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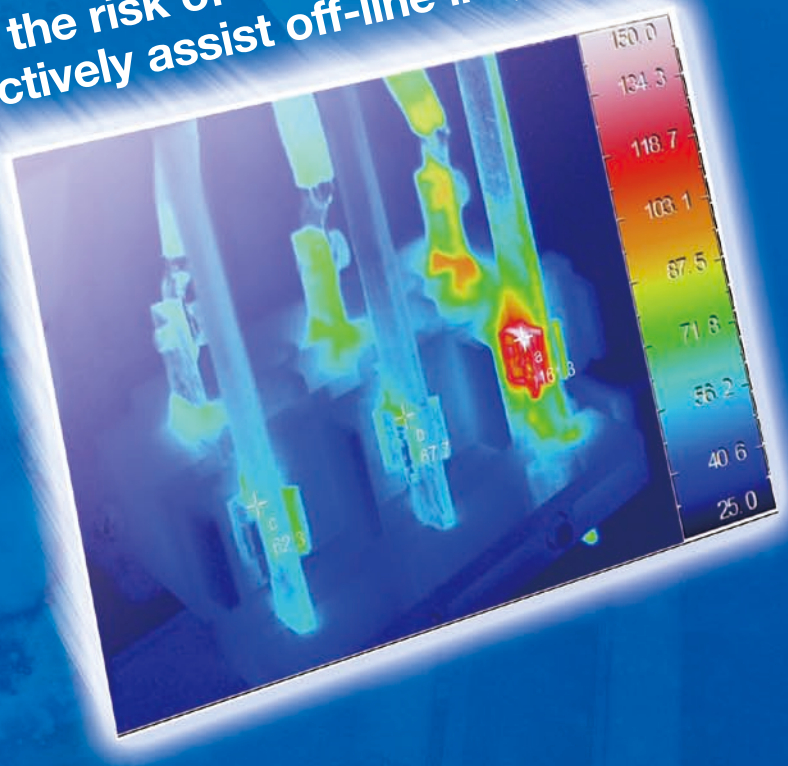
Quality connecting the next

Recommendation of Live-Line Diagnosis of Electrical Facilities

To reduce the risk of unexpected accidents and effectively assist off-line inspections



Recommendation of Live-Line Diagnosis of Electrical Facilities

Reduces the risk of occurrence of unexpected accidents and increases the efficiency of off-line inspections.

Advantages of live-line diagnosis

Live-line diagnosis can assess the state of facilities during normal operation and thus offers the following advantages.

1. Reduces the risk of unexpected accidents

Abnormalities that cannot be found by conventional inspections (daily visual and off-line inspections) can be detected, thus reducing the risk of unexpected accidents.

- Abnormalities that cannot be found by conventional inspections include: overheating, abnormal discharge, gas leakage, degradation of gas and insulation oil, and abnormal vibration of bearings; these are difficult to detect by visual and off-line inspections.

* Equipment and draw-out devices for which a sufficient safety distance cannot be maintained may not be diagnosed because the work is performed in the live line.

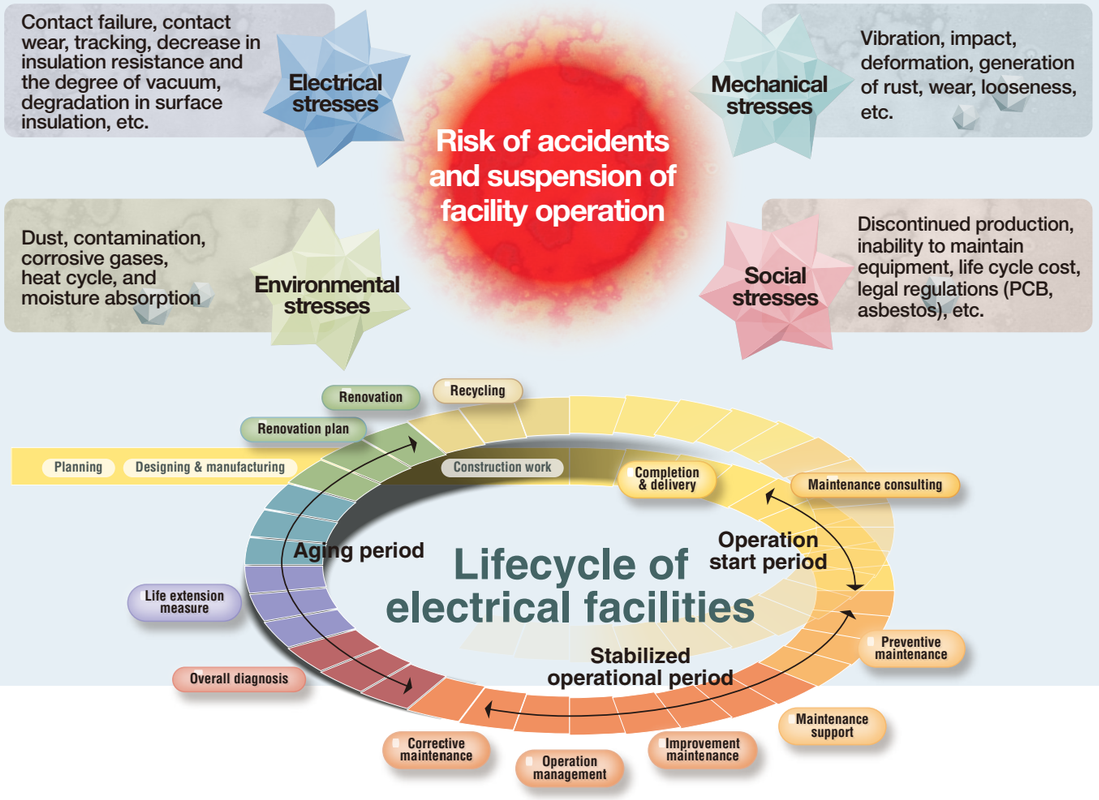
2. Assists off-line inspections efficiently and effectively

