POWER SURVEY
COMPANY

Contact Voltage Detection and Testing

David Kalokitis
CTO
dkalokitis@powersurveyco.com
Power Survey Company
www.powersurveyco.com
(888) PSC-2008

Who is Power Survey Company?

- Core business: Electrical hazard detection/mitigation services
- Technology R&D
- Formed in 2006 at Sarnoff Corporation
- Independent subsidiary of Sarnoff until 2007
- Responsible for detection of more contact voltage hazards than any other group of organizations
- US and Canadian utilities rely on Power Survey as an independent expert
- Headquartered in Kearny, NJ

What is Contact Voltage?

- Simply stated, Contact Voltage (CV) is the result of an unintentional connection between an structure or surface and an electrical distribution system
- CV can result in electrocution or shock of pedestrians and their pets
- CV is the result of a failure or fault in the system
- The underlying hazard is the existence of a fault
- Locate the fault through the surface voltage it produces
- Surface voltage can vary with time/weather/vibration/etc
- When the fault is repaired the hazard is removed

Where is Contact Voltage Found?

- Contact voltage is most commonly found in underground electric distribution areas
  - Inner cities and Underground Residential Distribution
  - Where buried infrastructure exists
- Densely populated areas increase potential for electrocution
  - Heavy foot traffic
  - Close proximity to buried infrastructure
- Street Lighting Systems
  - Represent largest class of findings
  - Built to a variety of standards

A Variety of Structures and Surfaces can be Energized

Part of Landscape

33V found on mailbox caused by burned service leg underground.

Public Proximity

108V found on streetlight on beach. Repaired corroded neutral.

Reliability Problems

60V found on sidewalk & front lawn. Service replaced.

Causes of Contact Voltage

In-situ Damage

- Construction dig-in
- Duct collapse
- Tampering by the public
- Vehicle damage

Aging infrastructure

- Expected life – 30 years
- Thermal, chemical, mechanical failure
- Abrasion against metal support racks
- Deteriorated taped connections

Workmanship

- Unintentional damage
- Material not designed for subsurface use
- Improper treatment of dissimilar metals
- Improper wiring (reversed polarity)

The goal of testing is finding these hazards

Key Concepts

- Contact voltage is the result of some type of failure
- The voltage on an energized structure can change with:
  - Moisture / Rain
  - Freeze / Thaw
  - Vibration
  - Load Current
- If you can detect and repair energized structures and surfaces you can prevent injury
- Find and Fix low voltage problems before they become high voltage problems
  - Voltages as low as 1 volt can signal presence of a fault

The Search

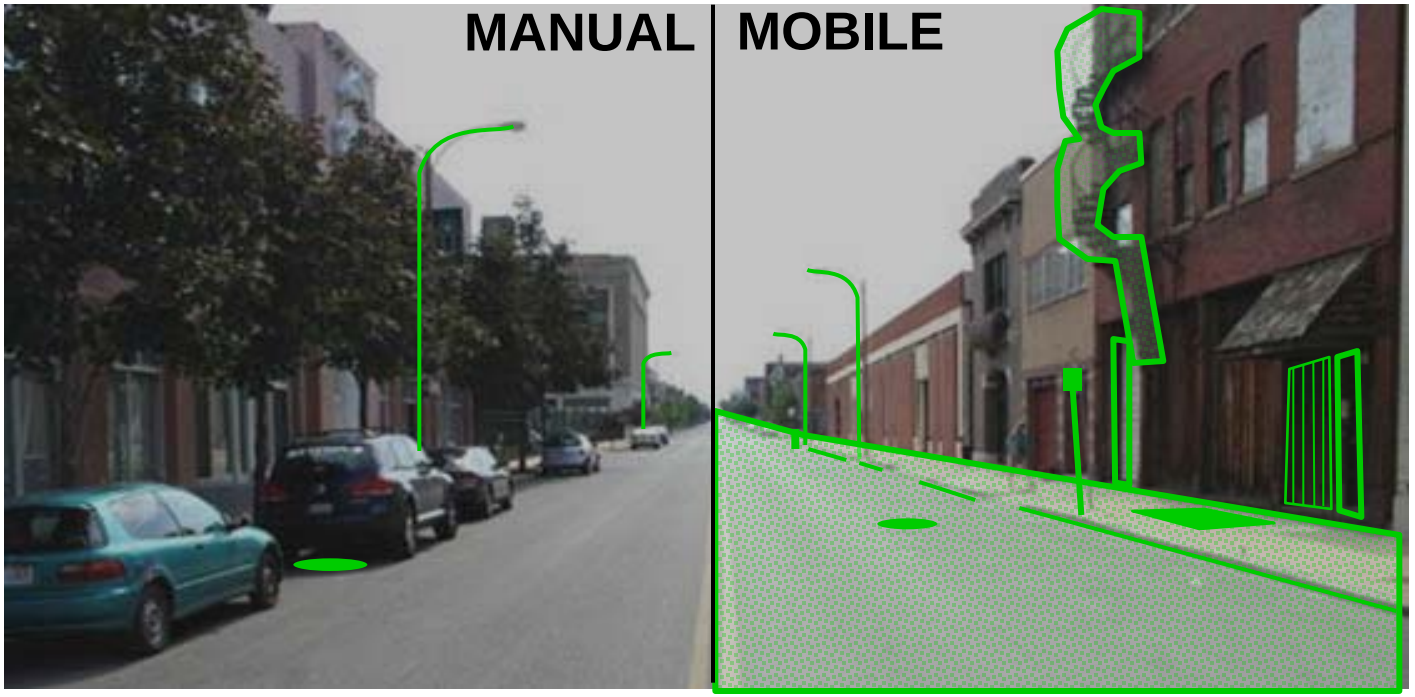
- When surveying a system for contact voltage, we are searching for structures and surfaces that are energized by a fault
  - Many problems exist
  - Specialized measurement procedures must be followed
  - Find and fix before conditions change, voltage increases
- Voltage can change with many variables
  - Finding and fixing the faults is key
  - The process begins with low voltage detection
- The test activity is infrequent
  - Thorough and accurate results are paramount
  - Maximize safety and cost benefit

