HIGH VOLTAGE CABLES WITH A SPECIAL SHEATH-BONDING SYSTEM

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ABSTRACT

Failure rates and cost of high voltage underground cable systems can be decreased by reducing the number of joints and accordingly by enlarging the section length between the joints. However, this may lead to unacceptable sheath voltage rises at normal operation as well as at faulty state. Furthermore, transient overvoltages may exceed the system's BSL/BIL in the case of switching operations or lightning strikes. A new possibility of doubling the section length for a given limit of the sheath voltage is presented. Its feasibility is analyzed in detail by means of EMTP.

KEYWORDS

Special sheath-bonding system, compensation conductor, neutral-path-cable, ATP-EMTP

INTRODUCTION

A report about failure statistics of high and extra high voltage cables has been issued by the CIGRE-Working Group B1-10 [1]. Based on this report, a data conversion has been performed in [2] in order to determine the failure rates of cable installations relating to the mean distances between joints. The results of both studies show that the failure rates could be sensibly decreased by means of two measures:

i. reduction of the number of externally caused failures (third party damages) and
ii. reduction of the number of joints.

The first measure could be realised by means of an enhanced mechanical protection of the cables (e.g. by tunnels or ducts), while the second factor, the number of joints, can be reduced by enlarging the delivery lengths. Combining both measures allows extreme reductions of the failure rates of high voltage cables. Thus for an enlarged delivery length of 3000 m and by avoiding external damages, the failure rate of the cable installations can be reduced by more than 70 %. Fig. 1 illustrates the analysis results from [2]. The three bars on the left hand side represent the failure rates of XLPE cables (blue) and accessories (red) for system voltages above 220 kV. The first bar shows the failure rates for the state of the art of cable technology, which means the mean distance between joints is 770 m. The second bar shows the effect if the section length is extended to 3000 m. The third bar shows the effect if an additional effective mechanical protection is realised in the cable installation, so that only internal failures of the cables could occur. For comparison, the right bar shows the result for system voltages below 220 kV.

With enlarged distances between the joints, the sheath voltages will arise at steady state operation as well as in the faulty or transient state. To determine the maximum

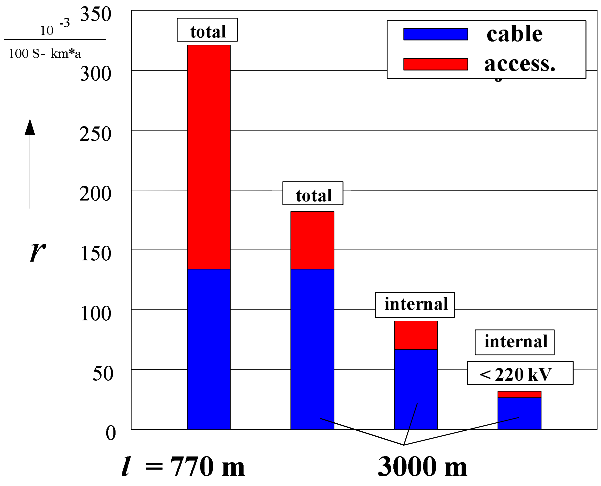

Fig. 1: failure rates of XLPE cables (blue) and accessories (red). With *U* ≥220 kV (explanations see text)

length of elementary or minor sections, various criteria must be considered [3, 4], e.g.:

- the maximum allowable sheath to earth voltage at steady state operation,
- the maximum allowable sheath to earth voltage during a short-circuit,
- the maximum allowable sheath to sheath voltage over the joint sleeves during a short-circuit,
- the insulation withstand levels of outersheaths and joint sleeves.

A new possibility of doubling the section length without exceeding the above given limitations is presented in this paper. Its feasibility with respect to the circuit behaviour in steady, faulty and transient state is analyzed in detail.

DESCRIPTION OF SPECIAL SHEATH-BONDING SYSTEM

The proposed sheath-bonding system is shown in fig. 2 (only for one phase): a so-called "neutral-path-cable" – "NPC" leads from the grounding points at the ends of the section to its central point, keeping there its zero-potential. There it is connected to a so-called "compensation cable" – "CC", which is laid directly beside the cable core. By this, induced voltages in CC and cable sheath are almost identical. At one end of the section, this CC is connected to the sheath. By this measure, the potential between sheath and earth does not exceed the sheath voltage corresponding to the half of the section length $l_0/2$. The additional expenditure for this installation is the NPC-cable. It is is often used as a grounding conductor in the cable trench, anyway. More significant is a CC-cable for each phase, which should have a cross section as well as an insulation strength similar to the cable sheath.