IRIS POWER ENGINEERING

DIAGNOSTIC NEWS

The Newsletter on Monitoring the Reliability of Electrical Equipment

Iris Power Engineering
Fall/Winter 2003

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LIFE CYCLE MANAGEMENT

Joe Kapler, Iris Power Engineering

With the increasing competition in the electric power industry, nuclear power plants are applying the life cycle management processes (LCM) to assess the long term reliability of the equipment and to manage aging degradation and obsolescence of important plant systems. EPRI has developed an LCM process and some supporting software to help plant engineers to develop such LCM plans for systems important to plant reliability, availability and profitability. The Institute of Nuclear Power Operations (INPO) has integrated LCM in its equipment reliability industry guidance. The general objective of LCM "sourcebooks" is to provide system engineers with generic information, data and guidance to generate long-term equipment reliability plans and cost profile for remaining plant life.

The main turbine generator is a critical component of a nuclear generating station. Iris Power Engineering was asked to develop an LCM process for generators since generators are:

- applicable to all plants
- important to power production and plant reliability
- subject to significant degradation and obsolescence of components
- costly to maintain.

The main generator sourcebook developed by Iris for EPRI contains, in addition to general description of critical generator components, the industry operating experience and performance history, guidance for plant specific generator condition assessment, generic aging and obsolescence assessment, generic alternative LCM plans and guidance for estimating future failure rates. The nuclear industry generator reliability data were derived from INPO databases such as NPRDS and EPIX, covering 104 generators at 46 nuclear plants in the United States since 1990. The calculated failure rates of major generator components from this survey can be compared to plant-specific failure data. Major deviations from industry average can be assessed and the need for improvements identified.

The guidance for generator condition assessment covers the review of maintenance history and current maintenance practices at a plant. A comprehensive listing of available generator and exciter inspections and tests is provided, including the frequency of such inspections for effective detection of component aging and developing failure mechanisms. Plant maintenance and inspection practices can be compared to this list. On-line monitoring technologies for detection of most frequent degradation modes are also presented.

The generic aging and obsolescence assessment provides practical guide to generator component life expectancies and identification of technically obsolete parts.

From the assessment of the generator condition, alternative maintenance strategies and practices can be identified for future operating periods, including to the end of currently licensed periods. The cost comparisons of the alternatives using Net Present Value (NPV), Benefit-to-Cost Ratio, Payback Periods, or other accounting criteria, may be used to decide on optimized maintenance strategies. A comprehensive hypothetical illustration is provided to demonstrate the process.

LIFE CYCLE MANAGEMENT

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The EPRI LCM planning tools, LcmPLATO of LcmVALUE, can be employed to determine the alternative cost on an NPV basis. Fairly complex models can be used, including non-linear failure rates and phasing of major component replacement over time.

To date, the LCM process for turbine generators was applied main generators at six nuclear generating stations (Wolf Creek, Diablo Canyon, South Texas Project Nuclear Generating Station, Palo Verde, Comanche Peak, and Callaway). The failure rates of main generator components, calculated from the average industry failure data, was compared to plant-specific failure rates. The LCM planning alternatives were then developed for the current licensed plant life period of 40 years and for probable life extensions to 60 years. The alternatives included: continue current maintenance strategy (do nothing), enhance generator on-line monitoring for early detection of component problems, replace/upgrade major generator parts (stator rewinds, rotor rewinds, exciter and AVR upgrades) and purchase new components (new stators, new rotors, new exciters). The gains in the expected reliability of generators was evaluated from the actions in each alternative. The total lifecycle costs of the alternatives were then calculated, including the capital expenditures of the enhancements and the production gains from improved generator reliability. The recommended alternatives were based on the lowest lifecycle NPV cost or on the highest benefit-to-cost ratio.

The life cycle management process has now been proven to be a valuable tool to assess maintenance/replacement options on an objective basis. Further information on what the LCM process can do can be obtained by calling Joe Kapler at Iris.

