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RESEARCH INSTITUTE

## **Project 128.005 2009/10 NEV & other Contact Voltage Diagnostics & System Design**

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# P128.005 – 2009/10 NEV & 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

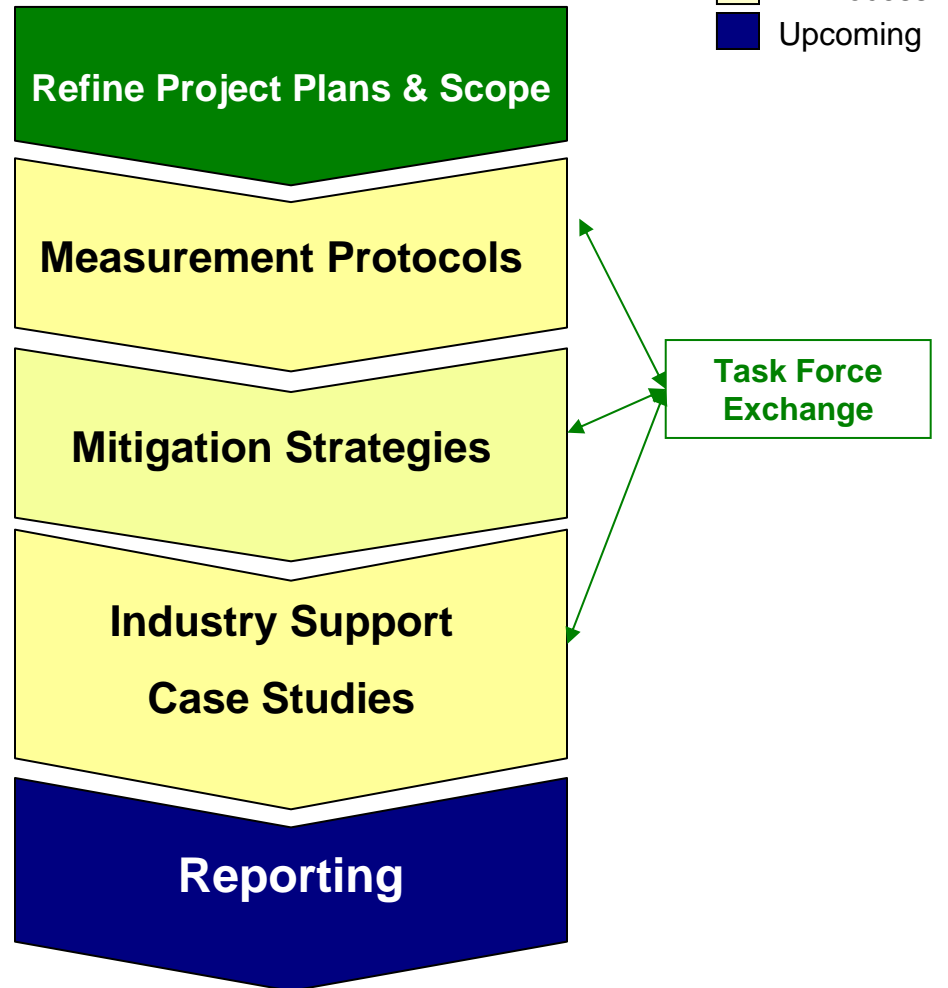
## Completion Date

- December 2009

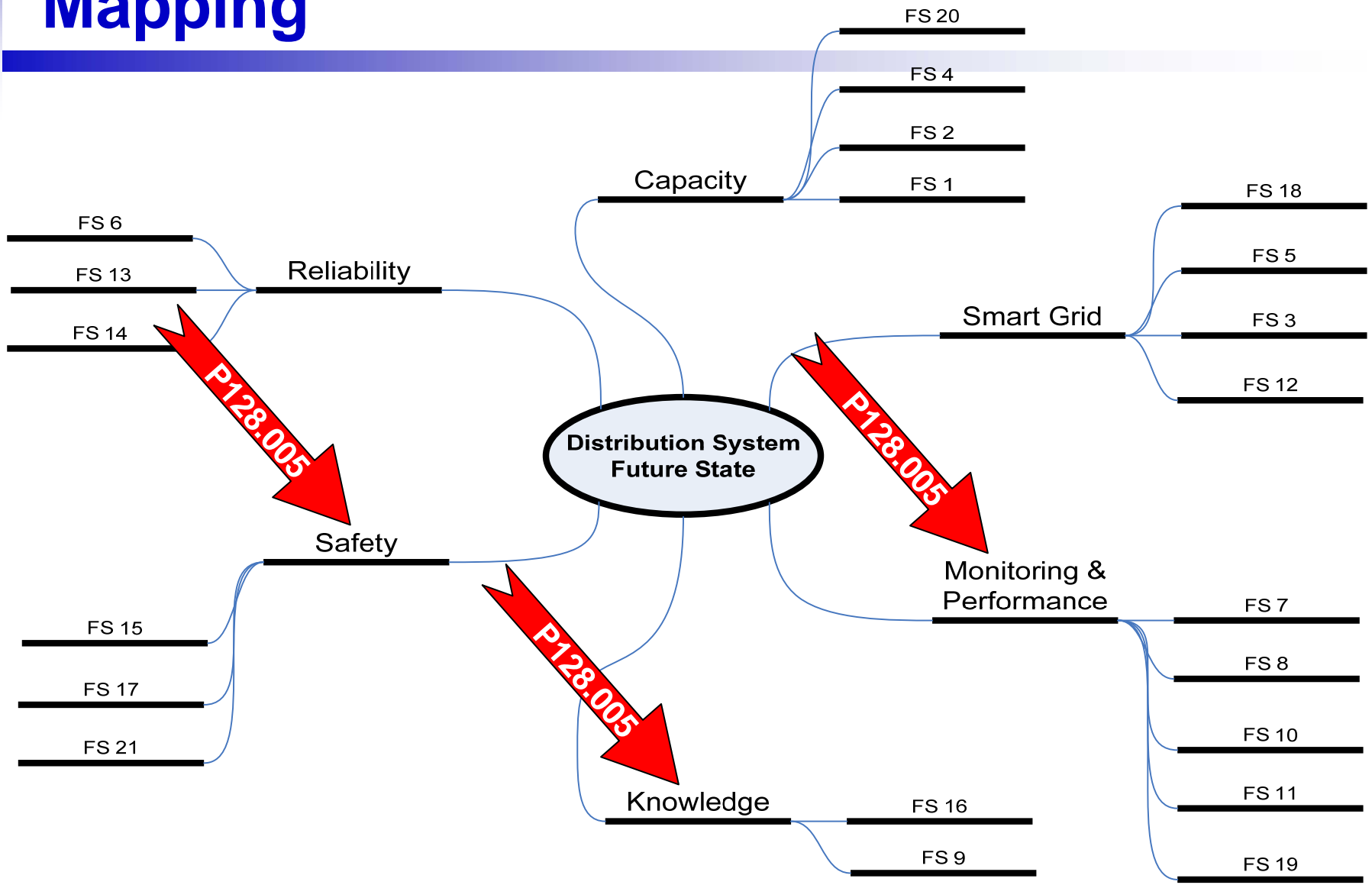
## The Big Picture

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

## Key Tasks and Milestones



# NEV & Contact Voltage Strategic Plan Mapping



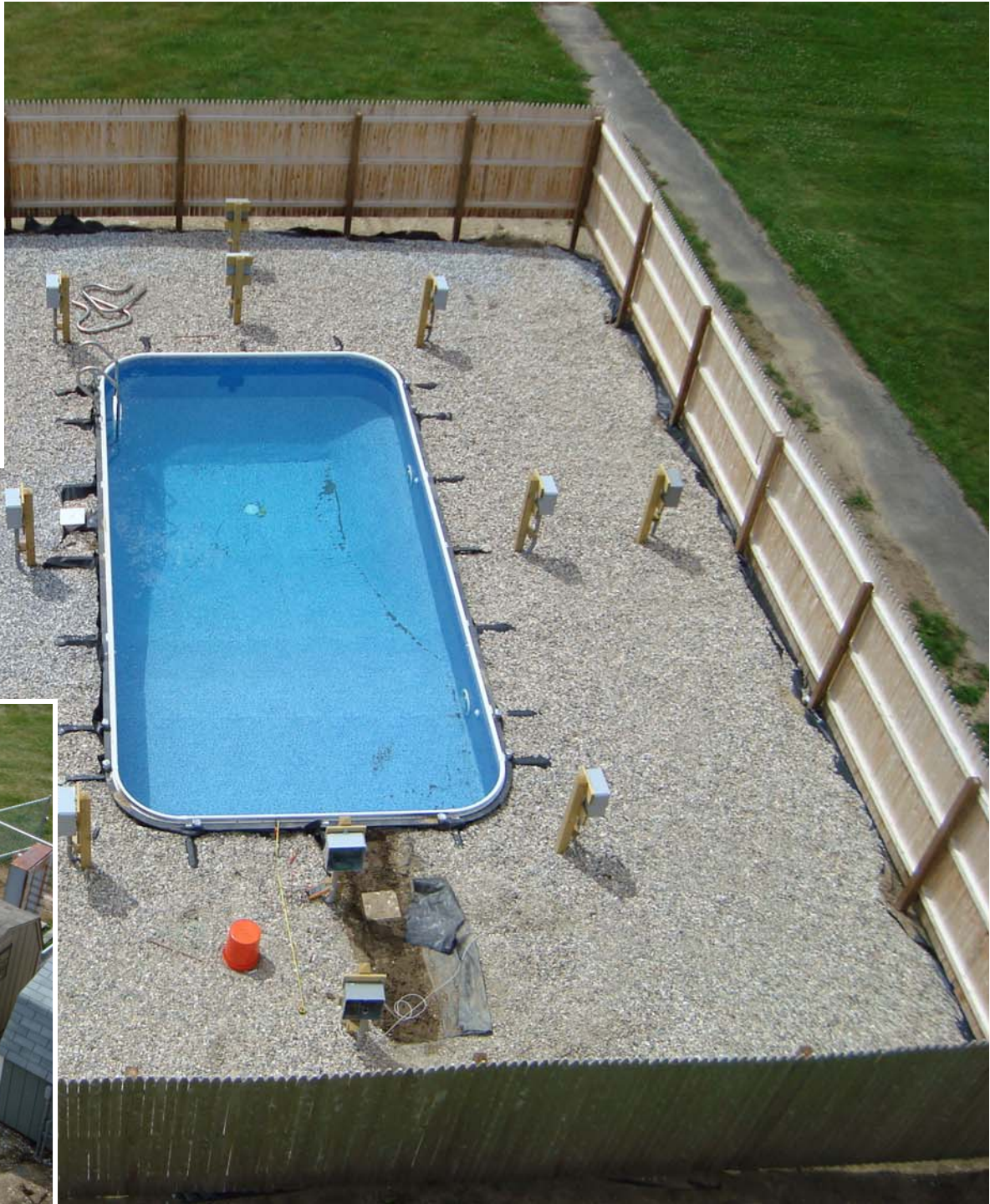
# ***NEV & (Contact) Voltage 2009/2010 Plans***

- **2009-10 Work Plans**
  - Lenox Testing
  - Field Case Studies
  - Waveform Library
  - Industry Support
  - Mitigation
  - Guidebook Chapters
  - Website
- **Supplemental Project on Advanced Early Detection Work**



# Lenox Testing

- Mitigation Using Ground Rings and Horseshoe Configs?
- Most Effective Application of Ground Rods?
- Can We Test with Artificial Voltage Sources?
- Impacts of Fault Currents Through the Pool Area?
- Impacts of Arc Voltage on the Neutral Path
- Mitigation with Conductive Concrete Surfaces
- Ultimate Training Structure
- Is the 2008 Florida NEC Art680 Interpretation Adequate?
- Does Depth of Ground Ring Installation Matter?
  
