HVDC Transmission for Rural Alaska

STAKEHOLDERS' ADVISORY GROUP
THIRD MEETING

October 25, 2011

ANCHORAGE, ALASKA

Joel D. Groves, P.E.

polarconsult alaska, inc.

ENGINEERS - PLANNERS - ENERGY CONSULTANTS

1503 W. 33rd Avenue, Suite 310
Anchorage, Alaska
(907) 258-2420
www.polarconsult.net
joel@polarconsult.net

PHASE II PROJECT TEAM

- Denali Commission (Funding Agency)
- ACEP (Grant Management, Economic Analysis, Independent Assessment / Reporting)
- Polarconsult (Project Management, Strategic Vision, Concept Design, Reporting)
- Princeton Power Systems (Converter Development)
- UAF/Dr. Wies (Alaska Integration / Practicality / Converter / System Review)
- AVEC (Alaska Integration / Practicality)
- SAG (Practicality / Industry Acceptance)
- Manitoba HVDC Research Centre (HVDC Expert – Integration, Technical Issues)
- Line Design Engineering (Structural and Code Expert)
- Golder Associates (Geotechnical Expert)
- Almita (Foundation Supplier)
- Arctic Foundations (Foundation Supplier)
- Zarling Aero Consulting (Thermal Soils Analysis)
- STG (Rural Intertie Contractor – logistics, cost)
- Alaska Foundation Technology (Foundation Contractor – logistics, cost)
- GeoTek Alaska (geotech. contractor – logistics, equipment)
- Cabletricity (Submarine Cable / HVDC Expert)
- Okonite (Cable Supplier)

PROJECT STATUS UPDATE

- Converters built, testing underway
- Overhead conceptual design complete, field tests starting in Fairbanks Nov. 7
- Submarine cable concept designs complete
- Overland cable testing next week
- Economic analysis underway
- Final report to ACEP for review Nov. 21

PROJECT STATUS UPDATE
Overhead System

- Conceptual design is very flexible, robust, adaptable
- Foundations are key - systems are being installed and validated in Fairbanks
- Long-term performance monitoring will be performed by ACEP

PROJECT STATUS UPDATE
Submarine System

- Existing cables work
  - Okonite URO-J 1/0 Cu Cable…
- Economics in Progress
  - Guidelines on need for armor
  - Laying equipment and costs
- Tel/co Integration
  - No technical hurdles
  - Looking for interested vendors

PROJECT STATUS UPDATE
Field Tests

- Fairbanks Test Site
- Erect guyed fiberglass pole
  - Test installation methods
  - Test pole base foundation
  - Test four guy foundations
  - Setup for multi-season monitoring by ACEP
- Materials and Contractors queuing for Nov. 7

PPS Presentation

Phase II Final Report

- Executive Summary – 2 or 3 pages
- Main Body of Report – ~ 30 pages
  - What was done
  - Current status of technology / system
  - Next steps for deployment

- Appendices
  - Project Record
  - Technical Data
  - References
  - Examples

Phase II Final Report

- SAG – Main Narrative
  - Main Narrative – overview of SAG's role, members
  - Appendix - Transcripts, Correspondence, etc.
- Code Issues
  - Main Narrative – Summary of Findings
  - Appendix - Discussions with Dept of Labor, MHRC White Paper

Phase II Final Report

- Demonstration Site Selection
  - Main Narrative - List of Goals, Criteria, Sites, Future Actions
  - Appendix - detailed info on candidate sites

Phase II Final Report

- System Integration
  - Main Narrative – How it all fits together. Interface with village micro grids, diesels, etc.
  - Appendix – Technical reports from sub-consultants (MHRC, etc) on MTDC networks, SCADA integration, communication options, etc.

Final Report

- Converter Development
  - Main Narrative – Headline functionality, footprint, cost, test results, etc.
  - Appendix - detailed info on development, specifications, testing, etc (PPS Report)

Phase II Final Report

- Overhead Transmission System
- Submarine Cable System
- Buried Overland Cable System
  - Main Narrative – Conceptual design methodology, conceptual designs, applications
  - Appendix - detailed info on design, loadings, etc. Technical reports from sub-consultants

Phase II Final Report

- Construction & Maintenance Methods
  - Main Narrative – design objective, results
  - Appendix – detailed technical data and subconsultant reports. Findings from Fairbanks Test Site.

