



# Elevated NEV & Urban Stray Voltage Concerns

## *EPRI Research Update*

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# Presentation Overview

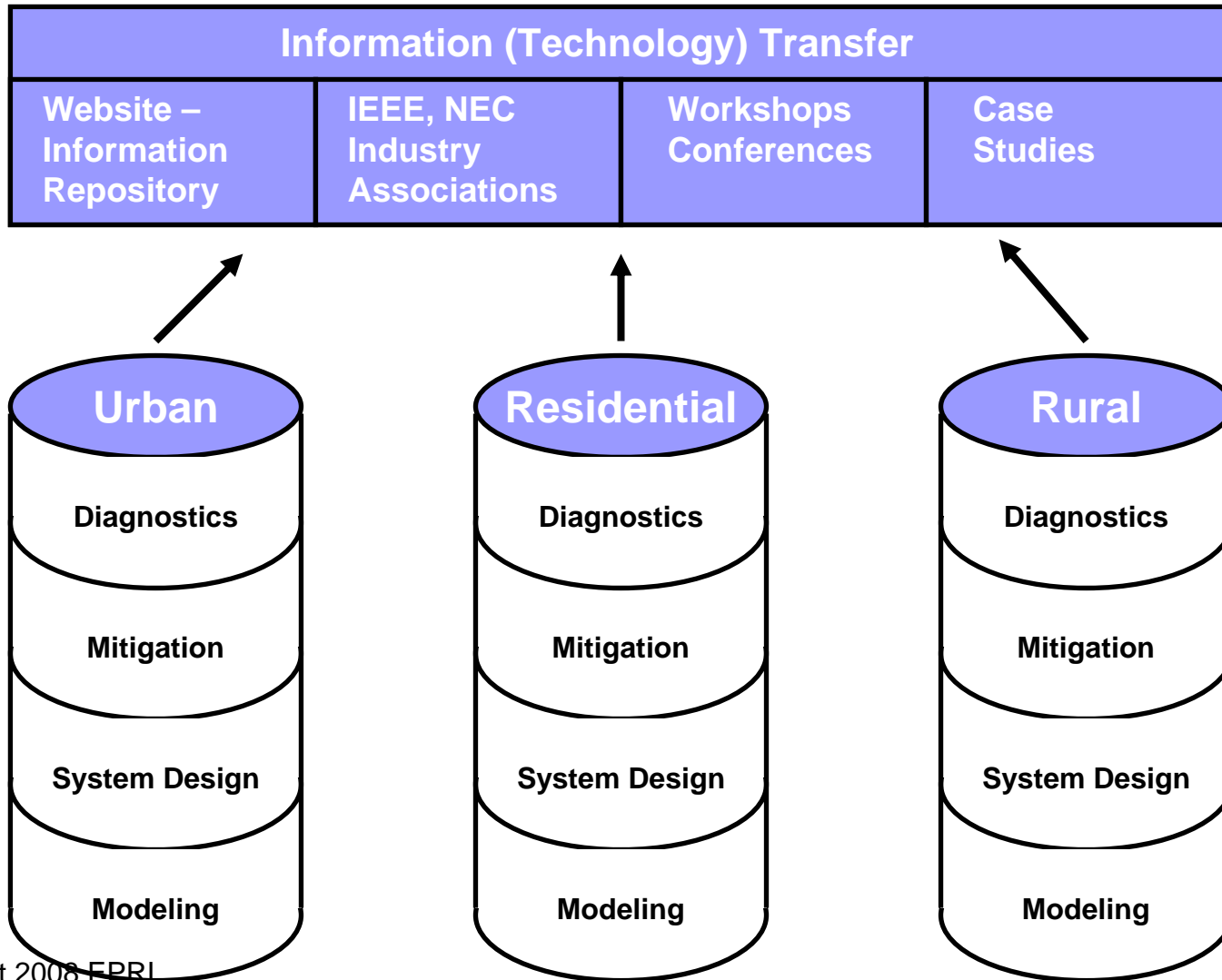
- EPRI Program Overview
- Example Results
- Case Studies
- 2008 Efforts and Future Work




# The EPRI Program Contains Five Primary Focus Areas

- Test and Measurement (Diagnostics)
- Modeling and Simulation
- Mitigation
- System Design (Condition Assessment)
- Information Dissemination