Maintenance can be focused on the points found by the live-line diagnosis, and replacement parts can be ordered in advance. Off-line inspections can thus be conducted efficiently and effectively.

3. Efficient use of maintenance budget and support for facility renewal plans

Capitalizing on our years of experience, technology, and expertise, we propose an optimum maintenance method to improve power supply reliability, ensure efficient use of maintenance budget, and support the facility updating plan.

Flow of improvement in overall economy and power supply reliability



Live-line diagnosis

Grasping of facility conditions during ordinary operation

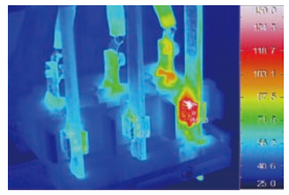
Detection of overheating, partial discharges, and other abnormalities caused during operation

Reducing the risks of sudden faults

Selection of maintenance points for off-line inspection

(Example of thermal image measurements on a disconnecting switch)

[No problem] as a result of visual checks



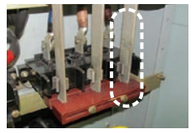
[Unusual overheating spot discovered] as a result of thermal image measurements

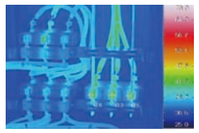
Off-line diagnosis

Grasping the facility status while the system is out of servicing

- Maintenance by overhauling
- Characteristic testing, etc.

Selective maintenance for abnormal spots defined as a result of live-line diagnostic services





Unbalanced thermal conditions among phases are improved and adjusted.

Extension of operational life and replacement of parts

Facility renewal and replacement

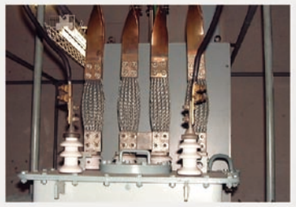
Improvement of overall economy and reliability in power supplies

Thermal image diagnosis

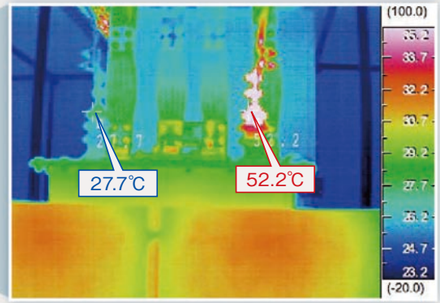
Unusual overheating conditions can be located by taking images of thermal conditions present in equipment.

Thermal image diagnosis: Example 1

This abnormality cannot be discovered by tightening checks.



Measuring position: Connections of an oil-immersed transformer

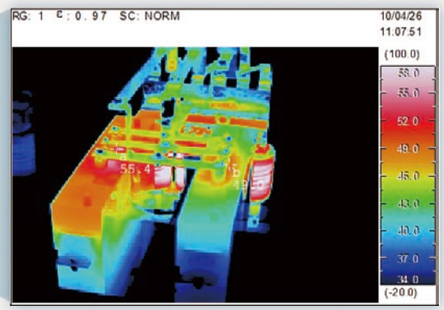


A local overheating point is discovered around the connection on the right side.

