

DIAGNOSTIC NEWS

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Your Source For Monitoring the Reliability of Electrical Equipment

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UPCOMING EVENTS

CMD, Tokyo, Japan	Sept 6-11, 2010
EL-CID ACE Course, Toronto	Sept 14-16, 2010
ENAM, Curitiba, Brazil	Sept 19-22, 2010
PCIC 2010, San Antonio, TX	Sept 20-22, 2010
EPRI Fleet-Wide & Generator On-Line Monitoring, Raleigh, NC	Oct 12-14, 2010
GE 7EA Users Conference, Memphis, TN	Oct 26-28, 2010
Turbogenerator & Motor Maintenance Course, Houston, TX	Nov 2-4, 2010
PD Course, Houston, TX	Nov 16-18, 2010
Iris Regional Conference, Dubai, UAE	Feb 6-8, 2011
IRMC, San Antonio, TX	June 20-23, 2011

Analyzing the Iris Power PD Database for the Influence of Machine Manufacturer and Age

By Vicki Warren

Since 1998, we have been collecting, in one very large database, all the motor and generator partial discharge (PD) data where Iris staff have performed test services, as well as some of the data customers have sent to us. With all this data in one location, we can analyze what factors seem to influence the statistical distribution of the PD magnitudes. The results of these analyses have been reported in a series of papers presented each year at the Iris Rotating Machine Conference. The latest analysis was presented in June 2010 and the results are on the Iris website: www.irispower.com under Technical Papers, General Testing.

The conclusion of previous papers was that when comparing PD data results from different machines the following parameters must be the same:

- Test instrument bandwidth and noise separation techniques
- Type of sensors
- Operating voltage of the machines
- Operating gas coolant of the machines – PD is pressure dependent

The following does not appear to have a significant impact on the statistical distribution of the PD magnitudes:

- Type of insulation system
- Machine type
- Winding type

However, PD levels appear to be influenced by the quality of design, manufacturing, and installation, and not solely operating hours or operating condition.

The latest analysis is based on 225,000 test results collected up to the end of 2009 using either the TGA or PDA-IV portable instruments. The actual useable data was much reduced to about 15,000 measurements since we analyzed only PD collected when the machine was operating at full power and the stator winding was hot. In addition, only the most recent data was used for each machine. Unlike the first analysis in 1998 where most of the results came from hydrogenerators, now most of the data comes from turbine generators (Figure 1).

The main purpose of these statistical analyses is to develop tables that allow users to determine how one of their machines compares against the results for similar machines in the Iris database. Over the years, we have learned that if a stator has higher PD than 90% of other similar machines (i.e. of the same voltage and using the same PD monitoring system), then there is a very high probability that when the machine is visually inspected, a serious insulation problem will be found. The tables from the latest analysis are in the full paper mentioned above.

Every year we look at a special topic. One of the most interesting is to see if the PD statistical distribution is different with different manufacturers, and how the most recent PD distributions are affected by the age of the winding. Ideally one would find that the distributions are not affected by manufacturer (i.e. all manufacturers make equally good windings) and that the older the machine, the higher will be the PD. As we have seen in past manufacturer and age analyses, this ideal response sometimes does not occur, and this was again verified in this year's reanalysis.

MANUFACTURERS AND AGE

Because PD results are dependent on the machine type and voltage class, to properly evaluate the industry trends, four of the most common air-cooled machine types and voltage classes were selected: Motors 6-8kV; Turbos 13-15kV; Motors 13-15kV; and Hydros 13-15kV. For each machine and voltage category, the results were separated based on manufacturer (labelled A-I in the figures). There was no attempt to evaluate type or method of manufacturing, or to extend the breakdown of machine types beyond the general categories listed. In addition, for all manufacturers, trends based on year of winding installation are also presented.

