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Hospital Engineering

Medium Voltage Cable:
To Test or Not To Test

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For many years, utilities, university campuses, medical centers, and industrial plants have made use of medium voltage (5 to 35 KV) power cable.

Factors such as temperature, water, or factory defects cause cables to fail.

Although medium voltage power cables are carefully tested by manufacturers before shipment, some defects go undetected or are more likely damaged during shipment, storage, or installation. Furthermore, cables that are currently in service are most likely approaching or already exceeding their life expectancy.

Cable in service is also subject to several factors that may cause it to fail:

1. Water permeates through outer layers and migrates into insulation, which can lead to creating water trees and then electric trees, causing partial discharge and failure.
2. Elevated temperature or overload can lead to chemical breakdown of the insulation, producing thermal runaway that can decrease insulation resistance and increase current leakage and failure.
3. Manufacturing defect or poor installation can result in voids or contamination, which will produce partial discharge and failure.

The question then becomes “How does a user determine the reliability of its medium voltage cable system?” The obvious answer is by field testing. Field testing is broadly divided into two categories:

1. Field tests that are intended to detect defects in the insulation in newly installed cable prior to energization or in cable after defects have been replaced and repairs have been made.
2. Field tests that are intended to examine the insulation integrity and the overall condition of an in-service aged cable system before it experiences future service failures.

Traditional Cable Testing Methods

A traditional method to test medium voltage cable has been DC high potential, also known in the industry as DC “Hipot” testing. For many years, this test worked well as a factory, field maintenance and assessment test. However, by the mid 1990’s, a multitude of reports and field data made it evident that DC Hipot testing could be the lead cause to damage or to prematurely cause the failure of extruded cables, specially to field aged cross-linked poly-ethylene (XLPE) insulated cable.

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This prompted the Electric Power Research Institute (EPRI) to fund two individual studies relating to the effect of DC Hipot testing on XLPE and EPR (ethylene propylene rubber) insulated cables. The results were never conclusive on the EPR insulated cable; however, they were on the XLPE insulated cable. The conclusions of the study were:

1. DC Hipot testing before energizing new medium voltage cable dose not cause any harm to the cable.
2. DC Hipot testing of XLPE insulated cable that is in service – aged in a wet environment using the industry recommended DC levels (i.e. 25 KV on 5 KV cable) and for the recommended length of time (15 minutes test) may cause the cable to fail after its return to service. The failure may not have occurred at that point in time if the cable has remained in service and has not been tested with high DC voltage.
3. Massive insulation defects in extruded dielectric insulation cable cannot be detected with DC Hipot testing at recommended voltage levels.
4. Applying over-voltage DC to a cable is to take a snapshot of the cable condition at a given time to determine if it's a go or no go. It provides no trend data, life expectancy or a condition assessment of the cable.

New Cable Testing Methods

Several new testing methods have recently been introduced to the industry and in 2002, the Institute of Electrical and Electronics Engineers (IEEE) took major steps in revising its Guide for Field Testing and Evaluation of the Insulation of Shielded Medium Voltage Power Cable (IEEE 400 – 2001) to include six new approved methods of testing: Direct Voltage testing, Power Frequency testing, Partial Discharge testing, Very Low Frequency (0.1 to 1.0 HZ) testing, Dissipation Factor testing, and Oscillating Wave testing. These tests vary from looking at the condition of the insulation but cannot locate problems (i.e. general health tests) to the "partial discharge locator," which can locate partial discharges that are signs of incipient faults in the cable. It is important to note that of all these tests, only the partial discharge (PD) test can be performed while the cable remains energized and in service, making it the least disruptive test. In many cases, this can be the determining factor in deciding which test to use.

These new test methods have only been developed in the last five to ten years, which make them new to the industry and in some cases subject to the interpretation of the test engineer. Even though new tests exist, there still is not an industry standard test for condition assessment of cable insulation, and none of the tests mentioned are a clear leader in determining everything you might want to know about the insulation or remaining life of a cable. For a detailed description of these tests and a list of advantages and disadvantages of each, refer to IEEE standards 400-2001 or consult with the test manufacturer.

Now that DC Hipot testing is becoming less common in the industry, most cable manufacturers recommend site testing the cable only after it's installed, but prior to energizing it, and most will tell you that the cable should not be disrupted again until it fails. However, the decision to employ annual maintenance testing must be evaluated by the individual facility taking into account the cost of service failure and other intangibles, verses the cost of testing, the possibility of causing damage to the system, and the disruption to the service. With the availability of the non-disruptive (Partial Discharge) test methods, the decision to test should become a little easier to make.

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