Waterpower XII Abstract

What's Going On in There? Efforts to Describe the Experiences of Turbine-Passed Fish

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The systematic development of advanced, fish-friendly turbines is based on acquiring an understanding of the stresses that kill or injure fish, and then altering the turbine design or operation to reduce those stresses. This research effort has been challenging, because such potential injury mechanisms as shear, turbulence, pressure changes, and the likelihood and severity of impact with structures are extremely difficult to measure inside of a turbine. Further, the stresses are not uniformly distributed; estimation of average values for the turbine may not be meaningful if much higher, damaging values are present in localized portions of the water passage. Finally, the significance of average or maximum values for these stresses to fish injury and mortality is often poorly known because the needed bioassays have not been performed.

The U.S. Department of Energy's Advanced Hydropower Turbine System (AHTS) Program is tackling these problems with a three-pronged research effort. The AHTS Program supports the development of sensor fish - portable, fish-shaped instrument packages that measure pressure, acceleration, and other physical parameters experienced during passage through the turbine. Advanced computational analyses (Computational Fluid Dynamics modeling) extend the data collected by sensor fish and other instruments in order to estimate the levels of physical stresses throughout the water passage. Finally, laboratory bioassays of individual stresses (e.g., shear, pressure, dissolved gas supersaturation) are being used to suggest biological criteria for new, fish-friendly turbine designs. These three complementary efforts, (1) measuring physical conditions in a portion of the turbine, (2) using advanced computational techniques to describe the environment in unmeasured parts of the turbine (or under other configurations or operating conditions), and (3) applying these physical conditions to fish in a controlled laboratory setting to measure the response, will shed light on the causes of mortality among turbine-passed fish. By integrating the results of these studies, we are reconstructing the effects of turbine passage, determining which stresses are most damaging, and developing a better understanding of how turbine operation or design can be modified to reduce the damage.

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