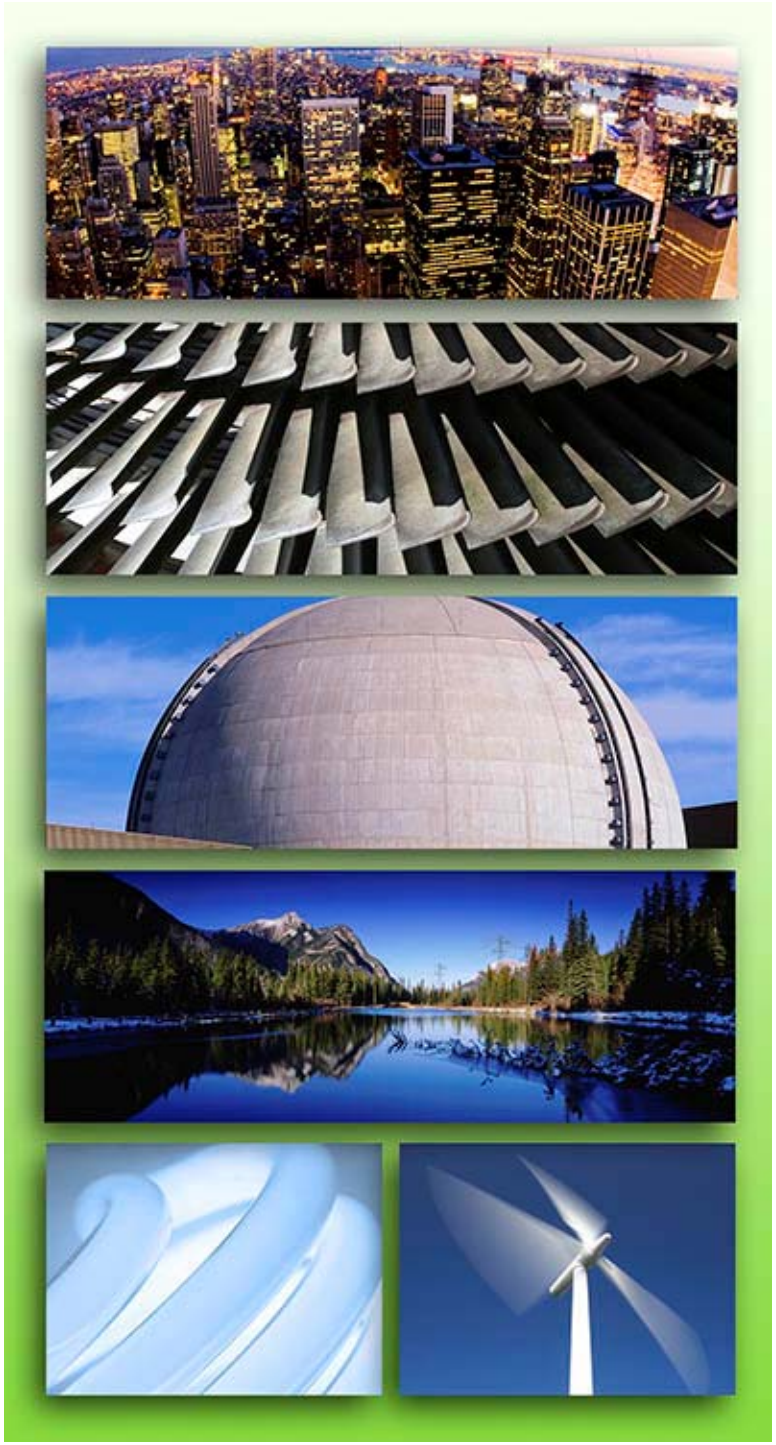

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Project 128.005 2009/10 NEV & Urban Stray (Contact Voltage) Diagnostics & System Design

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407-968-3010

February 24th 2009

Project P128.005 – 2009/10 NEV & Urban Stray (Contact Voltage) Diagnostics & System Design

Objectives

- Promote standardized methods to identify and deal with elevated neutral-to-earth voltages NEV and energized conductive objects

Deliverable

- Technical Update(s) – Website/Guidebook

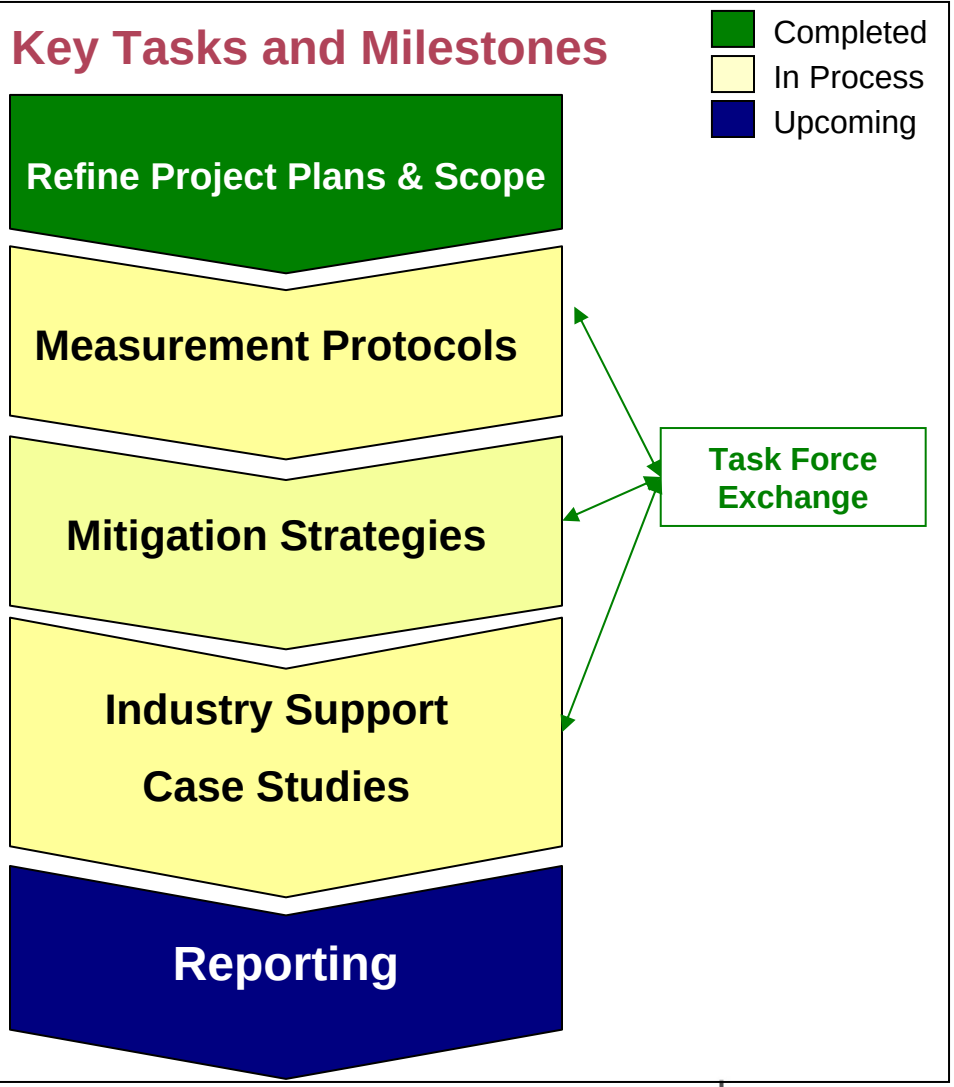
Completion Date

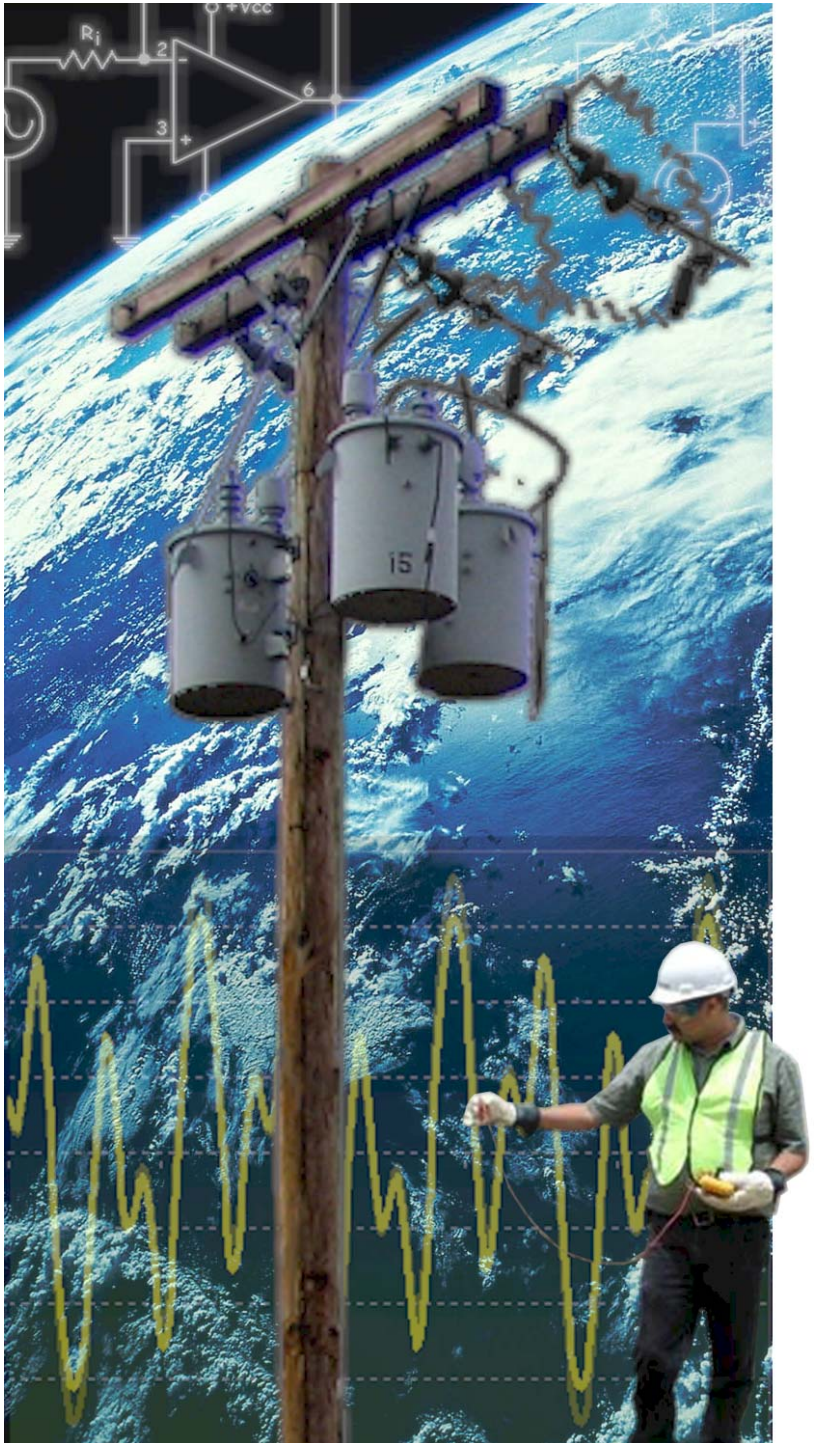
- December 2009

The Big Picture

- *Efficient diagnosis and mitigation of voltage related perception complaints benefits electric suppliers and the general public*

