

# DIAGNOSTIC NEWS

The Newsletter on Monitoring the Reliability of Electrical Equipment

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## TESTING SHOWS THAT SURGES ARE NOT THE CAUSE OF IFD MOTOR FAILURE AT PULP AND PAPER MILL

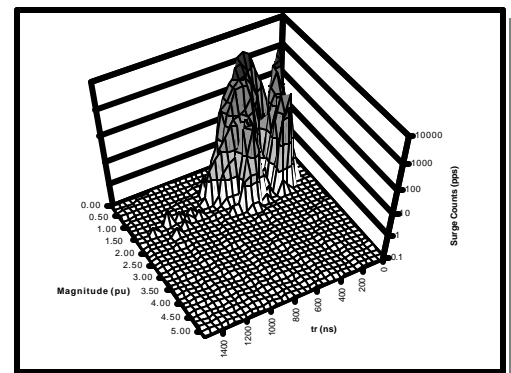
By: Steve Campbell

A pulp and paper plant in Alabama had experienced premature stator winding failure in 575 V motors powered by inverter fed drives (IFDs). The IFDs were of the pulse width modulated type, and had modern IGBT switching devices. As discussed in an article in the September 2000 issue of the IEEE Industry Application Magazine, such drives can create thousands of fast risetime voltage surges per second. Research has shown that if the risetime is fast enough, and the magnitude of the voltage surge at the motor terminals is high enough, then partial discharge may occur at certain locations in the stator winding, even in motors rated as low as 440 V motors. These partial discharges will gradually degrade conventional magnet wire insulation used in stators rated less than 1000 V. Eventually insulation puncture occurs, leading to a motor ground fault.

The vast majority of IFD motors do not experience motor failure due to IFD surges. The question the plant maintenance personnel at this pulp and paper plant faced was to determine if surges were the likely cause in their particular failures. If so, then appropriate corrective action could then be taken (see later).

To help determine if surges were the cause of failure, Iris Power Engineering provided a test service using its new SurgAlert instrument. SurgAlert rapidly measures the peak magnitude of every surge that strikes the motor. It also measures the risetime of the surges, as well as the number of surges counted in the measurement interval (usually 1 to 5 seconds). SurgAlert is distinguished from normal 'disturbance' meters or transient recorders, in that it can accurately measure the magnitude of all voltage surges, even those with a risetime as short as 50 ns.

Prior to Iris arriving at the plant, plant personnel temporarily connected a small, wideband voltage divider to 7 motors during a few-minute outage. With the motors running normally, the SurgAlert instrument was connected to the dividers on each motor, and the surges recorded in a 5 second interval.



Although SurgAlert can be operated stand-alone, a laptop computer was connected to SurgAlert to download the data and permanently store all the surge information.

The above figure shows the data collected on the motor with the worst surges. The SurgAlert output is plotted as a three dimensional curve, with the left scale being the magnitude of the voltage in pu, the bottom scale is the risetime of the surge in nanoseconds, and the vertical scale indicating the number of surges per second for each combination of surge magnitude and risetime. One pu is the peak line-to-ground ac voltage (for a 575 V system, 1 pu is about 468 V). The surges most likely to cause winding failure will have a short risetime and high magnitude – that is, they will appear in the lower right part of the three-dimensional plot. As seems to be common with all modern IFDs, the drive does not produce a single magnitude surge with a constant risetime. Instead, a variety of surge risetimes and magnitudes occur. The highest magnitude measured on this 20 HP motor was 1.8 pu, with a risetime of 150 ns. The other six motors had either much lower magnitude surges, or much longer risetimes.

The US National Electrical Manufacturers Association (NEMA), has established what an inverter duty motor should be able to withstand in its standard MG 1, Part 31:1998 (IEC is still establishing suit-



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## WHY DIGITAL NOISE SEPARATION IS CRITICAL TO PARTIAL DISCHARGE TEST CREDIBILITY

By Greg Stone

The key characteristic of the Iris on-line PD technology, originally developed by Ontario Hydro in research funded by the Canadian Electrical Association, is that electrical noise is separated from stator winding partial discharge (PD) using digital pulse-by-pulse technology. Although many other technologies are on the market, and all can detect PD, these other systems use analog noise separation methods (filters, differential amplifiers, etc.) or employ 'gating' systems where experienced test personnel are needed to find noise sources and/or set noise thresholds.