# Focus Areas Cross-Cut Applications





# Focus Area 1 - Diagnostics

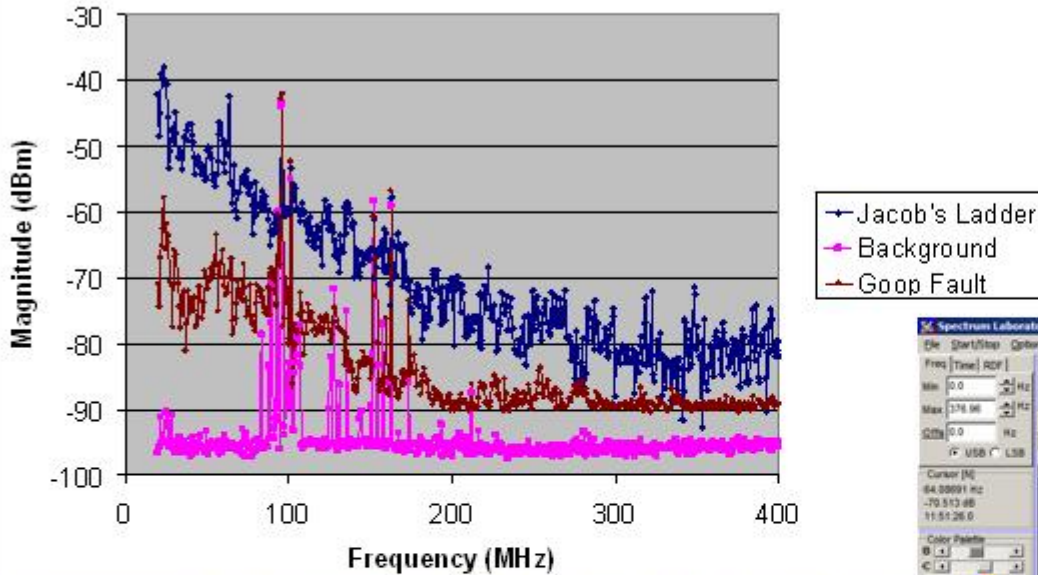
- Diagnostics – Primarily Measurements or Equipment Related to the Variety of Contact Voltage Scenarios
  - Are the investigative tools we use today adequate?
  - What are some areas of opportunity for new tool development?
  - Can we use existing monitoring devices to support early detection efforts?

# EPRI Lenox MA, Test Facility

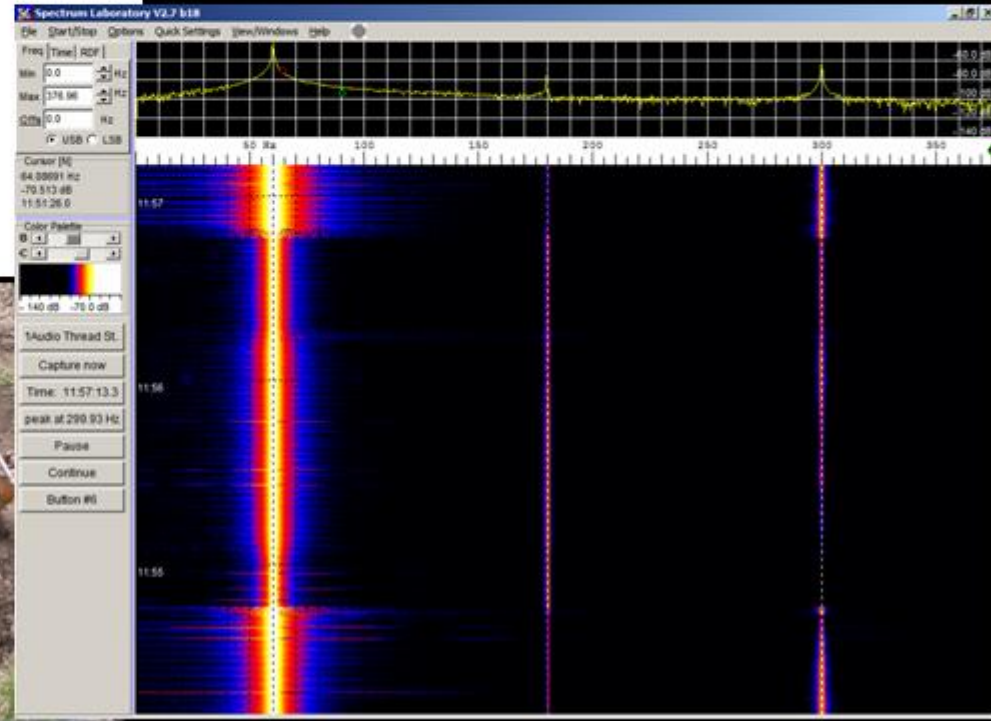


# Developmental Measurement Devices

RF Emissions From Faults



- Testing covered frequency range from 60Hz to 400 MHz
- 10 different test and measurement devices were evaluated

