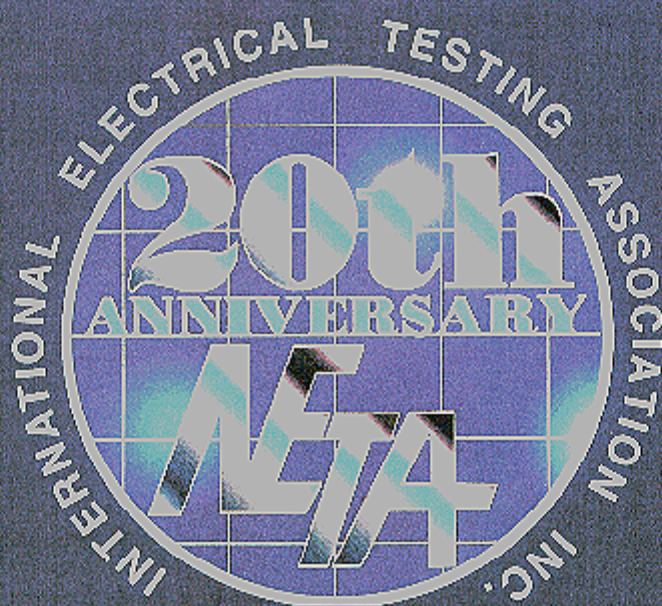


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Problems with Medium Voltage Air Magnetic Circuit Breakers

Technical
Feature

by Don A. Genulis
Power Systems Testing Company

Introduction

Serious problems affecting the operation of medium voltage air circuit breakers that can not be detected during basic testing and maintenance may be widespread throughout our electrical distribution systems. This article shall examine two potential problems that indicate the need for performing additional testing to ensure proper breaker operation.

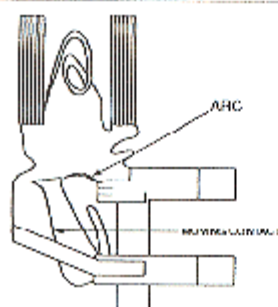


Figure 1A - As the moving contact separates from the stationary contact, an arc develops.

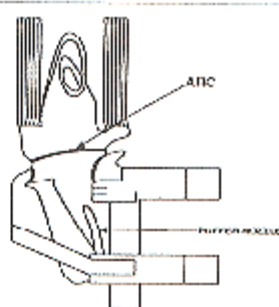


Figure 1B - The arc is transferred to the outer arc horns.

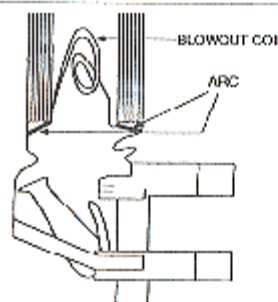


Figure 1C - The arc jumps to the inner arc horns completing a circuit through the blowout coil.

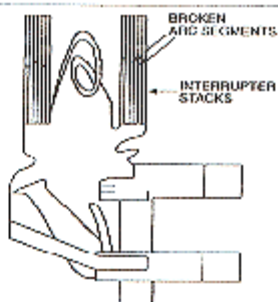


Figure 1D - The blowout coil creates a magnetic field which pulls the arc upward into the interrupter stacks which causes the arc to break up.

Arc Interruption

Arc interruption in medium voltage air circuit breakers occurs in the following manner: As the breaker contacts separate, an arc develops in the air space between the arcing contacts (Figure 1A). The arc progresses upward with assistance from a puff of air originating in the puffer nozzle (Figure 1B) until it is transferred to the arc horns (Figure 1C). When this occurs, current flows through the blowout coil which creates a strong transverse magnetic field, pulling the arc up the interrupter stacks (Figure 1D) where the arc is broken and extinguished.

The condition of the arc chutes and the velocity at which the arcing contacts part are critical to the arc interruption process.

Arc Chute Contamination Problems

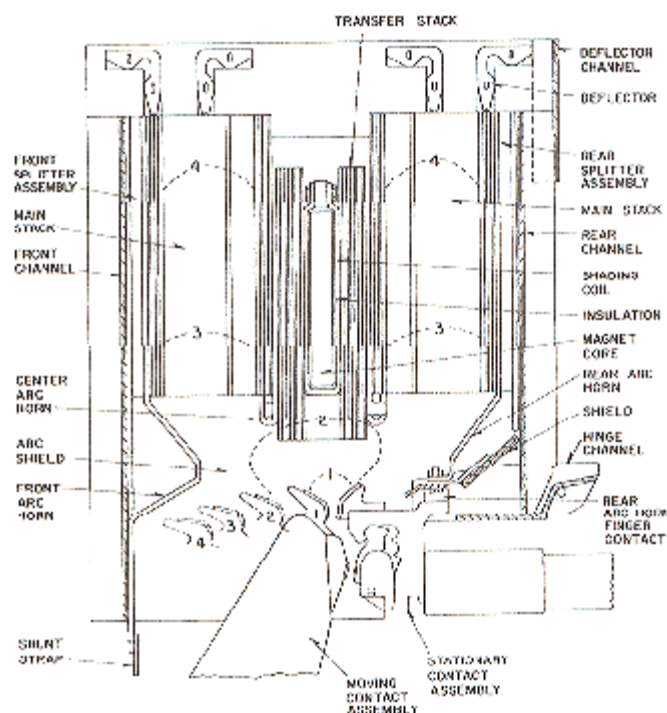
Failure of breakers attributed to moisture contamination of the arc chutes was first documented several years ago. It has been discovered that most arc chute materials absorb moisture when subject to

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high humidity conditions. Ultimately, arc chutes can absorb enough moisture to adversely affect the device's ability to interrupt a fault. Failures associated with this type of problem are almost always catastrophic. Power factor testing of the arc chutes can detect moisture problems and should be included in routine testing and maintenance.

