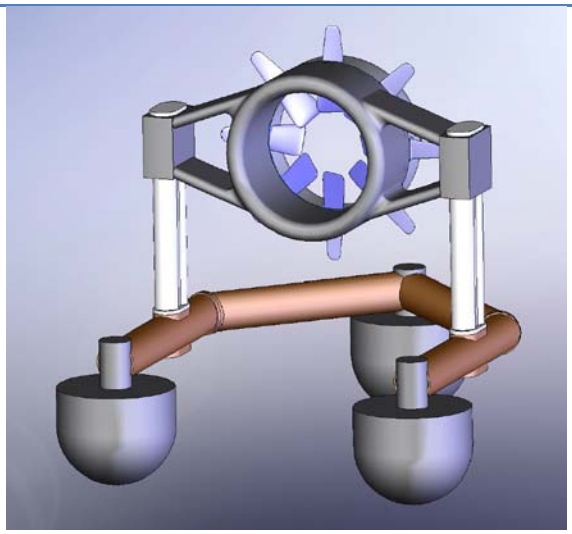
# Hydrokinetic Device Evaluation



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**Total Project Costs:**

Grant Funds Requested: $1,453,000
Match Committed: $620,000

**Previous Applications: None**

## 1. Project Summary

### *a. Project Description:*

Oceana Energy Company has been developing a patented hydrokinetic device that is an open-centered design with hydrofoils both internal and external to the supporting structural ring. The structural ring includes both a novel permanent magnet generator and a permanent magnet bearing system that is optimized for the Oceana device. Various aspects of the Oceana device have been demonstrated during testing at the Naval Carderock test facility.

The intent of this project is to build the next generation Oceana device and deploy it in a river environment and demonstrate the performance. This device will include new features, specifically designed to improve performance in the river environment, including combinations of sealing and opening up clearances to prevent abrasive particles from wearing. A new barge for river-based testing of hydrokinetic devices will be designed and built as part of this project. The barge will be the property of the University of Alaska and will be available throughout the state for the testing of hydrokinetic devices by UA, AEA or ACEP. The barge will have sensors for monitoring the velocity, turbulence and suspended sediment levels in the river and for monitoring the performance of the Oceana devices (e.g., vibration level, wear, and power output).

The river environment provides special challenges to hydrokinetic devices, including turbulence, debris and suspended materials, which can potentially damage the energy producing devices. The proposed project will characterize these challenges and monitor device performance in the face of these challenging conditions. Currently AHERC/ACEP is building a debris diversion system which will utilized during this project. The knowledge gained will be used to design an improved hydrokinetic device. The proposed project is synergistic as it will coincide with a separate UA study of hydrokinetic device impacts to hydrodynamics and sediment transport at the Nenana test site. It also relates to a UAA lab study of sediment-induced abrasion of hydrokinetic device components.

### *b. Project Eligibility:*

The proposed project is eligible for the advertised grant based on the following:

- Hydrokinetic energy utilizing river flows is an emerging energy technology that is a very active development area.
- Oceana Energy has built and successfully tested a device to capture hydrokinetic energy. The proposed device will incorporate new technologies including magnetic bearings, novel permanent magnet generator, and an improvement of design for manufacturability. In addition, the Oceana device will be designed to minimize the issues associated with river deployments, namely abrasive sediments that can potentially destroy mechanical components.
- Alaska has vast hydrokinetic energy resources, that once developed could provide a significant portion of the state's energy portfolio. River deployments have the unique ability to provide energy to remote communities
- Oceana Energy holds an Alaska business license (see copy attached).

### *c. Project Innovation:*

While the entire field of commercially viable hydrokinetic devices is relatively young and very active, deployments in rivers have additional significant challenges. Rivers carry debris and suspended materials that can cause damage to hydrokinetic devices. The rivers in Alaska may be the most challenging because of the large runoffs and the suspended materials can be very damaging and very abrasive; for example glacial “flour” is very abrasive. The Oceana Energy device has a patented magnetic bearing system that should be less sensitive to the suspended materials that can grind and wear mechanical type bearing systems.

