TIP 343: Enhancing Hydropower Reliability through Cavitation Monitoring and Noise Condition Assessment

Context

The project expands on many similar previous projects that have often been limited in scope. Specifically regarding the prediction of cavitation-erosion, past projects often had limited scopes with simplified instrumentation and did not consider cavitation-erosion model calibration based on data acquired over long time periods. This project thus expands on previous work and is the next logical step regarding cavitation-erosion monitoring, i.e. the use of long term data acquisition for the derivation of reliable and robust models and monitoring techniques.

Regarding noise measurements for condition assessment, past projects have often been limited to single assessment campaigns. These campaigns were useful to demonstrate the sensitivity of noise measurements at several locations in hydro turbine-generator to vibration-inducing load-dependent phenomena. They did not however allow the evaluation of noise measurements as an effective monitoring and periodic condition assessment tool by investigating if such measurements can capture vibration evolutions with time, and thus help prevent sudden failures. This project addresses this shortcoming and thoroughly evaluates all relevant aspects regarding the incorporation of noise measurements in the condition assessment and monitoring toolbox.

Description

The project is focused on two areas; the development of an efficient cavitation monitoring method based on vibration and noise measurements, as well as the detailed investigation of the efficiency of ambient noise measurements as a condition assessment and monitoring method.

Specifically, the first focus area will provide the ability to evaluate in real time the potential cavitation-erosion of a given operating condition and thus help the unit operation decision. The second focus area will determine if ambient noise measurements can be used at several locations in hydro turbine-generator units as an efficient condition assessment and monitoring technique.

The project requires the testing and evaluation of condition assessment and monitoring techniques, specifically the use of ambient noise measurements as well as the characterization of cavitation with vibration and noise measurements within hydro turbine-generator units. The explored measurement techniques will be evaluated based 1) on their ability to capture load-dependent phenomena (e.g. variation of cavitation intensity with discharge or head) and 2) on their ability to capture time-dependent phenomena (e.g. the gradual increase of vibration intensity following gradual wearing of a bearing's journal).

A single large-scoped measurement campaign will be conducted to address the former, while the latter will be address by analyzing data generated by a monitoring system that will be developed and installed to perform continuous measurements. The findings will allow establishing the specifications for the realization of condition and monitoring assessments based on the investigated techniques.

Why It Matters

The implementation of an operational cavitation monitoring system demonstrator will allow extending the turbine-generator unit operating range to the limits of incipient erosive cavitation and serve as a guide for the operating team to avoid high cavitation-erosion potential operating conditions. Ultimately, if applied to several turbine-generator units and integrated in the operation system, this monitoring system could greatly increase the units' flexibility and reduce the number of cavitation repairs needed in the hydro projects with which BPA has commercial activities.

In addition to significantly reducing the costs for cavitation repair campaigns, the minimization of required cavitation repairs would result in maximum availability of hydropower units for BPA to meet its balancing reserves and customer power demand drivers.

Furthermore the thorough evaluation of noise measurements as part of condition assessments practices will be beneficial to BPA by promoting the quality and reliability of condition and diagnostic assessments carried out in hydro turbine- generator units. This would allow the operating range of not only the turbine, but several components at the turbine and generator levels to be precisely characterized and potentially extended, thus enhancing flexibility of the unit

Goals and Objectives

The specific objectives include the planning and realization of an extensive hydro site measurement campaign, the subsequent analysis of data, the design and operation of a monitoring system, which will gather data for more than one year, and the analysis of the data acquired during this time.

Deliverables

Following the successful completion of the project, an initial transfer from research to application could be realized in the short term. The data collection and analysis activities of the project's third and last year are expected to allow tuning the developed monitoring system, thus allowing an immediate operational integration in the hydro turbine- generator unit studied. The project will produce a series of reports detailing the final evaluation of the monitoring methods and giving recommendations regarding specifications for a permanent, operational monitoring system.

A final report describing the achievements, conclusions and lessons learned of the whole R&D project will be presented at the project closeout.

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Project Start Date: October 1, 2015

Project End Date: September 30, 2018

Reports & References

Links

Funding

Total Project Cost:	$1,055,000
BPA Share:	$517,000
BPA FY2016 Budget:	$192,000

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