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HV BPL Project Summary

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Certification in Field Reliability

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HV BPL Demonstration Project Background

- **One of DOE's funded demonstration projects of advanced technology for smart grid applications (substation automation)**
- **Project started in Nov 2007.**
  - SOW was based on earlier 2006 work in Charleston, W.V.
  - Program supported by the Office of Electricity Delivery & Energy Reliability
  - Program administrator is DOE/NETL (National Energy Technology Laboratory)
- **Key applications**
  - Replace old pilot wire for protective relay applications. Motivation: significant cost savings. Pilot wire technology is being phased out
  - SCADA expansion to remote stations. Motivation: economical way to extend control and visibility to remote stations
  - Station surveillance. Motivation: protect critical assets (e.g. copper theft) and comply with DHS requirement
  - Advanced protection. Motivation: employing such new digital technologies as WAMs and SIPS

Transmission BPL Proof of Concept Demo

November, 2006 – Charleston W VA

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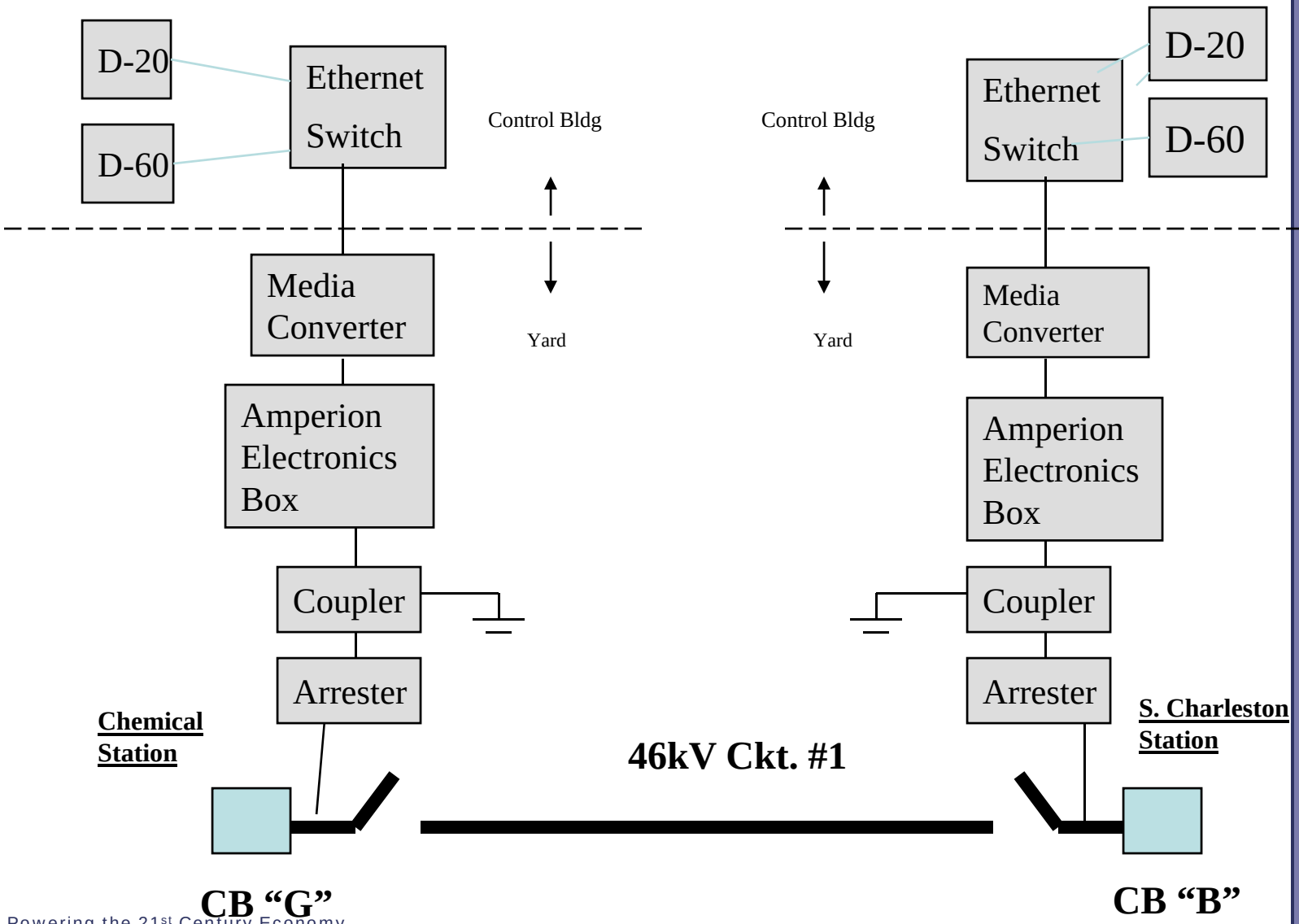

