5kV Testing

How Much Is Enough?

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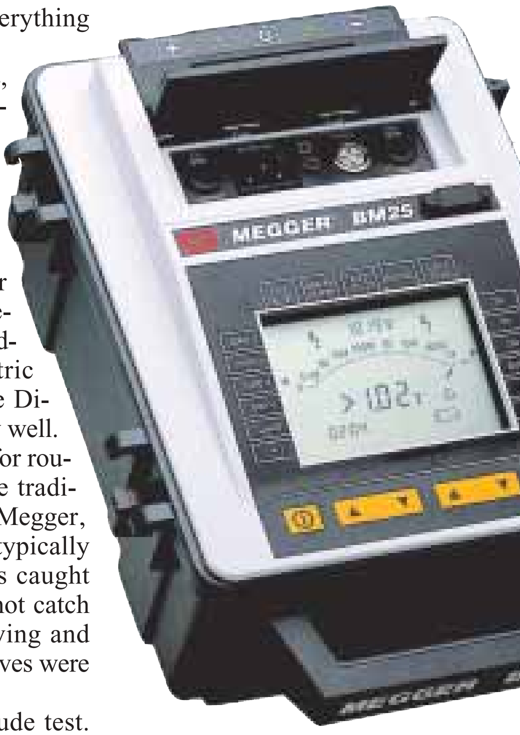
The plethora of insulation test methods and procedures that appear in the literature and product descriptions can seem bewildering to someone trying to establish a testing regime or meet an application. A thorough explanation of all of them, of course, is well beyond the scope of a single article, but for a convenient organizing principle, one can refer to the Law of Diminishing Returns. That is to say, no single test can tell everything about a particular section of insulation or its associated apparatus, so that additional tests may be required to isolate a problem or make a determination. But theory must be balanced against practicality in order to avoid the wasted time and expense of making more and more tests for fewer and fewer added results. A procedure issued to customers by a leading manufacturer of electric locomotives, GM Electro Motive Division, illustrates this concept very well.

Locomotives returned to shop for routine scheduled maintenance were traditionally tested by either/or 1 kV Megger, insulation tests or high-potting, typically at 1080 VAC. While these tests caught most problems, the practice did not catch them all. There persisted annoying and costly failures after some locomotives were returned to service. Why?

High-potting is basically a crude test. Many rely on it because its dramatic results (failure light and buzzer) tend to inspire confidence in the test, but therein lies the shortcoming. A high-pot makes a pass/fail determination based on a trip setting for either breakdown or leakage current, or both. This may be set by the operator, or it may be factory-set by the manufacturer. It gives only an indication of the condition of the test item (in this case, a locomotive) *at the time of the test.* It has no predictive value. If the insulation has a pinhole that arcs current to the frame, the high-pot indicates failure, and the problem is recognized. But if, say, moisture ingress has seriously lowered the resistance of the insulation to a value just above the trip setting, it's a case of "a miss is as good as a mile to a blind horse." The locomotive goes back into service, but may fail after the first heavy rain. Furthermore, because a high-pot will output higher currents and sustain an arc, it can further damage the insulation. A failure that could have originally been treated as a drying operation can become a rewind job.



An insulation tester (commonly referred to as a "Megger," although that is in fact a registered AVO trademark) overcomes these problems. Rigorous limiting of output current by a resistor network in the test circuit means that under the lowered resistance associated with deteriorated insulation, the test voltage will automatically drop to non-injurious levels. And an insulation test, instead of a simple pass/fail indication, provides an accurate *reading* of the resistance value. There can be no "near misses." If the reading is above bare minimum but close to unacceptable, further cleaning and drying may well restore it to a condition that will keep the equipment running satisfactorily well into the next scheduled maintenance period.

Then why did EMD still experience failures in the field? Because an insulation tester is commonly thought of as a 1 kV piece of test equipment. Many experienced and capable operators have used insulation testers for years without going above a 1 kV test. This is, of course, generally adequate. But there are problems that a 1 kV test may not see. Pinholes and cuts in insulation posed a big problem for EMD. Depending on their positioning with respect to ground, a given test voltage may or may not "pull" an arc. Remember, air is an effective insulator, so the more voltage that is applied, the greater the separation that can be arced. Carbon tracks and similar physical damage will also allow greater amounts of current at higher voltages. Such damaged spots may "pass" at 1 kV, but rapidly deteriorate to breakdown when put back into service. Does this mean that testing must be repeated at ever higher voltages? Fortunately, there's a practical limit, as EMD discovered through rigorous experimental testing.

They conducted an extensive and rigorous study of tests at increasing voltages from 1 kV up to 5, and were able to document that each increase in test voltage revealed additional problems in the tested insulation. Fortunately, by the time they reached 5 kV, they'd achieved "close to 100% success" in recognizing problems. As a result of the study, EMD has recommended the implementation of a 5 kV testing regime to anyone servicing their products.

The selection of test voltage is a critical first step in applying an insulation test. For most common situations, the familiar lower voltages will work just fine. But fortunately, as the EMD study has revealed, for bigger equipment and more demanding requirements, enormous test voltages are not the order of the day. A convenient compromise between the theoretical and the practical has been "proofed out" at 5 kV. ■