



## TIP 413: Kaplan Oil-Less Turbine Testing & Specification Development

### Context

In 2014 the Columbia River Keepers brought a Clean Water Act lawsuit against the US Army Corps of Engineers (USCOE). One result of the lawsuit was the USCOE agreed to address the oil pollution seeping from dams on the Columbia and Snake Rivers. The lawsuit created greater public awareness, changes to environmental regulations, and improved monitoring and reporting. These requirements resulted in more forced outages associated with oil leaks from Kaplan turbines.

Once leaks are detected the turbines are forced out of service. Outages can be prolonged and costly. Research into developing Kaplan oil-less turbines may result in a solution for reducing forced outages, minimizing environmental impacts, providing more operational flexibility and may create a standard for future turbine specifications.

### Description

This project is multi phased with the final outcome being Kaplan turbines that use oil free bearings. The first phase, covered under this project is the development of a detailed test system including test stand and testing protocols, designed for accelerated life testing of oil free Kaplan turbine bushings and material life testing. This work was done through the following tasks:

#### *Task 1: Conceptual design*

Conceptual design was provided that overviews the mechanical and electrical design strategy and presents relevant analysis. This milestone was met when the BPA project manager approved the design concept.

#### *Task 2: Detailed test stand design and test protocols*

The milestone was met with the creation of mechanical and electrical drawing sets for the bushing testing system and material life testing. Test protocols have been drafted and are subject to revisions prior to testing as needed.

### Benefits

As more Kaplan oil leaks are detected, more forced outages occur which can be prolonged and costly in both lost generation and repair.

Eventually, Kaplan oil-less turbines could provide a solution for reducing forced outages, minimizing environmental impacts, and providing more operational flexibility. By providing an accurate and appropriate

testing system, this project helps create a standard for future turbine specifications.

The results of this project will ultimately lead to:

- Positioning the BPA and the USCOE to develop technology that ensures long term reliability of turbines and by default FCRPS reliability.

The eventual benefit of developing this testing system includes:

- Elimination of oil-leaks from Kaplan turbines and resulting environmental hazard.
- Elimination of outages related to Kaplan turbine oil-leaks.
- Ensuring BPA maintain flexibility (e.g. spinning reserves, operating range).

### Accomplishments

The project succeeded in developing a design for a test stand to use to test bearing design and materials that will lead to an oil-free Kaplan turbine. A successful test system enables testing confirmation of:

1. The reliability of the oil free bearings for turbine runners,
2. Adequate material pairings to achieve the reliability,
3. Development of specifications that guides future project replacements with Kaplan oil-less turbines.

### Deliverables

The preliminary deliverables for this project have been received. They included mechanical and electrical drawing sets that enabling the construction of a test stand and draft testing protocols. Once the test stand is completed the system will be used to produce:

- Confirmed test results on the durability of the Kaplan Oil-Less bushings and mating materials (combination of materials tested for durability).
- Establishment of appropriate design standards and guide specifications.

# TIP 413: Kaplan Oil-Less Turbine Testing & Specification Development

**Project Start:** August 2019  
**Project End:** September 2021

**For More Information Contact:**  
**Technology Innovation Office:**  
[TechnologyInnovation@bpa.gov](mailto:TechnologyInnovation@bpa.gov)

## Participating Organizations

Hydroelectric Design Center (HDC), US Army Corps of Engineers  
Pacific Northwest National Laboratory (PNNL)

## Conclusions

PNNL has completed design and plans & specifications for the test stand.

HDC has drafted the test protocol, which BPA and PNNL reviewed to assure the test stand design would accommodate the protocol. However, the protocol is still a working document and HDC is expected to make minor revisions as they move into testing this spring.

PNNL having established a lab facility and construction team, will continue work to build the test stand and sourcing the parts through early spring. The initial bushing test results are due in the May timeframe.

BPA will continue funding this work through the John Day turbine replacement project.

The designs for the oil-free Kaplan turbines (guide specifications) are in development at HDC and will be further informed by the bushing testing results. BPA could specify oil-free turbines at John Day, if the bushing test results confirm the feasibility and longevity of the bushings. It is expected that this guide spec development will save time later for John Day and will have application at other facilities.

## Next Steps

In summary, next steps include:

- Complete test stand build
- Perform bushing testing
- Complete guide specification development
- If test results are positive, specify oil-free Kaplans for John Day turbine replacements
- Future Kaplan turbine replacement projects would likely utilize oil-free Kaplans