Eco-friendly turbines
Designed with fish in mind

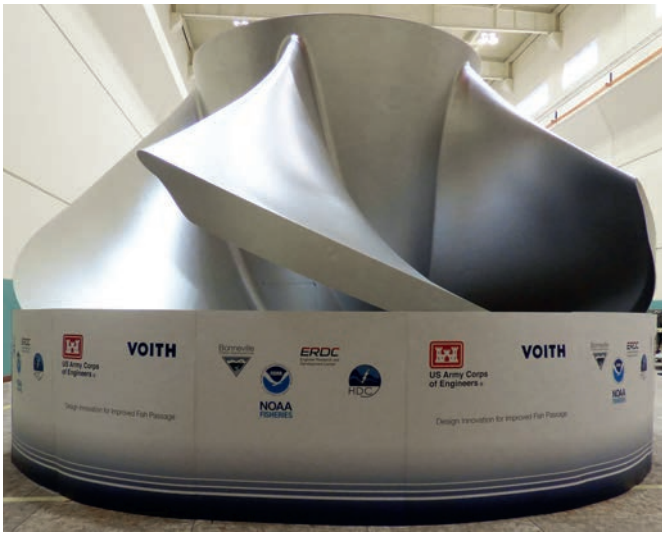
Voith turbine technology makes hydropower stations not only more economical, but also more eco-friendly. State-of-the-art turbine designs improve the water quality and ensure that fish are largely protected against injuries when passing through the turbine. For more than 30+ years, Voith Hydro has collaborated with numerous fish passage experts in the hydropower industry to better understand the relationship between turbine flow characteristics and fish survival.

Minimum Gap – maximum gain for the environment

Voith's earliest fish passage development focused on axial flow applications. During the adjustment of conventional Kaplan blades, a larger gap is created at the inner and the outer blade peripheries. Vortices created through this process, higher water speeds, pressure fluctuations and shear present a danger to fish swimming through the turbine. In order to preserve fish populations, Voith developed the Minimum Gap Runner (MGR) technology as part of the U.S. Department of Energy's Advanced Hydro Power Turbine System (AHTS) program. The MGR blades are precisely contoured to a fully spherical hub and periphery. This minimizes the gap size, which remains constant across the pitch range. In most cases, the MGR technology also results in higher turbine efficiencies.

Three blade Alden runner

Ice Harbor turbine



The Alden turbine for radial flow applications

The Alden research laboratory developed this innovative runner concept that rotates more slowly than conventional turbines and has only three blades. The design minimizes shear forces and pressure change rates, and avoids harmful low pressure regions within the water passage, which allows fish to pass through the turbine more safely. Depending on the fish species, the survival rate through the Alden turbine can be 98 to 100 percent. During the most recent development, Alden partnered with Voith Hydro to optimize the main features.

- Minimizes injury due to strike
- Optimum number of blades and guide vanes
- Improved hydraulic profiles of individual components
- Reduced rotation speed
- Excellent flow characteristics to support downstream fish passage

Next generation of axial flow turbines

To improve the survival of salmon and steelhead passing through the Ice Harbor Lock and Dam in Washington State, the United States Army Corps of Engineers (USACE) initiated a collaborative design effort with Voith Hydro and the Bonneville Power Administration (BPA). Two replacement solutions were investigated, including fixed blade and adjustable blade turbine designs, with a combination of Computational Fluid Dynamics (CFD) tools and physical model testing to evaluate design criteria for both fish passage and traditional hydraulic performance. These turbine solutions incorporate Minimum Gap Runner concepts while addressing other aspects of fish passage spanning the entire water passage.

After the final prototype geometries were manufactured and installed, a series of biological evaluations were performed on Unit 2 in October 2019. These tests demonstrated that the new fixed blade design achieves a survival rate of 98.25 % for Chinook salmon passing through the turbine while providing a 4 % boost in hydraulic efficiency. The Ice Harbor solution represents the next generation of hydro turbine technology for fish passage, made possible only by extensive collaboration between design engineers and biologists during the geometry development and evaluation phase of the project.

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