Speciality services

Electrical diagnostic testing

Answers for energy.

SIEMENS
Electrical diagnostic testing

Scope of supply
Within Siemens Energy Service (UK) the electrical diagnostics team (part of our Speciality services business stream) has the responsibility of providing expert advice on the condition of generator stators and rotors using the expertise of engineers with many years of experience in the field of electrical diagnostic testing. The test methods carried out utilise the latest technology in non-invasive diagnostic test techniques and equipment. The testing can be performed by the team on Siemens’ plants or non-OEM plants.

Failure of plant can result in expensive repairs and costly downtime. A planned generator stator and rotor monitoring and test regime is the best insurance against such failures.

Siemens can offer a number of diagnostic tests and monitoring regimes to ensure operators have the best possible information to operate their plant safely and reliably.

Customer benefits
A diagnostic service that will ensure optimisation of your generator and assist in planning of your maintenance regime:
- Access to Siemens OEM knowledge and experience
- Access to the Siemens expert network
- Utilisation as part of scheduled outages or inspections
- Optimisation of plant operation
- Information to be able to plan long-term maintenance programmes

Features
The diagnostic tests that Siemens offer are specifically designed to identify insulation defects in generator stators and rotors. This can also lead to an understanding of whether other problems exist, such as mechanical and vibration or in the coolant water flow, which could lead to performance degradation or potential failures. The tests executed are all in accordance with proven industry methods and standards and the following gives a definition of the range of tests available and their function.

Electromagnetic core imperfection detector (ELCID) test
was designed to detect regions of core with damaged interlamination insulation on generator and large motor stators. An ELCID test can be carried out with both the rotor removed from the stator and with the rotor in-situ. Using a low profile robotic inspection vehicle.

High power ring flux test
is also used to detect damaged regions of stator core but unlike the ELCID test, which uses a low excitation, for a ring flux test the core is excited using a winding to give between 85% and 100% of full rated flux.

HV diagnostic tests
are non-destructive tests of motors and generators to assess the condition of the stator insulation by the use of DC insulation resistance, AC loss tangent/capacitance, AC partial discharge measurements and high voltage withstand tests. The tests give a measure of contamination, ageing, delamination or isolated defects in the stator winding insulation.

Stator bar water flow checks
Direct water cooled generator stator bars are made up of rectangular hollow section copper coils through which de-mineralised water is circulated to extract heat from the winding. The conductor bars are connected to the water inlet and outlet manifolds via flexible polytetrafluoroethylene (PTFE) hoses. There are up to fifty sub-conductors and the small size of these sub-conductors leads them to be
vulnerable to be blocked by any small pieces of debris in the water circuit. The blockage can lead to overheating and subsequent major damage.

**End-winding modal analysis (Bump test)**
Generator stator windings are subjected to large electromagnetic forces while in operation. In order to reduce the effects of vibration on the end windings, a modal analysis (Bump Test) is carried out. If necessary, the end winding support structure is modified to change the natural frequency of the structure. Thus, reducing the risk of in-service failure and increasing the life expectancy of the stator winding.

**Stator bar wedge tightness**
Generator stator slot wedges fit into grooves near the tops of the stator core teeth. Loose wedges in stator slots can lead to vibration of the stator bars leading to insulation damage and partial discharge problems between the bar surface and stator core when the conducting coating on the outside of the stator bar has worn away.

An automatic hammer installed in a wedge tightness detector probe mechanically excites the wedge under test and the subsequent response values are processed to give a degree of tightness of the wedge.

**Stator and rotor inspections (rotor in-situ)**
A visual inspection of the generator stator bore and rotor surface can be performed using a camera system used with the robotic inspection vehicle. The available inspections will cover cooling vents, looking for debris, indications of fretting, partial discharge and blocked cooling ducts.

**Recurrent surge oscillograph (RSO) test**
An ‘off load’ technique used for determining the presence of winding inter-turn insulation defects and winding insulation resistance to earth faults, on generator and exciter rotor field windings.

An inter-turn insulation fault on a rotor can produce localised heating, causing further deterioration of the insulation, which can affect the current carrying shorted turns and earth faults.

The RSO technique can also be used as a valuable adjunct during repairs of winding insulation inter-turn faults in the rotor winding.

**Air gap search coils (flux probes)**
To detect the presence of current carrying inter-turn insulation an on-load test of the generator rotor field windings is carried out. This test utilises the output of search coils installed in the air gap between the rotor and the stator. The technique records the air gap search coil (AGSC) output and gives an indication of both the severity and position of any current carrying inter-turn defects. Current carrying shorted turns will mean that the rotor field ampere-turns are reduced. Hence, an increase in rotor current will be required to compensate for the reduction. Also, current carrying inter-turn shorts may cause unbalanced magnetic fields and uneven heating of the rotor which can result in vibration problems.

**References**
The electrical diagnostics teams have a vast experience of carrying out life assessment of electrical generators, working across the UK Power Station fleet and power station plants worldwide, in a variety of locations including Singapore, Sudan, Middle East, Africa and North America.

As part of their portfolio the teams have worked extensively on steam, gas, nuclear and hydro plant, including large 660 MW generators down to industrial 30 MW generators.