Rotating Machinery & Electrical Plant Reliability Workshop

Sponsored by the Doble Rotating Machinery Committee

Boston, Massachusetts
Westin Copley Place

Rotating Machinery Committee Technical Presentations:
Wednesday, March 25th from 7:30 AM to 12:00

Workshop:
Wednesday, March 25th from 1:00 PM to 5:00
Thursday, March 26th from 7:30 AM to 12:00, 1:30 PM to 6:00
Friday, March 27th from 7:30 AM to 1:00

Note: Workshop attendees will also be able to participate in the Doble Rotating Machinery Committee Technical Presentations and, by invitation, other Doble committee technical presentations and tutorials throughout the week.
Rotating Machinery & Electrical Plant Reliability Workshop
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Where: Turners Fisheries (Westin Copley lobby level)

When: Wednesday, March 25th from 1:00 PM to 5:00
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Advanced operations and maintenance training to maintain your generating and industrial plant at maximum performance and reliability.

Doble has been providing rotating machinery training and education for decades. At the 2015 International Conference of Doble Clients, Doble will host a two and a half day workshop to cover all aspects of generator and motors design, construction, operations, diagnostics and maintenance. Come learn about 15 topics from industry-leading presenters including numerous IEEE life fellows.

Earn CEUs

Continuing Education Units (CEUs) can be earned for the entire week’s presentations.

Cost

The cost for this 2.5-day intensive learning seminar is

- $195 USD per person for attendees who are Doble Services Agreement (DSA) Clients
- $695 USD per person for attendees who do not have a DSA

Lunch/breakfast will be provided on Thursday and Friday and is included in this price.

For more information, contact Brian Snyder at 919-215-6250 or bsnyder@doble.com
Rotating Machinery & Electric Plant Reliability Workshop

Wednesday, March 25th from 1:00 to 5:30

• AC & DC Generator Testing

The purpose of stator testing is to assess & mitigate detrimental situations before serious/expensive damage occurs while also providing confidence that the winding will not fail in-service prior to the next outage. In this tutorial, we will learn the purpose of conducting generator stator electrical tests, when they should (or should not) be conducted, and how to better analyze the collected data. Tutorial will cover stator DC test such as phase winding resistance, insulation resistance (Megger) & polarization index, DC leakage test, DC high potential over-voltage test, and RTD resistance & Megger test. Tutorial will also cover AC stator tests such power factor / tip up (Doble) test and AC high potential over-voltage test as well as Doble pole drop test and SFRA testing on hydro-generator rotors. Electromagnetic core imperfection detector (EL CID) test on stator iron will also be discussed.

• Generator Design & Construction, Geoff Klempner, Principal Engineer; AMEC NSS Ltd.

This session covers the construction of the generator and its major individual components. In addition issues that significantly influence the design of the various generator components are discussed. The class of generators under consideration is steam and gas turbine-driven generators, commonly called turbo-generators. These machines are typically used in nuclear and fossil fueled power plants, cogeneration plants, and combustion turbine units. They range from relatively small machines from a few MegaWatts (MW) to very large generators with ratings up to 1800 MW.

Geoff Klempner is a large rotating electrical machines specialist in the power industry. He is a Principal Engineer in the Operations Engineering Directorate at AMEC NSS Ltd. His responsibilities include: large generator consulting including, inspection, testing, design evaluation, failure analysis, electromagnetic FE analysis, life assessment preparation of technical specifications and test procedures, for large electrical machines. Previously he worked as a Senior Engineer-Specialist in Ontario Hydro (now Ontario Power Generation) for over 25 years. His consulting activities have included assistance to numerous electric utilities and generator manufacturers around the world. He has authored or co-authored numerous papers and documents, list over 50 articles and 2 text books on the operation and maintenance of large synchronous generators.

Thursday, March 26th

• Generator Operations & Control, Izzy Kerszenbaum, PhD, PE; IZZYTECH Electrical Power Engineering Consulting & Training

This session covers the operations and control of the generator including basic operating parameters including operating modes, machine curves and special operating conditions; system considerations and grid induced torsional vibrations; excitation and voltage regulation, performance curves and sample generator operating instructions.

