FIRST PRACTICAL UTILITY IMPLEMENTATIONS OF MONITORED WITHSTAND DIAGNOSTICS IN THE USA

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ABSTRACT

Hipot or voltage proof tests have long been used to assure the health of cable systems in the factory and when commissioning. One of the concerns with this approach is that there is no way to judge the quality of the Pass, ie did the system barely survive or was there a respectable margin. This paper shows how this problem has been practically addressed in US utilities with an approach which is termed "Monitored Withstand". The protocols and the test philosophies are discussed. A number of case studies are discussed together which some reflections on future activities in this arena.

KEYWORDS

Diagnostic Techniques, Very Low Frequency (VLF), Tan Delta, Decision Tools

INTRODUCTION

Monitoring a property during a withstand (or Proof) test has been proposed as a more complete diagnostic over simple non monitored withstand or single diagnostics (Leakage, PD, Tan Delta etc) [1 - 5]. This paper describes some of the first practical implementations of this approach in the US and provides the collated results to date.

Proof or withstand tests have been used for a very long time in the cable industry and find their origins in the well known routine tests carried out in accessory and cable factories. Although this test continues to serve the industry well, when a Simple Withstand is implemented in the field users continue to be concerned by three issues:

1. There is no way to estimate the quality of the cable system, and hence the risk of failure, prior to the application of the proof voltage.
2. There is no way to adjust the extent of the test (either by decreasing or increasing) according to the quality of the cable system
3. There is no way to judge the quality of the pass should the cable system support the proof voltage ie was the pass a good one or a marginal one.

It had been suggested that if a diagnostic parameter, such as dielectric loss, leakage or partial discharge, were monitored during a proof test then all of the three issues noted above might be addressed. Consequently since 2008 the authors have been conducting Monitored Withstand tests on utility systems using very low frequency (VLF) waveforms to assess the practicality of the initial hypothesis. Experience has shown that the Monitored Withstand whether using Partial Discharge or Dielectric Loss does bring considerable and useful information to the utility engineer.

This paper describes

- Background to Monitored Withstand approaches
- Differences associated with the metrics used for Monitored Withstands in comparison to the more normal pure diagnostics
- Approaches for determining critical values for the monitored features
- Decision tools for interpretations
- Utility and Laboratory Case Studies including follow ups on system performance

MONITORED WITHSTAND TESTS

Simple Withstand tests are proof tests that apply voltage above the normal operating voltage to stress the cable system in a prescribed manner for a set time [1 - 5]. These tests are similar to those applied to new accessories or cables in the factory where they provide the purchaser with assurance that the component can withstand a defined voltage. An alternative and more sophisticated implementation of the Simple Withstand approach requires that, in addition to its surviving the voltage stress, a property of the system be measured and monitored. This implementation of a withstand test, called Monitored Withstand, is discussed in this section.

One of the drawbacks of Simple Withstand tests is that there is no straightforward way to estimate the "Pass" margin – once a test (say 30 min at 2 U_0) is completed, it is impossible to differentiate among those passing segments. That is, it is impossible to distinguish the segments that would survive 120 min from those that would have only survived 40 min. Thus, it is useful to employ the concept of a Monitored Withstand Test whereby a dielectric property or discharge characteristic is monitored to provide additional data. There are four ways these data are useful in making decisions during the test:

- Provide an estimate of the "Pass" margin.
- Enable a utility to stop a test after a short time if the monitored property appeared close to imminent failure on test, thereby allowing the required remediation work to take place at a convenient (lowest cost) time.
- Enable a utility to stop a test early if the monitored property provided definitive evidence of good performance, thereby increasing the number of tests that could be completed and improving the overall efficiency of field testing.