- The cause of this local overheating stems from the reduced elasticity of a gasket and the increased contact resistance of this gasket that has been used for a long time around the connecting part. This example suggests the case of a serious accident such as a meltdown of the connecting part or the possibility of a fire if the load current has been greater.
- This connecting part has been checked and further tightened at the time of periodic inspection.

For grasping the condition of phase-advancing capacitors

Phase-advancing capacitors



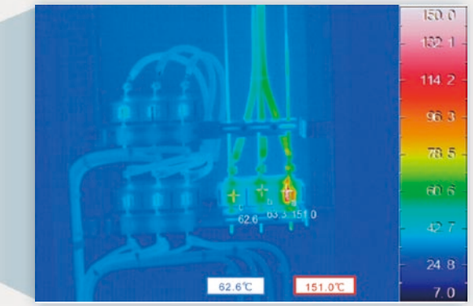
Overheating is discovered in the capacitor on the left side.

- This is an example of overheating in phase-advancing capacitors due to secular deterioration as a result of many years of operation.
- This abnormality was not discovered at the time of regular periodic inspections.
- Working efficiency can be improved by performing thermal image measurements during ordinary operation and making maintenance plans and by fixing programs for the next periodic inspection.

Thermal image diagnosis: Example 2

This abnormality cannot be discovered solely by visual inspection.

Measuring position: MCCB

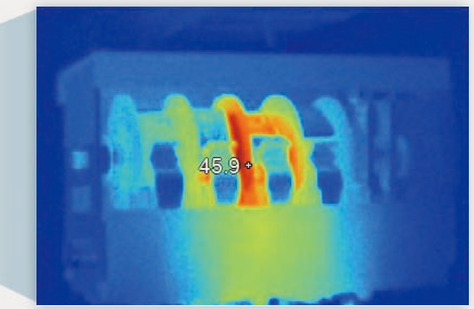


A local overheating point is discovered at the terminal block on the right side.

- This is an example of a case when local overheating is discovered in the red phase of the primary main disconnecting switch while a load current of 80A is carried in each phase.
- It is assumed that contact resistance has been increased around the contact section after many years of use.
- If this operation is continued further without any remedial measures, there is danger of a meltdown or a fire.
- It is difficult to grasp the situation by visual inspection. This section makes it difficult to discover any abnormality unless a failure occurs.

Grasping the condition of deterioration

Measuring position: Current changeover switch



A local overheating point is discovered in the center.

- This example shows the case of plating peeling-off on the sliding surface, leading to heat generation, which is caused as a result of frequent switchover operations for measurements.
- Poor contact in a current measuring circuit can generate unusual high voltage because the secondary circuit of the CT (instrument current transformer) is opened. This accident can lead to the burning of a device connected to the measuring circuit.

Partial discharge diagnosis

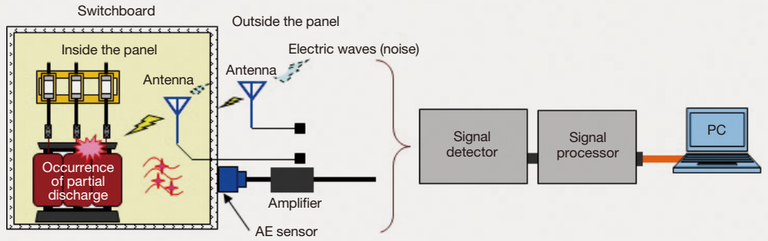
Presence of partial discharges can be examined. These partial discharges are often generated due to the effect of contamination or deterioration in the insulations of high-voltage equipment (mainly mold type equipment) where the location of faulty condition is difficult to ascertain by visual inspection.

Due to insulation deterioration or surface contamination in high-voltage electrical facilities, partial discharges (or corona discharges) are generated to cause insulation breakdown, thus leading to a serious accident in the final stage.

By detecting these partial discharges in the middle of system operation, a symptom of abnormality in electrical facilities can be discovered at an early stage of fault development so that a serious accident can be prevented. Also that can be reduction of energy losses, and investigation of conditions of deterioration.

