Electric Power Engineering Research Laboratory

Brief Overview

The Electric Power Engineering Research Laboratory is engaged in the advancement of fundamental technologies, including insulation and lightning protection technologies for power transmission and distribution equipment. It is also developing next generation power equipment and new electric power technologies, such as laser and applied plasma arc technologies.

Achievements by Research Theme

Countermeasure for Fault Current in power system

[Objectives]

To develop a fault current limiting technology, and to establish adequate disaster prevention measures for power equipment, for the purpose of preventing public disasters at the time of power failure and ensuring a stable power supply.

[Principal Results]

- The characteristics of pressure rise due to a fault arc inside power transmission/distribution equipment were experimentally obtained using sealed containers. The influences of the current, gap length and container size were clarified as such information is required for the development of a simulation method.
- Arching horns interrupting fault current were developed for 33 kV overhead distribution lines through joint research. These horns are capable of mitigating lightning damage, including the negative impacts of an instantaneous voltage drop, at a low cost.

Analysis of Transient Phenomenon and Electromagnetic Wave

[Objectives]

To develop design techniques of the electromagnetic compatibility between power transmission/distribution equipment and ubiquitous society, and of a new electric power system, for harmonisation between power equipment and society.

[Principal Results]

- A new technique was developed to infer the arrival directions of multiple pulsed electromagnetic waves based on their measurements at one site so that the electromagnetic noise generated by power transmission/distribution equipment can be used to search fault locations, and the impediment caused by electromagnetic noise can be reduced. An exploration system incorporating this technique was also developed and its practical accuracy was confirmed. [H08003; H08019]
- A new transient analysis programme (eXpandable Transient Analysis Programme: XTAP) was developed, which can analyse power systems incorporating many power electronic devices and power electronic circuits in stable and detail. [H08002]

Electric Power Apparatus Insulation for Next Generation

[Objectives]

To develop a next generation insulation technique to realise environmentally friendly and maintenance-free electric power equipment which will be required to meet the renewal demand of such equipment in the near future.

[Principal Results]

- The structure of the connections of hybrid gas insulated bus conductors was examined in detail to advance the design work of a real-scale verification model.
- The specifications of all-solid transformers were examined in detail, taking the interface configuration of the all-solid connections between different devices and the characteristics of the mould materials into consideration, to advance the design of a real-scale verification model (Fig. 1). [H08016]

Establishment of Electromagnetic Compatibilities

[Objectives]

To establish a method to assess the electromagnetic phenomena of the radiation and propagation of electromagnetic fields/waves from DC to GHz to ensure the convenience and reliability for both utilities and users.

[Principal Results]

- The influence of radiated electromagnetic waves generated by spark discharge as a result of a fault with power equipment on 2.4 GHz wireless LAN (IEEE 802.11 g) was evaluated experimentally. It was clarified that the reduction of the throughput of the

wireless LAN was very small compared to a microwave oven using the same frequency band.

Laser Photon Science and Measurement Technology

[Objectives]

To develop basic technologies for the measurement and diagnosis of the deep inside of materials and for a laser-induced breakdown spectroscopy (LIBS), to make appropriate diagnosis and understanding of the operating conditions for power equipment.

[Principal Results]

- A compact X-ray imaging system was developed for radiographic testing (RT) in narrow spaces (Fig. 2). A viable development prospect of a laser-plasma compact X-ray source head was established, which can make the transmission diagnostics of 1 cm thick steel. (H08005; H08009]
- The chlorine density at the torn surface of a concrete specimen was remotely measured using the LIBS technology to enable the field measurement of salt contamination to concrete structures. This experiment successfully demonstrated that measurement using this technology can be conducted with an equivalent resolution and time as that of the conventional potentiometric determination method. [H08012]

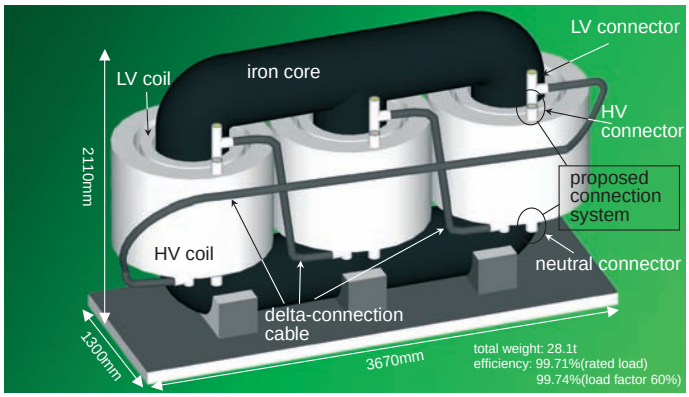

Fig.1 Trial design of all-solid transformer (20MVA, 60kV class)

By assuming epoxy resin with AlN filler as insulating materials of all-solid transformers, a trial design was carried out on condition that it is almost same size as a conventional oil immersed transformer (external size: 3.7m x 2.1m x 1.3m). According to this design its weight is about 28 ton, which is about 80% compared with a conventional transformer.

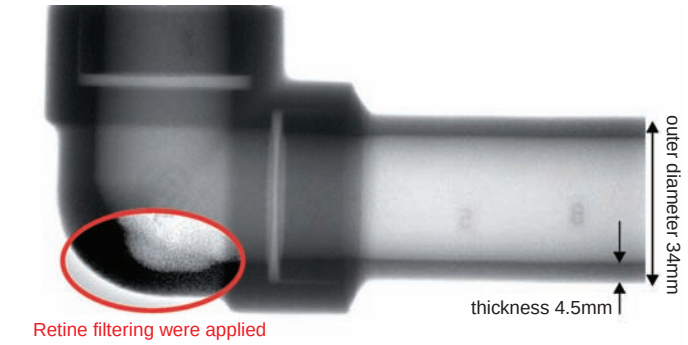

Fig.2 Example of radiographic picture by developed X-ray imaging system for narrow space

An elbow pipe, which is generally installed in a power plant, were artificially made thinning inside and scanned by using the compact X-ray imaging system. As a result of this measurement, the thinning part indicated by the red oval are clearly distinguished by smooth image connection and filtering.