- **Special acknowledgment to Southern Company for the seed money to build the basic test structure**

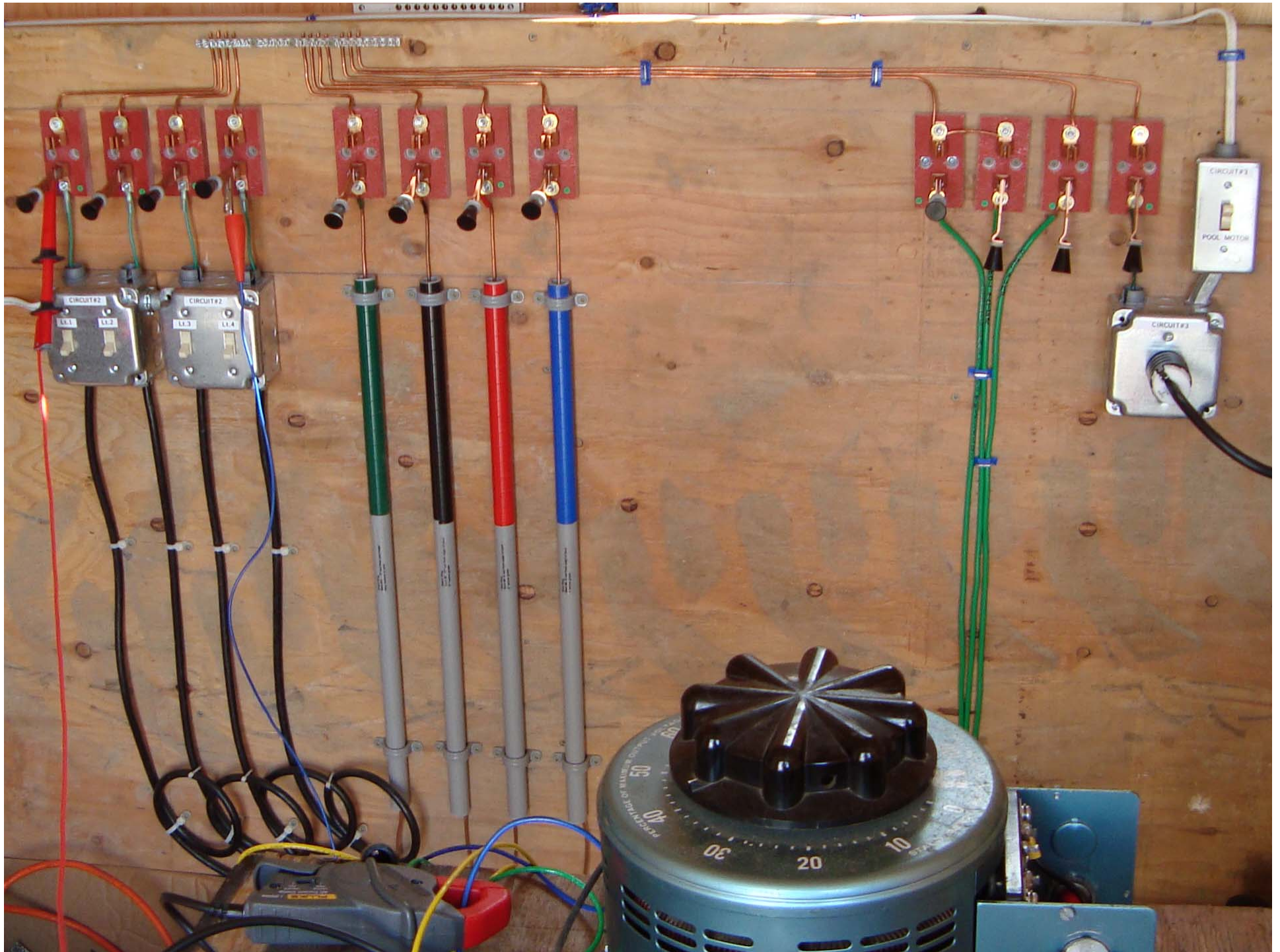


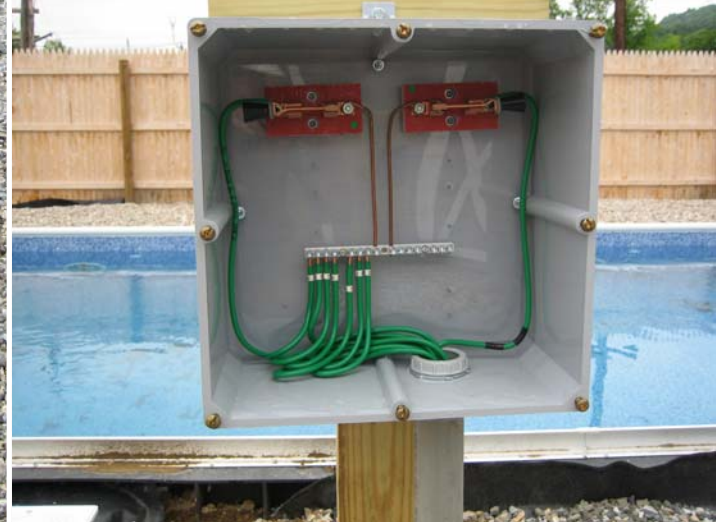


Wet Area will have #8 bare solid copper bonding ring around shell. Each ladder, light, and handrail will be connectable at a corner service box











