

IRIS POWER

PDA-IV

Periodic Online Partial Discharge
Monitoring Instrument for Hydro
Generators.



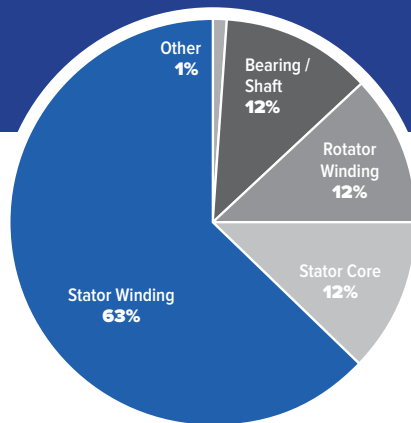


We have not found another test method that produces as much decision support data for generator stator maintenance planning based on actual in-service insulation condition... Analysts were able to recommend the needed corrective maintenance before the maintenance outages began.



Partial Discharge Is A Leading Symptom Of Failures On Generator Stator Windings

Insulation problems are one of the principal causes of forced outages for generators, motors switchgear and dry type transformers which result in considerable damage and lost revenues. Periodic online monitoring of partial discharge provides a cost effective and proven technique to minimize the risk of unexpected failures.



FAILURE MECHANISMS FOR GENERATORS

Allianz insurance, Survey 1996-1999
VDE Colloquium, June 28, 2001

Avoid In Service Failures With Early Detection Of Failure Mechanisms

Partial Discharge monitoring has become an important tool for condition based maintenance on generators by identifying risks of failure caused by abrasion of insulation, loose stator windings, thermal degradation of insulation and manufacturing defects.

Iris Power online partial discharge monitoring instruments have accurately identified problems on many hundreds of generators with hundreds of case studies and dozens of published papers by Iris Power customers that confirm Iris Power partial discharge monitoring instruments can help:

- Prioritize assets needing immediate maintenance
- Identify and repair damage at an earlier stage
- Avoid in-service failures
- Reduce outage frequency when results are good
- Obtain information regarding the type and location of maintenance required prior to outages
- Reduce overall cost of maintenance

Global Acceptance Of Online Partial Discharge Monitoring

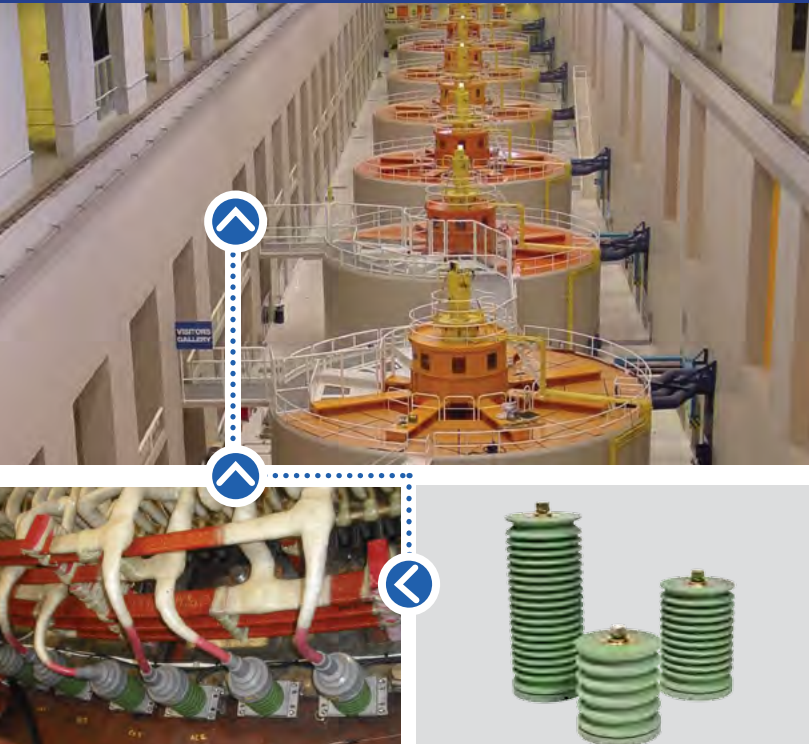
Partial discharges in degrading high voltage stator windings give rise to small voltage pulses which travel through the stator winding. The magnitude and number of these pulses depends on the degree of insulation deterioration. As the magnitude and number of partial discharge voltage pulses increase, the rate of electrical insulation deterioration is also increasing.

Partial Discharge monitoring has won worldwide acceptance across utilities, major industrial companies and manufacturers. Iris Power has provided products for partial discharge monitoring on over 16,000 assets globally in addition to partial discharge monitoring being recommended in industry standards such as IEEE Standard 1434-2014 and IEC TS 60034-27-2:2012.