Key Tasks and Milestones



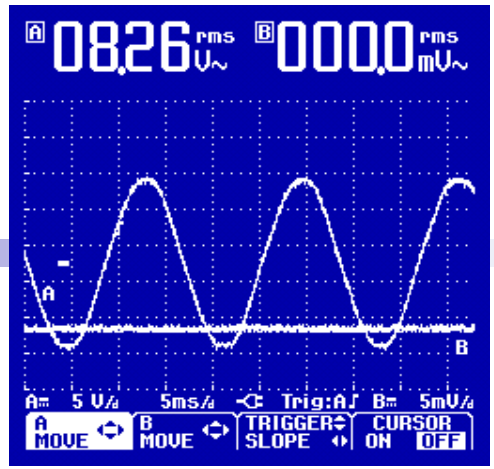


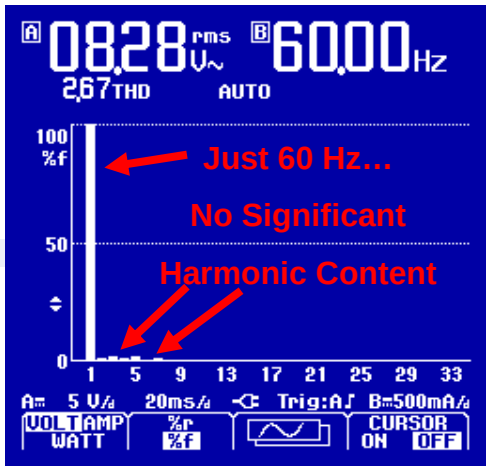
NEV & Urban Stray (Contact) Voltage 2009/2010 Plans

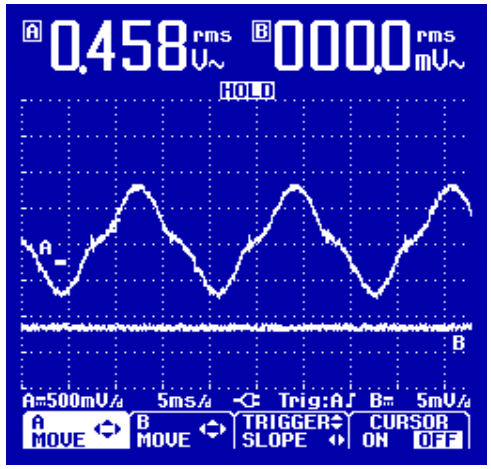
- **2009 Work Plans**
  - **EPRI Lenox Lab Testing**
  - **Field Case Studies**
  - **Waveform Library**
  - **Industry Support**
  - **Mitigation**
  - **Guidebook Chapters**
  - **Website**
  - **NEV levels**
  - **Modeling and Simulation?**

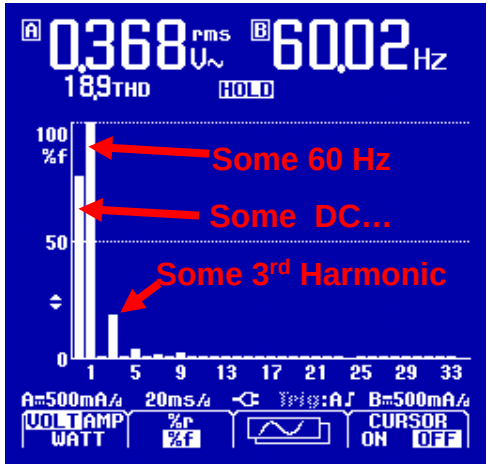
ScopeMeter Waveform Analysis Helps with Source Identification

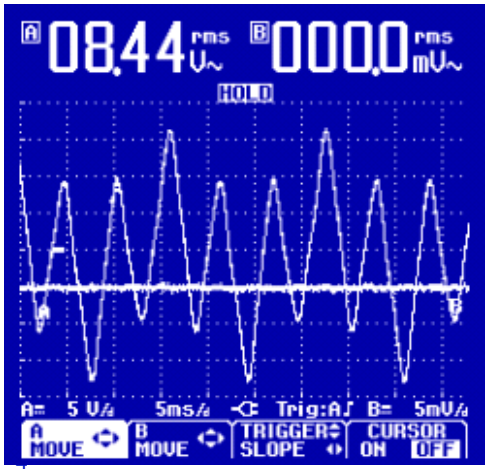
- 60 Hz Faulted Phase Conductor
- Higher Harmonic Content Neutral to Earth Voltage
- Voltage Snapshot Gas Pipeline to Remote Earth