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HV BPL Project Plan

Project Phases

- Phase 1: Establish point-to-point station communications between Heath and Granville stations over a single 0.77 miles HV BPL link
  - Requires only HV station class couplers
- Phase 2: Establish HV BPL communications between Granville and West Granville, over 4.4 miles using repeater links
  - Requires also HV pole mounted T-line couplers for the intermediate repeater nodes

Project Steps

- Lab evaluation of HV arrester technology
- Design and build of HV couplers
- Field installation and establishing HV BPL communications
- Remote monitoring and continuous measurements

Project Milestones 2008

- Completed phase 1 deployment successfully on May 2nd
- Completed phase 2 deployment successfully on October 10th

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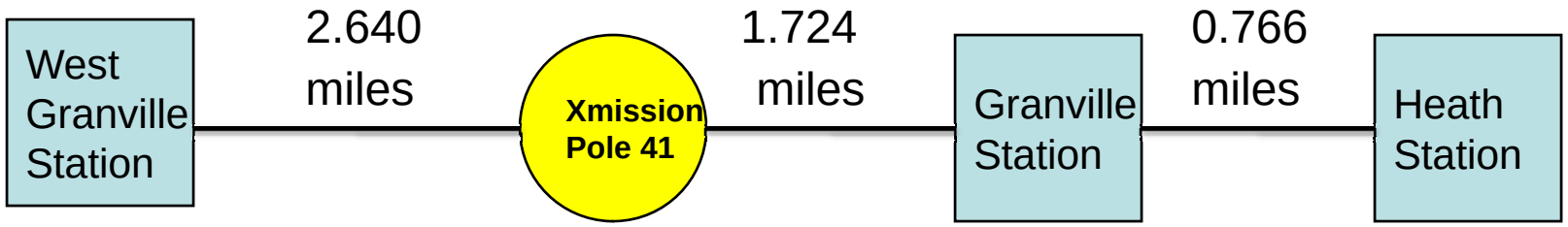
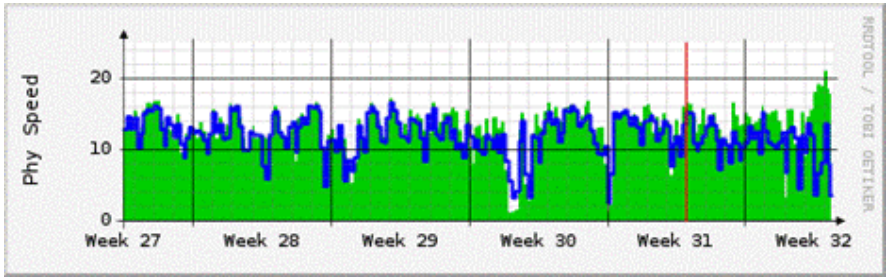
5.13 Mile 69 KV Network Diagram





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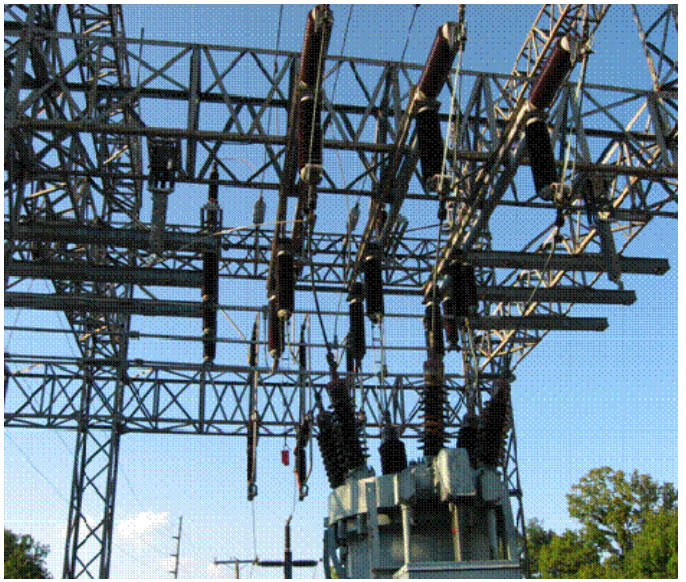
HV BPL Phase 2 Demo - Granville to West Granville communications over 4.4 miles

