

Proposal of Maintenance Planning Support Method for Transmission Equipment based on Supply Reliability and Cost Evaluation

Background

Due to low growth of demand and deregulation of the electric power industry, there will be fewer opportunities to replace aging equipment, and so existing equipment will need to be kept in good condition for as long as possible. Therefore, adequate maintenance plans need to be developed in order to use existing equipment efficiently.

Objectives

To propose a maintenance planning support method for transmission equipment based on supply reliability and cost evaluation;

Principal Results

1. Proposal of maintenance planning support method based on supply reliability and cost evaluation

A new concept of life-cycle risk map (LCRM) as shown in Fig. 1 is proposed. The LCRM shows the transition of outage risk due to aging from the time of installation to end-of-life of equipments under a specific maintenance plan that considers cost. The outage risk is evaluated based on expected energy not supplied and the cost is represented by the economic lifetime *1 as shown in Fig. 2. The maintenance plan for the transmission equipment should be evaluated in terms of supply reliability and cost. The LCRM shows how the different strategies need to be proposed in order to use existing equipment efficiently.

2. Application to transformer maintenance planning

Examples using a model system *2 are shown to represent how the LCRM can be used to propose the optimal transformer maintenance plan.

- (1) When the changes of state *3 and maintenance strategies *4 are assumed for a transformer *5 in the model system, LCRM is as shown in Fig. 3. In this example, the strategy of carrying out 'overhaul twice' during the lifecycle is the most economically efficient and the outage risk under this strategy is minimized.
- (2) The saving in repair cost during the aging period is examined for the above 'overhaul twice' strategy. As shown in Fig. 4, the LCRM provides useful information to optimize the tradeoff between maintenance cost and outage risk while keeping the supply reliability within an acceptable level of outage risk due to aging.

Future Developments

In future, we will extend the LCRM to evaluate the optimal maintenance plan for the entire transmission equipment. This extended LCRM will enable the maintenance plans of the whole network to be optimized in the long term.

Main Researchers: Hiroaki Tanaka, Research Scientist and Arisa Takehara, Research Scientist, Electric Power System Sector, System Engineering Research Laboratory

References

1. Hiroaki Tanaka, et al., 2008, "Proposal of Maintenance Planning Support Method for Transmission Facility based on Supply Reliability and Cost Evaluation - Proposal of a Life-Cycle Risk Map for Maintenance Planning -," CRIEPI Report R07030 (in Japanese)
2. Arisa Takehara, et al., 2008, "A New Life-Cycle Risk Map (LCRM) for Developing Maintenance Strategies for Transmission Equipment," Power Engineering Society General Meeting - Conversion and Delivery of Electrical Energy in the 21st Century, IEEE

* 1 : The economic lifetime is obtained by minimizing the annual average of lifecycle cost. The lifecycle cost in LCRM consists of installation cost, repair cost and overhaul cost. Refer to 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)

* 2 : Reliability test sub-transmission system which has 22 substations.

* 3 : Increase of failure rate and repair cost with aging and recovering effect of condition by overhaul.

* 4 : Times, timing and cost of overhaul are considered.

* 5 : It is assumed that the physical lifetime of the transformer is longer than the economic lifetime.

