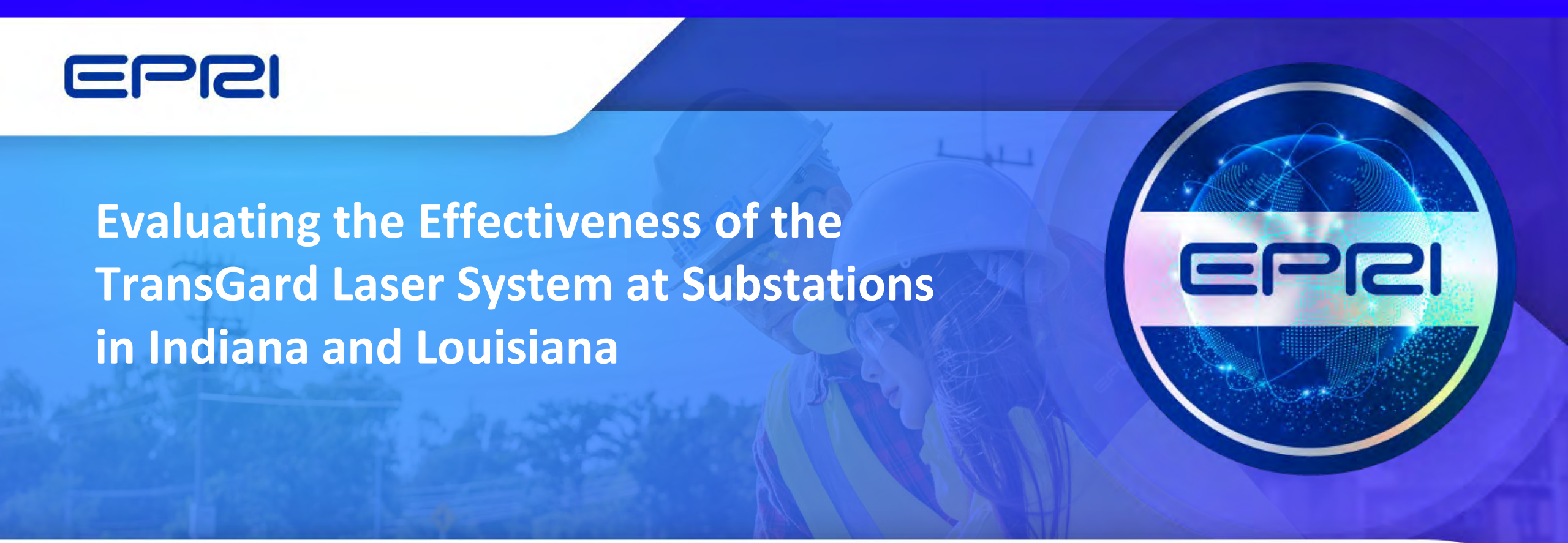

EDM
T&D SERVICES
ENVIRONMENTAL SERVICES
PRODUCTS
Overcoming utility infrastructure challenges by merging excellence in engineering, science and technology with a passion for client satisfaction.

Evaluating the Effectiveness of the TransGard Laser System at Substations in Indiana and Louisiana



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American Electric Power
Entergy

Today's Outline

- Background
  - The problem
  - TransGard overview
- Study 1 – Indiana
- Study 2 – Louisiana
- Summary
- Next Steps

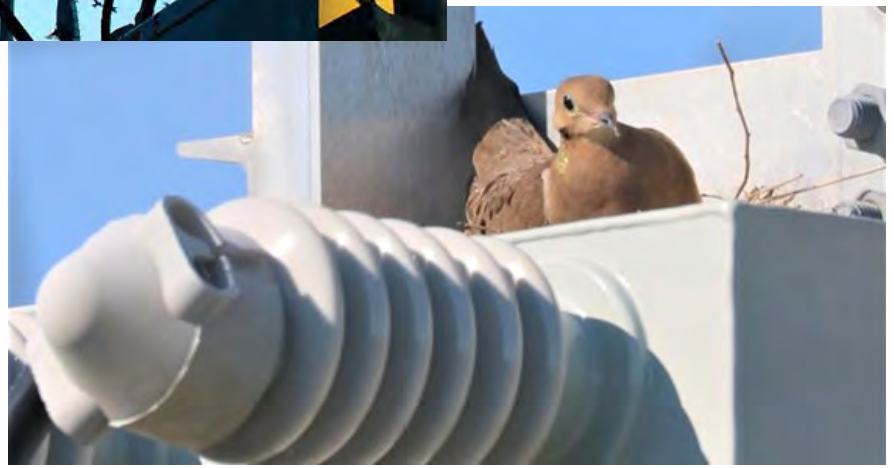
Photo: J.D. Dwyer, EDM

Background

- The problem – Preventing avian intrusions and outages at substations

- Bird caused outages
  - Activity contacts
  - Nesting
  - Nest predators
  - Soiling

Photos: J.D. Dwyer, EDM



Background

- Traditional Solutions
  - Physical Barriers
    - Covers
    - Perch deterrent spikes
  - Visual Deterrents
    - Decoy predators
  - Audio Deterrents
    - Simulated calls
    - Pink noise
  - Vegetation Management
    - Reduce adjacent nesting & foraging resources

Predator

Barrier

Photos: J.D. Dwyer, EDM

Perch spikes

Background

- Alternative Solution - Lasers
  - TransGard programmable mounted laser
  - Laser Bird Defense System (LBDS)
- How does it work?
  - Birds disperse from approaching laser beam
- TransGard described benefits
  - Low cost
  - Easy to deploy
  - Humane and low impact
  - Autonomous with custom programmed laser paths across substation
  - No habituation
  - Prevents nesting and roosting

PROGRAMMABLE MOUNTED LASER

Photo: J.D. Dwyer, EDM

Background

- Overall Goal – Evaluate the effectiveness of the TransGard LBDS

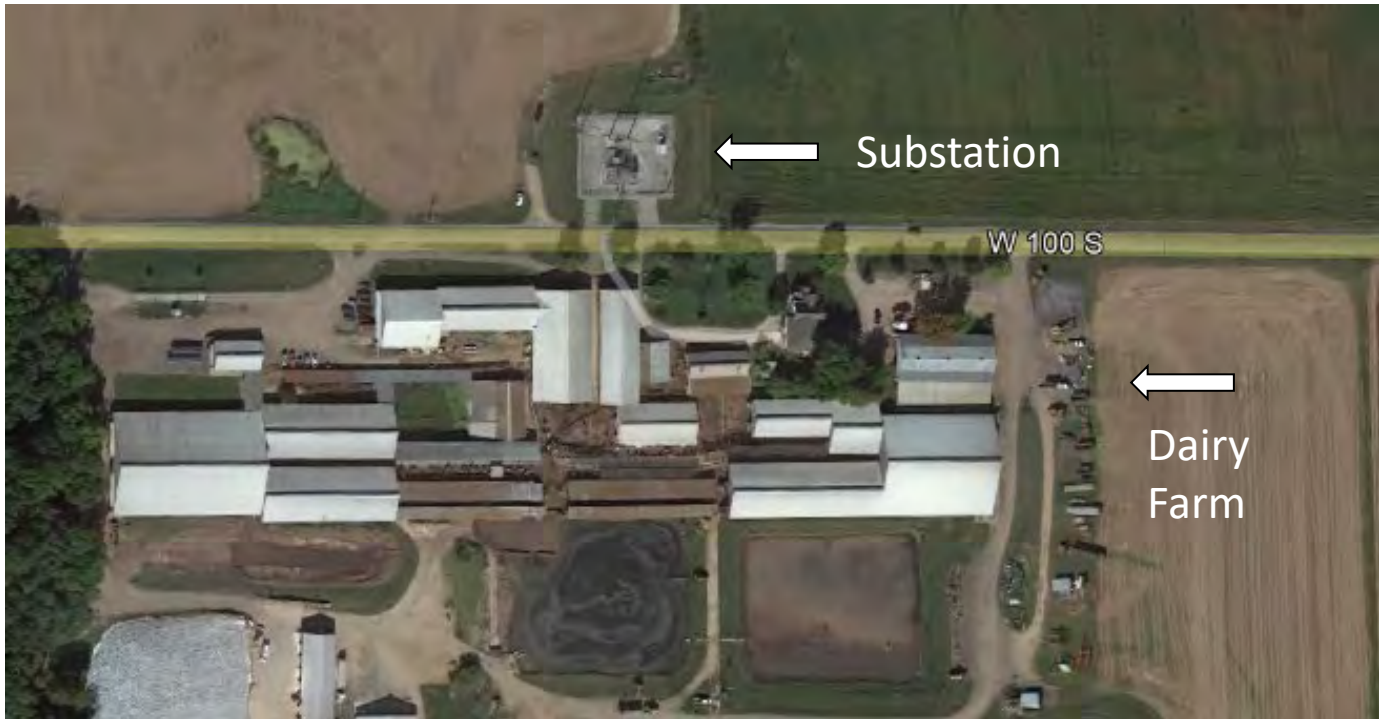
- Study Objectives
  1. Determine ability of the LBDS to deter avian nesting
     - Primary interest of AEP
  2. Evaluate the efficacy of the LBDS to discourage avian activity
     - Primary interest of Entergy
- Results from both studies will be discussed