Development Of Iris Power Partial Discharge Monitoring

The development of Iris Power partial discharge test instruments in the 1990s was funded by the North American utility industry (CEA and EPRI) to provide machine owners a method of detecting stator insulation problems and obtaining adequate data to make maintenance decisions independent of equipment manufacturers.

The PDA-IV was designed specifically for monitoring partial discharges under normal electrical, mechanical and thermal machine operating stresses without interference from external noise such as power system corona, output bus arcing or other common electrical disturbances. There are now over 65,000 Iris Power partial discharge Epoxy Mica Capacitive Sensors installed across thousands of motors, generators and metal glad switchgear globally that are monitored by Iris Power portable and continuous monitoring instruments.



Sensor Installation and Configuration

Iris Power Epoxy Mica Capacitors (EMCs) are 80pF capacitors that are used to block high voltage output from the generator since impedance is inversely proportional to frequency. The 60 Hz or 50 Hz power frequency is filtered with 100's M Ω impedance while the high frequency partial discharge pulses up to 250 MHz easily pass through the EMC with only 10's Ω impedance. This allows us to see small partial discharge pulse of under 100 mV on rotating machines rated over 4kV.

Typically, Iris Power installs two 80pF epoxy mica capacitive couplers per phase. The lengths of coaxial cables between the couplers and termination box are trimmed so 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 allowing the PDA-IV to distinguish between noise and winding partial discharge.

For larger hydro generators with more than two parallels per phase, it is possible to have a coupler on each parallel for improved resolution into the source and location of partial discharges within the stator winding.

EPOXY MICA CAPACITORS INSTALLED ON A HYDRO GENERATOR WINDING

EPOXY MICA CAPACITORS (80PF)

Data Collection Method

- The online partial discharge test takes less than 30 minutes per machine with data collected in a simple, safe and non-destructive manner based on sound principles that are recommended by manufacturers and industry standards such as IEEE Std. 1434-2014 and IEC60034-27-2: 2012.
- The operator connects low voltage coaxial cable from the Iris Power PDA-IV portable instrument to a coupler termination box. The PDA-IV instrument is then connected to a control computer that runs the PDLite Pro and PDView software using a USB or Ethernet cable.
- The test is initiated through the PDLite Pro software which automatically collects the partial discharge data while the machine is running and without any interference to normal operation of the generator.



TERMINATION BOX



CONTROL COMPUTER INSTALLED WITH PDLITEPRO & PDVIEW

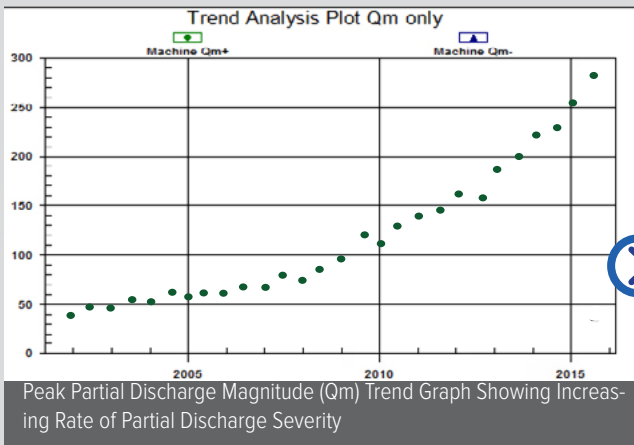


IRIS POWER PDA-IV

Data Analysis and Information Outputs

Iris Power is foremost focused on providing a clear, reliable and repeatable result that allows the user to understand the true condition of the generator and make educated decisions on operations and maintenance. The PDA-IV instrument has been designed to automatically collect partial discharge data and output the relevant information needed to provide a decisive means of:

- › Identifying Partial Discharge Severity
- › Identifying Probable Causes of Winding Deterioration
- › Comparing Relative Health Across Machines

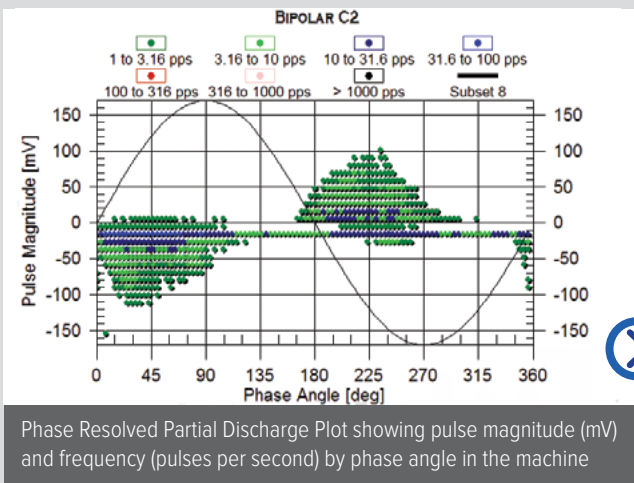


Peak Partial Discharge Magnitude

Peak pulse magnitude (Qm) values are automatically calculated by the PDA-IV instrument and output to help understand the relative health of each asset. The Qm value is defined in IEEE 1434 and IEC 60032-27-2 to allow several means of comparison including the following:

