

DIAGNOSTIC NEWS

The Newsletter on Monitoring the Reliability of Electrical Equipment

Iris Power Engineering

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What Can Go Wrong with Turbo Generator Rotor Windings

By: Blake Lloyd and Joe Kapler

One of the least monitored components of a turbine generator is the rotor winding. Rotor construction varies, but in general, there are three distinct elements of a turbine generator rotor insulation system. The insulation between the turns is usually an epoxy/polyester glass or Nomex laminate, sometimes bonded to the conductor surface. The slot liner is typically a molded laminate, shaped to the slot contours and used to isolate the coils from the rotor forging. In the end winding, insulation blocking is also used to mechanically support the coils; a molded insulation ring is assembled from laminate material to isolate the top turns from the retaining rings. Often, products such as Teflon are used as part of the insulation system to create "slip planes". This permits the copper turns to slide along the insulation without abrasion, breakage or distortion when the winding expands and contracts.

As with stator insulation systems, the rotor insulation must withstand electrical, mechanical, thermal, and environmental stresses. These stresses can assume many forms, including:

- Mechanical wear, distortion, breakage and migration due to constant centrifugal mechanical loading, thermally induced expansion and contraction cycles: the effect from these stresses is cumulative and increases with the number of unit starts or deep load

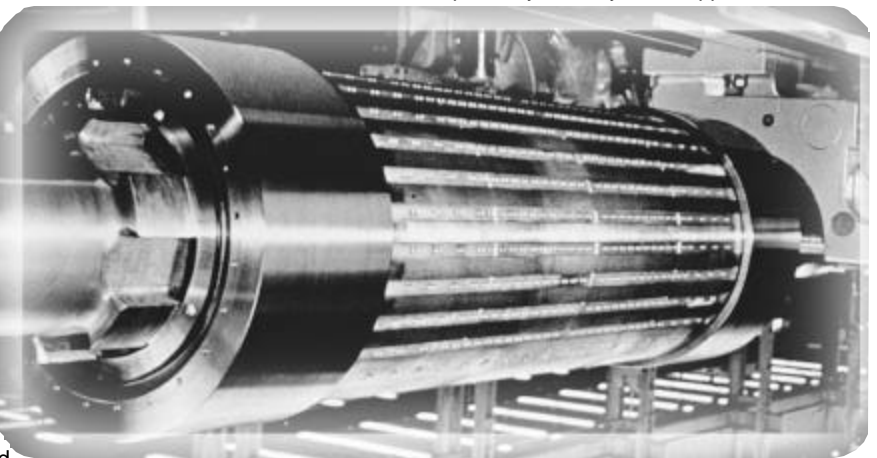
cycles

- Overheating due to overloading, over excitation, inadequate or diminished cooling: high resistance braze joints and shorted turns may cause local insulation overheating and damage

- Contamination due to copper dusting, or ventilation-born contamination of creep distances with conductive deposits resulting in surface tracking and bridging of insulation

- Over voltage transients due to short-term high voltages applied to the ground insulation by transmission system faults, frequent (or faulty) field forcing from fast response exciters, commutation voltage spikes from static excitation systems, etc.

Mechanical damage of winding insulation is the most frequently observed cause of rotor problems. The insulation life expectancy of many rotors appears to be



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HydroTrac™ Wins R&D 100 Award

By: Marta Blocki

Iris Power Engineering has recently been awarded the highly acclaimed R&D 100 Award by R&D Magazine, recognizing Iris's latest Partial Discharge (PD) innovation (HydroTrac™) as one of the most technologically significant new products available on the market today.

