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Influence of admittance asymmetry of underground cables in compensated systems behaviour

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Résumé

Une façon d'améliorer la qualité du fourniture est utiliser des câbles souterrains au lieu de lignes aériennes pour la distribution de l'énergie. La capacité phase-terre est déterminée par la géométrie du câble mais la tolérance de fabrication produit une déviation de la capacité théorique obtenue si la symétrie de la phase est considérée. Cette déviation mène à une asymétrie de l'admittance du départ avec une grande influence sur le comportement des systèmes compensés. Nous montrons ici l'influence mentionnée par rapport au seuil de la sensibilité des algorithmes de protection et du courant de défaut.

Abstract

One way to improve power quality is to use underground cables instead of overhead lines for energy distribution. The phase-to-ground capacitance is determined by cable geometry but the manufacturing tolerance produces a deviation from the theoretical capacitance obtained if phase symmetry is considered. This deviation leads to an admittance asymmetry with a big influence over compensated systems behaviour. We show here the influence mentioned below with regard to the sensitivity threshold of protection algorithms and fault current value.

Introduction.

One way to improve power quality is to use underground cables instead of overhead lines for energy distribution [1],[2]. The phase-to-ground capacitance is determined by cable geometry (basically by thickness r_2-r_1 of insulating material as we can see in the Figure 1 as EPR) but the manufacturing tolerance produces a deviation from the theoretical capacitance obtained if phase symmetry is considered.

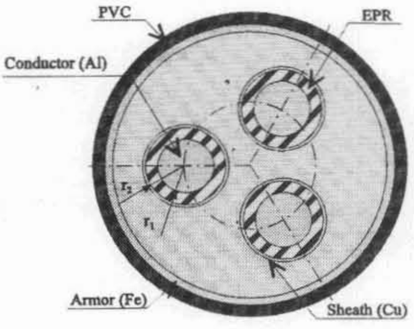

Figure 1. Cross section of an AL-EPROTENAX HF 3x150 mm² cable for 12-20 kV.

This deviation leads to an admittance asymmetry that could be calculated by Equation 1, has a big influence over system behaviour when the neutral of secondary winding of HV/MV transformers is grounded through a Petersen coil. This parameter has an arbitrary argument for each case and it is not possible to determine "a priori" its value.

$$\overline{K}=\left(\frac{1}{R_{E,1}}+a^2\frac{1}{R_{E,2}}+a\frac{1}{R_{E,3}}\right)+j\omega\cdot\left(C_{E,1}+a^2C_{E,2}+aC_{E,3}\right) \quad (1)$$

Where:

$R_{E,i}$: Phase-to-ground resistance.
$C_{E,i}$: Phase.to.ground capacitance.

We notice that electrical utilities whose compensated distribution systems are 100% underground have confirmed that the number of permanent faults increases with the total length of underground cables [3](because the asymmetry increases too). This assertion is due to two different effects: the fault current increases with asymmetry and classical