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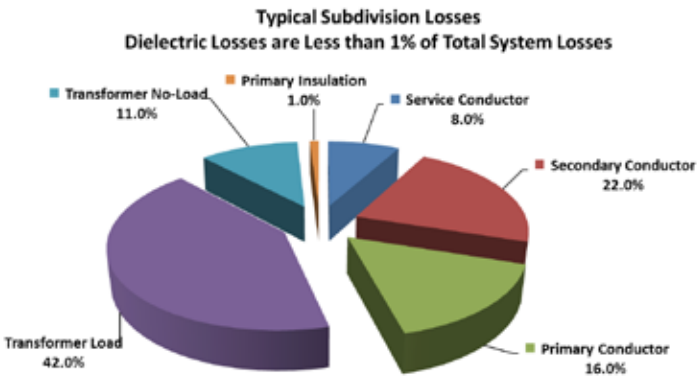
Dielectric Loss Considerations – URD Cable

General

Dielectric losses are not typically of interest or concern in medium voltage underground (URD) cables since they are insignificant in comparison to other variables and considerations. The purpose of this brief review of dielectric losses is to help put the subject in perspective, so the utility can focus on the other factors that determine the long-term cost and reliability of medium voltage underground cable systems.

Dielectric Losses – Utility Systems

Dielectric losses are only a part of system losses. Just how small a part can be given perspective by the following chart. The fact that primary cable losses (of which dielectric losses are a small part) amount to only 1 percent of URD system losses, makes the whole issue of insulation losses somewhat of a non-issue.



Dielectric Losses – Primary Cable

Dielectric losses from the primary cable are a function of the materials in the cable core (conductor shield, insulation, insulation shield) and the geometry of these materials. The characteristics of these materials can be found in the applicable ANSI/ICEA Standards. A review of these standards shows there is a lot of variety in materials allowed.

In the lab, we can measure the dissipation factor and capacitance of a cable sample. With this information the dielectric losses can be calculated. However, there can be a significant error in the measurement of these variables, especially at elevated temperatures. The only true way to get a comparative set of values between different cables is to ensure the cables are all the same design and length, with the same preconditioning, and measured at the same time.

In the field, this loss analysis becomes even more problematic, as there are numerous other variables affecting the dissipation factor and capacitance. For instance, when a cable core is cured in the extrusion process there is a generation of gaseous byproducts. These byproducts change the electrical characteristics of the materials, but are fugitive with time. The byproducts vacate the cable core at an initial high rate that decreases as the concentration of byproducts decreases. Residual byproducts can remain in the cable for many years.

Once the cable is installed it can take on water, where the water can have a wide variety of ionic level contaminants. The water and ionic contamination are factors that contribute to water treeing, which is limited by the insulation material design. All of this activity will change the electrical characteristics of the materials and correspondingly the dielectric losses.

Global Loss Analysis

Losses are evaluated on an annual basis and are accumulative based on the total footage of cable used. If a particular cable application uses tens of millions of feet of cable on an annual basis, a loss analysis might be more logical than for an application that uses tens of thousands of feet.

A typical 1/0 awg aluminum 15 kV URD cable using TRXLPE would have dielectric losses in area of 0.5 watts per 1,000 feet. The same EPR cable could typically range from 5 to 10 watts per 1,000 feet. To put this in perspective, the I2R losses of the 1/0 awg aluminum conductor at 50 amps is: I2R = 50 x 50 x approximately 0.168 = 420 watts per 1,000 feet.

Whether the utility engineer would use 0.5 watts for TRXLPE or anything in the range of 5 to 10 for EPR would not change the end result of an overall analysis of distribution systems losses.

The estimated present value of dielectric loss ($ per 1,000 feet over 40 years) is:

TRXLP @ .5 watts	$10
EPR @ 5 watts	$100
EPR @ 10 watts	$200

Summary Points

- Accurate measurement of dielectric losses is problematic and losses change over time
- Dielectric losses are not a significant part of distribution systems losses, so efforts should focus on other factors