A collaborative development by Iris Power Engineering, the New York Power Authority, and EPRI, HydroTrac is an economical instrument that provides automated, continuous PD measurements on hydro generators. Continuous on-line tracking of PD activity can identify the rate of electrical insulation degradation, and, in many cases, the particular type of failure mechanisms occurring. HydroTrac provides operations and maintenance staff with up-to-the-minute information on their generator's condition, which can be utilized to schedule preventative generator maintenance and/or repairs, avoiding catastrophic, costly, in-service hydrogenerator failures. For more information contact Olga Mazuera at extension 282 or visit our website: www.irispower.com





Iris is frequently asked to take our PD testing technology to the next level by providing a complete machine condition assessment service. To date, our services have been limited to direct support of products manufactured and sold by Iris and installation support, PD data analysis and instruction. The objective of this new initiative is to utilize the world-class expertise of 10 existing Iris staff members in assisting our clients in the on-going operation and maintenance of their motors and generators. This new initiative is a logical extension of our recent expansion into the United Kingdom which already includes testing and consultancy services for our overseas clients. Effective immediately, Iris is offering the following services to our rotating machine customers:

- **Inspection Service:** On-site visual inspection of your motor or generator by a rotating machine expert.
- **Technical Q/A:** For users who are installing new machines or rewinding existing machines, Iris can provide the following services:
 - Preparation of rewind specs for stator and rotor windings, preparing lists of qualified vendors, including reviews of plan manufacturing capability and quality.
 - Bid evaluation of the technical aspects for new machines or for machine rewinds.
 - Overviewing coil and bar manufacturing, including representing your interests should technical problems arise during manufacture and witnessing of Q/A tests.
 - On-site periodic or continuous reviews of winding installation and testing.

- **Condition Monitoring:** Iris can provide on-site equipment for machine monitoring which remotely accesses this equipment to give you periodic reports on your machine's condition.
- **Testing Service:** An independent machine on-line and off-line testing service for your routine electrical testing needs.

An important Iris advantage is that we have enough people with back-up on staff that we can meet your schedule needs, and supply personnel at the right level for the job. In addition, Iris has direct access to several world-renowned machines consultants, and can provide the turn-key solutions you require.



If you have a project that requires motor and generator expertise, and you cannot perform all aspects of the project in-house, then please give us a call.

What's Wrong with Turbo Generator Rotor Windings? (Continued from pg. 1)

By: Blake Lloyd and Joe Kapler

limited to a 15-20 year service, instead of the expected 30-year life. Because of the excessive amount of shorted turns or winding ground faults, rotor rewinds or re-insulations are required at considerable repair and unit outage costs. Examples of mechanical aging are:

- Broken or displaced turn insulation causing shorted turns. This occurs in most cases because of the thermal expansion of copper turns during rapid load changes and the lack of slip planes at insulation interfaces
- Migration of turn insulation blocking the gas ventilation passages causing winding overheating
- Tensile creep and distortion of copper turns in the end winding causing coil misalignment, shorted turns or shorted coils. Poorly placed blocking often aggravates this condition.
- Radial displacement of coils in the end winding can cause high compressive loads on slot liners, particularly at slot ends. Combined with axial copper expansion this leads to liner abrasion and ground faults.

Service overheating is often a result of relatively small changes in the ventilation circuits, mostly due to the displacement of insulation components. Frequently the cause of overheating stems from operating generators beyond their design rating. The evidence of overheating may not be apparent from the monitoring average winding temperature, as measured by the rise of resistance. Depending on design, the hot spot temperature rise may significantly exceed that permissible value for the insulation class, thus accelerating the aging.

The contamination with copper dust has been observed on rotors, which employ turns assembled from two strips that permit copper-on-copper interfaces. At turning gear speeds, the strips rub and produce copper fretting particles, which, in turn, cause turn short and ground faults. The only effective remedy is re-insulation or replacement of the winding.