Izzy Kerszenbaum is an IEEE Fellow, located in Irvine, CA. He is a generator specialist consulting to power plants on operation, maintenance and troubleshooting of large motors and generators. He started his career as a high-voltage protection engineer, moving next into the world of rotating machines, first as a designer and R&D engineer, and then as a specialist on large synchronous
generators. During his professional career, Izzy has consulted to power plants, both within the Edison International family of generating stations, as well as others, on generators. Izzy has published many technical papers, and authored and co-authored two books on the operation and maintenance of large synchronous generators. He is the current Chair of the Electric Machines Committee of the IEEE’s Power Engineering Society.

- Considerations For Selection of Insulating Materials for Medium/High Voltage Form Would Stator Coils, Dr. Nancy Frost; Gerome Technologies

The focus of this course is the basic aspects of insulation materials for the novice. The fundamental aspects of insulation materials will be covered, including how to select materials and how to test performance. The course covers the fundamental electrical insulation materials, including the properties and use of the various types of insulation for both low to high voltage applications. The major test methods and standards used in selecting and qualifying insulation systems will be discussed.

Dr. Nancy Frost is a Dielectrics Engineer working as Business Development Manager for Gerome Technologies, a fabricator based out of Menands (Albany), NY. She has worked in the electrical insulation industry since 1999, working with a variety of suppliers, manufacturers and service shops, after earning her Ph.D from Clarkson University, where she managed the High Voltage Laboratory. She has given over 40 presentations and multiple short courses in the area of insulation materials, aging phenomena and testing. Nancy has been active in several professional societies since 1997, including the IEEE DEIS, Chair of the IEEE PES EMC Materials Subcommittee working on standards, as well as USA Technical Advisor for IEC TC 112 for NEMA IM6.

- Core and Stator Winding Manufacturing, Testing and Installation, Bill Moore, Director of Technical Services; National Electric Coil

This presentation will cover how stator cores and stator windings are manufactured, tested and installed. The key acceptance tests, both in the factory and at site after installation, will also be presented. Common core and winding failure modes, and the methods to assure reliability, will also be discussed. Is your stator core loose?

Bill Moore, P. E. is Director of Technical Services for National Electric Coil (NEC) in Columbus, Ohio. Prior to joining NEC, Bill held plant management positions at FPL, starting his 30+ year career as an engineer with a major OEM. He is a P.E. in Florida and Ohio, and has published over 75 papers on generators. He is a frequent short course instructor on generator issues in the industry worldwide.

- Rotor Rewinds, Testing and High Speed Balancing, Bill Moore, Director of Technical Services; National Electric Coil

This presentation will cover how rotors are rewound, tested and high speed balanced. The key acceptance tests used after a rewind will be presented along with common failure mechanisms that can affect reliability.
• Gas Turbine Design & Maintenance and Outage Lessons Learned

The session will cover gas turbine theory will be provided followed by common application and new gas turbine design. We will also address lessons learned from outage experience across several combined cycle and single cycle power plants. Best practices developed and experience from these projects has enhanced outage work capabilities and efficiency. The program will cover some specific areas to focus on during inspections due to problems identified during inspections and maintenance testing. Compressor rubs and cracks, generator circuit breaker testing, unit cold alignment, control system power supplies and potential and current transformer testing will also be addressed. The results of 4 consecutive years of EMI testing will also be presented.

• Generator Hydrogen System Safety Fundamentals

In the early 1930s, demand for increased generator rating, without increasing the physical size of the generator, led to hydrogen being introduced as a coolant medium. The minimum size (megawatt output) of a generator to be considered for the use of hydrogen as a cooling medium will vary between manufacturers, however, the fact that hydrogen has better heat transfer characteristics and is less dense (providing less windage losses) has made it a standard coolant for large turbo generators.

While hydrogen is fourteen (14) times more efficient than air in removing heat and is the lightest of all gases, there can be major disadvantages if not used properly. Hydrogen can be very explosive when mixed with air, and it will lose efficiency when its purity decreases. Additionally, high moisture levels in the hydrogen can lead to generator component failure. This presentation will discuss the pros and cons for using hydrogen, hydrogen measurements, hydrogen auxiliary systems and generator purging.

