

# Study of decision support programs for maintenance strategy of electric power equipment

## Background

Due to the recent need to cut maintenance costs of electric power equipments, it is necessary to rationalize inspection, maintenance and renewal strategies of service-aged equipments. Therefore, in sections responsible for the maintenance of electric power equipment, in addition to the improvement of diagnosis techniques, there is a great deal of interest in asset management techniques \*1 that incorporate economic indicators. The operating condition data, inspection data and diagnostic data are being gathered, and attempts are being made to utilize them to support the maintenance and renewal strategy.

## Objectives

To develop a support tool for maintenance and renewal strategy, consisting of a support program for diagnostic data evaluation based on diagnostic database and a support program for maintenance strategy by considering repair cost;

## Principal Results

In order to support maintenance and renewal strategy wholly, technical evaluation of diagnostic data and economical evaluation of the strategy are two main components (Fig.1). Therefore, the programs listed below have been developed.

### 1. Support program for diagnostic data evaluation based on diagnostic database

One application of diagnostic data is to compare with a sufficient quantity of back data, which have been processed statistically as diagnostic database. This program is for oil-immersed transformers to support the dissolved gas analysis evaluation, whose functions are as follows:

- (1) Based on the gas analysis database prepared at the maintenance section, density distributions of the analyzed gases are displayed upon narrowing down the class and capacity, etc. of transformers, together with criteria \*2.
- (2) Positions of data from an evaluation target transformer are displayed on the density distributions mentioned above. These indications, together with ETRA's criteria \*3, support the evaluation.

### 2. Support program for maintenance strategy by considering an economic evaluation

By assuming repair cost of the target equipment increases with operating time, this program supports the creation of maintenance strategies, whose functions are as follows:

- (1) By considering a failure rate increase with operating time and "rejuvenation effect (Fig.2)" with an overhaul (suitable parameters for these factors should be selected by maintenance sections), an average annual maintenance cost (accumulated maintenance cost and expected trouble cost) during assumed operating period is calculated.
- (2) By shifting overhaul period and expense, which are selectable as a maintenance strategy, the change of the average cost mentioned above is displayed visually. It helps to decide suitable period and expense scale of overhaul (Fig.3).

This support tool is being utilized for trial evaluation in the electric power industry.

## Future Developments

Aiming for development of a synthetic maintenance and renewal support tool, suitable programs considering the characteristics of each equipment will be developed and functionally improved.

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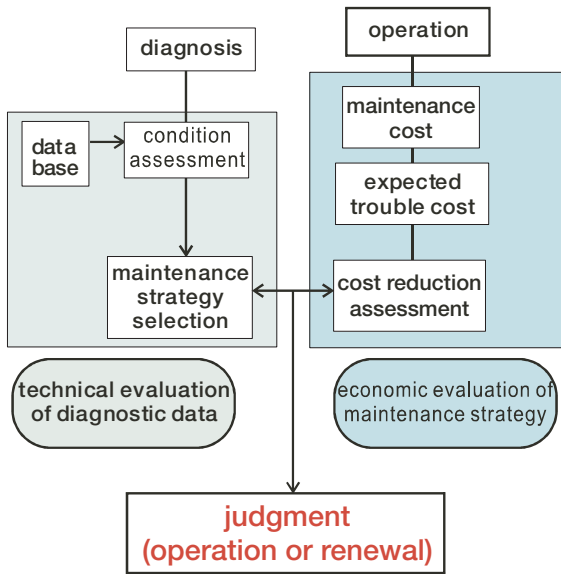
## Reference

T. Takahashi, et.al., 2007, "Study of decision support programs for maintenance strategy of electric power equipment - Proposal of diagnostic database application and repairing cost evaluation method," CRIEPI Report H06014 (in Japanese)

\*1 : For maintenance of electric power equipments, it is generally considered that not only technical judgement but also priority among other equipments and economic merit should be examined. Concrete researches have been leading in Europe.

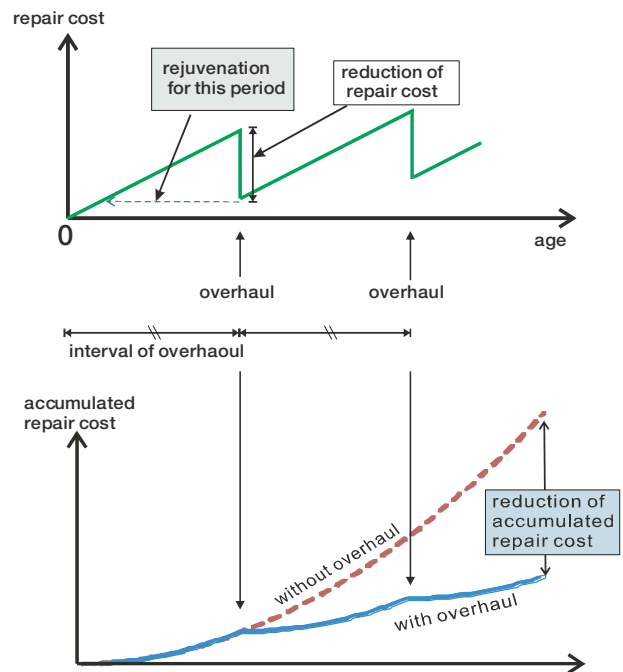
\*2 : For example, 5% or 10% value from worse side in the density distribution is set to be a criteria.

