Missouri Public Service Commission

Electric Roundtable Discussion Group

Record of Proceedings

Electric Utility
Storm Outage Planning and Restoration
& General Service Reliability

June 1, 2007
Governor Office Building
Jefferson City, Missouri
TO: Electric Roundtable Discussion Group
FROM: Warren Wood, Director of Utility Operations
SUBJECT: Record of Proceedings
DATE: June 12, 2007

Thank you for attending the Commission's Electric Roundtable session on Electric Utility Storm Outage Planning and Restoration & General Service Reliability held in Jefferson City, Missouri on June 1, 2007. As promised, please find attached a bound compilation of the materials presented.

Our desire is to make these meetings as informative, beneficial, and effective as possible. Any ideas or suggestions you may have to help us toward that end are always appreciated. Feel free to contact me at (573) 751-2978 or e-mail me at Warren.Wood@psc.mo.gov with any comments. We look forward to your attendance and active participation at future roundtable meetings.

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     Jim McBee, Sr. Distribution Planning Engineer for Aquila

5. **Attendance List**
Electric Utility
Storm Outage Planning and Restoration &
General Service Reliability

June 1, 2007 - 9:30 to 4:00
Governor Office Bldg., 4th Floor Ballroom, 200 Madison Street, Jefferson City, MO

9:00 Registration Opens
9:30 Introductions & Opening Remarks
   Warren Wood, Utility Operations Director, MoPSC Staff
   Mark Hughes, Advisor to Chairman Jeff Davis, MoPSC

Storm Outage Planning and Restoration
10:00 Recent Major Storms in Missouri – How They Impacted the Electric System
   Rob Land, Director of Risk Management & Training for the Association of Missouri Electric Cooperatives (AMEC)

10:25 What Customers Expect Prior to and Following Major Storms
   Christina Baker, The Office of the Public Counsel (OPC) & Mike Dandino, OPC

10:50 The Major Elements of an Emergency Restoration Plan (ERP)
   Dave Wakeman, Manager of Distribution Operations for Ameren

11:15 The Restoration Effort – What Worked & Future “Opportunities”
   Martin Penning, Director of Operations for Empire &
   Sam McGarrah, Director of Engineering and Line Services for Empire

11:40 Lunch on Your Own

1:00 Keeping All the Stakeholders in the Loop
   Jim Charrier, Training & Exercise Manager for State Emergency Management Agency (SEMA)

1:25 Open Discussion/Question Period

1:45 Break

General Service Reliability
2:00 What is General Service Reliability & How is it Measured?
   Mike Taylor, Energy Department Engineer for MoPSC Staff

2:25 Reclosers, Tap Fuses, and Sectionalizing Devices
   Jerry Josken, Regional Power Systems Engineer for Cooper Power Systems

2:50 Vegetation Management Programs – Structures & Objectives
   Jeff Wolf, Director of Resource Management for Kansas City Power & Light (KCP&L)

3:15 Infrastructure Inspection – Poles, Circuits & Devices
   Jim McBee, Sr. Distribution Planning Engineer for Aquila

3:40 Open Discussion/Question Period

4:00 Adjourn
Welcome to this Missouri Public Service Commission Roundtable on Electric Utility Storm Outage Planning and Restoration & General Service Reliability

This promises to be a very interesting exchange of information and opinions.
A compendium with all of today’s presentations will be posted to our internet site within two weeks @ http://www.psc.mo.gov/publications.asp under the “electric” category.

If you would like to be added to our roundtable distribution list, please make sure you sign the attendance sheet at the back of the room and give your e-mail address.

If you would like to receive a certificate of attendance for today’s roundtable, please provide me with a business card or your name and mailing address and clearly note that you wish to receive a certificate of attendance.

If you wish to receive CLE credit please make sure to complete the CLE attendance sheet and evaluation form.
The major elements of the infrastructure that delivers electricity to customers:

 Courtesy: AmerenUE
Infrastructure in this region is designed for 70 mph sustained winds or about ½” of ice. This wind load design criteria assumes about a 1 in 50 year recurrence interval.

Downburst and microburst can result in wind loads in excess of design criteria and cause a lot of damage to trees – on and off the easement.

As ice accumulates its impact on infrastructure rapidly increases.
- 1” of ice weighs ~ 4 times ½” of ice
- 1 ½” of ice weighs ~ 9 times ½” of ice
- 2” of ice weighs ~ 16 times ½” of ice
- Trees are not designed to any particular ice load.
Electric Utility Storm Outage Planning and Restoration

9:30 Agenda & Introductions
Warren Wood, Utility Operations Director, MoPSC

9:45 Opening Remarks
Mark Hughes, Advisor to Chairman Jeff Davis, MoPSC

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Electric Utility Storm Outage Planning and Restoration

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   Sam McGarrah, Director of Engineering and Line Services for Empire

Electric Utility Storm Outage Planning and Restoration

11:40 Lunch – On Your Own

BE BACK BY ~ 12:50
Missouri Public Service Commission

Electric Utility Storm Outage Planning and Restoration & General Service Reliability

June 1, 2007

Electric Utility Storm Outage Planning and Restoration

1:00  Keeping All the Stakeholders in the Loop

Jim Charrier, Training & Exercise Manager for State Emergency Management Agency (SEMA)

1:25  Open Discussion / Question Period

1:45 to 2:00  Break
Electric Utility General Service Reliability

2:00 What is General Service Reliability & How is it Measured?
Mike Taylor, Energy Department Engineer, MoPSC

2:25 Reclosers, Tap Fuses and Sectionalizing Devices
Jerry Josken, Regional Power Systems Engineer for Cooper Power Systems

Electric Utility General Service Reliability

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Jeff Wolf, Director of Resource Management for Kansas City Power & Light (KCP&L)

3:15 Infrastructure Inspection – Poles, Circuits & Devices
Jim McBee, Sr. Distribution Planning Engineer for Aquila
Electric Utility General Service
Reliability

3:40  Open Discussion / Question Period

4:00  Adjourn

Have a safe trip home and a great weekend.
3.a
RECENT MAJOR STORMS IN MISSOURI

How They Impacted the Electric System

Rob Land, Director
Risk Management & Training Department
Association of Missouri Electric Cooperatives
National Electric Safety Code (NESC) requires that electric lines are designed to withstand up to ½” of ice – heavy standard
System Impacts

Stretched/damaged conductor

- One systems will be replacing 59 miles of three phase line.

Whiplash effect
System Impacts (Cont.)

Loss of meters

- System must be built back to pre-storm conditions, sometimes with less number of meters
System Impact (Cont.)

Damaged Equipment

- Transformers
- Breakers
- Regulators
System Impacts (Cont.)

Oil Spills
- Must be cleaned up
**System Impact (Cont.)**

Individual consumer services

- Thousands of individual services were replaced
System Impacts (Cont.)

Repairs after service is restored
- Leaning/temporary poles
- Additional ROW clearing
- Debris removal

Communications

Do you have a back-up communication system?
# Shortages

Four separate ice storms in Central U.S.
Nov. 30 – Feb. 26

# Shortages (Cont.)

States affected by 2007 ice storms
- Missouri – 2
- Illinois – 2
- Kansas
- Nebraska
- Iowa
- Oklahoma
Shortages (Cont.)