• Machine Vibration & Alignment, John Piotrowski, President; Turvac

The presentation will discuss the six key blocks of information needed to align rotating machinery. Covered are machinery dimensions, off-line shaft positions measurements, boundary conditions, off-line to running machinery movement, external connections, and internal and external clearances. The presentation will explain what each of these blocks of information are, how they interrelate, and why they are important to insuring that rotating machinery runs within acceptable alignment tolerances during normal operation.

Mr. Piotrowski graduated from the University of Pittsburgh in 1974 with a degree in Mechanical Engineering. He has been working with rotating machinery in industry for over 36 years and is considered to be one of the leading authorities on alignment of rotating machinery. He has authored over fifty technical articles on the subject and is author of the Basic Shaft Alignment Workbook, the Shaft Alignment Self Study Guide, the Shaft Alignment Handbook (now in its third edition), the Turvac Engineering Field Service Files, and has written several software programs on alignment and balancing of rotating machinery.

• Stator Bar & End Winding Vibration

This presentation will focus on vibration phenomena that were observed on generator stator bars and end-windings. These phenomena have frequently been observed with the use of special sensors that can pick-up the in-slot movement of bars and the vibrations of end-windings. Four phenomena will be discussed including pure end-winding basket oscillation, rotor/shaft vibration contribution to end-winding vibration, component resonances contributing to end-winding vibration, and inadequate bar tightness allowing for in-slot stator bar vibration. The presentation will also analyze the effects of major
electromagnetic forces found inside the machine on the end-windings and bars and ways to track each component of the signals observed by studying the amplitude and frequencies of actual field results.

Friday, March 27th

- Generator Maintenance and Inspection

In this session, we will learn to formulate better plan regarding quality stator testing & inspection schedules and what to look for when conducting a visual inspection of the generator rotor and/or stator. Several case studies will be presented on problem detection, problem analysis, troubleshooting, reviewing collected data, and post-mortem evaluation. Determining looseness and various tightening methods will be discussed.

- Motor Theory & Principles, Howard Penrose, Vice President; Dreisilker Electric Motors

Motor theory will be discussed including basics of motor torque development, flux patterns, efficiency, NEMA design requirements and more. Motor construction will be discussed and all basic motor components will be reviewed for a medium voltage machine, including bearings, rotor and stator construction. Insulation classifications will be reviewed and compared against motor temperature rise. Motor testing will be discussed.

Howard W Penrose, Ph.D., CMRP is the Vice President of Engineering and Reliability Services for Dreisilker, the Web Editor-in-Chief of the IEEE Dielectrics and Electrical Insulation Society, and the Director of Membership for the Society for Maintenance and Reliability Professionals (SMRP). He has won five consecutive UAW and General Motors People Make Quality Happen Awards (2005-2009) for energy, conservation, production, and motor management programs developed for GM facilities globally and is an SMRP Certified Maintenance and Reliability Professional (CMRP). Dr. Penrose is the author of the Axiom Business Book Award (2008 Bronze and 2009 Bronze) winning Physical Asset Management for the Executive and the 2008 Foreword Book of the Year Finalist textbook, Electrical Motor Diagnostics: 2nd Edition.

- Partial Discharge Testing & Monitoring, Hugh Zhu, Principal Engineer, Doble Engineering

Over the past 30 years, great strides have been made in online monitoring of rotating machines, transformers and HV apparatus. Specifically, partial discharge (PD) monitoring offers an excellent method of assessing the condition of various HV components under actual in-service stress such as load and temperature. With these advances and a greater understanding of the mechanism of PD, a more informed decision can be made about the condition of their associated insulation systems. Rotating machines has been at the forefront of these advances due to their inherent PD generation and large cost of disruption. Supported by updated IEC, such as IEC 60270, and in-progress IEEE standards, these advances include better digital acquisition systems, noise rejection methods and sensors technology. On-line PD monitoring has come a long way since it became popular in the 1980s. Most notably, there have been improvements in the measuring data acquisition systems, software & data management, sensor technologies, and noise rejection. This presentation will present several of these advancements and the reason they should be incorporated into an online PD test program for rotating machines.

