Operating a 10kV cable on a system voltage of 20kV: The long term tests

Jacco **SMIT,** Frank **DE VRIES**; Liandon, Alkmaar, The Netherlands, Jacco.Smit@alliander.com, Frank.de.Vries@alliander.com
Ger **SEBREGTS,** John **VAN SLOGTEREN**, Nico **STEENTJES**; Liander, Arnhem, The Netherlands, Ger.Sebregts@alliander.com, John.van.Slogteren@alliander.com, Nico.Steentjes@alliander.com
Wim **BOONE**, DNV GL, Arnhem, The Netherlands, Wim.Boone@dnvgl.com

ABSTRACT

In 2010 Liander started a feasibility study if the current standard 10 kV 1x630Alrm XLPE power cable can be utilized on the voltage level 20 kV for the remaining life time of the 10 kV cable. The main goal of this study is the proof of principle of this concept thinking. If this concept is appropriate for use, Liander can achieve minimum environmental impact and big spend reduction in the developments of the 20 kV grid. In the feasibility study a literature study and heavy electrical tests were conducted. The approach of the total project was earlier described in Cired [1].

This paper deals with the last stage in the study, a long term electrical test, for the final proof of principle.

The 6/10 kV cable and 12/20 kV accessories did withstand the severe test criteria bravely and hence successful. This outcome opens the door for a future pilot project in the field, which is now under study.

KEYWORDS

Long term electrical test, Long duration test, MV cable, Proof of principle, Used grid cable, Upgrading, Increased operating voltage

INTRODUCTION

With approximately 40.000 km of underground MV cables, Alliander is one of the two biggest distribution system operators in the Netherlands. The MV network is mainly operated at a voltage level of 10 kV however on the longer term, due to increasing energy demand, Liander will expand their network at a 20 kV voltage level.

Liander started a feasibility study in 2010 if the current standard 10 kV 1x630Al XLPE power cable can be utilized on the voltage level 20 kV for the remaining life time of the 10 kV cable. If this concept is appropriate for use, Liander can achieve minimum environmental impact and big spend reduction in the developments of the 20 kV grid.

PRINCIPLE

The long term test will be performed in a HV laboratory and consists of a withstand test at elevated voltage for a period of several months combined with daily heat cycles on 100 meters of 6/10 kV power cable, 10 pieces of 24 kV joints and 4 pieces of 24 kV end terminations. The length of cable and number of accessories is chosen for statistic validation of the test.

The voltage during the long term test is determined based on the relation between electrical field strength and the lifetime, according to the following equation:

$$L \cdot E^{n} = C$$

Where: L = Lifetime; E = Electric Field strength; C = Constant

Based on earlier theoretical studies n=9 is assumed to be a realistic value that covers all common defects for the components under test. A test time of 3 months was selected in combination with a voltage level of 1,8xUo. The test time and voltage level corresponds with 50 years lifetime at Uo. See table 1 below.

Electrical stress	n=7	n=9	n=12	n=15
3xUo	200 hours	24 hours	50 minutes	2 minutes
2,5xUo	30 days	4,5 days	7,3 hours	28 minutes
2xUo	4 - 5 months	1 month	4,5 days	13,3 hours
1,8xUo	10 months	3 months	15 days	2,7 days
1,7xUo	14-15 months	5 months	1 month	6,4 days
Uo	50 years	50 years	50 years	50 years

Table 1: voltage level and testtime based on life time

During the voltage test, the conductor temperature of the cable will be varying daily between room temperature and 95 °C in order to simulate electric load of the cable.

The 6/10 kV cable to be used for this long term test must have been in operation for several years. The 24 kV accessories in this test are newly installed. This will be similar to the approach for future projects in the field.

The cable terminations were expelled from the long term test because in practice the cable ends (in substations) will be executed with 12/20 kV cable.

DESCRIPTION OF THE LONG TERM TEST

The test is performed on 1 fabricate and type of cable. For the test, a 6/10 kV cable which has already been in operation for several years is taken out of the MV network, placed on a cable drum and transported to the laboratory. During the preparation stage of the project, the cable has been winded on and of the cable drum for 3 times and experienced extra mechanical stresses. Additional, 4 types of cable joints were selected for the test. The types of joints are standard applied in the network of Alliander. 1 type of cable termination was selected, due to the fact that it does not make part of the long term test. All accessories were installed by de accessory manufacturers in order to eliminate failures due to poor workmanship.