Partial discharge diagnostic system

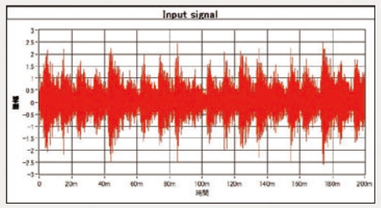
Detection of partial discharges by the acoustic method (AE sensor) or the electric wave method (antenna)

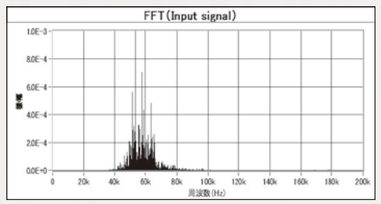


Detection of partial discharges by the acoustic method (AE sensor)

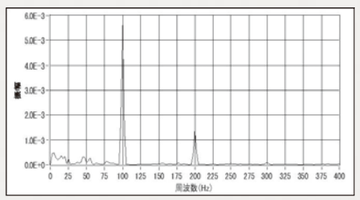
An example of partial discharge measurement with the aid of AE sensor

Partial discharge measuring unit by the use of AE sensor





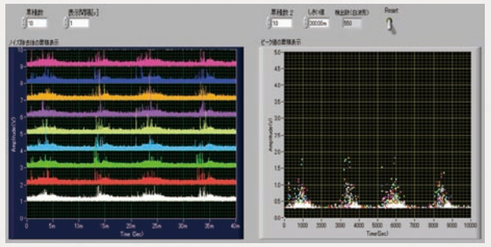
An example of detected partial discharge waveforms



Detection of partial discharge by electromagnetic waves

Example of partial discharge diagnosis using electromagnetic waves

A device for measuring partial discharge using electromagnetic waves

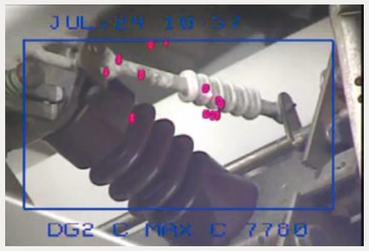


Typical partial discharge waveforms obtained by measurement using electromagnetic waves

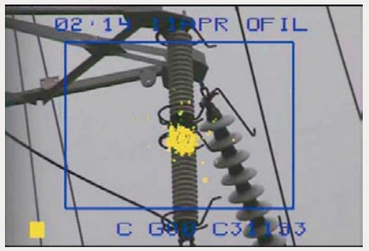
Identification of an abnormal region by visualizing corona discharge

Detection of partial discharge using a camera for corona detection

Examples of diagnosis using a corona camera



7.2 kV LBS



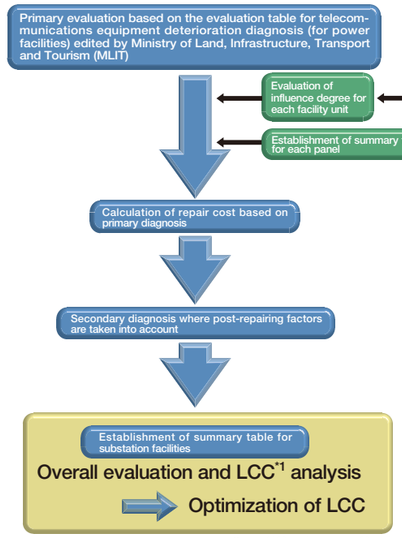
66 kV steel tower

Rotary machine stator coils

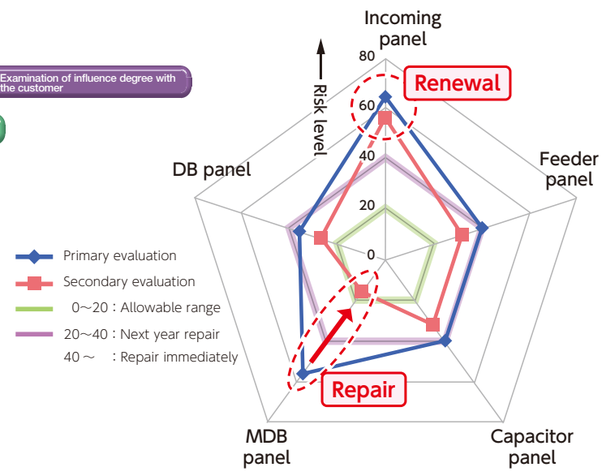
Shooting examples

Example of comprehensive evaluation of substation facilities where factors of influence and risk levels are taken into account in regard to deterioration

- Use of the evaluation sheet for degradation diagnosis of electrical communication facilities (for power facilities) by the Ministry of Land, Infrastructure, Transport and Tourism
- Calculation of a failure occurrence level based on degradation assessment score
- Evaluation of influence degree in the case of a failure for each facility
- Calculation of fault and risk levels based on the evaluation of influence degree
- Calculation of required processing cost based on primary evaluation and secondary evaluation where post-processing factors are taken into account



*1 LCC: Lifecycle Cost



Visualization of cost effectiveness by radar chart

Installation environment diagnosis,Analysis of gases and furfural in oil,Analysis of SF_6 gas

Installation environment diagnosis

Measures the electrical conductivity of contaminants deposited in the electric room/switch gear, and on the surface of equipment.