Study #1 – Host Site AEP

Study 1 - Methods

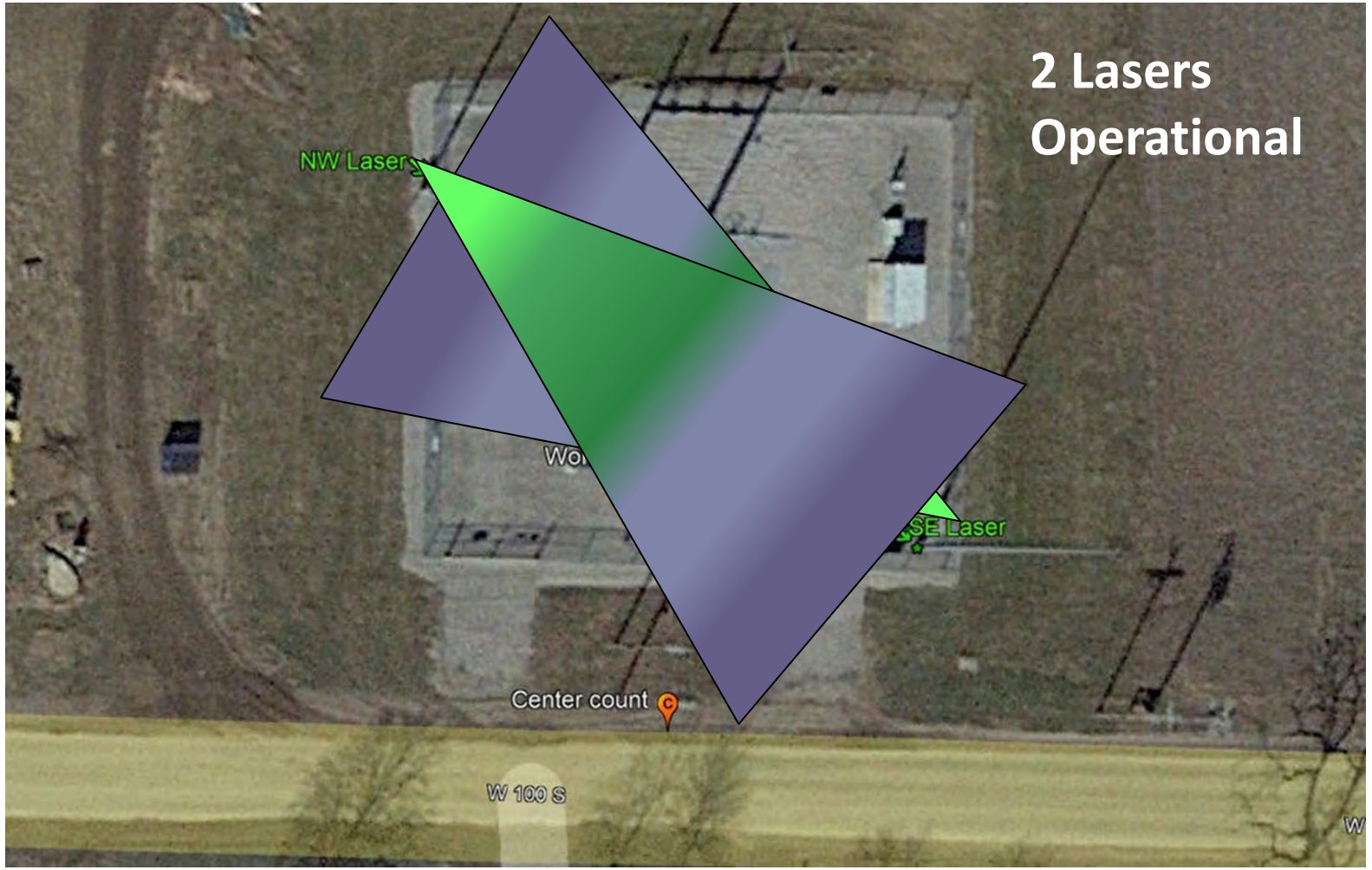
Study Location

- Substation
  - Wolf Lake, IN
- Issue – Nesting
  - Neighboring dairy farm



Study 1 - Methods

- Laser design & installation completed by TransGard



Study 1 - Methods

- Installation methodology followed TransGard recommendations

1. Site preparation
   - Removed all existing nests
   - Solvent and pressure washing targeted low-side rack to remove soiling
2. Placement of optical gel disks
   - Serves as nesting deterrents complementing lasers
   - Placement of gel disks targeted
     - Horizontal surfaces throughout the low-side rack
     - Substation transformer
     - High-side rack
3. Selection and programming of lasers and laser routes
   - Performed by TransGard
4. Laser was operational

Study 1 – Nest Removal

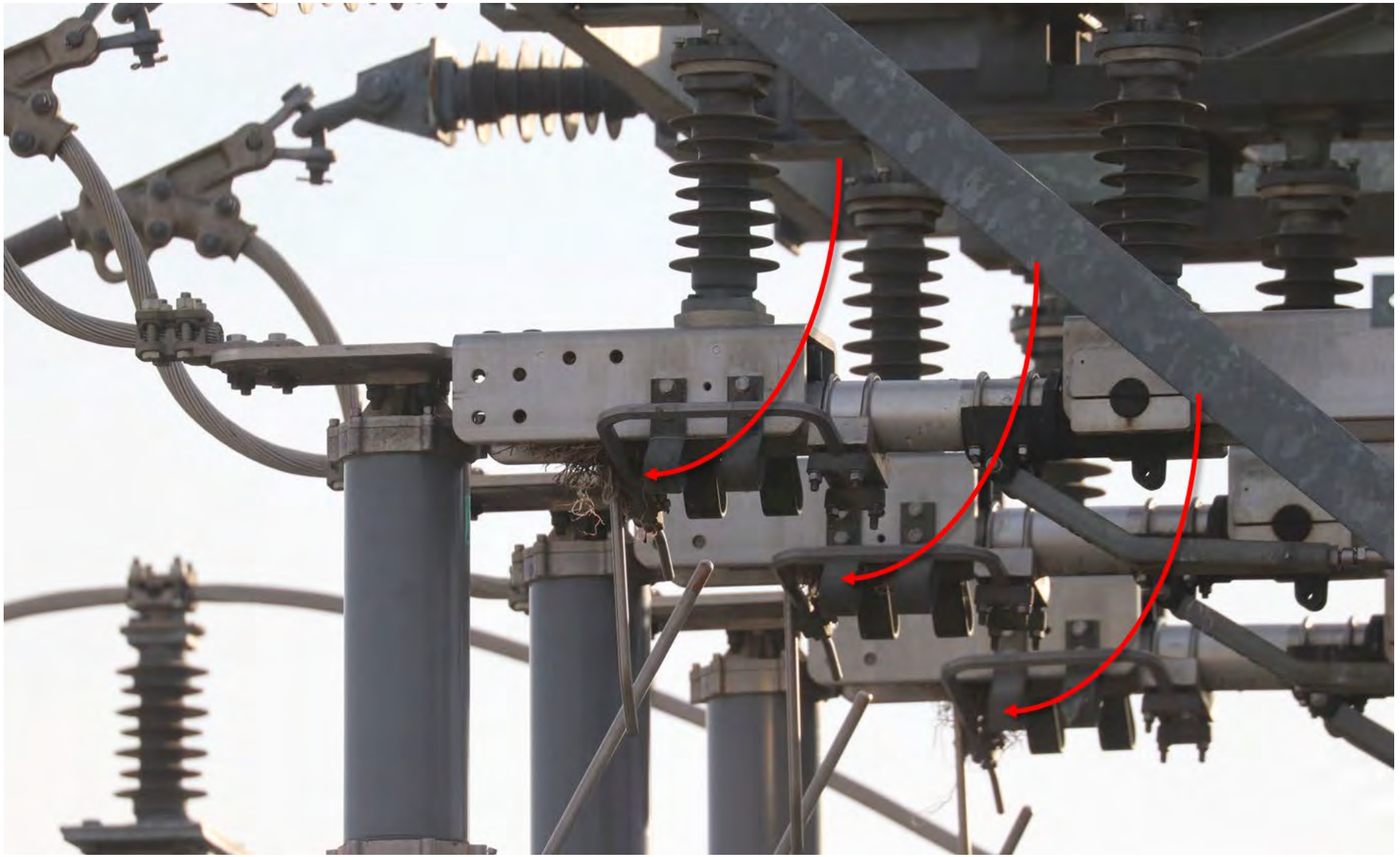


Photo: J.D. Dwyer, EDM

Study 1 - Washing

Photo: J.D. Dwyer, EDM

Study 1 – Installation of Optical Gel Disks

Photo: J.D. Dwyer, EDM

* Gel disks are used to complement the lasers serving as a physical deterrent & placed in areas nesting is expected

Study 1 – Study Design

- Demonstration with 1 study site
- Bird nesting and bird activity was compared before and after laser activation
- Laser effectiveness was assessed for low-side rack
  - Lasers were focused on low-side rack
  - 2 Lasers on daily from 4am – 10pm
  - March – September
    - Laser activation preceded start of nesting season for most birds

Photo: J.D. Dwyer, EDM

Study 1 – Data Collection

- Summer 2021
  - Prior to laser activation
- Summer 2022
  - Post laser activation
- **Nest counts**
- **Avian point counts**
  - Conducted at 3 locations
    - 400 m west (1/4 mile)
    - 400 m east (1/4 mile)
    - At substation
  - Count duration was 3 minutes
  - Point count methods followed North America Breeding Bird Survey
- Remote Cameras

