North American Performance Experience of HV and EHV Extruded Cable Systems

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ABSTRACT

Utilities and specification bodies are very interested in understanding industry wide performance of underground transmission system. The most recent document considered by utilities is CIGRE TB 379 from WGB1.10, issued in 2009. Unfortunately, some issues limit the usefulness of this document in the North American context. This work provided users with a current assessment of the risk associated with HV & EHV cable systems, by expanding on the information in the CIGRE document by surveying both manufacturers and utilities and focusing on cable systems installed since 2000. The disbursement of component failures was then obtained and the most likely failure rate and most likely failure range were estimated. A partial "bathtub curve" for HV & EHV cable systems was developed. This work found that North American HV & EHV Service Performance data for modern extruded systems differ from the reported CIGRE data.

KEYWORDS

Reliability, HV, EHV, Extruded Cable Systems, Cable, Accessories

INTRODUCTION

Underground transmission systems are viewed by some utilities as "New Technologies" and by others as "Established Technologies". Independent of which perspective is considered, utilities and specification preparation bodies are very interested in understanding the true meaning of industry wide performance surveys conducted to date. This interest is driven by the improved reliability index ratios for underground / overhead transmission systems (1) {SAIDI 350 / <30 & SAIFI 1.2 / <0.1}. The most recent document considered by utilities at the start of this work was CIGRE TB 379 from WGB1.10, issued in 2009 (2). Unfortunately, some issues limit the usefulness of this document in the North American context.

The work reported here sought to provide users with a current assessment of the risk associated with HV & EHV cable systems, by expanding on the information in the CIGRE document by surveying both manufacturers and utilities and focusing on cable systems installed since 2000, including components that failed in service and excluding third party damage. The authors simultaneously collected data on failures, installed lengths, and then identified components that failed, considering both HV (69 - 150 kV) and EHV (230 – 400 kV) cable systems. The disbursement of component failures was then obtained and the most likely failure rate and most likely failure range were estimated.

Finally, a perspective on a partial "Bathtub Curve" for HV & EHV cable systems was developed. This work found that North American HV & EHV Service Performance data for modern extruded systems differ from the CIGRE data. This could be due to differing data sets, larger North American participation, reduced confirmation bias, and/or increased data verification.

APPROACH

North American engineers reported a need to place extruded systems in perspective (1, 3) and had experienced difficulty in using the global survey results due to,

- Unfamiliar voltage ranges ,
- Inclusion of results from older cable technologies (pipe type, steam cure, etc.),
- Disbursement of failures at odds with experience.

Thus, there was interest in refining the CIGRE study (2) for the use in a US context by

- Limiting the period to cable systems installed during the years 2000 to 2014,
- Limiting the study to extruded cable systems only,
- Expanding the sources of information.

Sources of Data

To address the concerns that were raised when the project was launched, the following steps were included in the methodology. The procedure included the following,

- Inclusion of both manufacturers and utilities,
- A large Contact Group ,
- A clear request for information on cable systems installed since 2000;
- Consideration of only components that failed in service excluding third party damage (did not consider commissioning test failures, fires, dig-ins, etc.),
- Simultaneous collection of data on failures and installed lengths for the responding manufacturer and utility ie failure/length pairs,
- Collection of failures that were not provided with a corresponding length, termed here "orphan" failures,
- Wherever possible identification of components that failed,
- Voltage class groupings based on IEC standards HV (69 kV – 150 kV) and EHV (230 kV – 400 kV) were used for high level analyses,
- In most cases, duplicate data were identified and "double counting" of failures was avoided.

Analysis

Data

In total, 40 entities provided information. Cable system lengths were described in terms of conductor length. In this study, the convention of each failure encompassing 1 mile was adopted – the selection of 1 mile or 1,000 ft. as the basic length unit has approximately a 3% impact on the failure rates.