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EVALUATION OF A REPLACEMENT STRATEGY OF A MEDIUM VOLTAGE CABLE JOINT BASED ON STATISTICAL FAILURE ANALYSIS

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ABSTRACT

In the 1970's a specific type of resin cable joint was used in three phase medium voltage cables. These joints have now a considerable contribution in outage time because of breakdown of the resin insulation. From the statistical analyses of the life time data it can be concluded that the joints are in their wear-out life period and that ageing is the main cause for failures. A testing program started a few years ago, influences the number of occurring failures and has a positive effect on the number of occurring failures of joints during service. Preventive replacement of the oldest joints in service can also influence the number of expected failures. A comparison is made between testing and the replacement strategy and it can be seen that at this moment the testing of cable sections is an effective way to decrease the amount of failures.

KEYWORDS

Cable joints, Resin insulation, Statistical analysis, Life time data

INTRODUCTION

Life time data of in service failed components, when available, can be used for statistical analysis. By means of statistical analysis the residual life of assets based on reliability requirements can be determined and future failures can be predicted. Especially for non-repairable components, like resin cable joints, failure analysis can be a powerful tool for replacement strategies, particularly when the components are in the wear-out period of their lifetime.

A specific type of resin cable joints was used in three phase oil-impregnated paper-insulated voltage cables in the seventies. These joints have now a considerable contribution in outage time because of breakdown of the resin insulation. As a result a testing program was started a few years ago, that normally is used to eliminate infant mortality related failures. This shows good results, but the question is whether another replacement strategy can be more effective. The reported failures over the last six years, together with the population still in service are known from different databases and a part of the data is suitable for statistical analysis.

A testing program influences the number of occurring failures and the last years the number of failures during service decreased. The effect of the testing program can be compared with a replacement strategy. Replacement of the oldest joints in service can influence the number of expected failures. In this way it can be seen whether the testing of cable sections is an effective way to decrease the amount of failures.

In this paper the general problems with resin cable joints are discussed, together with the available lifetime data. The influence of the testing program of cable connections on the failure behaviour is also considered. Secondly the statistical analysis of the life time data is shown and the failure expectation which can be obtained from the analysis is presented. A comparison is made between the testing program and a replacement strategy to see the effectiveness of the testing program.

RESIN CABLE JOINTS IN SERVICE

The 10 kV resin cable joints still in service are installed in the period from 1970 up to 1980. These joints are now 27 up to 37 years of age.

The joint is used for 10 kV three phase mass-insulated cables. The three conductors of the cable are soldered or compressed together with a connector. The shield of the cable is connected by means of separate conductors. The mould is filled with fluid resin insulation which solidifies after some time. Then the mould is closed and the joint is finished. The connection and the filling process are shown in Figure 1.

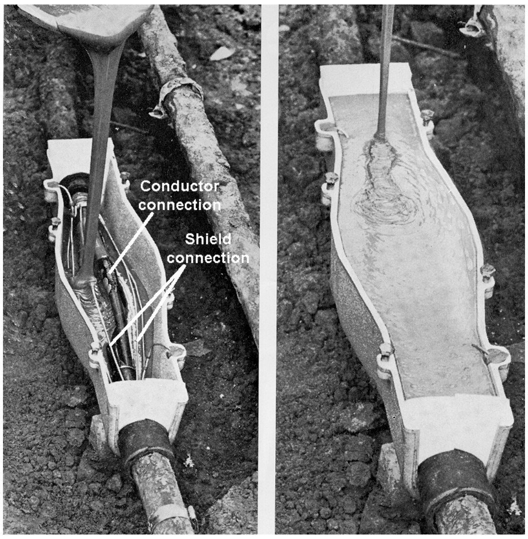

Figure 1 Filling of a three phase cable joint with resin insulation for a mass-insulated cable

Different origins can be designated to stresses of the insulation of the joint. Three categories of stresses can be distinguished [1]:

- Operational stresses, e.g. load cycles, short circuits,