Phase II Final Report

- Economic Analysis
  - Main Narrative – cost estimates for representative systems – similar to Ph 1 Report
  - Appendix – Detailed support for cost data, life cycle analysis, comparative costs.

Example

- Overhead System

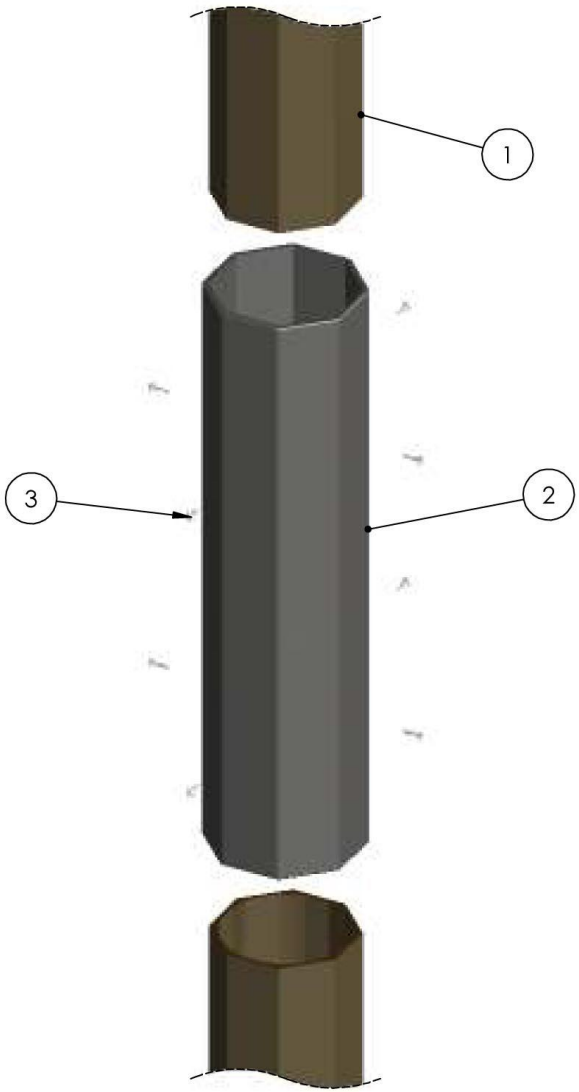
OVERHEAD SYSTEM
Conceptual Design Methodology

- Gather load data from utilities
- Design target is ‘worst case common’ condition
- Deal with unique loadings by reducing spans, doubling components, etc.
- Maintain robust, adaptive design
  - Deal with varying geotechnical conditions
  - Deal with variety of installation / repair conditions

OVERHEAD SYSTEM
Conceptual Design

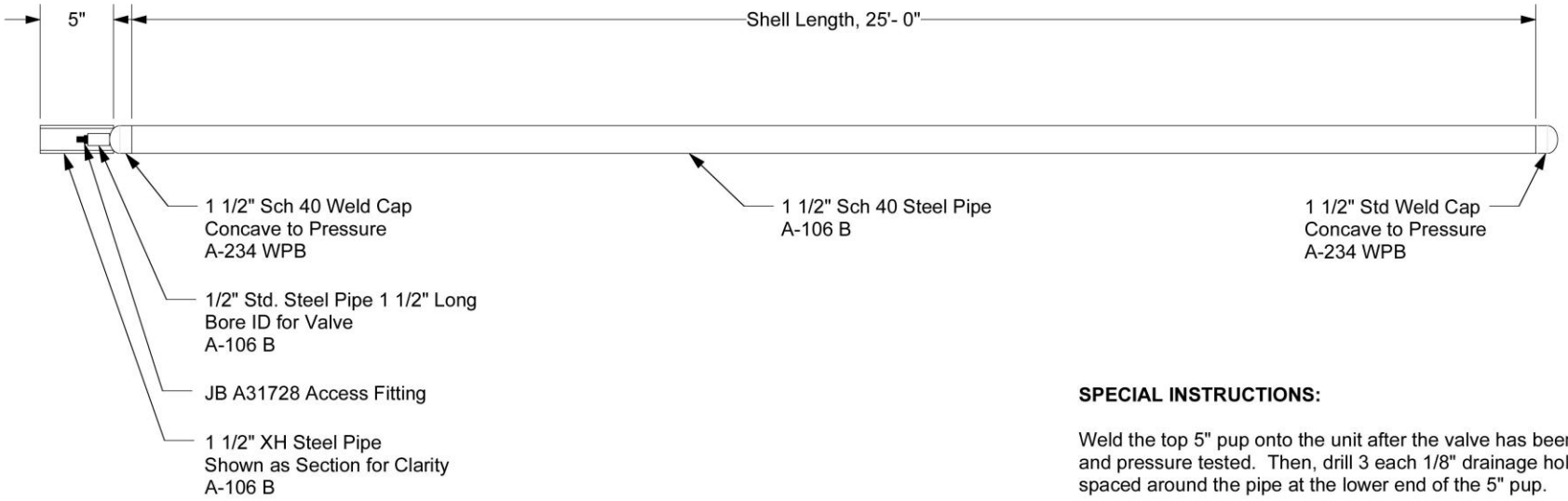
- 60-foot fiberglass pole, 14” dia x 0.3” wall. 4 guys per pole
- Post top insulator for monopolar
- Cross arm and suspension insulators for bipolar (shorter spans)
- All three for AC lines. (neutral lower on pole)
- Suite of standard foundation options for pole base and guys
  - Thermosiphon (1-1/2” x 25’ pipe, CO_2 working fluid)
  - Screw Anchor (multiple suppliers exist)
  - Micropile (2” – 3” pipe, 25-50’ long (as required)
- 19#10 Alumoweld at 30-40% initial tension