# Contact and Stray Voltage – How Can We Distinguish the Difference?



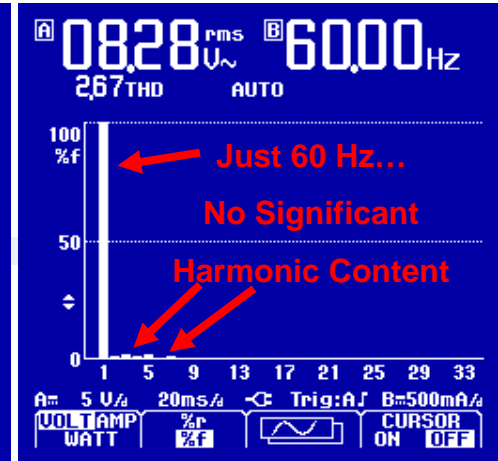
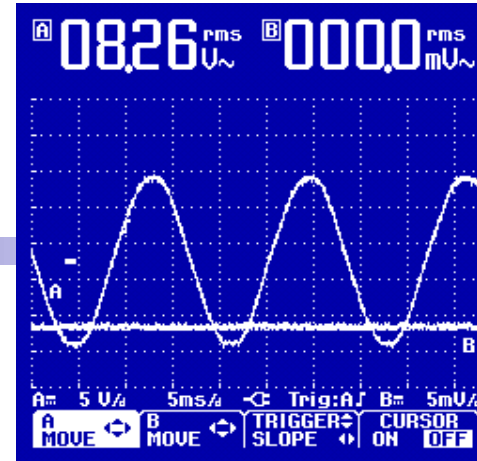
## Four Basic Voltage Sources:

- Faults that don't self clear (service box covers, light poles, moisture paths)
- Voltage Drop on Current Carrying Conductors – NEV
- Magnetic Induction from current flow (metallic pipelines, rails)
- Electric Induction (above ground pipelines, metal light poles)

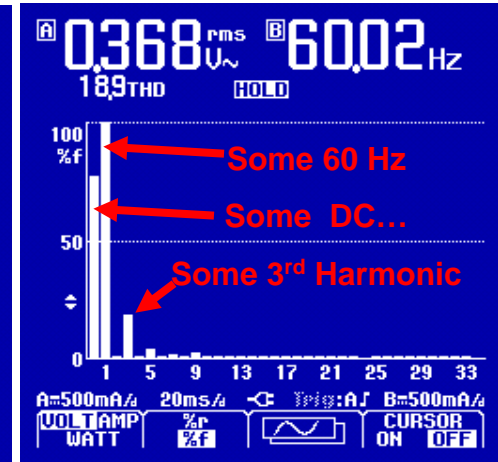
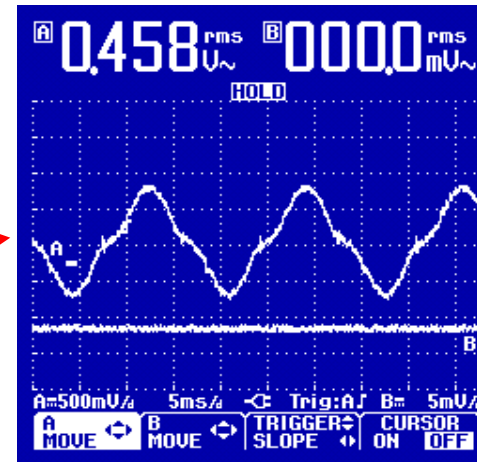
90% of the time the source is distinguishable via wave shape analysis and phase angle analysis

# Waveform Library 20 Cases to Date

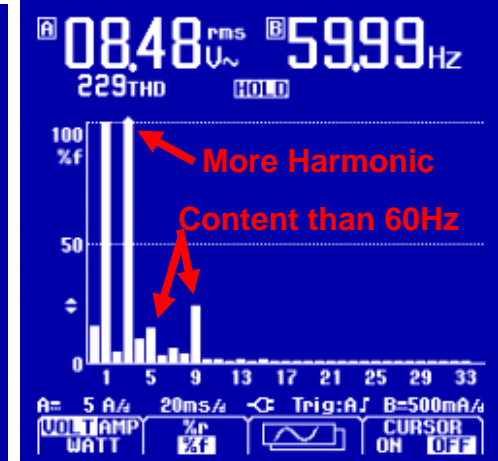
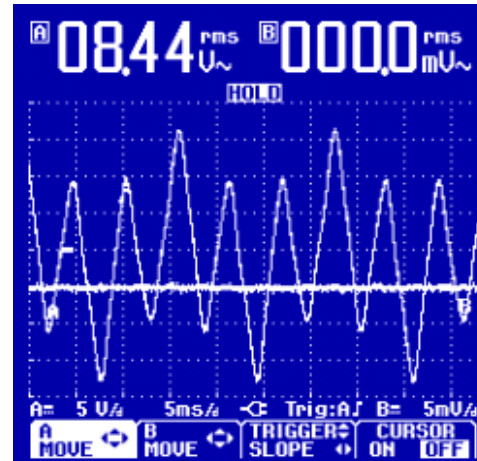
- 60 Hz Faulted Phase Conductor



