Validating Reliability Improvements of New Cable Designs – A Case Study of 600 V Self Sealing Cables

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ABSTRACT

Utilities and Manufacturers continually deploy new technologies on their systems with the goal of either providing new functionality or improving reliability. Although these devices can be tested in the lab, these results need to be confirmed by field experience. The traditional anonymous Control group approach is often not possible in the Utility context as installations are made when possible and older technologies remain active. This paper describes a technique that the authors have developed for use on Utility systems to validate the performance of a range of technologies (Reclosers, Transformers, Meters, Lighting etc). In this document the process is illustrated using a new design of LV cable.

KEYWORDS

600 V cable, reliability modelling, case study, self-sealing cables, Crow-AMSAA, reliability growth, validation

INTRODUCTION

Manufacturers continue to make and utilities continue to deploy new and innovative cable designs to address important technical and reliability problems. These new solutions are tested in the laboratory through a series of 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 in the field 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. 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 to provide a clear result. The clarity / certainty of the result is important as large investment decisions on the parts of the Utility and Manufacture will ride on this result.

In these cases, one issue that becomes important is the success of the new solution – if it is effective then there will be fewer 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 of Traditional 600 V CAble

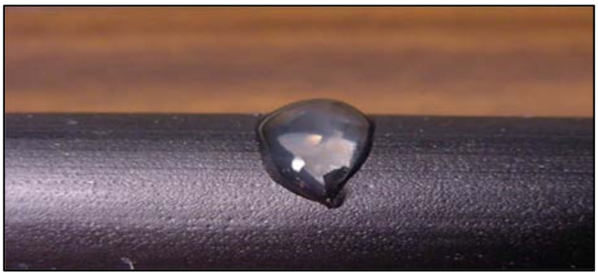

Figure 2: Self-Sealing 600 V Cable

A case study was undertaken on the Duke Energy system using their 600 V (LV) cable system and is described here to illustrate the procedure. 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