POLE SPLICE


1
2
3


Pole section will be stocked in 10ft and 8ft lengths
Locate screws on non-seam faces
Pole cap and plug must be stocked independently

THERMOSIPHON



SPECIAL INSTRUCTIONS:

Weld the top 5" pup onto the unit after the valve has been installed and pressure tested. Then, drill 3 each 1/8" drainage holes equally spaced around the pipe at the lower end of the 5" pup.

Prior to finishing, grind all girth welds smooth to the diameter of the pipe.

NOTES:

1) All pressure retaining welds are full penetration v-groove welds. Welding procedure specifications are qualified in accordance with ASME Section IX. Welding is performed by welders qualified per ASME Section IX.

2) The brass valve to steel connection is silver brazed per AFI standard procedure.

3) Coat upper twelve feet of anchor with H.B.Fuller IF-1074 fusion bond epoxy over 3 mils flame sprayed aluminum applied per AWS C2.2. Extend the 3 mils of flame sprayed aluminum applied per AWS C2.2 down the anchor shaft an additional 2 feet. Brush blast mill finish off bearing zone of anchors.

4) Charge Thermoprobes with R-744 per AFI standard procedure.

5) Materials are AFI standard for the intended service.

6) Build 5 units as shown hereon.

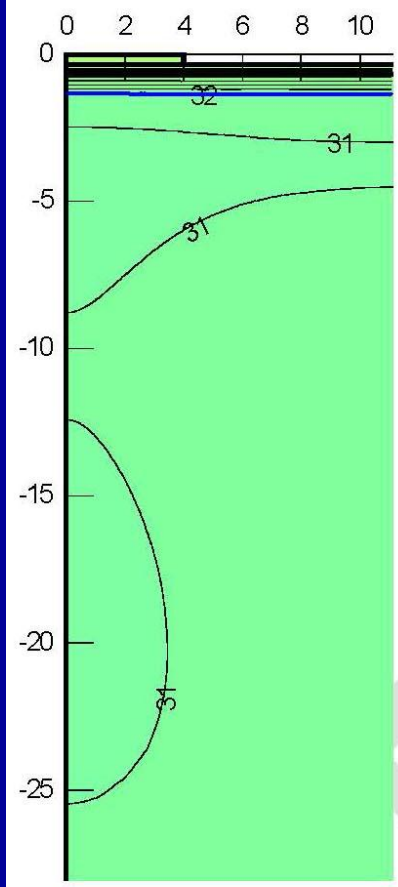
HVDC Line - Anchor		
Shop Drawing 1.9" O.D. Thermo Anchor		
For Polarconsult Alaska, Inc.	MADE IN ALASKA	Job No. 2011-27
ARCTIC FOUNDATIONS, INC. 5621 Arctic Boulevard Anchorage, Alaska 99518-1667		No Scale
		Drawn By: EY
Covered by one or more of the following US Patents: 3,217,791 3,706,204 3,797,257 4,067,198 5,172,587 5,190,098 5,238,053		09/22/2011
		Drawing # 2011-27-01Rev1