The instantaneous currents are expected to be turbid and turbulent. One of the main objectives of this projects is to develop modifications in the turbine design to best ensure long term performance in flow with these characteristics. The advancements will be available for future testing and development of hydrokinetic devices. A

design objective will be greater reliability while reducing initial capital expenditures along with recurring maintenance costs.

### *d. Priority:*

The proposed project should have a high priority based on the following:

1. The project team is composed of the University of Alaska Anchorage group that has already been performing research related to hydrokinetic devices.
2. Oceana Energy is providing a major level of in-kind funding related to the project. Oceana will design, build and conduct the baseline testing of the new device.
3. With many remote villages that currently have to employ expensive and environmentally undesirable methods for power generation due to their locations, the deployment of hydrokinetic devices has a widespread application to improve the quality of life in the communities.
4. The proposed testing bargewill remain the property of the University of Alaska Anchorage and ACEP for future testing of other hydrokinetic devices.
5. In addition, the instrument with remote access will remain the property of the State of Alaska and be maintained by the University of Alaska Anchorage and ACEP for future testing of systems, including those from AEA and ACEP.

## 2. Technology Validation and Research Methodology

### *a. Objectives:*

The main objectives of the proposed project include the following:

1. Design and build the next generation Oceana device with features intended to improve performance of the device in river deployments.
2. Test this device in the David Taylor Testing Basin (the Carderock Division of Naval Surface Warfare) to evaluate the hydrokinetic parameters and performance under controlled conditions.
3. Build a dedicated barge for hydrokinetic testing on the Tanana river at the Alaska Hydrokinetic Energy Research Center (AHERC) operated by Alaska Center for Energy and Power (ACEP) site near Nenana, AK. This barge will remain the property of the state of Alaska in the custody of the University of Alaska.
4. Develop instrumentation and remote access methods so that hydrokinetic devices can be monitored during testing from the barge.
5. Deploy the Oceana device on the barge at the site and perform testing of the device to demonstrate extended period performance . Included are periodic examinations of any wear.
6. Characterize the river water that is impinging on device (in terms of velocity, turbulence and suspended sediment character).

### *b. Methodology:*

In support of the listed objectives, the following methodologies will be employed:

1. The new Oceana device will be designed/modified to be compatible with the new barge. This device will include all the latest Oceana technology regarding the bearings, generator, hydrofoils and improvements for manufacturability.
2. This is actually the second test series of the Oceana device that will be performed at the Carderock facilities. The prior results have been documented to include all the water current data, the mechanical and electrical performance of the hydrokinetic device and photometric coverage. New instrumentation that supports the upcoming river barge testing will be incorporated in these tests to provide calibration and proof of concept.
3. The design features of the new barge include:
    a) Sufficient floatation and stability for expected currents, motor, weight of anticipated future hydrokinetic devices and expected river currents,
    b) A mechanism for raising and lowering the hydrokinetic device into the current,

c) Sufficient deck space to work on a raised device,
d) Mooring and anchoring capability with the test site,
e) Instrumentation enclosure to allow for data acquisition and equipment to be protected from the elements,
f) Assembly features so that the barge can be transported to the test site from the fabrication facility,
g) Communications to allow for remote access of the testing data.

4. Instrumentation will include sensors to monitor the river current, turbulence, sediment content, hydrokinetic device performance, photometric coverage, and weather conditions. This data will be made available by remote access internet connection.
5. After deployment of the device and initial testing, the device will operate without personnel attendance. The remote data transmittal will be monitored by the researchers to verify performance. Periodically, a crew will visit the site to raise the device and examine for damage from river debris and to assess surface wear from river sediment abrasion.
6. Following completion of the all testing and removal of the device, a final report or set of reports will be prepared that document the results of the testing