IRIS ANNOUNCES THE LAUNCH OF CSMeter™ INSTRUMENT

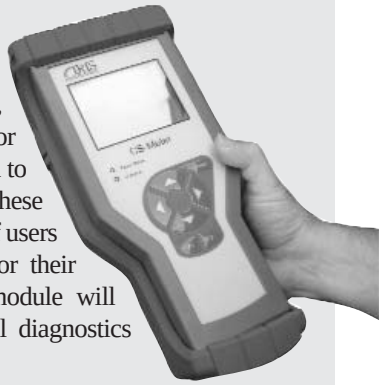
Slated for commercial launch in December 2003 is the CSMeter™ instrument. The CSMeter™ instrument is a bit different from the rest of our product line-up as it deals not with stator problems, but with rotor problems. It's the world's first hand-held broken rotor bar detector and can be applied to squirrel cage induction motors rated 50hp or more, both low voltage and high voltage.

Employing advanced current signature analysis algorithms, the CSMeter™ instrument needs only one input from a current probe that is clamped directly to one of the phase leads to a motor right at the MCC. A current trace can also be obtained from the secondary side of the main CT, usually from the measuring circuit. As such, the CSMeter™ instrument can be carried about on site with only a single accessory, i.e., a current probe.

One of the features likely to be popular with users is the instrument's on-the-spot diagnostic capability. The CSMeter™ instrument will display an actual current spectrum obtained from the measurement. It will also indicate if there are broken rotor bars and display severity of the problem right after the measurement. For reports and more comprehensive analysis the data can be downloaded to a computer.

The CSMeter™ instrument contains advanced algorithms and unlike other products, it does ***not*** require a strobe signal to calculate slip. Just clamp-on and go.

Keeping in step with other Iris instruments, the CSMeter™ instrument is designed to (a) significantly reduce the risk of false indications by employing sophisticated algorithms and (b) almost eliminate the need for an expert for testing and diagnosis.



Future releases of the instrument will offer additional diagnostic modules like air gap eccentricity, drivetrain analysis and shorted stator turn detection as options in addition to the broken rotor bar module. These options will be retro-active so that if users already have measurement data for their motors, the addition of a new module will enable them to perform additional diagnostics with the same data.

Competing products offer broken rotor bar detection only as a secondary or value-added feature in their instruments rather than making it the main theme. All are more than twice the price of the CSMeter™ instrument. If a user wants an instrument specifically for rotor bar detection, the CSMeter™ instrument is the only, and the best way to go. For more information please send us an e-mail at **csmeter@irispower.com**.

LIMITATIONS OF CONTINUOUS MONITORING OF PD WITH RTD SENSORS

We estimate that 80 pF capacitors and SSCs are used for on-line partial discharge (PD) detection in over 90% of the monitored motors and generators in the world. The overwhelming popularity of these sensors is due to their independently proven ability to facilitate the separation of PD from other electrical pulse signals, and enable a measurement with a high probability of detecting stator PD with minimal risk of false indications. False indications of stator winding PD are very expensive, since unnecessary repeat tests and a shutdown of the motor or generator is needed to verify the true condition of the stator insulation. False indications also destroy PD test credibility, in the minds of plant operators, of valid tests on other machines.

One organization persists in promoting RTD temperature sensors as PD sensors, for the very practical reason that RTDs are already installed, and thus retrofitting 80 pF capacitors or SSCs is not needed. This is an excellent reason for using RTDs as PD sensors. The problem is that RTDs make such poor PD sensors that the risk of false indications is very high. Therefore either high readings or low readings have to be viewed with such disbelief, that one cannot make practical use of the information.

The reasons for the low credibility of RTDs have been spelled out in IEEE and EPRI publications, but they can be summarized as follows:

- The PD is detected by the RTD leads, not the RTD itself.
- The length of the RTD leads, its proximity to coils likely to have PD (the high voltage coils), and whether the leads are shielded are not, are usually unknown in any specific motor or generator.
- The result is that signals from the same PD source can vary by over 10 to 1 (1000%). This makes it impossible to evaluate the severity of the PD based on magnitude.
- The RTD leads are usually twisted wire, which is very poor at transmitting the high frequency PD signals. Instead, RTDs are more efficient in detecting the lower frequency noise that is coupled from the stator core.

