnormal is occurring inside the case. This could be the result of a loose connection or a failing contact tip and could lead to a catastrophic failure of the circuit breaker.
- Trip unit settings have been found to be set too high. This can cause damage to the cable being protected, as well as posing a risk of electrical shock and fire.
- Metallic fixtures have been found attached to a circuit breaker. Anything metallic that has not been designed to be attached to a circuit breaker can become energized and pose an electrical shock hazard.
- Internal modifications to the case have been found. An internal modification to the case can weaken its structural integrity. Specifically, modifying the ribs between the phases can cause an internal phase to phase short circuit to occur. Removing material from the sides of the case can prevent the case from containing a fault event and may leave an opening that can pose a shock hazard.
- Circuit breakers have been found with missing and broken components. Each component inside a circuit breaker has a designed purpose. Certain components prevent electrical shock; other components dampen the arc of a circuit breaker operating under load, or provide insulation that prevents an internal short circuit.
- Replaced contact tips have been found that were not designed to work in a circuit breaker. The hazard in using contact tips not designed for a circuit breaker is that the tips can weld closed and affect the function of the breaker. This condition was the cause of a fatality.
- Undervoltage relays (UVR) that were not designed to fit in the circuit breaker have been found. To install an incorrect UVR, a case modification that can compromise its integrity may have to be made. The use of an incorrect UVR may compromise its function and the function of the breaker.
- UVRs have been adjusted or blocked to prevent the circuit breaker from tripping. If the UVR cannot perform its function, critical faults will not be cleared. This will cause a dangerous condition that can result in a serious injury or a fatality.

MSHA's authority for this PPL
The Federal Mine Safety and Health Act of 1977, as amended, 30 U.S.C. § 801 et seq.; 30 §§ C.F.R. 75.512, 77.502, 75.900-3, and 77.900-1.

Filing Instructions
This PPL should be filed behind the tab marked "Program Policy Letters" at the back of Volume II in the Program Policy Manual.

Internet Availability
This PPL may be viewed on the Internet by accessing the MSHA Home Page and choosing "Compliance Info," then choosing "Program Policy Letters."
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Distribution
MSHA Program Policy Manual Holders
MSHA Special Interest Groups
Coal Mine Operators

Attachment

RECOMMENDED GUIDELINES on REPAIR or REBUILD and MAINTENANCE of CIRCUIT BREAKERS

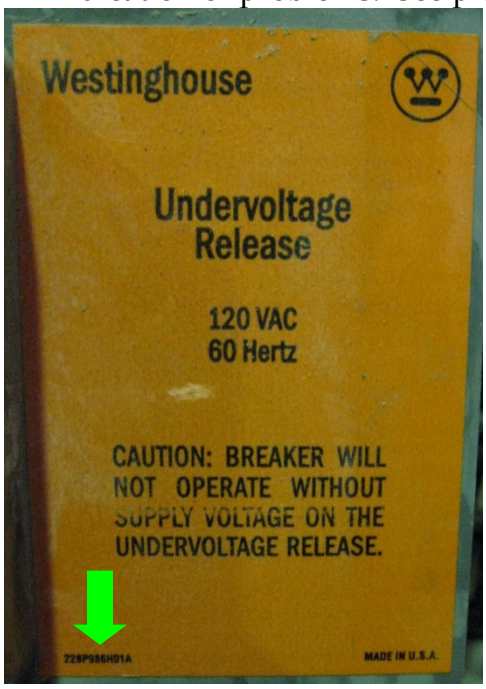
(NOTE: Pictures used are only examples.)

Prior History of Rebuild/Repair Facility

Based on inspection history and complaints, has the vendor had any previous issues with repair/rebuild problems that have required the removal and/or repair of a breaker repaired/rebuilt by that vendor?