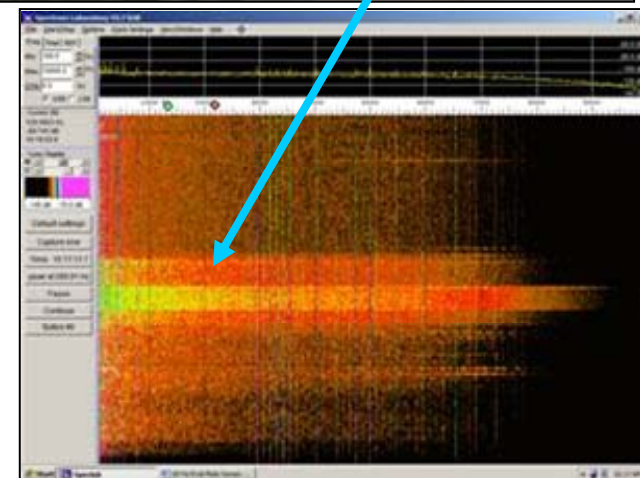
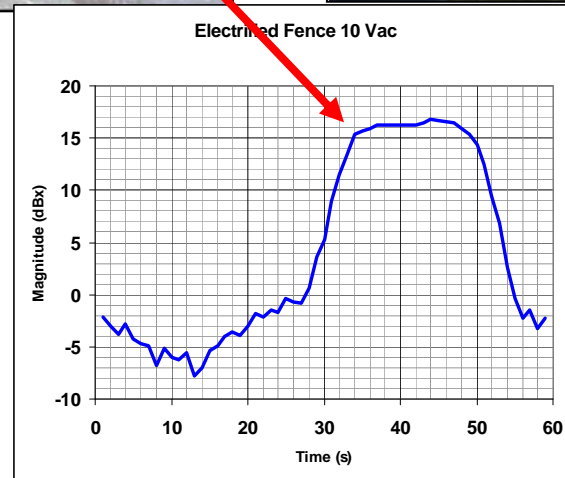
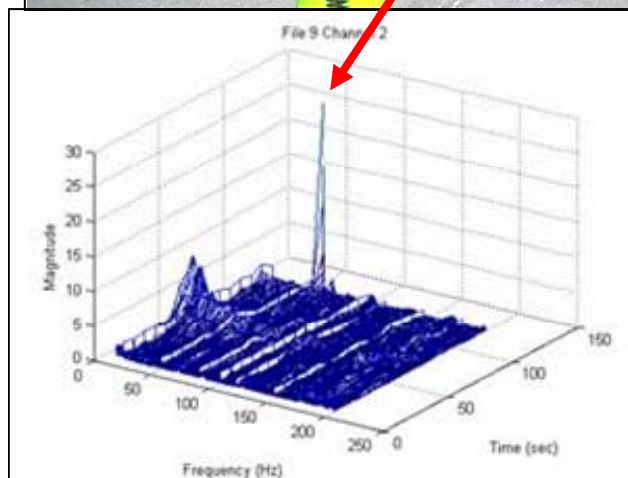
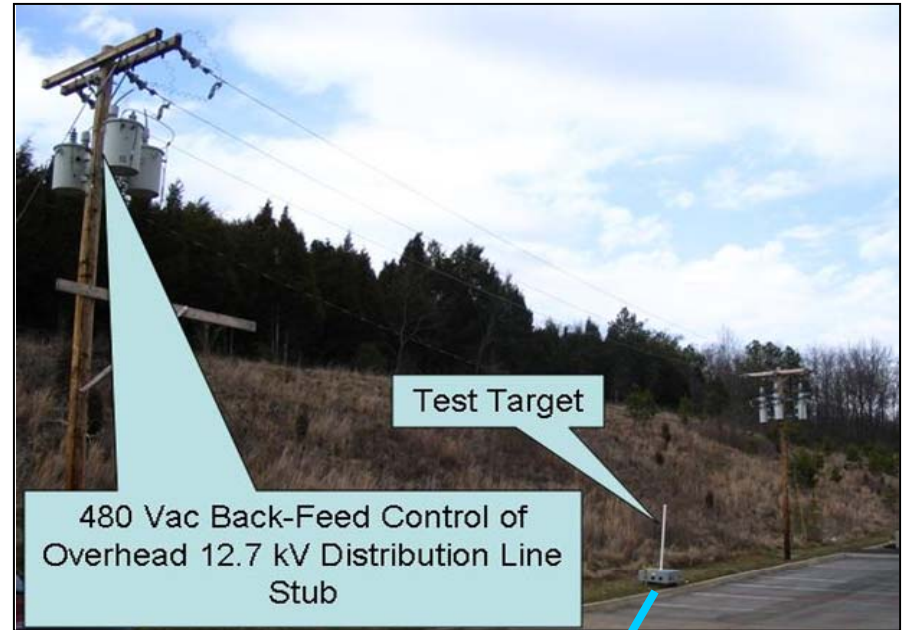


# NEV and Induced Voltage Evaluations





# Energized Object Testing



# Focus Area 2 Modeling & Simulation

- Modeling and Simulation
  - What parameters impact contact voltages? Which are most important?
  - Is it possible to model entire distribution systems?
  - What kinds of accuracies should be expected
- Modeling of Third Harmonic NEV in Northeast
- Modeling of Transient Pulses at Animal Contact Locations
- Modeling of NEV impacts from Methane Gas Wells
- EPRI Report 1012439 Assessment of Neutral to Earth Voltages in Distribution Systems – Modeling and Simulation Guidelines