Highly efficient differential coupling on phases 1 and 3 with balanced lines
Provides noise cancellation and signal recovery even in poor SNR conditions

Granville Station

West Granville Station



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69kV HV Station Coupler Installed in Granville

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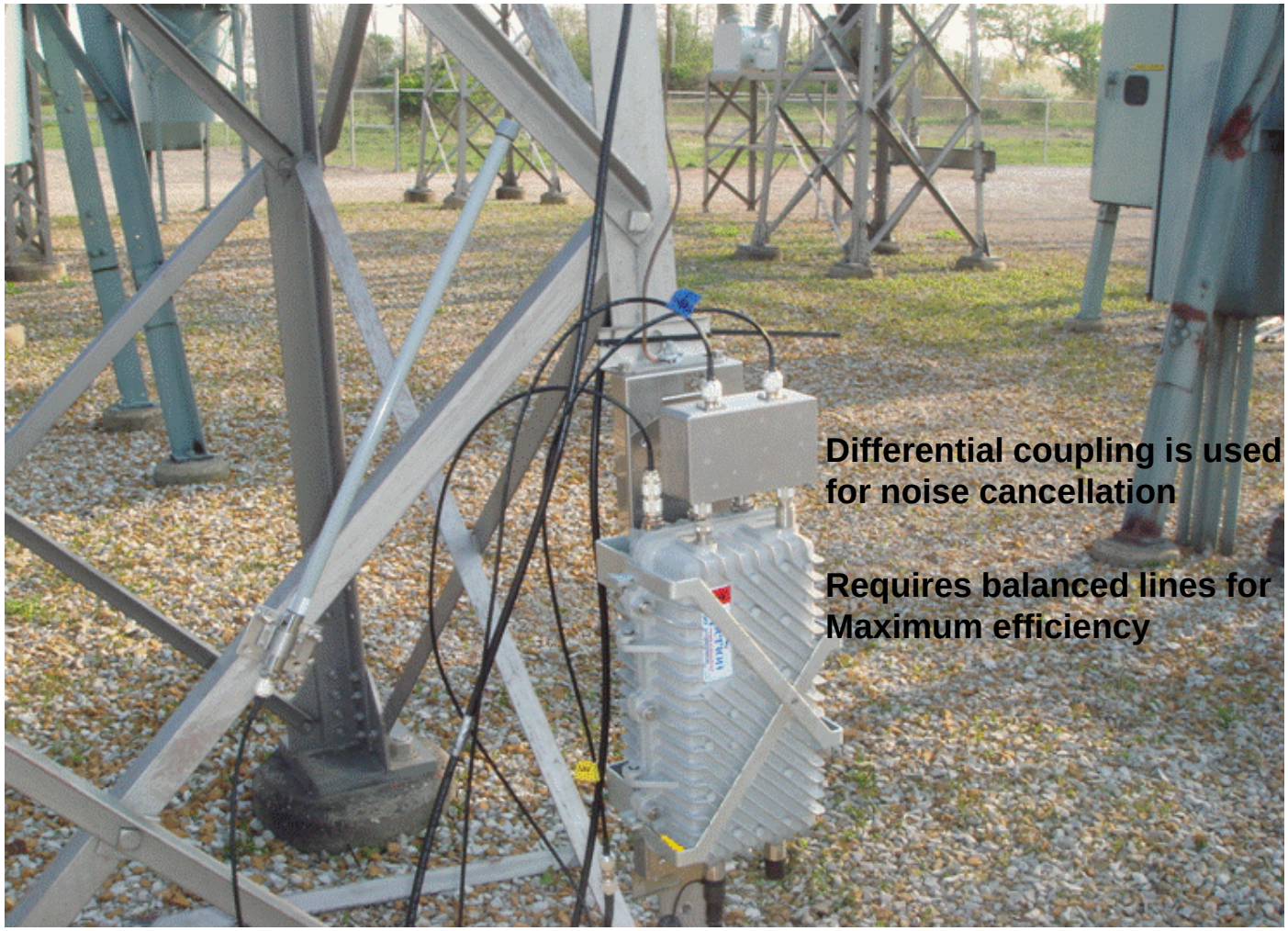
Griffin With Differential Coupling on Phases 1 & 3 at Heath Station



