

2. Advanced Maintenance Technology: Rational Operation of Electric Facilities

(1) Establishment of a gas turbine hot parts integrity assessment technology (promoted project subject): FY 2005 - FY 2009

[Objectives]

To develop a technology capable of assessing the remaining life of gas turbine hot parts (mainly the rotor and stator blades) based on the usage temperature of individual parts to thoroughly reduce the maintenance cost.

[Principal Results]

- The applicable temperature range of the temperature estimation method to thermal barrier coating (TBC) based on the state of the cut surface degradation of the corrosion resistance coating layer was clarified to enable estimation of the temperature of gas turbine blades with film cooling path system and coated with TBC. At the same time, temperature estimation was conducted by means of computer simulation and the suitability of the above-mentioned method was confirmed through comparative analysis. Moreover, a new TBC degradation indicator was introduced to upgrade this method.
- “The maintenance planning optimisation support system” was further improved to enable the more flexible planning of the parts rotation to respond to the demands of users.

(2) Development of remote monitoring and integrity assessment system for power generation plants: FY 2006 - FY 2008

[Objectives]

To develop a tool capable of monitoring the secular deterioration of equipment, assessing the impacts of changing equipment efficiency on plant efficiency and assessing the state of quantitative damage to boiler materials by means of analysing the thermal material balance through real time remote monitoring so that the thermal efficiency of power generation plants can be maintained/improved along with improvement of the efficiency of maintenance work.

[Principal Results]

- To make the already developed “analysis of the thermal efficiency of power generating system (EgWin)” more easily usable at actual power plants, its macroscopic functions were developed and the user support system was expanded.
- Trial operation commenced with a system which analyses the thermal efficiency by receiving the operating data of a power plant on-line and then produces a database from the analysis results. In addition, “plant computer data analysis tools” was developed to conduct heat absorption analysis at each heat transfer surface and balance evaluation of the combustion gas flow based on the received plant computer data.
- A basic technique to individually evaluate the performance of the compressor and turbine, which are element equipment of a gas turbine (GT), using such a dimension-less number as the Mach number was developed for its application to the inference of the causes of a declining pressure ratio of a GT compressor.

(3) Development of non-destructive assessment methods for power generation components and steel structures (promoted project subject): FY 2004 - FY 2008

[Objectives]

To develop crack detection, analytical assessment and monitoring methods for power generation components and steel structures to contribute to the preservation of the reliability and cost reduction of maintenance work.

[Principal Results]

- The growth behaviour of voids and minute cracks was clarified by means of the creep fatigue test of boiler piping high chromium steel welding joint inside a scanning electron microscope and a simulation method based on such behaviour was proposed. Through comparison with the fatigue test results, it was verified that this method is capable of predicting growth behaviour.
- Using an ultrasonic propagation simulation programme, the measuring conditions of the convenient and low cost ultrasonic inspection method (SPOD method) developed by the CRIEPI were optimized and the ability of this method to measure some 2 mm deep fatigue cracks, which are difficult to measure by other existing methods, was verified.
- The development of “Bending and Internal Pressure on real structural samples” was completed. This facility is one of the world’s largest base research facilities which enables the internal pressure and bending load testing of piping specimens equivalent to the reheat pipes of boilers at thermal power plants.

(4) Establishment of an autonomous demand area power system technology (promoted project subject): FY 2006 - FY 2007-12-08

[Objectives]

To clarify the impacts of the mass connection of distributed power sources in a wide area and to establish a control technology for the demand area power (distribution) system in order to ensure efficient energy supply through coordination between system

power sources and distributed power sources.

[Principal Results]

- A coordinated control system with distributed power sources was developed for voltage regulation and the validity of this system was verified using “hybrid experimental facility for a demand area power system”, a large-scale base research facility. It became clear that the system will contribute to the reduction of the required capacity of the loop controller.
- Based on the experiment results, a simulation model was added and improved to enable the analysis of various characteristics (voltage fluctuations of the distribution lines and characteristics of the distributed power sources at the time of an accident, etc.) during the connected operation of distributed power sources.
- Simulation analysis was conducted to clarify the necessary conditions for an independent operation detection system to prevent the simultaneous dropping out of distributed power sources at the time of a sharp change of the voltage phase due to switching over of the distribution route or other reasons.
- The conditions to allow the independent operation of distributed power sources, including those using natural energy, were clarified from the viewpoint of both technology and cost.