Trending of Qm to show any major change in the rate deterioration of the stator winding insulation.

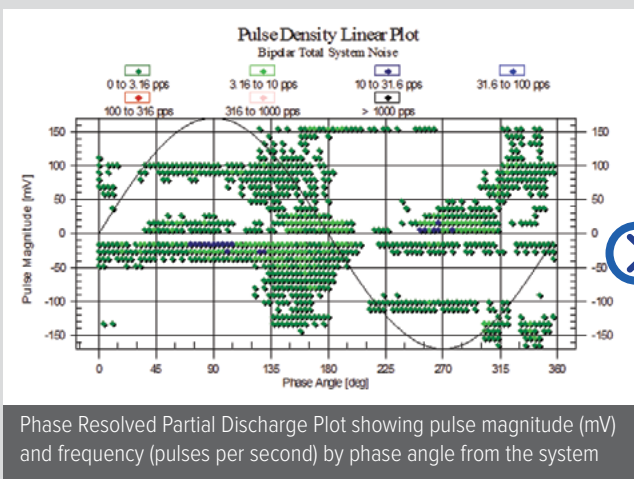
Comparison of generator condition against similar machines using the freely available Iris Partial Discharge Severity Tables which are composed of over 550,000 test results collected across most makes and sizes of machines.



Machine Partial Discharge

Electrical disturbances including partial discharges in the transmission lines (corona) or transformer as well as sparking of overhead cranes or onsite welding can create pulses similar to partial discharges. It is important to be able to understand the difference between system noise and machine partial discharges to avoid false positive indications, to prevent unnecessary shut-downs and to avoid in-service failures.

The Iris Power PDA-IV is designed specifically for Hydro Generators and ensures generator partial discharges are viewed and analyzed separately from system noises.



Separation of System Noise

Installation of two couplers per phase allows the PDA-IV instrument to automatically distinguish between power system noise by evaluating pulse shape and the time of arrival of pulses.

Pulses originating outside the generator which arrive to the instrument through each of the sensors at the same time and are automatically separated and classified as disturbances.

Other pulses that are classified as machine partial discharges and are attributed to the sensors are associated region of the generator covered by the sensor that detects the pulse first.

Product Overview

The Iris Power PDA-IV instrument provides the most reliable and accurate portable partial discharge monitoring solution on the market and is designed specifically for Hydro Generators.

- Advanced noise separation based on pulse shape and time of arrival methods to consistently quantify and isolate partial discharges from system disturbances.
- Test frequency range from 40 MHz to 350MHz while working with 80 pF Epoxy Mica Capacitors (EMCs) and from 2 MHz to 350MHz with 1 - 2 nF capacitors.
- Optional capability for offline partial discharge testing of individual stator bars, coils and windings.
- Ability to operate instrument from 12V battery pack



Partial Discharge Pulse Measurement

Frequency Bandwidth	0.1 MHz - 350 MHz
Phase Windows	100 phase windows per cycle
Pulse Amplitude Range	2 mV - 34,000 mV 10 Sensitivity Range Settings
Data Acquisition Time	5s per magnitude window
Resolution	6ns for EMS Sensor
Ambient Sensors	Ambient Temperature Sensor Ambient Humidity Sensor
Sensor Compatibility	80 pF EMC (6.9kV to 35 kV) 12 Sensor Inputs

Operating Conditions

Operating Temperature	-15°C to 45°C (5°F to 113°F)
Relative Humidity	Up to 95% non-condensing

Accessories Included

Power Supply Cord	1.8m (6 ft)
Power Supply Adapter	Input: 100-240 VAC, 1.5A, 50-60Hz Output: 12 VDC, 5A
Ethernet Cable	3m (10ft) CAT-5
AC Reference Cable	1.8m (6ft) Shrouded Plug
USB Cable	1.5m (5ft)
Impact Resistant Case	41 cm x 31 cm x 21 cm (WxDxH) 16" x 12" x 8" (WxDxH) 10 kg (22 lbs)