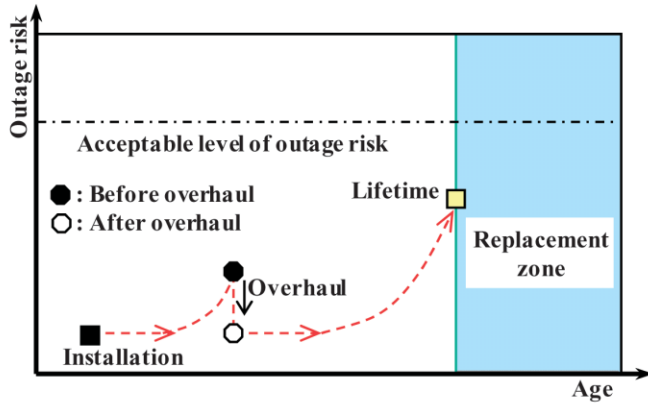


Fig.1 Concept of LCRM

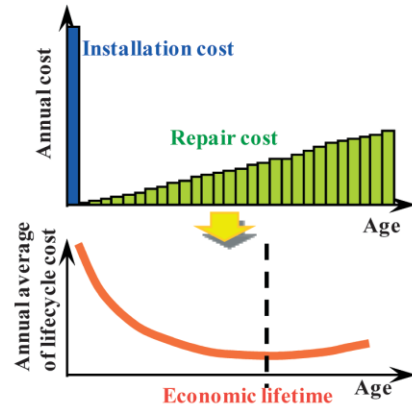


Fig.2 Economic lifetime

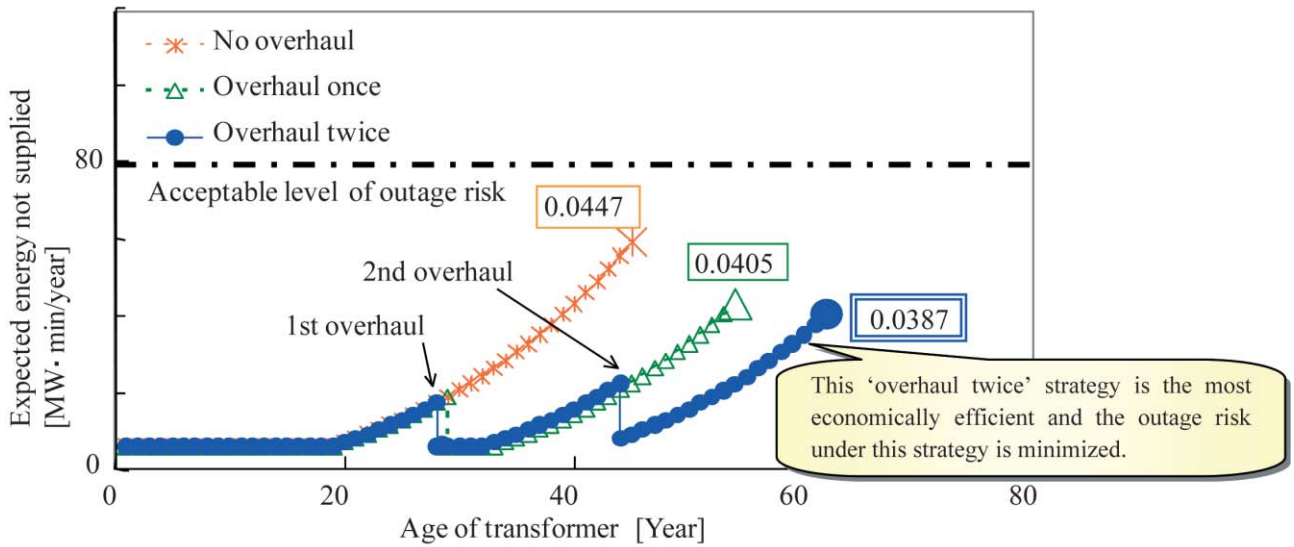


Fig.3 Study of maintenance strategy

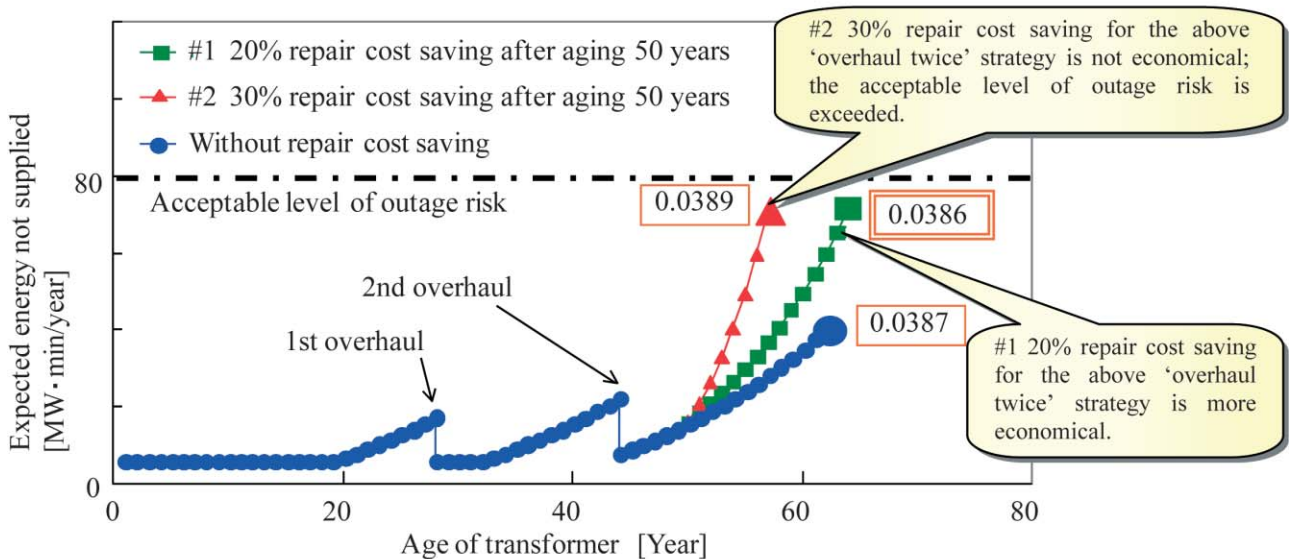


Fig.4 Study of repair cost saving

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