- Higher Harmonic Content Neutral to Earth Voltage



- Voltage Snapshot Gas Pipeline to Remote Earth



# Industry Awareness

- IEEE Stray Voltage Working Group
  - January 2009 PES Mtg
  - July 2009 PES Mtg
- IEEE PES Conf Proceedings Paper
  - Paper Number: 09GM0484 – PES July 27th 2009
- NARUC invited presentation on Contact Voltages
  - Summary of the EPRI R&D Efforts
- Pool and Spa Association Collaboration
  - Training and Presentations on Relevant Topics
- Jodie Lane Annual Conference
  - **October 19<sup>th</sup> 2009**

## NARUC Presentation Summary

- Contact Voltage Complaint Sources
- Background on prior 'industry' research
- EPRI Strategic Roadmap and Gap Analysis
- EPRI Research Program Summary
- Significant Industry Needs
- Human and Animal Response to Current
- Establishing Levels of Concern
- Contact Voltage due to Faults vs NEV – Is there a way to tell the difference?
- Summary

*Useful references are included on the final slide*



# 2009 Information Repository – Continuation

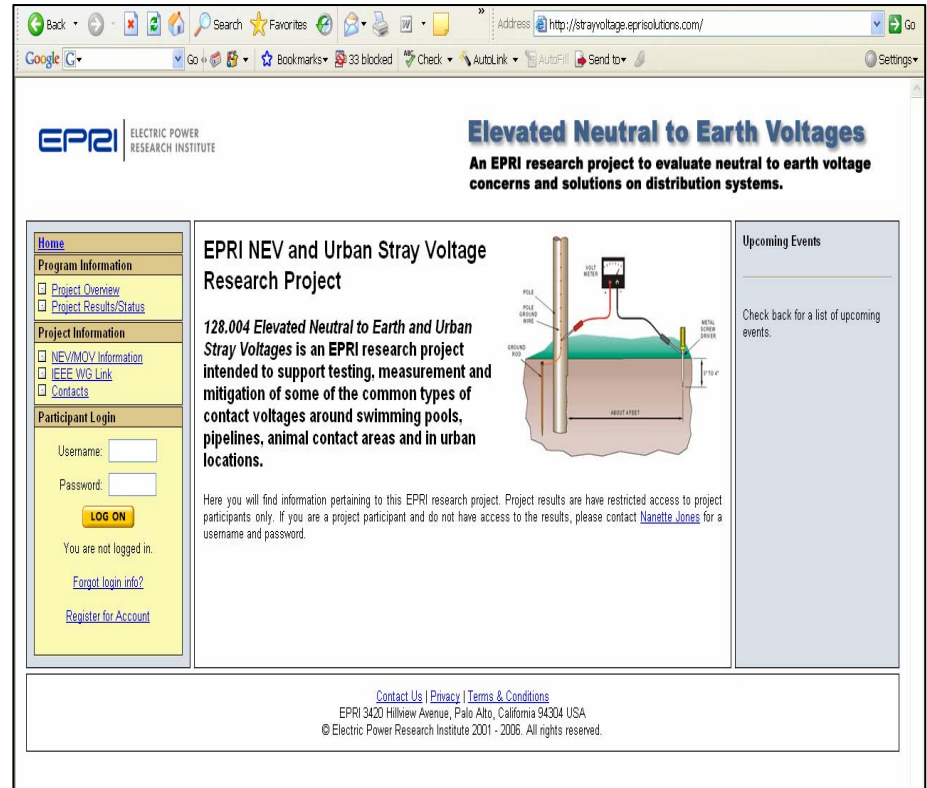
- Website

- Update existing information to reflect 2009 status
- Provide additional application guidance on use of test and measurement equipment
- Provide additional application guidance on mitigation solutions
- Position papers and credible reverence document repository
- Increment Case Study library

- Vision Statement

- The EPRI ‘Contact Voltage’ website is the preferred resource for credible and unbiased understanding of the evaluation and mitigation of contact voltage related concerns

- New Web URL: <http://strayvoltage.epri.com>



The screenshot shows a web browser window displaying the EPRI website. The page title is "Elevated Neutral to Earth Voltages" and the subtitle is "An EPRI research project to evaluate neutral to earth voltage concerns and solutions on distribution systems." The page features a navigation menu on the left with sections for "Home", "Program Information", "Project Information", and "Participant Login". The main content area includes a section titled "EPRI NEV and Urban Stray Voltage Research Project" with a diagram of a swimming pool and a diagram of a contact voltage measurement setup. The diagram shows a "PILE" with "PILE GROUND WIRE" and "METAL EXPOSED SURFACE" connected to a "VOLT METER". The diagram also shows a "GROUND ROD" and "GROUND SURFACE" with a "1 FT" scale. The text describes the project as "128,004 Elevated Neutral to Earth and Urban Stray Voltages" and mentions that it is 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. The page also includes a "Participant Login" section with fields for "Username:" and "Password:" and a "LOG ON" button. The footer contains contact information and copyright details.

