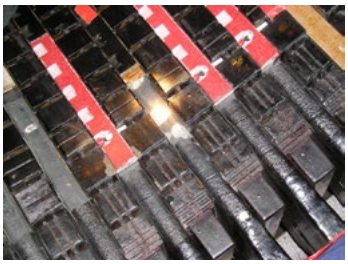
DOBLE CONSULTING & TESTING SERVICES

ROTATING MACHINERY SERVICES OVERVIEW

Rotating machinery assessment services from Doble Power Services provide a solid foundation for effective condition-based maintenance programs based on industry best practices. No one can precisely answer when equipment will fail, but it's essential to manage the risk.
The Doble condition assessment method for turbo-generators, hydro-generators, motors and other rotating machinery types follows the same evidence-based process used for other major plant items. Assessment services are performed by experienced Doble engineers, technicians and analysts using proprietary software and methods to establish asset health.

Typical benefits:

- Unbiased, expert opinion
- Recommends maintenance strategies based on assessment
- Enables limited maintenance budgets to be targeted toward critical and/or problematic assets
- Provides metrics to evaluate maintenance program effectiveness or improvement initiatives



ON-LINE TESTS

On-line Stator Winding Partial Discharge

PD-Guard Services

Doble offers a complete solution for continuous PD monitoring on rotating machines including the Doble PD-Guard, couplers, calibrators, interference rejection sensors and all necessary connectors. Doble provides site commissioning, training and diagnostic services available 24/7.

PD Testing Services using PD-Smart

Utilizing the Doble PD-Smart, Doble Power Services provides on-line PD testing services for generators, motors and other rotating machinery.

Doble's solution utilizes low frequency 2 nF Failsafe and LC coupling capacitors which, unlike high frequency capacitors, provides a superior PD testing solution. And using a coupling adapter, Doble can interface with previously installed capacitance couplers.

The PD-Smart can be extended to perform synchronous multi-channel measurement. It also provides advanced statistical analysis using Star-Diagram analysis to reject interference, cross-coupling and to identify separate PD features.

Electromagnetic Interference (EMI) Diagnostics Survey

Non-invasive, on-line survey that will detect a far broader range of electrical and mechanical system (generators, motors, transformers, iso-phase bus, cables, switchgear, etc.) component defects than stator winding partial discharge testing alone.

Trending data is not required and maintenance recommendations can be provided on the very first test. EMI Diagnostics has been proven with over 8,000 successful field tests on more than 500 different designs with over 70 types of defects and conditions identified, catalogued and verified.

OFF-LINE GENERATOR TESTS

DC Insulation Resistance and Polarisation Index

The insulation resistance test is a check that the stator will not be at risk from AC testing at lower gas pressure following degassing. At the end of the outage, it is an important indicator of adequate dryness and absence of foreign bodies.

AC Power Factor and Capacitance

After satisfactory completion of DC tests, these high-voltage AC tests measure power factor (or loss tangent), capacitance and partial discharge. They give a measure of contamination, moisture debonding and void growth within the insulation and contamination on the end-winding.

AC Partial Discharge

The partial discharge characteristic can be used to identify the type of defect and adds an additional diagnostic tool to the power factor tip up. If end covers are removed and end-winding discharge is indicated, these areas can be scanned when the winding is energized using ultrasonics and a corona camera to locate the discharge area.

Air Gap Search Coils

A current carrying inter-turn fault is best detected using pre-installed air gap search coils. Doble can monitor the condition and analyze results with the generators on load.

Rotor Winding Integrity using RSO

Rotor winding insulation inter-turn and earth faults are detected using the recurrent surge oscillograph (RSO) method. The test is very sensitive and will provide an early stage indication of an inter-turn fault.

ELCID and Ring Flux

The electromagnetic core imperfection detector (ELCID) identifies the presence of faulty core insulation by an electromagnetic technique. It operates on the basis that currents will flow through failed or significantly aged core insulation even when a flux equivalent to a few percent of rated voltage is induced in it.

AVR Testing

AVRs are inspected off load plus a test sequence involving three-phase injection with DC sequence and operating load tests during re-commissioning of the unit.

Test for Instrumentation

Thermocouples, RTDs and insulated bearings are checked with a low-voltage DC test for continuity and resistance to earth.

Generator Condition Monitor

Many generators have a detector to identify particulate products of overheating. Doble will visit on a three-month schedule to check the functionality of your system.

MOTOR TESTS

Vibration Monitoring

This is a simple test made on a routine visit to indicate unusual vibration levels.

Motor Current Signature Analysis (MCSA)

On smaller motors rated at 600V or less, the stator current in one phase can be measured with a portable clamp-on CT placed on a phase lead, either in the motor terminal box or at the motor control center or breaker.

For larger motors rated above 600V, the current is usually measured by a clamp-on power frequency CT, on the secondary of the CT, that measures the supply current to the motor for protection purposes (usually at the MCC). MCSA provides on-line monitoring and analysis of current to assess the condition of an induction motor drive system.

MSCA helps to effectively diagnose problems prior to motor drive failure including:

- Broken rotor bars
- Abnormal air-gap eccentricity
- Shorted turns in LV stators
- Abnormal rotor dynamics
- Pump wear
- Misalignment

Off-line Tan Delta and Partial Discharge

High-voltage AC tests that involve measurement of power factor (or loss tangent), capacitance and partial discharge.

VISUAL INSPECTION

This inspection is one of the most valuable processes and needs to be done with care by an experienced engineer. In a minor outage this is confined to the end winding areas. With the rotor removed, the visual inspection will be more extensive when slot wedges and core teeth are visible. Wedge tightness can also be checked.

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