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Granville to West Granville Intermediate T-Line Repeater Installation on Pole 41

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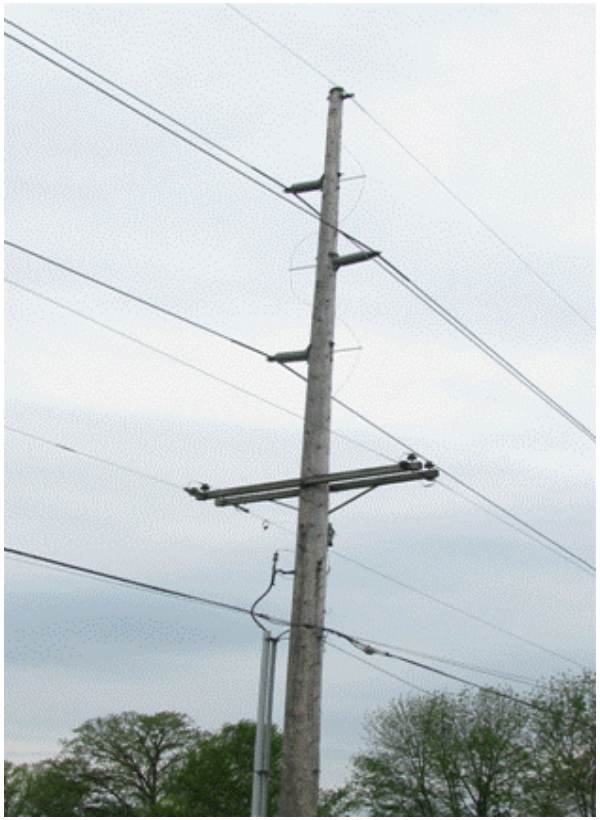

Pole 41 Before the installation and … After with all 4 HV couplers installed

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Griffin Mounting Bracket with BBU – Battery Back Up Unit on Pole 41

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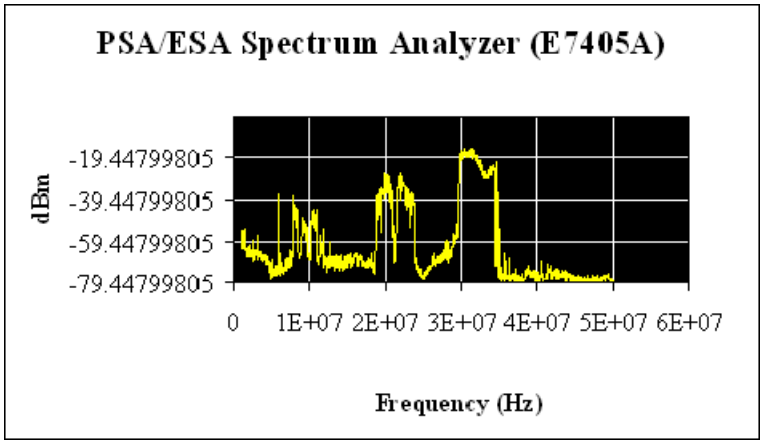
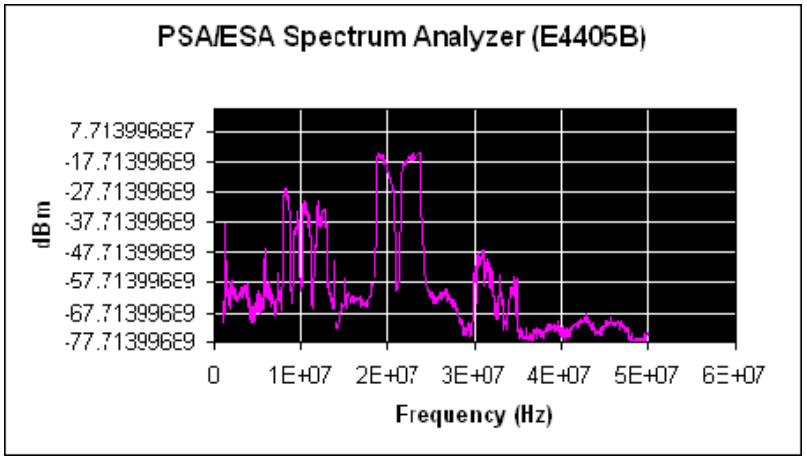
Views From Spectrum Analyzers in Both Stations





