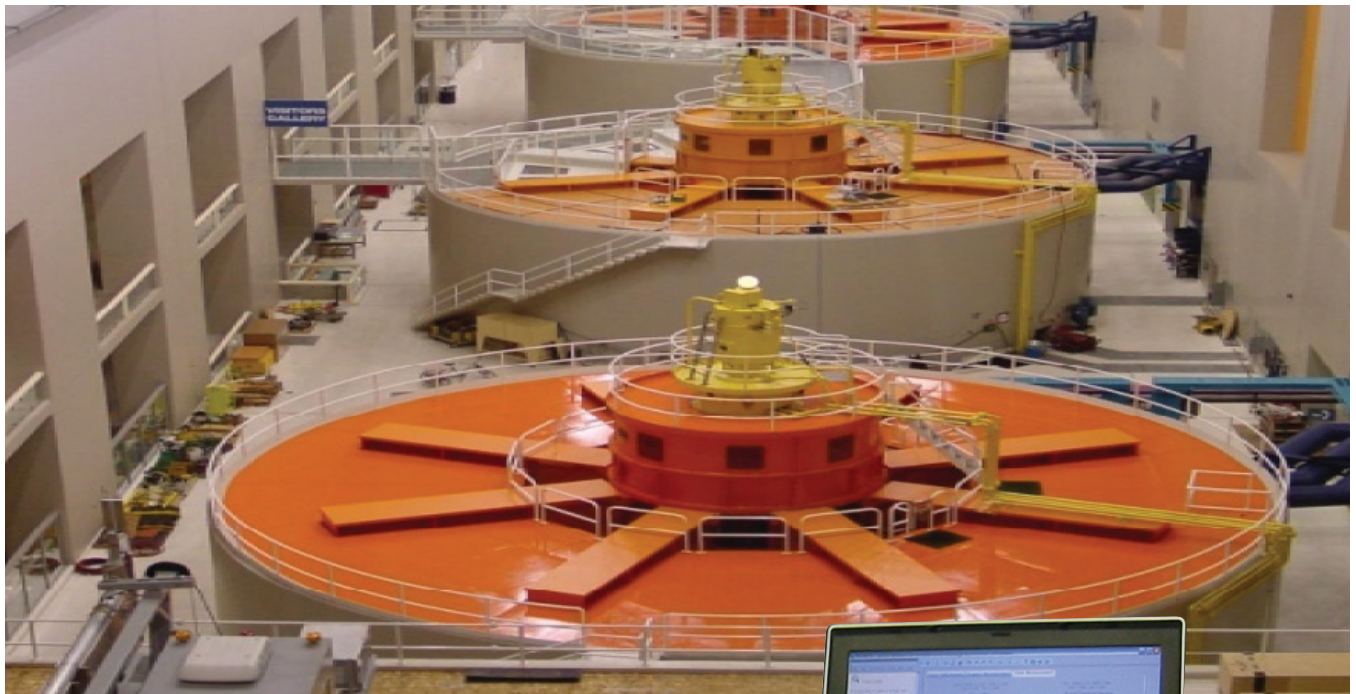


Iris Power PDA-IV™

Periodic On-line Partial Discharge Monitoring Using a Portable Instrument for Hydro Generators



A USER'S PERSPECTIVE:

"By combining on-line monitoring and a diminished schedule of off-line testing, the utility has switched from time-based to a condition-based procedure for allocating resources for testing and maintenance..., the maintenance staff can discern more thoroughly the condition of the insulation and what, if any, repairs or changes in operating procedures need to be done to increase the lifespan of the unit."

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PERIODIC ON-LINE PARTIAL DISCHARGE MONITORING OF HYDRO GENERATORS

The test enables predictive maintenance on hydro generator stator windings, resulting in the increased availability and extension of operating life. The technique was introduced more than three decades ago and has since been used on over 5000 hydro generators to identify deteriorated stator windings.

The method is non-destructive and based on proven scientific and empirical principles and is recommended by manufacturers and industry standards such as the IEEE Std. 1434-2000.

The monitoring technique is based on the application of 80pF capacitive couplers, resulting in a high frequency measurement range and a favorable signal-to-

noise ratio. This enables the automatic separation and recording of both partial discharges and noise, so that test results can be easily interpreted by users. The most common method of monitoring hydro generators involves using an Iris Power PDA-IV portable instrument with multiple sets of permanently installed capacitive couplers. The instrument is controlled by means of a computer and includes Windows™-based control and data display software.

