U.S. DEPARTMENT OF ENERGY

HYDROPASSAGE
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Computational Model-Based Assessments of the Biological Performance of Hydropower Turbines

One of hydropower's most significant challenges is providing safe, timely, and cost-effective downstream fish passage.

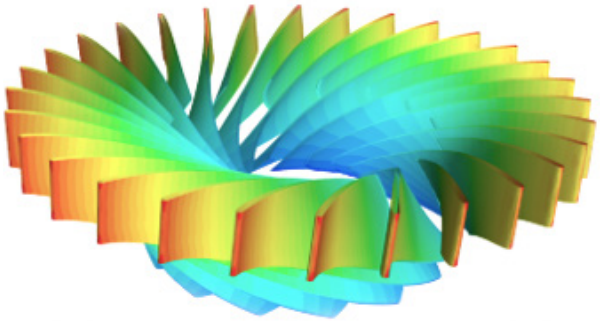
The HydroPASSAGE project builds on over 25 years of U.S. Department of Energy-supported basic and applied research aimed at understanding the impacts of hydropower on fish. This work has led to the development of hydropower turbines that have a much lower impact on fish. Some have nearly 99 percent fish passage survival predicted as demonstrated by the Ice Harbor Dam turbine replacement on the Snake River. HydroPASSAGE provides state-of-the-art toolsets for evaluating the impacts of different hydropower turbine designs and operation schemes for fish species of concern, including over 20 different fish species, such as American eel, Chinook salmon, and American shad.

Opportunities to Address Hydropower Challenges

HydroPASSAGE toolsets and technologies enable improved fish passage through better design and evaluation which are critical to supporting the development of new and refurbishment of existing hydropower facilities. HydroPASSAGE toolsets are currently being used by diverse stakeholders during the decision-making process when developing new turbines, refurbishing old turbines, or designing new structures at existing plants to improve fish survival.

Biological Performance Assessment

The Biological Performance Assessment (BioPA) toolset informs the design and operation of hydropower turbines by relating computational fluid dynamics (CFD) models of hydraulic conditions to fish biological response models.



BioPA Benefits

BioPA enables hydropower manufacturers and owners with CFD models of their turbines to assess the potential impacts to fish. It also estimates the relative risk of adverse effects that fish may experience during turbine passage, while also evaluating turbine designs and operations based on the following potential injury mechanisms to passing fish:

- ***Rapid decompression:*** *Damage to fish body tissues caused by a rapid decrease in pressure. These direct injuries to fish, known as barotrauma, include ruptured swim bladder and bubbles in the tissues.*
- ***Strike:*** *Direct impacts from collision with a turbine blade or structure that leads to injuries.*
- ***Shear:*** *Injuries occurring as fish pass through the interface of two water masses moving at different velocities or directions.*
- ***Turbulence:*** *Fluid motion distinguished by fluctuating changes in pressure and flow velocity. These changes may cause fish to become disoriented, making it easier for predators to capture them.*

BioPA Computer Requirements

- ***Microsoft Excel 2010***
- ***Windows 7*** *or* ***Windows 10*** *operating systems*

BioPA is used by hydropower owners and operators, turbine manufacturers, and other hydropower stakeholders when making decisions about hydropower turbine design and operations. This toolset can be used for a wide variety of actions, including optimizing the biological performance of current operating conditions and identifying hydropower turbine designs that have reduced impacts on fish during downstream passage. The toolset has been used to evaluate the biological performance of Kaplan and Francis turbines. For example, BioPA has been used at John Day Dam, a large hydropower dam on the Columbia River (WA/OR) operated by the U.S. Army Corps of Engineers. BioPA was applied to determine the probability of fish exposure to rapid decompression during passage through the hydropower turbines under different operating conditions.

Current Users

Currently, licenses for BioPA are held by:

ANDRITZ

VOITH

NATEL ENERGY

For information about licensing BioPA:

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