Although many off-line tests are available, such testing (when the rotor

is not subjected to the normal mechanical and thermal stresses), often prove ineffective for determining the true rotor condition. Even visual inspections (one of the most effective off-line tests for any component) are difficult unless the rotor is pulled and partially disassembled with wedges and retaining rings removed - a very time-consuming and expensive alternative. On-line monitors that are typically utilized in large generators include:

- **Operating point on a capability chart:** Monitoring the rotor voltage and current as a function of generator output.
- **Start/Stop Cycling:** Tracking the "stress" on the rotor as assessed in terms of thermal/loading cycles.
- **Rotor ground detector:** Used to determine if the winding has shorted to ground.
- **Temperature:** An average rotor winding temperature can be calculated from the copper resistance as a function of temperature. Requires access to the rotor current and voltage.
- **Overheating:** On units outfitted with condition monitors, overheating of the rotor, stator, or core results in particulates in the hydrogen stream. The use of "tagging compounds" allows some localization of the overheated regions.
- **Vibration:** Bearing and pedestal vibration can indicate rotor conditions such as shorted turns and thermal unbalance, mechanical unbalance, wedge or forging cracking, etc.
- **Air gap magnetic flux monitoring:** Monitoring the leakage flux via a stator mounted flux probe can detect conditions such as shorted rotor turns or coils.

Stayed tuned next month for a discussion on Squirrel Cage Induction Motor (SCIM) rotors...



Automated PD Data Collection via Trac Instruments

By: Blake Lloyd

Iris has extended its line of cost-effective, continuous, automated PD data collection instruments to include all types of rotating machines. The Trac line that originated with MotorTrac™ now includes HydroTrac™, BusTrac™ and TurboTrac™ instruments for monitoring hydrogenerators, motors, and turbine generators of all sizes. The Trac instruments include all of the critical features from our Guard line of products except the pulse phase analysis and analog inputs for machine operating parameters, resulting in significant per unit cost saving. Trending data and/or alarms from your Trac instrument will free you from periodic PD testing and warn you when problems are occurring. At that point, the full pulse phase analysis capabilities of a portable instrument and/or other diagnostic electrical tests can be applied to determine the specific problem and the appropriate maintenance required. These new continuous monitors include the standard capabilities you would expect from Iris:

- Rugged field ready NEMA 4x packaging
- Digital front-end electronics and the same noise elimination algorithms available in our portable instrument and Guard line of continuous monitors
- Built-in multiplexer and termination panel including BNC outputs to facilitate confirmatory testing via a portable instrument

- Flexible communications options including RS232, RS485 (twisted pair or fibre), and TCP/IP Ethernet (via external terminal server)
- Two modes of operation:
 - Standalone:** continuous collection of PD data including alarm levels on NQN or Qm for each coupler pair. Up to 18 months of summary data can be stored and retrieved via the built-in RS232 port.
 - Networked:** remote or local control of up to 255 Trac instruments with scheduled data collection or data on demand via our Windows™-based TracCon™ software. Pulse height data and summary numbers are stored in the same database format as our other instruments lines allowing you to utilize PDView™ software for plotting and analysis
- Data compatible with Iris portable instruments and Iris's database of 30,000 test results

With our Analog Output option, the Trac instruments can provide analog signals that are proportional to NQN and Qm which can be directly wired to existing PLC or DCS inputs allowing you to integrate PD data with your normal plant monitoring or control instrumentation. Contact your regional technical sales representative for more details and demonstration of how the Trac line can work for you.

New Web Tool Launch

The Iris website now features a new interactive web tool: "the Client Login" that walks current users and potential customers through our existing and new technology with great ease and flexibility. An icon has been added to 'Education Services' on the Iris website that enables users to view product and company-related presentations over the internet while being assisted by one of our sales representatives on the telephone. This will allow the user to get a more detailed and

visual idea of our technology and a chance to have things clarified by an Iris professional.

For security purposes, this device is not available to just anyone. To participate in this virtual tour of our technology with

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a Client Login user by contacting someone in our marketing department. You will then be assigned a user login name and a password which will grant you access to our PD tour. If interested, please contact your nearest Iris sales representative.



Iris to the Rescue...
For all your Predictive Maintenance needs!!!!