External Criteria for further inspection and/or removal from service

1. Labeling – if visible
    a. If the circuit breaker has been rebuilt by a third party facility, it should have the name of that rebuild facility attached.
    b. A new or OEM rebuilt breaker should have OEM labeling. Most OEM labeling can be identified by a label number. Comparison will show lack of a number; different font sizes; layouts not the same; and possible misspellings. OEM labels that have been reproduced may be an indication of problems. See pictures below.



OEM

NON-OEM

    c. Circuit breaker full load current, voltage, and type should be present.

2. Shot Blasting

    Shot blasting removes resin from the case and may weaken the structure so that it could fail under a catastrophic event inside the breaker, such as an arc blast. This is an indicator for further inspection.

Shot Blasted & Painted

3. Paint

   Paint on the outside of the case does not pose a hazard. However, painting could mask other hazards. Therefore, paint on the exterior of a circuit breaker case is cause to have the mine operator open the circuit breaker for a more in depth inspection.

4. Epoxy Repairs

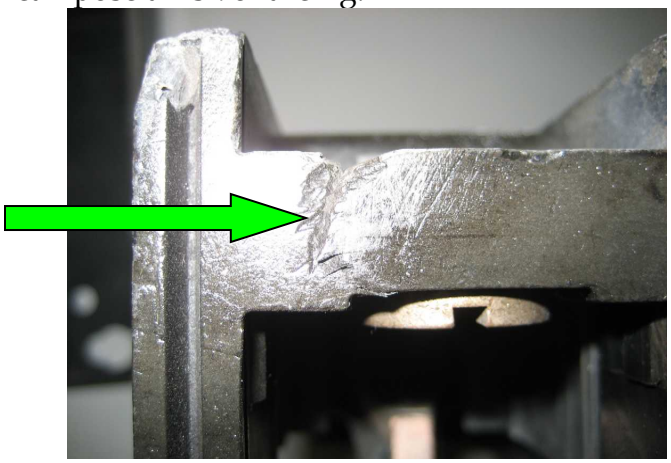
   Cases repaired and/or modified using epoxy can be hazardous. A damaged case can be weak enough that an event occurring inside the circuit breaker can cause the case to fail and rupture causing the epoxy to become shrapnel that can injure personnel nearby. The patching material may not be enough to restore the case's strength. Some patching material may be conductive and can cause a shock hazard.

Epoxy Repair to Case Corner

Epoxy Modification to Cover

5. Hairline Cracks, Broken Pieces

   Hairline cracks and broken pieces on the case can present a serious hazard in that they compromise the integrity of the case in the event of a fault. Cracks in the case also compromise the electrical integrity of the circuit breaker and can pose a risk of arcing.



Cracked Case

6. Signs of Overheating

   Signs of overheating (such as carbon smears, warped or melted case, and/or burnt areas) are cause for having the mine operator open a circuit breaker for a more in depth inspection or removal from service. These are indicators that the circuit breaker case integrity has been compromised. Signs of overheating are also indicators that the electrical insulation between the phases may have been compromised through carbon tracking.

Bubbled & Charred

7. Trip Unit Settings

   If the circuit breaker trip unit is not properly set, it can cause damage to the cable it is protecting. It also poses the hazards of shock and fire. The trip unit must be visibly identified to ensure it is adjusted correctly.

Settings on High

8. Metallic Fixtures Attached to the Breaker Cover or Housing

   Circuit breakers should not have anything attached to the case, and especially not with metallic fasteners. However, some of the older circuit breakers still in use have metallic ID tags fastened to the outside of the breaker with metal rivets. The metallic plate is an indicator to inspect for insulating material inside the breaker. These rivets must not extend to the inside of the case. If the rivet hole is drilled through, it must be insulated with a suitable dielectric. Failure to follow this requirement could allow a dangerous electric potential to be present on the exterior of the breaker, which could be contacted by personnel.

