

Medium-Voltage Circuit Breaker Maintenance

Medium-voltage circuit breakers, breakers for systems with voltages of 2.4 to 38 kV, have maintenance procedures that will vary based on construction of main contacts and mechanisms used to operate these contacts. In all cases, manufacturer's recommendations must be known and understood by those performing this work. Tests of oil-filled medium-voltage circuit breakers are not covered in this discussion as these tests may be more elaborate than those listed below.

Safety

Maintenance on switchgear should only be performed by qualified individuals and most manufacturers have personnel trained for this work.

Always follow safe practices for circuit breaker operations. Never attempt to remove a closed circuit breaker from an energized bus or bypass safety interlocks. Be aware of arc-flash hazards and ensure proper safety gear is worn prior to switching operations. If available, use remote racking to help reduce possible hazards.

When working within circuit breaker cells there may be multiple sources of control power, both ac and dc.

The following maintenance activities are written from the perspective of a circuit breaker having been removed and in a safe area for inspection with control power available for testing. Safety boundaries must be established and observed for high-potential testing and during application of control voltage.

When removing a circuit breaker from a cell that does not permit rolling it directly onto the floor, exercise caution and use the manufacturer's recommended lifting/handling device.

Circuit breaker mechanisms contain systems that store mechanical energy and accordingly extreme care must be exercised when working within the mechanism.

Tests

A number of common tests and inspections should be done each time medium-voltage circuit breaker maintenance is performed. Prior to performing any of the discussed inspections or tests, is that the breaker must be removed and disconnected from any power sources. Following is a discussion of the minimum inspections and tests required:

Visual inspection of breaker mechanism, frame, insulators, internal wiring, arc-chutes, main contacts (for air circuit breakers), and disconnects (primary and secondary). Care should be exercised to identify any corrosion, overheating, wear, pitting, loose components, cracking, fraying, tracking damage, and general level of cleanliness. Observe the contact pattern in the lubricant on the fingers of the disconnect device of the circuit breaker as this shows any misalignments that may be present. All observations should be carefully documented and, if necessary, photographed. Inspection of the grounding devices should be performed.

Mechanical operation tests will demonstrate the mechanism is functioning per design and that there are no obvious defects within the mechanism. The circuit breaker cycle counter should be observed during each cycle to verify it is counting correctly. Typically a breaker is cycled five times or so to perform this operational test. Interlocks should be inspected and tested to ensure they are present and functioning as designed.

Insulation resistance tests are performed to determine phase-to-phase and phase-to-ground resistances as well as across the open poles of the breaker. These will include high potential tests per recommendations. The manufacturer will often list acceptable values for such tests and for open pole resistances for their circuit breakers and vacuum bottle testing. These tests are conducted in a sequence that includes both closed and open main contacts in order to determine the condition of insulation resistances. Control wiring insulation resistance to ground can be checked using the appropriate dc overvoltage for the rating of the control wire. If solid-state components or control devices that may be harmed by overvoltage are in the circuit, follow manufacturer's recommendations for such testing.

Contact resistance tests are typically performed by passing ten amperes across each closed main contact and measuring the voltage drop of that contact. The measurements are given in microhms and determine the condition of the main contacts to carry current.

Electrical operation of the circuit breaker will permit the verification of charging spring motor, closing coil, trip coil, and antipump relay operation. For the antipump relay testing, when applying control power to the circuit breaker at the testing station, the circuit breaker should not automatically close after the closing spring has charged. The breaker can be tripped (mechanically) while the closing switch or button on a test station is closed and the breaker should open but not reclose. Although not always necessary, the actual voltage for closing coil pickup and trip coil pickup can be tested and checked against manufacturer's data to determine their health. Care should be taken when testing the relays. Apply voltages near the stated pickup voltage and for short periods only so as not to damage the coils. Always follow the manufacture's recommendations.

Tripping time tests may be needed depending on results of other tests. Higher than normal contact resistance, for instance, would justify performing timing tests. Compare results with manufacture's stated data for tripping time to ensure the breaker is performing correctly.

The circuit breaker cell should be carefully inspected and cleaned of any debris. Check operation of the mechanism operated switches (MOC) and truck operated switches (TOC) along with condition of the secondary disconnect, rails, and racking screw. If the bus is de-energized, the operation of the shutters as well as condition of line and load connection spouts should be inspected. Check spouts and connections for wear, discoloration, cracking, and cleanliness. Clean and lubricate wear points in the circuit breaker. When relubricating, keep the lubricant to a minimum to reduce accumulation of dust.

Cleaning of the circuit breakers and cell should be done using lint free rags, denatured alcohol, and a vacuum cleaner with an appropriate filter. Lubrication of mechanisms and connection fingers should be with manufacturer's recommended lubricants. Typically connection fingers are lubricated with non-gumming lubricants. Application of such

lubricant on contact fingers should be a very thin layer such that it is transparent. If there is an obvious accumulation of lubricant, it should be removed. It serves no purpose and can cause increased accumulation of dust and debris as well as increased contact resistance.

Frequency of Maintenance

Frequency of testing will be determined by the conditions the circuit breaker experiences throughout its life. If the circuit breaker has interrupted fault current then the breaker should be taken out of service immediately and maintenance testing should be performed to ensure the breaker remains able to perform the function for which it was designed. Additionally, where power continuity is critical or unplanned outages are costly, the frequency of maintenance testing may need to be increased.

Maintenance testing of breakers typically occurs based on number of cycles, varying for circuit breaker rating, or time period between maintenance, whichever comes first, i.e., every 1000 cycles or each calendar year.

A partial list of specific conditions that may require different and additional maintenance responses are circuit breakers that are exposed to frequent cycling, high magnitude current switching, exposure to temperature and humidity variations, etc. Each of these conditions will require particular attention to be paid to the components of the circuit breaker most affected. It is important to know what conditions circuit breakers are experiencing in order to service them in the best possible manner.

Following guidelines from manufacturer, NETA, and IEEE should result in increased service life of circuit breakers and many years of reliable operation.

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