# Additional Supplemental Work

- Special Acknowledgment to ConEdison for supporting the early detection supplemental project work



## Con Edison and EPRI Partnership on Detection of Arcing Faults Around Manhole Structures

August 4<sup>th</sup> 2009

### Project Review Meeting

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Kermit Phipps [khipps@epri.com](mailto:khipps@epri.com) 865-218-8021  
Tom Cooke [tcooke@epri.com](mailto:tcooke@epri.com) 865-218-8010



## Early Detection of Energized Conductive Objects

- Objectives
  - Promote standardized methods to identify and deal with perceptible voltages at human and animal contact locations
- The Big Picture
  - Faster and more efficient diagnosis and mitigation of voltage related perception complaints benefits both electric suppliers and the public



**Green On/Off indicator.  
If green LED won't light,  
unit needs a re-charge**

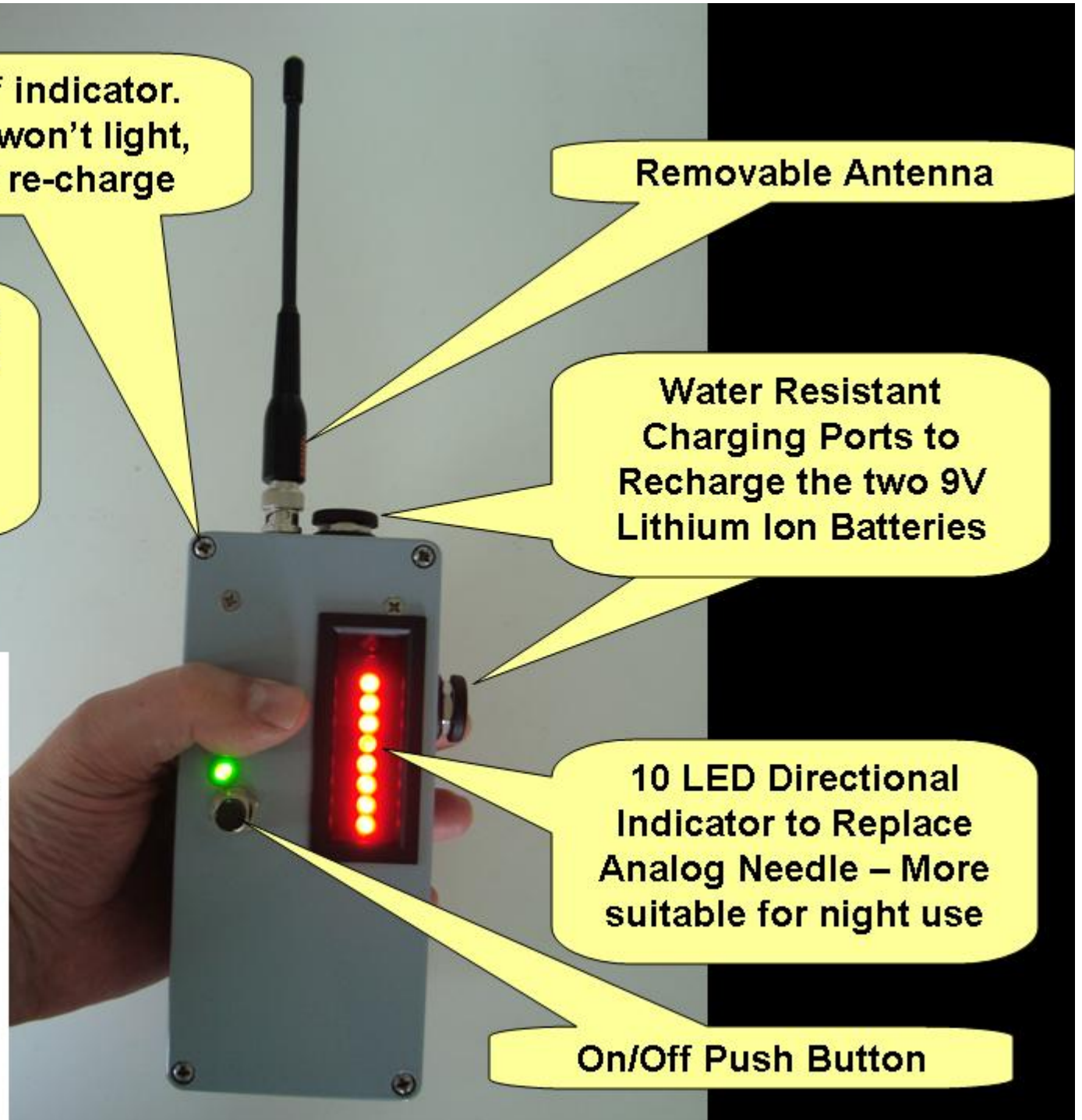
**Each unit comes with  
a standalone charger  
(for wall outlet or  
lighter jack) and a  
calibrator/tester**

**Removable Antenna**

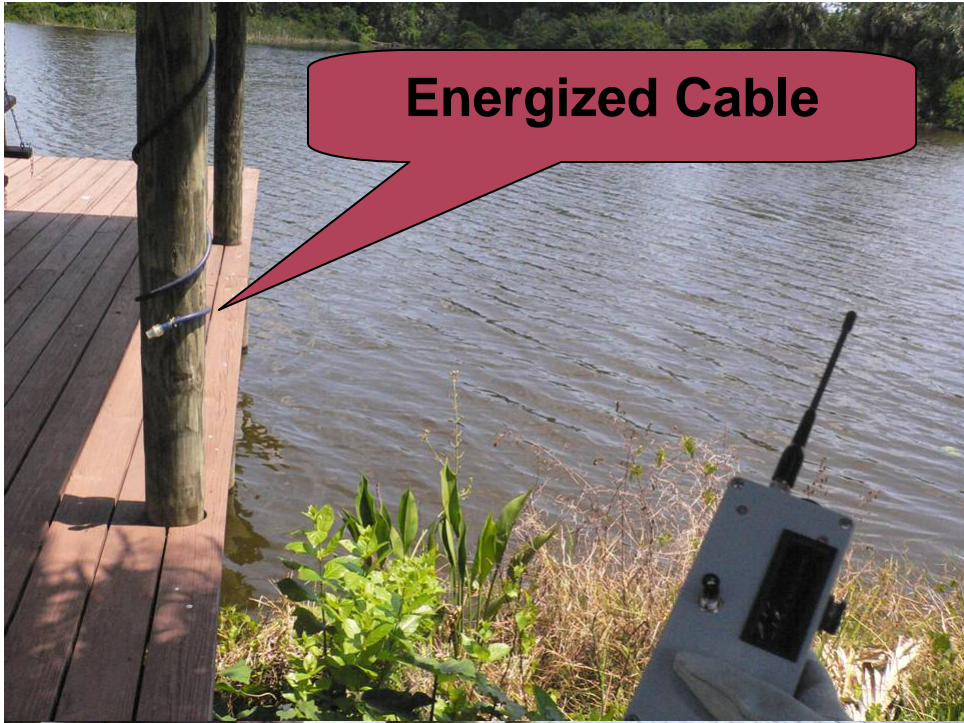
**Water Resistant  
Charging Ports to  
Recharge the two 9V  
Lithium Ion Batteries**