Materials
- Conductor
- Poles
- Crossarms
- Splices

Mutual Aid Assistance

Over 2660 total employees

- 1716 Mutual aid employees
  - Kansas
  - Iowa
  - Illinois
  - Kentucky
  - Tennessee
  - Mississippi
  - Arkansas
Specialized Equipment

- Track Vehicles
- Skidster
Questions?
3.b
What Customers Expect Prior to and Following Major Storms

Mike Dandino, Deputy Public Counsel

and

Christina Baker, PE, Assistant Public Counsel

Customer Satisfaction

- Satisfaction has lowered in past year
  - Ameren summer storms/ice storm public comments reflect expectations and indicate failure meeting them
  - American Customer Satisfaction Index
Primary Expectation of Customers

- Reliable-Safe-Reasonably Priced Electric

Reliability

Planning

- Design for known conditions in Missouri
  - Tornados/heavy winds
  - Ice storms
  - Earthquakes
Reliability

Planning

- Financial planning
  - Engage in efficiency monitoring

Reliability

Planning

- Long-range planning for upgrades
  - Value-based planning
- Embracing new technology
Reliability

Staffing

- Customer support centers
  - Responsive to customer’s needs
  - Assistance for customer’s locality
  - Timeliness of receiving support

- Customer information centers
  - Accurate restoration times
  - Restoration progress
  - Contact information
Reliability

Staffing

- Getting work done in the customer’s area
  - Maintenance crews
  - Tree trimming crews
  - Emergency crews

Reliability

Maintenance

- Clear statement of who is responsible for what
  - What is customer’s responsibility
- Schedule for maintenance determined
  - Schedule must be adhered to so catch-up not necessary
Reliability

Maintenance
- Repair based on worst performance
  - If it is broken…fix it
- Band-aid vs. replacement
  - Which one costs the ratepayer more?

Safety

Effect of loss of electrical service on safety
- Health issues
  - Availability of heat/AC
  - Medical support equipment
  - Traffic light outages
  - 911 Availability
Safety

Effect of loss of electrical service on safety

- Other Utility Services
  - Water supply
  - Wastewater processing
  - Telephone / Cell phone

Reasonably Priced

What customers are willing to pay

- Customers willing to pay more if perceive they are getting more
- Believe they should get what they pay for
- Customers becoming well informed about costs, wages and bonuses
Something to Remember

- Everything a utility does as it responds to an emergency has a public relations component to it...*

*Although There’s No Such Thing As An Average Disaster, Common Themes And Practices Characterize 10 Utilities’ Exceptional Responses, Peter Jump, Electric Perspectives, Jul/Aug 1999

Bottom Line

Customers can forgive a lot if:
- Feel utility is working for them
- Feel like they are important
- Utilities realize they cannot be a utility without customers
- Problems occur due to something truly unexpected and beyond utility’s control
3.c
Ameren Electric Emergency Restoration Plan

Plan Content

- Overview
- Emergency Operations Center
- Individual Job Duties/Responsibilities
- Damage Assessment
- Restoration Update Conference Calls
- Extensive Damage Recovery
- Division Electric Emergency Restoration Plans
- Division Supply List
- Logistics
- Sending/Receiving Crews with Ameren System
- Handling Outside Crews
- Mutual Assistance to Other Utilities
- Technology
- Contingency Planning for Loss of Critical Systems and Facilities
Emergency Operations Center

- EOC Activation
- Storm Levels
- EOC/Division Responsibilities
- EOC Operations
- Resource Procurement/Release
- Restoration Update Conference Call
- Storm Critique

Individual Job Duties/Responsibilities

- EOC Personnel
- Distribution Dispatch Offices
- Division Storm Center
- Construction Field Jobs
- Service Crew Work
- Damage Assessment Roles
- Division Support
Damage Assessment

- Information Review
- Initial Field Damage Assessment (High Level)
- Detailed Damage Assessment
- Heavy Localized Damage Assessment

Restoration Update Conference Calls

- Call timing
- Call set up
- Call content
- Call documentation
Division Electric Emergency Restoration Plans

- Template SharePoint site
- Critical logistics information
- Annual Review is necessary

Division Supply List

- Items that may benefit a Division during a restoration
- Can be updated with new items
- Must have contingency plan for local offices
Logistics

- Major component of a successful plan/restoration effort
- Must prepare for a variety of situations
- Power outages can affect your vendors
- Must build relationships/criteria before the need

A Key to Success
Logistics - Lodging

- Lodging
  - Hotels
  - Dorms
  - Gyms/ Large Facilities
  - Tents
- Number of facilities can be large
- Contracts are a huge benefit

Logistics – Meals

- Breakfast
- Lunch
  - Box Lunches
  - Snacks
  - Supplemental deliveries
- Dinner
  - Buffet
  - Restaurants
Logistics - Miscellaneous

- Parking
- Busing
- Laundry
- Ice
- Water/Sports drinks
- Security
- ... (the thing you haven’t thought of yet)
Staging Sites

- Selected sites and Contracts upfront
- Sample layouts for sites
- Must staff sites
- Storm Trailers and Mobile Command Center
Handling Resources

• Sending Internal Resources
• Receiving Internal Resources
• Receiving Outside Resources
• Sending resources off property

Sending/Receiving Crews within Ameren System

• Sending Crews to Assist
  – Supervisors, Superintendents, Crew Dispatchers, Equipment
• Receiving Crews to Assist
  – Staging Sites, Material Trailers
Handling Outside Crews

- Checkpoints
- Checkpoint Coordinator
- Ameren Liaison
- Safety Coordinator
- Squad Leaders
- Crew Guides

Mutual Assistance to other Utilities

- Handled By Operations Managers
- Discussions with EOC
- Typically not supported by EOC
Energy Delivery Technology

- Dispatch/EOC phones
- Cell phones
- Voice Radios
- Consoles/Truck/Portables

- Mapping
- SCADA
- Weather tools
- Web pages

- Contingency planning for loss of critical systems and facilities

Energy Delivery Resources on Demand

- System to track personnel and equipment
- Used to manage resources during storm restoration
- Information is kept to the individual level
- Web based for view throughout the company
- Tracks history and documents movements
Storm Plans

• Questions or comments
3.d
The Empire District Electric Company
Response to Ice Storm January 2007

Presented by
Martin Penning & Sam McGarrah

- 166,000 Customers
- 705 Employees
- 330 Commercial Ops
Overview of Storm Impact

- Storm was predicted about several days in advance.

- Three “waves” of storms:
  - Friday, January 12th
  - Saturday, January 13th (36,000 customers out)
  - Sunday, January 14th (85,000 customers out – 52% of total customers)

How Much Ice?

- Three to four times the amount we would consider a serious ice storm.

- The following pictures will give you an idea of the magnitude of the ice.
Variation Across EDE System

West Side
- Ice accumulation of 3-4 inches on the roads.
- Difficulty maneuvering vehicles
- Difficulty walking and working on the ground
  (1 collarbone was broken while walking to hotel)

East Side
- More ice on wires and trees.
  - Increased galloping of conductors
  - Damage continued to accumulate long after the rain stopped.
How Much Damage?

1,040 Poles
1,100 Cross Arms
302 Transformers
118 Miles of Conductor
Cost - $29M

Restoration
What Worked?

- Planning
- Communication
- Coordination
- Flexibility
- Manpower
- Materials
- Tools
Planning/Communication

Early weather predictions allowed us to:

- Make early inquiries concerning outside line and tree contractors (tree trimmers were scheduled on Saturday)
- Alerted selected EDE Commercial Operations personnel
- Notified materials suppliers and ordered selected materials

Communications during the storm

- Regularly scheduled conference calls among EDE managers
- Frequent unscheduled calls between managers

Coordination

Transmission restoration was centrally coordinated. (Damage assessment, tree trimming and reconstruction.)