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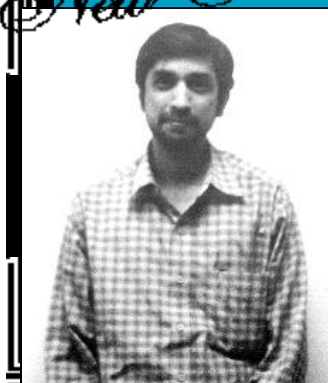
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More New Sales Reps



Hasnain Jivajee is Iris's newest addition to domestic sales as Applications Engineer. Hasnain joins us from Alstom TND (Transmission and Distribution) in Pakistan where he worked as their sales engineer selling medium voltage switchgear. Hasnain has experience in project management and design engineering. He has completed his Master's degree at the University of Missouri Rolla Electrical Engineering. To contact Hasnain dial (416) 620-5600 X 288 or e-mail: hjivajee@irispower.com

International sales continue to expand as **Chris Tan** joins Iris in his new role as International Projects Manager. Originally from Singapore, Chris enjoys playing guitar and listening to classical music. After earning his Electrical Engineering degree from New Brunswick University some ten years ago, Chris has recently graduated from the University of Waterloo with a post graduate Engineering degree. He can be reached at (416) 620-5600 X 290 or at: ctan@irispower.com



Iris Expansion Complete

By: Marta Blocki

Iris has been growing steadily for almost a decade now since its inception in 1990, when the company consisted of only four founding members. Today, Iris includes almost 60 employees, with additional staff being hired regularly, particularly in the marketing department.

As a result of this steadfast growth, Iris has leased the neighbouring offices on Westside Drive in Toronto, expanding their total space to some 22,000 square feet. With a much-needed new conference room and several additional offices, Iris can now comfortably house its new members with space left over



for future prospects.

The three-month expansion project involved various renovations, upgrades and staff relocations - some of which included combining the marketing and field services departments and the expansion of our finance office.

After a trying and tedious period, the Iris team is stronger in number and spirit. We would like to thank everyone for their continued patience and help during this transition.

Conferences

- Aug 20-23: EPR Steam Turbine, Baltimore, MD
- Sept 1-3: IEEE SDEPMED, Gorizia, Italy
- Sept 23-25: PCIC, Toronto, Ont
- Sept 27-30: Hydro 2001, Riva del Garda, Italy
- Oct 14-18: IEEE CEIDP, Kitchener, Ont
- Oct 30-31: IECC, Spain

Did You Know...
Iris is *constantly* working on new products and developments to bring you the very best in predictive maintenance technology?

Courses

- Oct 29-31: Partial Discharge Course, Sydney, Australia
- Nov: Motor & Generator Maintenance Course, Long Beach, CA
- Nov 27-30: Hydrogenerator Course, Orlando, FL
- Dec 4-8: Partial Discharge Course, Orlando, FL

Tradeshows

- Oct 15-18: EIC/EMOW, Cincinnati, OH
- Nov 5-8: Pulp & Paper, Atlanta, GA



This could be you at next year's IRMC

IRMC Review

By: Kim Zarb

This year, the celebrated Iris Rotating Machine Conference was held near the nation's capital in picturesque Alexandria Virginia, and yes, it was once again a great success. While the days buzzed away with tutorials, technical papers and user breakouts, the evenings provided a great opportunity for the delegates to take advantage of the capital city's main attractions - its string of art galleries, war memorials and historical sites. The ever-increasing acceptance of predictive maintenance on stator windings of rotating machines was exemplified by the fact that 10 out of the 20 technical papers were presented by international authors from Austria, France, Denmark, Mexico, the UK and South Africa, to name a few. Attendees came from as far as Bahrain, Japan and Trinidad.

The four-day event was divided into three technical sessions - motors, turbine generators and hydro generators that featured a variety of papers from OEMs, customers and consultants. The remaining time was filled with informative training courses and lively user group meetings. Many thanks to the paper presenters for enriching us with their knowledge and experience, and, of course, thank you to those who attended. Details for next year's conference will be available in early 2002. See our website for details.