**10 LED Directional  
Indicator to Replace  
Analog Needle – More  
suitable for night use**

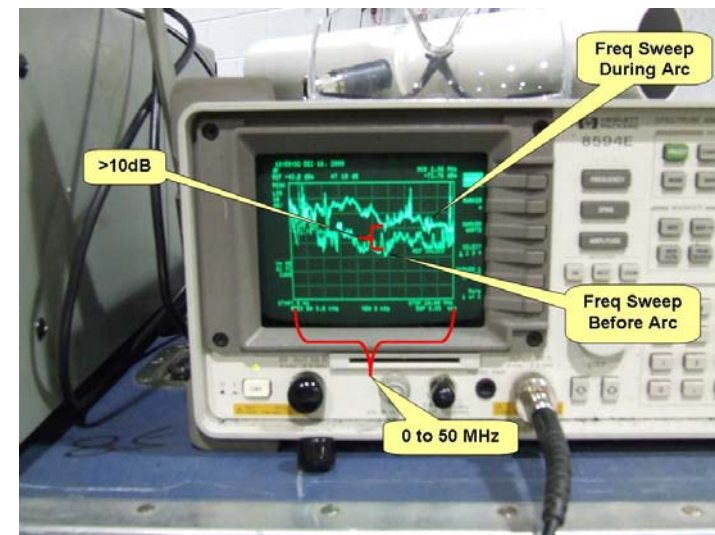
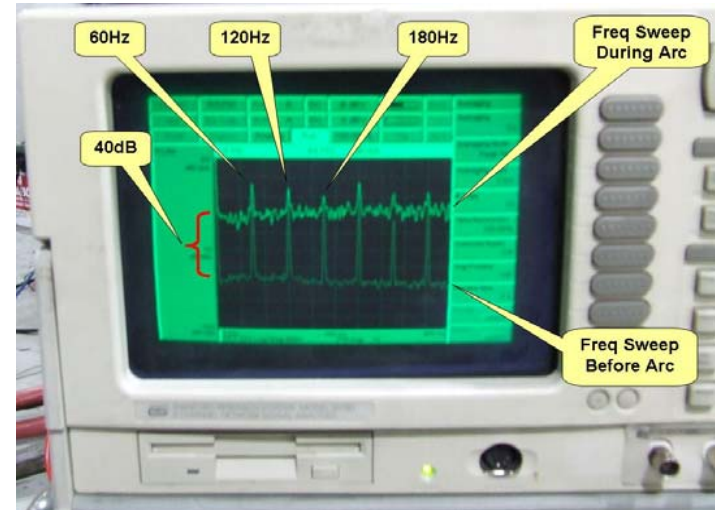
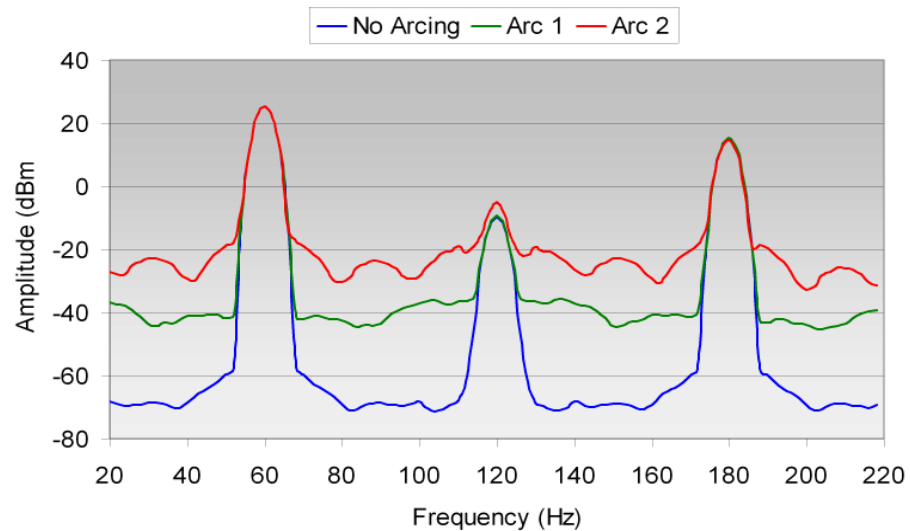
**On/Off Push Button**