(5) Construction of aged component maintenance standards for power distribution facilities (promoted project subject): FY 2006 - FY 2008

[Objectives]

To establish a remaining life verification method for power distribution facilities based on accurate diagnosis of the conditions of aged equipment and on-site testing, etc. with a view to developing maintenance standards capable of reducing the maintenance cost and securing the reliability of aged equipment.

[Principal Results]

- A method to determine a reasonable voltage for the withstand voltage test based on assessment of the cumulative breakdown probability was established to contribute to judgement of the renewal timing for gas insulated switchgear and XLPE power cables, considering the damage of test voltage application. (Fig.4).
- The partial discharge magnitude was measured at the site of a hydropower generator windings to accumulate data for the deterioration analysis to establish an on-line monitoring methods. The mechanism of insulation deterioration due to partial discharge was clarified using removed hydropower generator windings.
- Through the experimental examination of a method capable of externally diagnosing such abnormalities as displacement of the windings of an aged transformer, it became clear that the frequency response analysis (FRA) method can be applied to the identification of internal abnormalities of actual equipment.

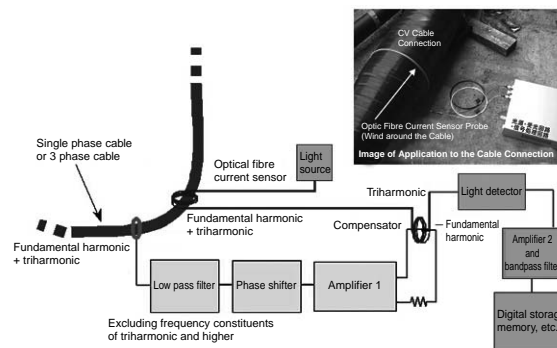


Fig.4 Conceptual Drawing of Third Harmonic Wave Current Detection System for the Detection of the Water Treeing of XLPE power Cable

(6) Study of management measures for electricity network under a competitive environment: FY 2006 - FY 2008

[Objectives]

To promote measures to establish the rationality of and effective use of an electricity network under a competitive environment through examination of the technical, economic and legal issues in order to secure the fairness and transparency of the use of electricity distribution facilities in Japan.

[Principal Results]

- Cases in the US and Europe were studied to propose measures to establish the rationality of and to effectively use an electricity network under a competitive environment. One finding is that while the financial transmission right (right to enjoy a financial benefit from the use of a distribution facility when the system is congested) is mainly used as a mechanism to prevent an increase of the transmission congestion cost from the viewpoint of the effective use of existing network facilities, this right is not likely to provide an adequate incentive of transmission investment to facility owners.
- By focusing on the transmission congestion cost which could become a factor hampering the economy of the power trade, a prototype model was developed to evaluate the economic merit (reduction of the transmission congestion cost) which could be enjoyed by system users for a long period of time after the construction or expansion of a transmission line.

(7) Network asset management of the electric power system

[Objectives]

To develop a tool to assist the risk-based rational management and maintenance of the network asset of an electric power system based on evaluation of the reliability and cost from the viewpoint of the entire network in collaboration with studies on the maintenance and diagnosis of power equipment and also studies to evaluate the economy of such equipment.

[Principal Results]

- In the light of the future arrival of a time of the intensive replacement of distribution equipment, the framework for a tool to assist the levelling of capital investment was clarified from the viewpoint of the reliability and cost of the entire power system.
- The existing reliability analysis system was improved to enable more realistic examination of power source operation and other aspects in connection with the quantitative evaluation of system reliability.

(8) Asset management decision-making support tools for power apparatus

[Objectives]

To provide a decision-making support tool to reduce the maintenance cost of existing power apparatus, taking the renovation as well as the replacement costs into consideration.

[Principal Results]

- An asset management decision support tool based on evaluation of life cycle repairing cost of the objective equipment was developed. The tool considers the age and failure rates of power apparatus to evaluate the life cycle cost. This tool has been used for the power apparatus replacement plans of electric companies through entrusted research work, etc.
- The document search programme for power apparatus diagnosis technologies was improved and the index data for documents was expanded to improve the efficiency of the search for apparatus diagnosis and maintenance technologies.