West Granville shows all 3 BPL links

Granville shows all 3 BPL links

BPL Links use 5Mhz bands: 8 to 13Mhz, 18 to 23Mhz and 29 to 34Mhz

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Detection of noise source using 24/7 continuous monitoring of HV BPL Link

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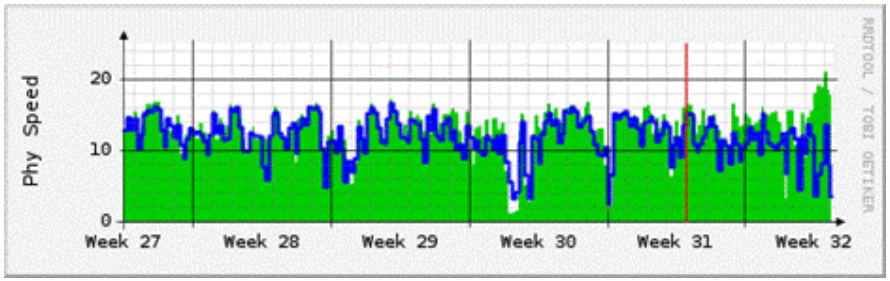

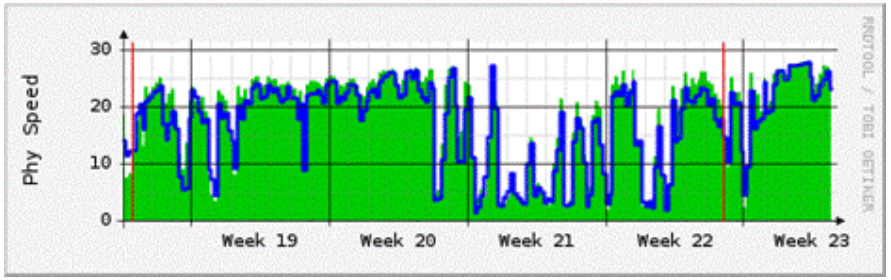

On week 23 there was a noise source that reduced throughput to single Mbps, but the link stayed up with 100% availability

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Arcing on Pole 1 near Granville Station was source of noise detected by Amperion BPL unit inside the station

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Arcing source found - pole ground wire was too close to a floating 69kV insulator base

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Pole 1 after the mitigation – GND wire was moved 2” away from the insulator base. A potential pole fire and an outage was avoided

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Added Benefit of BPL – Early Detection of Failures improving grid reliability and SAIFI

- **Initial site surveys prior to BPL deployment can locate noise sources to be cleaned up (Exacter used for this project)**
- **BPL system can be used for early detection of failures on the HV feeder**
- **The network management system provides continuous monitoring of the lines and can be configured to send alarms to a back office application when a noise event is triggered or a low BPC threshold is reached**
- **Complete link health reports can also be sent automatically from the management system for further analytics**

Summary: HV BPL Substation Communications

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- HV BPL Applications
  - •Protective Relaying
    - Replacing pilot wire
    - Advanced protection schemes
  - •SCADA Expansion
    - Connecting remote substations
  - •Station Surveillance
    - Protecting unmanned stations and utility assets with wireless cameras

- HV BPL RF Coupling Technology
  - •Field tested on 46kV and 69kV lines
  - •Uses standard utility arresters
  - •Uses differential coupling for noise cancellation and improved stability
  - •Lab testing 138kV technology

8/26/09

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Project Goals Met or Exceeded

- **Continuous BPL operation achieved for 6 months over a 5-plus mile link using one station-based and one line-based repeater**
- **Noise source location methods developed and found effective**
- **Arrester coupling techniques successful and scalable**
- **Differential coupling techniques developed and proven**
- **FCC compliance demonstrated**
- **Next Steps**
  - Increase to 138 KV operation using similar techniques
  - Survey noise characteristics on a variety of HV lines
  - Develop low cost method to power transmission line repeaters from line voltage
  - Improve noise source location diagnostics
  - Develop correlation of noise sources and line defects
- **Most recent accomplishment: Station-to-station repeater-less link over 4.4 miles demonstrated**

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Contact Information

For additional information, contact

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