Study 1 – Results

2021 – No Lasers

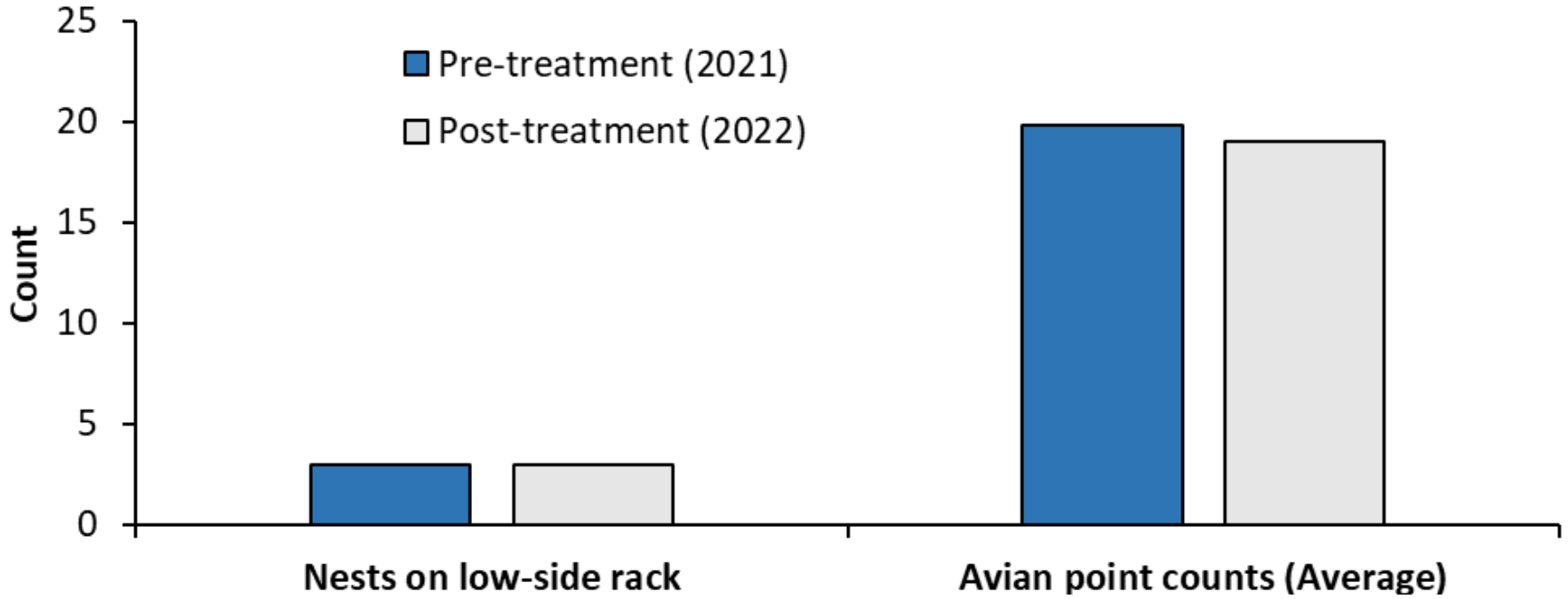
- Low-side nests = 3
- Avian counts
  - Mean 19.8
  - SD = 1.2

2022 – Lasers

- Low-side nests = 3
- Avian counts
  - Mean 19.0
  - SD = 0.9

→ **Nesting 2022**

- 2 nests found on 3/9/22
  - 1 week post cleaning
- 1 nest found on 6/15/22
  - 15 weeks post cleaning



Study 1 – Results

2021 – No Lasers

- Birds in substation
- Nesting
  - House Sparrow
- Roosting
  - European Starling
  - House Sparrow

2022 – Lasers

- Birds in substation
- Nesting
  - House Sparrow
- Roosting
  - European Starling
  - House Sparrow

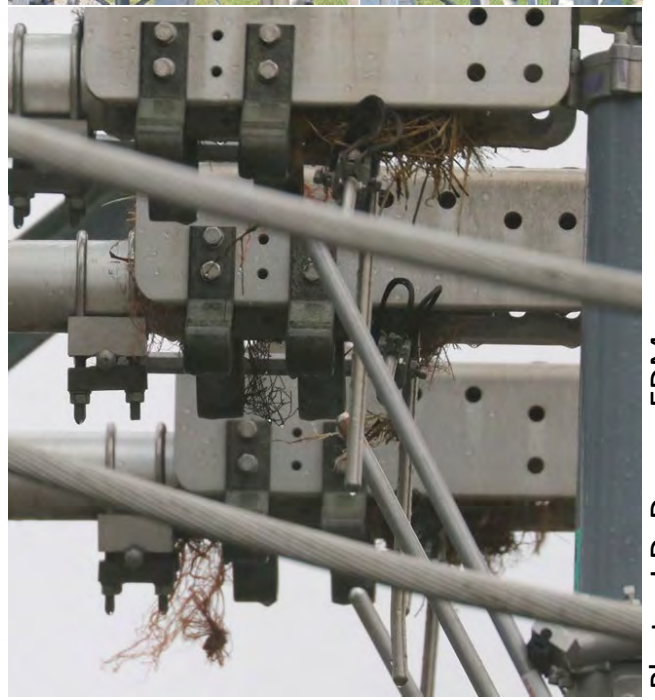


Photo: J.D. Dwyer, EDM

Study 1 – Results

Photo: J.D. Dwyer, EDM

- Gel disks over course of study

Study 1 - Conclusions

- No difference in the number of **birds** observed during point counts
- No difference in the number of **nests** on the low-side rack

Conclusion

- TransGard lasers were not effective at this location

Caveats

- A sample size of 1 substation
  - Limits inference to this study
- Different locations may have different results
- TransGard protocols were followed at this location

Study #2 – Host Site Entergy

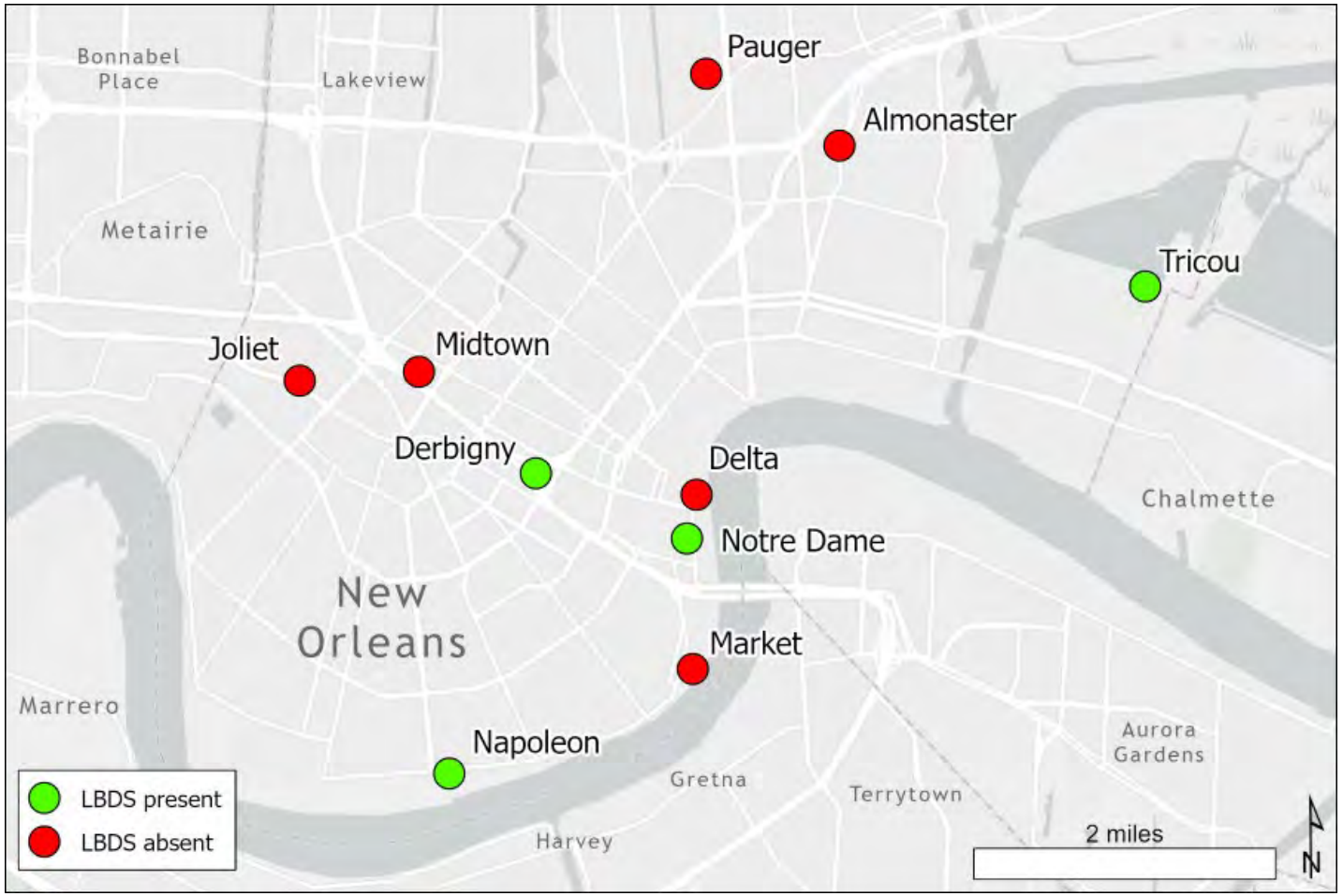
Study 2 - Methods

Study Location

- Substations - New Orleans, LA
- Issue – Avian contacts
- Tested LBDS in 10 substations
  - 4 with lasers
  - 6 with no lasers
- Lasers operated during daytime
- 4 lasers at each study site

