

TechTopics Topic: Checking Integrity of Vacuum Interrupters

Recently, one of our customers asked us to explain why we recommend the use of a dielectric test to check for the integrity of the vacuum in a vacuum interrupter. The customer asked what standard dictated that a dielectric test be used.

A dielectric test is appropriate for any electrical equipment, but this issue is a matter of practicality, not of standards. For old technologies, i.e., air magnetic circuit breakers, the user could visually examine the arc chutes for integrity, and could also examine the contacts. However, for any circuit breaker with sealed interrupters (i.e. vacuum or SF6), it is not possible to visually determine the internal condition of the arc interrupting structure or examine the contacts. Therefore, another means is needed to determine the condition of these vital elements.

Vacuum interrupter contacts are designed so that they practically never wear out. Our circuit breakers (typically) are capable of 10,000 interruptions at full load current, which is also the typical mechanical endurance of the operating mechanism. Depending on the interrupting rating, the interrupters are capable of 20-100 full fault current interruptions. Compared to the endurance of the old technologies, the contact life of vacuum circuit breakers is nearly unlimited. By comparison, air magnetic circuit breakers were only required to endure four full fault rated operations before rebuild or replacement.

OK, that takes care of contact life. What about dielectric integrity? Since the inside of the vacuum interrupter cannot be visually examined, the only practical means to check vacuum integrity is a dielectric test across the open contacts. This is recognized in a variety of standards, but the major ANSI standard is C37.09-1999. Clause 5.8 of this standard has this to say on the subject:

5.8 Vacuum integrity tests

The purpose of vacuum integrity tests is to demonstrate that the pressure on the vacuum interrupter is still below the maximum level required for the acceptable performance of the switching and insulating functions. The vacuum level will have been checked by the vacuum interrupter manufacturer before shipping the unit to the circuit breaker manufacturer. Therefore, the tests identified in this standard are to demonstrate that the assembly of the vacuum interrupter into the circuit breaker and the operation of the circuit breaker do not affect the vacuum integrity of the interrupters.

Measuring the pressure inside of a vacuum interrupter is a very difficult task and those measurements can only be performed on a vacuum interrupter by itself, not when installed in a circuit breaker. Therefore, the requirements of this standard are limited to the use of a voltage withstand test to verify that the vacuum pressure is still within the acceptable limits.

After assembly, the vacuum circuit breaker shall be subjected to a dielectric withstand test to demonstrate its integrity. The test voltage shall be stated by the manufacturer and the final dielectric test shall be carried out after the routine mechanical production tests. These tests may be combined with the requirements of 5.16.

This basically says that vacuum integrity is checked by means of a dielectric test across the open contacts. On a new 15kV circuit breaker, this is performed at 36kV AC. For a used circuit breaker, the test voltage should be 75% of the new test voltage, or 27kV for this example. The 75% level for field dielectric tests is

established in ANSI C37.010, clause 5.5.1, and provides a margin for normal deterioration, minor contamination, and the like.

The use of a dielectric test to check vacuum integrity is also incorporated in in ANSI C37.85-1989. This document is entitled "Power Vacuum Interrupters—Safety Requirements For X-Radiation Limits", and clause 6 is as follows:

6. Dielectric Withstand Voltage Tests on Used Interrupters

Dielectric withstand voltage tests should be performed by users of switchgear devices, as part of a preventive maintenance program, to prove the ability of insulating materials and spacings to withstand specified over-voltages for specified times without dielectric breakdown or puncture. The test voltage levels used for field tests are typically 75 percent of the levels used on new equipment by the suppliers.

Dielectric withstand voltage tests may also be used to establish the vacuum integrity of vacuum interrupters. Suppliers shall prescribe the test procedures, including gap settings and test voltages, for conducting dielectric withstand voltage tests on used vacuum interrupters or switchgear utilizing vacuum interrupters.

When dielectric withstand voltage tests are performed on used vacuum interrupters, or on switchgear utilizing vacuum interrupters, precautions shall be taken for the safety of test personnel. If distances normally required for electrical safety are maintained, X-radiation exposure to test personnel generally does not exceed established dose limits (see ANSI/NBS 114-1974). Nevertheless, adequate precautions such as shielding or distance should be used to protect personnel against possible higher X-radiation occurrences due, for example, to incorrect contact spacing, or to the inadvertent application of voltages in excess of the values prescribed in Column 3 of Table 1.

For 'clean' applications (environments which meet the "usual service conditions" in ANSI), we recommend a vacuum integrity test at normal maintenance (For the type GMI circuit breaker, 5 years or the number of operations appropriate to the rating as shown in the instruction manual). For environments which are more severe, the dielectric test should be performed more frequently to detect contamination of the external surfaces of the interrupter (the inside of the interrupter isn't affected by the environmental conditions).

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