RETURN OF EXPERIENCE OF 380 KV XLPE LANDCABLE FAILURES

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ABSTRACT

This contribution summarizes the experiences of three European TSO's with respect to 380 kV cable systems installed on land. It is shown that cables with single lengths exceeding 10 km's impose a high risk to the business value quality of supply of a TSO. In particular, the failure probability and outage time are the two main contributors for this risk position. Opportunities to reduce both outage time and failure probability are described in order to obtain a low risk position.

KEYWORDS

Long 380 kV XLPE cables, Risk assessment, Failure frequency, Outage time, Return of experience

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 and wind parks at sea, but also to connect the HVDC link to Great Britain in a reliable way. The project is called Randstad380, and the two specific rings are called Zuidring and Noordring. The total length of both new mixed 380 kV rings 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 in a meshed grid with high security of supply requirements 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 secure 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 reserves, it is inevitable the wish to partly apply extra high voltage cables in the new systems. Since application is hardly unavoidable, TenneT has set up a research project for the coming 6-8 years in order to gain more practical knowledge on the behaviour of long EHV power cables, their reliability and their influence on the grid stability.

In order to calculate the risk for the company, the impact and failure probability are two important input parameters. In this paper, the failure probability is the main objective. Besides the failure probability, the total cable outage time after a failure is of importance. To obtain this data, knowledge available at other TSO's regarding cable failures and repair times was investigated.

This contribution summarizes the experiences of three European TSO's. It will be shown that only a small part of the total cable outage time is due to the repair time of the cable itself. However, it was shown in at least 6 of the 8 failures, that the total outage time strongly depends on other aspects like getting approval to enter the premises, arranging the proper permissions to start working, cleaning the area, availability of spare parts, availability of skilled personnel, etc. The minimum outage time is 2 weeks and can get as high as several months. The effect on the risk position of the TSO is described and measures to reduce this position will be investigated.

RISK ASSESSMENT

To assess the risk for the company, the impact of a failure on the different business values is estimated and combined with the failure frequency. Business values like safety, quality of supply, financial, compliance, reputation, customers and environment are of importance, depending on the TSO's corporate strategy.

Failure frequency

Almost 15 years ago, the first XLPE 380 kV cable system has been installed. Since that date, several 380 kV cable systems have been installed worldwide, however, most of them as sea cables and therefore the total amount of installed circuit kilometres on land is still very limited and the service life very young. As a result, there is uncertainty about the failure rates for EHV XLPE cables and accessories/joints. More specifically, the available statistics in international literature is limited and the uncertainty is high. The most recent report is presented by Cigré in Technical Brochure 379 [1]. Compared to overhead lines, the current experience with EHV cables shows significantly longer repair times, Table 1.

Table 1: Typical failure rates for 380 kV XLPE cable systems and 380 kV overhead lines values per system (3 phases) from Cigre TB 379 [1]

	Failure rate [100 comp.years] or [100 cct.years]	Repair time [hours]
Overheadline	0.220	8
Cable [1]	0.133	
Termination [1]	0.032	600
Joint [1]	0.026	

In case of the Zuidring of the Randstad380 project, the total trajectory length is about 22 km's long, consisting of about 11.2 km's overhead line and 11 km's underground cable, divided into two parts. The Zuidring contains two circuits and due to the transmission capacity of 2635 MVA, two cables per phase are required for the cable part