

**C5.8****Estimation of thermal loss of life of MV/LV cables taking into account moisture migration**

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**Résumé :**

Le rapport analyse le problème de l'évaluation probabilistique de la vie utile des câbles enterrés. Cette évaluation est faite en considérant le phénomène de migration de l'humidité dans le sol entourant les câbles, parce que la teneur en humidité est un des plus importants entre tous les facteurs susceptibles d'avoir une influence sur la résistivité thermique du sol et, donc, sur la température du câble. Soit une procédure numérique Monte Carlo soit des relations analytiques sont proposées. Des applications numériques soit à un câble soit à plusieurs câbles appartenant à un réseau de distribution démontrent l'influence du phénomène de migration de l'humidité dans le sol de la vie utile des câbles.

**Introduction**

The loss of cable life is a problem of major importance due to the wide increasing concern on system reliability and also the great economical investments involved. The studies on loss of life are usually performed with reference to deterministic scenarios, in which the random changes of the thermal conditions that occur during the cable service are not taken into account. Indeed, the heat transfer is certainly random in nature [1,2], so that the useful life evaluation has to be performed by means of probabilistic approaches.

In a preceding paper [3], the effects of randomly varying temperature on useful cable life in MV/LV energy systems has been examined, employing both Monte Carlo procedure and closed form solutions. One of the key finding of this study is that the soil thermal resistivity, the ambient temperature and the cable loading are crucial factors in estimating the cable useful life; however, the moisture migration phenomenon was not taken explicitly into account.

In this paper, the approach developed in [3] to derive the probabilistic characterisation of the cable useful life is extended to the case in which the moisture migration is explicitly taken into account; in

**Summary**

The problem of the evaluation of the buried cable useful life in non-deterministic scenario is analysed. The evaluation is done taking into account the moisture migration, being this phenomenon one of the most important factors that can influence the thermal resistivity of the soil and, then, the cable operating temperature. Both Monte Carlo procedure and closed form solutions are considered. Numerical applications referred to only one cable and to more cables of a medium voltage energy distribution system are discussed in order to show the influence of the moisture migration on the cable useful life.

such a way the proposed approach allows a more realistic and accurate representation of the cable thermal ambient conditions.

Both Monte Carlo procedure and closed form solution are employed, the latter leading the evaluation be effected in an easy and quick manner since it requires the knowledge of only first and second order central moments of the input random variables.

Numerical applications to test cases concerning only one cable and more cables of a distribution energy system are presented and discussed showing the strong influence of the moisture migration phenomenon on the expected value of the cable useful life.

**Cables Useful Life in Non-deterministic Scenario**

The heat transfer is a non-deterministic phenomenon so that the cable temperature – and hence the cable life – is a random quantity, whose randomness is linked to the probabilistic behaviour of the involved quantities in the heat transfer process. So, in the frame of the cumulative damage theory [4], reference can be done to the expected value of the thermal loss of cable life proposed in [5]: