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EPRI Contact Voltage R&D Program Update

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**2009 Jodie Lane Annual Conference
October 19th 2009**

Presentation Summary

- This summary contains excerpts from the materials presented at the EPRI power delivery advisory committee meetings in Chicago, IL (Sept 2009)
- The materials summarize all of the relevant research under the EPRI Contact Voltage Program (128.005)
- In all, there are four seven distinct program and supplemental project research areas described as follows:
 1. Diagnostics
 2. Mitigation
 3. Modeling and Simulation
 4. Industry Support
 5. Early Detection of Contact Voltages
 6. Early Detection of Arc Fault Conditions
 7. Technology Transfer

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

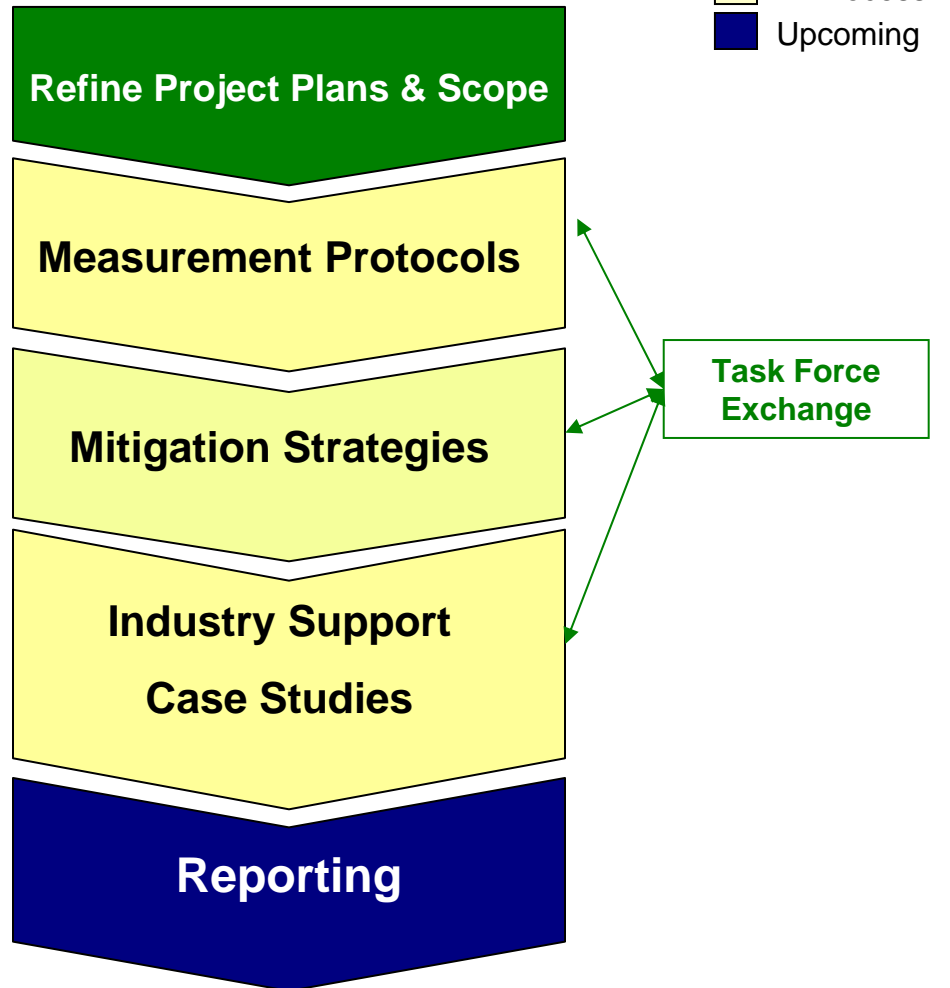
Completion Date

- December 2009

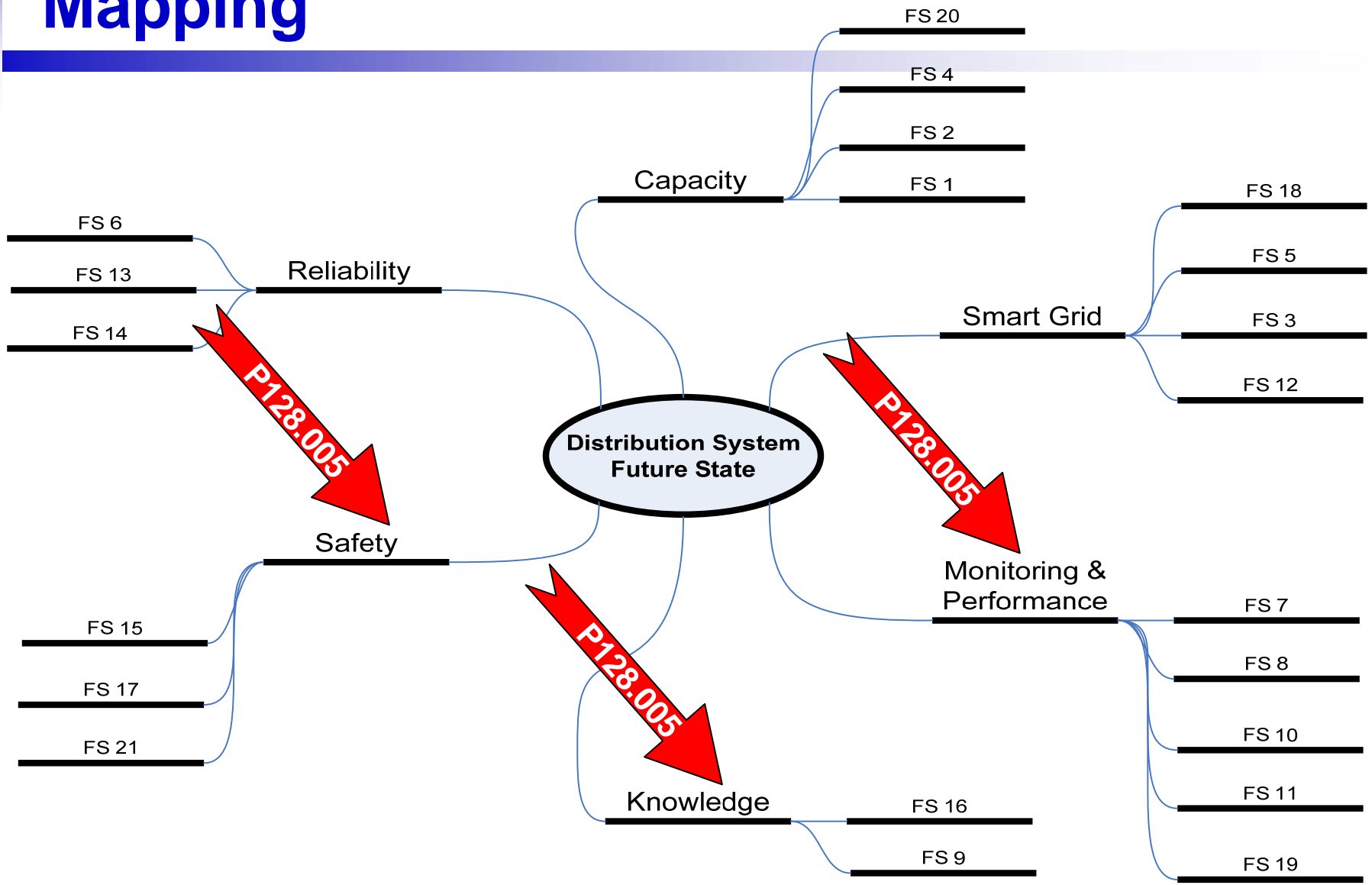
The Big Picture

- *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



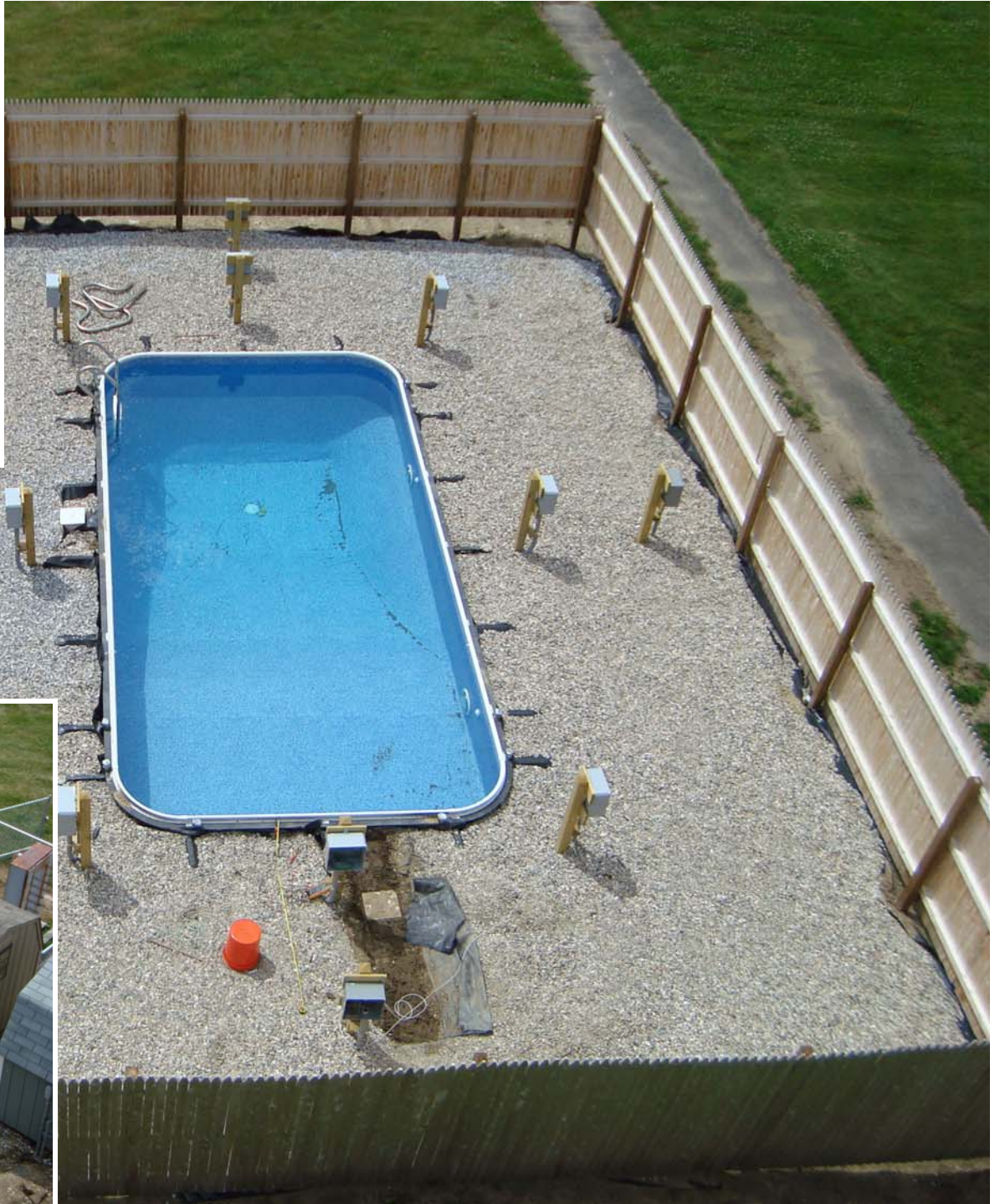
NEV & (Contact) Voltage 2009/2010 Plans

- **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

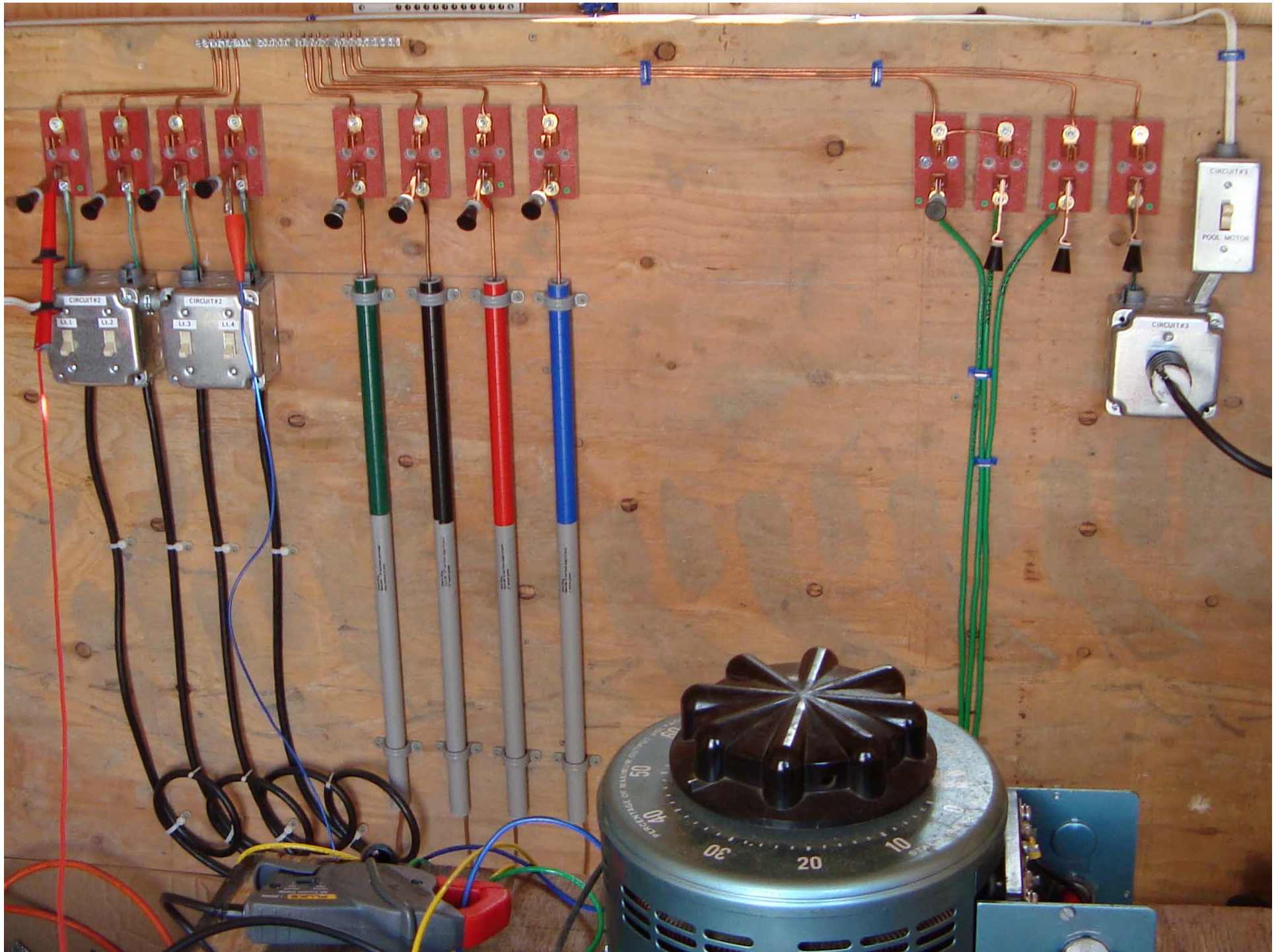
- Mitigation Using Ground Rings and Horseshoe Configs?
 - Most Effective Application of Ground Rods?
 - Can We Test with Artificial Voltage Sources?
 - Impacts of Fault Currents Through the Pool Area?
 - Impacts of Arc Voltage on the Neutral Path
 - Mitigation with Conductive Concrete Surfaces
 - Ultimate 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

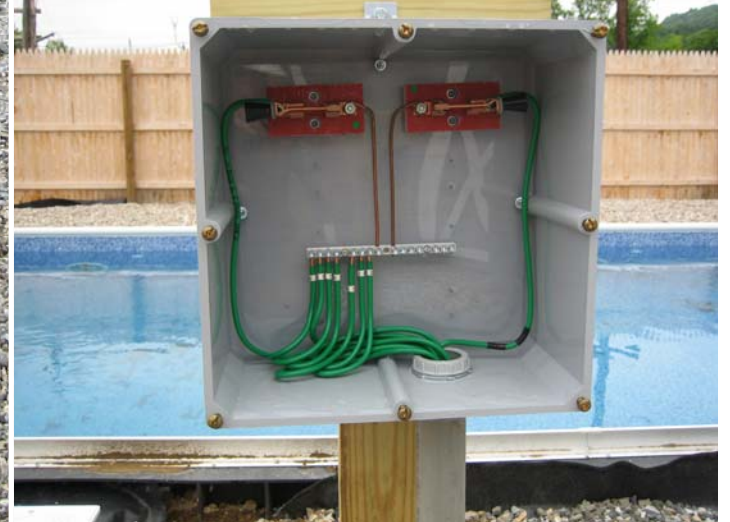




Wet Area will have #8 bare solid copper bonding ring around shell. Each ladder, light, and handrail will be connectable at a corner service box









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



Four Basic Voltage Sources:

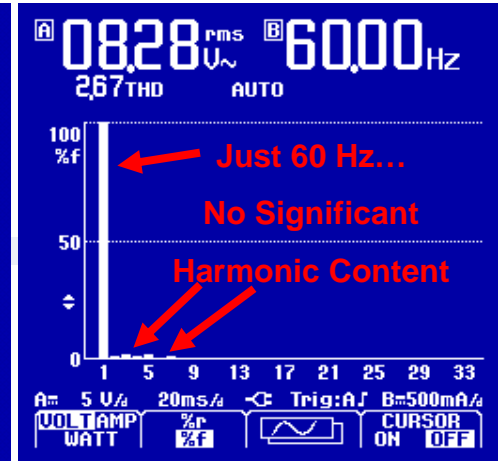
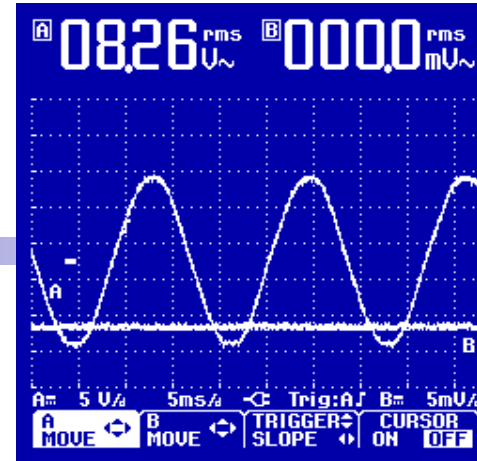
- Faults that don't self clear (service box covers, light poles, moisture paths)
- Voltage Drop on Current Carrying Conductors – NEV
- Magnetic Induction from current flow (metallic pipelines, rails)
- Electric Induction (above ground pipelines, metal light poles)

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

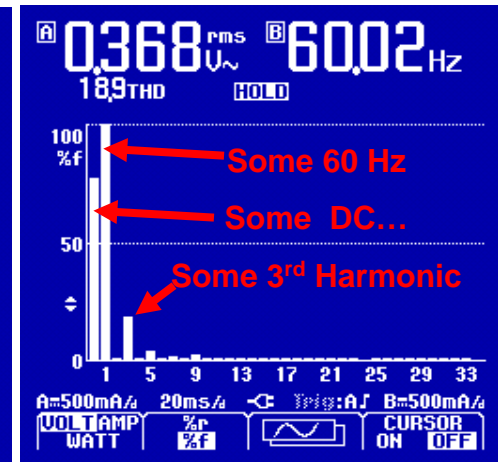
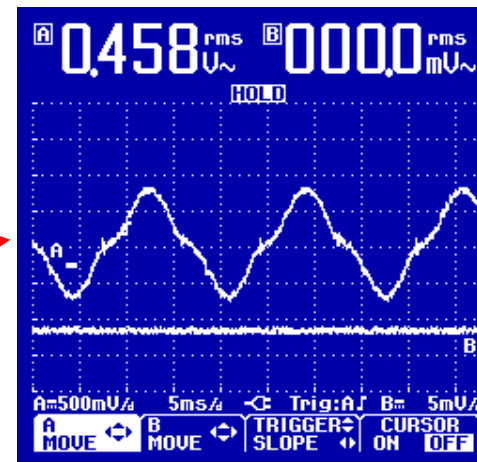
Waveform Library

20 Cases to Date

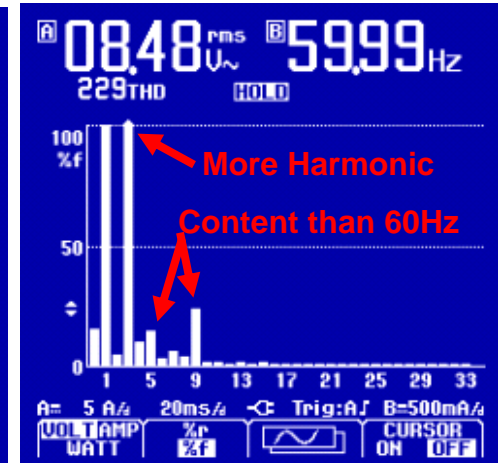
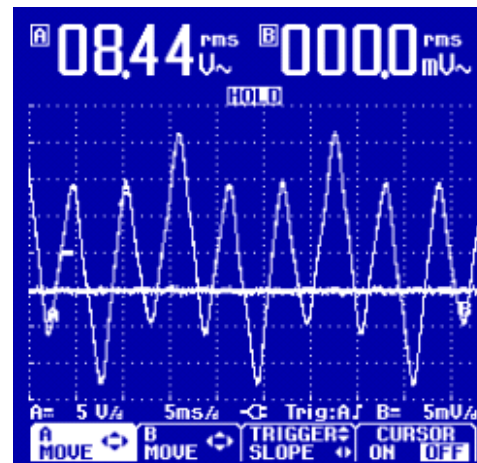
- 60 Hz Faulted Phase Conductor



- 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 19th 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

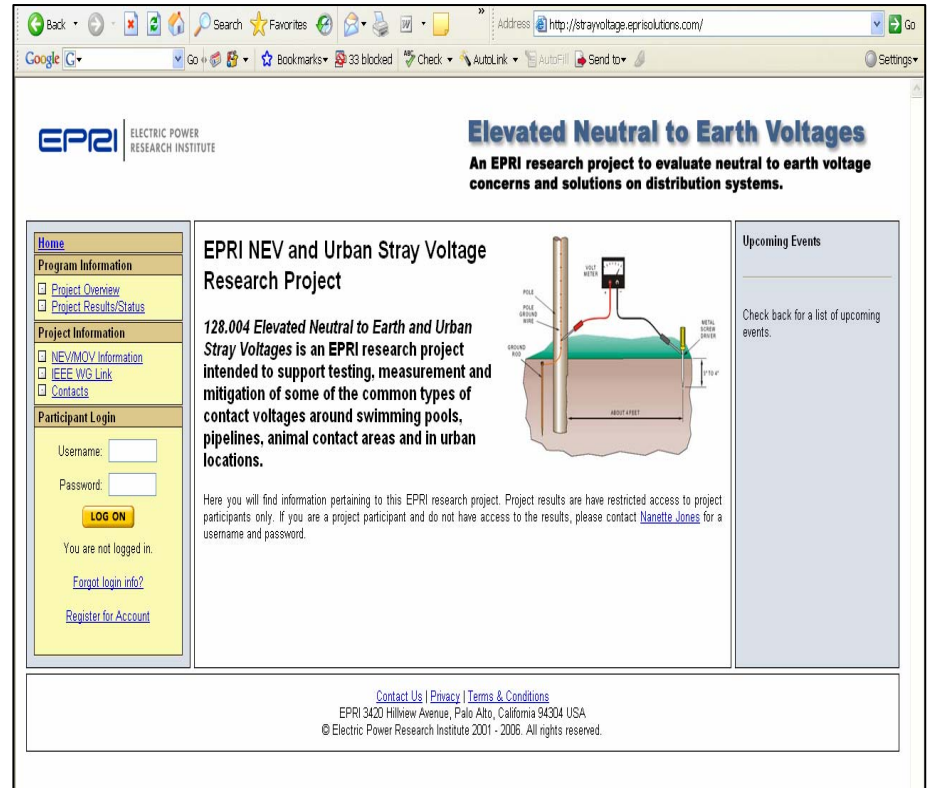
- Website

- 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 main content area features a diagram of a power line tower with a "PILE" and "PILE GROUND WIRE" connected to a "METAL EXPOSED WIRE" which is "ABOUT 4 FEET" above the "GROUND SURFACE". The diagram also shows a "METAL EXPOSED WIRE" and a "GROUND SURFACE" with a "1 FT" scale bar. The text below the diagram reads: "EPRI NEV and Urban Stray Voltage Research Project" and "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." Below this text is a paragraph: "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." The page also includes a "Participant Login" section with fields for "Username:" and "Password:" and a "LOG ON" button. There are also links for "Forgot login info?" and "Register for Account". The footer contains "Contact Us | Privacy | Terms & Conditions", "EPRI 3420 Hillview Avenue, Palo Alto, California 94304 USA", and "© Electric Power Research Institute 2001 - 2006. All rights reserved."

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 4th 2009

Project Review Meeting

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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**

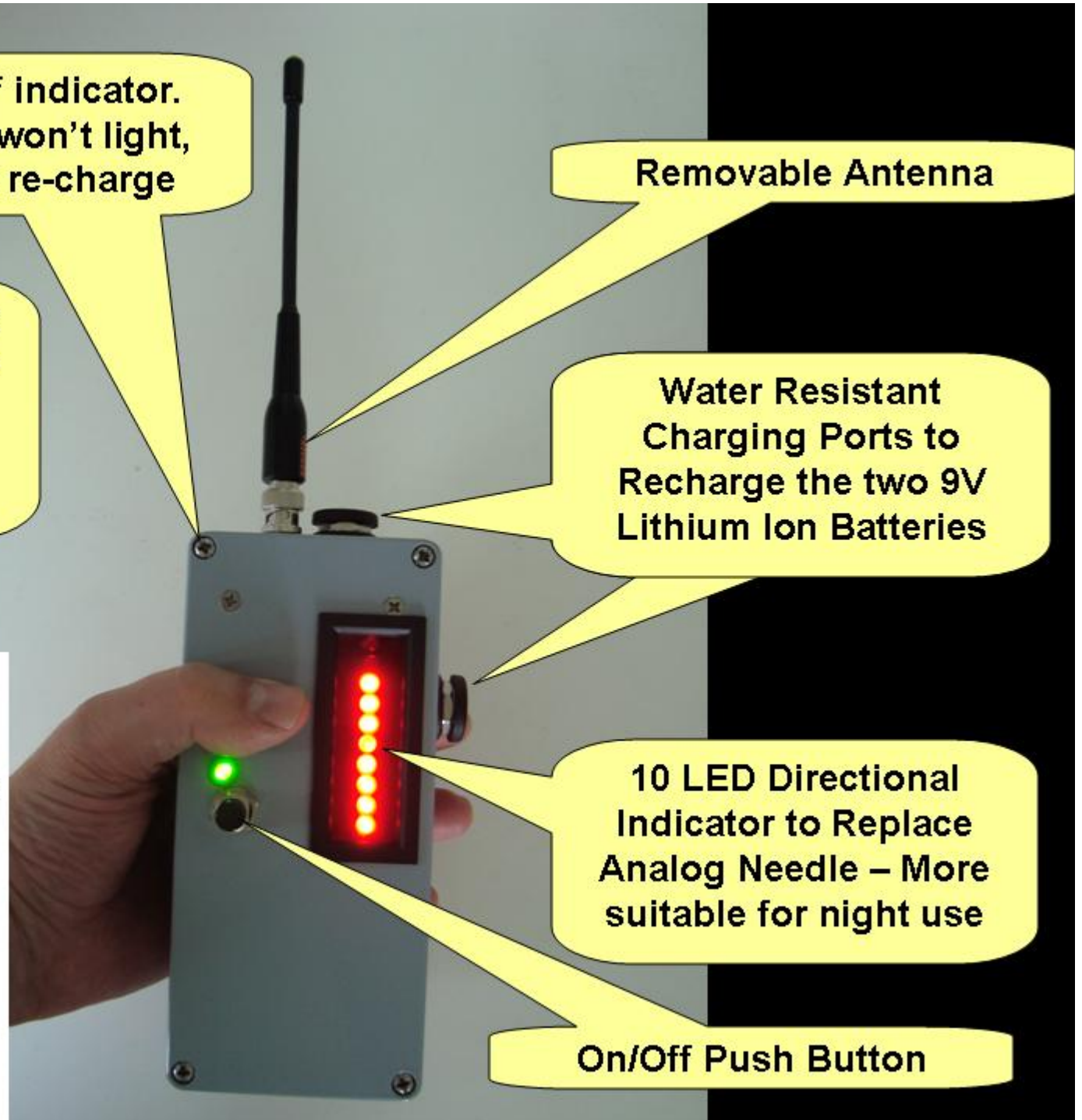
**Each unit comes with
a standalone charger
(for wall outlet or
lighter jack) and a
calibrator/tester**

Removable Antenna

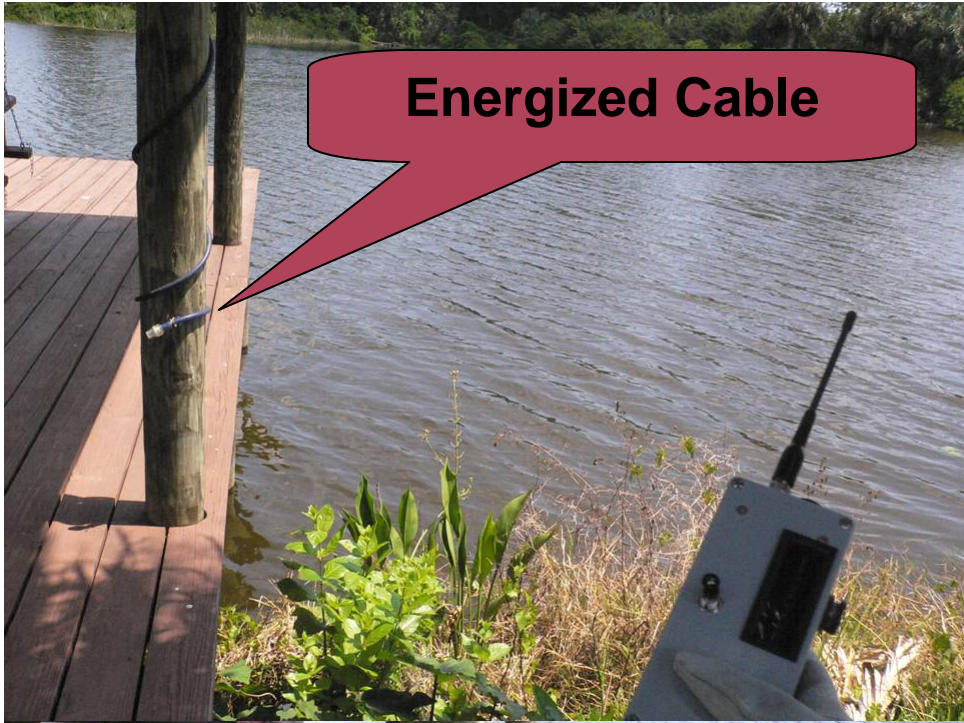
**Water Resistant
Charging Ports to
Recharge the two 9V
Lithium Ion Batteries**

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

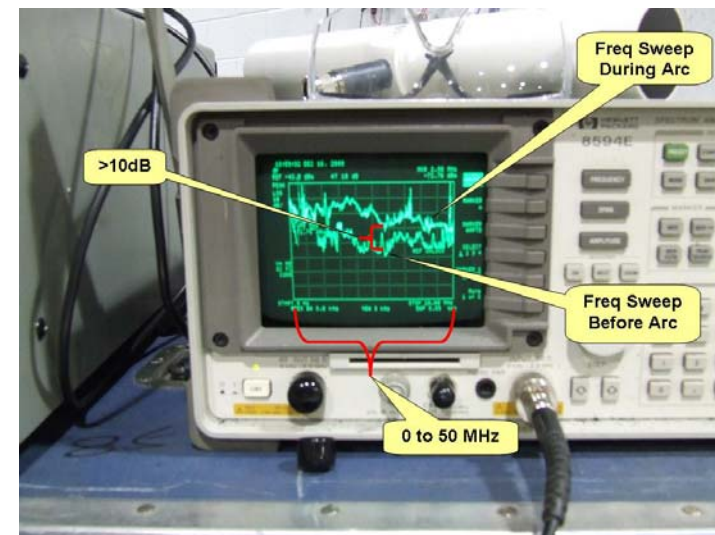
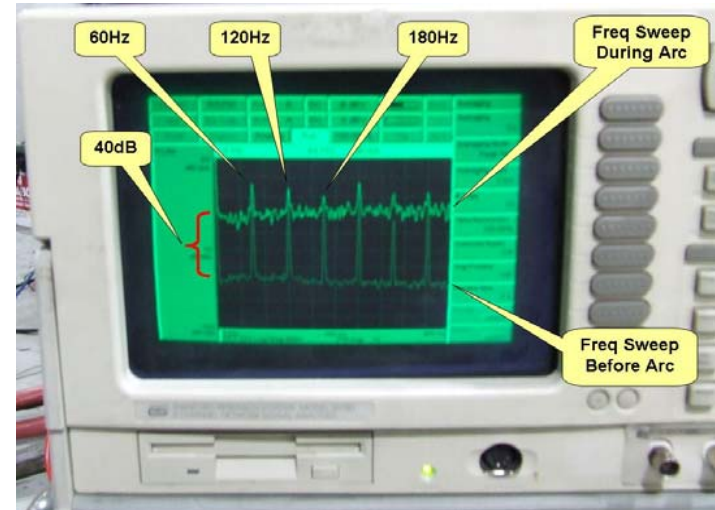
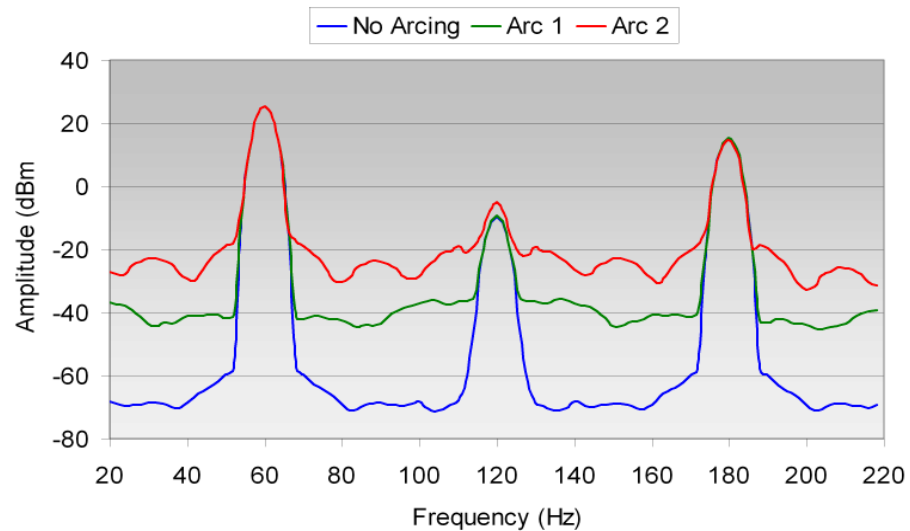
On/Off Push Button



Energized Cable

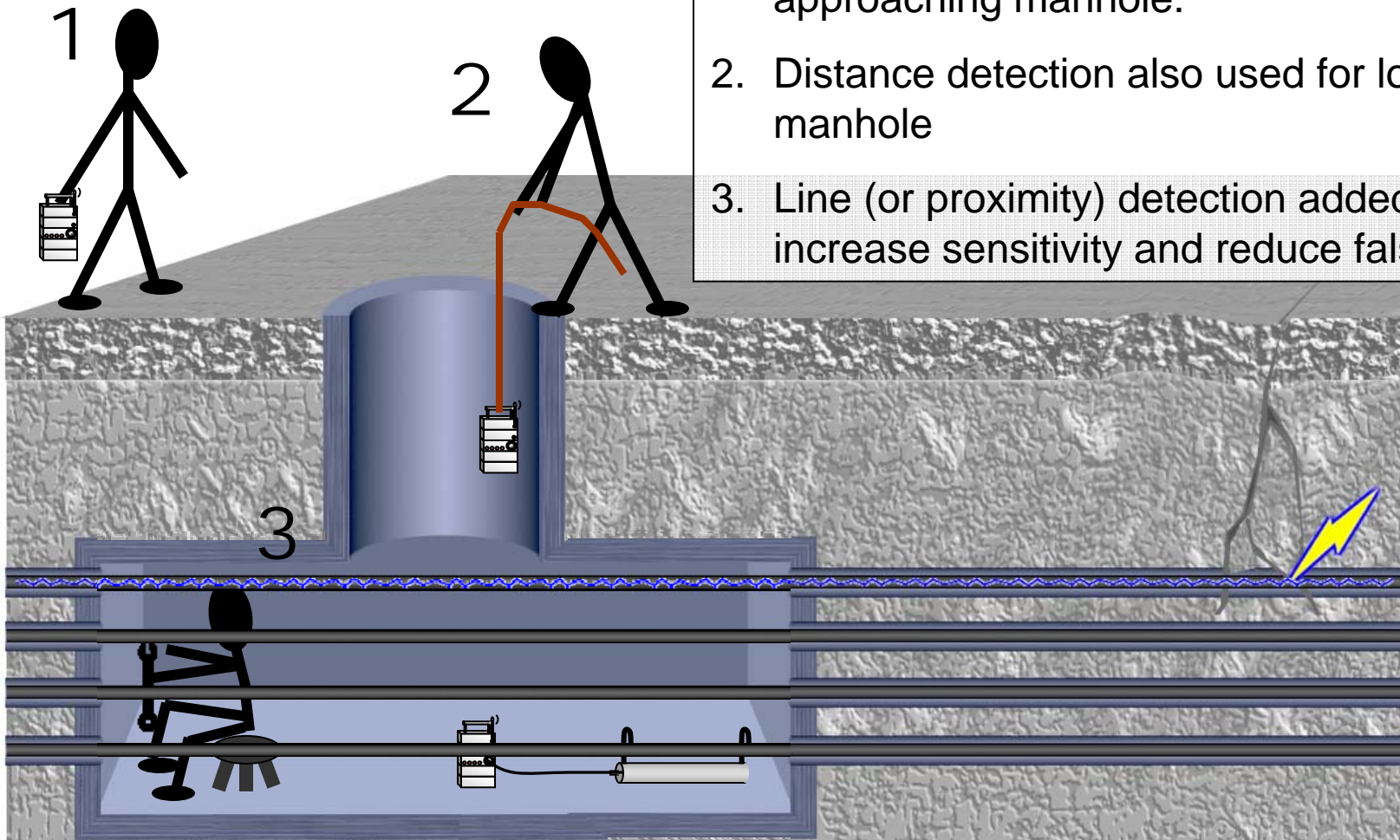


Preliminary Tests to Define Frequency Bands



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 the URL <http://strayvoltage.eprisolutions.com/>. The page header includes the EPRI logo and the title "Elevated Neutral to Earth Voltages" with a 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 links for "Home", "Program Information", "Project Information", and "Participant Login". The middle column features the heading "EPRI NEV and Urban Stray Voltage Research Project" and a diagram of 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 Dec 2009