Improving Cable System Reliability with Monitored Withstand Diagnostics - featuring high efficiency at reduced test time

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ABSTRACT

Medium voltage cable systems are degrading over time and subsequently more failures are recorded. Effective asset management strategies are required to manage the ageing underground cable infrastructure. Here, smart cable diagnostic methods are implemented to provide information on cable degradation at reduced test voltage levels avoiding unnecessary stress.
Effective maintenance programmes help to renew the weak cable accessories or cable sections in time.
Monitored Withstand Diagnostics offers the highest efficiency and significant time saving due to simultaneous PD and tan delta diagnostics. The simultaneous diagnostic trending provides unique information. Best practice examples of Monitored Withstand Diagnostics are illustrated.

KEYWORDS

Condition-based maintenance CBM, cable diagnostics, Monitored Withstand Diagnostics MWD, Monitored Withstand Testing, hybrid cable systems, diagnostic trend monitoring, partial discharge, dissipation factor tan delta, tan delta hysteresis, aged cable systems, very low frequency, improving cable system reliability

INTRODUCTION

Medium-voltage cable systems are common and important components for a reliable electric energy supply. The cable networks of power suppliers have mostly evolved over time. The older cable networks mainly comprise paper-insulated lead covered cables (PILC) laid decades ago as well as, in recent years, popular extruded cable types with PE, XLPE or EPR insulation. Many older cable systems have been built with PILC cables and through ancient network extensions and reconstructions have been converted to hybrid cable systems now consisting of various cable insulation types.
Medium-voltage cables are typically developed and designed for a service life of 30 to 40 years. Many medium-voltage cables of the older generation have reached the end of the statistical service life, including the cable accessories such as terminations and joints.
Replacing buried cables is very expensive and very complicated, especially in dense city areas, and is usually associated with administrative complications often caused by city authorities. Power utilities are required here to ensure reliable power supply to customers using efficient maintenance strategies.

Fig.1: old 3-phase termination of a 3-lead cable

Maintenance strategies:

To safeguard power supply, utilities usually prepare maintenance plans, whereby the cable systems are regularly tested for electric strength and reliability by a voltage withstand test and priority is given depending on the importance of the cable and the cable history. The VLF cable test in particular has been established in recent years and is used worldwide by most power utilities. As commonly known, during a cable test the cable is loaded with higher test voltage to detect prospective defects and weak points. The cable withstand test, guided by international and national standards, is described and known as a destructive test procedure: weak spots in the cable system are brought to breakdown and then the defective insulating material is replaced. [1]
Unlike the conventional cable test, cable diagnostics is a gentle and smart procedure for condition evaluation. Cable diagnostics is mostly applied with a slightly reduced test voltage and provides information on developing faults and the condition of the cable system without damaging the cable.
Many European utilities have built their maintenance strategy based on this technology and have been using it successfully for many years.