# Modeling & Simulation Guidelines

## ■ Key Findings

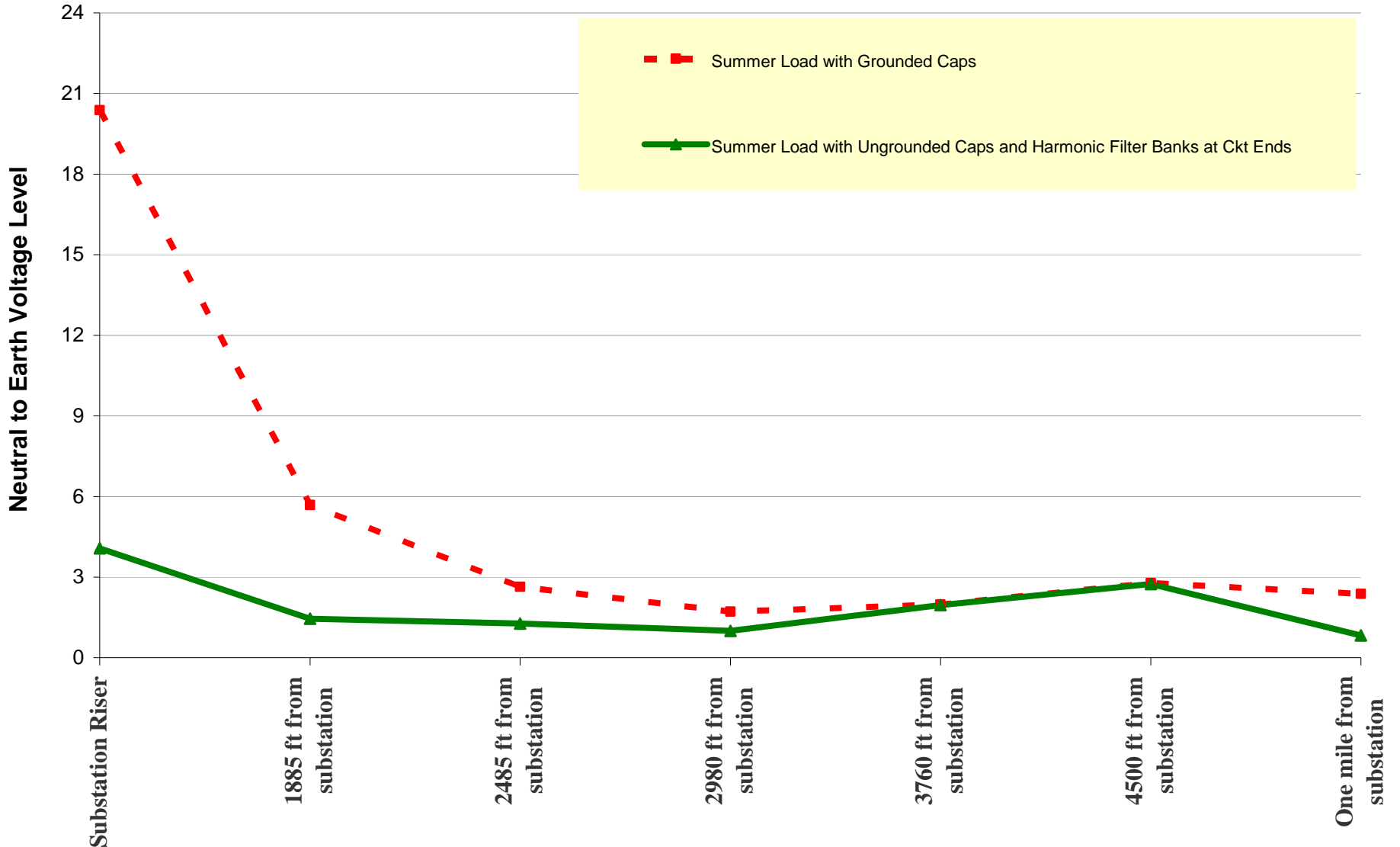
- Final report describes how different changes to resistances, impedances and capacitor bank configurations impact NEV levels
- With careful field measurement verification, we can expect accurate (plus/minus 10%) modeling results to evaluate distribution level parametric changes and can compare economics of changes with relative benefit in NEV reduction

# Mitigation Option vs Relative Improvement (Case Specific)

Option	Cost	Percent NEV Improvement
Larger Size Neutral	\$20X	33%
Parallel Neutral	\$15X	30%
Enhanced Pole Grounding	\$20X	15%
Enhanced Grounding Substation	\$10X	10%
Cap Bank Modifications	\$1X	100%
Harmonic Filters	\$3X	100%

