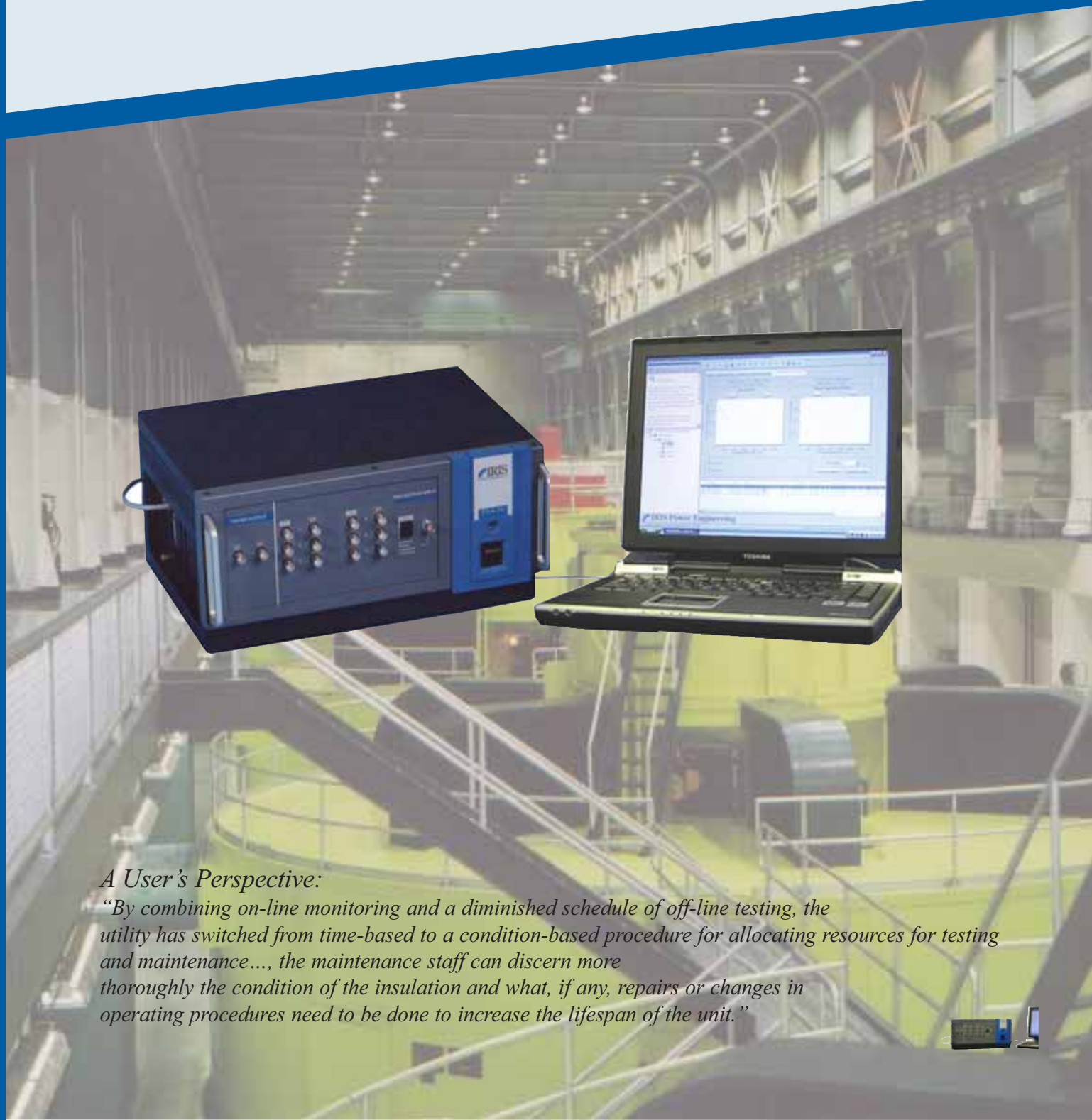
HYDROGENERATORS

IRIS POWER

Periodic On-line Partial Discharge Monitoring of Hydrogenerators



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."

PDA-IV™

PERIODIC ON-LINE PARTIAL DISCHARGE MONITORING OF HYDROGENERATORS

PDA-IV: The Standard for On-Line Partial Discharge Monitoring

- 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 two decades ago and has since been used on over 2000 hydrogenerators to identify deteriorated stator windings.
- The method is non-destructive and based on sound scientific and empirical principles.
- 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 (S/N) ratio. This enables the automatic separation and recording of both partial discharges and noise, so that test results can be easily interpreted.

The most common method of monitoring hydro-generators involves using a 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 Iris. They can be integrated with plant SCADA and facilitate remote monitoring.

HOW THE PDA-IV MEASURES AND ANALYSES PARTIAL DISCHARGES

The 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.

PDA COUPLERS

The PDA-IV instrument is used in conjunction with the 80pF, high voltage capacitors, permanently installed at specific locations on the stator winding. Normally, Iris supplies the compact capacitive couplers made of high quality mica, encapsulated in a specifically formulated epoxy compound. These are certified to be discharge free at twice the operating voltage and are resistant to surface tracking. Each coupler is delivered with an individual test certificate confirming that it has exceeded the requirements of IEEE/ANSI C37.20.2.

If required, Iris can also supply the “cable-type” 80pF couplers, commonly used prior to the late 80s.