Metallic Tag (Painted)

Internal Criteria for further inspection and/or removal from service

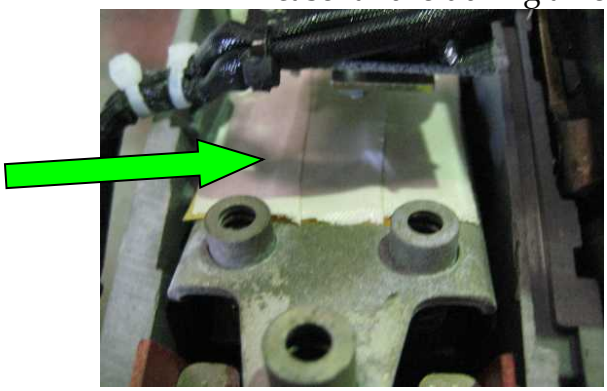
1. Modifications

A modification is anything that changes the structure of the case. The Original Equipment Manufacturer (OEM) provides acceptable modification instructions for permitted accessory installation. Any other modification will be considered criteria for removal from service. Some instances of non-specified or unapproved modifications are:

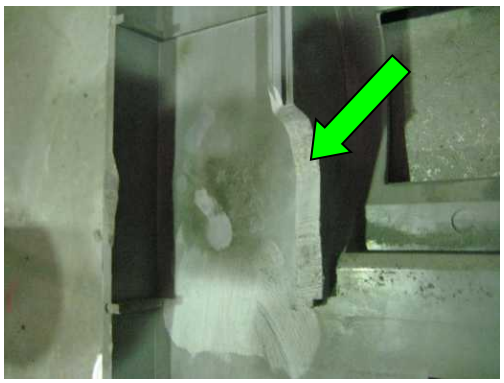
- holes through the outside of the case, except as allowed by the OEM. Example: a hole for wire from an auxiliary switch to pass through from the inside of the case that is no longer used would be allowed
- cut-outs between the phases that compromise the electrical separation
- cut-outs that are not as specified by the OEM for mounting a UVR or other certified component

These types of modifications cause hazards that would allow:

- the potential for shock due to exposure of a miner to fault current
- arcing between phases
- case failure during an electrical fault



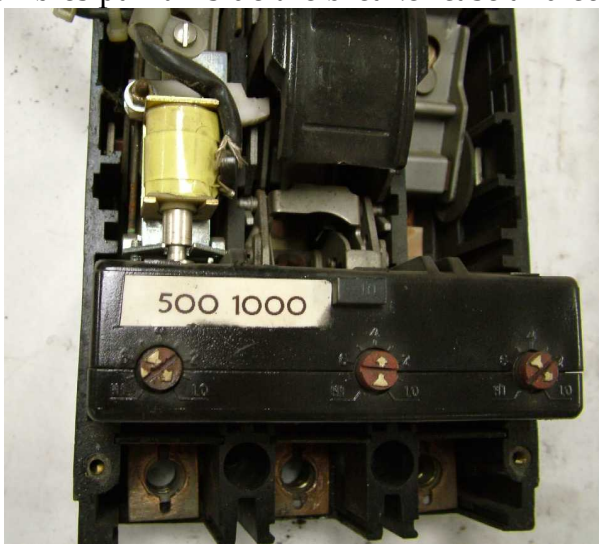
Tape Around Movable Arm



Case Phase Barrier Cut Away

2. Paint

   Paint inside the case of a circuit breaker creates at least two hazardous conditions. The first is a change in insulation characteristics of the molded case. Over time, the paint can deteriorate from the heat and ionization that occurs in the circuit breaker. This can lead to carbon tracking between the phases and subsequent phase to phase and/or phase to ground faults. The second hazard is the addition of a potentially flammable component to a plasma ball occurring because of a fault. Be aware, some Westinghouse 1000 volt circuit breakers do have a dielectric coating that resembles paint inside the breaker case and cover.