Number of additional personnel secured was coordinated with logistic capabilities and available material supply in mind.
Flexible Plan

- Large storms require an “adapt and overcome” mentality
- EDE personnel respond to the need as required (never “not in my job description”)

Manpower

Adequate numbers of personnel:
- 400 EDE employees
- 1,565 Contractors
  - 860+ Linemen
  - 700+ Tree Trimmers
- Total of nearly 2,000 personnel

Regular hours
- Crews were placed on a regular schedule when we knew this was going to be a “long one”
Materials

Entered a supply chain alliance with Stuart Irby Company late ‘06

- Irby secured and began stocking a warehouse on EDE’s system late fall
- Irby flew in support personnel to assist throughout the storm
- They were excellent and as a result we had very few material problems

Other suppliers also did an outstanding job

- Hubbell Power Systems in Centralia, Missouri made themselves available 24x7

Tools

Outage Management System

- Provided for an efficient means to troubleshoot and dispatch crews
- Saved days of restoration time

Mapping System

- Printed circuit maps in advance for 3 areas
- Very helpful to contractors
Logistics

Food
- Many restaurants opened their doors and worked through the night preparing food (hot food and brown bags)

Housing
- Joplin and Branson hotels/motels were extremely accommodating to our needs

Transportation
- Tour busses out of Branson were used to bus contractors to/from staging areas to Branson hotels

Laundry
- Area laundries assisted to clean soiled clothing

Fuel
- Tankers delivered fuel through the night to parked vehicles (in areas where fueling locations were scarce)

Restoration

Areas for Improvement

System Damage Assessment
- Transmission system damage assessment to be done sooner
- Pre-arrange to be done ASAP (weather dependent)

Communication
- General
  - Do a better job informing all customers, cities and emergency agencies concerning restoration status (was improved throughout the storm)
- A website is being developed
- Call Center
  - Considering a “home agent” approach to large events
  - Allows additional call center representatives to respond quickly even when roads are inaccessible (must have internet access)
Restoration Areas for Improvement

Materials
- Make even better use of Stuart Irby Company (alliance was in its infancy)
- Eliminate duplication/confusion between EDE stores personnel (done)

Tools
- Outage Management System
  - Extreme call volumes caused our Interactive Voice Response (IVR) system to fail (settings have been changed)
  - Extreme situation overwhelmed our ability to “close out” outages in a timely manner (trained manpower and hardware)
  - Additional “reconnaissance” personnel to look for blown fuses, tripped reclosers and other problems would have allowed for manual tagging in the OMS
- Pre-Printed Circuit Maps
  - We needed more paper circuit maps for the contractors

Logistics
- Very large numbers of contract employees made it difficult to keep up with them
- Make advance notification and contractual agreements with restaurants, hotels, laundries, etc
- Considering a contract with a professional logistics company
- Review adequacy of EDE backup generators
- Review backup power plans for communications facilities
Questions??
“We Had a Little Ice Storm in Parts of Missouri Last Night”
Ike Skelton Training Site
(Missouri State Emergency Management Agency)
(SEMA Operations Center - SEOC)

SEMA Mission Statement
RSMo Chapter 44.020

• The State Emergency Management Agency is created for “assisting in [the] coordination of national, state and local activities related to…response, recovery, planning and mitigation.”

• “This agency shall also serve as the statewide coordinator for…the National Flood Insurance Program.”
Missouri
State Emergency Management Agency

GOVERNOR
Public Safety Director
SEMA Director
SEMA Deputy Director
Missouri Information Analysis Center (MIAC)

Routine Operations Configuration

Public Information Officer (PIO)
Information Technology Office
MO Emergency Response Commission
MO Statewide Volunteer Coordinator
Operations, Training & Exercise
Homeland Security
Planning & Disaster Recovery
Floodplain Management & Mitigation
Fiscal & Administration

SEMA Organization

Missouri
State Emergency Management Agency

Major State Emergency Program Participants

- Governor’s Office
- Department of Transportation
- Department of Health & Senior Svcs
- Department of Natural Resources
- Department of Labor
- Department of Corrections
- Department of Agriculture
- Office of Administration
- Elementary & Secondary Education

- MONG
- Department of Public Safety
- Department of Mental Health
- Department of Economic Development
- Department of Revenue
- Department of Insurance
- Department of Conservation
- Department of Social Services
- Higher Education
SEMA Emergency Management Programs

- Emergency Management Performance Grant
- Homeland Security Grants
- Nuclear REP (Callaway & Cooper Nuclear Plants)
- Mitigation & Floodplain Management Programs
- Emergency Management Training & Exercises
- Response & Recovery Programs
- Statewide Volunteer Coordinator & Volunteer Programs
- Missouri Emergency Response Commission
- Seismic Safety Commission
- 911 Advisory Committee

Disaster Declarations

1993 – 2007
(as of May 10, 2007)

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<td>Storms/Tornadoes</td>
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<td>Ice Storm</td>
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<td><strong>TOTALS</strong></td>
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Total costs for 26 declared disasters is $900 M
**2006/07 Disaster Events**

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<td>DR-1676</td>
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</tbody>
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Missouri currently has 10 open disasters

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**Missouri State Emergency Management Agency**

**Routine Operations Configuration**

- GOVERNOR
- Public Safety Director
- SEMA Director
- SEMA Deputy Director
- Missouri Information Analysis Center (MIAC)
- Public Information Officer (PIO)
- Information Technology Office
- MO Emergency Response Commission
- MO Statewide Volunteer Coordinator
- Operations, Training & Exercise
- Homeland Security
- Planning & Disaster Recovery
- Floodplain Management & Mitigation
- Fiscal & Administration
Missouri State Emergency Management Agency

Disaster NIMS Configuration

GOVERNOR

Public Safety Director

SEMA Director

SEMA Deputy Director

Command Section

Missouri Information Analysis Center (MIAC)

Intelligence Section

Public Information Officer (PIO)

Information Technology Office

MO Emergency Response Commission

MO Statewide Volunteer Coordinator

Operations Section

Homeland Security

Planning & Disaster Recovery

Planning & Disaster Management & Mitigation

Fiscal & Administration

Planning Section

Logistics Section

Fiscal/Admin Section

SEMA’s 9 Area Coordinators

- Nine Regions - Statewide local interface
- Liaison, advise & train local officials
- Help develop local emergency plans
- Evaluate & advise local emergency response activities
- Provide situation reports & damage assessments to SEOC
- Help develop local HAZMAT plans & support HAZMAT activities
- Support & coordinate response & recovery actions
Troop A
Kansas City
Lee's Summit
Sedalia/Pettis County
Johnson County
Tri-District FPD

Troop B
Kirksville
Hannibal

Troop C
St Charles / Warren County
St Louis County
St. Louis City
Jefferson County
Franklin County

Troop D
Springfield
Logan-Rogersville
Joplin
Taney County / Branson
City of Neosho

Troop E
City of Jackson / SEMO Hazmat Team
Ozark Regional Hazmat
WMD Team
City of Kennett

Troop F
Columbia / Boone Co
Camden Co Hazmat Tm
Cole Co Hazmat Tm

Troop G
West Plains

Troop H
Buchanan County / Northwest Mo. Hazmat Tm

Troop I
Rolla / Phelps Co
City of Lebanon

Available National Guard units from Missouri & other States provide disaster support.

 Teams in Boone, Hannibal and Kirksville will deploy to Region C and stage in Wentzville.

 Teams in Cole, Camden and Pettis will deploy to Region C and stage in St. Clair.

Teams in Region I, G, and the three eastern teams in Region D will deploy to Region E and stage in Poplar Bluff.

Homeland Security Response Teams (HSRT)
Deployment Strategy

- HSRT Teams on alert
- HSRT Teams Responding
- HSRT Teams Out of Service

28 Teams Total
8 Teams in affected area
11 Teams initially deployed
9 Teams for replenishment

Missouri National Guard Unit Locations

AN OF 10 SEP 02
Catastrophic Disaster Response Development

- Aviation Staging Areas
- Military Intermediate Staging Bases
- Military Forward Staging Areas
- FEMA Staging Areas
- FEMA Forward Staging Areas
- Fed Mobilization Center - Proposed
- MoDot Staging Areas
- Missouri Staging Areas
- Affected Area Staging
- Fire Marshal Regional Coordinators
- Highway Patrol Regional HQ
- State Area Command – C
- State Area Command – E
- State Unified Command
- National Guard

Catastrophic Disaster Area Command Activation

Emergency Management Training

SEMA Conducted 204 Courses in FY 06
Exercise Scope
- Event – Catastrophic Earthquake – M7.6 +/-
- Challenges – Disaster & SONS Response
- Multi-state – MO, KS, New Madrid States
- Exercise Type – Functional but Flexible
- Date/Length – Week of June 18, 2007

Exercises

Exercises
SEOC
Life Support
Kitchen
Bath/Shower
Power
Water Filtration
Air Filtration
CRT Tele / Radio Switching
Weather Radar Display
Nuclear Power Plant Lines
Control Room
EAS Access
State/National Warning Lines
Computer Stations
Phone Recorders

MULTI-MEDIA PROJECTORS
10 FT. X 10 FT. IMAGES
16 CHANNEL TV NETWORK TO ALL BUILDINGS IN THE COMPLEX
CLOSED CIRCUIT SEOC TELEVISION BROADCAST
HOW CAN ELECTRIC UTILITIES HELP SEMA IN DISASTERS?

