Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

The effect of active control on the performance and wake characteristics of an axial-flow Marine Hydrokinetic turbine CRAIG HILL, KATHERINE VANNESS, Department of Mechanical Engineering. University of Washington, ANDY STEWART, Applied Physics Lab. University of Washington, BRIAN POLAGYE, ALBERTO ALISEDA, Department of Mechanical Engineering. University of Washington — Turbulence-induced unsteady forcing on turbines extracting power from river, tidal, or ocean currents will affect performance, wake characteristics, and structural integrity. A laboratory-scale axial-flow turbine, 0.45 m in diameter, incorporating rotor speed sensing and independent blade pitch control has been designed and tested with the goal of increasing efficiency and/or decreasing structural loading. Laboratory experiments were completed in a 1 m wide, 0.75 m deep open-channel flume at moderate Reynolds number ($Re_c = 6\ 10^4 - 2\ 10^5$) and turbulence intensity ($T.I. = 2 - 10\%$). A load cell connecting the hub to the shaft provided instantaneous forces and moments on the device, quantifying turbine performance under unsteady inflow and for different controls. To mitigate loads, blade pitch angles were controlled via individual stepper motors, while a six-axis load cell mounted at the root of one blade measured instantaneous blade forces and moments, providing insights into variable loading due to turbulent inflow and blade-tower interactions. Wake characteristics with active pitch control were compared to fixed blade pitch and rotor speed operation. Results are discussed in the context of optimization of design for axial-flow Marine Hydrokinetic turbines.

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Date submitted: 30 Jul 2016 Electronic form version 1.4