

## Generator Operations and Diagnostic Testing

### Overview:

This interactive 3-day seminar combines theoretical background with practical field experience to provide engineers and technicians with the vital knowledge for off-line and in-service electrical testing of generators. For each test, there will be an in-depth discussion of each measurement, physics behind the measurement, setup and test methodology and acceptance criteria. Learn from Doble's collection experience from testing 1,000's of rotating machines worldwide.

### Learning Outcomes:

Upon completion of this course, the participant will be able to:

- Understand when to perform various off-line and in-service electrical tests.
- Establish benchmark results to significantly increase diagnostic value of future tests.
- Interpret test results, case studies and numerous field examples.
- Improve asset management through accurate electrical asset condition assessment.
- Manage critical asset risk by learning to detect faults early

### Course Audience:

Electrical engineers and technicians working in operations, maintenance, engineering, or other service field in which knowledge of electrical generator and motor testing methods and evaluation is required part of job responsibility.

### Duration:

Three Days

### Class Size:

8 - 15 Attendees

### Credits:

Up to 2.4 CEUs or 24 Professional Development Hours

## COURSE OUTLINE

# Generator Operations and Diagnostic Testing

The course program contains the following training outline:

### 1. Generators & the Insurance Industry

### 2. Generator Design

This introduction will concentrate on a basic but brief review of generator design principles. This leads onto how theory and practice relate in practical designs, together with an introduction to the various tools such as computer programs that are available and where they are used.

### 3. Insulation Systems

This is an introduction to basic processes associated with high voltage testing. As insulation ages it will delaminate and this will increase partial discharge activity- but what is a partial discharge and how is it measured. Both offline and on line PD measurements will be explained and also why you need both and the pro's and cons of both types of assessment. The second key diagnostic is dielectric loss as measured by power factor or tangent delta. This measures deterioration caused by moisture or contamination. It will also provide a measure of the total discharge activity within the winding.

### 4. Generator Operation – Problems and Concerns

The traditional operation practices will be described, together with the basic decisions facing the station staff. This will include operations such as barring, run-up and run-down, synchronization, problems associated with two-shifting, temperature cycling, gas in water, water conductivity, and hydrogen condition.

### 5. Generator Condition and Remaining Life Assessment

There is no clear perception of technical life expectancy of a rotating machine as with transformers. What is known is that defects in design, manufacture and use will limit life. The role for diagnostics is to identify a problem to be rectified in an outage- a key step in the transition from time to condition- based maintenance. This presentation will review the range of problems and their diagnostic. The latter pose a more complex situation than with transformers. The failure mode is often in a different area from the failure cause- many failures end with an earth fault.

### 6. Trouble and Failures for Rotating Machines

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### 7. Visual Inspection – How to Perform

### 8. Core tests – ELCID and Ring Flux

One of these tests is undertaken during a major outage with the rotor removed. The core is excited in one case with a high flux the other with a very low. The bore is scanned for imperfections that would produce hot spots in service. The cause is nearly always physical damage. The test locates the site and the aim would be to repair it during the outage.

### 9. Rotor tests – RSO, Air gap search coils

With many parallel paths an open/ short circuit can exist for some time before catastrophic heating and an earth fault ensues. Several methods can be used, some on-line, for detecting faults at an early stage.



## 10. Stator Tests – Power factor and capacitance, partial discharge, DC tests

A variety of methods are used to assess the condition of the stator winding. PF/C is used to assess the condition of the surface of the end-winding, global voiding and the bulk insulation. Partial discharge, which can be done off and on line, seeks out localized damage. Localisation of discharge sites can be done using EM or ultrasonic probes and if the discharge is in the end-winding by using a UV camera. DC testing is traditional and simple way of assessing dryness. Both offline and on line PD measurements will be explained and also why you need both and the pros and cons of both types of assessment.

## 11. Electromagnetic Signature Analysis (EMI) Testing

This session will discuss the effectiveness of EMI diagnostic testing for medium voltage motors and critical electrical equipment above 4.2 kV. A non-invasive condition assessment technique, EMI diagnostic testing is performed while the machines are in-service – providing more efficient outage planning and prioritization of needed repairs. When outages take place, time is saved because the initial discovery has already occurred, allowing for more in-depth testing of targeted areas and/or quickly addressing identified issues inside the outage window. This session provides case studies of electrical and mechanical deterioration identified in rotating machines with EMI diagnostic testing. Since 1980 EMI testing has identified more than 70 different electrical and mechanical defects in HV electrical plant equipment such as motors, turbine-generators, hydro-generators, emergency diesel generators, iso-phase and non-segregated phase bus duct, transformers, switchgear and power cables.

## 12. Essentials of Generator Protection

This session is for electrical engineers looking for introductory exposure to power system protection and would like to broaden their knowledge base.

### Presenter(s):

Chris Capel, Senior Test Engineer, Doble PowerTest

Ian Simmonds, Senior Test Engineer, Doble PowerTest

### Division of Responsibilities:

If the course is hosted at a customer location, to ensure smooth training course delivery, Doble requests the following division of responsibilities:

### Doble will provide:

- Confirmed training dates upon receipt of a purchase order.
- Technical agenda for program.
- One experienced instructor including their travel/living expenses.
- Training manual (soft copy) to each participant.
- If applicable, all required measurement test equipment and tools for class and site training.
- All personnel safety equipment for Doble's instructor.

### Customer will provide:

- Confirmed training schedule at least 60 days in advance.
- Training coordinator through whom all contractor requests will be coordinated.
- Training facility, AV equipment, whiteboard and pens.
- Printing hard copy training material as required.
- If applicable, site access for any areas of the program outlined above for practical on-site training. Responsible for all safety issues before, during, and after the field demonstration.