*ALASKA ENERGY AUTHORITY RFA 2014-007: EMERGING ENERGY TECHNOLOGY FUND*

**PROJECT TITLE:**

# TESTING OF INNOVATIVE OVERHEAD POWER LINE COMPONENTS

**SUBMITTED SEPTEMBER 5, 2013**

**APPLICANT ORGANIZATION & CONTACT:**


**polarconsult alaska, inc.**
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**APPLICANT PARTNERS:**

UAF UNIVERSITY OF ALASKA FAIRBANKS

**TOTAL PROJECT COST: $ 132,000**

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| EETF Grant: | $ 120,000 |
| Applicant/Partner Match: | $ 12,000 |

**PREVIOUS PROJECT PHASES:**

**HVDC Transmission System For Rural Alaska Applications**
**Phase II: Prototyping and Testing**
Funded by: Denali Commission, Award #01201-00
Completion Date: May 2012

**PREVIOUS EETF APPLICATION TITLE: NONE**

**PROJECT ABSTRACT**

## 1.0 PROJECT SUMMARY

### 1.1 PROJECT DESCRIPTION

***Background***

In 2011, Polarconsult Alaska, Inc. (Polarconsult) installed an innovative overhead pole at a private test site in Fairbanks, Alaska. This test installation was part of Phase II of the "High Voltage Direct Current Transmission System for Rural Alaska Applications – Phase II Testing and Prototyping" funded by the Denali Commission. The objectives of this installation were to demonstrate alternatives to traditional overhead power line construction that could lower the capital costs of remote power interties.

The installation at the test site consists of:

- A 60 foot tall fiber-reinforced polymer (FRP) pole consisting of a 40 foot section, 20 foot section, and moment-carrying FRP splice.
- A pole base plate that fits the FRP pole to three micro thermopiles[1] and provides for winch erection of the pole,
- Four conventional guys each set at 45° and anchored as follows:
  - The north guy anchor is a standard 6" screw anchor with two flights,
  - The south guy anchor is a standard swamp anchor,
  - The east guy anchor is a micro thermopile installed in line with the guy (45°), and
  - The west guy anchor is a micro thermopile installed at 70°, a 20° skew angle from the guy.
- Two thermoprobes to monitor soil temperatures – one near the pole base (within the zone of effect of the base thermopiles), and one approximately 50 feet from the base to provide reference ground temperature.
- Load cells on each guy axis to monitor guy tension.

Of these elements, the FRP pole is a commercially proven technology, although it is not widely used in Alaska. The micro thermopiles are also a commercially proven technology, although they have not been used in this application, and have seen very limited use in tension applications (guy anchors).

Polarconsult has periodically monitored the installation for guy tension and differential foundation movement, which would indicate creep or heave of the individual foundation elements. No significant differential foundation movement has been observed in the 20 months since installation.

Polarconsult proposes to increase the instrumentation, monitoring, and reporting at the test site to more rigorously test the various innovative components present at the site and probe the failure limits of certain components. This proposal includes a two-year testing and monitoring program, which will provide a total of four years of field data for the installation and innovative components. At the conclusion of the project, the installation will be removed and the site restored. This data will be useful to rural utilities in considering use of these elements in future intertie projects.

[1] Each micro thermopile is a 1.5-inch diameter by 30-foot long sealed pipe designed to passively cool the surrounding soils by removing heat from the ground during the cold months by means of convection and phase change of a working fluid within the vessel (pressurized $CO_2$). The top 5 feet of the micro thermopile is above ground and serves as the radiator. The basic concept of the thermopile elements is similar to those used on the vertical support members of the Trans-Alaska Pipeline (however the working fluid is different).

***Proposed Scope of Work***

**Task 1: Site Instrumentation**

Polarconsult will augment existing site instrumentation with the following:

- Fit existing guy load cells with data loggers to record guy tension.
- Install a weather station to record wind speed and direction, ambient air temperature, and snow depth.
- Install data logging temperature strings in both thermoprobes to record daily soil temperature.

This instrumentation will provide more detailed data about the ambient site conditions and performance of the foundation elements.

**Task 2: Installation Monitoring and Testing**

Polarconsult will regularly monitor telemetry from the installation to identify changing conditions that may warrant action. A differential level survey will be performed on a quarterly basis to detect differential vertical movement between the foundation elements (e.g., creep, settlement, or heave). Letter reports will be prepared on a quarterly basis that summarize current data, apparent trends and action items.

At the last quarterly site visit and prior to site decommissioning, Polarconsult will perform a stepped load test to evaluate the failure modes and limits of the foundation elements under high compressive and tensile loads.