• DURING MAJOR WIDE-SPREAD OUTAGES, INSERT LNO INTO EOC
• KEEP POINTS OF CONTACT FOR ASSOCIATION UPDATED OFTEN
• ASSIST WITH IDENTIFYING SPECIAL NEEDS FACILITIES FOR POWER RESTORATION EFFORTS, LIKE NURSING HOMES, ELDER CARE FACILITIES, WATER AND SEWER PLANTS
• PARTICIPATE IN EXERCISES
• PROVIDE EMPLOYEES BASIC NIMS TRAINING
• PARTICIPATE IN AFTER-ACTION REVIEWS WITH LOCALS AND STATE
• DEVELOP AND MAINTAIN GOOD WORKING RELATIONSHIPS NOW
• LET US KNOW HOW WE CAN HELP YOU HELP YOUR CUSTOMERS
• IT TAKES STRONG PARTNERSHIPS TO WORK DISASTER RESPONSE
“INTO EACH LIFE A LITTLE RAIN MUST FALL; LET’S US GROW TALL”

QUESTIONS, COMMENTS, FEEDBACK, COMPLAINTS?

CONTACT INFORMATION:
STEVE MOODY, OPERATIONS CHIEF
STATE EMERGENCY MANAGEMENT AGENCY
OFFICE: 5573 526 9100  24 HR. DUTY #: 573 751 2748

MEMBER CO-MO ELECTRIC COOPERATIVE SINCE 1997,
OZARK BORDER ELECTRIC CO-OP SINCE 1977
4.a
What is General Service Reliability and How is it Measured?

Electric Utility Roundtable on Storm Outage Planning and Restoration & General Service Reliability

By Mike Taylor, PSC Staff Engineer
Missouri Public Service Commission
June 1, 2007

General Service Reliability

- General—pertaining to every member of a category
- Service—providing the use of something
- Reliability—dependability
General Service Reliability

Providing the use of something (electricity) to every member of a category (customers) dependably (with minimal interruptions)
How is General Service Reliability Measured?

- 4 CSR 240-23.010 {proposed} (Reliability Rules)
- Other definitions
System Average Interruption Frequency Index (SAIFI)

\[
SAIFI = \frac{\sum \text{Total Number of Customers Interrupted}}{\text{Total Number of Customers Served}}
\]
System Average Interruption Duration Index (SAIDI)

\[
SAIDI = \frac{\sum \text{Customer Interruption Durations}}{\text{Total Number of Customers Served}}
\]

Customer Average Interruption Frequency Index (CAIFI)

\[
CAIFI = \frac{\sum \text{Total Number of Customer Interruptions}}{\text{Total Number of Customers Interrupted}^*}
\]

* The customer is counted once regardless of the number of times interrupted.
Customer Average Interruption Duration Index (CAIDI)

\[
\text{CAIDI} = \frac{\sum \text{Customer Interruption Durations}}{\text{Total Number of Customers Interrupted}} = \text{SAIDI}
\]

Average Service Availability Index (ASAI)

\[
\text{ASAI} = \frac{\text{Customer Hours Service Availability}}{\text{Customer Hours Service Demands}}
\]
Momentary Average Interruption Frequency Index (MAIFI)

\[
\text{MAIFI} = \frac{\sum \text{Total Number of Customer Momentary Interruptions}}{\text{Total Number of Customers Served}}
\]

Customers Experiencing Long Interruption Durations 8 (CELID8)

The total number of customers that have experienced a cumulative total of more than eight hours of outages.
Customers Experiencing Multiple Interruptions 8 (CEMI8)

Total number of customers that experienced >8 sustained interruptions

$$CEMI8 = \frac{\text{Total number of customers served}}{\text{Total number of customers served}}$$

Adjusted vs. Not Adjusted

- Allow major events to be studied separately from daily operation
- Eliminate large statistical effect of major events
- Various definitions for “major event”
- Other adjustments
Major Event Day Classification

A Major Event Day is a day in which the daily system SAIDI exceeds a threshold value ($T_{MED}$)

$$T_{MED} = \text{threshold value for major event day}$$

$$T_{MED} = e^{(\alpha + 2.5\beta)}$$

IEEE Std 1366-2003

---

Major Event

1. Sustained interruption; conditions beyond the control of the utility; $\geq 10\%$ of customers
2. Unscheduled interruption resulting from action taken by utility (ISO, prevention, or emergency)
3. State of emergency or disaster declaration
4. Mutual aid being provided

4 CSR 240-23.010 (proposed)
SAIFI (Not Adjusted)

Occurences

Ameren  | Aquila MPS  | Aquila L&P  | Empire  | KCPL

SAIFI (Adjusted)

Occurences

Ameren  | Aquila MPS  | Aquila L&P  | Empire  | KCPL

1.24 Avg. (wghtd)
Underground Distribution

- Installation and maintenance costs are higher
- Fewer interruptions from typical sources, e.g., vegetation, storms, animals (SAIFI ↓)
- Increased time to locate and correct faults (SAIDI ↑)

\[
\text{CAIDI} = \frac{\text{SAIDI}}{\text{SAIFI}} \Rightarrow \text{SAIFI} \downarrow + \text{SAIDI} \uparrow \Rightarrow \text{CAIDI} \uparrow
\]
Line Sectionalizing for Improved Reliability

Missouri Public Service Commission
Round Table Meeting
June 1, 2007

Jerry Josken
Regional Power Systems Engineer
Greg Palmer
Sales Engineer

GOAL: Reduce Outage Rates
PHILOSOPHY: Sacrifice the Faulted Section of Line on the Radial System

Distribution Reliability Components

- Fault Prevention
  - Vegetation Management
  - Line Construction
    - Good construction practices
    - Regular maintenance
- Fault Management
  - Line Sectionalizing
  - Fault Restoration Plan
**The Fuse Cutout**

- Simplest form of overcurrent protection.
- Effective for permanent faults.
- Temporary fault create nuisance outage.

---

**Simple Feeder Protection Scheme**

Diagram showing a simple feeder protection scheme with a substation.
Causes of Temporary Faults

- Wind & Trees 46%
- Lightning 19%
- Equipment & Wiring 11%
- Miscellaneous 24%

One Year’s Fault Experience

<table>
<thead>
<tr>
<th>Fault Experienced</th>
<th>Successful Reclosers</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>896</td>
<td>First</td>
<td>88.7</td>
</tr>
<tr>
<td>46</td>
<td>Second</td>
<td>4.5</td>
</tr>
<tr>
<td>13</td>
<td>Third</td>
<td>1.3</td>
</tr>
<tr>
<td>55</td>
<td>Lockout</td>
<td>5.5</td>
</tr>
<tr>
<td>1010</td>
<td></td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Basic Rules for Line Sectionalizing

- Allow a fault to be temporary
- Lockout for permanent faults
- Sectionalize the fault to the smallest possible area.

What does the Recloser do?

- Sense fault current
- Interrupt fault current
- Reclose (4 shots max.)
- Resets for temp faults
- Lockout on permanent faults
- Dual Timing (fast/slow operations)
Definition of a sectionalizer

A device that automatically opens the distribution circuit after sensing a count of successive fault currents greater than a preset actuating current. **It opens while the distribution circuit is de-energized.**

Demonstration Software

Three Phase Recloser for Substation Feeder Protection
**Momentary Outages**

- Fast Trips may cause nuisance momentary blinks
- SCADA link can switch control profiles
  - Good Weather – No Fast Trips
  - Storms – Fast Trips Enabled

**Mid Line Recloser Technique**

![Diagram](image)

**Figure 3.** Calculating reliability.

**OPTION TO IMPROVE SERVICE RELIABILITY**

1. **With No Line Recloser:**
   - Fault at F1: 1000 customers x 1 hr. = 1000 cust. hrs.
   - Fault at F2: 1000 customers x 1 hr. = 1000 cust. hrs.
   - Outage Total = 2000 cust. hrs.