THERMOSIPHON

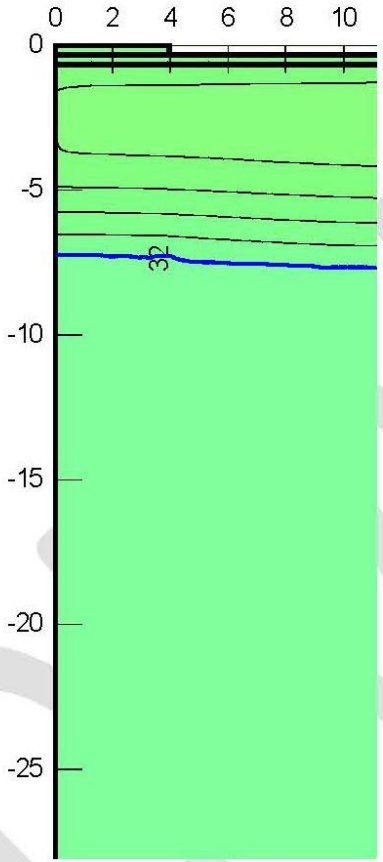
Zarling Aero and Engineering

Thermal Analysis of Thermal Pin Piles

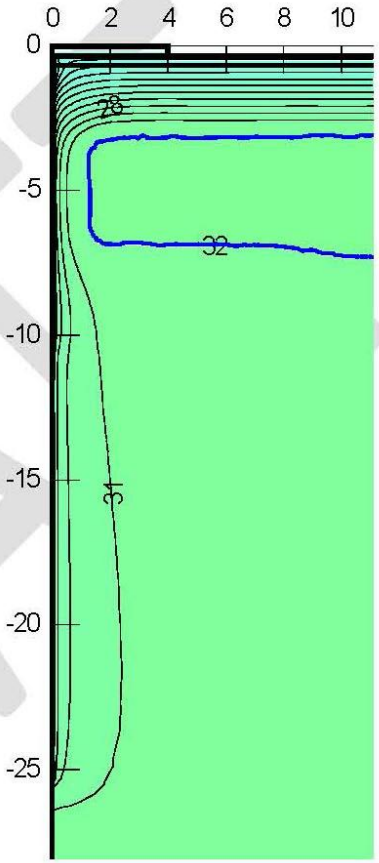
Thin organic layer, no insulation and thermal pile unit conductance is 1.0 BTU/hr-ft-F



