NEXT GENERATION 200 KV VLF FIELD TESTING AND DIAGNOSING OF POWER CABLES

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ABSTRACT

With the available new technologies, VLF withstand, VLF tan delta, and VLF partial discharge detection. VLF AC field testing of high voltage cables has become possible. The testing system consists of a 200 kV VLF AC high potential test set paired with a tangent delta and partial discharge measurement system. Existing standards that govern field testing of medium voltage power cables with a VLF source such as IEEE 400.2 and the testing of HV/EHV power cables such as IEC 60840 and IEC 62076 will be discussed and correlated. Finally, actual field testing of HV/EHV power cables with the VLF test system, results, and field experience will be discussed.

KEYWORDS

VLF Withstand, VLFTD, VLFPD, Tan Delta, Partial Discharge, High Voltage, Dielectric Insulated.

INTRODUCTION

VLF AC high potential withstand testing and diagnostics of HV/EHV cables. The main reason for performing a cable test (DC, 50/60Hz, Resonant, and VLF) is to verify the integrity of the cable system under test. An AC hipot test is preferred over the DC test because of the AC diagnostic techniques available and the known detrimental effects of DC high potential testing on solid dielectric insulated cables [1], [2]. The logistics of AC cable testing in the field play an important role in which type of test is applied. The information presented proves that VLF AC testing is the most efficient method, when applied to field cable testing. Figure 1 below shows an example of a geographical location where it is almost impossible to implement any method other than VLF.

Figure 1 – 8 km of 220 kV XLPE Insulated Cable in Chile

THE WITHSTAND TEST

A range of HV and EHV cables can be withstand tested with a 200 kV peak VLF high potential test set. The traditional withstand test is known among utilities and testing service providers where a test voltage of 2-3 times the phase-to-ground voltage 'U0' is applied for a certain time duration. The results of this test would be pass or fail. Healthy cables that have been subject to proper installation and proper jointing and termination workmanship will pass a withstand test, Unhealthy cables will not. There are known standards that govern such tests such as IEEE 400.2.

THE TAN DELTA TEST

There are cables in our networks that are critical. In this case, does the cable user or owner want to subject this cable to the high potential of withstand voltages with risk of failure, or does the cable user/owner want to assess the condition of this particular cable?

Tan Delta testing is used to diagnose our cables by means of performing tan delta 'TD' measurement without subjecting the cable to the higher potentials or electric stress of a traditional withstand test. For example, the voltage levels for a traditional tan delta cable test are the following: $\frac{1}{2}\cdot U_0$, $1\cdot U_0$, and $1.5\cdot U_0$ over time spans of 5-10 minutes. This test criterion is mentioned in the recent revision of Standard IEEE 400.2 and in a number of publications [3].

Tan delta tests assess the overall condition of a cable system, which includes the length of installed cable along with the joints and terminations. Research has rendered indicative information to assessing certain tan delta readings whereas a cable maybe categorized as no action required, further study needed, or immediate action required [3]. The following Table – 2 with courtesy of NEETRAC CDFI Tan Delta Diagnostic Handout provides information on assessing XLPE insulated cables and will be available in coming updates of Standard IEEE 400.2.

Condition Assessment	VLF-TD Stability (standard deviation) at U_0 [10^{-3}]		Differential TD (difference in mean VLF-TD) between 0.5 U_0 and 1.5 U_0 [10^{-3}]		Mean VLF-TD at U_0 [10^{-3}]
No Action Required	< 0.05	OR	< 5	OR	< 4
Further Study Advised	0.05 to 0.5		5 to 80		4 to 50
Action Required	> 0.5		> 80		> 50

Table – 2 Condition Assessment of PE-based Insulations (i.e. PE, XLPE, WTRXLPE) with courtesy of NEETRAC, CDFI Tan Delta Diagnostic Handout