Survey Concepts for Contact Voltage

- Goal: Find and eliminate energized surfaces and structures
  - Method: Detection
  - Any surface above buried infrastructure can be energized
  - Best method is to “sniff” for leaks as is done in gas distribution systems
  - Look for electric field signature from energized structure
- Pinpoint energized structures or surfaces
  - Measurements: 1 volt or greater, qualified ground
  - Troubleshoot: Determine source of voltage
  - Repair
- Detection is far more effective than inspection
  - Asset lists limit scope of testing
  - Wire and cable are assets

Detection and Process Comparison

Manual Testing	Mobile Detection
Inaccurate – highly dependent on testers' body and hand position, frequent false negatives	Accurate – sensitive to 1V or less at 30 ft, operator verifies findings
Incomplete – only tests listed assets	Complete - surveys entire area
No way to detect underground failures	Detect voltage on metal or pavement
Slow – walking speed	Fast – driving speed of 25 mph



Contact Voltage Survey Elements

- Equipment
  - Mobile electric field sensor system
  - Hand-held instruments for localization
  - Voltage and harmonic measurement tools
  - GPS and mapping tools to track survey
- Trained Technicians
  - Operate equipment
  - Perform field investigations
  - Track progress and record findings
- Operations Center
  - Planning
  - Data Processing
  - Quality Assurance

SVD2000 Mobile Contact Voltage Detection System

Operates at speeds up to 20 MPH

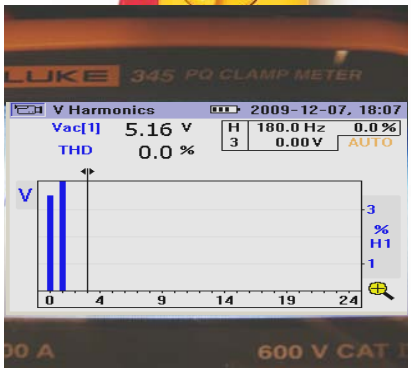
Range of over 30 ft.