**With Line Recloser A:**
   - Fault at F1: 1000 customers x 1 hr. = 1000 cust. hrs.
   - Fault at F2: 500 customers x 1 hr. = 500 cust. hrs.
   - Outage Total = 1500 cust. hrs.

Outage rate with line recloser equals \(\frac{1500}{2000} = 75\%\) of rate without line recloser; or \(\frac{500}{2000} = 25\%\) reduction in outage rate.
**Mid Line Recloser Technique**

**Without Midline Recloser**

Each outage = 1 hour in length (time required to locate fault and restore service).

* With No Line Recloser:
  - Fault at F1: 1000 customers x 1 hr. = 1000 cust. hrs.
  - Fault at F2: 1000 customers x 1 hr. = 1000 cust. hrs.
  - Outage Total = 2000 cust. hrs.

**Option to Improve Service Reliability**

Adding a recloser at point A, shown in Figure 3, as a main-line-sectionalisng device will reduce outage rates caused by faults on the main feeder.

* With Recloser at A:
  - Fault at F1: 1000 customers x 1 hr. = 1000 cust. hrs.
  - Fault at F2: 500 customers x 1 hr. = 500 cust. hrs.
  - Outage Total = 1500 customer hours

Outage rate with line recloser equals 1500/2000 or 75% of rate without line recloser; or: 500/2000 = 25% reduction in outage rate.

---

**Create High Reliability Zones**

- Emphasize reliability near substation
  - * Mid Line Recloser
  - * Replace Fused Taps with Single Phase Recloser
  - * Activate Substation Recloser Sequence Coordination Feature
High Reliability Zone

Substation

Critical Load

Single vs. Three Phase Sectionalizing

Single phase Advantage
• 2/3 More Reliable only one ph out

Three Phase Advantages
• Ground Fault Sensing
• Three phase trip and lockout

Single phase Disadvantages
• No Ground Fault Sensing
• Single Phasing of 3 ph customers

Three Phase Disadvantages
* Less Reliable - ph to grd fault LO all 3 ph
The Answer is Triple/Single Reclosers

- Three modes of operation
  * 1 Phase Trip & 1 Phase L.O.
  * 3 Phase Trip & 3 Phase L.O.
  * 1 Phase Trip & 3 Phase L.O.

All three Phases trip for Ground Trip.

Form 6 Control
Questions?????

Contact Information

Jerry Josken
Regional Power Systems Engineer
630-717-4505
jjosken@cooperpower.com
4.c
Vegetation Management Programs
Structures and Objectives

Electric Utility Roundtable
Jefferson City, MO
June 1, 2007

Jeff Wolf
Director Resource Management
Kansas City Power & Light Co.

Presentation Overview

- KCP&L System Overview
- Contracting Philosophy and Performance Management
- Program Strategies, Specifications, and Guidelines
- Implementation of Best Practices
- Customer Satisfaction and Community Programs
KCP&L System Profile

- Distribution: ~8,500 miles of overhead 12kV & 35kV lines
- Transmission
  - 69KV: ~75 miles
  - 161KV: ~1,000 miles
  - 345KV: ~300 miles
- 65% of the metro tree workload is inaccessible to bucket trucks (industry average 27%)

Tree density
- METRO
  - 115 trees per mile
  - 4,000 square feet of brush per mile
- RURAL
  - 35 trees per mile
  - 2,700 square feet of brush per mile
  - Industry average ~80 trees per mile
  - Missouri utility average ~100 trees/mile

Accessible: 2-man crew, can drive to and trim with bucket truck
Trimming from the bucket
Inaccessible: 3 man crew, must carry equipment to back yard……

…..manually climb the trees……
….and tie off and trim in the tree

Don't try this at home!
Bottom line – 30 to 40% more time to manually trim

Proactive contractor management improves efficiency and decreases cost

- KCP&L contracts with a vegetation management specialist, Environmental Consultants, Inc. (ECI) to manage the program
  - Overall line clearance strategy
  - On-site program supervision, administration, and record-keeping
  - Staffed with degreed foresters and/or ISA Certified Arborists
  - Tree-trimming contractor scheduling and contract administration

- KCP&L uses three line clearance contractors to trim trees
  - Keeps costs in check by using multiple contractors to ensure competition
  - Use performance-based contracting and evaluate performance regularly
  - Contractors are provided comprehensive specifications with species-specific clearance guidelines

- Vendor incentives are aligned with KCP&L service objectives to better manage their performance
  - If program costs are under budget, savings are shared between KCP&L and ECI, assuming:
    - Reliability is at or above target
    - Trimming is on schedule
  - Tree trimming contractors have incentives for productivity
Our program is based on clearly defined strategies, specifications, and guidelines

Systematic preventive maintenance focused on maintaining high reliability while controlling costs

- Distribution - long-term preventive maintenance strategy based on outage risk and customer impact
  - 2-year backbone patrol & selective maintenance schedule
  - 4-year Metro backbone schedule
  - 5-year Metro lateral / rural schedule

- Transmission
  - Annual patrols/inspections and selective maintenance
  - 2-year urban trimming cycle
  - 3-year rural trimming cycle

- Reliability-based trimming means that work is planned based on risk and importance of specific lines, rather than using the same cycle for trees on all lines
  - Worst-performing circuits and laterals incorporated into scheduling criteria
  - Proactive and preventive scheduling, rather than reactive maintenance
  - Prescriptive work selection in advance of tree trimming crew assignments

Prescriptive work selection means pre-planning each tree that will be maintained……..
Using a hand-held device to capture tree-specific data

<table>
<thead>
<tr>
<th>Species</th>
<th>Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ailanthus (Tree of Heaven)</td>
<td>F</td>
</tr>
<tr>
<td>Ash (all species)</td>
<td>S</td>
</tr>
<tr>
<td>Baldcypress</td>
<td>S</td>
</tr>
<tr>
<td>Birch (all species)</td>
<td>S</td>
</tr>
<tr>
<td>Box-elder</td>
<td>F</td>
</tr>
<tr>
<td>Catalpa</td>
<td>F</td>
</tr>
<tr>
<td>Cherry, black</td>
<td>S</td>
</tr>
<tr>
<td>Coffeetree, Kentucky</td>
<td>S</td>
</tr>
<tr>
<td>Cottonwood (and all other poplars)</td>
<td>F</td>
</tr>
<tr>
<td>Crabapple (all varieties)</td>
<td>S</td>
</tr>
<tr>
<td>Elm (all species)</td>
<td>F</td>
</tr>
<tr>
<td>Fir (all species)</td>
<td>S</td>
</tr>
<tr>
<td>Ginkgo</td>
<td>S</td>
</tr>
<tr>
<td>Golden Rain Tree</td>
<td>S</td>
</tr>
<tr>
<td>Hackberry</td>
<td>F</td>
</tr>
<tr>
<td>Hawthorn (all species)</td>
<td>S</td>
</tr>
<tr>
<td>Hemlock (all species)</td>
<td>S</td>
</tr>
<tr>
<td>Hickory (all species, including Pecan)</td>
<td>S</td>
</tr>
<tr>
<td>Hophornbeam</td>
<td>S</td>
</tr>
<tr>
<td>Honeylocust</td>
<td>F</td>
</tr>
<tr>
<td>Linden (all species, including Basswoods)</td>
<td>F</td>
</tr>
<tr>
<td>Locust, black</td>
<td>F</td>
</tr>
</tbody>
</table>
…then trimmed to meet program clearance guidelines

Clearance Guidelines (in feet)

<table>
<thead>
<tr>
<th>Clearance from trees</th>
<th>Rate of Growth</th>
<th>Primary Voltage (2-25 KV)</th>
<th>34 KV</th>
<th>69 KV</th>
<th>161 KV</th>
<th>345 KV</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIDE</td>
<td>Slow Fast</td>
<td>8 12</td>
<td>10 15</td>
<td>10 15</td>
<td>25 25</td>
<td>35 35</td>
</tr>
<tr>
<td>OVER</td>
<td>Slow Fast</td>
<td>(a) None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>UNDER</td>
<td>Slow Fast</td>
<td>6 8</td>
<td>10 12</td>
<td>10 12</td>
<td>15 15</td>
<td>20 20</td>
</tr>
</tbody>
</table>

(a) Remove all hazardous overhang, and all overhang within 15 feet of the conductors that could contact them if weakened or broken. Remove all overhang on 3-phase lines.

