Priority Subjects with Limited Terms — **Further Improvement of Facility Operations and Maintenance Technologies**

# Development of Maintenance Technologies for Aged Power Transmission and Distribution Facilities

**Background and Objective**

The development of systematic maintenance technologies is important in order to successfully standardize maintenance and renewal work on aged power equipment, as well as consider the cost-benefit performance. In this research project, we improve our degradation diagnosis method and our ability to gather degradation data, then establish support methods of facilities for renewal.

**Main results**

## 1 Abnormality diagnosis of a power transformer by FRA

We have been developing a degradation detection program to detect transformer wires abnormalities using FRA (Frequency Response Analysis). Currently, a technique is applied to shunt reactors with winding structures similar to transformers with power company members[1] and we succeeded in detecting winding abnormality of the equipment as shown in Fig. 1. After dismantling the shunt reactor, we discovered the abnormality, thus confirming the applicability of the FRA method in detecting abnormalities in shunt reactor structure.

## 2 Insulation diagnosis of XLPE and OF cables

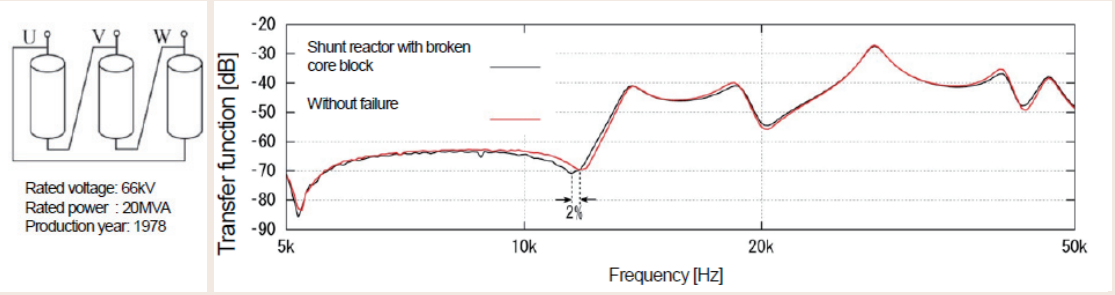
We have been measuring the breakdown strength of used 20-60 kV XLPE (cross-linked polyethylene insulated) power cables supplied by Japanese power companies and the water tree degradation level, that determines the breakdown strength of the cables, has been measured. After accumulating data, we plan to develop an estimation method for the remaining life of those XLPE power cables considering their usage conditions and cable structures.

As for OF (Oil Filled) cable joints, recently it has become very important to determine their degradation mechanisms because PD (Partial Discharges) traces are detected in the replaced cables without any detection of PD by gas analysis. We began PD measurement tests of OF cable joint models with defects as shown in Fig. 2 (a). We clarified the PD process of the model from the voltage application to the final breakdown. We discovered it was possible to detect the extent of degradation through trend management of PD occurrence frequency, duration and electrical discharge load (Fig. 2)(H13014).

## 3 Degradation diagnosis of rust and surface paint of power equipment

We are trialing THz (tera-Herz) wave to measure rust under the opaque anticorrosion coating and develop a deterioration degradation method for coated steels of power equipment. THz wave has the advantage of being easily absorbed by the rust of the material surface. We found that this measurement method could also be applied to the deterioration degradation of metal under paint coats of equipment installed near the sea (Fig. 3)[2].

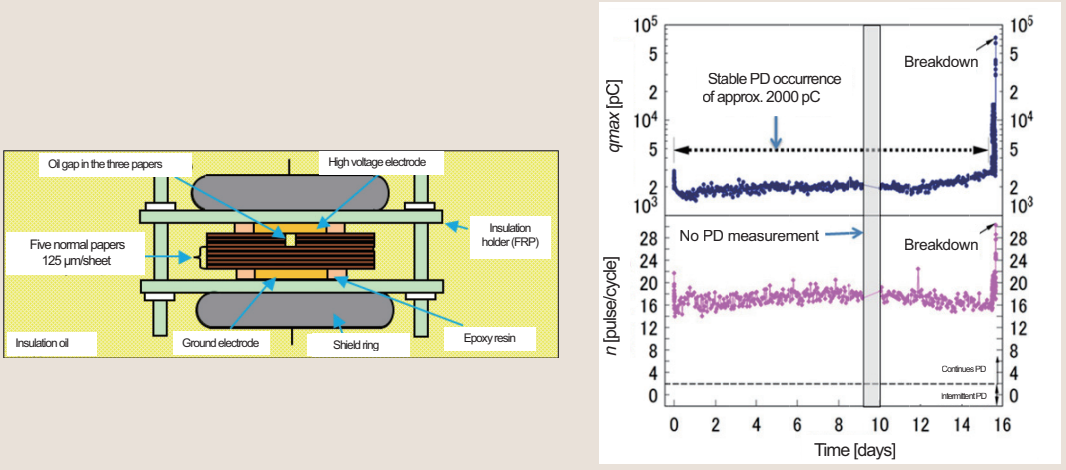
[1] S. Miyazaki et. al., IEEJ, B-Society Convention Paper No.405, 2013
[2] N. Fuse, et. al., IEEJ, IIS-13-64, 2013




(a) Specification (b) FRA analysis results

Fig. 1: Abnormality detection of a shunt reactor

The measurement result of a shunt reactor is shown. A downward peak at 12 kHz shifted to lower frequency due to the occurrence of an abnormality. This abnormality was confirmed by dismantle analysis of the reactor. This result confirms the validity of FRA method as a detection method for shunt reactor abnormalities.




(a) Oil-paper model specimen with gap defects (b) Time dependence of PD characteristics

Fig. 2: PD measurement with an OF cable model specimen

A PD occurrence of over 2000 pC was observed with a sheet specimen under continuous alternating voltage application condition. With this experimental result, we found that the potential for breakdown can be estimated by the PD magnitude after it exceeds approx. 2000 pC.

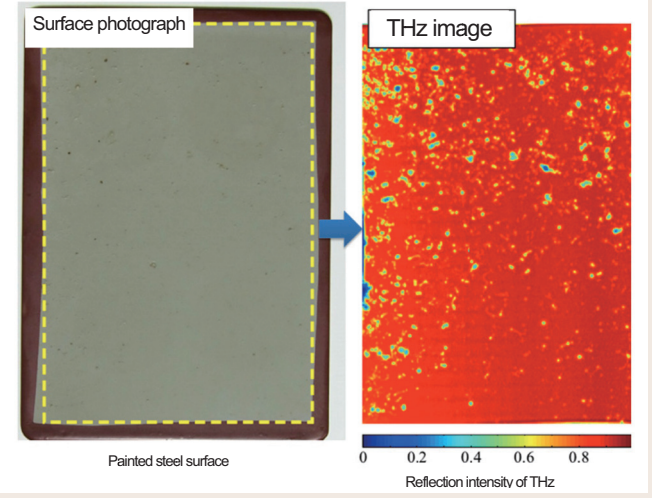



Fig. 3: THz analysis of paint polyurethane coated steel surface

THz imaging was carried out on the surface of a 9 cm × 12 cm painted steel plate. A THz wave was projected onto the surface at a perpendicular angle while reflection intensity and time were measured. While the surface photo (left) does show a small amount of degradation, the THz image is capable of detecting degradation with much greater clarity. The THz image was normalized by the intensity of the projected signal. A reflection intensity of 1 indicates full reflection, while that of zero corresponds to complete absorption. The closer the intensity is to zero, the higher the extent of degradation.