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Shielding technique to reduce magnetic fields from buried cables

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Résumé

De nombreuses études n'ont pu conclure à la nocivité pour la santé des champs magnétiques alternatifs rayonnés par les liaisons de puissance. Néanmoins, la préoccupation croissante des autorités de la santé public impose l'adoption d'un principe de prudence. Il peut localement être nécessaire d'envisager la pose d'un blindage électromagnétique pour réduire significativement les champs magnétiques rayonné par les câbles de puissance. Des simulations par éléments finis de liaisons, dans des configurations variées, ont permis de proposer deux techniques de blindage et d'optimiser leur forme.

Abstract

Although many studies have been carried out on the subject, it has been impossible to confirm that magnetic fields, particularly due to alternating current, have any harmful effect on health. The increasing concern by public health authorities makes caution essential. It may be necessary to consider placing local electromagnetic shielding in order to significantly reduce the magnetic fields radiated from the cables. Simulations with a finite element software (MATLAB) were used as a basis for proposals for two types of electromagnetic shields and a means of optimizing their design.

A. Introduction

Electric power transmission links carrying alternating currents create an electromagnetic field that radiates throughout the space surrounding the cables. Considering the low value of the frequency of these currents (50 or 60 Hz), the magnetic field and the electric field can be studied separately. Furthermore for buried cables, electric fields in the ground are negligible, and therefore only the magnetic fields could have an influence on the environment. Although no scientific study has been able to confirm any danger to health caused by alternating magnetic fields, industry must always err on the side of caution, and consequently overhead lines are not used near residential areas. Unfortunately this approach is impossible for underground lines since they are often located along roads or through towns. Therefore, it would be possible to use magnetic shielding in order to reduce the values of the field by a large factor compatible with criteria considered acceptable for public health.

Simple analytic solutions are no longer possible if a ferromagnetic component is added. The few attempts made to solve these problems (work done by Mr. POLLAZCEK in 1931) only deal with the case of an infinitely large plate. Most results presented were obtained using the finite elements method. Economic feasibility parameters for the various simulated types of shielding have been included based on the assumption that the price of shielding is proportional to its weight for constant permeability, and that prices increase strongly with the relative permeability.

In the absence of shielding, preliminary results were obtained using Ampere's theorem and the superposition principle. A simple analytic calculation can be used to compare the maximum values of the magnetic field in different cable laying configurations: flat, spaced flat, in clover leaf. This in itself shows that the field can be reduced significantly if the cables are laid precisely.