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NYPA Improves Hydrogenerator Reliability and Reduces O&M Costs With HydroTrac Continuous Partial Discharge Monitoring System

Hydropower Operations and Asset Management Target

"HydroTrac will allow NYPA to more effectively monitor the stator winding condition of our all units, plan maintenance, and reduce forced outages."

- Michael Christensen
- Robin McLaughlin
- Misak K. Krikorian
- Brent Whitcomb
- Alan Zelinski

New York Power Authority

Benefits

- **The HydroTrac on-line partial discharge (PD) monitoring system will save NYPA approximately $3,850,000 over 10 years in rewind deferrals, O&M cost savings, and preventing catastrophic failures.**
- **Continuous on-line tracking of PD activity will help engineers determine the rate of insulation degradation and, in many cases, the particular type of failure mechanism.**
- **Early warning of insulation deterioration will allow convenient scheduling of repairs with minimal outages, and restoration of windings to nearly new condition.**
- **Identifying older machines with stator windings in good condition helps NYPA avoid premature rewinding.**
- **Linking PD data with other process data in an expert diagnostic system will allow NYPA to reliably operate the St. Lawrence FDR units.**

Challenge

The reliability of hydroelectric generators is tied to the condition of the stator winding insulation. About 40% of all hydrogenerator outages are caused by the failure of stator winding insulation. For that reason, a large percentage of the testing and maintenance costs at a hydro plant are devoted to assessing the condition of the stator winding and performing repairs or rewinds when the risk of failure is high.

As stator winding deteriorates, tiny electrical sparks occur in the insulation. These sparks (called partial discharges or PD pulses) result from high-voltage breakdown of air pockets or voids in the insulation. By measuring and tracking the PD activity over several years, plant engineers can determine the rate of insulation degradation and schedule preventive maintenance and/or repairs, thus avoiding catastrophic and costly in-service machine failures.

Since the mid-1970s, the primary tool for performing this measurement has been the partial discharge analyzer (PDA) test. To perform PDA tests, high-voltage sensors are permanently installed in the stator winding. At intervals (e.g., every six months or so), a portable instrument—the PDA—is brought to each hydrogenerator and temporarily connected to the sensors to take readings.

NYPA recognized that periodic PDA testing has its limitations and that automated, continuous PD monitoring was needed. For example, partial discharge is often affected by operating conditions such as winding temperature, load, and voltage. To obtain accurate PD trend data, many measurements must be taken at various times under similar operating conditions. If these conditions are not the same from test to test, the trend data may be in error, leading to false conclusions on the condition of the winding. In pumped-storage

plants, performing the PDA test under the same operating conditions is particularly difficult since the load may frequently change. Thus the cost and resources necessary for reliable PD testing using portable instrumentation can be significant.

Response

Although partial discharge testing has been used for many years, NYPA has taken the technology to a new level by pioneering the development and application of automated PD data acquisition system called HydroTrac. Developed in collaboration with NYPA, EPRI, and Iris Power Engineering, HydroTrac offers a more cost-effective and less labor-intensive approach to PD testing than traditional portable instrumentation.

HydroTrac has revolutionized PD testing by providing affordable, on-line information on the condition of the generator stator winding. The system continuously monitors generator operating conditions and takes PD measurements when the desired operating conditions occur. These measurements give maintenance personnel compatible trend data to assess the stator condition. The main key parameters used are Qm and NQN for each PDA coupler used.

NYPA installed and extensively field-tested a prototype HydroTrac system at its St. Lawrence Franklin Delano Roosevelt (FDR) power project. Based on the prototype's successful performance on one hydro unit, NYPA has installed HydroTrac on all 16 units at its St. Lawrence FDR power project and is currently planning for the installation of HydroTrac on all units at its Niagara power project. The plan is to integrate the HydroTrac instruments with other process data in an expert diagnostic system.

HydroTrac has been licensed to and is now available as a commercial product from Iris Power Engineering. HydroTrac received the R&D 100 Award from *R&D Magazine* for being one of the most technologically significant products of 2001.

EPRI Perspective

Hydroelectric units are being called upon to provide a wider range of services in a time-sensitive and competitive environment. Reliable and fast-starting hydro units can provide ancillary services, peaking power, or standby power. HydroTrac provides information that enables hydrogenerator operators to assess stator winding conditions and make decisions that meet both technical and business needs.

Typical stator winding problems that can be detected via PD monitoring include thermal deterioration, problems caused by load cycling, loose windings, electrical slot discharge, improper impregnation of insulation, contamination in endwindings, inadequate spacing, and endwinding vibration. Tracking PD activity as a function of generator operating conditions helps engineers differentiate among these failure processes and determine what type of maintenance is required. Moreover, such information enables hydrogenerator owner/operators to plan maintenance when, and only when, it is required. With decreasing maintenance budgets and staffing levels in plants, the ability to predict a deteriorating winding and take corrective action should reduce overall maintenance costs and the likelihood of a costly forced outage and loss of revenue-generating production.

Calculated Benefits of NYPA's Application

Total Net Savings (10 Years)	$3,850,000

Basis for Benefits

- St. Lawrence FDR Project: 16 units of 60 MW each.
- Total generating capacity of 960 MW.

The savings breakdown is as follows:

- Rewinding deferral of three years with total savings of $2,400,000.
- Preventing one catastrophic failure over 10 years with an estimated savings of $1,107,000.
- O&M savings associated with automation of the data acquisition and interpretation of results of $578,000.
- Total development cost of $226,000.

Total net savings of approximately $3,850,000 over next 10 years in rewind deferrals, O&M, and prevention of catastrophic failures.

References

- D.L. Evans, "IEEE Working Group Report of Problems with Hydrogenerator Thermoset Stator Windings: Part 1", IEEE Trans PAS-100, July 1981, p 3284.
- HydroTrac: Continuous Partial Discharge Monitor for Hydrogenerators. EPRI TR-114841, March 2000.
- Tailored collaboration opportunity: Field testing of continuous hydrogenerator partial discharge monitor.

Products are available from EPRI Customer Service at 1.800.313.3774 (press 2).

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Interest Categories

- Hydropower operations and asset management
- Plant maintenance & life management

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