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Sheath overvoltages affecting specially bonded underground links during single-phase faults

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Summary

To design specially bonded underground links, it is necessary to evaluate the voltage rises of the cable metallic screens during system faults.
This article presents a method of calculation making it possible to evaluate relatively simply sheath overvoltages during a single-phase fault occuring on a connection between two substations, the underground link being supposed connected to an overhead line at both ends.

Résumé

Pour dimensionner les liaisons souterraines à connexions spéciales d'écran, il est nécessaire d'évaluer les montées en potentiel des écrans par rapport à la terre en régime de défaut.
Cet article présente une méthode de calcul permettant d'évaluer relativement simplement les surtensions de gaine en régime de défaut monophasé dans le cas d'une liaison souterraine insérée dans une ligne aérienne.

1 - INTRODUCTION

The determination of sheath overvoltages affecting a specially bonded cable link during single-phase faults is relatively complex because these overvoltages strongly depend on the distribution of the fault current in the ground network. [1] [2]

First, a general method of calculation to determine the potential rises of the earth electrodes of an underground link inserted in an overhead line is presented.

Then an approximate method of calculation is described,. allowing to evaluate relatively simply the voltage rise of the earth electrode located at the transition overhead to underground in the case of a defect occuring at this site.

The voltage stress applied to the cable sheaths during faults, external or internal to the underground link., may be deduced.

Lastly, the overvoltages between sheaths to be considered at cross-bonding points for a cross-bonded link are clarified.

2 - GENERAL CONSIDERATIONS

An overhead line, between two substations, with an underground link inserted, is the considered connection.

The line is equipped with a ground wire either entirely or partially (has minimum in the vicinity of the underground part).

The underground link either is single-point bonded or sectionalized cross-bonded.

By analogy with the terminology used for the line, one calls underground span an elementary section of a single-point bonded underground link and a major section of a cross-bonded one.

When a fault occurs on the connection, the short-circuit current is distributed in the ground network comprising the earth electrodes and the " ground conductors " i.e. :
* the ground wire for overhead lines,
* the earth continuity conductor for single-point bonded underground links,
* the 3 metallic screens set in parallel for cross-bonded underground links.

In this last case, the 3 screens of the cables of a major section can be compared to a single conductor characterized by a self-impedance and a mutual impedance with the faulty phase conductor , whose expressions are given below :

$$Z'_e = \frac{1}{3}.\left[Z_e + 2.Z_c - 2.\frac{(Z_c - Z_e).(Z_L - Z_c)}{3.(Z_e - Z_c) + (Z_L - Z_c)} \right]$$

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The main notations in use are clarified in table 1.