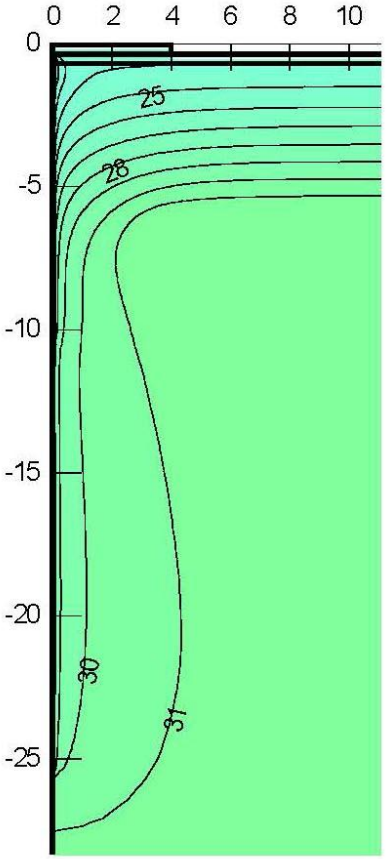
Spring



End of Summer



Early Winter



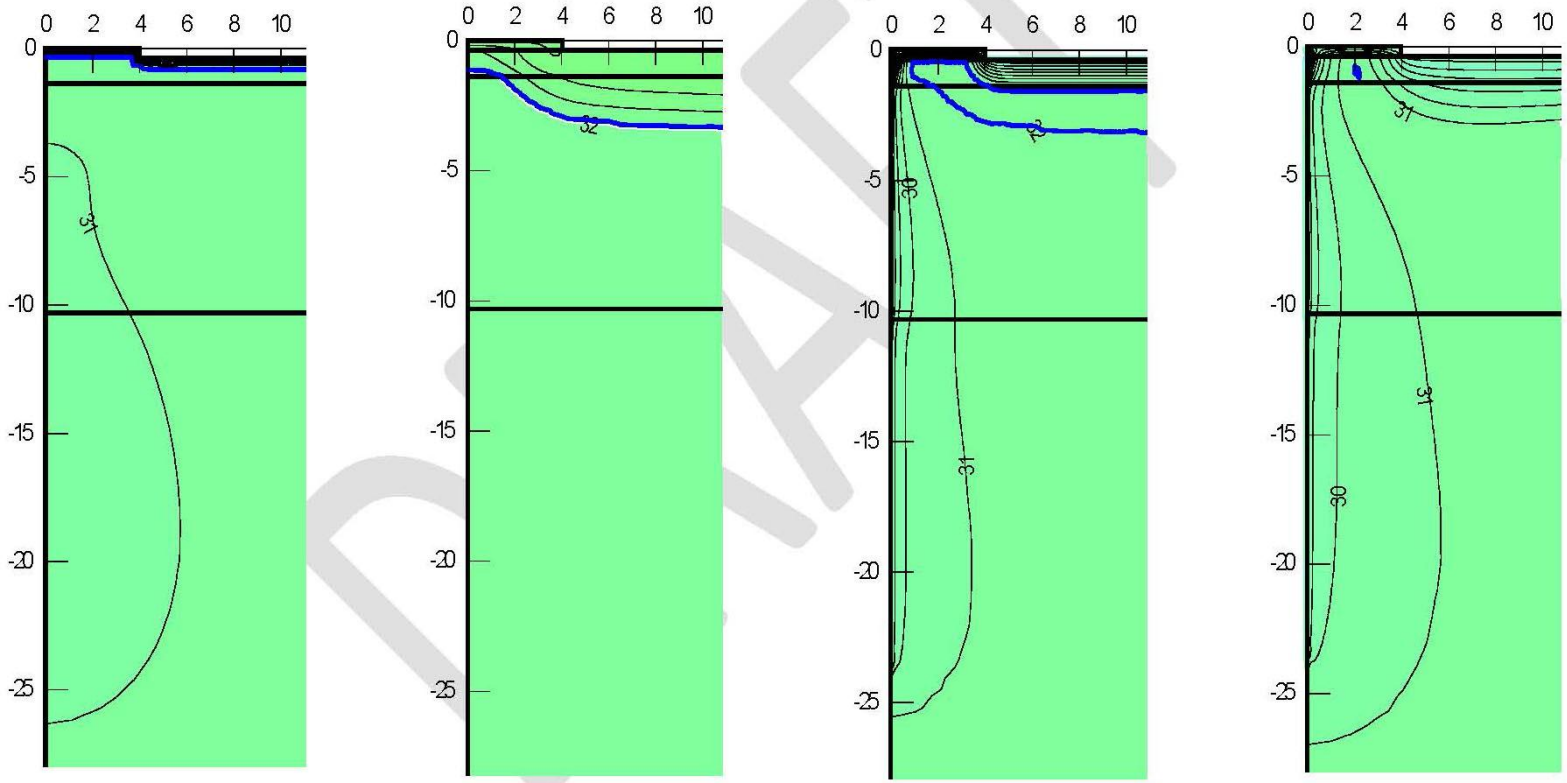
Mid Winter

THERMOSIPHON

Zarling Aero and Engineering

Thermal Analysis of Thermal Pin Piles

Thick organic layer, four-inch thick insulation and thermal pile unit conductance is 1.0 BTU/hr-ft-F