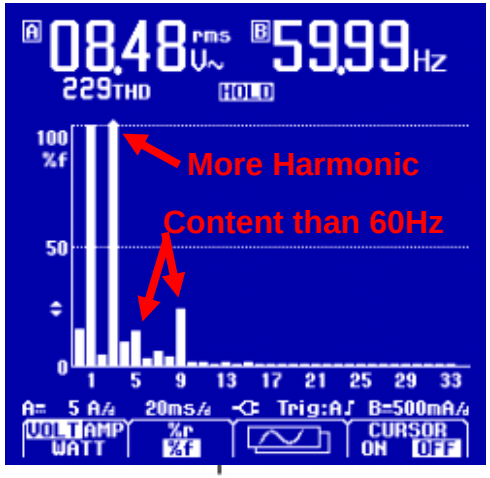




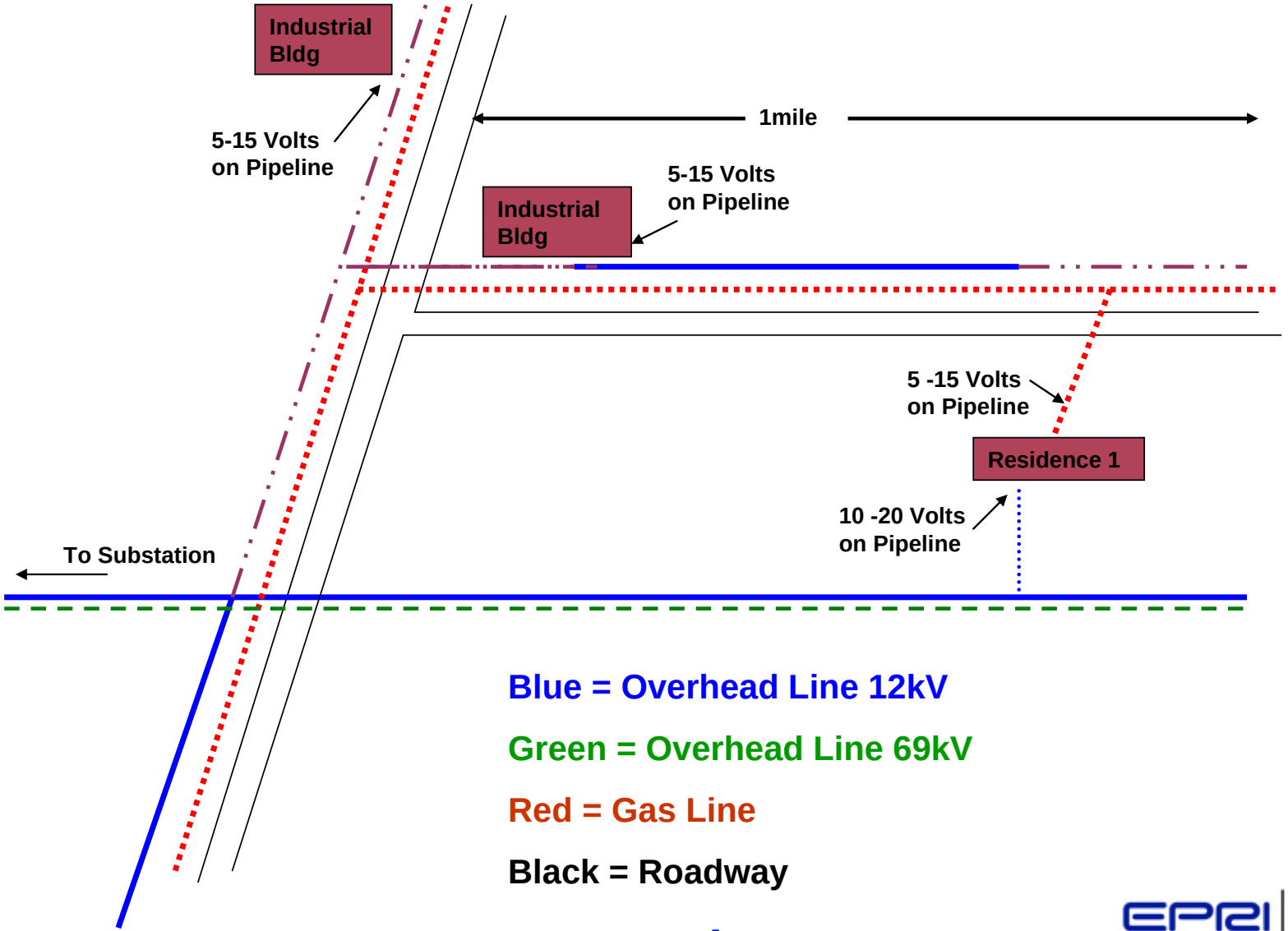








Waveform Analysis Can Help with Pipeline Magnetic Induction – Source Location

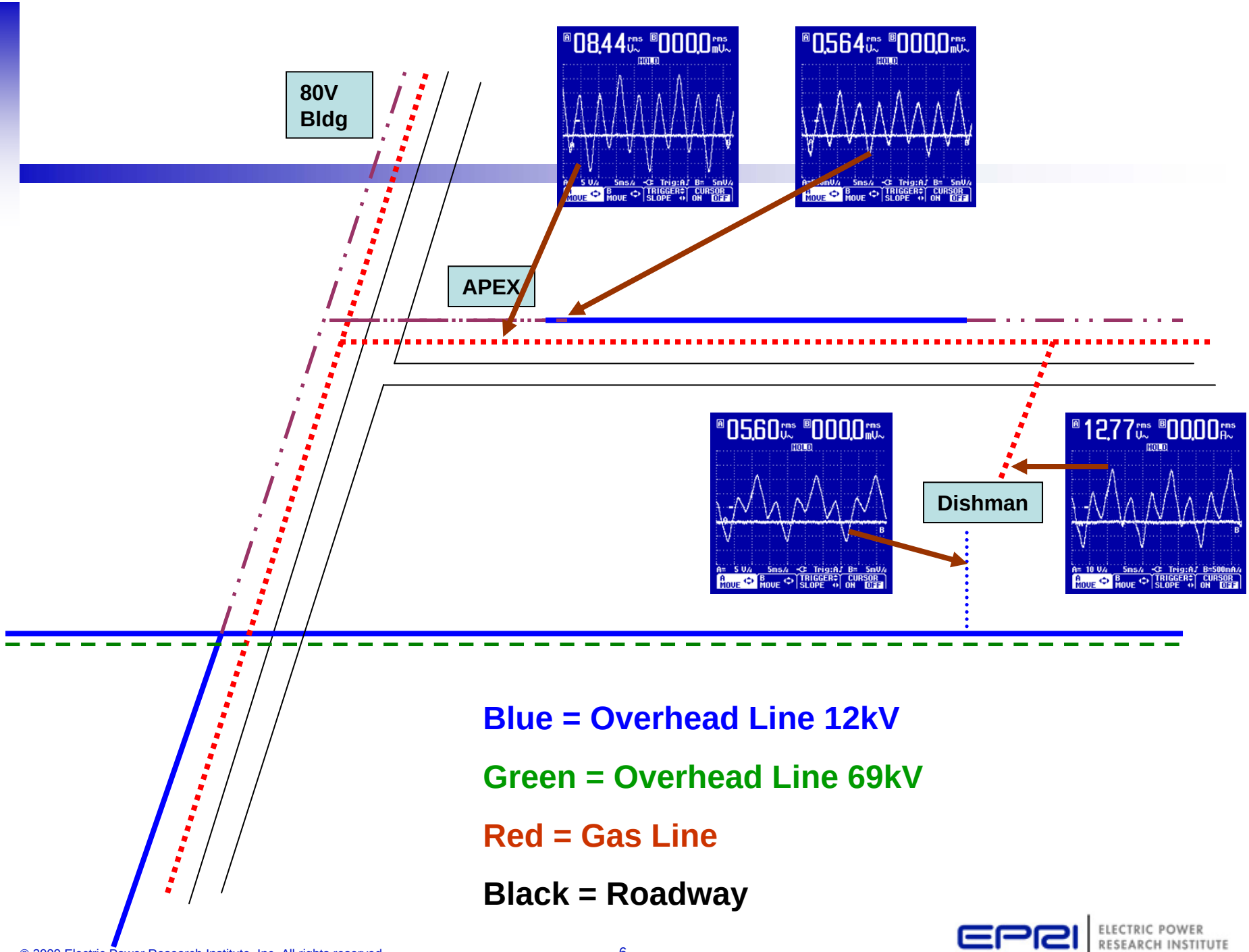


Blue = Overhead Line 12kV

Green = Overhead Line 69kV

Red = Gas Line

Black = Roadway



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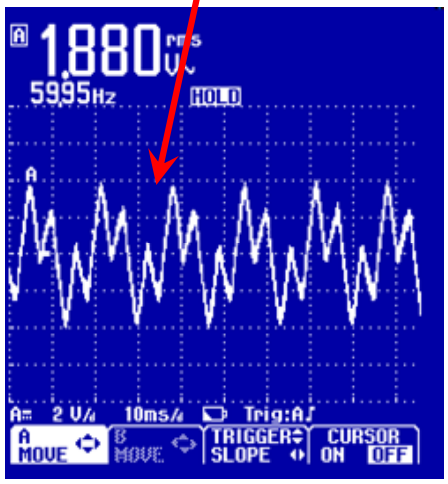
Voltages Measured on Street Lighting Can Come from Different Sources

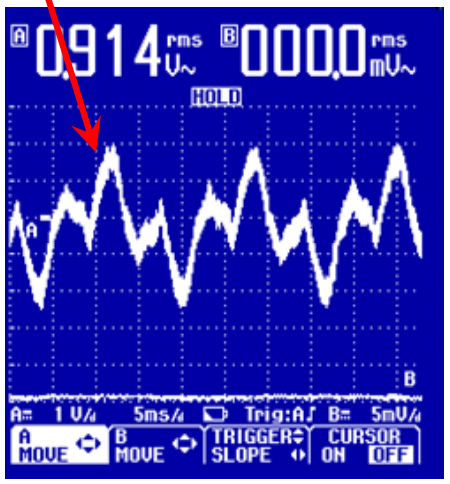
- Three street lights evaluated - Three different sources of voltage found

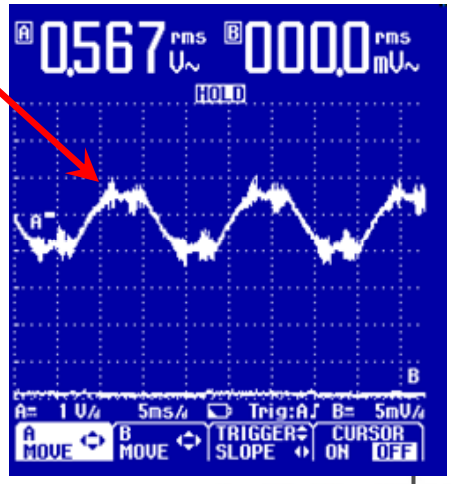
Case 1 – classical NEV source

Case 2 – magnetic induction source

Case 3 – possible 60Hz fault







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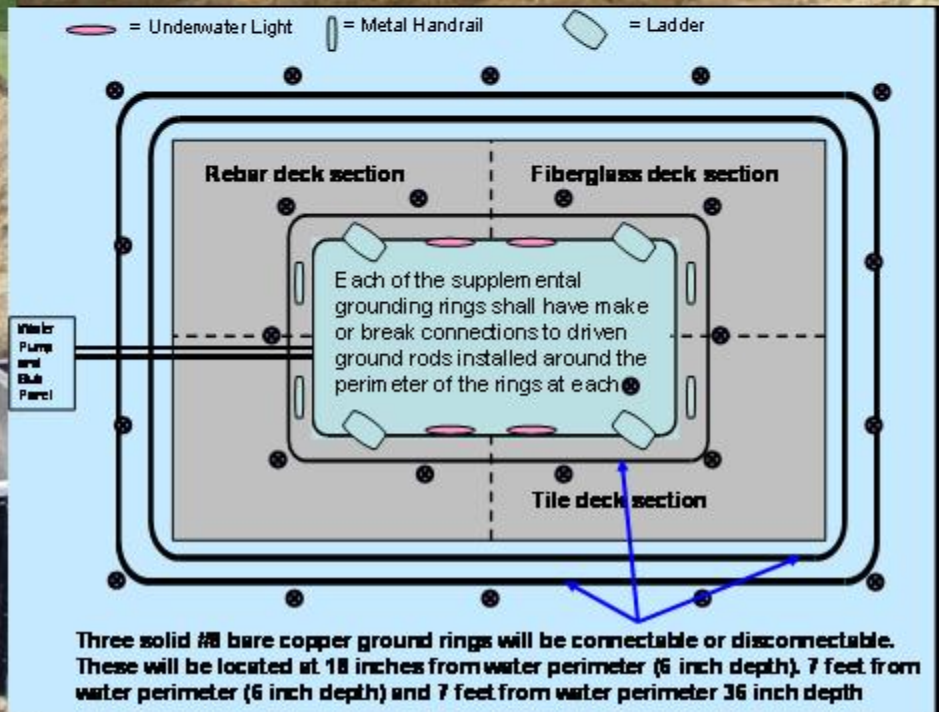
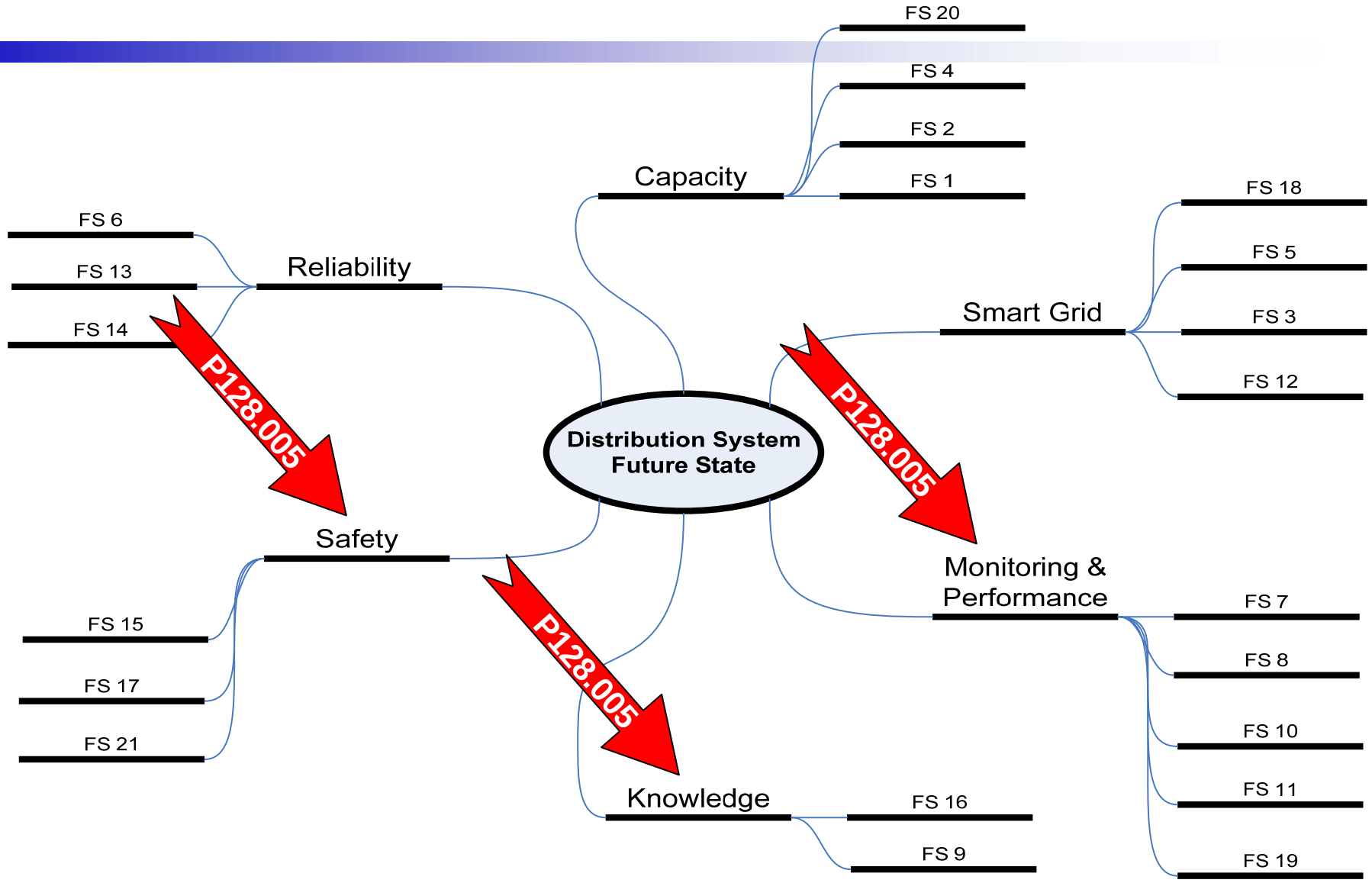
Swimming Pool Testing to Be Conducted at the EPRI Lenox, MA Outdoor Test Facility

