Diagnosis and Operation of Aged Transmission and Distribution Facilities

Background and Objective

Due to recent economic situation in Japan, power utility companies face cost reduction issues with extremely old underground power apparatus as well as the degradation of overhead transmission lines due to sea salt and rust on the surfaces of transmission towers. Therefore, maintenance cost reduction and review of maintenance strategy for aging and degraded apparatus is more important than ever.

This project aims to develop diagnostic methods for high voltage XLPE power cables, large power transformers and GISs (Gas Insulated Switchgear) and their effective utilization methods and also aims to develop several decision support tools for maintenance strategies for aging power apparatus based on recent asset management technologies. The project also supports to develop a diagnostic method of paint coatings of transmission tower surfaces in order to establish efficient recoating strategies.

Main results

1. Development of diagnostic methods of power apparatus for underground power transmission and substations

As for a diagnostic method of GIS with little insulation gradation, we proposed a highly sensitive decomposed gas detection method as an abnormality detection method using the gas-absorbent system of GIS [H09009].

OWTS (Oscillating Wave Testing System) was applied to detect locations of degradation in XLPE power cables and measured the signal propagation characteristics through the cables in order to evaluate the applicability of the method for on-site diagnosis.

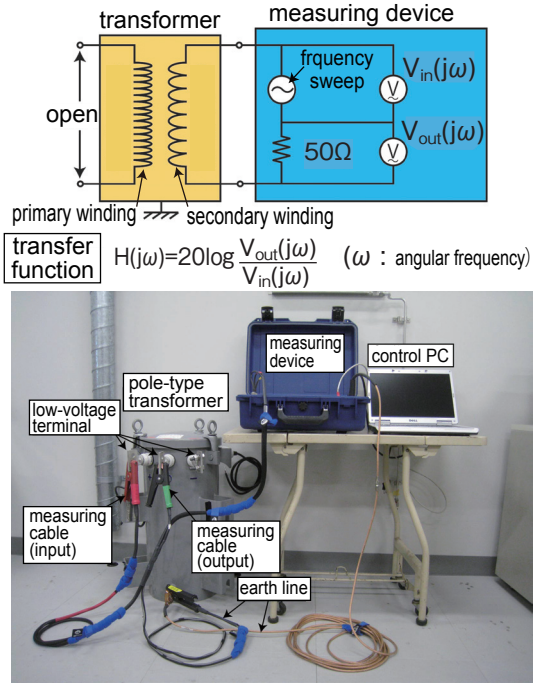
Thermal degradation diagnosis of insulation paper in a large power transformer using its thermal history was proposed by improved transient temperature estimation method to meet the experimental degradation data. On the other hand, detection methods of layer short and winding abnormality of a small transformer were developed based on FRA (Frequency Response Analysis) [H09008] (Fig. 1).

2. Decision support tools for maintenance strategies of aging power apparatus

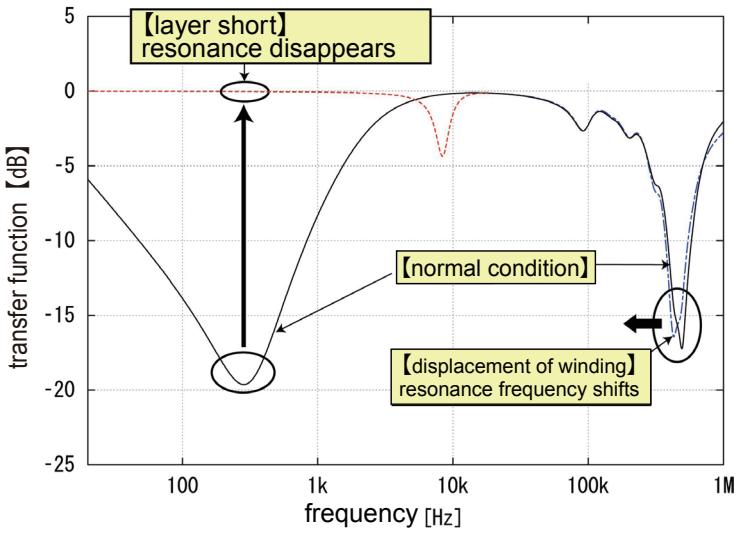
We have proposed several decision support tools for maintenance strategies for each power transformer and GCB, and those for GIS systems composed of several types of equipment using maintenance cost data and failure probability of that equipment [H06014, H07013, H08011]. Based on the experience obtained through developing those tools, a new decision support tool for a maintenance strategy was developed [H09010] (Fig. 2). This tool assists us in the planning of appropriate maintenance schedules for conductors, ground wires, and towers of overhead transmission lines based on the maintenance costs of those components.