\* Example only – every case will have different values

### Potential for Reductions in NEV Levels on Circuits Where Capacitors Banks are Reconfigured as Harmonic Filters



# Focus Area 3 Mitigation

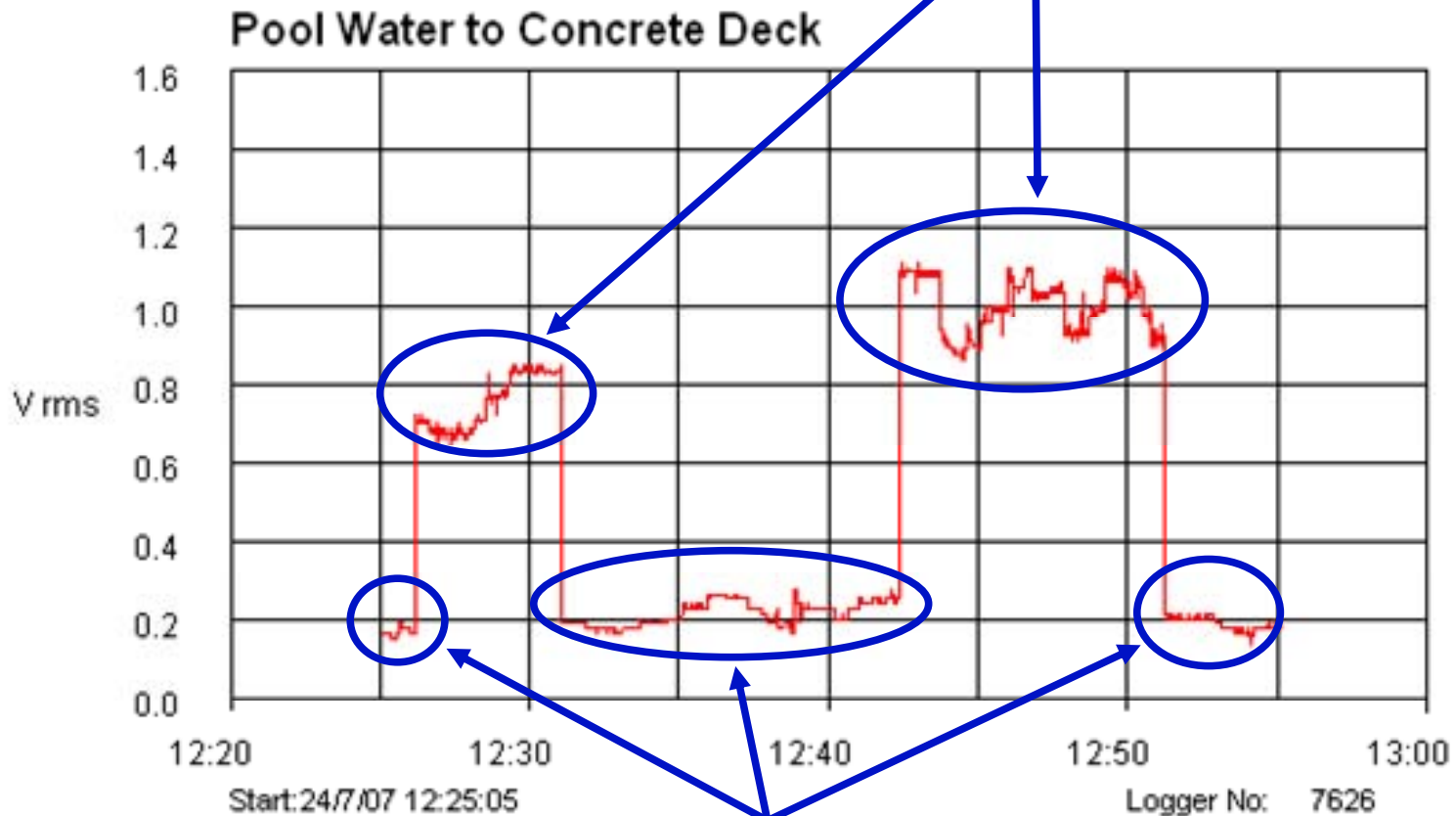
- Mitigation Case Studies Enable
  - Better ways to quickly identify the source(s)
  - Prioritization based on the type of contact voltage concern
  - Better likelihood the correct mitigation solutions get applied

# Mitigation Techniques – Ground Ring



# Mitigation Techniques – Ground Ring 4X Reduction at Poolside

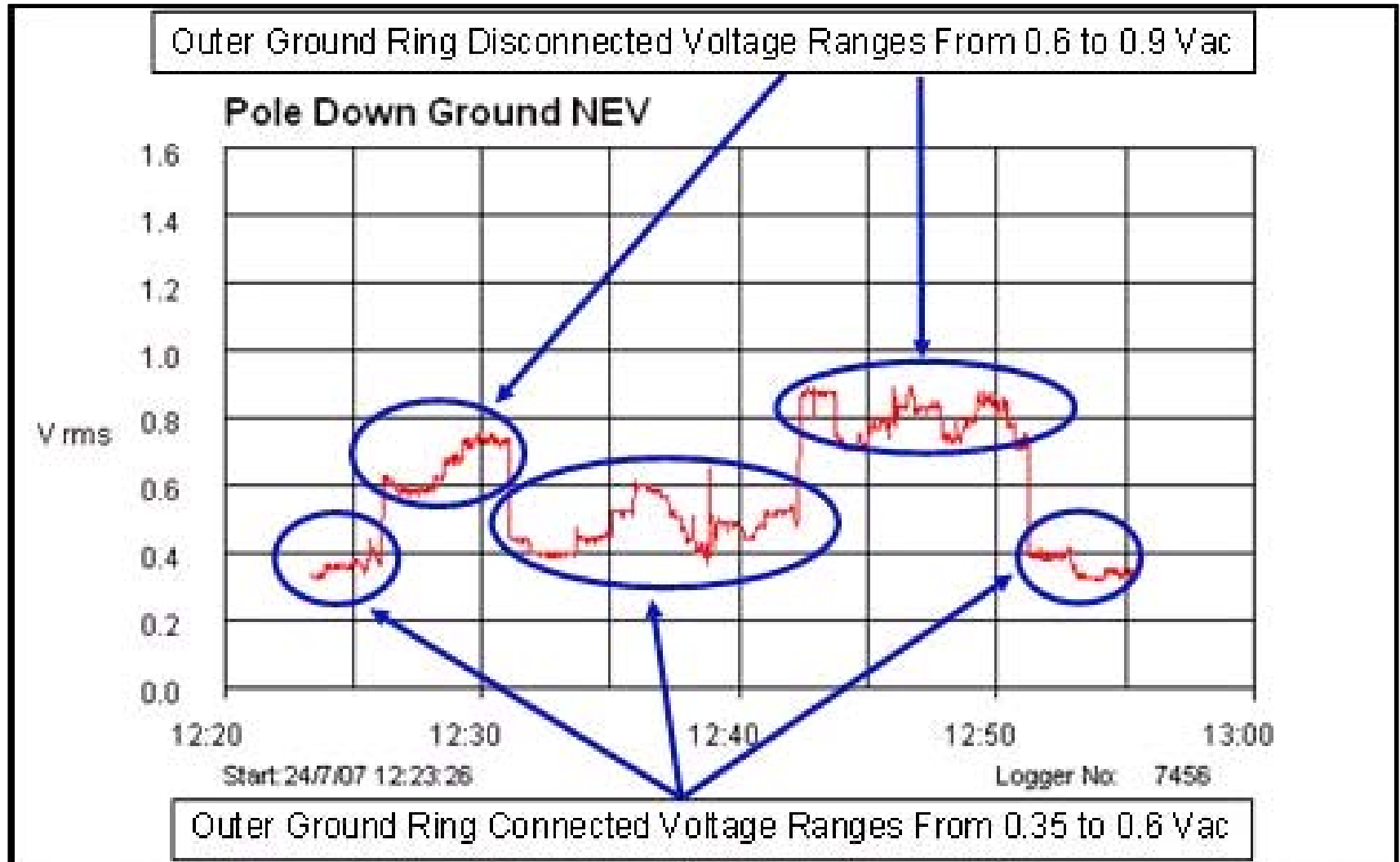
Outer Ground Ring Disconnected Voltage Ranges From 0.7 to 1.1 Vac