To support the project objectives, we have constructed a controllable test area at the Lenox, MA facility
Can vary: Distribution Configurations, Neutral impedances, grounding configurations, NEV sources....



NEV & Urban Stray (Contact) Voltage 2009/2010



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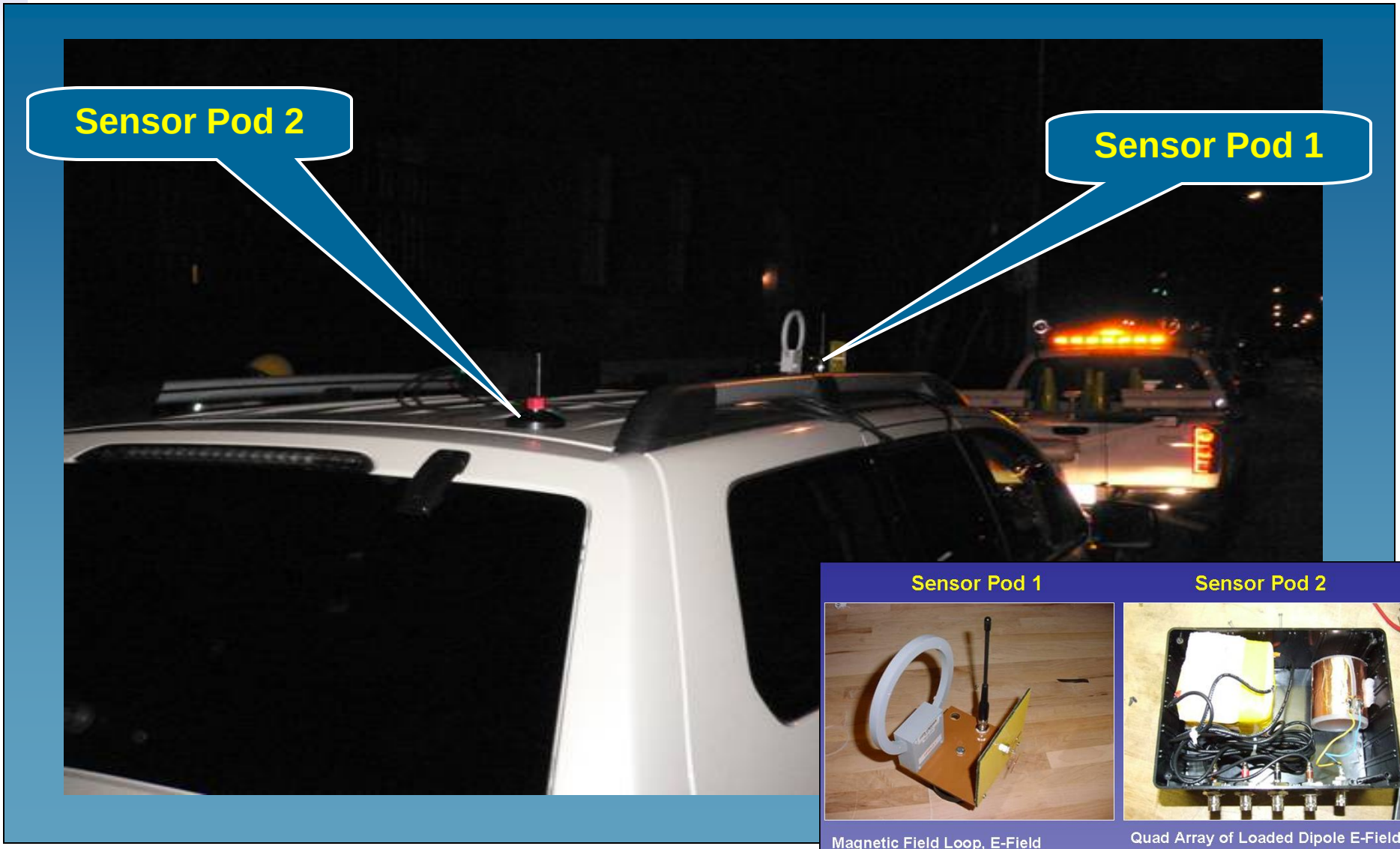
Field Trials in Feb 2008 For Con Ed TC Project on Advanced Early Detection of Contact Voltage



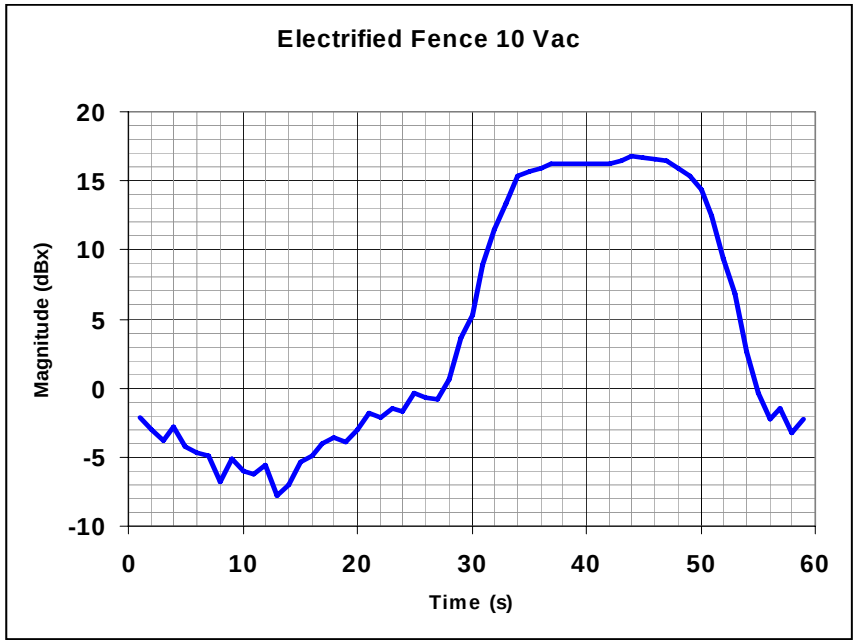
Sensor Pod 1

Magnetic Field Loop, E-Field Monopole, and Loaded E-Field Dipole Antenna Pod

Sensor Pod 2

Quad Array of Loaded Dipole E-Field Sensors and B-Dot Magnetic Field Sensor

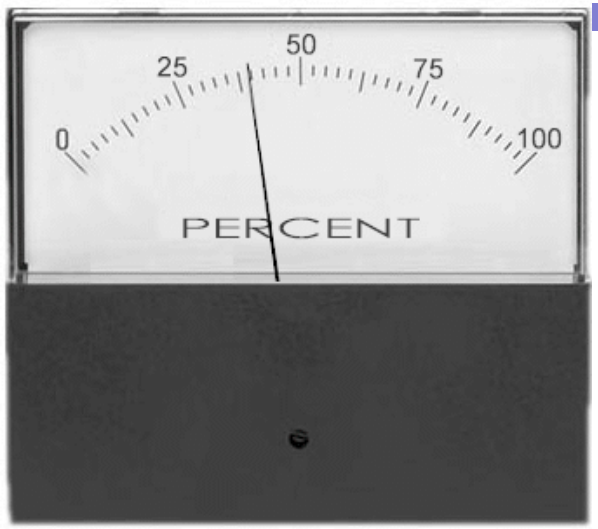
Electrified Fence Detectible During Drive By



EPRI Data From Detection Run Trail

- The EPRI team took data after the Contact Voltage truck detected an electrified fence (10 Vac).
- This trial was a confirmation of the basic detection scheme.