Electrical noise is caused by many sources in operating plants: corona from overhead power lines, brushgear sparking, electrostatic precipitators, power tool operation, inverter drives, etc. All of these noise sources create electrical pulses that have many of the same characteristics as pulses caused by stator winding PD. Yet, for the most part, these noise sources are relatively harmless or even normal. If the noise environment is severe, the noise will give rise to higher pulses than the PD,

and thus the PD signals may be obscured. If the noise is mistaken for PD, then the unwary user may assume that the winding is deteriorated, when it is not. This is called a false positive test result. The consequence of the false positive is that the machine must usually be shut down for either off-line tests, or a visual inspection. If nothing is found, the shutdown, with an associated loss of production and maintenance costs, was unnecessary. Since in fact only a small percentage of stators are actually significantly deteriorated at any one time, even a low percentage of false positives can result in more machines being identified as bad, than the number of machines correctly being identified as bad.

In addition to preventing false indications, digitally separating PD from noise has other benefits, including:

- if desired, plant staff can perform all testing and most interpretations. This lowers overall test cost
- once noise is separated, the PD magnitudes can be compared against the Iris database, so that users can objectively

**“In addition to preventing false indications, digitally separating PD from noise has other benefits...”**

determine the relative winding condition with only one test. Since the definitions of 'good' and 'bad' windings are published in the public domain, they are not subject to redefinition, depending on vested interests

- if the noise environment changes over time, no further visits to the plant by an expert are needed to readjust the filtering or the noise gating systems. The pulse-by-pulse noise separation system

— CONTINUED FROM PAGE 1 —

## TESTING SHOWS THAT SURGES ARE NOT THE CAUSE OF IFD MOTOR FAILURE AT PULP AND PAPER MILL

By: Steve Campbell

The standard says the stator should be capable of withstanding surges less than 3.7 pu, and a risetime longer than 100 ns. Since the surges on this motor are much less than the 3.7 pu allowed, the conclusion is that the motor should be capable of withstanding the surge environment. The other 6 motors have an even lower risk of failure due to surges.

Since motors may sometimes not meet specifications, the capability of several motors (regrettably not the motors that already failed) was directly measured. A Baker Model D12000 surge tester, capable of outputting 100 ns risetime surges to the motor, was used to apply surges to motors disconnected from the power system.

All motors tested withstood the NEMA surges of 3.7 pu (1740 V). One motor, with the same rating as the motor experiencing the worst surges, was energized to 2600 V, and did not fail. In addition, the partial discharge activity on these motors was measured with Iris's XTrac PD detector, while the surges were being applied. No PD was detected below 3.7 pu, and, in fact, the 20 HP motor only experienced PD above about 2600 V. Clearly, the motors tested should not suffer from PD induced by IFD switching surges at this plant.

This testing regime was able to conclude objectively that surges are unlikely to cause failure in the specific plant environment in

date seems to indicate that most motors have a significantly less severe surge environment than would be expected from simple analytical techniques that can be used to estimate the surge environment.

If SurgAlert does find a motor with a severe surge environment which exceeds NEMA ratings, then plant owners can consider a variety of methods to reduce surge severity, including adding filters, altering cable length and/or grounding, and upgrading the stator winding insulation system. Since all of these measures can be expensive, it is best to determine first if they are necessary using SurgAlert.

## INCREASING LOCAL PRESENCE

Marta Blocki joins Iris as their new Communications Coordinator. Her main duties involve coordinating tradeshow, courses and conferences, while attending to advertising and other media/communications related responsibilities. A recent Mass Communications and English graduate from Carleton University in Ottawa, Marta enjoys writing, and drawing in her spare time, that is, when she can find it.



**Marta Blocki**  
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Coordinator  
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Eugene joins us with a long history of experience in the industry under his belt. Before his arrival to Canada, Eugene worked in the circuit board industry, plant management and business. After his departure from Belarus he has dabbled in technical support, field service and applications. Currently Eugene is Iris's new International Projects Manager – who knows what the future will hold for him!



**Eugene Kazlou**  
International Projects Manager  
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Rajiv is the latest addition to Iris's marketing department under the title of Applications Specialist. He joins the Iris marketing team with a combination of qualifications in engineering and information technology, not to mention a broad-based learning aptitude. Over the years, Rajiv has gained knowledge and expertise in numerous fields, namely sales, designing, system analysis, installation and maintenance of engineering products.



**Rajiv Sharma**  
Applications Specialist  
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Khanano has come aboard the sensor and kits department just two short weeks ago. As a member of manufacturing and support staff, Khanano will be primarily involved in building up manufacturing. Apart from his avid interest in music, playing guitar and sports, Khanano boasts of a three-year electronics degree which he attained in Iraq.



**Khanano Khanano**  
General Support Worker  
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A graduate from Leeds Metropolitan University in England, Mark's academic background mainly involves electronic engineering. As our Junior Software Engineer, Mark is expecting some intensive training ahead. Some temporary cut-backs in football (or soccer, as we understand it) may very



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## IRIS ALSO WELCOMES...

