FAILURE EXPERIENCE OF MEDIUM VOLTAGE CABLE HEAT SHRINK ACCESSORIES IN SAUDI ARABIAN TRANSMISSION NETWORK

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ABSTRACT

As the network of National Grid SA is enormously expanding, medium voltage power cables are extensively used. Knowing that medium voltage power cables are responsible for considerable amount of network interruptions, a special consideration was taken in order to improve their performance.

Joints and terminations which form a critical part of the cable system are known as the weakest link and susceptible to failure due to many aspects related to design, installation and operational parameters. It is very important for network owners to know the most threatening source of failures in order to decide the direction of improvement.

This paper shows field experience of National Grid SA with MV heat shrink cable accessories over five years and introduces a fault analysis method to improve their performance by learning from fault experience.

KEYWORDS

Fault Analysis, Cables Accessories, Heat Shrink, Medium Voltage

INTRODUCTION

In the last decade, Saudi Arabian transmission network has expanded with an annual average rate of 6%; which has been considered one of the biggest rate of expansion in the world. As the network expands, the failures of medium-voltage (MV) heat-shrink terminations become a serious concern because of its negative effect on the quality of energy transmission and because of the costs due to equipment damage as a result of these failures. These damages could be as significant as a total loss of a 100 MVA step down transformer. In august 2008, 132/33 kV transformer was burnt down completely in Qassim area and investigations revealed that the triggering event was a failure of 33 kV heat-shrink accessory on the low-voltage (LV) side of the transformer. This failure started a flame with a presence of an oil leak from the LV-side bushing which started a fire and, as a result, the transformer was destroyed completely.

Knowing that joints and terminations, in general, are the weakest link in cable systems and susceptible to failure due to many considerations related to design, installation and/or operational environment, transmission utilities around the globe have invested a considerable amount of money and effort in order to limit the effect and minimize the occurrences of MV accessory failures. This paper shows the experience of National Grid SA with 33 kV heat-shrink cable accessories over five years and illustrates the effort that has been done to improve their performance by learning from fault experience.

MV CABLES IN TRANSMISSION GRID

Due to the large amount of power involved, the voltage levels used in transmission networks fall in the categories of high-voltage and extra high-voltage. However, medium voltage links are used inside switching substations to connect LV-side of transformers to the MV bus-bars and in outgoing feeders of the switching substations. These small links are essential for transmission network's reliability. This study concentrates on the cable accessories inside 132/33 kV switching substations and it is limited to the central area of Saudi Arabia in which there were 227 of 132/33 kV substations at the time of this study.

FAILURES STATISTICS AND DISCUSSION

As already been said, this study covers the cable links that are installed in 227 132/33 kV switching substations in the central area of Saudi Arabia. The total number of failed components during the five years under consideration was 112 failures out of approximately 10300 33 kV terminations installed. Figure 1 illustrates the number of failures in each year. The records show that 68% of these failures have taken place in 11 substations only which represent 4.8% of the total number of the substations in the central grid. These substations were experiencing unacceptable interruption rate because of the MV cable termination failures. They were investigated in order to find the root causes for their repeated failures, and thus, prevent two thirds of the interruptions by applying the proper solutions.

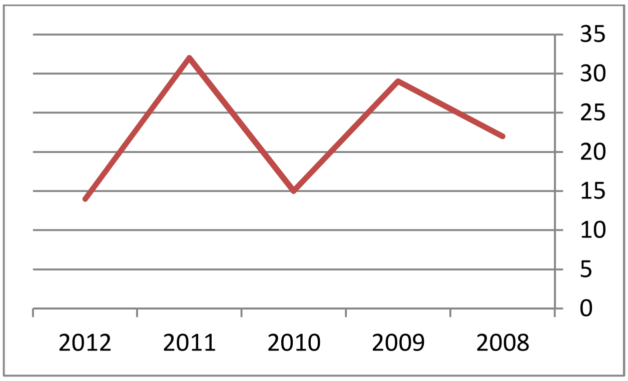

Fig. 1: Number of failures with respect to each year.

It is tempting to say that the main root cause for the repetition of these failures was human errors, or in other words, bad workmanship because these accessories are totally assembled at the work site. Therefore, workers are more likely to make mistakes because site conditions