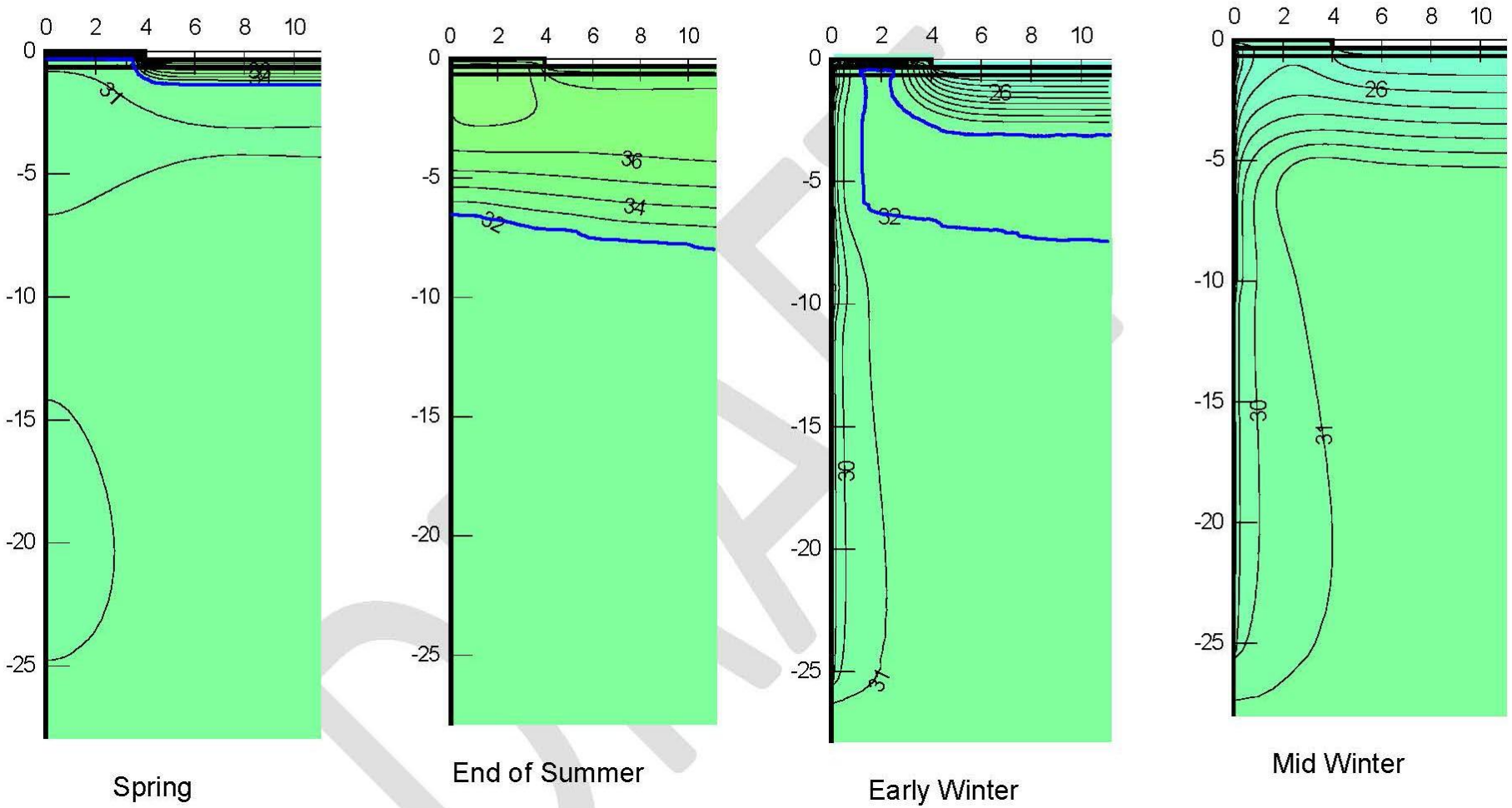


THERMOSIPHON

Zarling Aero and Engineering

Thermal Analysis of Thermal Pin Piles

Thin organic layer, four-inch thick insulation and thermal pile unit conductance is 1.0 BTU/hr-ft-F