Hugh Zhu is a Principal Engineer with Doble Engineering Company. He received his Ph.D. studying partial discharge (PD) measurement of rotating machines and his post-doctor fellowship studying PD measurement of transformers in the UK. Hugh has 25- year experience on testing rotating machine
insulation through working in the UK, Canada, and USA. He has been involved in field and lab testing, and condition assessment of hundreds of rotating machines worldwide. His expertise includes quality assurance testing on stator bars/coils, PD testing, condition assessment, and failure investigation of generator and motor insulation. His experience also includes PD testing on transformers, cables, and other HV apparatus. He has published over 40 technical papers that relate to his specialization. Hugh chairs the Aging Factors Technical Committee of IEEE Dielectrics and Electrical Insulation Society. He is a member of the Technical Committees of IEEE, IEC and CIGRE to develop the standards of rotating machine insulation testing.

- Electromagnetic Signature Analysis Testing - Generators, Iso-Phase Bus, Generator Step-up Transformers and Emergency Diesel Back-up Generators
  James Timperley, Principal Engineer; Doble Engineering

EMI (electromagnetic interference) Diagnostics has been utilized to provide information for the condition based maintenance of large machines at power plants and industrial sites since 1980. The advantages of totally non-intrusive data collection, in real time, while a motor or generator remains in service has a great economic and safety benefit all facilities. Design modifications are not necessary to collect data and there are no connections made to energized circuits. EMI Diagnostics will detect a variety of system and machine related problems during the first evaluation. Trending data over weeks or months is not required for accurate condition assessment. EMI Diagnostics can be applied to all machines and systems operating at 2400 volts and above. This paper provides examples of trouble free systems, as well as defects uncovered during EMI Diagnostics.

James E. Timperley (BSEE, 1968 Oklahoma State University) began working in the utility industry with American Electric Power in Canton, Ohio USA. He was involved with station engineering, establishing an electrical R&D laboratory and a large motor repair shop as well as inspecting, operating and maintaining large electrical rotating machinery. He retired from AEP after 38 years of service and joined Doble in 2007. Mr. Timperley has published over 75 technical papers on operating, maintaining, testing, advanced insulation materials and repairing rotating electrical machinery. Other activities include upgrading and maintaining high current isolated phase bus, equipment root cause failure analysis, and the development and application of EMI Diagnostics. Mr. Timperley is an IEEE Life Fellow and was presented the 2006 Dakin Award by the IEEE Dielectric & Insulation Society for the development of EMI Diagnostics. He is active in several IEEE standards groups and is a registered professional engineer in the state of Ohio.

- Rotating Machines Failure Analysis

Large generators and motors are usually very reliable. A new generator without defects or exposure to misoperation can be expected to have a reliable life of 30 years or more. However, there are numerous mechanical and electrical deterioration mechanisms that can shorten its life. Some of these mechanisms are primarily related to design/manufacturing of the stator winding; some are related to operation/ maintenance issues. This session discusses the mechanical and electrical defects that may result in deterioration and offers basic suggestions for repair.

- Introduction to Generator Protection

The role of the generator in a power system is to produce electrical energy at the correct voltage and frequency that meets the electrical transmission system’s load demands. The generator connects to the transmission system along with other generators and must automatically react to conditions that affect its ability to meet the requirements for voltage and reactive power support. In case problems on the transmission system or within the generating plant arise, the generator has protection systems.
designed to ensure safety for operations personnel and prevent, or at least minimize; equipment damage.

Generator protection includes monitoring operating conditions within the generator and its associated components as well as monitoring external conditions. Numerous relays and other control elements provide this protection. The American National Standards Institute (ANSI) developed a numeric coding system to identify all electrical protective and control devices and this is the system used by the industry to classify the various generator protection components.

Generator protection starts by monitoring conditions for faults within the generator itself including faults in the stator windings such as phase fault protection by monitoring current differentials (87) and back-up overcurrent protection (51). The protection system also checks for overvoltage and ground faults (59) as well as undervoltage (27), and faults in the rotating field circuit (64F). Loss-of-field protection (40) detects and protects the generator in case of a loss of field excitation current, or faults in the excitation system (24).

- Isolated Phase Bus Inspection and Maintenance Best Practices

Best practices that have been identified for inspection, cleaning and maintenance of Isolated Phase Bus will be the topic of this session. Presentation topics will include case studies detailing the ramifications of poorly and/or inadequately maintained Isolated Phase Bus systems, current trends in predictive maintenance programs and best practices for Isolated Phase Bus inspection and cleaning, including insight into the newest technologies available.