## 3. Summary of Project Schedule and Summary of Project Budget

### *a. Schedule of Project Tasks*

| | |
|---|---|
| Design and Manufacturing of Hydrokinetic Device | 8/12 - 2/13 |
| Instrumentation Development | 9/12 - 2/13 |
| Controlled Testing of Hydrokinetic Device at Carderock | 2/13 |
| Hydrokinetic Barge Design and Fabrication | 11/12 - 4/13 |
| Deployment of Hydrokinetic Barge | 5/13 |
| Testing of Hydrokinetic Device Suspended from Barge | 6/13 - 9/13 |
| Reporting on Testing Results | 9/13 - 11/13 |

### *b. Project Budget*

**Oceana Energy Hydrokinetic Device Evaluation**

| Major Tasks | Cost | Oceana In-Kind | UAA In-Kind | Grant Proposal |
|---|---|---|---|---|
| Project Management | $100,000 | | | $100,000 |
| Oceana Device Design/Engineering | $150,000 | $150,000 | | $0 |
| Oceana Device Fabrication | $300,000 | $300,000 | | $0 |
| Carderock Analyses and Testing | $150,000 | $150,000 | | $0 |
| Device Shipping to AK | $20,000 | | | $20,000 |
| Barge Design | $100,000 | | | $100,000 |
| Barge Fabrication | $150,000 | | | $150,000 |
| Barge Shipping and Assembly at Site | $50,000 | | | $50,000 |
| Instrumentation and Remote Access Development | $100,000 | | $20,000 | $80,000 |
| Device and Barge Assembly and Testing | $150,000 | | | $150,000 |
| Long-Term Testing Support with Periodic Evaluation | $100,000 | | | $100,000 |
| ACEP Site (45 days at $7k/day) | $315,000 | | | $315,000 |
| Post Testing Data Reduction, Analysis and Reporting | $100,000 | | | $100,000 |
| Fish Study during Testing | $75,000 | | | $75,000 |
| Removal and Storage of Barge | $25,000 | | | $25,000 |
| Contingency (10%) | $188,500 | | | $188,500 |
| **Totals** | **$2,073,500** | **$600,000** | **$20,000** | **$1,453,500** |

## 4. Project Team Qualifications

### Oceana Energy Company

Business objective: commercial hydrokinetic device development
Technical Leads:

#### Ned R Hansen, Ph.D., P.E., Mechanical and Project Manger

Responsibilities: project manager, hydrokinetic mechanical device design, testing hardware design, instrumentation, and mechanical design of barge equipment

#### Kent Davey, Ph.D., P.E., Electro-magnetics

Responsibilities: magnetic bearing design of hydrokinetic device, permanent magnetic electrical generator for hydrokinetic device, testing hardware design and instrumentation

### US Naval Surface Warfare Center, Carderock Division

The engineers at Carderock that normally design and test all the Navy propulsion systems have and will continue to provide hydrodynamic design and analytical support for the design of the Oceana hydrofoils. In addition, the Carderock Division includes the David Taylor Model Basin that includes long tow tank for controlled testing.

### University of Alaska Anchorage,

#### Technical Lead: Tom Ravens, Ph.D.

Responsibilities: barge and supporting structure design and fabrication, testing site coordination, planning and development of testing protocol, hydrodynamics and sediment monitoring and modeling, and design and development of instrumentation and controls for test parameters monitoring and data acquisition.

### Alaska Hydrokinetic Research Center

#### Technical Lead: Jerry Johnson

Responsibilities: mooring/anchoring and test site support

## 5. Discussion of Commercialization of Funded Technology

The unique environments imposed on hydrokinetic devices in river applications is not well characterized and even understood. The primary objective of this project is to improve the understanding of these environments so that any necessary design upgrades can be incorporated in the device prior to commercial development. Both of these objectives are intended to support the commercial deployment in less than five years from testing.

## 6. Signed Applicant Certification

By signature on this application, I certify that we are complying and will comply with the amount of matching funds being offered.

Signed:

3/8/12

Dan Power, President Date