Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Turbulence Kinetic Energy Budget in the Near-Wake Region of a Tidal Stream Turbine at Elevated Levels of Free-Stream Turbulence[1]
CONG HAN, ASHWIN VINOD, ARINDAM BANERJEE, Lehigh Univ — Tidal stream turbines (TSTs) are typically deployed at high energetic tidal sites that are characterized by elevated levels of free-stream turbulence (FST). In the current work, the tidal turbulence testing facility at Lehigh University that incorporates an active grid turbulence generator is used to study the effects of elevated FST (turbulence intensity, Ti = 12.6%) on the near-wake characteristics of a 1:20 TST model. The results are compared with a baseline quasi-laminar flow (Ti=2.2%). Wake parameters investigated include, energy recovery, swirl, length scales, and turbulence intensity. We also discuss momentum and turbulence kinetic energy (TKE) budgets in the turbine wake under the different inflow conditions to quantify the production, re-distribution, and dissipation of TKE in the near wake high shear regions. The results show that TST wake displays considerable differences at the higher FST, most notably, enhanced energy recovery and swift break up of flow periodicities. The convection term was found to dominate the energy exchange process in the wake. Production of TKE closely correlates to the periodic tip vortices shed from the blade, creating an annular region with prominent shear stresses.

[1]The authors thank the US National Science Foundation for financial support for this project (Award 1706358, Fluid Dynamics Program).

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Date submitted: 02 Aug 2020 Electronic form version 1.4