Human Contact Voltage Detection Protocols

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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
Concern for Contact Voltage?

Contact Voltage: An unintentional connection between an electric distribution system and publicly accessible structures and surfaces. Contact voltage has been responsible for injury and death in cities across the US and around the world.

Associated Press: *Rhode Island lawmakers ask National Grid to find stray voltage spots after dog is electrocuted*

Miami Herald: *Boys’ Paired lives ended together*

Boston Globe: *City Takes blame in Dog’s Electrocution*

Baltimore Sun: *14-year-old girl who died of shock*

NY Daily News: *Con Edison Admits Woman’s Death by Electrocution Was Their Fault.*

Washington Post: *Girl, 6, Burned by Live Wire at Bus Stop*

Ohio State Lantern: *Uninsulated Wires Caused Boy’s Death*
What is for Contact Voltage?

• 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
A Variety of Structures and Surfaces can be Energized

Part of Landscape

Public Proximity

Reliability Problems

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

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

60V found on sidewalk & front lawn. Service replaced.
Some Areas are Particularly Dangerous

Elementary School Playground

112V on fence

Service duct cracked by tree roots under sidewalk
Electric Distribution: Secondary System

Secondary Distribution (<600V)
- No protection against electric shock
- No monitoring or failure indication
- Utility notified of cable failure, fire, or shock incidents by the public or active testing
## 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)

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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

• Finding and fixing the faults is key
  – Many problems exist
  – Specialized measurement procedures must be followed
  – Find and fix before conditions change, voltage increases

• Active testing is needed
  – 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**
Inaccurate – highly dependent on testers’ body and hand position, frequent false negatives
Incomplete – only tests listed assets
Buried Cable faults often missed
Slow – walking speed

**Mobile Detection**
Accurate – sensitive to 1V or less at 30 ft, operator verifies findings
Complete - surveys entire area
Detect voltage on metal or pavement
Fast – driving speed of 25 mph
SVD2000 Mobile Contact Voltage Detection System

Operates at speeds up to 25 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
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
Planning

- Select coverage areas
- Map generation
- Scale of operation
  - Number of trucks
  - Period of performance
Evaluation of Energized Structures

Detection process has evolved to target cases of contact voltage and provide utilities with actionable and documented findings.
Contact Voltage Technicians

Trained in all aspects of contact voltage survey
- Detection of hot spots
- Job specific procedures
- Specialized measurements
- Specific experience in CV scenarios
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

• 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
Summary of Concerns

- Contact voltage exists in all electric distribution systems
- CV is the product of a fault or failure
- Protection devices largely non-existent
- Hazards can emerge and change suddenly
- Where detection is performed, density of CV findings is high
- Electric Distribution systems should be swept for faults just like gas and other distribution systems
Resources

Guidelines for the Design, Installation, Operation & Maintenance of Street Lighting Assets

http://www.esasafe.com

IEEE Working Group on Voltages at Publicly and Privately Accessible Locations

http://grouper.ieee.org/groups/td/dist/stray/
Additional References