Spring

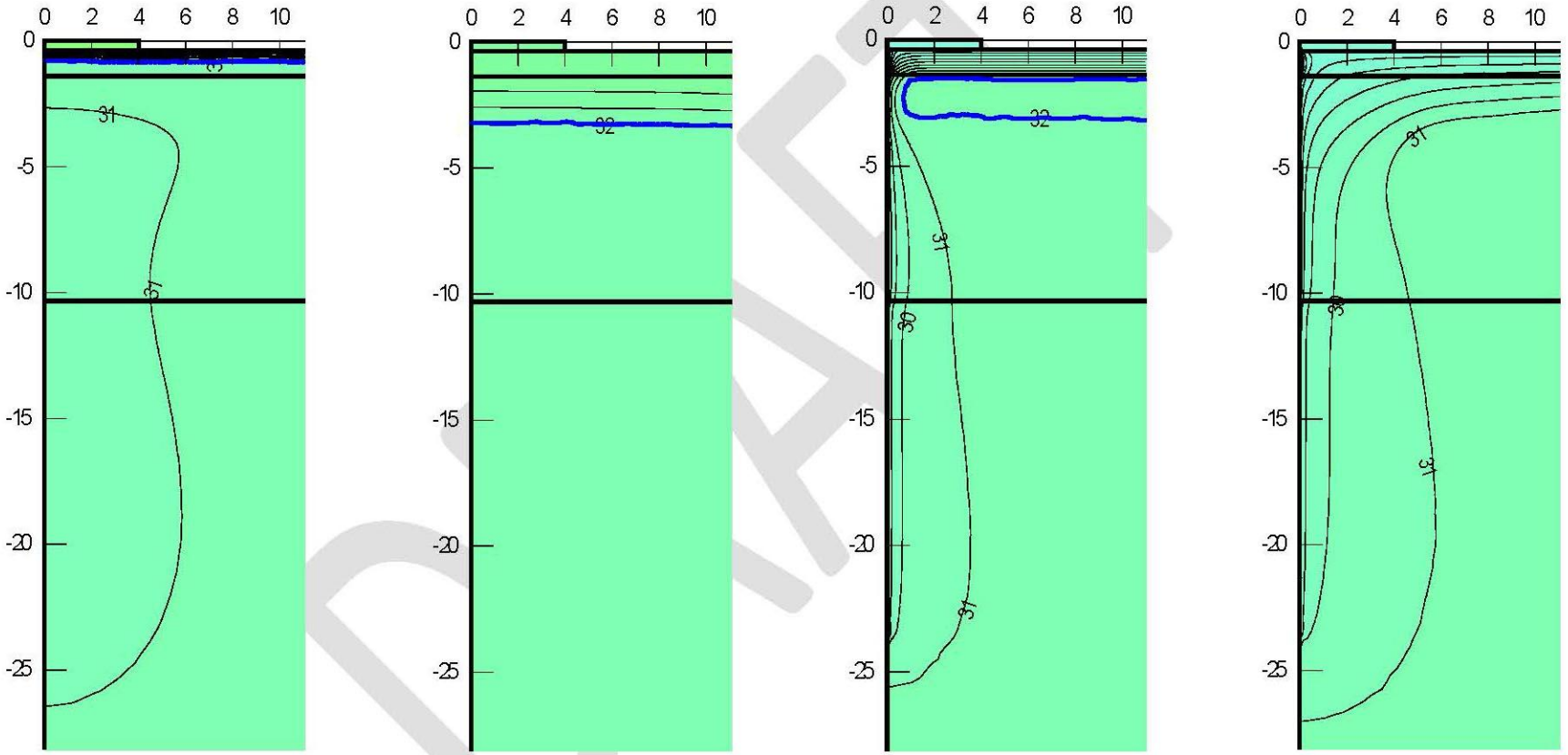
End of Summer

Early Winter

Mid Winter

THERMOSIPHON

Thick organic layer, no insulation and thermal pile unit conductance is 1.0 BTU/hr-ft-F



SCREW ANCHOR

SCREW ANCHOR

PROJECT STATUS UPDATE
Overhead System Load Cases

- NESC 250B, 4 psf wind, no ice
- NESC 250C, 120 mph wind, no ice
- NESC 250D, 80 mph wind, ¼" ice
- 1" ice, no wind

- Max final tension (42.1%) and sag (25.5') with 1" ice
- Max transverse load on guys with 120 mph wind (27.8% of NESC limit, 3/8" EHS guy wire)
- 24' ground clearance goal met with 50' pole/insulator.
- Standard construction OK for 10-degree angles