(b) Special clearances may be needed at times because of field conditions.

12 KV Distribution Line (3-phase): A hedge tree before trimming….
…..and after

12 KV Distribution Line (3-phase): Two maple trees before and after trimming
12 KV Distribution Line (3-phase): An oak tree before and after trimming

12 KV Distribution Line (Single-phase): An ailanthus tree before and after trimming
Contractor safety is a critical element of the program

- All contractors conduct accident investigations and perform root cause analysis on OSHA recordables
- Formal results from tree contractor are shared with ECI who creates a safety message for the other contractor
- Each will schedule appropriate training to reduce chances of repetitive occurrence
- KCP&L and ECI receive monthly OSHA reports from tree contractor
- Standard daily tailgate sessions are performed in the field
- Every VM meeting begins with a safety topic

Use of industry best-practices is another key to our program

- Strategic plan built specifically for the vegetation management program, addressing both long and short-term goals
- Workload data for budget forecasting, allocation of crew resources and development of management tactics
- Staff consisting of degreed foresters and/or ISA Certified Arborists
- Appropriate maintenance cycle based on tree re-growth rates, clearance and reliability metrics
- Prescriptive work selection in advance of crews
- Clearance guidelines established
- Tree selectivity based on individual tree outage risk
- Tree removal criteria established
- Initiated foliar and cut stump herbicide program
- Brush control techniques varied and appropriate to conditions
- Mechanical Equipment (Jarraff & Mowers)
- Proper pruning techniques implemented (ANSI A-300)
Specialized equipment - Jarraff trimmer

Specialized equipment – Track Bandit
Specialized equipment – brush mower

Herbicide application
Herbicide application

We focus on maintaining customer satisfaction as we complete our vegetation management work

- Customers notified in advance of tree maintenance
- Follow-up communication to answer questions and resolve problems before crews arrive
- Written permission for all removals over 4" in diameter
- Customer satisfaction surveys average over 90% satisfaction with line clearance tree maintenance
- Vegetation Management representatives provide plant pest & disease diagnosis and solution to homeowners
- Tree replacement program on valued landscape trees
- Customer Assisted Removal for off cycle trees
Customer notification door hanger

Tree Trimming Required
Your tree could cause a power outage

Tree Work Required
There is no charge for this service

Customer satisfaction survey card

We’d Like Your Opinion
Thank you for your cooperation during our recent tree trimming near electric lines in your area.

We value your feedback on our service. Please take a moment to complete this survey and let us know what you think of our service. Your input helps us improve and serve you better.

We’d Like to Hear From You
Thank you for your time and cooperation.

KCMO Water & Light

[Image of survey card]

[Image of tree trimming sign]

[Image of KC Water & Light logo]
We also have a strong community focus as part of our vegetation management program

- “Tree Line USA” recognition since 2003
- Development of an Utility Arboretum in Shawnee, KS
- Issued a new and more comprehensive “The Right Tree in the Right Place” booklet in March 2007
- Community tree plantings - Arbor Day and Earth Day plus other events in tandem with local agencies such as Heartland Tree Alliance, MO Dept of Conservation and KS Forest Service
- Distribution of wood chips
- Working with KCPL stakeholders to develop a tree grow-out farm
- Tree Replacement Program
  - About 10% of all trees addressed by the VM program each year are removed.
  - The vast majority of these trees are not of landscape quality (homeowner planted), but were propagated naturally.
  - KCP&L’s tree replacement program secures ‘hard-to-get’ removals of landscaped trees.
  - Tree replacement vouchers for local nurseries up to $250

Yes, sometimes tree trimmers are even appreciated!
QUESTIONS?
4.d
INFRASTRUCTURE INSPECTION

Poles, Circuits & Devices

Aquila Inc.
NYSE: ILA
www.aquila.com

James J. McBee, P.E.
Sr. Planning Engineer
819-737-7170
Jim.McBee@aquila.com

System Components

7700 miles of OH line
2600 miles of UG line
200,000 Poles
600 capacitor banks
1000 reclosers
650 regulators
70,000 transformer installations
10,000 switches
Distribution Patrol

- Patrol all components of the distribution system both overhead & underground on a 5 year cycle

- Visual Inspection

- Patrols at parks and Schools conducted annually

- Files of deficiencies found maintained

- Repairs of deficiencies made are documented and maintained in the files
OVERHEAD

1. Poles
   A. Broken or Severely-Rotted
   B. Leaning Severe

2. Crossarms
   A. Crossarms or Braces Broken
   B. Guy Insulator Height

3. Guys & Anchors
   A. Loosened or Damaged
   B. Guy Insulator Height

4. Equipment / Other
   A. Transformer, Capacitor or Other
   B. Arrester Blown

5. Conductor Clearance (see Guidelines below)
   A. Line Clearance from Ground
   B. Too Close to Building, Signs, other Structure

UNDERGROUND

7. Underground Equipment
   A. Lock Missing
   B. Access Blocked
   C. Leaking Oil
   D. Leaking Oil
   E. Secondary Pedestals, missing or broken lid

8. Underground Cable
   A. Cable Exposed
   B. Condul Broken

GUIDELINES:

For Conductor Clearance: See Table below.

Primary - If less than 19 feet
Secondary - If less than 17 feet
Services - If less than 16 feet over road or drive
Services - If less than 8.5 feet across yard
Over RR Track - If less than 27 feet

Structure Clearances

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Clearance</th>
<th>Overhead</th>
<th>Ground</th>
<th>0-750 Volt</th>
<th>Over 750V-22kV</th>
</tr>
</thead>
</table>
**Overhead Conductors**

Reviewed for replacement when more than 2 failures/1000’ have occurred

**Underground Conductors**

- Terminations inspected during distribution Patrol

- Replacement Methodology:
  - Section 300’ or less – Replace after second fault
  - Cable Loops – more than 4 failures in the loop and the entire loop averages more than 2 failure per 1000’
  - Replace elbows when replacing cable

- Currently evaluating cable injection as an alternative to cable replacement
Cutouts, Insulators & Lightning Arresters

Switches

Additional inspection during the normal course of construction and system maintenance
Reclosers

Monthly – each installation is visually inspected & counter reading recorded

Regulators

Visual inspection is performed each month

Counter reading, drag hand position and current state are recorded
<table>
<thead>
<tr>
<th>Date</th>
<th>OEM 1</th>
<th>OEM 2</th>
<th>OEM 3</th>
<th>Position Indicator</th>
<th>Comments* Reported by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td></td>
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<td>Mar</td>
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<td>Apr</td>
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<td>May</td>
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<td>Jun</td>
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<td>Jul</td>
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<td>Aug</td>
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<tr>
<td>Nov</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Dec</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

*Check and report if:
1) Line or load side arrester failure
2) Arrester failure between S&L bushing
3) Tank vents are not clear
4) Low oil level as shown in sight glass
5) Oil seeps or leaks
6) Control box arrestered
7) Cracked or broken bushing
8) Pole/Platform is leaning
9) Regulator stuck in position
10) Position indicator operates correctly
11) All gauges are in good condition
12) Control cabinet gaskets seal

14 Transformers
Distribution Pole Inspection & Treatment

• Dedicated inspection program in addition to 5 year distribution patrol

• Why do pole inspection & treatment?
  • Identify system deficiencies and correct them before problems arise
  • Stop the proliferation of decay, extending the useful life of the infrastructure

• What is looked for during inspection?

