River and Debris Diversion Structure Generated Turbulence Effects on the Oceana River Energy Converter

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Outline

- Alaska Hydrokinetic Energy Research Center (AHERC) overview
- Debris hazards and mitigation
- Oceana river energy converter (REC) testing
- Natural river turbulence
- River debris diversion device generated turbulence
- Effect of turbulence on Oceana power output
AHERC Overview

Goal: Develop technology and methods to enable a sustainable hydrokinetic industry in Alaska

- Site characterization
  - Hydrodynamic measurement/modeling
  - Baseline fish population studies
  - Debris

- Technology development and testing
  - River debris diversion platform (RDDP)
  - Debris modeling and mitigation
  - Mobile test barge
  - River energy Converter testing
    - Fish interaction monitoring

- Infrastructure development
  - Anchoring, river energy converter (REC) deployment, operations and integration in remote communities with islanded grids

Tanana River Test Site (TRTS)
Debris Hazards and Mitigation

Tanana River stage & debris frequency vs. time

Debris Index & Stage vs Time (2011)

Debris Index

Stage (m)

Date

5/21/11 6/10/11 6/30/11 7/20/11 8/9/11 8/29/11

0 5/21/11 6/10/11 6/30/11 7/20/11 8/9/11 8/29/11

0 0.5 1.0 1.5 2.0 2.5 3.0 3.5

Debris interaction with REC infrastructure

River debris diversion platform
Oceana Testing

- Oceana Energy Company conducted tests of their REC at the AHERC tests site (Reported at this conference)
- Additional tests to examine the effect of RDDP generated turbulence on Oceana REC power output were conducted with the turbine located at **14.5, 50 and 100 m** downstream from the RDDP
Oceana REC testing
Normal Test Configuration

Diagram showing a barge with cleats, centering block, bridles, high strength rope, mooring post, spreader bar, RDDP, and connections to mooring buoy.
Sources Of Turbulence

RDDP generated turbulence

Debris object
Turbulent zone Behind the RDDP

Vortex eddy

Natural river turbulence
Turbulence effects on Power Output

\[
\Delta \frac{\bar{P}}{P_{100}} = \left( \frac{P_{D_{RDDP}} - P_{100}}{P_{100}} \right) \%
\]

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<th>(D_{\text{RDDP}})</th>
<th>(\bar{V})</th>
<th>(\bar{P})</th>
<th>(2\sigma_{\bar{P}}/\bar{P})</th>
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The RDDP effectively protects floating platforms from river surface debris.

Maximum protection from debris requires the floating platform be connected to the RDDP using a bridal mooring system.

Natural river turbulence produced a $2\sigma$ power output variation of 6% for the Oceana REC.

RDDP-generated turbulence reduced Oceana REC mean power by 8.3% at 14.3 m from the RDDP and by 0.3% at 50 m from the RDDP.

Improving RDDP hydrodynamic design may reduce the magnitude of RDDP-generated turbulence.