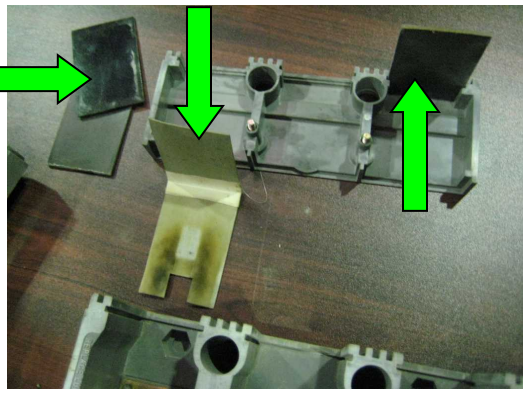
Painted & Shot Blasted

3. Shot Blasting

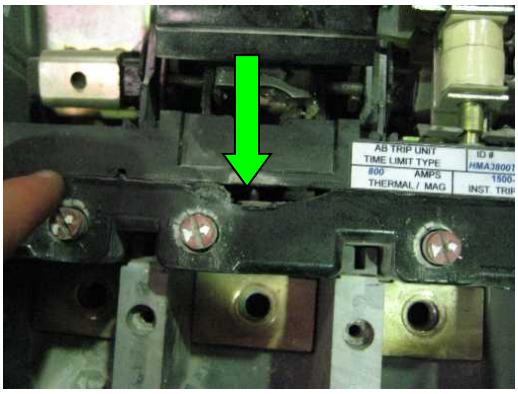
   As noted above, any shot blasting may weaken the case integrity, but internal shot blasting also changes the insulating characteristics of the case, which can lead to arcing between the phases. This can happen when the exposed fibers catch conductive material that builds up and eventually leads to a track between phases.

4. Missing and/or Broken Parts

   There are removable insulators (fish boards) within the circuit breaker case. If any of the fish boards, (cardboard like tabs around the tips), inserts along side of the reset handle that allow removal of the reset mechanism, or any of the top and/or bottom phase insulators are missing or broken, a short circuit hazard or electrical shock hazard is created. Missing components, such as missing or damaged arc chutes, can pose an arc flash hazard.



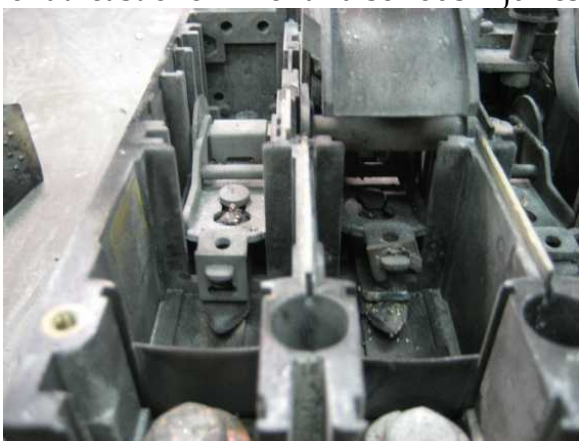
Fish Boards



Broken Trip Unit Housing

5. Contact Tips

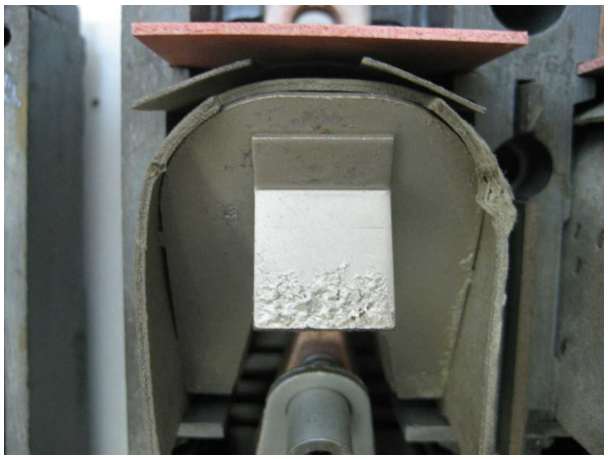
   Contact tips used in mining circuit breakers are made of a special alloy that allows the tips to open under load without welding. The use of tips other than those specified by the circuit breaker manufacturer pose a risk of welding under load. The hazard is potentially life threatening and has caused the death of at least one miner and serious injuries to others.