Outer Ground Ring Connected Voltage Ranges From 0.18 to 0.25 Vac



# 0.4X Reduction at Pole Ground



# Mitigation for Pipelines Varies

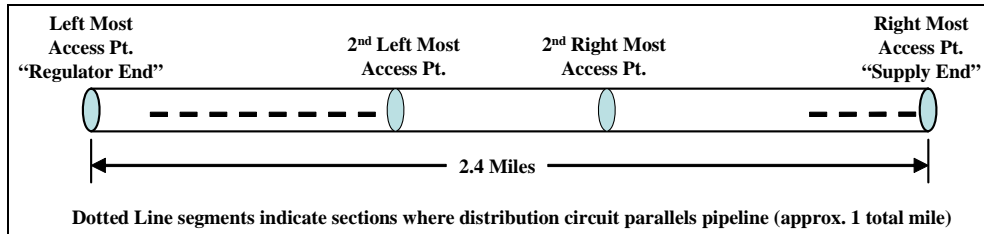


Figure 1-A Visual of the segment of pipeline indicating the 4 (four) voltage access points and the parallel distribution line locations.

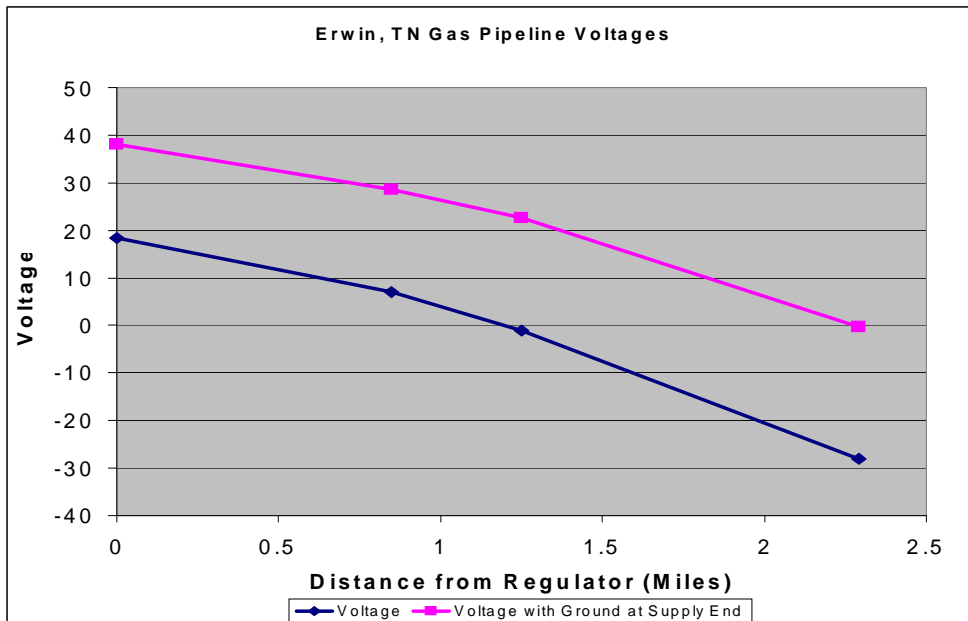


Figure 1B. Voltage Plots with Supply End (Right side of Graph) of Pipe Segment "Grounded" and "Ungrounded" (the negative voltage indicates that end of the pipe it is "out of phase" with respect to the other end of the pipe segment). Left side of graph is the end of the insulated pipe segment where the pressure regulator is located.