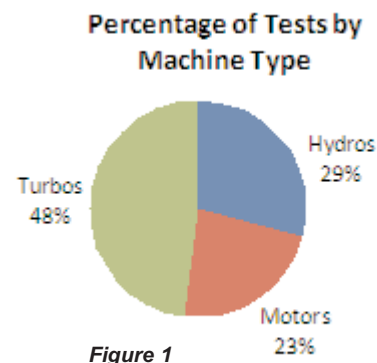


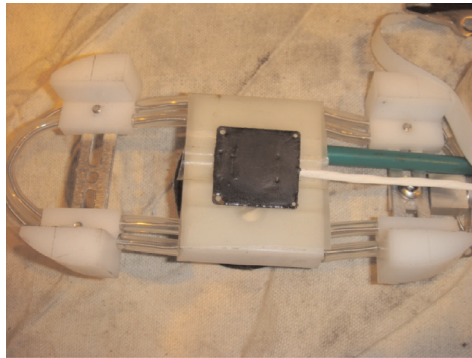
Figure 1

Proven Method to Install Flux Probes on Turbine Generators while the Rotor is in the Generator

Shorted turns in turbine generator rotor windings are often first noticed by an increase in bearing vibration. The best way to confirm that rotor winding shorts are the cause of the high vibration, and to determine the rotor slots where the shorts are, is to monitor the air gap magnetic flux from the rotor winding during normal operation. This requires a flux probe. Unfortunately, until now, conventional flux probes could only be installed during a major outage, when the rotor was removed from the generator. Thus, unless a flux probe had been installed during a previous major outage, there was no direct on-line way to confirm that shorted turns are the cause of the vibration.

In 2007 Qualitrol-Iris Power introduced the TFProbe™, which has a very flat profile, and is intended to be glued to the stator core. In contrast, older technologies relied on a solenoid type of coil that is pinned to a stator wedge, and projects several centimetres into the air gap. It is not possible to retrofit such a flux probe when the rotor is in place. Due to the thinness of the TFProbe, and since it is simply glued to the stator core, Iris's Ron Wheeler proposed that the TFProbe could be retrofitted to a turbine generator without pulling the rotor. Over several months, he developed the required tooling and procedures. In the spring of 2010, he finally had the opportunity to retrofit a probe on a 129/149 MVA, 2 pole, 18kV GE turbine generator in the US Midwest. The only access available was from the turbine end of the generator, with the top half of the end shield removed.

The tooling involves a carriage to carry the flux probe in place, and extension poles slide the carriage into the correct position at the end of a slot, away from the "step-iron" at the two ends of the core. Epoxy glue is placed on the TFProbe, prior to insertion. A special air-bladder, which is expanded into the space between the rotor and the stator core, is used to apply pressure to the carriage, to ensure the TFProbe is held firmly against the stator core while the epoxy glue cures.



TFProbe installed on carriage prior to insertion into the airgap.



Air bladder holding the carriage in place while the glue cures. The rotor is at the bottom of the photo.

Thus, it is now feasible to retrofit such a flux probe during a minor generator outage. At the present time, Iris Power offers "rotor-in" flux probe installation services. However, we anticipate offering a kit of tools with a detailed procedure so that service organizations, OEMs and end-users can retrofit the sensors themselves.

Qualitrol-Iris Power's New Off-line Assessment Tools

Since our integration into the Qualitrol group of companies, we have expanded our range of condition assessment and predictive maintenance technologies for electrical apparatus. You may be familiar with the Qualitrol DMS Company, manufacturer of on-line PD monitoring systems for Gas Insulated Switchgear. We are taking this opportunity to introduce our users to products from PDTech, a division of Qualitrol DMS. PDTech manufactures AC power sources to energize stator windings or other apparatus windings during off-line electrical testing. We can now also offer PDTech's capacitance and tan delta instrumentation to support your condition assessment efforts.

Please visit our website to review the latest literature on both of these products and contact your nearest application engineer.



Capacitance and Tan/Delta Instrument

On-Line Turbine Generator Forum

Several months ago, National Electric Coil established a web-based discussion forum that is located at <http://www.generatortechnicalforum.org>.

End-users, consultants, equipment providers and service providers are all active on this forum related to the mechanical and electrical issues of turbine generators, and recently hydrogenerators.

We encourage you to join this forum, to share your ideas and get answers to questions you may have.

Motors 6-8kV

Figure 2 depicts the 25th, 50th, 75th, 90th and 95th percentiles of the PD magnitude distribution for each of the manufacturers. It is apparent that for manufacturers D and F, the PD values are higher than typical (ALL), especially for the machines with measured PD levels in the 90th and 95th percentiles. This indicates that for these two manufacturers, the highly PD-active machines are substantially more active than similar machines from other manufacturers.

