SERVICE EXPERIENCE AND LABORATORY TESTING OF MV XLPE CABLE TERMINATIONS

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ABSTRACT

Failures of accessories in the Norwegian grid are collected and systematically examined in the laboratory for more than 30 years. Some of the most important findings from these examinations are presented in this paper, and compared to results from laboratory testing.

Long terms testing of terminations installed on XLPE cables with fully bonded insulation screens are performed. The cables were prepared with different peeling tools prior to the installation of the terminations, where typically cable preparation failures were introduced by the installers for some of the test loops.

In total 11 breakdowns occurred between 2 and 13500 hours ageing. None of the breakdowns can be directly related to the use of bad peeling tools. The life time is first of all dependent on accuracy during the installation; good workmanship. The terminations are not very sensitive to irregularities from the peeling tools if they are correctly installed. If a combination of several failures occur at the same time, this may lead to considerably reduced life time.

KEYWORDS

Service experience, cable terminations, peeling tools, artificial installation errors, ageing

INTRODUCTION

The utilities in Norway changed from using strippable insulation screens on XLPE insulated cables to fully bonded insulation screens for MV XLPE-cables (12 and 24 kV) from 1992. The main factor was the relatively large number of failures caused by poor cable preparation. Knife cuts introduced during the removal of the insulation screen was one reason. Such knife cuts may result in partial discharges in the highly electrical stressed region of the termination. Another reason was the formation of an air pocket or void due to unwanted lifting of the strippable insulation screen.

In order to remove the fully bonded insulation screen, specially designed tools must be used. It was anticipated that the problems described above was avoided. However, presumably new problems may be introduced. This might depend on the peeling tool and accessory type installed.

It was these current problems the Norwegian utilities would have investigated. The objective was to perform thermal ageing of the terminations in order to evaluate the impact the different tools might have on the behaviour of the accessories.

This paper reports results from laboratory examinations on thermally aged terminations installed on 24 kV XLPE cables with fully bonded insulation screens and two different conductor cross-sections. In addition, a reference 24 kV XLPE cable with strippable insulation screen was included. The main purpose of this work was to examine the sensitivity of different silicone rubber and EVA terminations to different but practical installation errors combined with thermal cycling. Secondly, the purpose of this paper was to compare the obtained results with common features of service breakdowns of medium voltage terminations.

SERVICE EXPERIENCE

Cables with strippable insulation screens

Several of the termination faults on XLPE cables with strippable insulation screen are caused by knife cuts introduced during the removal of the insulation screen. Such knife cuts may result in partial discharges in the highly electrical stressed region of the termination.

The today's MV XLPE cables are all tested with respect to partial discharges. The requirements are very strict; if partial discharges larger than 5 pC are measured the cable is not accepted. The reason for this strict requirement is that the XLPE material can not withstand partial discharges for a long time. A knife cut will create a void in the XLPE surface that will reduce the expected life time of the cable. The actual shape of the knife cut is also important. If moisture is introduced in the knife cut the electric field enhancement can get higher than the electrical withstand stress due to the high permittivity of water.

The background for the service problems that can occur is illustrated in Figure 1. Several terminations installed in this network broke down due to deep knife cuts in the XLPE insulation material close to the high field area.

After introduction of the fully bonded insulation screen in 1992 in Norway the number of knife cut failures have significantly decreased. For new installations no knife cut problems are likely to occur. A tool is now used to remove the insulation screen. However, still a lot of old cables with strippable insulation screen exist in the Norwegian network.

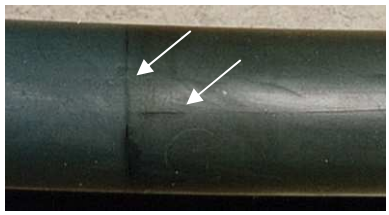

Figure 1: Knife cuts after removal of the strippable insulation screen was the most common reason of service failure of XLPE cables. This was especially observed for 24 kV cables where the electrical stress is higher than for a 12 kV XLPE cable systems.