Oven baking of arc chutes has been found effective in correcting high power factors. Additionally, the breaker cubicles should be inspected for proper environmental fit, and all cubicle heaters must function properly to avoid future moisture contamination. Should problems reoccur, switchgear manufacturer's cubicle design or heater ratings may be inadequate. This is especially true for older equipment. Several papers addressing the baking of arc chutes, switchgear environmental fit, and heater problems have been listed in the bibliography.

Although a less common occurrence, breakers subject to heavy duty may develop metal deposits on the arc chutes from contacts vaporizing during interruption.



Arc Chute Arrangement
Figure courtesy Westinghouse Electric Corp.

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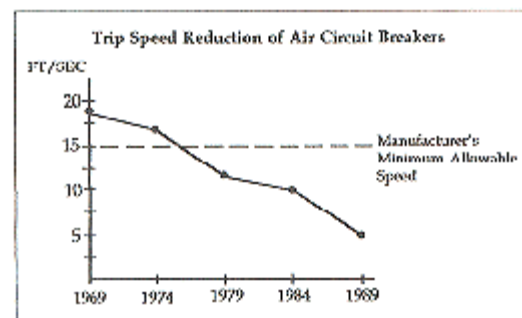


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This problem may be identified by power factor tests or close visual examination and usually occurs in conjunction with severe contact wear. Arc chute replacement is normally the best solution to correct this problem.

Power factor testing of circuit breaker bushings may also detect moisture problems within these insulation systems. Since the power factor test equipment will already be set up from the arc chute testing, it is well worth the relatively short additional time required to perform bushing tests.



Operating Speed Reduction Problems

Although much less documented than arc chute moisture contamination problems, reduced breaker operating velocities should be a major concern.

Research was recently performed on over 500 major midwest utility 15 kV class air circuit breakers. The breakers studied had in-service dates ranging from the early 1950s to the mid 1980s and represented all major manufacturers. All breakers had been timed at acceptance and at approximately five-year intervals thereafter. Approximately 90% of all breakers exhibited decreasing operating times, with approximately 25% of the breakers exhibiting operating velocities below manufacturer's specifications. It is feared that great quantities of the older breakers that are found throughout industry and utility electrical systems may also have reduced operating velocities.



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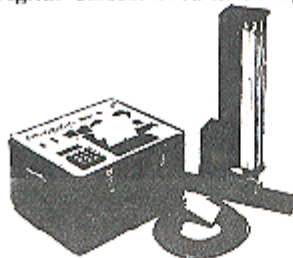
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Ongoing research to correct operating speed problems continues. Exercise and proper lubrication may correct some of the problems. Complete disassembly and rebuilding of the breaker are often necessary to correct more stubborn problems. Regular maintenance is critical in keeping operating speeds at optimum values.

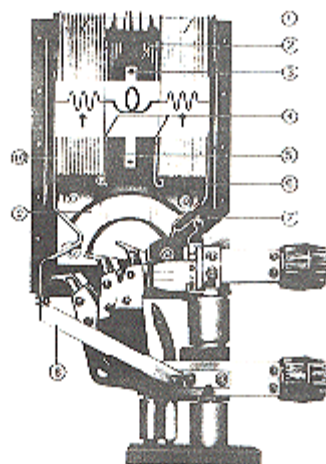
Vacuum Retrofit Option

Vacuum retrofitting of medium voltage air circuit breakers typically costs twice as much as replacing three arc chutes and a set of contacts. Factors such as increased reliability and reduced maintenance costs make such conversions a very attractive option to repairing and maintaining older breakers.

Summary

The following steps should be added to routine breaker testing and maintenance:

- A. Thorough visual examination of the arc chutes and bushings.
- B. Power factor testing of arc chutes and bushings.
- C. Testing of the breaker's operating speeds.
- D. Inspection of the breaker cubicle for environmental fit and heater function.



- | | |
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Pole Unit with Arc Chute — Section View
Figure courtesy Westinghouse Electric Corporation.

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- B. Ultrasonic detection should be performed when possible before de-energizing the breaker to identify tracking or corona occurring in the breaker or switchgear insulation systems. ☼

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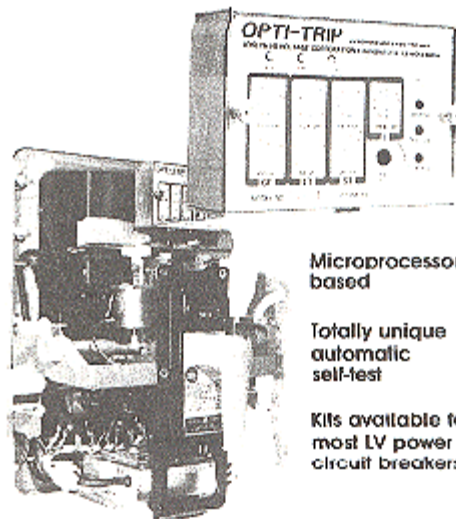
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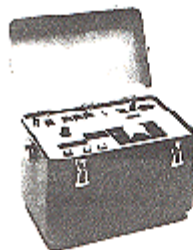


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