In our opinion, the company promoting the use of RTDs as PD sensors has acknowledged these serious limitations, although apparently not in their commercial presentations. In 1999, during their verbal presentation of a paper on using RTDs as PD sensors at the IEEE Electrical Insulation Conference in Cincinnati, they indicated that such sensors give false indications 30% of the time, even when their own experts were interpreting the data. At the 2002 IEEE Petroleum and Chemical Industry Conference in New Orleans, they said that 80 pF capacitors are the preferred PD sensors for continuous monitoring, since they have the lowest amount of noise. In 2001, Iris submitted a formal discussion on one of this company's PD papers, expressing strong disagreement with the paper's technical methods (see IEEE Transactions on Energy Conversion, December 2001, pp380-381). The authors of that paper chose not to disagree with our statements. It is unprecedented that the authors chose not to rebut our discussion, since we challenged the entire technical content of their paper. Finally, we have never seen even one case study on the effective use of RTDs as PD sensors published by an independent organization.

Recently, EPRI Report 1007742, "Assessment of PD and EMI On-Line Testing of Turbine Driven Generator Stator Winding Insulation Systems" published March 2003, concluded that "the use of RTD temperature measuring elements for PD measurements ...has become a controversial issue.."

Although it is clear that RTDs can detect PD, the range of signals measured and the propensity for the RTD to be more sensitive to noise, makes the readings unreliable. The huge uncertainty of the information presented makes testing with RTDs worse than never doing any PD testing, since the false indications that occur with RTDs will undermine the confidence of plant management of any PD test. We believe technical merit is more important than earnest salesmanship.

2004 COURSE SCHEDULE

Large Motor Course
March 23-25, 2004
San Antonio, TX

Hydro Generator Course
October 19-21, 2004
New Orleans, LA

Turbo Generator Course
May 25-27, 2004
Chicago, IL

Partial Discharge Course
November 16-18, 2004
Los Angeles, CA

For more information, please visit our website at www.irispower.com or call Michelle Harris at (416) 620-5600 ext. 241.

UPCOMING EVENTS

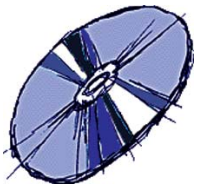
Dec 10: **Iris' Stator Testing Seminar**
Boston, MA

Jan 27-29: **EXFOR**
Montreal, PQ

March 15-17: **NETA**
San Antonio, TX

March 21-26: **Doble**
Boston, MA

PDTracPRO VERSION 3



Announcing the release of PDTracPro (Version 3) for all PDTrac Monitors. This software application will allow you to configure and remotely control your PDTrac. This new release is simply an upgrade to the current version, addressing minor issues and incorporating new features such as Database Protection. PDTracPro is available upon request or from the Iris Download Site. This version of software is being shipped out with all new orders.

IRIS' NEW DOWNLOAD SITE

Announcing Iris' Download Site where software, firmware and instructional documents can be downloaded. Currently we have five available packages BusTrac, HydroTrac, FluxTrac, PDTrac and PDView 3.2. New material is added to this site frequently – keep checking the Iris website (www.irispower.com). If you own a Trac (and require the latest software or firmware) or if you would like to download PDView 3.2 please contact Carla Dal Mina at cdalmina@irispower.com or 416 620-5600 ext 306 for more information.

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IRMC 2004 CALL FOR PAPERS

Iris' annual IRMC will be held from June 14-16, 2004 in fabulous New Orleans, LA.

Abstracts are requested for the conference which is attended by industry professionals* from around the world.

Suggested topics include:

- new diagnostic test methods
- winding repair methods
- detection of rotor winding problems
- new developments in rotating machine insulation
- the effect of inverter fed drive surges on motor insulation
- case studies on motor and generator predictive maintenance

SCHEDULE OF SUBMISSION

January 16, 2004:
Abstract submittal deadline

February, 2004:
Authors notified of acceptance

March 29, 2004:
Paper submittal deadline

For more information, please contact **Kim Zarb** at (416) 620-5600 ext. 240, or email *kzarb@irispower.com*

*Authors receive one free 2 day registration for the conference per accepted paper.

IRIS WINS 2003 ONTARIO HYDRO SOCCER LEAGUE CHAMPIONSHIP

On Thursday October 9th, the Iris Power soccer team won the Ontario Hydro soccer trophy in a close fought game against Darlington Nuclear Plant at Esther Shiner stadium.

The trophy is proudly displayed in the lobby of Iris. The team will defend their title in May of next year. Next years goal is to win the 'double' by winning the regular season league and defending their trophy.