**Energized Cable**

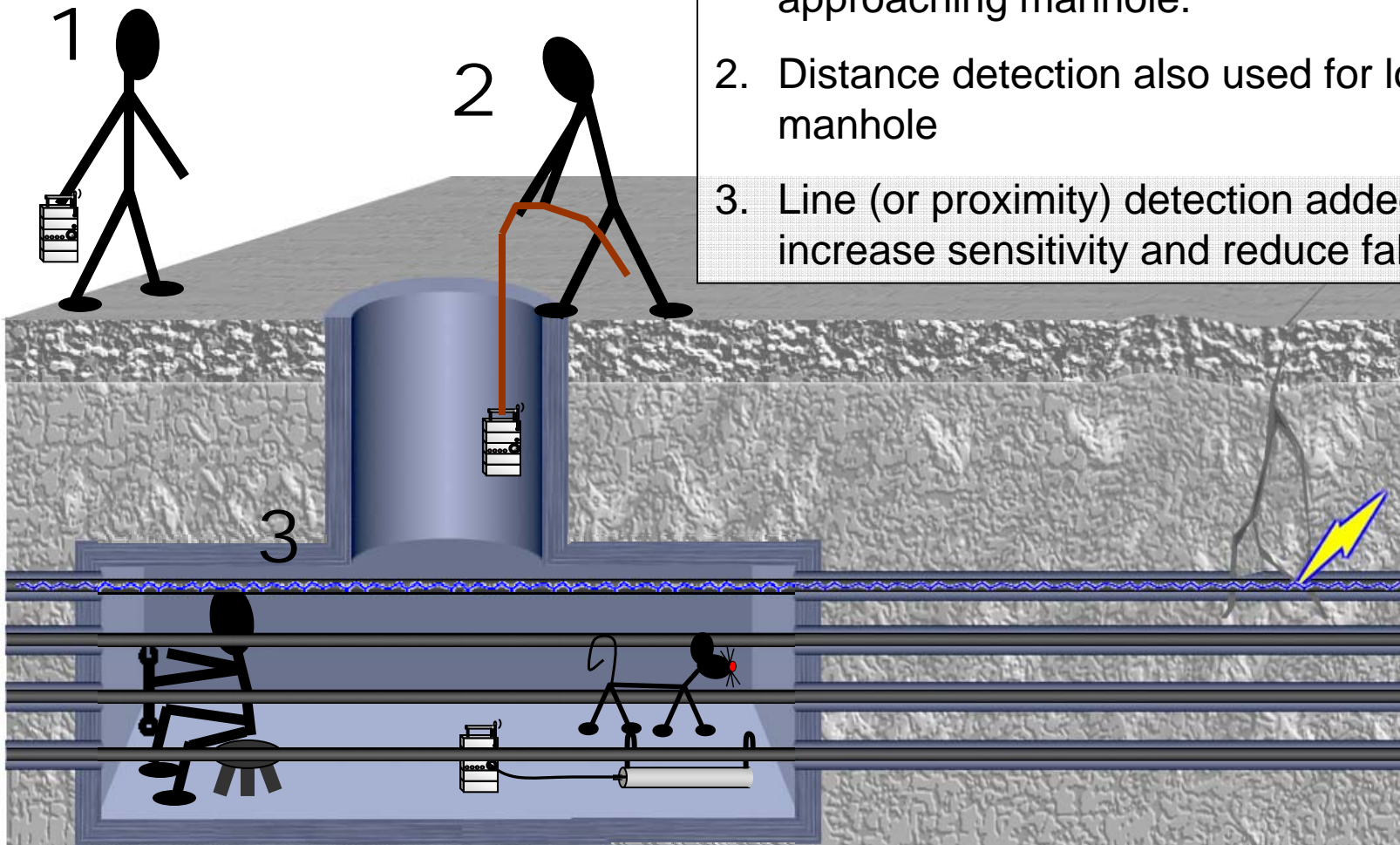


# Preliminary Tests to Define Frequency Bands



# Prototype Concept of Use

1. Distance (or range) detection is used when approaching manhole.
2. Distance detection also used for lowering into manhole
3. Line (or proximity) detection added to increase sensitivity and reduce false positives



# Deliverables for the 2009 Base Work

## 1. Technical Report - TR

- ❖ Contents:
  - 2009 State of the Art
  - Measurements Findings
  - Mitigation Findings
  - Case Studies
  - Three More Guidebook Sections

## 2. Website

The screenshot shows a web browser window displaying the EPRI website. The address bar shows <http://strayvoltage.eprisolutions.com/>. The page header includes the EPRI logo and the title "Elevated Neutral to Earth Voltages" with the subtitle "An EPRI research project to evaluate neutral to earth voltage concerns and solutions on distribution systems." The main content area is divided into three columns. The left column contains a navigation menu with sections for "Program Information", "Project Information", and "Participant Login". The middle column features the heading "EPRI NEV and Urban Stray Voltage Research Project" followed by a detailed description of the "128.004 Elevated Neutral to Earth and Urban Stray Voltages" project, which aims to support testing and mitigation of contact voltages around swimming pools, pipelines, and in urban locations. A diagram illustrates a swimming pool setup with a "PILE GROUND ROD", "METAL COVER", and "GROUND ROD" connected to a "METAL COVER" and "GROUND ROD". The right column is titled "Upcoming Events" and contains a placeholder text "Check back for a list of upcoming events." The footer includes contact information and copyright details: "© Electric Power Research Institute 2001 - 2006. All rights reserved."

**All 128.005 Deliverables on Track for Completion Dec 2009**

# Prioritizing the Remaining Work....

- Sources of Input to Accomplish the Prioritization :
  - Project adviser and sponsor inputs, media coverage, IEEE and Jodie Lane industry meetings and pubs, miscellaneous telephone discussions and support requests
- Prioritization Conclusions:
  - Research should continue to center around: Diagnostics, Mitigation, System Design, Modeling, and Information Dissemination
- Floor is Open for Discussion.....