

Tech Brief

Testing for Loss of Vacuum in Vacuum Interrupters

In the 30 years or so that they have been used in circuit breakers, vacuum interrupters have proved to be extremely rugged, reliable devices. However, like any man-made device, they can fail. A frequently-asked question is "How can I tell if my vacuum interrupter has lost vacuum?"

Modern vacuum interrupters are evacuated to a pressure on the order of 10^{-7} Torr. A Torr is the pressure exerted by 1 mm of mercury, or 1/760 of a standard atmosphere. 10^{-7} Torr is approximately equal to the pressure of the atmosphere on the surface of the moon. Testing by manufacturers of vacuum interrupters shows that the vacuum interrupter will still interrupt its rated interrupting current at a pressure $\leq 10^{-3}$ Torr, but at pressure above 10^{-3} Torr is interrupting capability falls off. Thus, a successful loss of vacuum test must detect the difference between pressures above and below 10^{-3} Torr.


An ideal loss of vacuum test would be an on-line test that constantly monitored the pressure within the vacuum interrupter and alarmed when this critical pressure was approached. Unfortunately, no such device is presently commercially available.

The present state of the art leads Powell to recommend the use of a high voltage test across the contacts of an open vacuum interrupter. This test should be at least 25 kV, 50/60 Hz, or the equivalent dc voltage, 35 kV⁽¹⁾. A breakdown during this test indicates a loss of vacuum in the interrupter. If dc is used in this test, it must be supplied from a full-wave rectifier. The use of a half-wave rectifier in the power supply can lead to applying excessive dc voltage to the vacuum interrupter. In all cases, the manufacturer's instruction book for the circuit breaker should be consulted for proper procedure and cautions before making the test.



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At least one switchgear manufacturer is stating that loss of vacuum can be detected by disconnecting the movable contact of the vacuum interrupter from the mechanism and manually pulling on the movable contact. Atmospheric pressure (760 Torr) on the exposed side of the movable contact pushes the contact closed with a force proportional to the area of the contact. This force is about 40 pounds for a typical vacuum interrupter used in our PowlVac® (circuit breakers). If there is a complete loss of

vacuum, this 40-pound force disappears, and a pull test will certainly be effective. However, partial loss of vacuum in the 10^{-2} Torr pressure range puts the vacuum interrupter at risk of not performing properly, but decreases the 40-pound force by only a fraction of an ounce. This minor change in contact loading would hardly be detectable by a good force gauge, much less by feel. Powell therefore does not recommend this pull test as a satisfactory loss of vacuum test. 

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