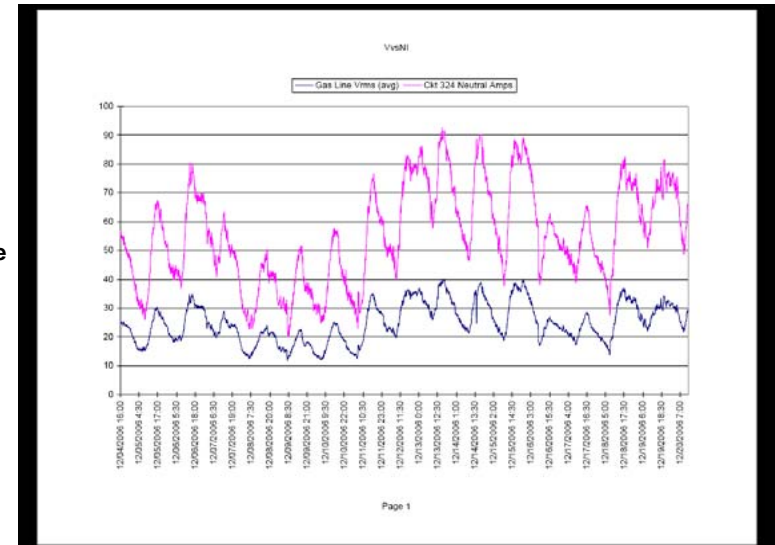


Figure 1C. Trend Data (Previously Recorded by TVA) at Source End of Pipe Segment Comparing Pipeline Voltage to Neutral Current on the Distribution Ckt.

## Mitigation Options:

- Isolated Small Segments
- More Grounded Segments
- Reduce Neutral Currents

# Boat Lift Shocking Complaints and Mitigation Options



# Boat Lift Shocking Complaints and Mitigation Options

## Measurement Results for Boat Dock Investigation

NEV at meter base prior to testing	1.22 Vac (A/C On – 12 Noon)
NEV at meter base at commencement of testing	1.18 Vac (A/C On - 2:15 PM)
Vac Metal to water w/beams in water	2.02 Vac
Metal to water Vac w/beams out of water	2.50 Vac
Metal to water Vac w/beams out of water and one lamp shade in water	1.47 Vac
Metal to water Vac w/beams out of water and two lamp shades in water	0.98 Vac
Metal to water Vac w/beams in water and two lamp shades in water	0.61 Vac

# Focus Area 4 System Design

- System Design and Condition Assessments
  - Based on the Source(s)
    - Are there alternative mitigation solutions
    - What is considered “Typical” or “Normal?”

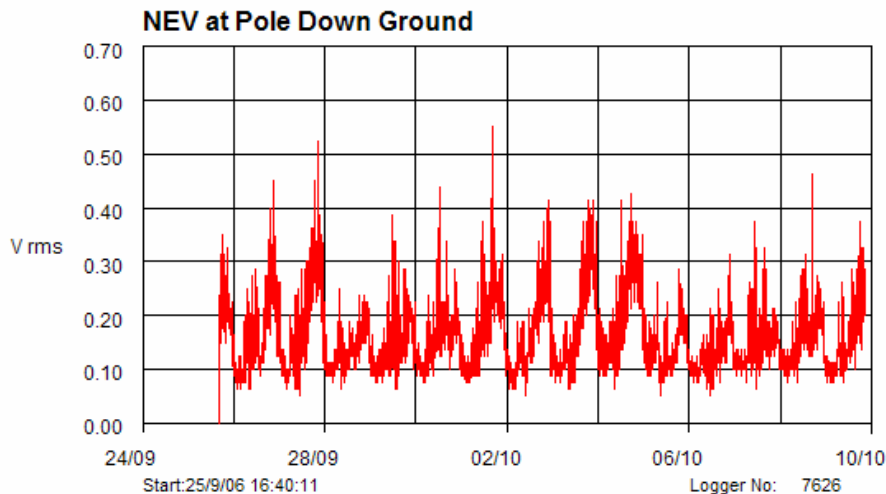


Fig 4. Max Pole Down Ground NEV Reading 0.54 Vac (16 Days)

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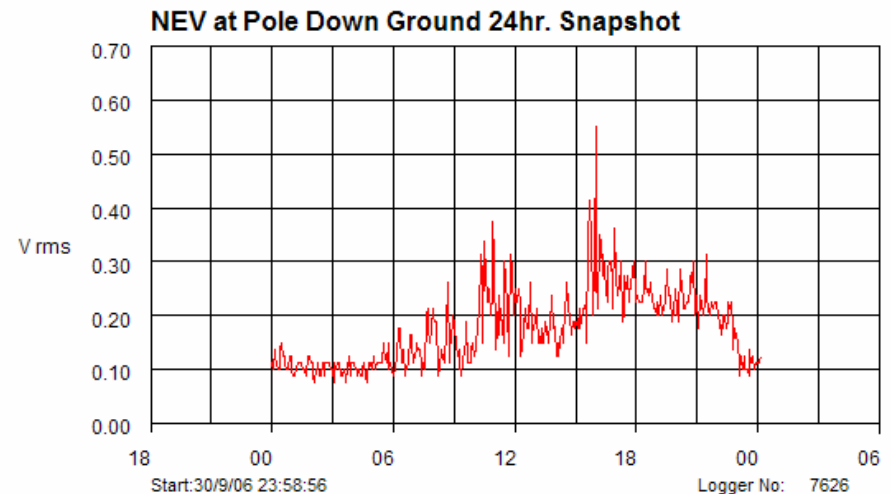


Fig 6. Max Pole Down Ground NEV Reading 0.54 Vac (24 Hrs.)