Iris' new technical director, Andy Brown, has assumed his position at our new UK office in Nantwich near Manchester. Andy's responsibilities include expanding Iris's test service and rotating/electrical plant condition assessment. With prior experience in working for large engineering companies like Nuclear Electric and Mott MacDonald, we have complete faith in his elaborate repertoire of expertise.



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## INDUSTRY NOTES



**Don Speer** has become a consultant specializing in insulation materials development and evaluation. Most of his recent work has been on subjects related to magnet wire insulation and processing of stator windings. **Don** can be reached at 636-949-3149, or by e-mail: donaldspeer@netscape.net

**Dr. George Gao** has joined the corporate R&D center of General Electric. **Dr. Gao** has been an

active developer of rotating machine insulation systems, most recently at TECO Westinghouse. He can be contacted at (518) 387-6219, or by e-mail: gaoge@crd.ge.com

**Dr. Bal Gupta** of Hydro Ontario has retired. He is a well-known researcher of rotating machine failure mechanisms and test procedures. **Dr. Gupta** is now a consultant specializing in these areas. He can be reached at (416) 621-6035, or by e-mail at: b.gupta@ieee.org

**IEEE 1434-2000** has finally been published. This guide discusses the benefits of partial discharge testing of rotating machines, and outlines all the various off-line and on-line methods. The guide was produced under the chairmanship of **Bill McDermid** of Manitoba Hydro. To order IEEE Std 1434-2000, call (800) 678-4333 in the U.S.A. and Canada, or from other countries call (732) 981-0600. Orders by fax may be sent to (732) 981-9667. For Web access to IEEE standards information visit

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# CALENDAR 2000/2001

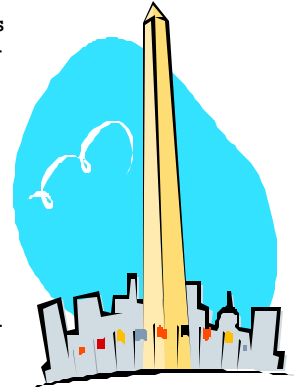
		
December 31	Jan 15-18	Jan 23-25
Paper abstracts due for IRMC	EPRI Conference New Orleans, LA	EGC (Energy Generation Conf.) Bismarck, ND
Jan 30-Feb 1	April 9-11	June 2001
EXFOR Conference Montreal, PQ	PD Course California	Iris' 4th Annual IRMC Conference

## CALLING ALL PAPERS!

Iris' Fourth Annual IRMC Rotating Machine Conference is scheduled for **June 2001** in the Washington DC area. A detailed brochure of the conference is currently available on hard copy and on the Iris website at [www.irispower.com](http://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. We are soliciting abstracts for papers 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, we also offer several tutorials that educate plant maintenance personnel on predictive maintenance and test methods. Usually over 125 people attend this conference – it is an excellent forum for exchanging ideas.



**Iris Rotating  
Machine  
Conference  
June 2001  
Washington DC area**

To submit a paper or for more information, contact **Marta Blocki** at 416-620-5600 X 241 or fax: 416-620-1995 or e-mail:

## ANNOUNCING A NEW AGENT!

Grupo Industrial Rubalcava S.A., otherwise known as GIRSA, a new agent with many offices across the country is assuming the responsibilities of our sales in Mexico. Peter Kantardziski and Joseph Mbuyi will now share the support

for the agents in South America. The new address is as follows:

**GIRA Grupo Industrial Rubalcava, S.A.,  
Fray Juan de Torquemada #33  
Col. Obrera, Del. Cuauhtemoc  
06800  
Mexico**

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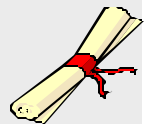
## CONGRATS ON PROMOS!

**Mark Romanko** has joined Iris as a full-time employee after having worked here on a part-time basis. Mark is officially our 'lead-hand,' in charge of the department responsible for SSCs, EMCs and order assembly.

**Peter Kantardziski** has been promoted to Senior Manager of International Projects. He is currently contributing in the development of our expansive international projects.

**Paul Magder** has been involved with more than just manufacturing for many years now. While Paul will retain many of his habitual responsibilities, as the General Manager of Production, he will also be responsible for shipping, product certification and health and safety.

Finally, **Byron Mazariegos** who worked in Manufacturing will be shortly joining Field Services. As the Field Service Specialist of Iris's products, Byron's five years' experience in testing will



## New VP of Marketing: Joseph Mbuyi

Recently, Joseph Mbuyi has been promoted to Vice President of Marketing and Sales.

Although not entirely a *new* face among us – Joseph has been working in sales for the past four years at Iris. We are all the more convinced that Joseph's education, past experiences and a vast knowledge of Iris will constitute a definite asset in meeting this new challenge in his current position.

