Iris Power Engineering Inc.

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THIS ISSUE

PROBLEMS NOTED WITH MODERN AIR-COOLED TURBO GENERATOR STATORS

BY GREG STONE

Over the past decade, air-cooled turbine generators for use with gas or steam turbines have become the most common means of increasing generating capacity. Intense competition has occurred amongst the dozen or so manufacturers who make such machines. In an effort to be more competitive, there has been pressure to reduce production costs. This has caused machine designers to adopt innovative manufacturing processes to increase the mechanical, thermal and electrical stresses acting on the stator insulation. Although most machines have exhibited an excellent service record, there is no doubt that a significant number of stator winding problems are showing up in many brands of machines that may be only 5 to 10 years old. These problems have sometimes resulted in premature failure or increased maintenance efforts, in comparison to what was common in turbo generators in the past.

We have noticed several different types of failure processes occurring in these air-cooled machines. One of the most common problems is partial discharge occurring in the endwinding area, outside of the stator slot. The tendency to reduce groundwall insulation thickness increases the electric stress in the air spaces between adjacent coils in the endwinding. In addition, shortening the length of the coils or bars in the endwinding tends to reduce the distance between adjacent coils/bars. The resulting increased electric stress in the air spaces makes it much more likely that partial discharge may occur, degrading the insulation, especially when phase-end coils of different phases are adjacent to one-another.

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LARGE GENERATOR FAILURE RISK ASSESSMENT

GenLife™, a new set of tools will soon be helping decide maintenance plans for large generators**,** consisting of five computer programs (or tools), which will evaluate the risk of large generator failures for such problems as stator winding water leaks & vibration, stator core problems, rotor winding insulation damage, and rotor component faults from mechanical overstressing. The project is sponsored by EPRI and is being developed at Iris on a shared cost basis.

When fault mechanisms are not detected and mitigated, then component damage will increase with time and the generator will fail. In the past, the generator inspection and maintenance periods were scheduled to detect and repair most of the problems in time to prevent costly in-service failures. As generator users extend the times between planned inspections, they have a need to assess the incremental risks of such failures and adopt cost optimized maintenance strategies.

GenLife™ has been developed using failure data collected from the industry reliability statistics and generator expert inputs. The risk calculations performed by GenLife™ are based on a "decision tree" analysis of possible maintenance and repair options. They include specified probabilities that failure mechanisms will occur on a generator, that they will be present for some time before detection, and that the generator failure will occur with some probability if repair actions are not effected.

The first GenLife™ tool is now available. This tool evaluates the failure risk from water leaks in a stator winding. It is available for purchase from Iris. The remaining tools are scheduled for release in 2000 and 2001.

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NYPA to install 16 HydroTrac™ Monitors at St. Lawrence Plant

Since its commercial introduction in 1980, the PDA test has been used on the vast majority of large hydro-generators in North America and is increasingly used around the world. Although all of New York Power Authority's (NYPA) hydro-generators have been equipped with PDA sensors for more than 10 years, they are constantly evaluating technologies to help in predicting the current condition of their hydro-generator fleet. As part of the St. Lawrence automation project, NYPA decided to development an economical, continuous partial discharge monitor to automatically measure PD in hydro-generators. A collaboration by Iris Power Engineering, NYPA, and EPRI resulted in the development of HydroTrac™.

It is anticipated that 16 HydroTrac™ units will be installed at the St. Lawrence Plant and interfaced to a local HydroTrac™ controller for data archiving. Trending of key PD parameters will show if significant changes in the winding condition are occurring and will warn the maintenance staff (via an alarm) of the need for further examination of the machine's windings. At this point, if necessary, the full spectrum of PD activity can be tested for using a portable PDA instrument. This will more closely determine the problem so that maintenance options can be assessed

The main goal of the continuous partial discharge monitor is to provide an automatic and economical assessment of the condition of stator windings in the hydro-generators. The HydroTrac™ system proved attractive for a utility like NYPA with a large number of smaller units. A continuous monitor is installed at each hydro-generator (allowing measurement for up to six coupler pairs) and is directly connected via an RS485 serial link to a central controlling computer. The HydroTrac™ units are connected in a daisy chain fashion to a single computer serial port. Software running on the controlling computer can trigger a measurement by a HydroTrac,™ and this computer will also act as a database server to archive the test data. Other users can remotely access the HydroTrac™ data in the database from any computer on the LAN. On-going work will integrate HydroTrac,™ along with monitoring systems for mechanical vibration and air gap, into an expert system, to provide maintenance staff with up to the minute information on each unit's condition.