Overall Study Goal

- Assess effectiveness of LBDS in mitigating bird activity and outages



- Green substations with lasers
- Red substations without lasers

Study 2 – Methods

- Data collections
  - Monthly Oct – Dec 2022; Feb – August 2023
- **Nest counts**
  - Substation inspected for nests
- **Avian point counts**
  - 2 timed counts each 3 minutes
- **Site visit counts**
  - Duration of site visit
  - All birds seen or heard were recorded
- Remote cameras
  - 2 trail cameras in each substation
  - Purpose: capture bird activity outside site visits
- Data analysis
  - Model selection focused on point counts, site visit counts, nests

Photos: J.D. Dwyer, EDM

Study 2 – Results

Avian Point Counts

Model	K	Δ AIC	ω_i
Substation + Minutes after Sunrise	3	0.00	0.380
Minutes after Sunrise	2	1.40	0.189
Minutes after Sunrise + Confounding	3	1.83	0.152
LBDS + Minutes after Sunrise	3	2.90	0.089
Null	1	3.94	0.053
Confounding	2	4.58	0.038
LBDS	2	5.09	0.030
Substation	2	5.56	0.024
LBDS + Substation	3	6.13	0.018
LBDS + Confounding	3	6.34	0.016
Substation + Confounding	3	6.97	0.012

- Overall best model
  - Substation
  - Minutes after sunrise
- AIC values < 4 considered competing models
- LBDS is in a competing model but lower weight
  - 0.38 vs 0.089
- Note: Minutes after sunrise is in all competing models
  - Greater importance

Study 2 – Results

Site Visit Counts

Model	K	Δ AIC	ω_i
Substation + Minutes after Sunrise	3	0.00	0.148
LBDS	2	0.15	0.137
Minutes after Sunrise	2	0.42	0.120
LBDS + Minutes after Sunrise	3	0.43	0.119
Null	1	0.54	0.113
Minutes after Sunrise + Confounding	3	0.96	0.091
Confounding	2	1.21	0.081
Substation	2	1.52	0.069
LBDS + Confounding	3	1.81	0.060
Substation + Confounding	3	3.04	0.032
LBDS + Substation	3	3.26	0.029

- Overall best model
  - Substation
  - Minutes after sunrise
- AIC values < 4 considered competing models
- LBDS is in several competing models
- Parameter estimate for LBSD only model was NS (P=0.12)

Study 2 – Results

Nest Counts

Model	K	Δ AIC	ω_i
Substation	2	0	0.467
Substation + Confounding	3	1.872	0.183
LBDS + Substation	3	1.9453	0.176
Substation + Minutes after Sunrise	3	1.9748	0.174
LBDS	2	30.5805	0.000
LBDS + Confounding	3	32.4525	0.000
LBDS + Minutes after Sunrise	3	32.5784	0.000
Null	1	33.7299	0.000
Confounding	2	34.2137	0.000
Minutes after Sunrise	2	35.6434	0.000
Minutes after Sunrise + Confounding	3	36.1072	0.000

- Overall best model
  - Substation
- AIC values < 4 considered competing models
- Only 4 competing models
  - LBDS is in 1 model
- Substation is in all competing models
- Greater importance in explaining nests than LBDS

* Variable “Confounding” represents confounding factors such as workers in substations

Study 2 - Conclusions

- Model selection results did not identify LBDS as an important variable explaining: 1) Bird point counts, 2) Site visit counts, or 3) Nests
- 2 substations had before and after laser installation data
  - No difference was found for bird counts or nests present

Conclusion

- TransGard lasers were not effective at these locations

Caveats

- Confounding factors - Crews in substations; work affected laser activity
- Operational issues – Different switch setup, laser failure
- LBDS less effective in urban area? Lights, noise, traffic

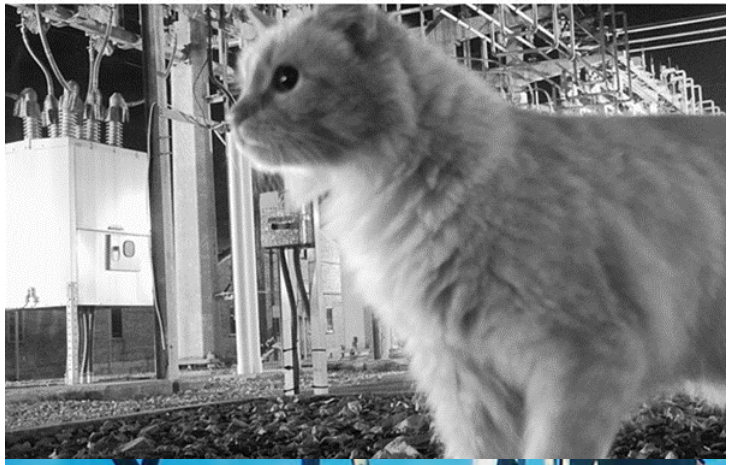
Overall Summary

- TransGard LBDS was not effective at reducing bird **activity** or **nesting** at the 2 locations evaluated in this study
  - 1 site was tested in Indiana
  - 4 sites with lasers were evaluated in New Orleans, LA
- At both locations, bird activity and nesting were similar regardless of lasers
- Outage data were also compared before and after laser installation
  - No differences found for the IN or LA study sites
  - However, outage data overall contained few outages, limiting analyses
- Camera data at both study locations did capture bird activity in substations once lasers were active

Study Challenges

- Factors that may have affected study results
  - Inconsistent laser activation
    - LBDS was often deactivated for maintenance & construction activities (e.g., LA)
  - Substations without laser also had construction activity
    - Possible impacts to birds and nesting
    - To address, added more replication; included confounding variable in analyses
  - Operational challenges
    - 1-2 individual lasers failed in each of the 4 LBDS installed at the LA sites
    - Maintenance crews turning off lasers but not back on
    - Laser sweep zone outside planned area
  - Sample size for testing lasers remained low
  - Laser evaluation period varied depending on installation date
- Future Questions
  - How LBDS performs with different bird species?
  - Is laser effectiveness impacted by surrounding landscape (e.g., urban vs rural)?
  - Can lasers be coupled with other deterrents to improve overall mitigation success?

Fun Camera Captures



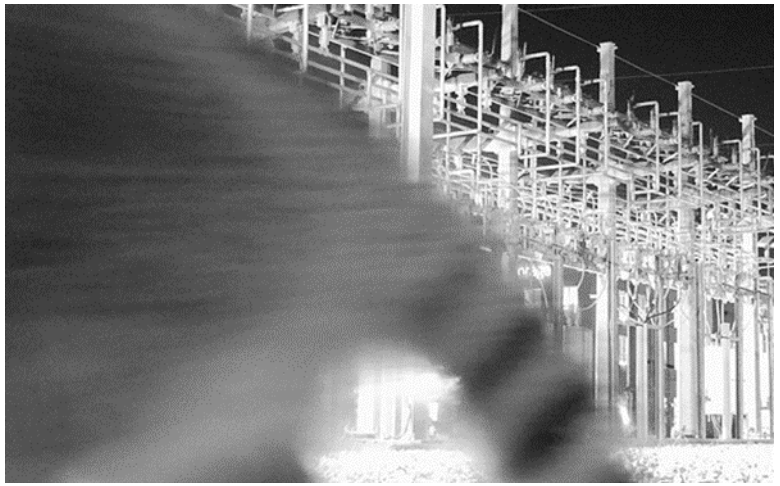


Photo: J.D. Dwyer, EDM

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April 18, 2024

Toward Eagle Rule Compliance: Lessons & Challenges in Cross-Departmental Collaboration

Environmental Management | Cristina Frank

Outline

- Pepco Holdings Avian Program Context
- Learnings from the Trenches
- Future Applications

