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RE: Circuit Breaker Pole Resistance Testing

**Background**
The measurement of pole resistance is a common industry practice useful for detecting problems of improper assembly (ex: loose joints, low contact force, etc) in new breakers and end of life conditions (ex: contact wear) in used breakers. Unfortunately the ability of this test to separate good breakers from bad is limited by the nature of the circuit breaker main power contacts. Main power contacts, as normally tested during commissioning, will routinely measure values well in excess of published typical values.

There are two main reasons for this. One is the normal build-up of resistive oxides on the contact surfaces, possible accumulation of particulate contaminants during shipping and storage, and the composition of the contacts themselves. Each breaker has its own contact composition with unique dynamic resistance properties. Some contacts, such as those containing graphite for example, have notably higher resistance at room temperature than during the much warmer normal operating conditions. Fortunately these effects are almost never detrimental to the proper functioning of the breaker as they tend to be self-correcting and disappear as the device enters service and achieves normal operating temperature. The second reason is that the published pole-resistance values themselves are typically calculations based on Watts-loss tables which indicate the maximum heating expected of a pole during full-load service conditions. This assumes warm, conditioned contacts free from the adverse factors listed above.

The end result is that the vast majority of new circuit breakers which test high for pole resistance are in fact no different in terms of fitness for use from those accepted, and the measurement of pole resistance using low power techniques without proper conditioning cannot be considered as 100% reliable.

**Recommendation**
A more correct technique would involve allowing the circuit breaker to experience the normal exposure to current, voltage and temperature as seen in service over a time period long enough for the contacts to reach normal operating temperature. Test procedures which request primary injection testing as prelude to pole resistance testing have taken a step in the right direction. In some cases this is sufficient but not in others, particularly with newer circuit breaker constructions which may include features such as dual break contacts and those in which arcing occurs on a different contact or part of a contact than what mates during normal service, and some contact compositions.
We have found that the most reliable technique to bring the contacts quickly to the approximate in-service condition is to apply an over current of 300% for a time up to about 75% of the minimum tripping time (generally just several seconds). The breaker is not tripped nor opened after the application of current but rather allowed to cool (power connections are within 5C of ambient) and then tested using low power direct current methods.

In the absence of a good conditioning procedure prior to testing, it is reasonable to apply a factor of three to the published value based on calculations from Watts-loss tables. If the cold resistance value exceeds 3x, we would recommend contact conditioning as described in the previous paragraph, and re-testing.

**Conclusion**

It is true the device is good if the pole resistance measurement says it is so. However, for reasons discussed above, a high pole resistance merely indicates that more work, including contact conditioning, is needed to determine if there is a real problem or if the main power contacts are simply behaving in their normal, somewhat variable manner.

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