3. Development of diagnostic method of paint coatings of transmission tower surfaces

We investigated the applicability of a.c. impedance methods and current interrupting methods to diagnostic methods of paint coating degradation for transmission tower surfaces. With accelerated degradation tests and long-term exposure tests, we found the impedance of the coating can be a good index of paint coating degradation [Q08031]. Based on those results, we have been accumulating ageing data for several types of paint coatings.



(a) application to pole-type transformer



(b) transferfunction for normal conditon and abnormal conditions

Fig.1 Diagnosis of pole-type transformer winding with Frequency Response Analysis (FRA)
Layer short of winding and displacement of winding can be detected by the change of transfer functions.

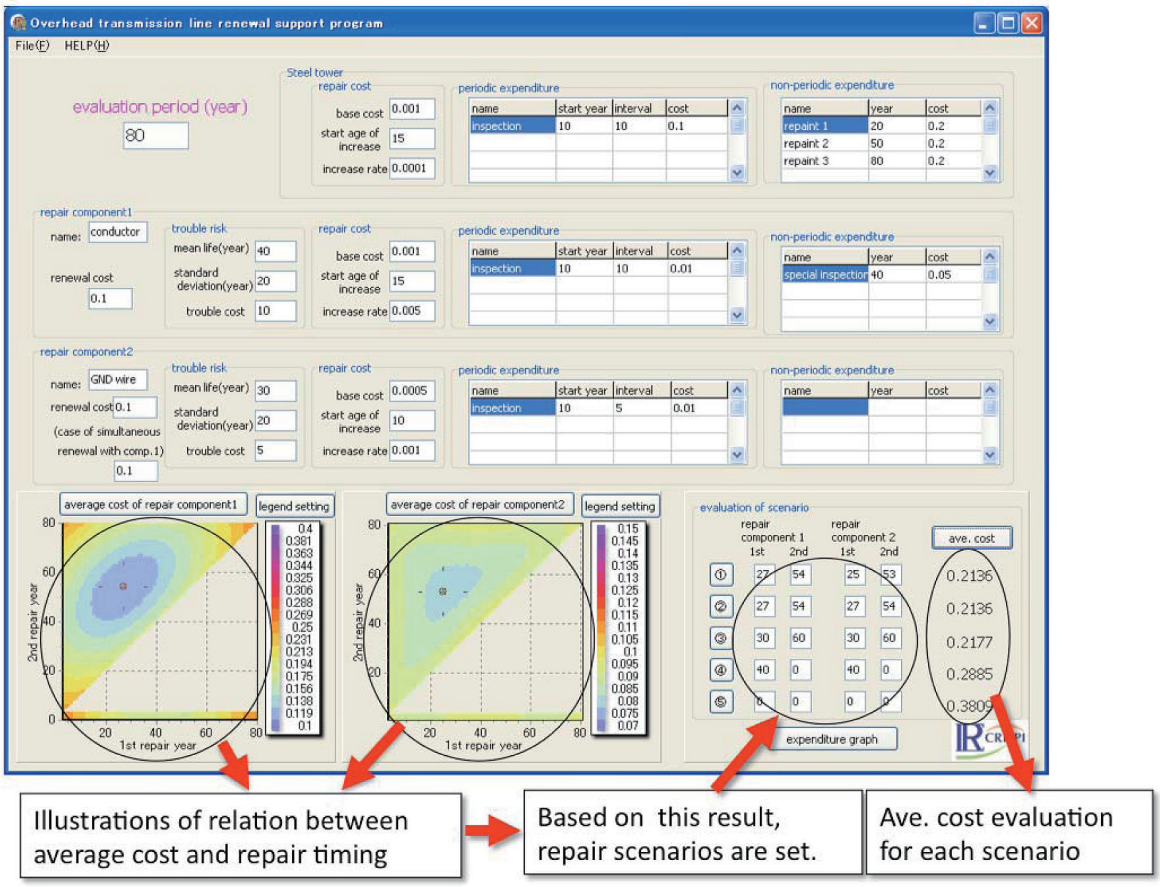


Fig. 2 Display example of a maintenance scenario support tool for overhead transmission lines
This program proposes the appropriate maintenance schedule for conductors, ground wires, and towers of overhead transmission lines based on the maintenance cost for each component of an overhead transmission line.