Software & Manual

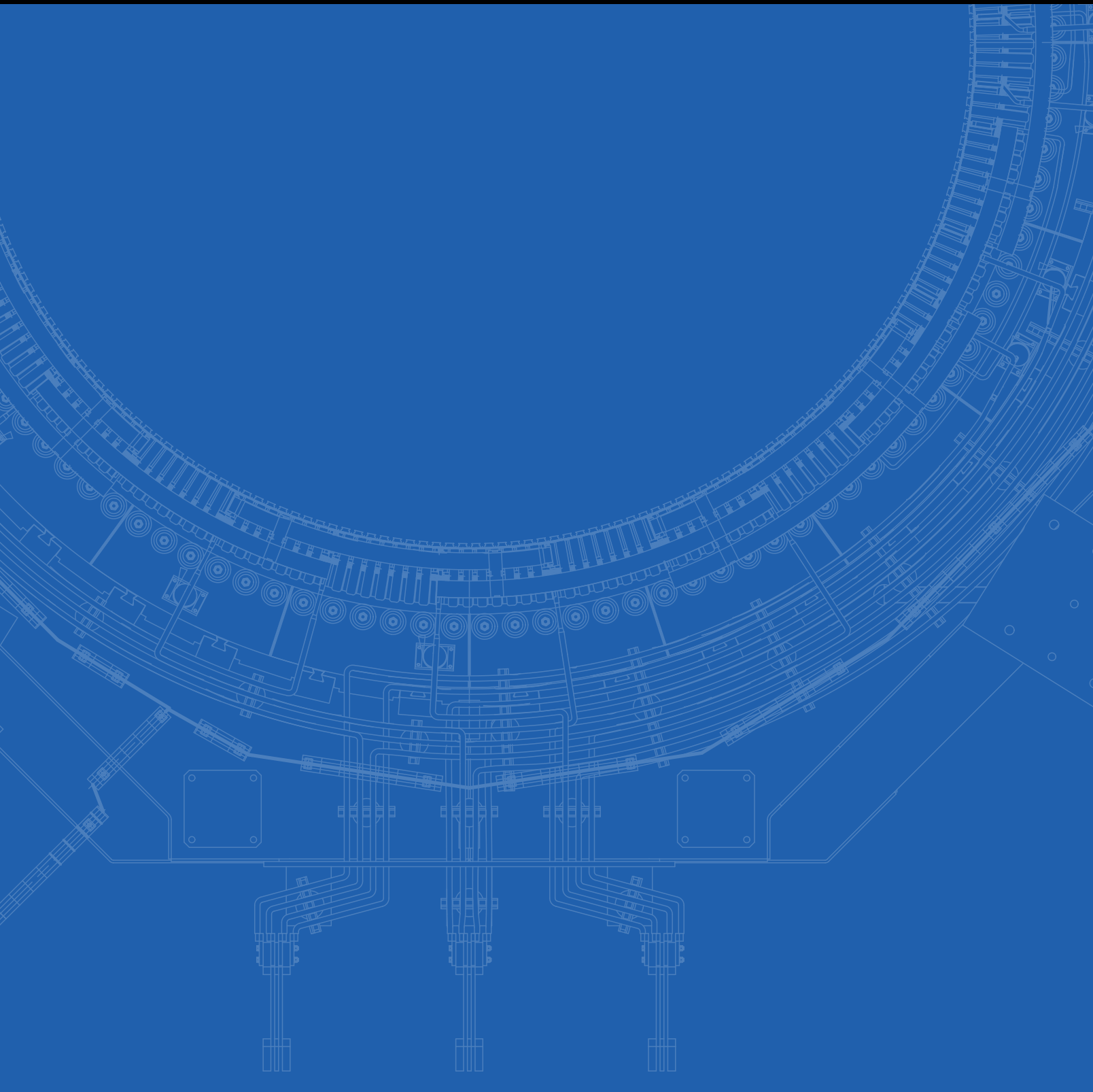
PDLITEPRO	Included
PDVIEW Standard Edition	Included
PDVIEW Advanced Edition	Optional
User & Installation Manuals	Included

Testing And Certification

Vibration Test	IEC 60068-26
Shock Test	IEC 60068-2-27
Transit Vibration	MIL-STD 810G, Method 514
Electrical	CE, UL

Options

Controlling Computer	Details Available On Request
Sensor Compatibility	Stator Slot Coupler (TGA-SP) BUS Couplers (TGA-BP)
VFD Motor Operation	20 Hz - 100 Hz Reference Circuit Capacitive Divider (TGA-BP)
Low Frequency Test	Offline Testing 80pF EMC 25kV or 28 kV 50 kHz- 5 MHz



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