Sensitive down to 1 volt AC

Enabling technology for detection process

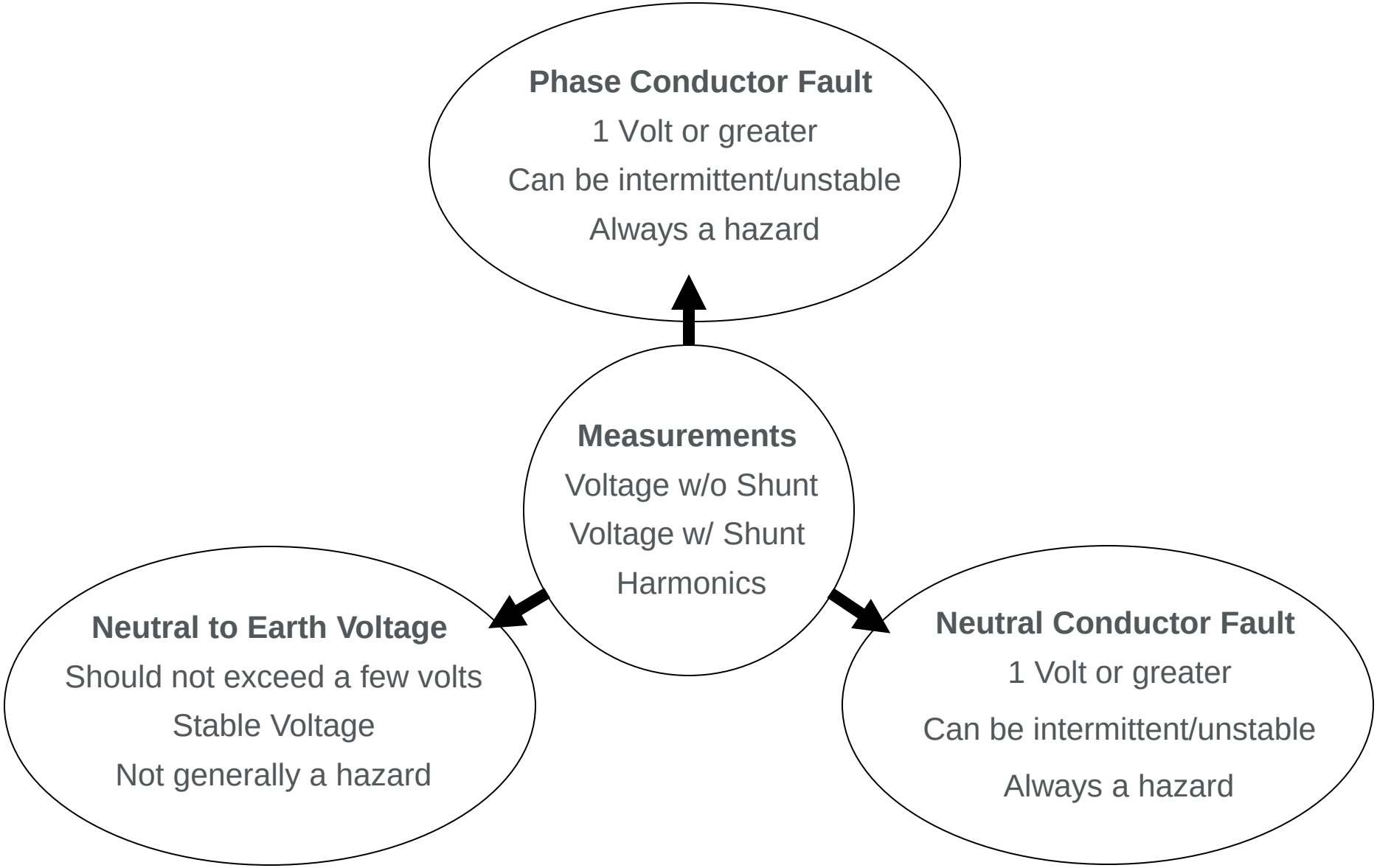
Subject to extensive independent lab testing and certification by NYPSC