Welded Contact Tips

6. Painted or Damaged Arc Chutes

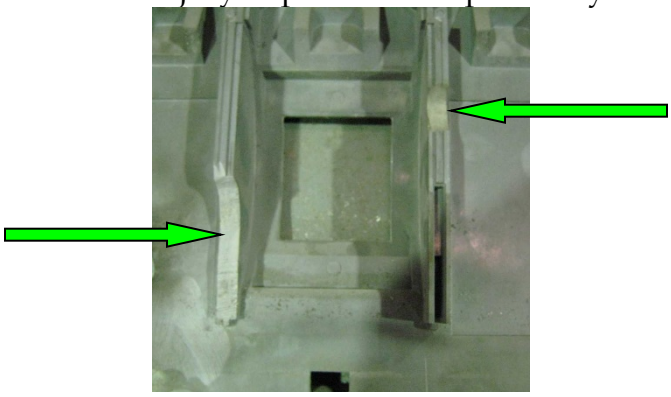
   The arc chutes in a circuit breaker are designed to spread and cool the arc that occurs when the tips break. Paint covering the arc chute diminishes or prevents the arc from being extinguished in a controlled manner. In addition, the paint can contribute to the arc's heat and plasma ball. A damaged arc chute can also minimize the effect the arc chute has on extinguishing the arc. An uncontrolled arc can lead to a short circuit event inside the circuit breaker causing an arc explosion.



Painted Arc Chute

7. Insulation Between Phases

   The circuit breaker case is designed to maintain the arc flash, caused by a breaker opening under load, inside the case and to prevent any shorting between the phases. The material of the case between the phases can be compromised through damage, such as cracks or broken pieces, or from modifications not approved by the manufacturer of the circuit breaker. This can cause the case to become weakened enough that it will no longer contain the force it was designed to contain and/or the electrical clearance between the phases could be compromised and allow an arcing short to occur. Either can cause injury to personnel in proximity to the breaker.