Conditions of the facility installation environment can be confirmed by quantitative analysis of the degree of contamination by converting the measured electrical conductivity into equivalent salinity adhesion quantity and by ion analysis of contaminants, and measures to improve the environment can be taken.

Oil transformer diagnosis
(Analysis of gases and furfural in oil)

Based on the result of insulation oil analysis mainly for oil-immersed transformers, the amount of insulation oil components, the status of equipment interior, and deterioration degree can be checked.

* This service is limited to only equipment with an oil-sampling drain outlet.

Analysis of SF_6 gas

Mainly based on the result of gas component analysis for transformers, the status of equipment interior and deterioration degree can be checked.

Diagnosis for high-voltage power cables

Example of diagnosis for high-voltage power cables while charging.

Grasps signs of degradation and provides detailed diagnosis and renewal period.

(A specialized terminal box needs to be installed.)

Visual checks/Miscellaneous

The electrical facilities of our customers are checked by professional personnel.

Through our live-line diagnosis, precise and optimal plans for preventive maintenance services can be drawn up.

Quick Reference Table of Diagnostic Items

Equipment for live-line diagnosis and diagnostic items

Diagnostic items / Objective equipment	Thermal-image measurement (P.3)	Corona discharge measurement (P.5)	SF_6 gas analysis (P.7)	Gas-in-oil analysis (P.7)	Furfural-in-oil analysis (P.7)	Battery status analysis	Measurement of contamination degree (P.7)	Overall evaluation approach (P.7)	Insulation resistance measurement	Resistance measurement
Gas-insulated switchgear (GIS, C-GIS)	●	●	●	–	–	–	●	●	–	–
Pole-on air switch (PAS)	●	●	–	–	–	–	●	●	–	–
Disconnecting switch (DS)	●	●	–	–	–	–	●	●	–	–
Air load switch (LBS)	●	●	–	–	–	–	●	●	–	–
Power fuse (PF)	●	●	–	–	–	–	●	●	–	–
Lightning arrester (LA)	●	–	–	–	–	–	●	●	–	–
Vacuum circuit breaker (VCB)	●	●	–	–	–	–	●	●	–	–
Phase-advancing capacitor (SC)	●	●	–	–	–	–	●	●	–	–
Series reactor (SR)	●	●	–	–	–	–	●	●	–	–
Oil-immersed transformer (T)	●	●	–	●	●	–	●	●	–	–
Dry type molded transformer (T)	●	●	–	–	–	–	●	●	–	–
Switchboard	●	●	–	–	–	–	●	●	–	–
Indicating meter	●	–	–	–	–	–	●	●	–	–
Protective relay	●	–	–	–	–	–	●	●	–	–
Mold type instrument transformer (VT, CT)	●	●	–	–	–	–	●	●	–	–
Magnetic contactor	●	●	–	–	–	–	●	●	–	–
Air circuit breaker (ACB)	●	–	–	–	–	–	●	●	–	–
Molded-case air circuit breaker (MCCB)	●	–	–	–	–	–	●	●	–	–
Electricity leakage circuit breaker (ELCB)	●	–	–	–	–	–	●	●	–	–
Storage battery	●	–	–	–	–	●	●	●	–	–
DC power unit	●	–	–	–	–	–	●	●	–	–
Uninterruptible power unit	●	–	–	–	–	–	●	●	–	–
High-voltage power cables	–	●	–	–	–	–	–	–	●	●
Measuring equipment	Thermal-image measuring equipment	Corona discharge measuring equipment	SF_6 gas analyzer	Insulation oil analyzer	Insulation oil analyzer	Battery checker	Conductivity measuring equipment	–	Equipment for live-line diagnosis for cables	Equipment for live-line diagnosis for cables
Contents of diagnosis	Measurement of absolute temperature and comparison of relative humidity	Presence of corona discharges	Deterioration degree of gases	Deterioration degree of insulation oil Internal abnormality	Deterioration degree of insulator	Deterioration degree of storage battery	Contamination degree	Overall evaluation approach	Cracks/deterioration of sheath	Corrosion/rupture of shielding tape
Method of diagnosis	Temperature analysis by infrared rays	Discharge sound analysis	Analysis of SF_6 gas component	Oil property test Gas-in-oil analysis	Furfural analysis	Discharge characteristics and capacitance analysis	Conductivity analysis	Visual checks	Insulation resistance measurement for sheath	Insulation measurement for soft copper shielding tape

* Since this is a live-line inspection, diagnostic services cannot be carried out in some cases, for example, for equipment where a separation distance cannot be secured or for draw-out type of equipment.

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