• How often should inspection be done?
  • Ultimately targeting a 10 year cycle

Types of Pole Inspection

Visual
Sound & Bore

Partial Excavation

- 4-6” excavation plus sound & bore
**Full Excavation**

- 18-24” excavation plus sound and bore with surface treatment of remedial preservatives

**Pole Treatments**

- **External Treatment** - a wood preservative is applied to the pole and then a shield moisture barrier is applied to prevent intrusion of moisture and allow the treatment to penetrate the pole

- **Internal Treatment** – additional holes are drilled in the pole and fumigant or insect treatment is injected as necessary. Then treated plugs are inserted in holes
Pole After Treatment

Final Inspection Step

Poles are tagged to indicate the year of inspection, type of inspection and treatment if any.
Terms

• Reject Pole
  Pole that had been deemed to have a shell thickness below 2” or less than 87.5% of original ground line circumference

• Priority Pole
  Pole that has been determined to have a shell thickness below 1” or less than 67% of original ground line circumference.

• Reinforceable Reject Pole
  Pole that has been found to be deteriorated below required strength but can be restored utilizing a pole truss

Pole Restoration

Rejected poles will either be replaced or trussed, depending upon condition of the structure.
Aquila Distribution Pole Inspection Program

- Began inspection in 2000 with 3 phase poles only
- Single phase poles were added to the inspection in 2004 – subsequent to the ice storm in 2002
- Approximately 75,000 distribution poles inspected through 2006
- Reject rate 3.4%
- Treatment rate 3.6%
- Reinforced rather than replaced 770 poles – resulting in a deferred capital investment of approximately $850K
- As an added benefit, the inspection program is being utilized to populate pole data into the mapping system