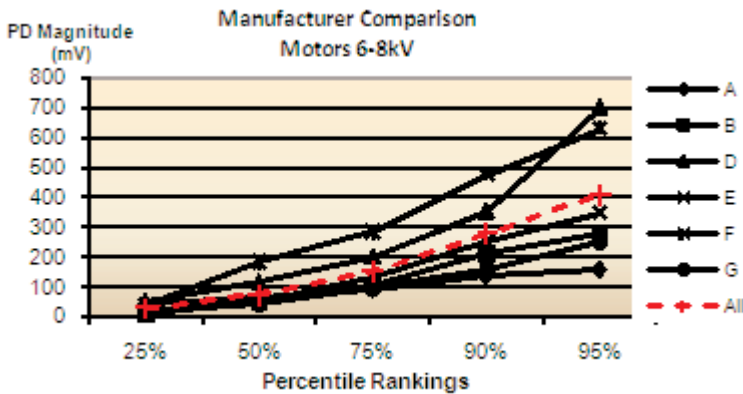


Figure 2: Motors 6-8kV by OEM

Figure 3 depicts the 25th, 50th, 75th, 90th and 95th percentiles for all manufacturers based on date of winding installation. Note that only the most recent test data is displayed, that is, even if a winding was installed in 1986, only the PD results collected in 2009 are included. It would be reasonable to expect that due to aging, the older machines in the 2009 test results would have higher PD results than the newer ones. In other words, there should be a noticeable downward trend from those manufactured before 1981 to those installed in 2006-2010. However, it is apparent that this is not the case. Instead, the newer windings manufactured from 2006-2010 actually have higher PD for the 75th, 90th and 95th percentiles than motors made in the previous decade of 1996-2005. This suggests that across the industry there is a trend in some of the newer windings of this voltage class to have problems that result in PD activity that was not present in the past decade, but perhaps was present in earlier machines.

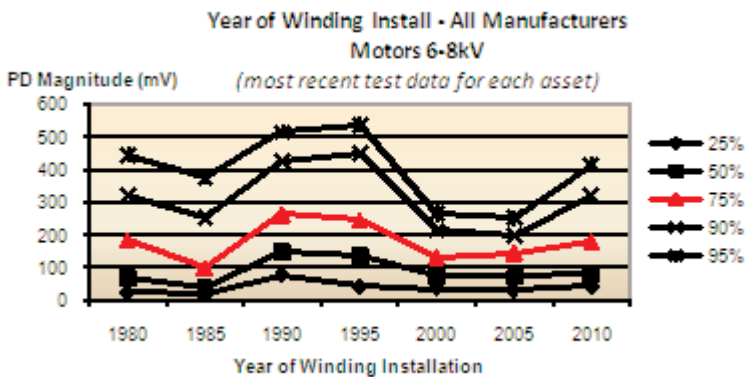


Figure 3: Motors 6-8kV by Year of Install (test results obtained in 2009)

CONCLUSIONS

Only the analyses for motors rated 6-8 kV are presented here. However, this same analysis was also carried out for the most common voltage ratings of hydros and turbos, as presented in the full paper. The overall findings of the statistical analysis are as follows.

Motors 6-8kV

- The overall trend of the 2009 data separated by date of winding installation for all manufacturers has emerged with an upward trend to indicate that newer machines have more PD activity than older machines, and thus a PD-source problem has developed within the industry.
- Machines from manufacturers D and F have higher PD activity than everyone else.

Turbos 13-15kV

- The overall trend of the 2009 data separated by date of winding installation for all manufacturers has been stable to indicate that the older machines do not possess more PD-related problems than the newer machines. This is unexpected, as it is assumed that older machines would have higher PD due to long-term aging.
- Machines from manufacturers B, F and J have higher PD activity than everyone else.

Motors 13-15kV

- The overall trend of the 2009 data separated by date of winding for all manufacturers has emerged with an upward trend to indicate that newer machines have more PD activity than older machines, and thus a PD-source problem has developed within the industry.
- Machines from manufacturers D and F have higher PD activity than everyone else.

Hydros 13-15kV

- The overall trend of the 2009 data separated by date of winding installation for all manufacturers has emerged with a downward trend. This is the expected pattern, where older machines have higher PD levels in 2009 than the newer ones due to long-term thermal aging.
- Machines from manufacturer F have higher PD activity than everyone else.

