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Testing of vacuum interrupters with dc test sets

On occasion, Siemens receives reports of vacuum interrupters that have failed to pass the vacuum integrity test in the field. Often, the circuit breaker that includes the failed interrupter is returned to our engineering headquarters for further examination. Vacuum integrity tests, either with an ac high-potential test set (as used in factory testing) or with a dc high-potential test set (more common in field testing), are performed and the vacuum interrupter passes the vacuum interrupter test.

Why would a user testing in the field obtain different results than when tested in the factory?

There are a variety of portable test sets available from manufacturers for performing a high-potential test on open vacuum interrupters. The great majority of these test sets are dc test sets, as they are considerably more compact, and hence, more portable, than available ac high-potential test sets.

These portable dc high-potential test sets vary considerably in their output current limitation. A sampling of units available shows output current limits ranging from 300 μA (0.3 mA) to 20 mA, a range about 60 to 1. Most of the reports of failed vacuum interrupters that Siemens receives are associated with dc high-potential test sets with output current limits at the low end of this range, typically those units with 300 μA (0.3 mA) output current limit.

One of the vendors of such test sets addresses the issue of false failure indications as follows:

“When a dc test voltage is used, a high field emission current from a microscopic sharp spot on one contact can be misinterpreted as a sign of a vacuum interrupter filled with air. To avoid a misinterpretation of the test result, the vacuum interrupter should always be subjected to both dc voltage polarities. This means the test should be carried out by reversing polarities. A bad interrupter filled with air will have a similarly high leakage current in both polarities.”

A good interrupter with a good vacuum level may still have a high leakage current, but this will generally be in only one polarity. An interrupter with a tiny sharp spot on the contact produces a high field emission current only when it is a cathode, not an anode. So repeating the test by reversing the polarities will avoid any misinterpretation of the result. The test voltage to be used for testing a vacuum interrupter is recommended by the manufacturers of vacuum interrupters.¹”

Siemens rarely, if ever, receives reports of vacuum interrupters failing the vacuum integrity test when the test is conducted using a test set with a higher output current limit.

Therefore, when performing the vacuum integrity test using a dc high-potential test set, the test should be conducted with both polarities.

Footnote:

¹ Source: Vanguard Instruments Company, Inc. “Vacuum Bottle Circuit Breaker Application and Testing Guide, Revision 1.1, July 20, 2016

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