

***This test is described in Section 5.4 of NEMA AB 4-1996 (Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers used in Commercial and Industrial Applications)\*. NEMA AB4-1996 first notes that the circuit breaker must be removed from the equipment for this test, and contains the necessary warnings relative to the impact of hazardous voltages associated with electrical equipment. NEMA AB4-1996 then discusses the purpose of the test:***

## **5.4 Individual Pole Resistance (MILLIVOLT DROP)**

### **5.4.1 Purpose**

To assess the electrical integrity of connections and contacts in a circuit breaker. This can be done by conducting a millivolt drop test across the line and load terminals of each pole with the circuit breaker contacts closed.

The millivolt drop of a circuit breaker pole can vary significantly due to inherent variability in the extremely low resistance of the electrical contacts and connectors. Such variations do not necessarily predict unacceptable performance and should not be used as the sole criteria for determination of acceptability (See 5.4.5).

The millivolt drops test can show a great deal of variability and that the variations do not necessarily predict unacceptable performance. The Molded Case Circuit Breaker standard, UL 489, for example, does not dictate particular millivolt drop values. Rather, that standard deals with the temperature of the terminals, and other external breaker locations, under continuous current conditions. Thus the millivolt drop test should only be considered as an indicator of the circuit breaker's thermal performance. It is not an absolute test.

### **5.4.2 Equipment**

#### **5.4.2.1**

This test should be conducted using a 24 volt, or less, direct current power supply capable of supplying the rated current of the circuit breaker. For circuit breakers rated higher than 500 amperes, the power supply should be capable of delivering no less than 500 amperes.

### **5.4.3. Procedure**

#### **5.4.3.1**

Operate the breaker to the OFF position. Turn OFF all power to the breaker to electrically isolate it from all other circuits.

#### **5.4.3.2**

Open the enclosure. Verify that there is no voltage on the incoming conductors (and on control power conductors, if present) and between these conductors and ground to positively ascertain that the equipment is de-energized. Follow practices in NFPA 70E, Part II, to perform these steps.

#### **5.4.3.3**

Remove the breaker from the enclosure.

### **5.4.4 Test**

*Note: If the circuit breaker is equipped with an under-voltage trip release, the under-voltage trip release must be energized to allow proper operation.*

#### **5.4.4.1**

The test is performed as follows:

##### **5.4.4.1.1**

Apply test current across a pole equal to the breaker rating (or 500 Amperes minimum for breakers rated in excess of 500 Amperes). Record the millivolt drop and the test current. Do not maintain current for more than one minute.

The referenced IEEE paper "Measuring Molded Case Circuit Breaker Resistance" shows that millivolt drops can actually decrease with time during the passage of continuous current. Further, the UL temperature rise test is associated with equilibrium conditions and involves current flow for significantly longer time periods

than one minute. Thus the above test will provide an indication of millivolt drop, but will not measure the equilibrium value.

5.4.4.1.2

Deenergize the test circuit. Manually operate breaker to the OFF and then ON positions.

5.4.4.1.3

Repeat steps 5.4.4.1.1 and 5.4.4.1.2 for a total of three readings on the pole being tested.

5.4.4.1.4

Repeat steps 5.4.4.1.1 through 5.4.4.1.3 for each of the remaining poles of the circuit breaker.

## 5.4.5 Results

The data will vary according to the breaker frame type, ampere rating and manufacturer. The manufacturer should be consulted to determine the acceptable level for the breaker under test. If the average test values on any pole of the breaker exceed the manufacturer's data, a potential overheating condition may be indicated and additional tests may be required. For additional guidance, consult the manufacturer.

Test results will be affected by many circuit breaker variables, and also by many measurement variables such as source voltage, source current, source stability (zero ac component), and current duration. In particular, as a result of these factors, millivolt drops measured under the above conditions will be higher than the drops encountered under continuous ac duty. The determinant for continued use of the breaker should be the external temperatures measured under equilibrium conditions. However, in the absence of that capability, if the average millivolt drops exceeds 200 millivolts, under the above test conditions, it is recommended to consult the original equipment manufacture (OEM).

It is noted that values exceeding 200 millivolts can be expected for motor circuit protectors (MCP, HMCP, HMCPS, HMPCE through 100A) found with manufactures such as Cutler-Hammer since they are equipped internally with high impedance coils. Here the measured value does not reflect the millivolt drop across the electrical contacts. Similarly it is noted that 15A molded case circuit breakers are equipped internally with high resistance bimetal[s]

## 5.4.6 Reinstall Breaker

Follow manufactures instructions to reinstall circuit breaker.