PDA Couplers

PERIODIC ON-LINE PARTIAL DISCHARGE MONITORING

Hydrogenerator 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 on each phase as shown in Figure 1. The lengths of 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 automatically distinguish between noise and winding partial discharge.

THE PDA-IV TEST PROCEDURE

With the generator operating under normal service conditions, the operator connects the PDA-IV instrument to a coupler termination box and to a portable computer running the Iris 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. Iris can also assist the user with result inter-pretation using its unique database of over 20,000 results, collected over a decade on generators of all makes and sizes.

“Differential” Coupler Configuration For Hydrogenerators

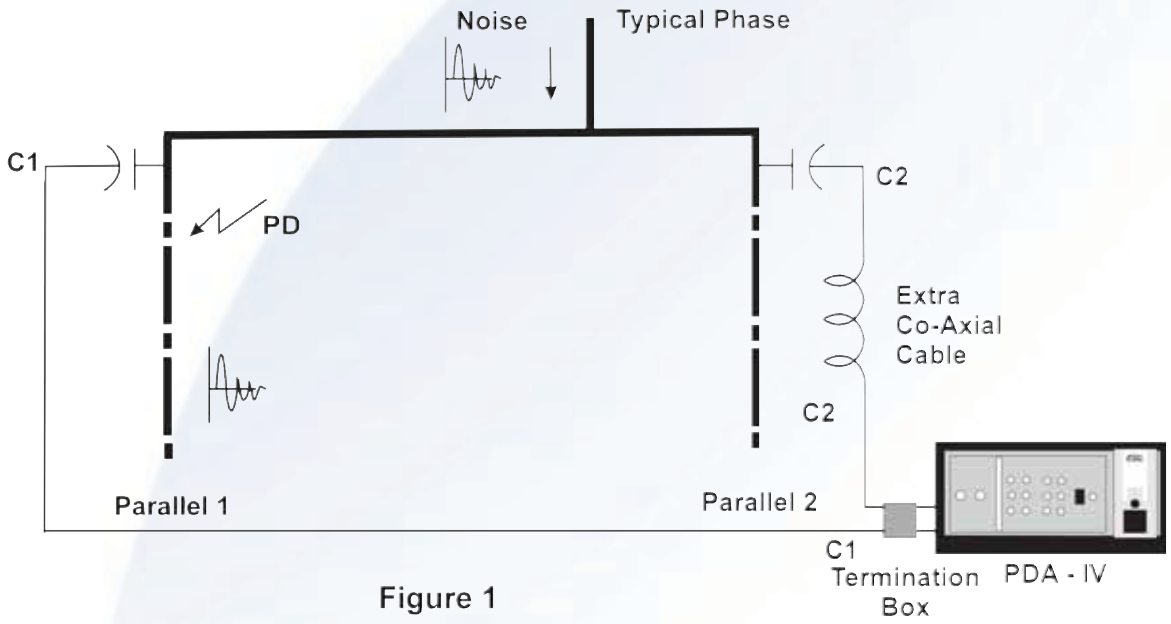
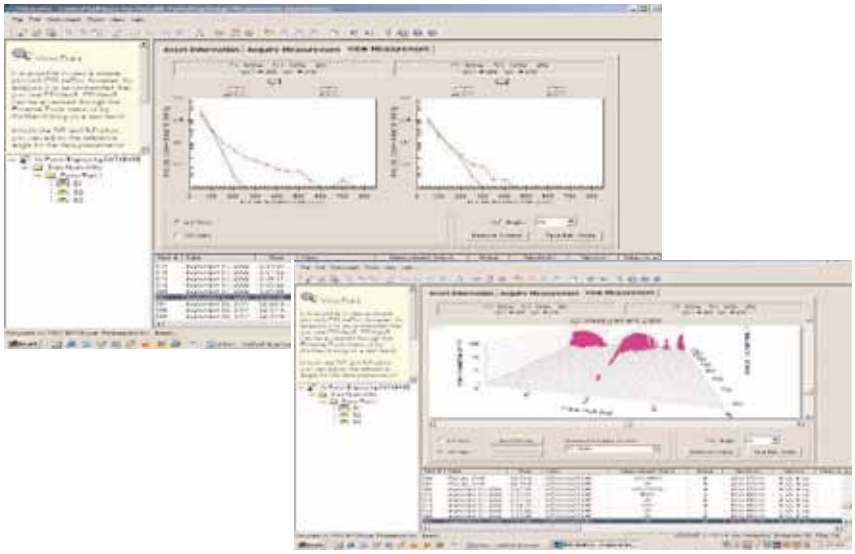


Figure 1

Planning Predictive Maintenance
Using On-Line Partial Discharge Monitoring



Stator winding insulation problems occur in 40% of all hydrogenerators and are one of the principal causes of forced outages, which result in lost revenues. On-line partial discharge monitoring, a proven technique developed by Ontario Hydro and the Canadian Electrical Association in the late 70s, helps to minimize the risks of unexpected stator winding failure. Using permanently installed couplers and a portable instrument, utility plant personnel worldwide have found this method reliable and easy to use.

In its 20-year history, the on-line partial discharge test has produced results on thousands of hydrogenerators. 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 windings.
- Intervals between generator inspection outages can be increased if the PDA results are good.
- Most stator winding in-service failures can be avoided.

THE 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 PDA-IV instrument.

WORLDWIDE INDUSTRY ACCEPTANCE OF ON-LINE PD MONITORING

The 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 hydrogenerators 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 with minimal training.

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