Evaluation of Energized Structures

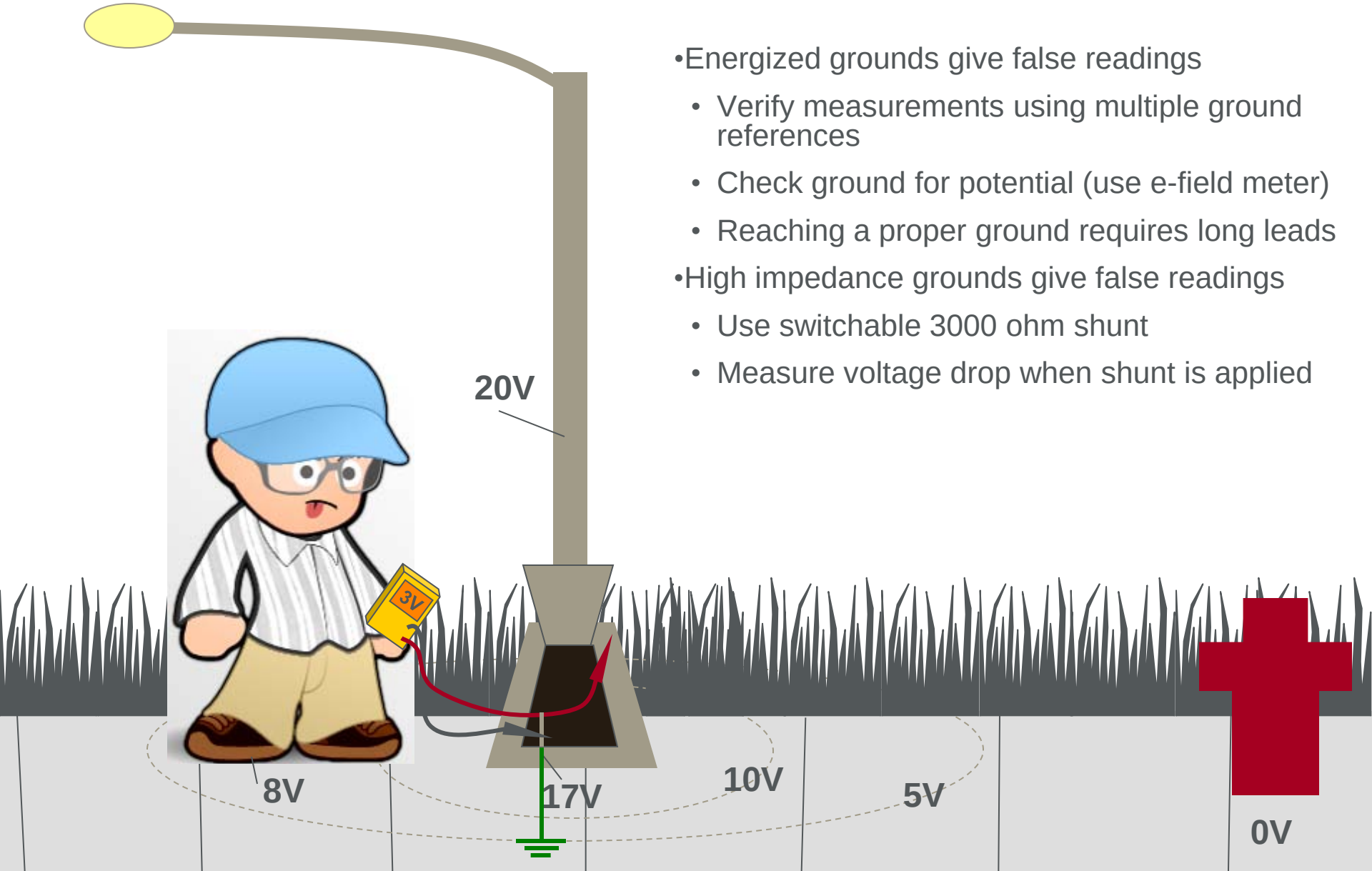


1. Select ground point
2. Check for e-field
3. Connect ground lead
4. Measure voltage
5. Engage shunt
6. Evaluate connections
7. Repeat
8. Measure Harmonics
9. Document result
10. Secure location
11. Repair

Troubleshooting



Measurement Challenges



- Energized grounds give false readings
  - Verify measurements using multiple ground references
  - Check ground for potential (use e-field meter)
  - Reaching a proper ground requires long leads
- High impedance grounds give false readings
  - Use switchable 3000 ohm shunt
  - Measure voltage drop when shunt is applied

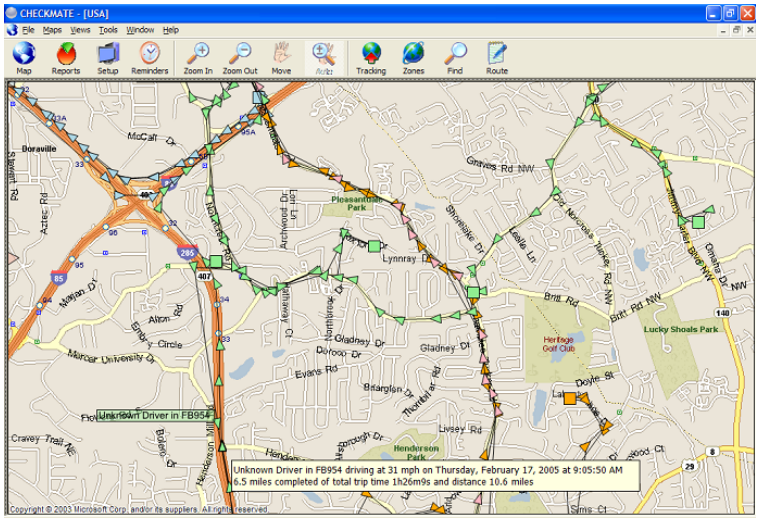
Document Findings and Progress

Site Safety

- Cone and tape area
- Deploy Standby Personnel
- Prepare report for repair activity
- Repair

Progress Tracking

- GPS System
- Paper Maps



Specific Concerns for Street Lighting Equipment

- Protective devices largely non-existent / ineffective
- Connections below grade inadequately waterproofed
- Maintenance crews not equipped or trained to find CV
- Subject to traffic damage
- Voltage can change suddenly
- Tamper / theft

Common Misconceptions

- Use a screwdriver in earth as a ground reference
  - Impedance is too high for current (shunt) measurements
- 2 Volts is safe
  - Only if you know its source is NEV
- If step potential is low, structure is safe
  - Area around energized structure often energized
  - Must measure using a qualified ground
  - Step potential is not an accurate indicator of fault existence