1

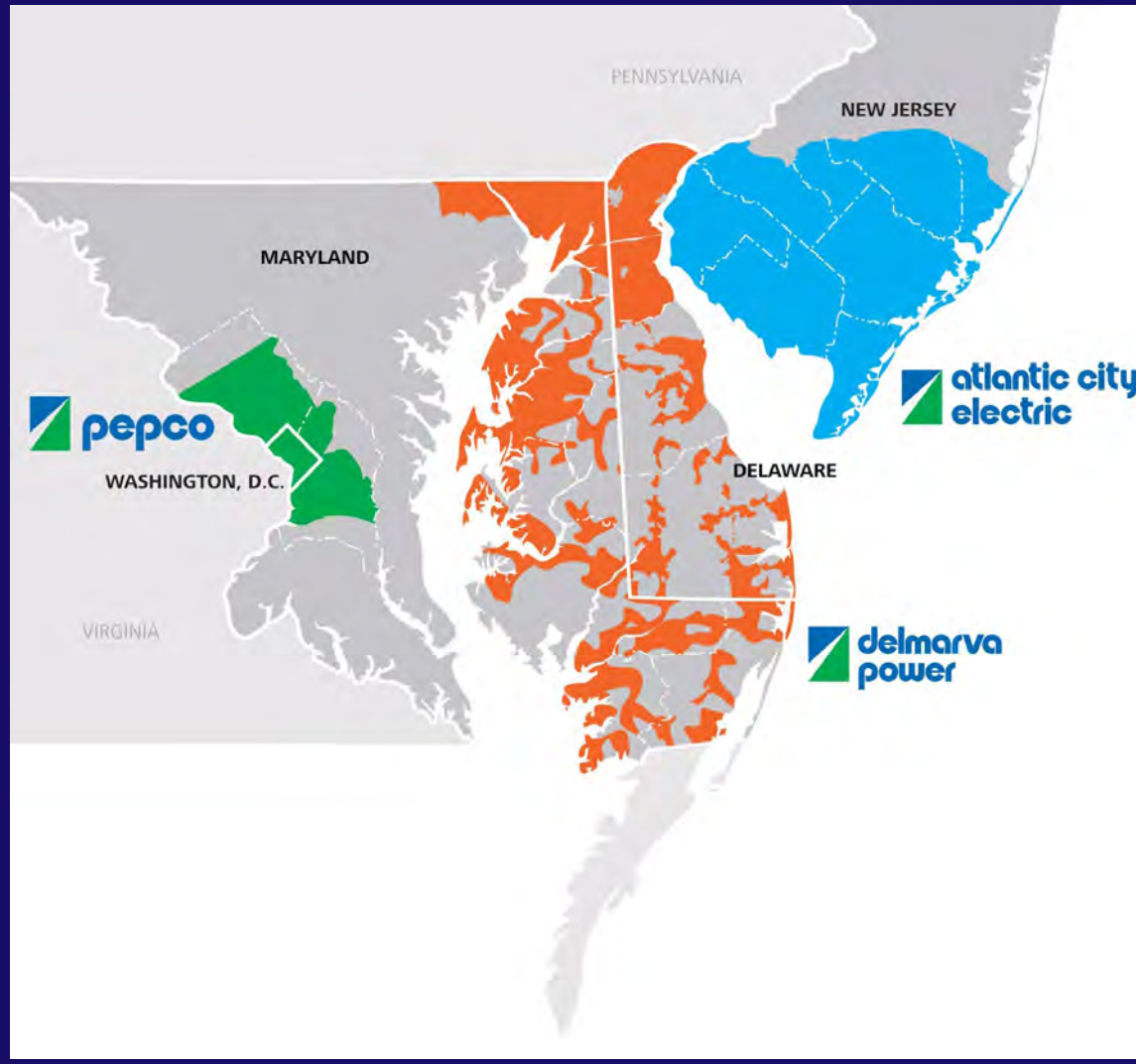
PHI Avian Program Context

Bald & Golden Eagle Protection Act (1940) and New Incidental Take Permit for Power Lines

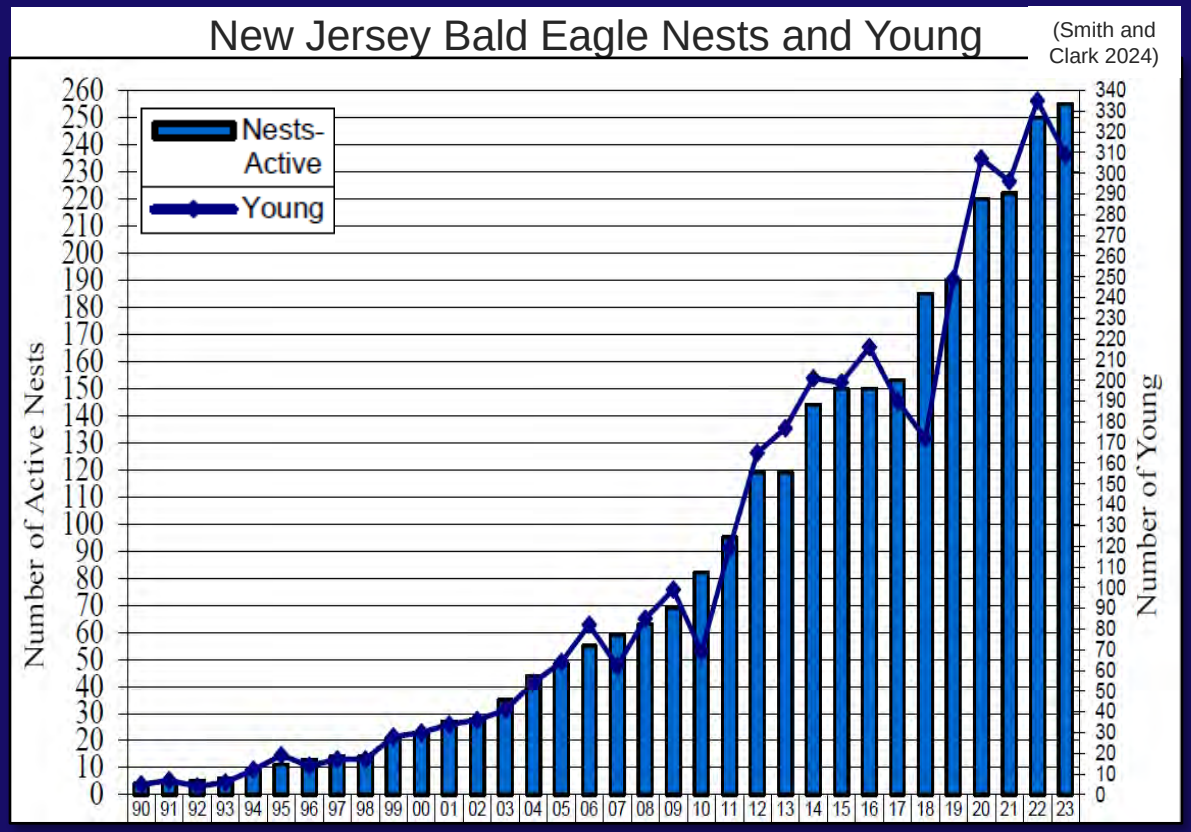
- Originally, protection from bounty hunting
- Protects Bald and Golden Eagles
- Protection for birds, parts, nests (year-round), eggs
- Electrocution is prohibited as “incidental take”
- State of mind: knowingly or with “wanton disregard”
- May 2024 - New incidental take permit available under BGEPA affirming/challenging Avian Program strategies

