SPRING 2003

DIAGNOSTIC NEWS

The Newsletter on Monitoring the Reliability of Electrical Equipment

INSIDE THIS ISSUE:

ANNOUNCING
the Launch of IRIS' New BOOT

See page 3 for details

IRIS POWER ENGINEERING

How is Partial Discharge Affected by Winding Age, Manufacturer and Insulation Type?

V. Warren

Most users of the Iris on-line partial discharge measurement technology are aware that every year Iris publishes a statistical summary of the distribution of peak PD magnitudes (Qms) for different sensors types and stator winding voltage classes. The resulting statistical tables for data collected until the end of 2001 was culled from over 37,000 test results that customers had submitted in confidence to Iris. The usefulness of these tables is that a user can compare the results from any individual machine with the results from many other similar machines, to gauge how the severe the PD activity is. The publication of these tables was a tremendous advancement in the objective interpretation of PD results, and also allowed users to make an initial interpretation of winding condition from only a single test.

In addition to the statistical tables, we have been able to examine the database to see what the effect of stator design parameters, manufacturer, insulation type and winding age has on the PD levels in any particular machine. The following briefly outlines some of the results of these analyses.

Winding Age

Table 1 shows the PD results in the database from machines that were from a year old to greater than 50 years old. For example, in Table 1, for stators made between 1976 and 1980, 25% of stators had a Qm <9 mV, 50% had a Qm <20 mV, 75% were less than 77 mV and 90% of all stators (air-cooled, rated between 13 and 15 kV) had a Qm <214 mV. We normally become concerned if the winding has a Qm >90% of similar machines.

One of the most surprising outcomes from the statistical analysis of the database was the distribution of Qm as a function of winding age. There is no consistent trend in Table 1 - which is surprising since one would normally think older windings would be more deteriorated and thus have higher PD levels. That there was no general trend implies that both older windings and new windings can have about the same high PD activity. In fact, air-cooled windings manufactured in the past 5 years seem to have higher PD activity than some vintages of older machines. This may reflect the fact that modern windings tend to operate at higher thermal and electrical stresses than older machines. Other explanations for the inconsistent pattern of PD versus winding age may include the observation that manufacturers of machines have a learning curve to climb as they adopt new design and manufacturing techniques, or that utilities are continuously oscillating between proactive and breakdown maintenance strategies.

Table 1: Effect of Winding Manufacturing Date on PD Levels in 13-15 kV Air Cooled Stators

	YEAR							
PD Percentile	'61-65	'66-70	'71-75	'76-80	'81-85	'86-90	'91-95	'96-99
25%	35	51	58	9	48	4	26	29
50%	102	143	141	20	104	19	80	79
75%	225	206	341	77	228	112	138	172
90%	526	380	548	214	1404	346	244	327

Continued on page 2

Manufacturer

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An analysis of the statistical distribution of PD for several different manufactures was performed. Table 2 shows the results for 13-15 kV stators from 8 different OEMs based around the world. Note that the data covers all ages of machines, and all insulation systems made by these manufactures over the years. Clearly there are differences between the manufacturers. For example OEMs E and F have relatively low PD on average, whereas manufacturer C has relatively high PD for its fleet of machines. The cause of the differences between manufacturers is unknown, but it may be due to different manufacturing processes, electric stress design levels and assembly methods.

Table 2: Effect of Manufacturer on PD Levels for 8 OEMs (13-15 kV Stators)

Manufacturer	A	B	C	D	E	F	G	H
25%	48	23	44	81	10	34	17	114
50%	127	98	142	138	63	65	97	188
75%	287	205	338	239	157	106	201	278
90%	385	655	803	399	280	237	406	400

Winding Rating and Insulation System

Similar analysis was done for the other factors. The analysis showed that the distribution of Qm did not depend on the power rating of the machine, as long as the voltage class, type of sensor and type of cooling/pressure was held constant. That is, the 90% Qm level is the same for a 20 MW and a 200 MW generator, as long as the voltage class, etc is the same.

Additionally, the 90th Qm percentiles for stator windings bonded by asphalt, polyester and epoxy are 475 mV, 382 mV, and 356 mV, respectively, for 13-15 kV, air-cooled stators. Although slightly higher levels of PD are measured for asphaltic mica windings, the difference from epoxy mica windings is surprisingly small given the lower thermal capability of the asphaltic mica insulation system and the fact that such windings are usually at least 40 years old.