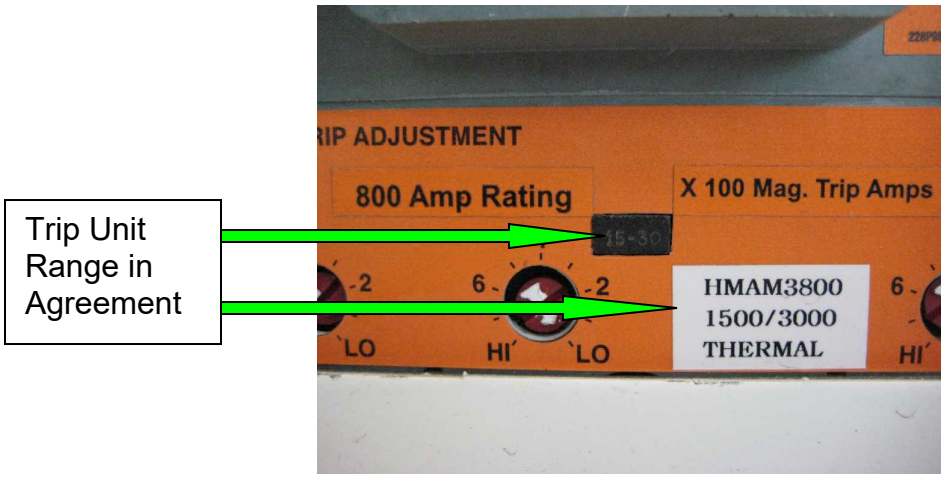
Cover Insulation Cut Away

8. UVR Undamaged and Adjusted Properly

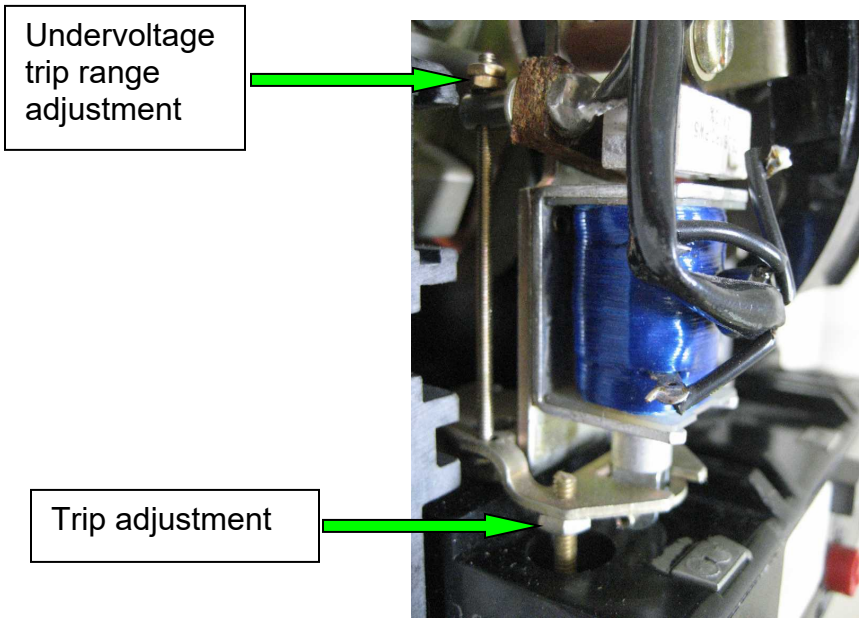
   The ground fault, ground wire monitor, and undervoltage protection circuits rely on the undervoltage release relay (UVR). If the relay is damaged or not properly adjusted, these safety circuits cannot operate the breaker. An inoperative UVR poses hazards of injury, fire, and death.

Trip Unit Visibly Identified

The trip unit must be visibly identified in order to ensure it is adjusted properly to protect the cable attached to the output connector. The identifier must be clearly visible and it must agree with the markings on the trip unit, if it is placed on the outside of breaker case. A trip unit that has had the identification markings removed or the wrong identification attached through human error could allow the cable it is protecting to experience enough current on a fault to generate enough heat to cause a fire.



Trip Unit ID and Settings



UVR Adjustment Points

9. 1000V - Swab Test Pass (**Westinghouse Only**)

   Classic 1000 VAC Westinghouse (now Eaton/Cutler-Hammer) circuit breaker frames HMAM, HLAM and HKAM that are new or refurbished by the OEM can be verified as rated for 1000 VAC by performing a "swab test" of the inside of the circuit breaker. A 1000 VAC rated circuit breaker is coated with a special insulator/anti-track paint that is necessary for the safety of the circuit breaker. A cloth or cotton tipped swab that has solvent applied to it and is wiped across the inside frame of the breaker at the arc chute area of the case will have blue tint from this coating. The inside of the cover at the arc chute area also has this coating applied. The cloth or cotton tipped swab with solvent applied to it will cause a minute amount of the coating to adhere to it, causing the blue color. If a new or OEM refurbished Westinghouse 1000 VAC breaker of these types does not return a blue color after being "swab tested", it may not be able to handle the energy generated during a fault.

Operation

1. Trips on Operation of Safety Circuit

   The circuit breaker must trip on overcurrent, grounded phase, short circuit, undervoltage, and loss of ground wire monitor. The circuit breaker must be tested for trip functionality at least monthly. The easiest and most generally used safety circuit to test the trip functionality is the ground-wire monitor circuit. It is recommended that the other safety circuits be occasionally utilized for testing tripping operation in order to ensure full functionality of the safety devices.