Validating and Quantifying Reliability Improvements of New Cable Designs - A Case Study of 600 V Self Sealing Cables

Chris **Fletcher**[1], Joe **McAuliffe**[2], & Joshua **Perkel**[3]

1 Duke Energy, Charlotte, USA, Chris.Fletcher@duke-energy.com
2 Southwire, Carrolton, USA, Joe.McAuliffe@southwire.com
3 NEETRAC, Atlanta, USA, joshua.perkel@neetrac.gatech.edu

Manufacturers continue to make and utilities continue to deploy new cable designs to address important technical and reliability problems. These new solutions are tested in the laboratory through development and approval tests. Although the deployment begins only when all of these tests are completed to the satisfaction of all involved; there is still a need to verify that the solution really does address the problem and does not introduce other unforeseen issues. This need exists because there are some very important differences between laboratory tests and field experience; laboratory tests are designed to deliver consistency and repeatability, service experience increases the scale (generally by length of product) and exposes the solution to the ill-defined rigors of service. However, although absolutely essential, monitoring performance in service is a challenging undertaking.

Classically, the service performance challenge would be addressed by selecting an area of known problems and constructing a group with the new solution and a group without the new solution – *the control population*. The performance would be monitored for a suitable period of time until a clear and verifiable difference could be discerned. Unfortunately for new cable solutions this approach is not feasible for a number of reasons:

- Record keeping is often not robust enough to segregate the inputs from the mixed Control and New populations
- Installation needs to be part of the normal operation of the utility such that stock & training variables do not interfere
- Confirmation Bias (an *ab initio* perception of good or poor performance) can overwhelm the desired signal
- Once the effectiveness of the new solution is confirmed upgrading the control population can prove to be a logistical and philosophical challenge

Thus, often the only practical way forward is to deploy in areas and compare performance with a non matched, non intercalated Control Group. Consequently the analytical strategies used need to be sufficiently robust. In these cases one issue that becomes important is the very success of the new solution – if it is effective then there will be a lower incidence of problems (i.e. we end up dealing with very small numbers) such that the effects will be quantized and effect of any incorrectly attributed problem will be amplified (the effect of 2 missed failures in 100 is small compared to 2 missed in 15).

Figure 1: Corrosion Failure

A case study was undertaken on the Duke Energy system using their 600 V cable system. The final connection between residential customers and the primary underground distribution system is made using low voltage (600 V) unshielded cables (often termed "secondary" cables). These low voltage systems can often be damaged during or soon after installation as builders and landscapers complete their construction work. Sometimes this damage results in an immediate failure (dig in) while other times the insulation is just damaged enough to allow moisture ingress and eventual corrosion of the conductor (Figure 1).

Cable manufacturers have approached this problem in a couple of ways: (1) tougher insulation materials and (2) self-sealing insulation (Figure 2). The example studied in this paper involves the transition from traditional 600 V insulations to a self-sealing insulation.

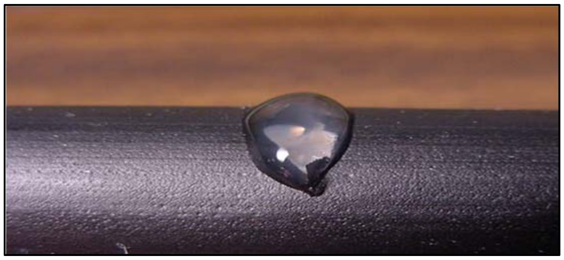

Figure 2: Self-Sealing Cable

This paper will discuss an effective analytical solution using the Crow / AMSAA methodology using the secondary cable case study from Duke Energy. In particular the paper will describe:

(1) Issues faced in verifying new cable solutions
(2) Crow-AMSAA technique for Performance Evaluation
(3) Overview of Low Voltage (600 V) Cable Designs
(4) Why Low Voltage Cable Systems Fail?
(5) Results of Duke Energy Case Study
    a. Data from multi-year pilot study
    b. Initial performance predictions
    c. Comparison of predicted performance to actual performance in service
(6) The benefits in more rapid uptake of new technology with and effective way to quantify benefits