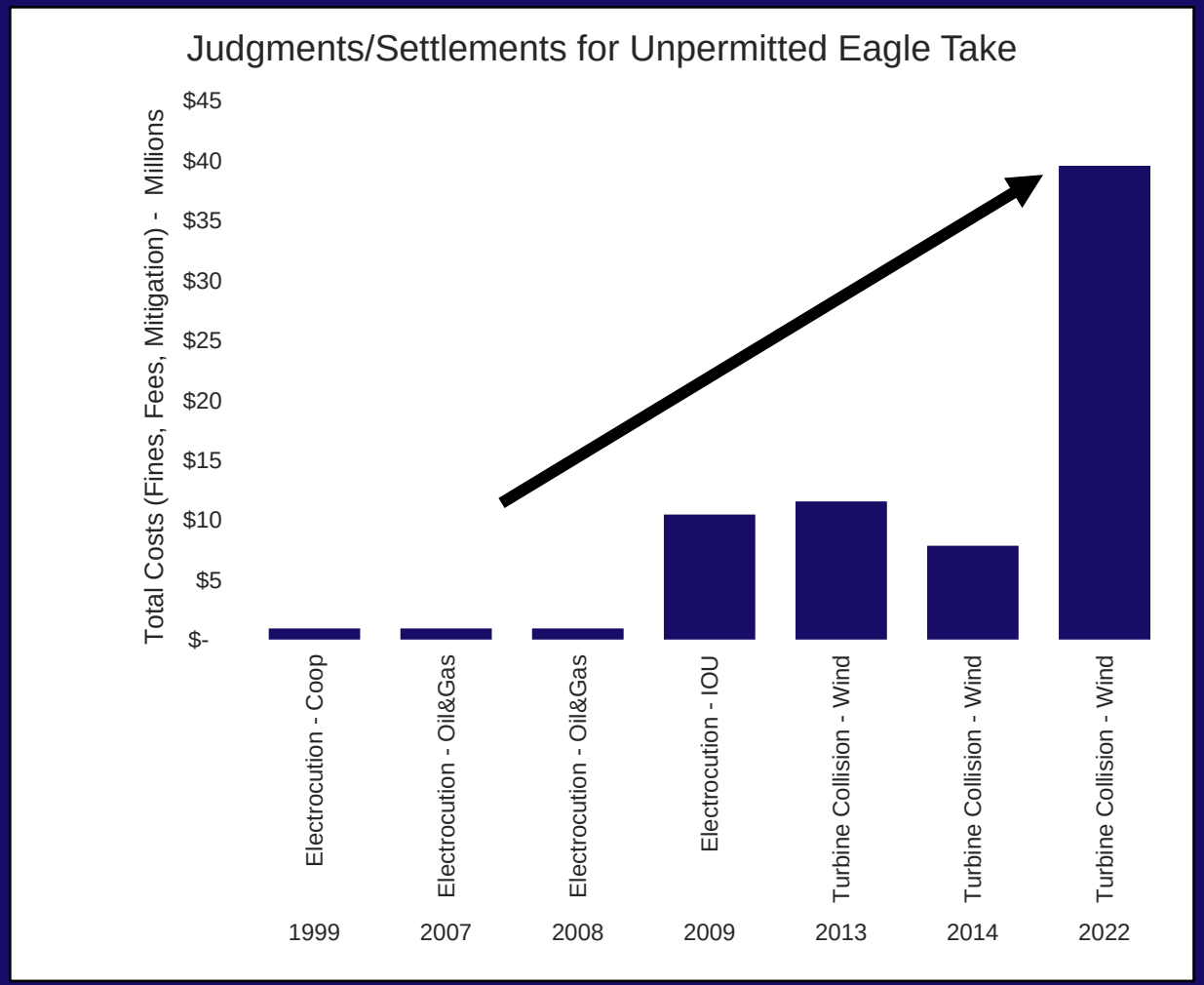
Avian Program Background

- Pepco Holdings, Inc. (PHI):
  - Atlantic City Electric (ACE; New Jersey)
  - Delmarva Power and Light (DPL; Maryland & Delaware)
  - Pepco (Washington, D.C.)
- 2010-2011: Avian Protection Plan (APP) Development
- 2011-2012: Avian Risk Assessment
- 2012-Present: APP Implementation
- 2009-2012: Eagle Incidental Take Permit for Wind Industry
- 2024: Eagle Incidental Take Permit for Power Lines/Wind



Eagle Population and Risk





Penalties for incidental eagle take have increased, with the largest penalties applied to large corporations, and those who have elected not to seek available permit despite persistent high rate of take.

Avian Program Responsibilities

- **DEVELOP** and **IMPLEMENT** avian protection and management plans, processes, and procedures to enhance alignment with state and federal law.
- **OVERSEE** the Program by monitoring the Program elements for alignment with regulatory requirements and Corporate Policy.
- **SUPPORT** internal departments through guidance and/or training on bird regulations, permits, and reporting requirements.
- **PROVIDE** subject matter expertise regarding bird identification, behavior, and natural history, as needed.
- **INTERFACE** with external avian groups including regulatory agencies, wildlife rehabilitators, and consultants.
- **OVERSEE** and **MAINTAIN** federal and state migratory bird permit requirements, conditions, applications, and reports.

Avian Program Tasks and Initiatives

- Avian Friendly Distribution Standards
- Avian Friendly Trans. Standards
- Mitigation Device Selection
- Computer-Based Training
- Mitigation Video Training Modules
- Wildlife Mitigation Guide
- Lineman Field Guide
- Field Decision Flow Charts
- Eagle Nest Permitting & Management
- Eagle Nest Containment
- Eagle Egg Micro-climate
- Eagle Roost Line Marking
- Transmission Nesting Reliability
- Avian Nesting Surveys
- Capital Projects Avian Assessment
- Transmission Wildlife Reliability
- Avian Feces Reliability Impacts
- Nesting Habitat Vulnerability Analysis
- Substation Wildlife Outage Vulnerability Assessment
- Substation Vulture Roosting
- Substation Hardening Recommendations
- Automated Hazing Pilot
- Avian Procedures Development
- Avian Incident Search/ Tracking/ Recordkeeping
- AIMS App Development (Incident Reporting and Tracking)
- Avian Incident Investigations
- Mitigation Prescriptions
- Storeroom Facilitation
- Mitigation QA/QC
- Mitigation Rate Recovery
- Regulatory Agency Communications
- Internal Communications
- Customer Outreach & Comms
- Avian Steering Committee/Eagle Working Group Facilitation
- APLIC Leadership

Why Do We Collaborate?

- Program cannot succeed in a vacuum
- Nearly every PHI department has a role to play…whether they know it or not.
- Operational budget squeeze
- Avian actions are not seen as core responsibilities
- Avian Program has little in the way of carrots or sticks
- Collaboration is the only way forward…on partners' terms

Interacting or Collaborating Business Units:

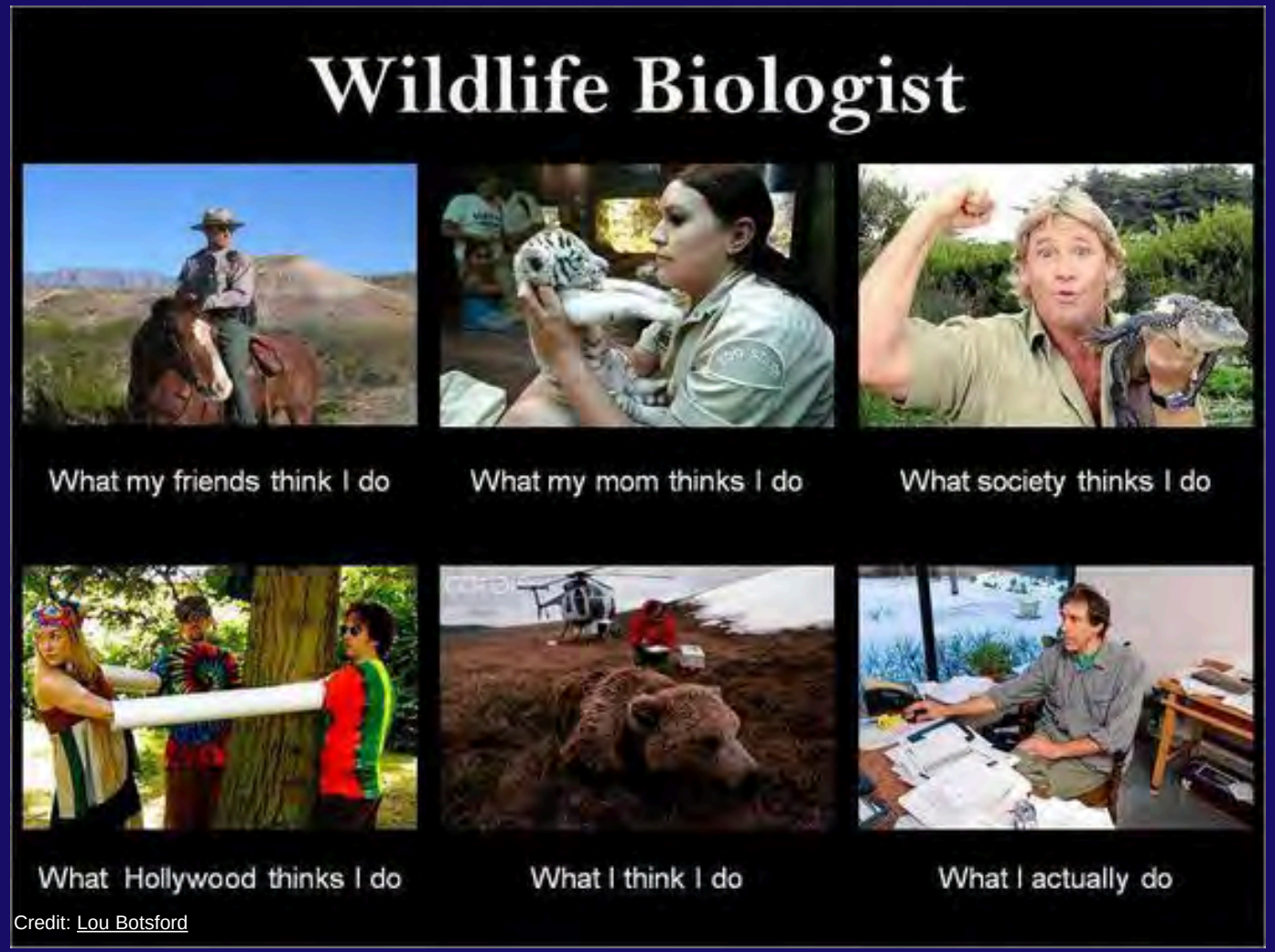
Accounting and Finance
Administrative
Business Analytics
Corporate Comms
Customer Service
Distribution Standards
Distribution Operations
Engineering
GIS
Information Technology
Legal
Materials Management/Procurement/Storeroom Stocking
Outage Control Center
Project Planning & Mgt
Rate Recovery/Regulatory
Reliability Engineering
Substation Operations
Training
Transmission Standards
Transmission Operations

2

Learnings from the Trenches

Traction—an Ongoing Challenge

- Avian Program Job Description: Problem Solver
- Most problems must be solved more than once
- Success is incremental and solutions are incomplete
- Lessons have been learned along the way, many of them painfully
- Best practices are precursors to success, not guarantees of success



Credit: Lou Botsford

Hard-Won Wisdom:
Lessons from the Front Lines

Identify stakeholders early, then:

1. *Seek partners' input*
2. *Communicate clearly…in the partners' language*
3. *Align asks with partners' goals; articulate benefits to partners*
4. *Seek solutions within partners' existing work-flows*