Summary

- Majority of components inspected on 5 year cycle
- Many components on a distribution system that fail require replacement, repair is not an option
- Components that can be fixed are considered for repair if the repair cost is less than 75% of the replacement cost
- Over the last 3 years, of the 19 outage categories tracked, outages attributable to material/structure failure was fourth on the list of outage causes at 12.5% and third on the list of total minutes interrupted at 10.9%
- Going forward, subdividing the material category in order to obtain better tracking for the types of material failures that are causing outages
<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
<th>E-mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martin Penning</td>
<td>Empire District Electric</td>
<td><a href="mailto:mpenning@empiredistrict.com">mpenning@empiredistrict.com</a></td>
</tr>
<tr>
<td>Sam McGarrah</td>
<td>Empire District Electric</td>
<td><a href="mailto:smcgarrah@empiredistrict.com">smcgarrah@empiredistrict.com</a></td>
</tr>
<tr>
<td>Susan Sundermeyer</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:susan.sundermeyer@psc.mo.gov">susan.sundermeyer@psc.mo.gov</a></td>
</tr>
<tr>
<td>Dan Beck</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:dan.beck@psc.mo.gov">dan.beck@psc.mo.gov</a></td>
</tr>
<tr>
<td>Warren Wood</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:warren.wood@psc.mo.gov">warren.wood@psc.mo.gov</a></td>
</tr>
<tr>
<td>Karen Volmer</td>
<td>Aquila</td>
<td></td>
</tr>
<tr>
<td>Norman Hillman</td>
<td>Aquila</td>
<td><a href="mailto:Norm.Hillman@Aquila.com">Norm.Hillman@Aquila.com</a></td>
</tr>
<tr>
<td>Steve Yates</td>
<td>Aquila</td>
<td><a href="mailto:Steve.Yates@aquila.com">Steve.Yates@aquila.com</a></td>
</tr>
<tr>
<td>Brett Williams</td>
<td>Aquila</td>
<td><a href="mailto:Brett.Williams@Aquila.com">Brett.Williams@Aquila.com</a></td>
</tr>
<tr>
<td>Jim Risch</td>
<td>Shade Tree Service</td>
<td><a href="mailto:jrisch@stsco.net">jrisch@stsco.net</a></td>
</tr>
<tr>
<td>Judy Ness</td>
<td>Aquila</td>
<td></td>
</tr>
<tr>
<td>Jim McBee</td>
<td>Aquila</td>
<td><a href="mailto:Jim.McBee@Aquila.com">Jim.McBee@Aquila.com</a></td>
</tr>
<tr>
<td>Robin Souder</td>
<td>Aquila</td>
<td><a href="mailto:Robin.souder@aquila.com">Robin.souder@aquila.com</a></td>
</tr>
<tr>
<td>Dan Morales</td>
<td>Shade Tree Service</td>
<td><a href="mailto:dmorales@stsco.net">dmorales@stsco.net</a></td>
</tr>
<tr>
<td>Gaye Suggett</td>
<td>Ameren</td>
<td>g <a href="mailto:Suggett@ameren.com">Suggett@ameren.com</a></td>
</tr>
<tr>
<td>Jerry Josken</td>
<td>Cooper Power System</td>
<td><a href="mailto:jjosken@cooperpower.com">jjosken@cooperpower.com</a></td>
</tr>
<tr>
<td>Jeff Wolf</td>
<td>Kansas City Power &amp; Light</td>
<td><a href="mailto:Jeff.Wolf@kcpl.com">Jeff.Wolf@kcpl.com</a></td>
</tr>
<tr>
<td>Wess Henderson</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:wess.henderson@psc.mo.gov">wess.henderson@psc.mo.gov</a></td>
</tr>
<tr>
<td>David Linton</td>
<td>SPP</td>
<td><a href="mailto:djlinton@charter.net">djlinton@charter.net</a></td>
</tr>
<tr>
<td>Cully Dale</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:cully.dale@psc.mo.gov">cully.dale@psc.mo.gov</a></td>
</tr>
<tr>
<td>Ray Wiesehan</td>
<td>Ameren</td>
<td><a href="mailto:RWiesehan@ameren.com">RWiesehan@ameren.com</a></td>
</tr>
<tr>
<td>Bill Herdegen</td>
<td>Kansas City Power &amp; Light</td>
<td><a href="mailto:william.herdegen@KCPL.com">william.herdegen@KCPL.com</a></td>
</tr>
<tr>
<td>Steven Gilkey</td>
<td>Kansas City Power &amp; Light</td>
<td><a href="mailto:steven.gilkey@kcpl.com">steven.gilkey@kcpl.com</a></td>
</tr>
<tr>
<td>Tim Schwarz</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:tim.schwarz@psc.mo.gov">tim.schwarz@psc.mo.gov</a></td>
</tr>
<tr>
<td>Curtis Blanc</td>
<td>Kansas City Power &amp; Light</td>
<td><a href="mailto:Curtis.Blanc@kcpl.com">Curtis.Blanc@kcpl.com</a></td>
</tr>
<tr>
<td>Derick Miles</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:derick.miles@psc.mo.gov">derick.miles@psc.mo.gov</a></td>
</tr>
<tr>
<td>Lesa Jenkins</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:lesa.jenkins@psc.mo.gov">lesa.jenkins@psc.mo.gov</a></td>
</tr>
<tr>
<td>Doug Nickelson</td>
<td>Kansas City Power &amp; Light</td>
<td><a href="mailto:doug.nickelson@kcpl.com">doug.nickelson@kcpl.com</a></td>
</tr>
<tr>
<td>Comm. Lin Appling</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:lin.appling@psc.mo.gov">lin.appling@psc.mo.gov</a></td>
</tr>
<tr>
<td>Wade Hunt</td>
<td>Utilimap Corp</td>
<td><a href="mailto:whunt@utilimap.com">whunt@utilimap.com</a></td>
</tr>
<tr>
<td>Jeff Baker</td>
<td>Shade Tree Service</td>
<td><a href="mailto:Jeffbaker@stsco.net">Jeffbaker@stsco.net</a></td>
</tr>
<tr>
<td>Dave Wakeman</td>
<td>Ameren</td>
<td><a href="mailto:dwakeman@ameren.com">dwakeman@ameren.com</a></td>
</tr>
<tr>
<td>Shawn Lange</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:shawn.lange@psc.mo.gov">shawn.lange@psc.mo.gov</a></td>
</tr>
<tr>
<td>Mike Taylor</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:michael.taylor@psc.mo.gov">michael.taylor@psc.mo.gov</a></td>
</tr>
<tr>
<td>Rob Land</td>
<td>AMEC</td>
<td><a href="mailto:rland@amec.org">rland@amec.org</a></td>
</tr>
<tr>
<td>Bill Washburn</td>
<td>Utilimap</td>
<td><a href="mailto:washburnbillj@mchsi.com">washburnbillj@mchsi.com</a></td>
</tr>
<tr>
<td>Kelly Walters</td>
<td>Empire District Electric</td>
<td>k <a href="mailto:Walters@empiredistrict.com">Walters@empiredistrict.com</a></td>
</tr>
<tr>
<td>Dan Dasho</td>
<td>Columbia Water &amp; Light</td>
<td><a href="mailto:dmdasho@gocolumbiamo.com">dmdasho@gocolumbiamo.com</a></td>
</tr>
<tr>
<td>Mike Cleary</td>
<td>AmerenUE</td>
<td><a href="mailto:mcleary@ameren.com">mcleary@ameren.com</a></td>
</tr>
<tr>
<td>Ted Robertson</td>
<td>Office of Public Counsel</td>
<td><a href="mailto:ted.robertson@ded.mo.gov">ted.robertson@ded.mo.gov</a></td>
</tr>
<tr>
<td>Dan Stokes</td>
<td>City of Columbia Water &amp; Light</td>
<td><a href="mailto:DFS@GoColumbiaMo.com">DFS@GoColumbiaMo.com</a></td>
</tr>
<tr>
<td>Steve Murray</td>
<td>Aquila</td>
<td><a href="mailto:Steve.murray@aquila.com">Steve.murray@aquila.com</a></td>
</tr>
<tr>
<td>Rep. Ed Emery</td>
<td>Missouri House</td>
<td><a href="mailto:ed.emery@house.mo.gov">ed.emery@house.mo.gov</a></td>
</tr>
<tr>
<td>Name</td>
<td>Company</td>
<td>E-mail</td>
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</tr>
<tr>
<td>Mike Dandino</td>
<td>Office of Public Counsel</td>
<td><a href="mailto:mike.dandino@ded.mo.gov">mike.dandino@ded.mo.gov</a></td>
</tr>
<tr>
<td>Christina Baker</td>
<td>Office of Public Counsel</td>
<td><a href="mailto:christina.baker@ded.mo.gov">christina.baker@ded.mo.gov</a></td>
</tr>
<tr>
<td>Contessa Poole-King</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:contessa.king@psc.mo.gov">contessa.king@psc.mo.gov</a></td>
</tr>
<tr>
<td>Gay Fred</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:gay.fred@psc.mo.gov">gay.fred@psc.mo.gov</a></td>
</tr>
<tr>
<td>Jim Ketter</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:jim.ketter@psc.mo.gov">jim.ketter@psc.mo.gov</a></td>
</tr>
<tr>
<td>Russ Trippensee</td>
<td>Office of Public Counsel</td>
<td><a href="mailto:russ.trippensee@ded.mo.gov">russ.trippensee@ded.mo.gov</a></td>
</tr>
<tr>
<td>Ewell Lawson</td>
<td>MPVA</td>
<td><a href="mailto:elawson@mpva.org">elawson@mpva.org</a></td>
</tr>
<tr>
<td>Connie Kacprowicz</td>
<td>Columbia Water &amp; Light</td>
<td><a href="mailto:CSK@GoColumbiaMo.com">CSK@GoColumbiaMo.com</a></td>
</tr>
<tr>
<td>Bob Keller</td>
<td>City of Kansas City, Missouri</td>
<td><a href="mailto:bob_keller@kcmo.org">bob_keller@kcmo.org</a></td>
</tr>
<tr>
<td>John Norris</td>
<td>Aquila</td>
<td><a href="mailto:JOHN.NORRIS@AQUILA.COM">JOHN.NORRIS@AQUILA.COM</a></td>
</tr>
<tr>
<td>George Swogger</td>
<td>Noranda Aluminum</td>
<td><a href="mailto:swoggerg@noralnm.com">swoggerg@noralnm.com</a></td>
</tr>
<tr>
<td>Guy Gilbert</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:guy.gilbert@psc.mo.gov">guy.gilbert@psc.mo.gov</a></td>
</tr>
<tr>
<td>Leon Bender</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:leon.bender@psc.mo.gov">leon.bender@psc.mo.gov</a></td>
</tr>
<tr>
<td>Nathan Williams</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:nathan.williams@psc.mo.gov">nathan.williams@psc.mo.gov</a></td>
</tr>
<tr>
<td>Anne Ross</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:anne.ross@psc.mo.gov">anne.ross@psc.mo.gov</a></td>
</tr>
<tr>
<td>Comm. Connie Murray</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:connie.murray@psc.mo.gov">connie.murray@psc.mo.gov</a></td>
</tr>
<tr>
<td>Wendy Tatro</td>
<td>AmerenUE</td>
<td><a href="mailto:wtatro@Ameren.com">wtatro@Ameren.com</a></td>
</tr>
<tr>
<td>Lois Liechti</td>
<td>Kansas City Power &amp; Light</td>
<td><a href="mailto:lois.liechti@kcpl.com">lois.liechti@kcpl.com</a></td>
</tr>
<tr>
<td>Carol Sivils</td>
<td>Kansas City Power &amp; Light</td>
<td><a href="mailto:carol.sivils@kcpl.com">carol.sivils@kcpl.com</a></td>
</tr>
<tr>
<td>Debbie Bernsen</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:debbie.bernsen@psc.mo.gov">debbie.bernsen@psc.mo.gov</a></td>
</tr>
<tr>
<td>Susan Braun</td>
<td>Aquila</td>
<td><a href="mailto:susan.braun@aquila.com">susan.braun@aquila.com</a></td>
</tr>
<tr>
<td>Kelly Wiese</td>
<td>Associated Press</td>
<td><a href="mailto:kwiese@ap.org">kwiese@ap.org</a></td>
</tr>
<tr>
<td>Lisa Kremer</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:lisa.kremer@psc.mo.gov">lisa.kremer@psc.mo.gov</a></td>
</tr>
<tr>
<td>Bob McKeon</td>
<td>Aquila</td>
<td><a href="mailto:bob.mckeon@aquila.com">bob.mckeon@aquila.com</a></td>
</tr>
<tr>
<td>Jim Fischer</td>
<td>Fischer &amp; Dority PC</td>
<td><a href="mailto:jfischerpc@aol.com">jfischerpc@aol.com</a></td>
</tr>
<tr>
<td>Lena Mantle</td>
<td>Missouri Public Service Commission</td>
<td><a href="mailto:lena.mantle@psc.mo.gov">lena.mantle@psc.mo.gov</a></td>
</tr>
<tr>
<td>Barrett (Barry) Williams</td>
<td>Ameren Ratepayer</td>
<td><a href="mailto:tass92@juno.com">tass92@juno.com</a></td>
</tr>
<tr>
<td>Greg Palmer</td>
<td>Cooper Power systems</td>
<td><a href="mailto:gpalmer@cooperpower.com">gpalmer@cooperpower.com</a></td>
</tr>
<tr>
<td>Denny Frey</td>
<td>Missouri Public Service Commission</td>
<td>denny.frey2psc.mo.gov</td>
</tr>
<tr>
<td>Jim Charrier</td>
<td>State Emergency Management Agency</td>
<td><a href="mailto:Jim.Charrier@sema.dps.mo.gov">Jim.Charrier@sema.dps.mo.gov</a></td>
</tr>
</tbody>
</table>