Prototype Handheld Efield Meter

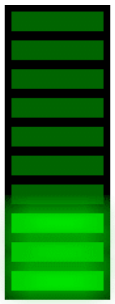


Analog Meter

- Good Measurement Resolution
- Great Sampling Resolution

Digital Meter

- Great Measurement Resolution
- Poor Sampling Resolution



LED Bar Graph

- Poor Measurement Resolution
- Good Sampling Resolution

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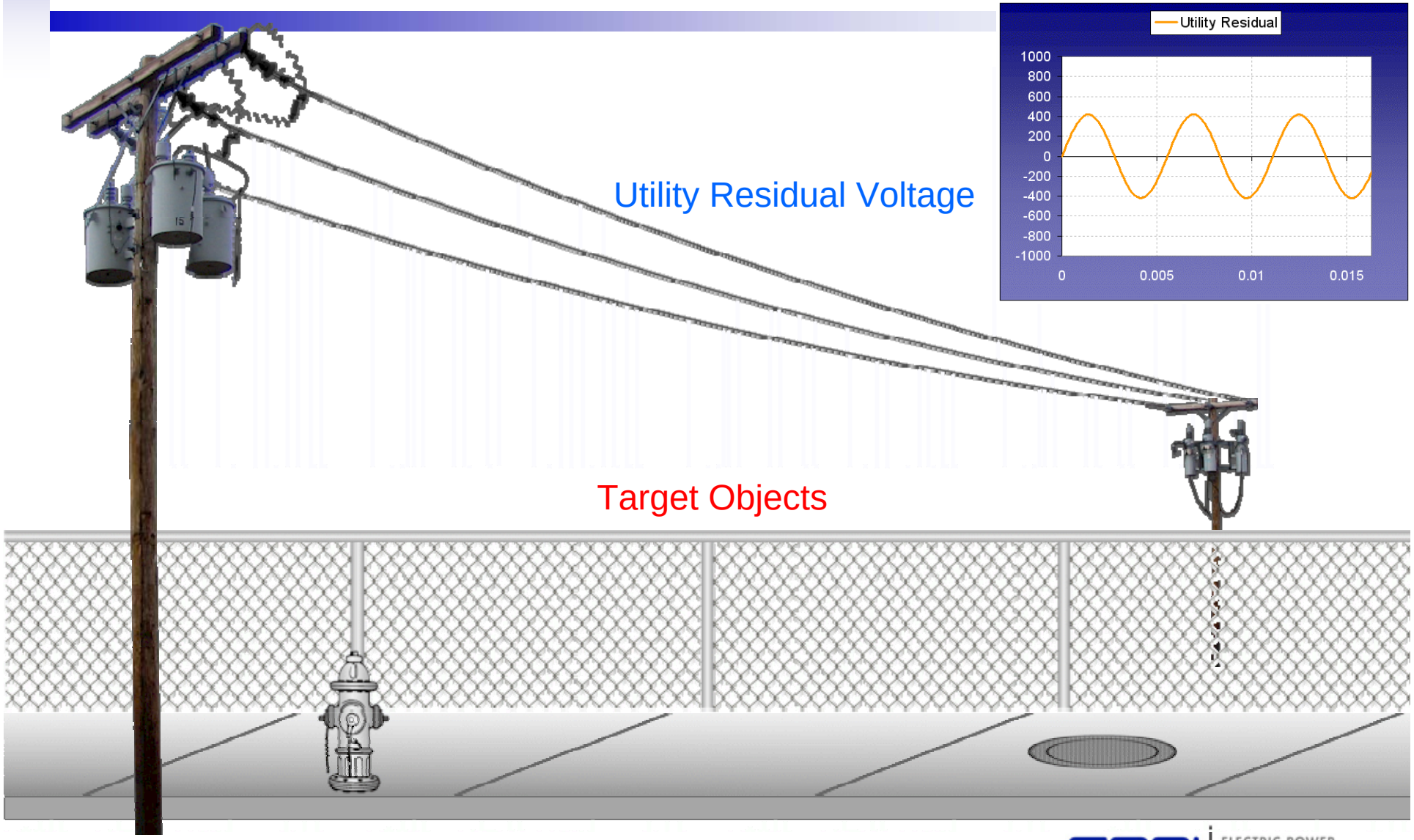
Dealing with Overhead Efield Interference



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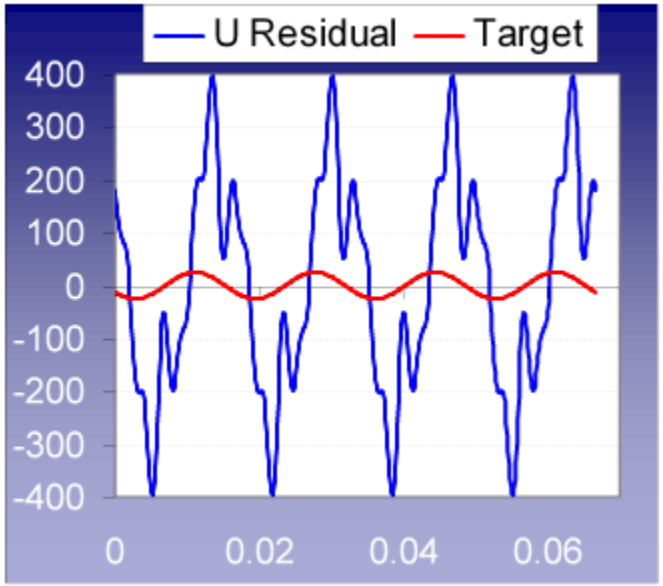
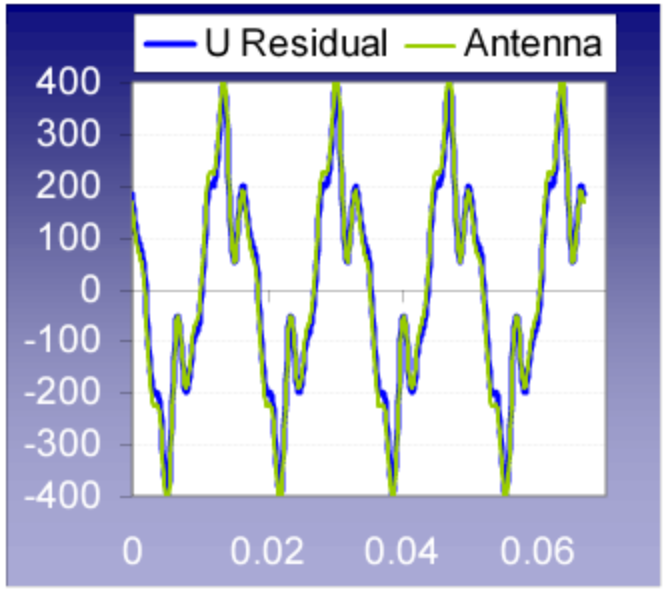
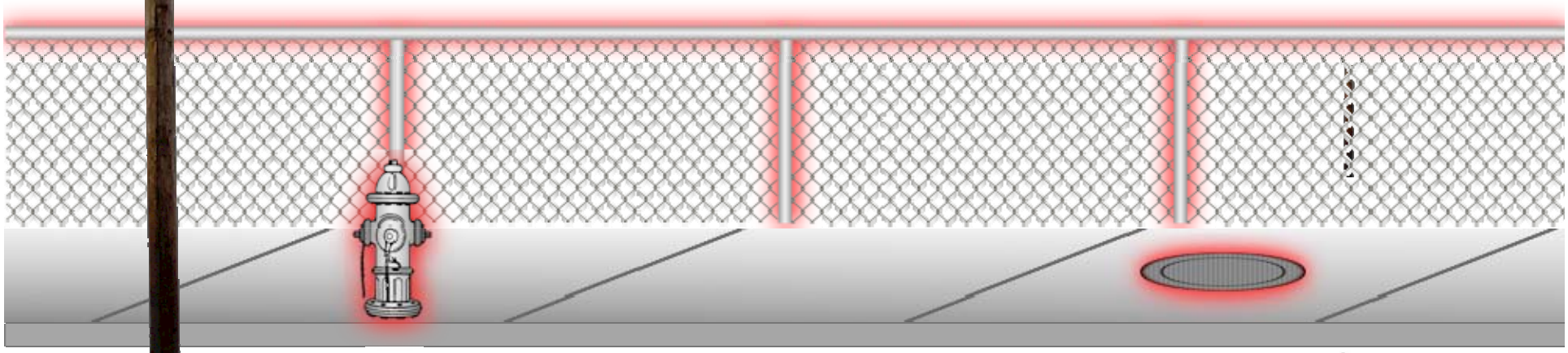
Many Algorithms are Useful in “Zeroing” out Overhead Sources