# Focus Area 5 Information Dissemination (Tech Transfer)

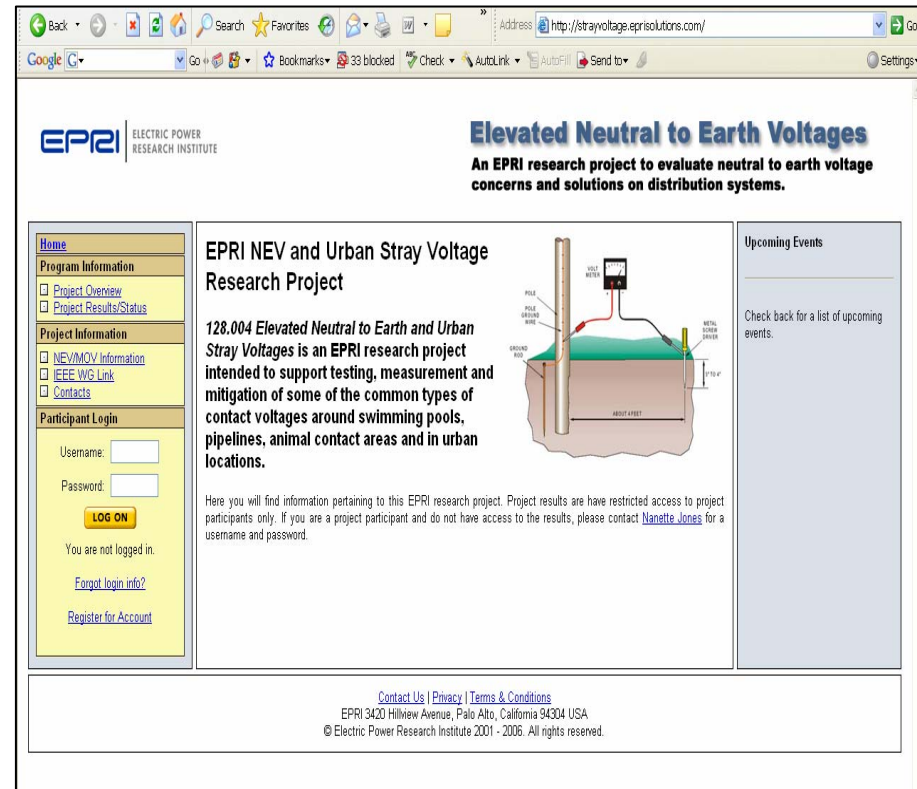
## □ Technology Transfer

- Accurate and factual information for informed decision making
- Clear understanding of the differences in contact scenarios and the objective: (aversion, injury due to startle reaction, let go thresholds, etc..)

# 2008 Information Repository

## ■ Website

- Update existing information to reflect 2008 status
- Provide additional application guidance on use of test and measurement equipment
- Provide additional application guidance on mitigation solutions
- Position papers and credible reference document repository
- Add to Case Study library



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### Elevated Neutral to Earth Voltages

An EPRI research project to evaluate neutral to earth voltage concerns and solutions on distribution systems.

**Home**  
Program Information

- Project Overview
- Project Results/Status

Project Information

- NEV/MOV Information
- IEEE WG Link
- Contacts

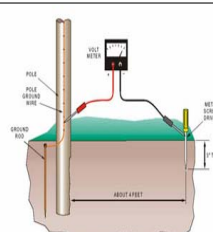
Participant Login

Username:   
Password:   
**LOG ON**

You are not logged in.  
[Forgot login info?](#)  
[Register for Account](#)

#### EPRI NEV and Urban Stray Voltage Research Project

128,004 Elevated Neutral to Earth and Urban Stray Voltages is an EPRI research project intended to support testing, measurement and mitigation of some of the common types of contact voltages around swimming pools, pipelines, animal contact areas and in urban locations.



Here you will find information pertaining to this EPRI research project. Project results are have restricted access to project participants only. If you are a project participant and do not have access to the results, please contact [Nanette Jones](#) for a username and password.

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Upcoming Events  
Check back for a list of upcoming events.

- The EPRI 'Contact Voltage' website provides a credible and unbiased resource for assessment and mitigation of contact voltage related concerns <http://strayvoltage.eprisolutions.com>

# 2008 Industry Group Support

- Support ongoing IEEE “contact voltage” stds and other industry and association efforts
  - Jodie Lane National Conference on Urban Stray Voltage and Safety – May 29-30<sup>th</sup> 2008
  - IEEE PES Distribution Subcommittee – Stray Voltage WG Meetings – January 2008 July 2008 Webcast TBD
  - IEEE T&D Conference – Panel session on ‘contact voltage’ related subject matter
  - IEEE PES Summer Power Meeting – Panel Session on NEV Modeling



# Conclusions

- Sources and situations where contact voltage situations may be present are numerous and diverse
- Levels of concern may be different based on the differences in contact scenarios and safety objectives (aversion, injury, etc.)
- Mitigation options range from simple to complex depending on the situation
- Source identification and advancement in early detection are priority EPRI objectives