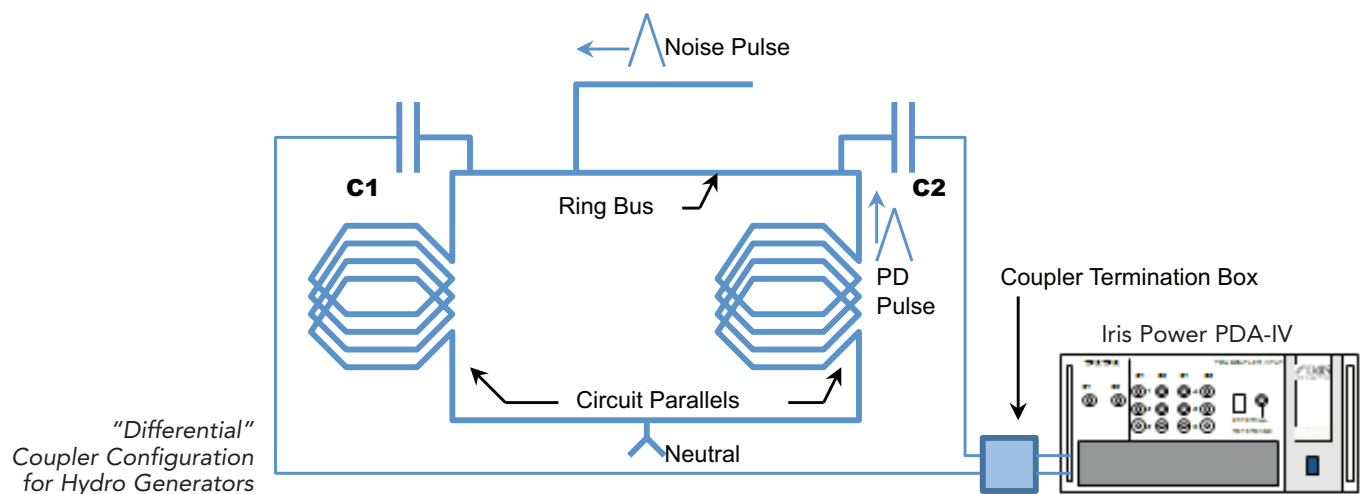
Alternatively, continuous monitoring systems are available from Qualitrol-Iris Power. They can be integrated with plant SCADA and facilitate remote monitoring.

HOW THE IRIS POWER PDA-IV INSTRUMENT MEASURES AND ANALYZES PARTIAL DISCHARGES

The Iris Power PDA-IV test has been designed to monitor partial discharges during normal generator operation, i.e. under normal electrical, mechanical, thermal and environmental operating stresses. The readings are not affected by external interference (or noise) such as power system corona, output bus arcing or other common noise sources. The tests are typically performed semi-annually and take about 30 minutes per generator.

HYDRO GENERATOR TESTING

The 80pF capacitors block the 50/60Hz power frequency voltage allowing high frequency fast rise-time voltage pulses (which are caused by partial discharges in the winding) to pass through. Couplers are normally installed in a "differential" configuration. For example, in a winding with two parallel circuits per phase, two couplers are installed, one on each parallel, as shown in the diagram below. The lengths of the coaxial cables between the couplers and the termination box are trimmed so that noise pulses originating outside the machine arrive at the two instrument inputs simultaneously. Partial discharge pulses originating in the winding arrive at the two instrument inputs at different times. Consequently, the system can digitally distinguish between noise and winding partial discharge.



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IRIS POWER PDA-IV TEST PROCEDURE

With the generator operating under normal service conditions, the operator connects the Iris Power PDA-IV instrument to a coupler termination box and to a portable computer running the Iris Power software. The magnitude, phase position and number of partial discharge pulses detected at each coupler are then recorded and can be viewed immediately, or stored for a subsequent analysis. The results presented to the user include:

- graphs depicting the nature and severity of particular insulation aging mechanisms
- trend curves highlighting the progression of these mechanisms over time
- statistical values which can be compared with historical databases for similar generators.

In most cases, the assessment of the condition of the stator winding insulation, based on the on-line partial discharge measurement, can be performed independently by the user after a short training course. Qualitrol-Iris Power can also assist the user with result interpretation using its unique database of over 225,000 results, collected over 20 years on generators of all makes and sizes.

IRIS POWER PDA CAPACITIVE COUPLERS

The Iris Power PDA-IV instrument is used in conjunction with 80pF, high voltage capacitors, permanently installed at specific locations on the stator winding. Iris Power supplies the compact capacitive couplers made of high quality mica splittings, encapsulated in a specifically formulated epoxy compound. These are certified to be discharge free at twice the operating voltage and are resistant to surface electrical tracking.