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Problems Noted With Modern Air-Cooled Turbo Generator Stators

Similarly, if the endwindings become polluted and there is insufficient spacing between the coils, the probability of electrical tracking increases. Another problem, which was also very common in hydrogenerator windings two decades ago, is slot discharge. Coils or bars that have not been adequately supported in the slot cause this. The looseness allows the coils and bars to vibrate at twice power frequency, leading to abrasion of the insulation, and discharges occurring on the surface of the coils or bars. Unless re-side packing, rewedging or injection of a carbon-loaded resin corrects the looseness, ground faults eventually occur. As found in hydrogenerators, the problem is avoided by installing ripple springs, two-part wedge systems and/or using conformal materials in the slot. Of course an initial conventional side packing and wedging system that ensures little clearance also works.

Problems with load cycling have also been noted. This is particularly important with gas turbine generators that have the ability to change from no load to full load in a matter of minutes. This rapid change in load causes a rapid change in stator winding copper temperature, and the consequent expansion (or shrinkage if the load is decreased) of the copper. Shear forces can build up between the copper and the groundwall insulation due to the difference in expansion, or between the groundwall and the stator core in the case of global VPI. After sufficient load cycles the insulation can break away from the copper (or from the core in the case of some types of global VPI windings). The air spaces created allow partial discharges to occur, which further degrade the winding.

In the next issue of Diagnostic News we will look at some specific examples, and some of the actions users can take to reduce the risk of experiencing these problems. In the meantime, Mr. Jan Stein of EPRI has set up an informal forum for organizations to discuss problems with the new breed of air-cooled turbo generators. If you have such machines, contact aircoolgen@listbot.com to participate.

Additional Hazardous Area Certification

Much of Iris' PD measurement technology has been certified since 1997 to be used in hazardous (chemically explosive) environments. The Class 1, Division 2 certification is widely required by refineries and chemical plants in North America and certain other jurisdictions. However, Europe and other parts of the world use a "zone" classification system. We are pleased to announce that our capacitive sensors, MotorTrac™ monitor, and SurgRisc™ monitor will be BASEEFA (British Approvals Service for Electrical Equipment in Flammable Atmospheres) certified by the end of February by Electrical Equipment Certification Services (EECS), for Zone 2, Category 3 areas. Contact Iris for further details.

Increasing Local Presence

Sales Rep for Texas

Gerry Griffin was hired in November 1999. Gerry comes to Iris from the electrical distribution industry where he had domestic and international assignments in Corpus Christi, Odessa, and Mexico City.

Gerry (pronounced Gary) grew up in the plains of West Texas. He has been working in the electrical industry for almost 30 years, and still enjoys every day. The newest addition to the Iris Marketing Team, Gerry will be responsible for sales in the state of TEXAS, and will be only a phone call away for his customers now that he's set up an office in La Porte, TX.

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Field Services Supervisor for California

Iris welcomes **Ron Hoffman** who joins us to provide technical direction, supervise customer installations, and offer product support in the west coast area. Ron brings mechanical, electrical, and customer service skills to his new position which he developed during his 14 year career at a large U.S. research facility.

Ron was born and raised in the northern California/Nevada area. An area he continues to enjoy with this wife four children.

Ron Hoffman
Field Services Supervisor
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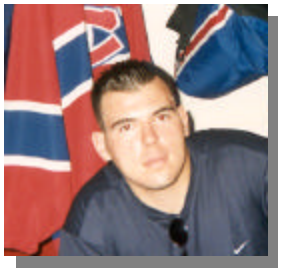
Iris Also Welcomes



James Thompson was brought on board this January as Iris's new Product Support Technician. He is available for advice on Iris software, hardware, and user manuals. James, is an Electronics Engineering graduate of Seneca College here in Toronto. In his free time, James enjoys playing a grueling match of tennis, baseball, billiards, and of course, like all good Canadian lads…..hockey.