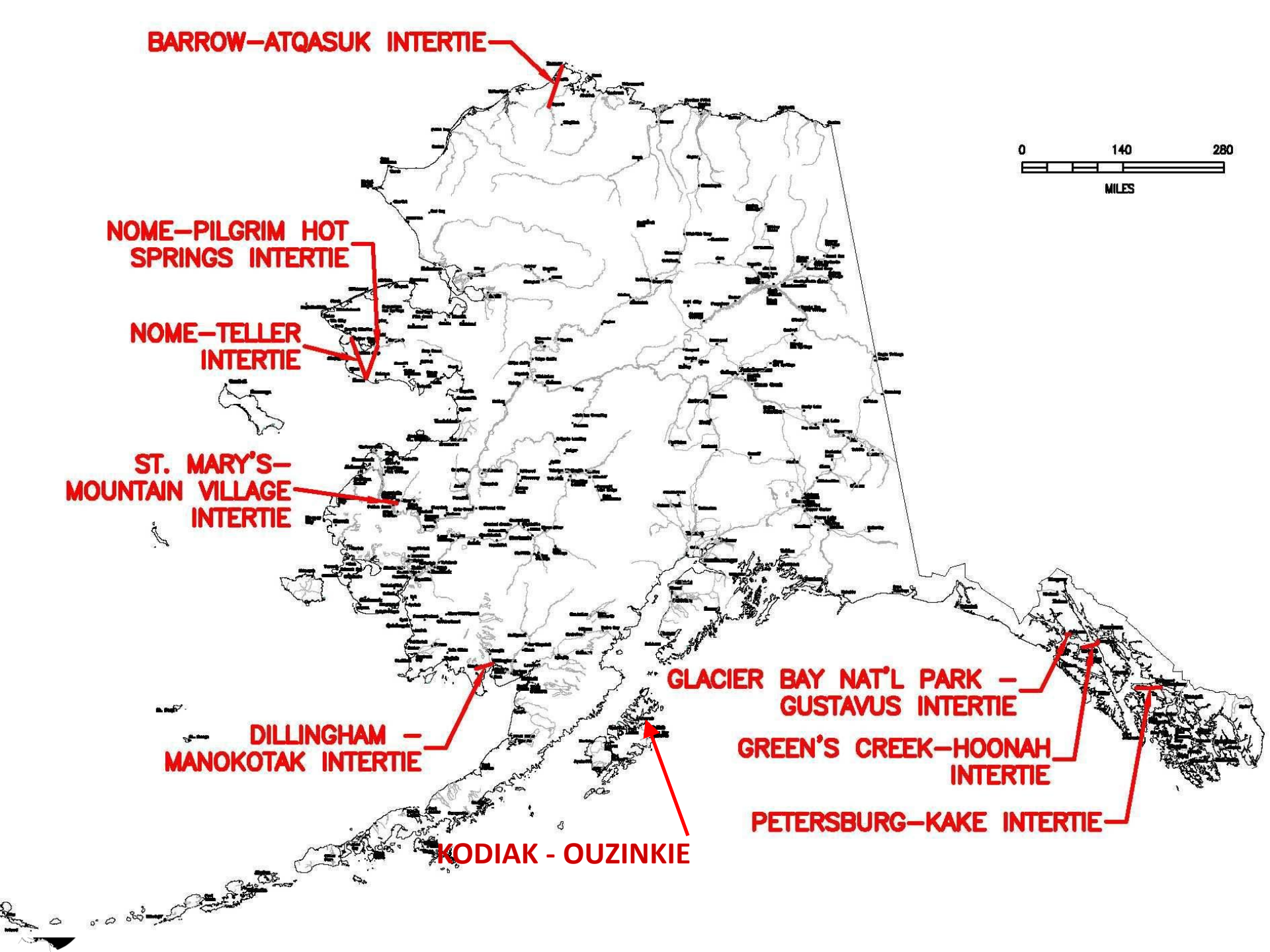
PROJECT STATUS UPDATE
Overhead System Foundations

- Pole base – compression (and some moment)
  - 5,000# short-term load
  - 10,000# long-term load
- Guys – tension loads
  - 5,000# short-term load
  - 10,000# short-term load
- Guys must resist creep and frost jacking

SAG Discussion

Future of Project and Technology

- Recap
  - Extensive review of possible demonstration sites
  - Applied for Phase III Funding (EETF)


BARROW–ATQASUK INTERTIE
NOME–PILGRIM HOT SPRINGS INTERTIE
NOME–TELLER INTERTIE
ST. MARY'S–MOUNTAIN VILLAGE INTERTIE
DILLINGHAM – MANOKOTAK INTERTIE
KODIAK - OUZINKIE
GLACIER BAY NAT'L PARK – GUSTAVUS INTERTIE
GREEN'S CREEK–HOONAH INTERTIE
PETERSBURG–KAKE INTERTIE
0
140
280
MILES

Future of Project and Technology

- Lessons Learned
  - Focus on successful converter demonstration
  - Shouldn't wait for a rural intertie (~5 years?)
  - Railbelt feeder line 'demo conversions' don't demonstrate much, not very cost effective.

    (thanks to utilities for helping!)
  - Focus on useful demo of converter with rapid deployment schedule

Current Working Plan

- Part 1
  - More testing in Princeton, final commercialization work
- Part 2
  - Alaska demonstration installation
  - Working on a site
- Part 3
  - Work with utilities to find HVDC projects
  - Forge partnership with utilities/communities for full demo

QUESTIONS AND COMMENTS