MONITORING FACILITIES FOR FAILURE RATE REDUCTION OF 380 KV POWER CABLES

Sander **MEIJER**, TenneT TSO B.V., (Netherlands), Sander.Meijer@tennet.eu
Johan **SMIT**, Xiaolin **CHEN**, Delft University of Technology (Netherlands), j.j.smit@tudelft.nl, x.chen@tudelft.nl
Edward **GULSKI**, onsite.hv.solutions AG (Switzerland), e.gulski@onsitehv.com

ABSTRACT

This contribution describes the need for failure rate reduction of 380 kV power cables from a risk management point of view. Technology getting more mature, quality assurance, specification and on-line monitoring are opportunities for failure rate reduction. Although not each opportunity can be controlled by a TSO, implementation of monitoring facilities can. Most important parameters and phenomena to be measured will be described.

KEYWORDS

Long 380 kV XLPE cables, Risk assessment, Condition monitoring, Monitoring facilities, Failure probability

INTRODUCTION

To strengthen the Dutch 380 kV transmission system, the Dutch TSO TenneT TSO B.V. will build two new 380 kV rings in the western part of the Netherlands. In this way, TenneT will be able to provide sufficient transport capacity for the new conventional power plants, wind parks at sea, but also to connect the HVDC link to Great Britain in a reliable way. The total length of both new mixed 380 kV transmission systems is about 80 km route length, of which 20 km will be installed as underground 380 kV XLPE power cable. The transport capacity will be two times 2635 MVA, by means of two cables per phase and a double circuit. Such kind of application is rarely used world-wide and mainly as connection of large power plants to the grid. Integration of such a large amount of 380 kV power cable in the transmission grid is therefore an innovative application.

With respect to the obligation of TenneT to provide a reliable and safe electricity transmission system, the innovative application of 380 kV power cable seems to be a conflicting solution. However, due to the fact that the new transmission system needs to cross rivers, canals, densely populated areas and natural reserve, it is inevitable the wish to partly apply extra high voltage cables in the new systems. Since application is unavoidable, TenneT has set up a research project for the coming 6-8 years in order to gain more practical knowledge on the behavior of long EHV power cables (more than 20 km's length), their reliability and their influence on the grid stability.

It has been shown [1] that based on the currently available knowledge, the risk position of a TSO is assessed as high. Opportunities to reduce the risk position were identified, mainly by taking proper pre-cautions. Figure 1 summarizes the currently assessed maximum risk position and the possible risk position reduction. The risk position is shown as function of the failure probability of one circuit in the redundant system versus the total outage time required for restoring the availability of the failed circuit. It clearly shows, that if the failure probability is fixed, the risk position worsens with an increasing outage time. Based on the outcomes from [1], a maximum failure probability of one circuit of 0.12 failures/year, a minimum failure probability of 0.08 and a maximum outage time of 6600 hours results in the "current risk positions", as indicated in figure 1. Taking precautions to reduce both the failure probability as well as the total outage time, the risk position of a TSO can be reduced from high to low.

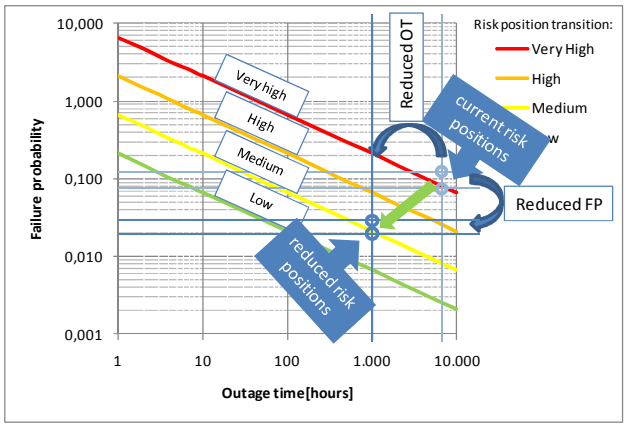

Fig. 1: Reduced risk position showing the effect of preventive measures

In this contribution, the main objective is to describe the different investigations that need to be done in order to reduce the failure probability. Reduction of the total outage time will be investigated as well, but will not be further described in this paper.

FAILURE PROBABILITY REDUCTION

One possibility to improve the risk position of a TSO is reduction of the failure probability. Several items and opportunities have been identified, which will be described in some more detail in the following sections.

Maturing technology

Analysis of several failures of 380 kV XLPE cable systems that occurred during the last 5 years showed that 380 kV XLPE cables seem to be at the beginning of the bathtub curve [2], see figure 2. Therefore it can be stated that 380 kV XLPE cable systems are still an innovative solution for transmission grids.

However, return of experience will lead to a more and more mature technology and, although difficult to estimate, it can be expected that the failure rate will reduce over time by a factor of 4-8. It is clear that this is issue is difficult to control by a TSO, but quality assurance is an important tool to speed up this technology maturing.