**Task 3: Analysis**

Polarconsult will analyze field data to draw conclusions about the performance of the foundation elements at the test site. Analysis will address:

- Heat removal performance of the micro thermopiles,
- Load capacities, creep characteristics, and failure modes of all foundation elements,
- Performance of the FRP pole, base assembly, and FRP splice,
- Trends in soil temperature profiles over the term of the test, and
- Other useful findings that may be ascertained from the field data.

**Task 4: Reporting**

Polarconsult would prepare a final report detailing the achievements of the project. The report would include the task 2 data and task 3 analysis results, as well as conclusions regarding use of these innovative components and any recommendations for future evaluation.

**Task 5: Site Management**

Polarconsult would maintain the lease for the project site and be responsible for removing the installation and restoring the site after the field demonstration is completed.

## 1.2 PROJECT INNOVATION

The existing installation is demonstrating FRP poles and innovative foundation elements for overhead transmission structures. Commercial use of these components in rural intertie construction can lead to decreased materials costs, shipping costs, installation costs, O&M costs, and/or increased design life of interties. These benefits will decrease the capital and life cycle costs of electric interties.

## 1.3 PROJECT SITE AND DEMONSTRATION ENVIRONMENT

The Fairbanks Test Site is located on private property in Fairbanks off Farmer's Loop Road along the northern periphery of Creamer's Field. Polarconsult has an existing lease for the test site, with option for annual renewal. The test site consists of silty permafrost soils with a mixed black spruce and deciduous forest. The subsurface soils and thermal regime are representative of subsurface conditions commonly found throughout wide parts of Alaska, which are comparatively challenging conditions for conventional overhead line construction.

### 1.4 PRIORITY

This project meets all of the priority criteria set forth in AS 42.45.375(d)(1) through (4) as follows:

(1). Polarconsult is an Alaska business owned by and employing Alaska residents.

(2). Polarconsult will contract with UAF and ACEP for peer review of the project.

(3). The application includes applicant matching funds.

(4). The successful adoption of this existing commercial technology will enable rural electric utilities to build interties with lower capital costs than existing construction methods.

(5). Heating Efficiency. By lowering the capital cost of rural power interties, this project can foster the conversion of high-energy-cost villages to electric heat by connecting them with comparatively low-cost power, for example from the railbelt grid.

## 2.0 TECHNOLOGY VALIDATION AND DATA COLLECTION

Key performance metrics are satisfactory structural and functional performance of the components being tested at the facility (FRP pole and foundation elements). A successful project would confirm no excessive creep, heave, or settlement of foundation elements under real-world loadings and service conditions, and would define load limits and failure modes for these foundation elements. Similar performance metrics exist for the FRP pole.

Loading (guy tension) and environmental (air and subsurface temperatures) data will be collected so that the performance of the pole and foundation elements can be compared relative to the applied loads.

## 3.0 PROJECT SCHEDULE AND BUDGET

The proposed budget for this project is $132,000. This includes $12,000 as in-kind labor from Polarconsult and $120,000 in grant funds.

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| Task 1(site instrumentation): | January to March 2014 | $ 24,000. |
| Task 2 (site monitoring): | January 2014 to December 2015 | $ 48,000. |
| Task 3 (data analysis): | January 2016 to March 2016 | $ 27,000. |
| Task 4 (reporting): | May 2016 | $ 21,000. |
| Task 5 (site management): | January 2014 to December 2015 | $ 12,000. |
| **TOTAL** | | **$ 132,000.** |

## 4.0 PROJECT TEAM QUALIFICATIONS

***Polarconsult*** is a professional engineering consulting firm headquartered in Anchorage since 1978. Polarconsult specializes in innovative, affordable and robust engineering solutions tailored for Alaska conditions. Polarconsult has successfully served over 200 municipal, public, and private-sector clients throughout Alaska. Polarconsult will manage this project, with Joel Groves, P.E. acting as project manager. Mr. Groves has managed Phases I and II of the HVDC system development efforts.

## 5.0 COMMERCIALIZATION OF FUNDED TECHNOLOGY

This project is demonstrating existing commercially available technology that is not widely used in Alaska (in the case of the FRP poles) or widely used, but not for transmission line applications (in the case of thermopiles). By providing real-world test data in an Alaskan application, for these product applications, this project will directly support commercial use of these technologies. Commercial vendors of this technology are available and commercial deployment of these technologies can happen in the near-term upon acceptance of the technology by the utility industry.