Installed Iris Power PDA couplers within a hydro generator

PLANNING PREDICTIVE MAINTENANCE USING ON-LINE PARTIAL DISCHARGE MONITORING

Stator winding insulation problems occur in 40% of all hydro generators and are one of the principal causes of forced outages, which result in lost revenues. On-line partial discharge (PD) monitoring, a proven technique developed by Ontario Hydro and the Canadian Electrical Association in the late 1970s, helps to minimize the risks of unexpected stator winding failure. Using permanently installed couplers and a portable instrument (the Iris Power PDA-IV), utility plant personnel worldwide have found this method reliable and easy to use.

In its 30-year history, the on-line partial discharge test has produced results on thousands of hydro generators. Published case studies by dozens of PDA test users have confirmed the following benefits:

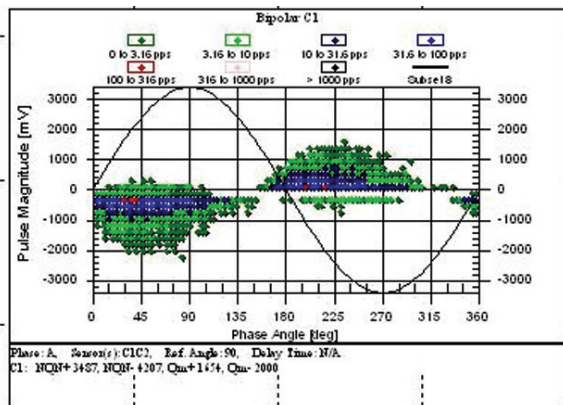
- the root causes of stator problems can be identified and often repaired at an earlier stage.
- the monitoring can increase the availability of generators, and can contribute to the extension of the useful life of the unit stator winding

- intervals between generator inspection outages can be increased, if the PDA results are good
- most stator winding in-service failures can be avoided
- there is an exceptionally low rate of false indications
- clear levels at which machines need maintenance have been established
- can be applied to existing and new hydro generators.

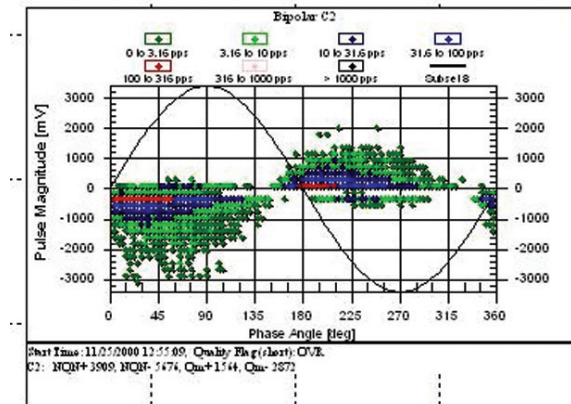
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DETECTION OF PARTIAL DISCHARGES

Partial discharges in degrading high voltage stator windings give rise to small voltage pulses which travel through the stator winding. The magnitude and number of these pulses depends on the degree of insulation deterioration. That is, as the magnitude and number of partial discharge voltage pulses increase, the rate of the electrical insulation deterioration must also be increasing. The partial discharge signals are often mixed with electrical noise from sources such as corona and output bus arcing, but are separated for analysis by the Iris Power PDA-IV instrument.



PD in Parallel C1



PD in Parallel C2

WORLDWIDE INDUSTRY ACCEPTANCE OF ON-LINE PD MONITORING

The PDA partial discharge test has won worldwide acceptance with all major utilities. This general acceptance has been achieved because:

- the test has been proven effective in thousands of installations, by identifying hydro generators which require maintenance
- the test equipment is cost-effective
- the test is performed on-line and requires no generator shut-down
- generator station staff can perform the test and interpret the results with minimal training.

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Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

QUALITROL-IRIS POWER HAS BEEN THE WORLD LEADER IN MOTOR AND GENERATOR WINDING DIAGNOSTICS SINCE 1990, PROVIDING A FULL LINE OF ON-LINE AND OFF-LINE TOOLS, AS WELL AS COMMISSIONING AND CONSULTING SERVICES.



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www.irispower.com

www.qualitrolcorp.com

Iris Power LP
3110 American Drive
Mississauga, ON, Canada L4V 1T2
Phone: 1-905-677-4824
Fax: 1-905-677-8498
sales.iris@qualitrolcorp.com

Qualitrol Company LLC
1385 Fairport Road
Fairport, NY, USA 14450
Phone (585) 586-1515
Fax (585) 377-0220



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