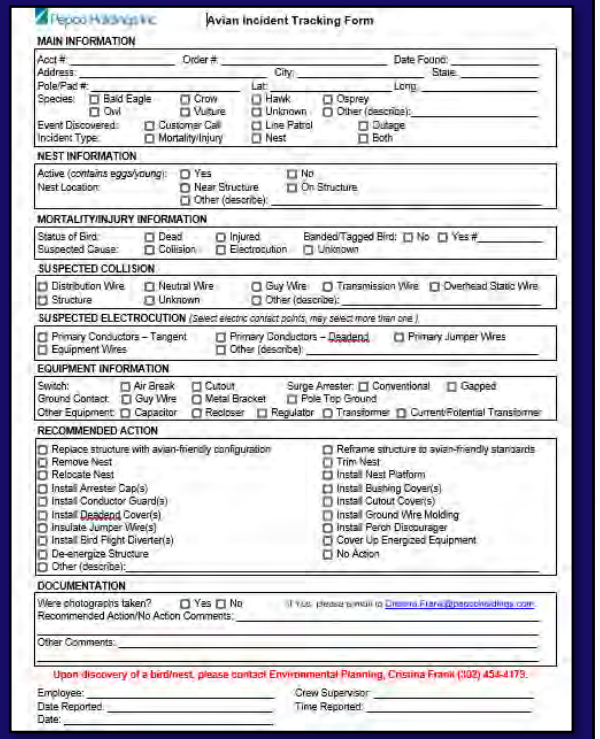
1. Seek Partners' Input: *(A) Incident Reporting*

Problem 1: Low avian incident reporting despite corporate wide requirement

- OMS record info only, no photos
- No easy way to track progress/completion of incidents

Solution 1: Develop Avian Incident Management System (AIMS)

- Online GIS-based smart form
- Link incident records to location and pole
- Photos and drop-down menus provide key info
- Direct and track incident response, resolution
- QR code stickers provided



Pepco Holdings Inc. — Avian Incident Tracking Form

MAIN INFORMATION

Acct #: _____ Order #: _____ Date Found: _____
Address: _____ City: _____ State: _____
Pole/Pad #: _____ Lat: _____ Long: _____
Species: ☐ Bald Eagle ☐ Crow ☐ Hawk ☐ Osprey ☐ Owl ☐ Vulture ☐ Unknown ☐ Other (describe): _____
Event Discovered: ☐ Customer Call ☐ Line Patrol ☐ Outage
Incident Type: ☐ Mortality/Injury ☐ Nest ☐ Both

NEST INFORMATION

Active (contains eggs/young): ☐ Yes ☐ No
Nest Location: ☐ Near Structure ☐ On Structure ☐ Other (describe): _____

MORTALITY/INJURY INFORMATION

Status of Bird: ☐ Dead ☐ Injured Banded/Tagged Bird: ☐ No ☐ Yes # _____
Suspected Cause: ☐ Collision ☐ Electrocution ☐ Unknown

SUSPECTED COLLISION

☐ Distribution Wire ☐ Neutral Wire ☐ Guy Wire ☐ Transmission Wire ☐ Overhead Static Wire
☐ Structure ☐ Unknown ☐ Other (describe): _____

SUSPECTED ELECTROCUTION (Select electric contact points, may select more than one.)

☐ Primary Conductors – Tangent ☐ Primary Conductors – Deadend ☐ Primary Jumper Wires
☐ Equipment Wires ☐ Other (describe): _____

EQUIPMENT INFORMATION

Switch: ☐ Air Break ☐ Cutout Surge Arrester: ☐ Conventional ☐ Gapped
Ground Contact: ☐ Guy Wire ☐ Metal Bracket ☐ Pole Top Ground
Other Equipment: ☐ Capacitor ☐ Recloser ☐ Regulator ☐ Transformer ☐ Current/Potential Transformer

RECOMMENDED ACTION

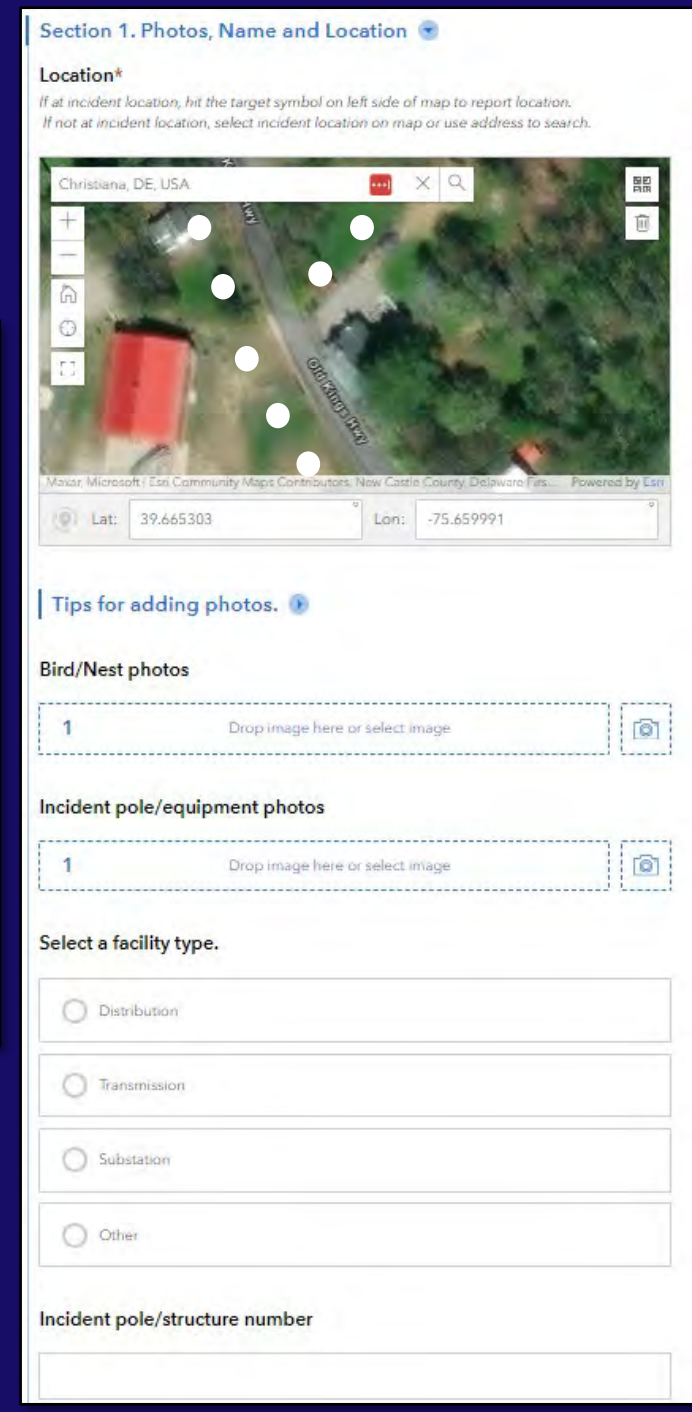
☐ Replace structure with avian-friendly configuration
☐ Remove Nest
☐ Relocate Nest
☐ Install Arrester Cap(s)
☐ Install Conductor Guard(s)
☐ Install Deadend Cover(s)
☐ Insulate Jumper Wire(s)
☐ Install Bird Flight Diverter(s)
☐ De-energize Structure
☐ Other (describe): _____
☐ Reframe structure to avian-friendly standards
☐ Trim Nest
☐ Install Nest Platform
☐ Install Bushing Cover(s)
☐ Install Cutout Cover(s)
☐ Install Ground Wire Molding
☐ Install Perch Discourager
☐ Cover Up Energized Equipment
☐ No Action

DOCUMENTATION

Were photographs taken? ☐ Yes ☐ No (If Yes, please email to Cristina.Frank@pepcoholdings.com)
Recommended Action/No Action Comments: _____
Other Comments: _____

Upon discovery of a bird/nest, please contact Environmental Planning, Cristina Frank (302) 454-4173.

Employee: _____ Crew Supervisor: _____
Date Reported: _____ Time Reported: _____
Date: _____



Section 1. Photos, Name and Location

Location*

If at incident location, hit the target symbol on left side of map to report location.
If not at incident location, select incident location on map or use address to search.

Christiana, DE, USA

Lat: 39.665303 Lon: -75.659991

Tips for adding photos.

Bird/Nest photos

1 Drop image here or select image

Incident pole/equipment photos

1 Drop image here or select image

Select a facility type.

- Distribution
- Transmission
- Substation
- Other

Incident pole/structure number

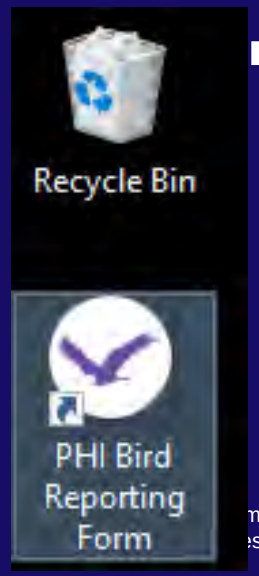
1. Seek Partners' Input:
(A) Incident Reporting

Problem 2: Low reporting continues…

- District Supervisors' input: Linemen want to use PHI field devices

Solution 2: Add AIMS shortcut to PHI field device Outcome: in-house reporting improves

- Contactors rely on QR--helpful for nesting surveys, etc.
- Parallel pathways to AIMS works well!