For Hydros 13-15kV, there appears to be an overall industry trend that newer windings have lower PD levels than older ones, which implies that in general the manufacturing and design process of newer machines is good while the older machines have some signs of thermal or mechanical aging. For Turbos 13-15kV, there appears to be little difference in the PD levels between older machines and newer machines, which suggests that the older machines were well made and are well maintained, or that the newer windings are not as well made or maintained. For Motors 6-8kV and Motors 13-15kV, new windings manufactured since 2006 tend to have higher PD levels than motors made in the previous decade. The reason for this has not been examined, but it has been speculated that smaller frames are being used for higher power output, and therefore spacing in the endwinding may be an issue and the operating temperatures are higher.

For each category, there are 1 to 3 manufacturers for whom the PD levels of their machines are higher than the typical levels for all machines.

New Continuous On-Line Monitor to Detect Rotor Winding Shorted Turns Successfully Commissioned

by Pablo Rojas

Recently our Field Service specialists participated in the commissioning of several FluxTrac//S™ monitors for a power producer in South Asia in a pump-storage hydro facility. This constitutes a key event in the expansion of the rotor flux monitoring products of Qualitrol-Iris Power. We have been offering the RFA//™ line of portable instruments for periodic rotor flux monitoring to detect rotor shorted turns in synchronous machines. The RFA// instruments revolutionized flux testing by reducing the need to change load for preliminary analysis, thanks to the use of specialized algorithms and higher resolution. The RFA// instruments also incorporate an input for a sync sensor (once-per-revolution signal) to locate eventual shorted turns relative to the position of a machine shaft marker. Qualitrol-Iris Power also introduced the TFProbe™ to measure total flux. The TFProbe is glued to a core tooth (instead of screwed in a wedge as done with traditional leakage flux probes). The new flux continuous monitors fill a gap in our flux products scope, and are totally compatible with the RFA// instruments, TFProbes, as well as conventional flux probes.

The first generation of HydroFluxTrac continuous on-line monitors saved users the travel time to remote plants to take flux measurements during unit run-ups, made the data available over LAN/WAN, and allowed automated flux data recorded at the correct unit load for optimal analysis conditions, and enabled integration with plant monitoring and other machine diagnostic monitoring systems. These first HydroFluxTrac monitors acted as flow data collectors, and the resulting flux data had to be analyzed by experts.

The FluxTrac// monitors for both turbine generators and hydro generators are second generation instruments that, in addition to the advantages from the first generation, have built-in analyzing algorithms already used with the RFA// instruments so that, once a shorted turn is detected, an alert relay is activated. The relay contact can be wired to a digital input of a control system or alarm panel. The FluxTrac// monitors are installed permanently and will work stand-alone, i.e. they do not need to be connected to a computer to work. FluxTrac// can separately measure and trend the flux readings for pump and generator mode. Furthermore, they incorporate an Ethernet port for a LAN, and Modbus TCP/IP protocol for communication with third party software for displaying, trending and alerting. In addition, the flux data can be locally downloaded to a computer for further analysis with the RotorFluxPro™ software used with the RFA// instruments.

The FluxTrac// monitors have inputs for TFProbes and sync sensors, and they can use signals from traditional leakage flux sensors. There are two types: FluxTrac//S monitors for salient pole machines (such as most hydrogenerators, usually with 6 or more poles), and FluxTrac//R monitors for round rotor machines (such as most turbo generators, usually with 2 or 4 poles). Each FluxTrac// monitor can be used with one machine and optionally up to a total of four machines.

The FluxTrac// monitors are ideal for those users who want to save the cost of periodic services for flux data collection and reports. The FluxTrac// monitors are necessary for integration with plant monitoring and other diagnostic monitoring systems. Rotor shorted turn detection is important because shorted turns indicate insulation failure in the rotor, may limit machine output, and can lead to thermal unbalance and mechanical vibrations since slots with shorted coils run cooler. For additional information, contact your Qualitrol-Iris Power sales representative.



Installation of the FluxTrac//S (right side) as well as the HydroGuard PD monitoring system in a hydrogenerator plant in South Asia.

UPCOMING EVENTS

14th Iris Rotating Machine Conference - 2011

June 20 - 23, 2011

Sheraton Gunter Hotel, San Antonio, Texas

1st Regional Iris Conference

there will be training opportunities as well as state-of-the-art presentations in the areas of rotating machines, switchgear and transformers

February 6 - 8, 2011

Dubai, United Arab Emirates

TRAINING COURSES

Turbogenerator & Motor Maintenance Course
November 2-4, 2010, Houston, Texas, USA

Partial Discharge Course
November 16 - 18, 2010, Houston, Texas, USA

for more information contact:
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