IMPROVEMENT OF AN HEALTH INDEX FROM AGEING STUDIES AND FIELD OUTCOME.

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ABSTRACT

An important fraction of cables in the French underground network has been installed before 1980. Feedbacks show that some cables or joints know an increasing number of outages.

The Health Index of a link, which reflects its probability of breakdown, is a tool for asset management, which aims at defining priorities in renewal and replacements, to keep the fault rate to an acceptable level, while optimizing investments.

This paper provides details on EDF Health Index and reports on studies and tests carried out to improve its design.

INTRODUCTION

Health Indexes have been worked out as tools providing asset managers with technical inputs, to give priority in renewals, and optimize investments.

The Health Index (HI) dedicated to Underground Links, worked out by EDF, is based on a pragmatic approach to face lacks in knowledge and input data.

This paper presents the EDF HI design and the learning from a first large-scale application.

BACKGROUND

Should the factors that play a role in links life expectancy be identified and be quantified as inputs in well-established ageing models, should links characteristics be well-documented, grid reliability could be easily determined.

Unfortunately, present knowledge and available data are quite insufficient to achieve this target.

So that reliability studies have to accommodate with uncompleted models and poor inputs.

To tackle this situation, a common way is to select some influencing factors, to characterize their effect through semi-empirical laws and to assume their relative impact through weighting factors according to experts' tells.

Should the fault records be exhaustive and indicate the link between fault and influencing factors, statistics tools could assess experts' tells.

Once again, lacks in input data have to be managed.

Fault statistics often provide only the date and identification of faulted links. Sometimes, cables and accessories are distinguished and the breakdown cause is given (in particular, in case of third party damage).

Should the outputs of diagnostics tools be clear enough (and cheap to get), an alternative solution to reliability studies could be found. But knowledge rules have still to be worked out to assess diagnostics results.

As a consequence, the Health Index developed by EDF is more or less a mix between different approaches : it tries to combine ageing modeling, statistical analysis of the outcome of experience and diagnostics outputs.

In early EDF designs [1,2], the HI was an estimate of the cumulative breakdown probability. Ranging between 0 and 1, it was easily reading, but it did not fully meet asset managers' expectation.

So now the HI is defined to be an estimate of the expected fault rate of the link.

GENERAL FEATURES

The HI design does not start with influencing factors, but with failure causes, that are likely to be identified in fault records.

Three concerns are identified : electrical ageing, thermal stresses, mechanical constraints. These concerns are considered both for cables and accessories.

The cumulative breakdown probability with respect to concern i is assumed to be given by a Weibull's law, with following format :

$$P_{ci} = 1 - e^{-G_i} \qquad G_i = \lambda_i . t^{a_i} . F_i$$

F_i is a function of various influencing factors, that play a role in life expectancy with respect to concern i, and which is not or is weakly dependent on the age of the component.

As a consequence, the breakdown mechanisms being assumed independent one from another, the failure rate of a link is given by:

$$\tau = \sum_{i=1}^{6} G_i' \approx \sum_{i=1}^{6} a_i . \lambda_i . t^{a_i - 1} . F_i$$

Should the failure records be precise enough to identify one of the breakdown mechanisms as the failure cause, ($\lambda_i . F_i$) and a_i values could be estimated, using for instance maximum of likelihood method, for every cables and accessories families.