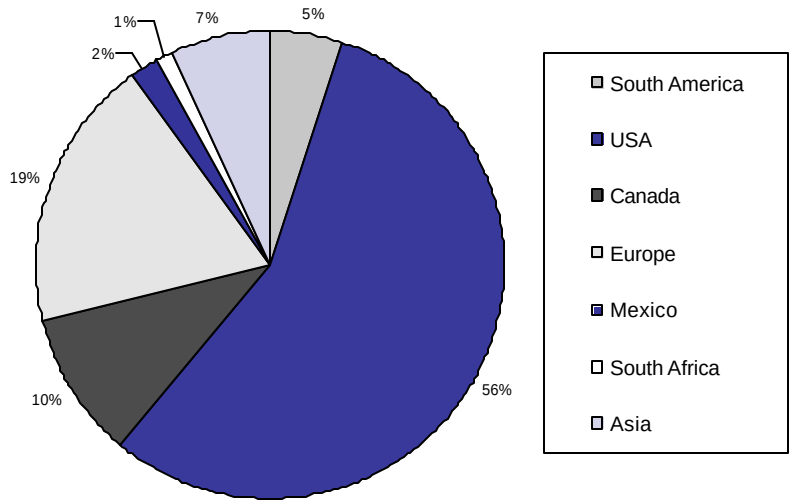
ACCEPTANCE OF IRIS' TECHNOLOGY OUTSIDE OF THE USA AND CANADA

Over 50% of the utility generations rated more than 20 MW in the USA and Canada are now using Iris' on-line partial discharge technology. This widespread acceptance is probably due to:

- it works - it really does identify stator windings with problems
- low risk of false identifications
- availability of a database of over 37,000 test results to help interpret results
- low marginal test costs, since plants can install sensors, perform tests and do their own interpretations

What may not be so apparent is the wide acceptance of this technology outside of Canada and the USA. The attached chart illustrates the take-up of the on-line PD testing by users throughout the world, based on 2002 sales. It is clear that European, Asian and South American countries are also seeing the advantage of on-line PD testing.

Iris Power's Sales by Region 2002



IRIS' ANNUAL IRMC

The Annual IRMC (Iris Rotating Machine Conference) is scheduled for **June 16-19, 2003** in sunny **Santa Monica, CA** at the Double Tree Guest Suites just minutes from the world famous Santa Monica beach and pier, the Promenade and numerous other attractions.

The IRMC is one of the few non-commercial conferences dealing exclusively with practical problems in operating and maintaining motors and generators. In addition to our technical program (June 17 & 18), we will also be offering several tutorials (June 16 & 19) designed to educate plant maintenance personnel on predictive maintenance and test methods. These tutorials will include: **Condition-Based Maintenance for Motor Windings, Partial Discharge Theory, Introduction to Current Signature Analysis, Introductory /Advanced Partial Discharge Interpretation**, and much more. For our previous attendees - all our courses have been updated to reflect our latest software, test data, test instruments, procedures and interpretation techniques. For our customers - we are offering a 1.5 hour workshop on the new PDView 3 software.

To download more information pertaining to this event, including conference and tutorial registration forms, visit our website at: www.irispower.com (events section) or
contact Kim Zarb at (416) 620-5600 X 240
or e-mail: kzarb@irispower.com. We anticipate your participation.

PDView Users

Watch for your letter

Iris announces the release of its new and enhanced software application - PDView 3. Complete with viewing and reporting capabilities, PDView 3 is the ultimate tool for partial discharge reporting. All existing customers using PDView can expect to receive an email during the month of April telling them more about the newest version of PDView. For further information, please contact your Iris Sales Representative.

Announcing the Launch of IRIS' New BOOT

The innovative new Iris BOOT will be replacing the insulation tape used for the previous 12 years for securing and protecting the high voltage jumper cable connected to the coupler. The BOOT is made from high quality silicone rubber. The BOOT has undergone rigorous BIL testing procedures carried out by an independent company to ensure its reliability during high voltage exposure. Test results declare that a 25 kV capacitor covered with the BOOT can withstand a lightning impulse level of at least 200 kV and a 16 kV capacitor could withstand lightning impulse levels of 175 kV corrected as per IEEE Std4 1995 with no flash over.

The Boot design provides a rubber insulation seal designed for Iris capacitors with three key features:

· Increased protection of coupler and high voltage cable connection

· Uniform installation across all couplers of all sizes in all locations

· User friendly, for easy installation and time efficiency

Iris has introduced the new BOOT for a number of reasons. One very important rationale is to improve the time efficiency and ease of every installation and ensure that our customers are satisfied with our service. The previous taped insulation applied to the coupler was subject to variation depending on skill and care of application. The Boot will ensure that all high voltage insulation will be uniformly reliable, of the same quality and will enhance the uniformity of installations of couplers within a rotating machine, across plants and worldwide.

The BOOT will increase the caliber of protection afforded each coupler and eliminates any concern associated with elevated operating temperatures found in some machines. The new Boot will become the standard coupler insulation supplied with each kit.For more information on the BOOT please contact a Field Service Specialist at Iris Power Engineering.