Unbalance and Harmonics





Antenna = U Residual + Target



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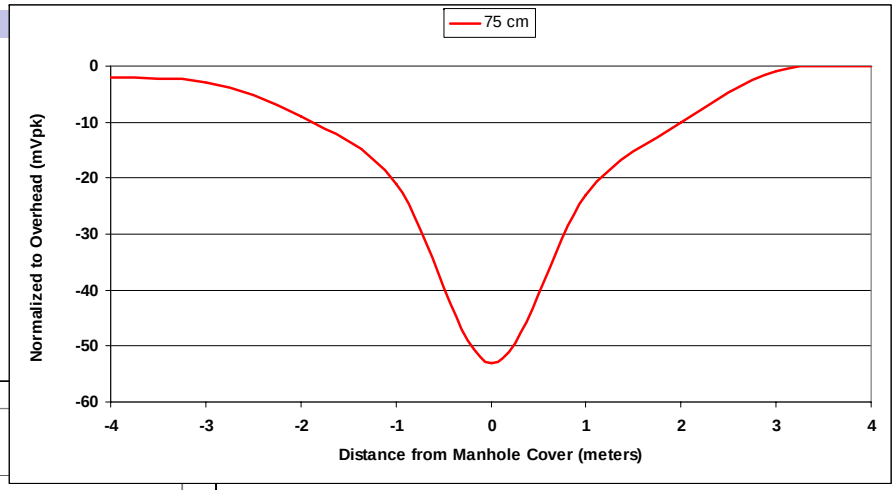
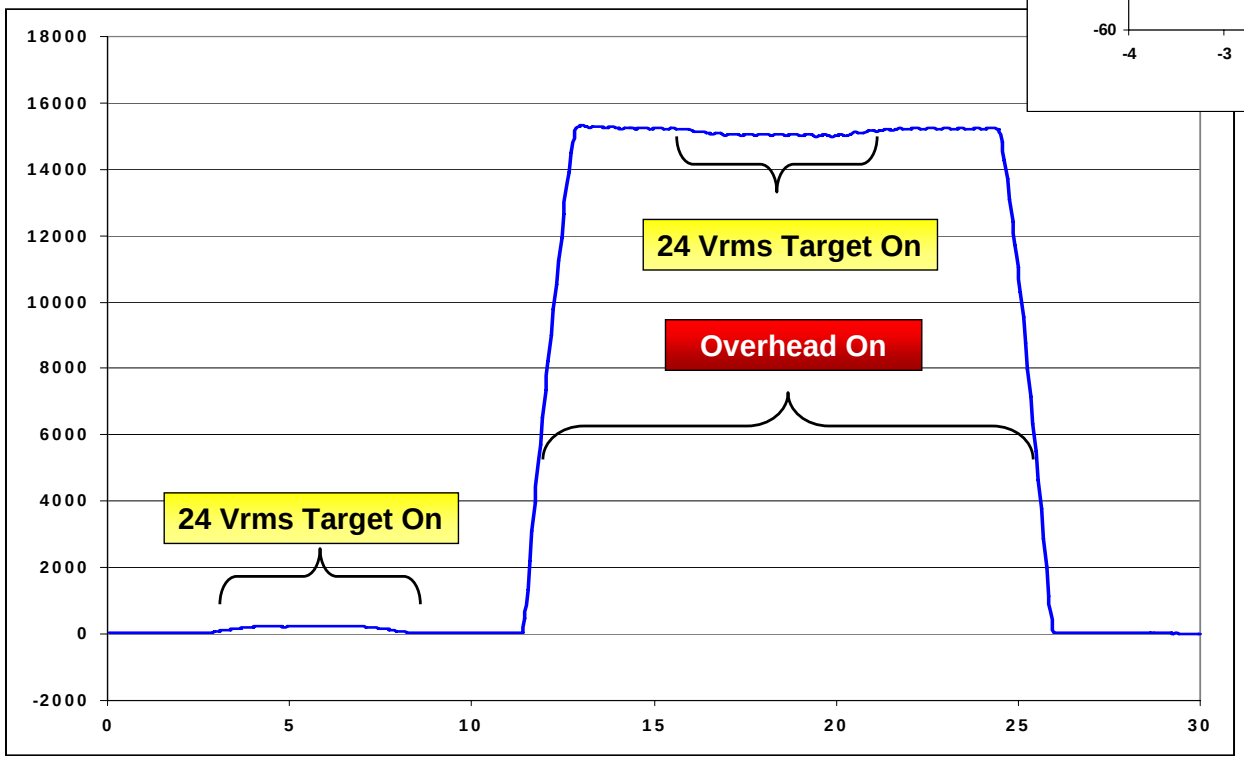
Shielded Antenna - Target & Overhead Measurement
24 Volt Target (blue) and surface object (red)





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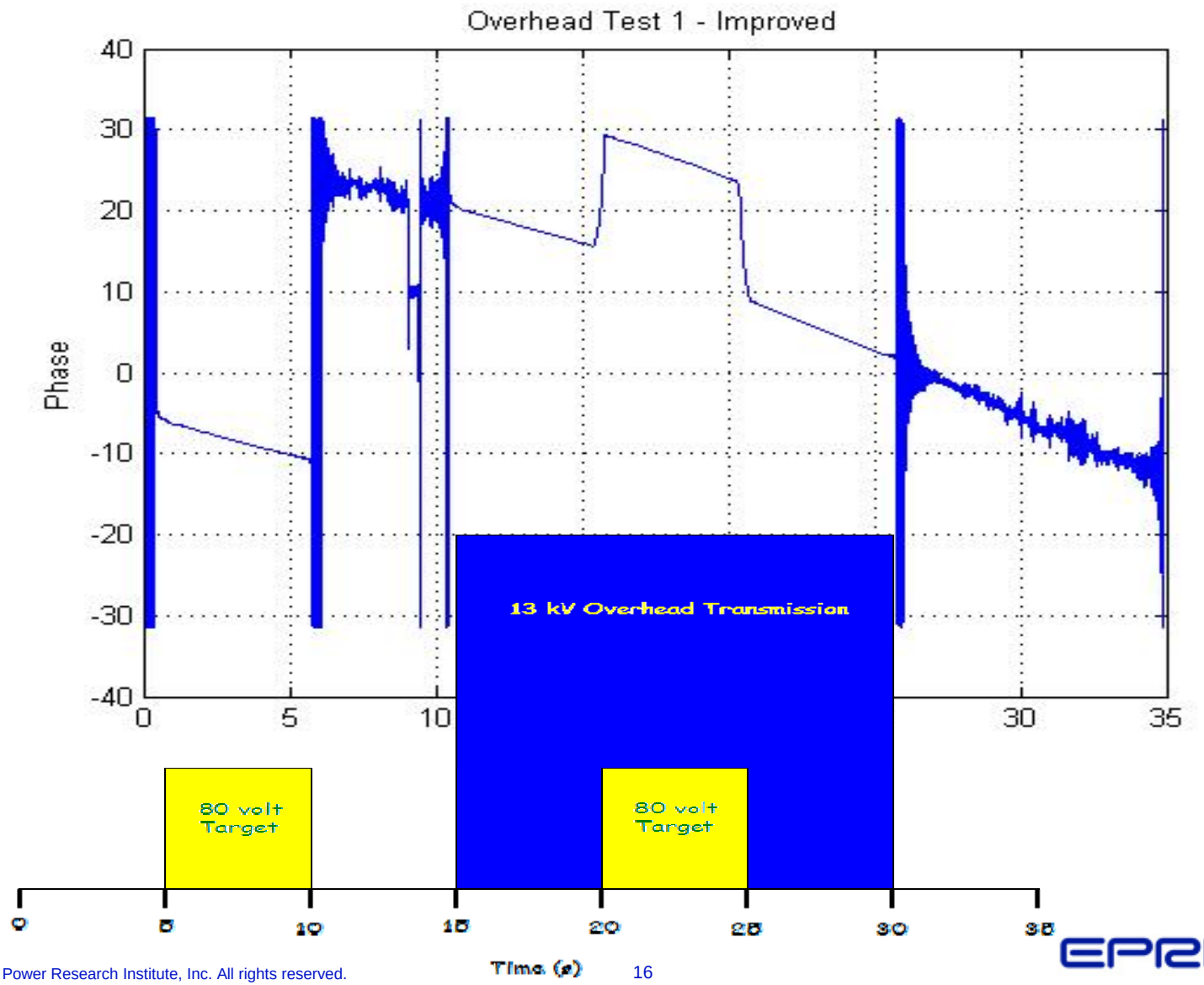
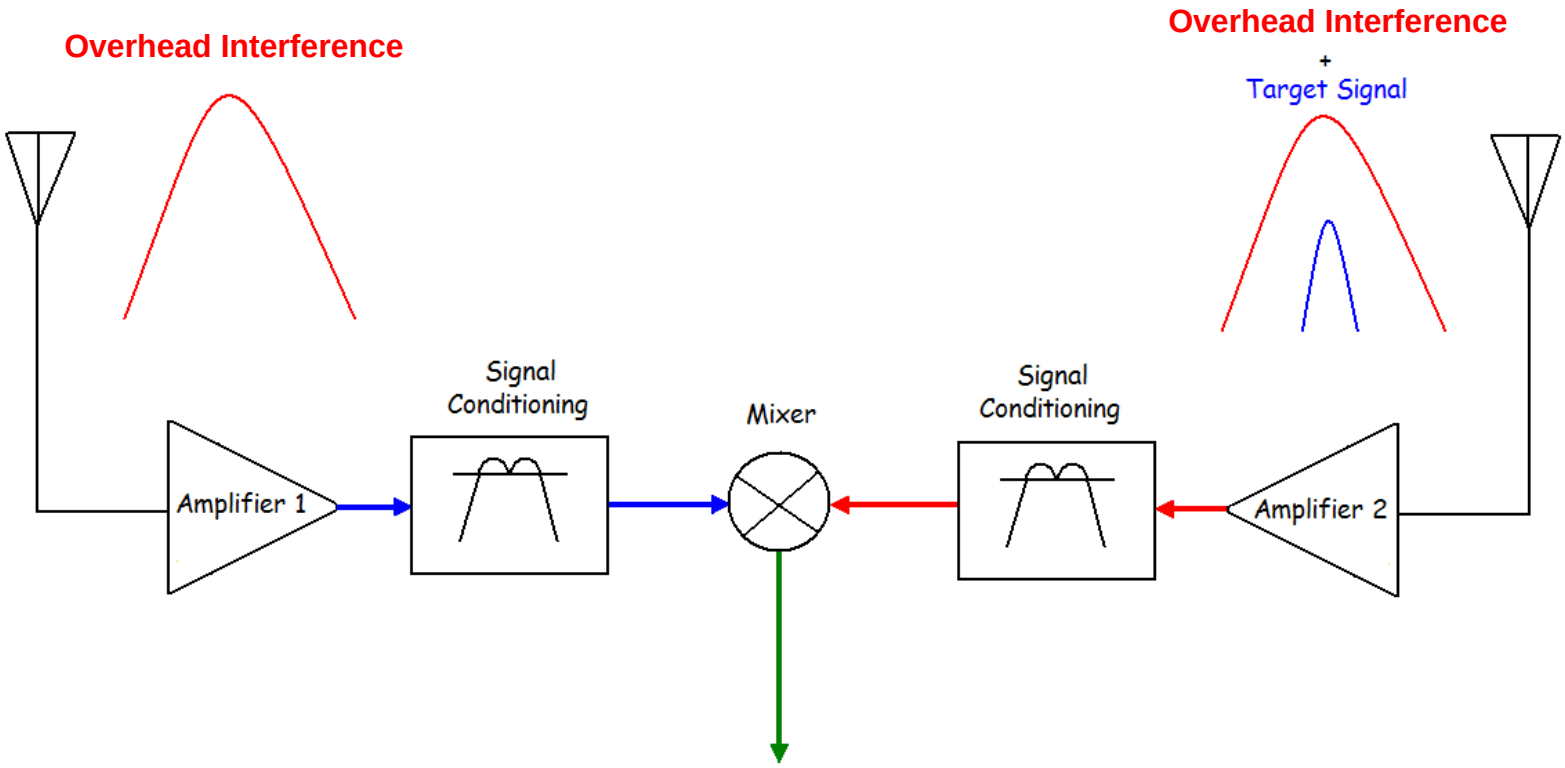
Existing Processing Algorithms Can Pick Out Energized Objects in Overhead Areas