James Thompson
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Iris' Field Services team has another great addition! We would like to introduce **Dave Quinn**. Dave, a veteran tradesman winder/mechanic, worked at various locations throughout North America specializing in hydro generation services. His responsibilities now include giving guidance and instruction for installations, calibration of sensor systems, and test data interpretation. A diehard Leafs fan, he predicts this will be the year to celebrate. David calls Niagara Falls, Ontario home.

Dave Quinn
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Updated PD Database Results

Iris is the only company in the PD business that publishes a statistical summary of all the PD test results its customers send in. This database enables other users to determine the relative severity of the PD in their particular machines, in comparison to other similar machines. This gives them a powerful way to extract useful information about their stator winding insulation condition, even with only one measurement of their own. A new analysis has just been published based on the 19,000 test results received up to the end of 1998. The table shown here from that analysis is a summary for air-cooled machines of different rated voltages using the Iris 80 pF capacitive coupling system. The table indicates the cumulative percentage of measurements with a peak magnitude (Qm) below the indicated level. You can see that a 13.8 kV winding with a reading Qm of 360 mV has higher PD than 90% of all other measurements in similar machines. Thus such a machine deserves closer attention, such as more frequent testing and/or a visual inspection. Iris updates and publishes the database every year. Contact us for a copy the full analysis.

Iris Results For Air Cooled Machines

	Rated V	2-4 kV	6-8 kV	10-12	13-15	16-18	> 19 kV
	Qm Avg	89	88	121	168	457	401
	Qm Max	2461	1900	3410	3396	3548	3552
percentile	25%	2	6	27	9	145	120
percentile	50%	15	29	63	79	269	208
percentile	75%	57	68	124	180	498	411
percentile	90%	120	247	236	362	1024	912

Plan To Attend The 3rd Annual IRIS Rotating Machine Conference New Orleans – June 19-22, 2000

The third IRMC is scheduled for **June 19-22, 2000** in New Orleans. A detailed brochure of the conference has been included with this issue of DIAGNOSTIC NEWS. It is also available on the Iris website at www.irispower.com. The IRMC is one of the few non-commercial conferences dealing exclusively with practical problems in operating and maintaining motors and generators. This year's conference has a strong program with several manufacturers discussing recent innovations in machines and testing, as well as papers given by machine users on problems they have experienced and repair methods. In addition to the technical program (**June 20 & 21)**, there are several tutorials **(June 19 & 22)** that educate plant maintenance personnel on predictive maintenance and test methods. With over 125 attendees the conference is an excellent forum for exchanging ideas.

2000 Iris Rotating Machine Conference
June 19-22, 2000
Le Meridien
New Orleans, Louisiana

For more information contact Kim Zarb at:
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Calendar

Motor & Air-Cooled Turbine Generator Maintenance Course
August 15-18, 2000
Toronto, Ontario

Hydrogenerator Maintenance Course
November 7-10, 2000
Orlando, Florida

Partial Discharge Course
November 21-23, 2000
Long Beach, California

For more information contact Deborah Aimer at:
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Have You Ordered Couplers For Your Next Outage?

A Familiar Face! . . .Greg Stone Named As Iris'New President

We are pleased to announce that commencing in April, Greg Stone (formerly VP Business Development) will be taking over as the new President of Iris Power Engineering. Dr. Stone, Dielectrics Engineer, has over 20 years experience in the application and testing of large motor and generator windings. Prior to founding Iris in 1990 with his three partners, he worked at Ontario Hydro for 15 years, where he specialized in testing the machine windings of the company's 200 generators and hundreds of motors in nuclear, fossil and hydro generating plants. He has authored or co-authored almost 100 technical papers on motor and generator windings and testing, and is a Fellow of the IEEE.

Dave Ferguson, Iris' President since September 1998, is moving to The Netherlands to take on the responsibility of European & Middle East Manager for Tru-Tec Process Diagnostics (a sister division of Iris and part of Tru-Tec Services, Inc.). Everyone at Iris will be sorry to see him leave, but we all wish him the best of luck at his new position.

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