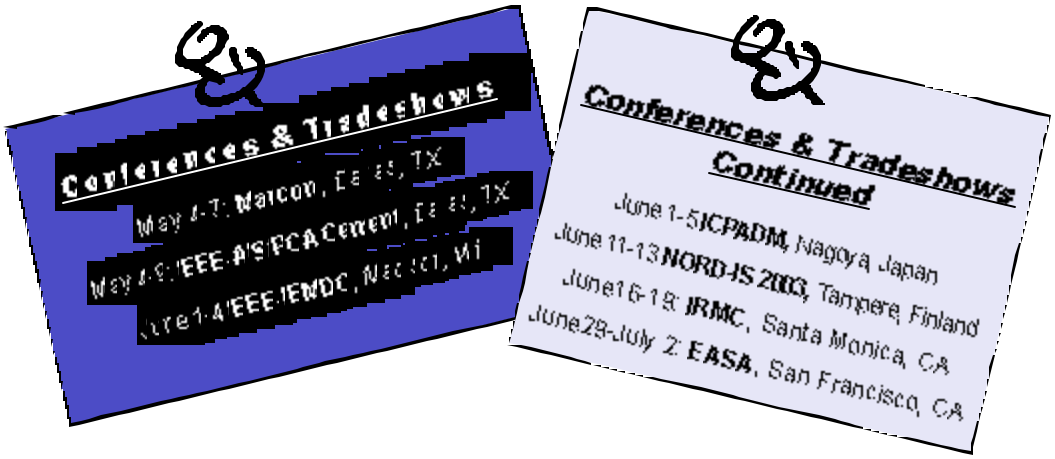
CASE STUDIES

As our website evolves, Iris has made available a selection of case studies from our customers. These anecdotes can provide you with information on unique and interesting application and technology situations around the world. Be sure to check out these case studies to learn more about PD Technology and Interpretation at www.irispower.com.

TracCheck Promotional Offer!

Iris is offering all existing Trac customers the TracCheck Promotion. This promotion includes one Trac PD Data Assessment Report per Trac installed and commissioned. When you send in your Trac data we will provide you with a report which will give you a look into the health of your stator winding, 2D and trend analysis and a diagnostic report on the Trac instrument itself. If you are interested in this Trac Promotion please contact your Sales Representative at Iris.

UPCOMING EVENTS



VERIFICATION OF DELAY TIME FOR BUS INSTALLS

V. Warren

A particular challenge with PD measurements performed in normal motor or generator operation is that electrical interference (noise) often is present. This noise obscures the PD pulses, and may cause the unwary technician to assume that a stator winding has high levels of PD, when in fact the high levels are caused by the noise. One of the noise separation techniques pioneered by Iris staff for use with capacitive couplers, is to compare the time of PD pulse arrival between a pair of capacitive couplers installed on each phase of the output bus of the machine. This noise separation technique requires knowledge of the delay time for a high frequency "PD-like" pulse to travel from one coupler to the other on a given phase, as well as the pulse distortion and attenuation. Characterization of these factors for a given site must be done before on-line measurements with a TGA-B are made. This process is referred to as "verification of a bus coupler install" and is normally done as part of a coupler installation process.

Often, the physical geometry of a plant, accessibility and space constraints, will necessitate the installation of the bus couplers at positions less than ideal. Such installations often require that the two sensors per phase be placed on opposite sides of current transformers, excitation transformers, flexible leads or perhaps even placing a sensor on a bus tap. High frequency pulses attenuate significantly when traveling across devices or connections that lead to impedance mismatches. Though these may not prevent the TGA-B instrument from properly classifying noise, they will affect both the magnitude and frequency characteristic of the pulses detected and must be identified during verification. Through low voltage pulse injection techniques, Iris Field Service staff will establish the classification for a bus install, to be one of the following.

- *Class 0: single ended*
- *Class 1: second pulse within 50% magnitude*
- *Class 2: second pulse less than 50% magnitude*
- *Class 3: second pulse not discernible*

In this classification system, the term "second pulse", refers to the response measured at the coupler furthest away from the pulse injection point. In addition, to ensure that the attenuation is actually due to the presence of devices between the sensors, the response to a pulse injected at both the machine, and system end couplers are recorded. This is referred to as a balance check. Types of responses to a balance check are:

- *Symmetrical: reversal of responses*
- *Asymmetrical: non-reversal of responses*
- *Unknown: no balance check done*
- *Not Applicable*

Knowledge of these factors can be critical when configuring the TGA-B instrument delay time, as well as collecting and interpreting the PD test data.

One further verification of the installation characteristics is also used by Iris Field service staff during the first baseline measurement with a TGA-B. At this time, a Delay Time Verification check will be performed. This involves varying the Instrument Delay Time, above and below the nominal value, and noting the PD and noise classifications in the resulting test data. Using this technique verifies both the installation, and ensures the noise separation algorithms are working as expected.

As you can see, it is very important to have an understanding of the verification process when configuring and interpreting data. Let the experts at Iris provide solutions for your particular application.

ANNOUNCING A NEW AREA MANAGER

Iris Power Engineering is please to announce the promotion of Johann David Bustin to Area Manager of our office in Nantwich, England. Johann will not only manage this office but will also be responsible for sales in England, Scotland, Wales and Ireland. This office offers both Iris' partial discharge testing products and services and offline monitoring and consultancy services. For more information please contact Johann at *jbustin@irispower.com*. Also, coming soon a website specifically for our UK office.