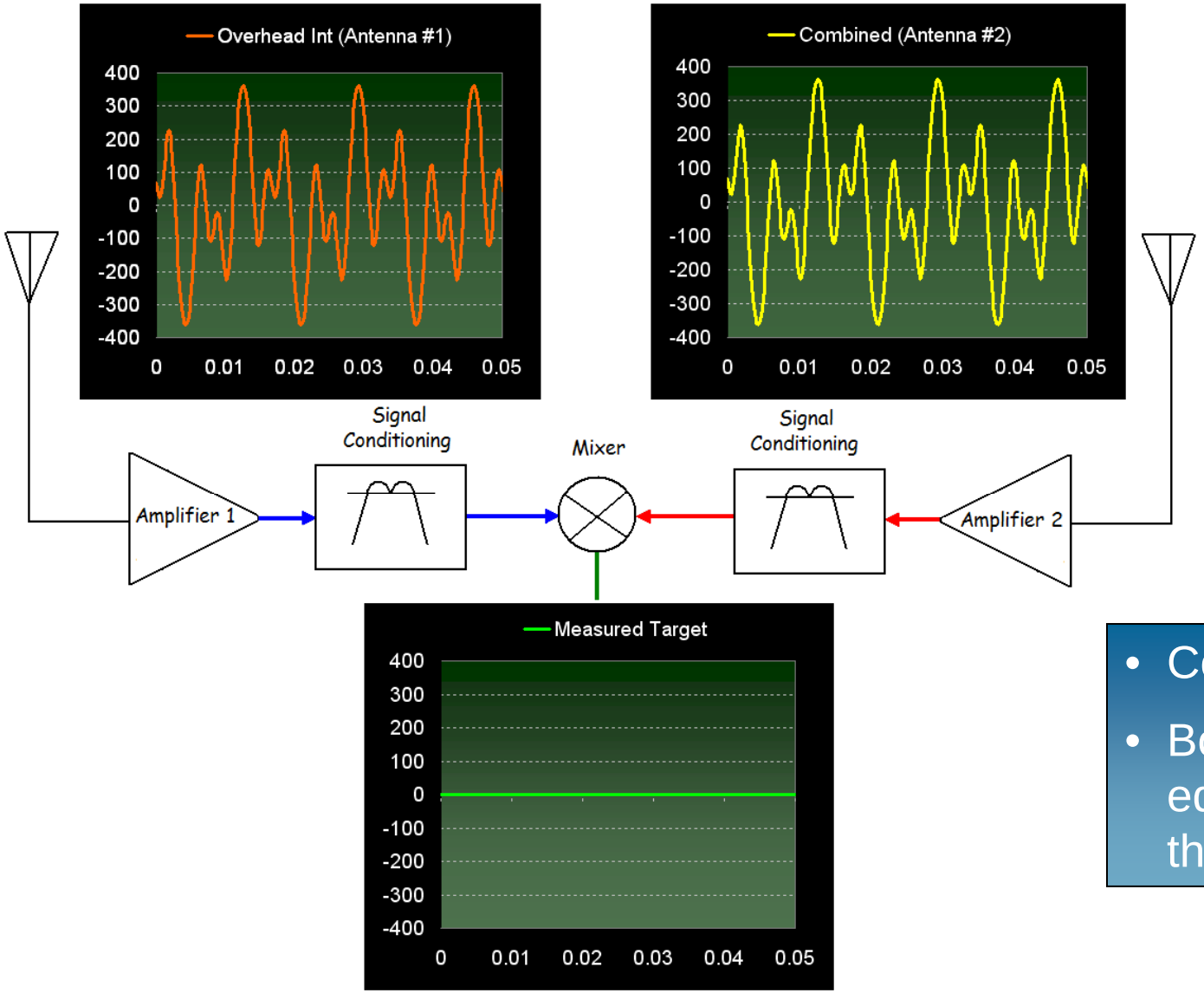
Overhead Detection Scheme Using Two Sensor Method (Still Under Test & Development)



When Coherence is 1 Both Antennas see equal amounts of the same signal.

When Coherence is Less than 1, 0.7 to 0.9, then signal may contain a target.

Overhead Detection Scheme Using Two Sensor Method (Still Under Test & Development)



- Coherence = 1
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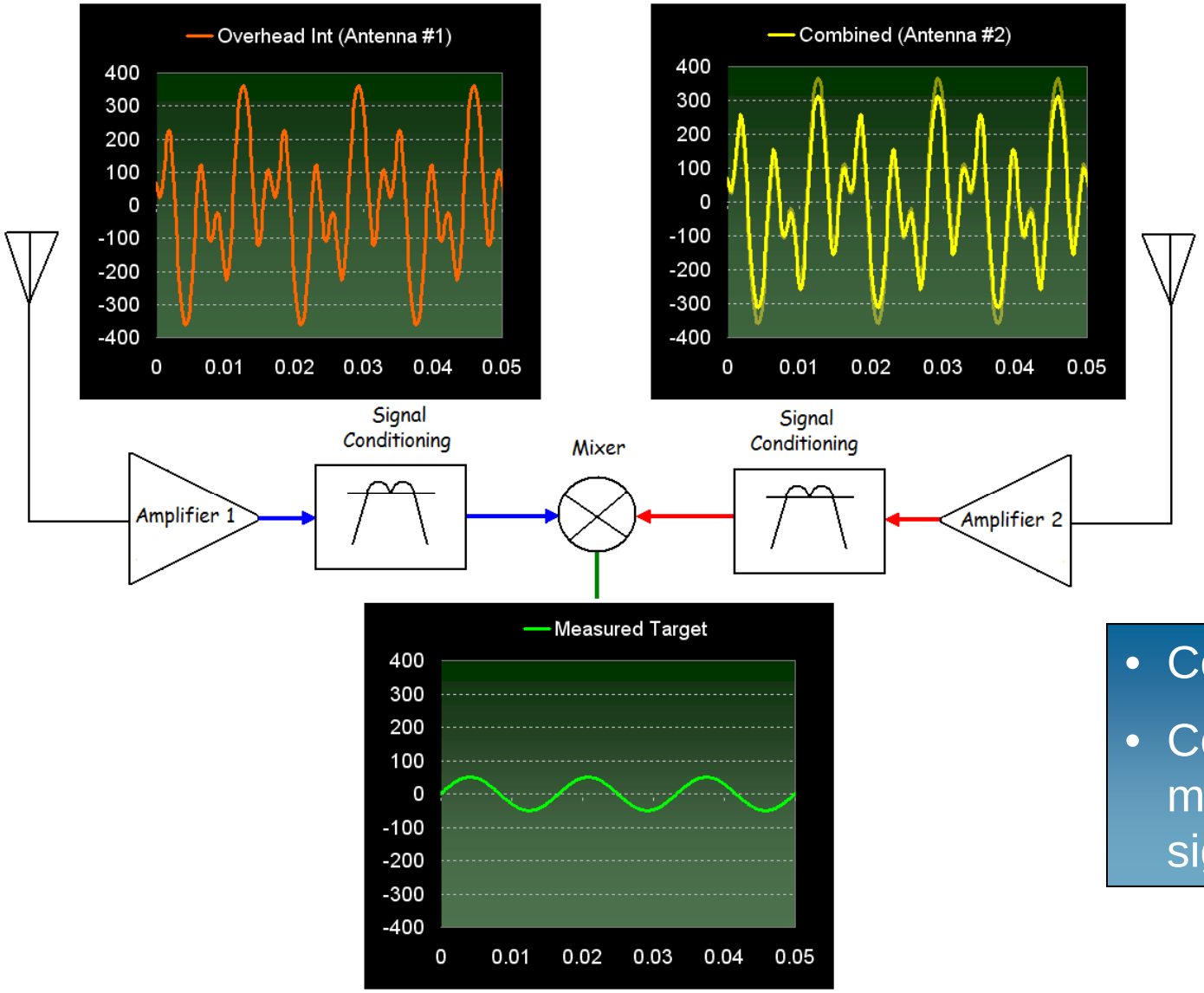

- Coherence < 1
- Combined Antenna measures the target signal.

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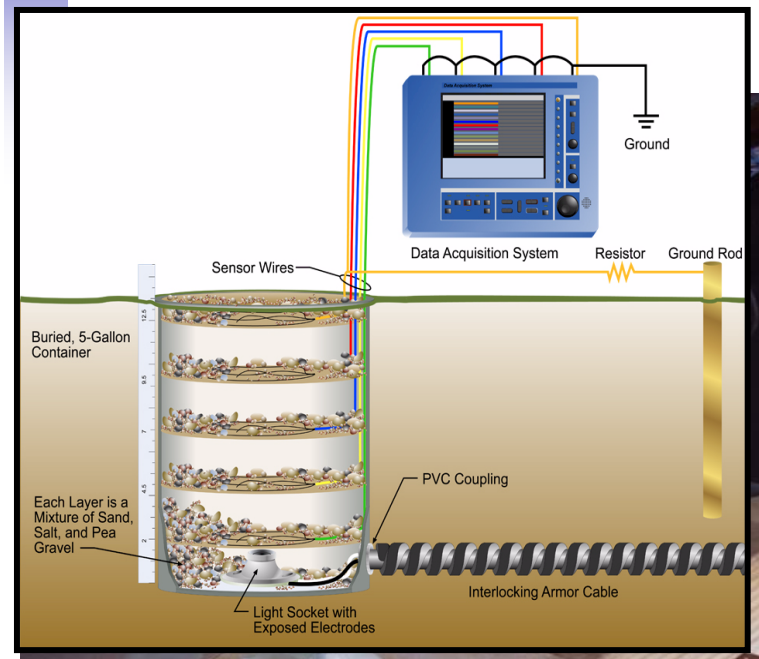
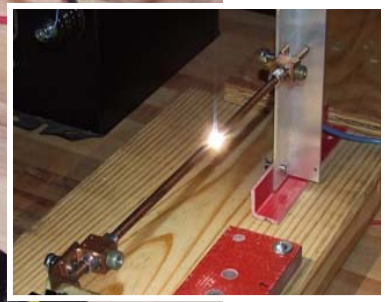
Arcing Sources Testing