\*3 : Electric Technology Research Association (ETRA) technical report, Vol.54, No.5 (1999)(in Japanese)



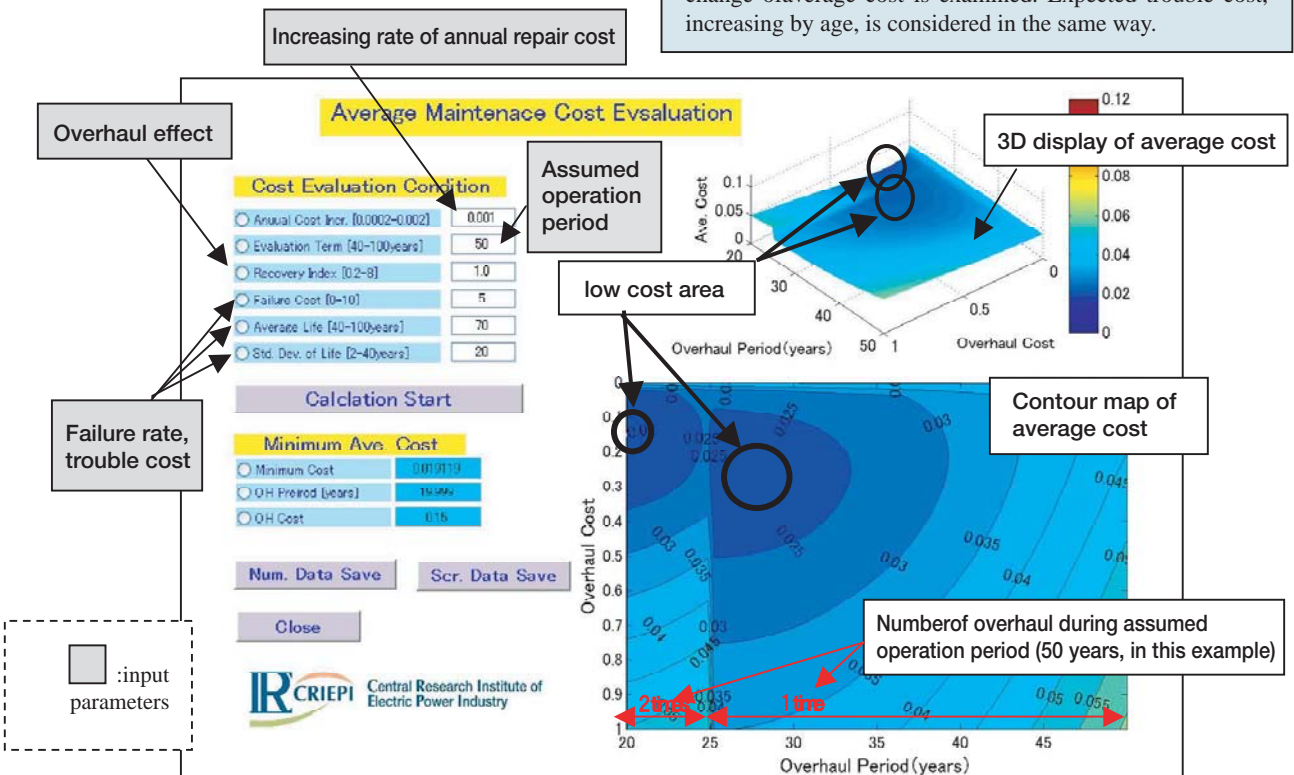
**Fig.1** Relationship between diagnostic and economic evaluation

Technical evaluation of diagnostic data and economical evaluation of the strategy are two main components judgment of maintenance and renewal.



**Fig.2** Concept of “rejuvenation effect”

Annual repair (maintenance) cost is assumed to increase by age and reduce by overhaul as the upper figure, accumulated repair cost changes by overhaul as the lower figure (It shows only repair cost. Overhaul cost is also considered in the program). By shifting period and expense level of overhaul, change of average cost is examined. Expected trouble cost, increasing by age, is considered in the same way.



**Fig.3** Display of Support program for maintenance strategy by considering an economic evaluation

By inputting increasing rate of annual repair cost, lifetime (average value and dispersion), recovery parameter (it decides rejuvenation effect) and assumed (expected) operation period, average maintenance cost is calculated, and low cost condition of overhaul strategy can be examined (all costs are normalized value).