- Based on UL Arc Fault Breaker Test
- Stabilized Arc which allows for simplified measurements
- Waveform analysis provides clues for detection

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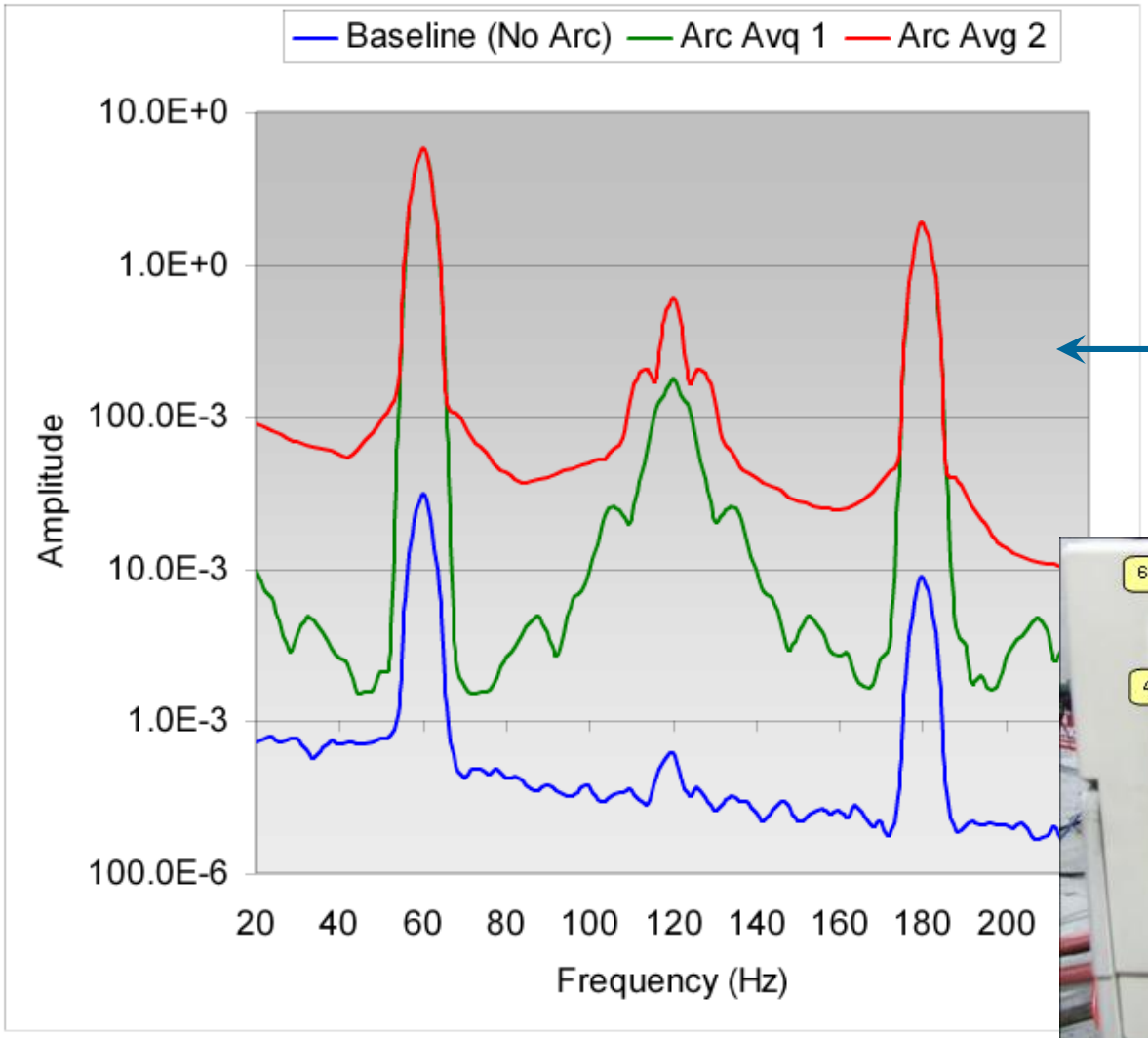
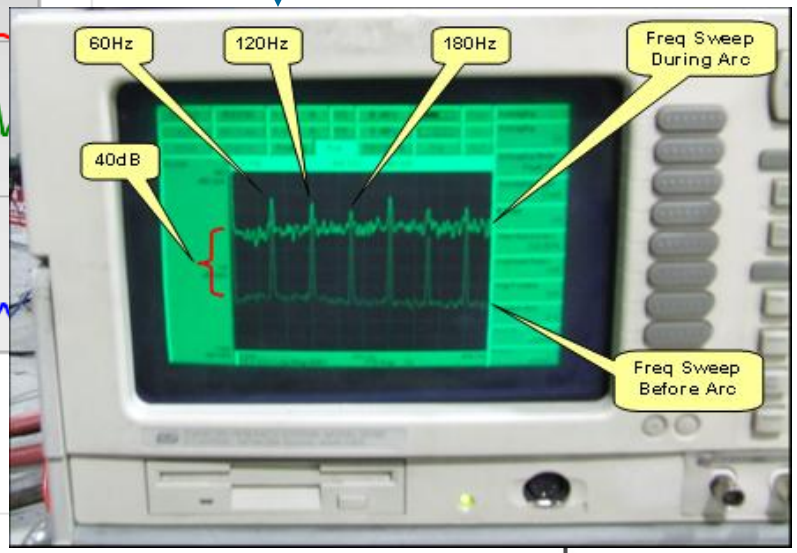
If Arcing can be Detected Early, the Event Can be Mitigated Before it Becomes a Shock Concern



- Increase in signal level as voltage rises to surface
- Increase in wide band noise during recording of arcing

Compare FFT of arcing characteristics to the bench test.



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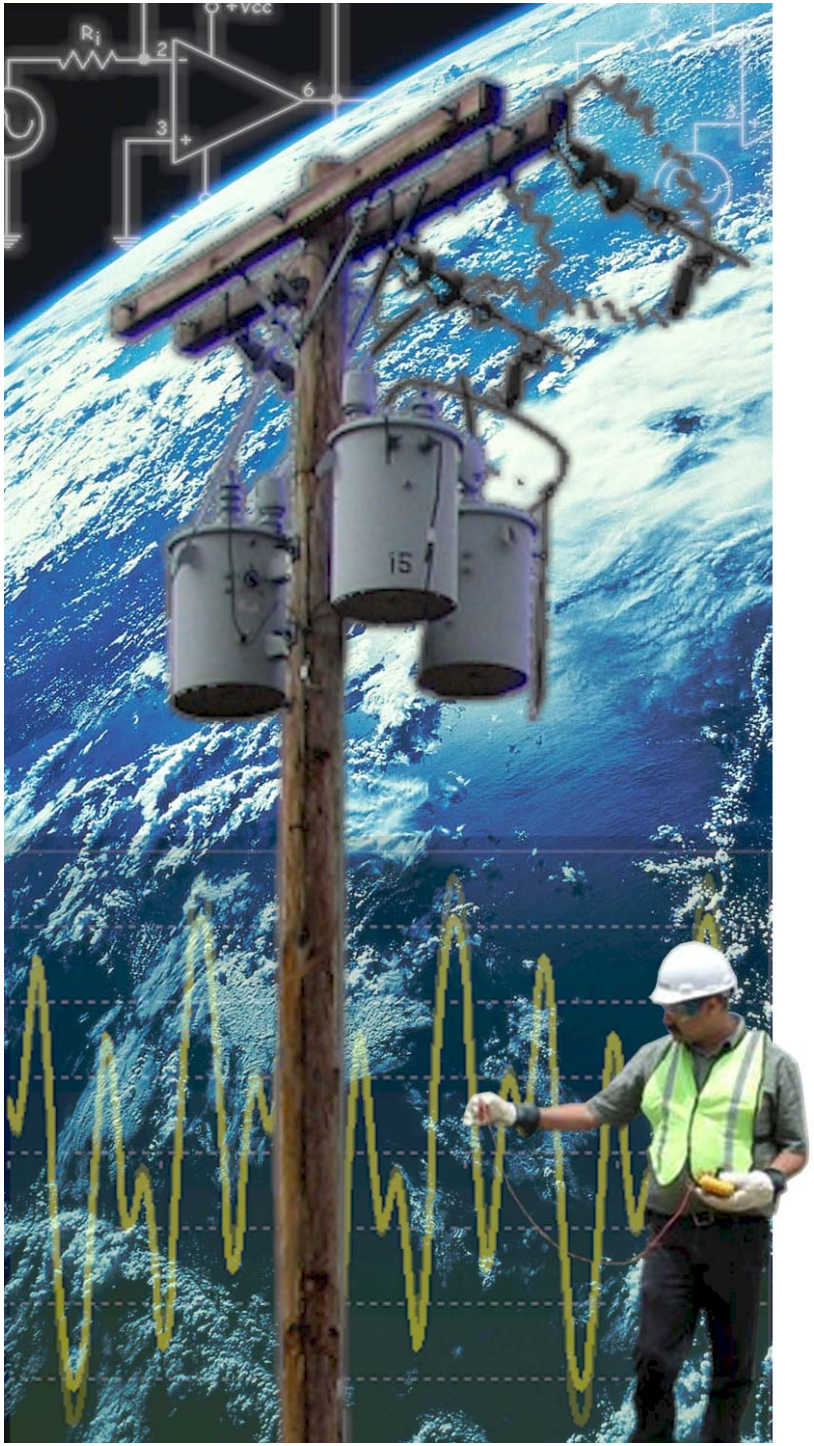

NEV & Urban Stray (Contact) Voltage 2009/2010 Plans

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NEV and Urban Stray (Contact) Voltage

- Discussion