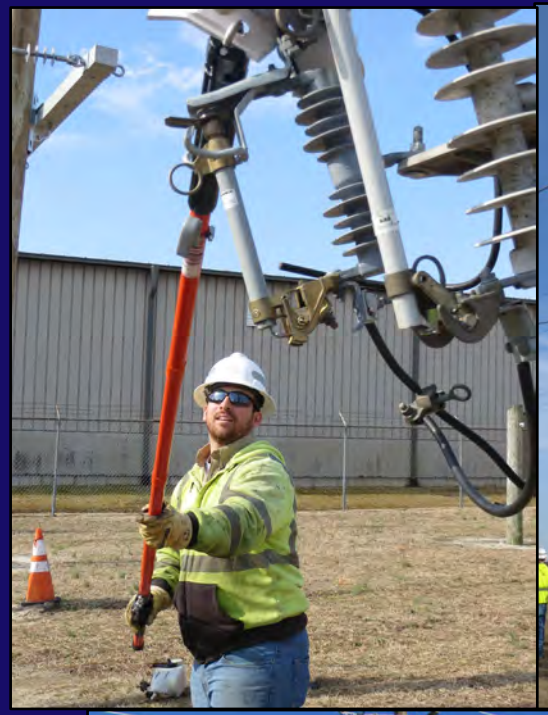
1. Seek Partners' Input:
(B) Mitigation Implementation

Problem: Mitigation products not used properly, often "end up in the bushes"

- WHY?: District Insight -
  - Poor fit/security, impedes operations, linemen don't like

Solution: Involve linemen in mitigation product selection!

- Help identify use cases (eqpt type, jumper routing, line angle, etc.)
- Standards ID's performance requirements (V-0, dielectric rating)
- Road show at regional training yards
- Ratings (fit, security, time & ease of install)
- Outcome: a cadre of lineman evangelists for the program!
  - "nobody has ever asked us what we like before…"
  - "less likely to end up in the bushes…from falling off or never going on"
  - "now we know…even if it's not perfect, we know are using the best possible alternative"



2. Communicate in Partners' Language:
Training and Resources

Problem: Installation of wildlife product not to PHI standard

- Standards notes are not a lineman's love language!
- Visual is most practical!

Solution 1: Wildlife Mitigation Manual

- Distribution Standards collaboration
- Visual resource – photo-based, few words
  - How should each product be installed?
  - How do you know it's installed correctly?
  - Show correct and common mistakes
  - Extra emphasis on tricky installs (e.g., recloser)
- Avail in field thru Exelon intranet

2. Communicate in Partners' Language:
Training and Resources

Problem: Installation of wildlife product not to PHI standard

- Standards notes are not a lineman's love language!
- Visual is most practical!

Solution 2: Training Videos

- Who really wants to thumb through a manual?
- EM staff not credible, not prepared for hard questions
- Journeyman lineman trainers from EDM
    - Decades of experience, informality, straight talk
- Outcomes:
  – Device-by-device video install training demo
  – On-demand viewing in field

3. Align Asks with Partners' Goals: *Incident Response*

Problem: Districts not completing reactive mitigation in a timely manner

- Not meeting Exelon committed timeline
- WHY?: District Insight –
  - O&M budgets stretched thin, limited manpower
  - Exception: Multiple Device Outages (MDO's) (Reliability issues)

Solution: Reliability Engineering (RE) designated as initial contact for reactive retrofits

- Goal alignment: electrocutions cause outages, and reactive retrofits are addressing a proven outage risk
- Outcomes:
  - RE able develop in-house designs and accelerate through que
  - RE integrates wildlife protection with large scale system improvements, which are capitalized

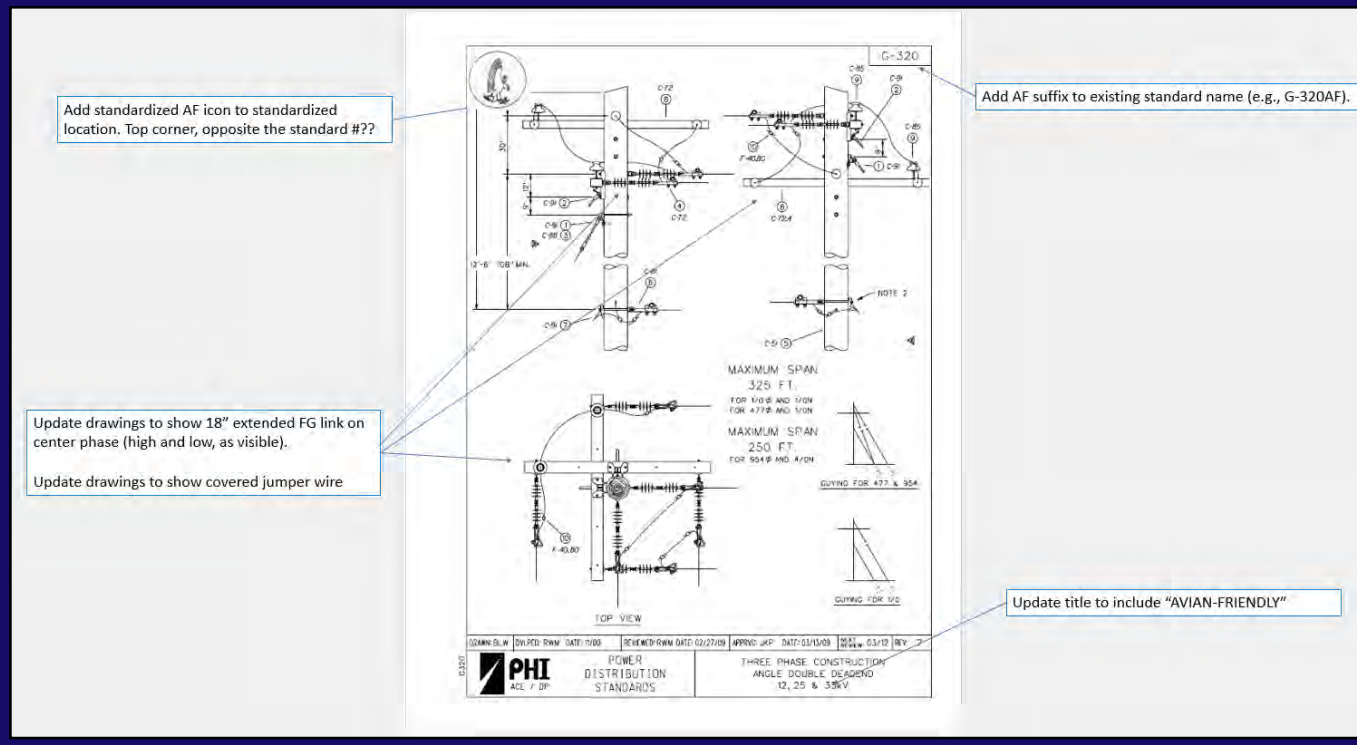
4. Seek Solutions within Partners' Existing Work-flows: *Avian-Friendly Standards*

<u>Problem</u>: As of 2016, avian friendly (AF) new construction standards available for only some design cases

***<u>Attempted</u>* <u>Solution (2017-2019)</u>**

- Reviewed all standards, provided recs
- Uneven implementation

- Outcomes:
  - Complexified an overwhelming project
  - Competing priorities, not a reg workflow
  - Punt: AF updates during 5-yr rolling review
  - Set stage: Mitigation Manual, products selection, awareness building



4. Seek Solutions within Partners' Existing Work-flows: *Avian-Friendly Standards*

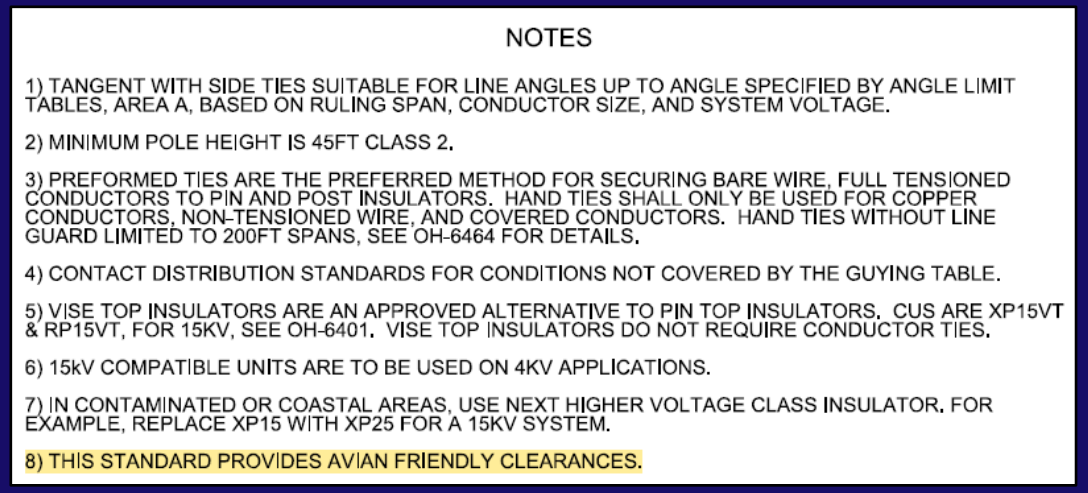
Problem (2023): AF standards never incorporated due to turnover in leadership

***Attempted* Solution (2023):** Re-evaluate strategy

- Develop Avian Notes to summarize steps to make standards avian friendly
  - Universal adoption of covered jumper, bushing covers, etc.
  - Standardized avian notes on every standard
- Outcomes (2023):
  - Spot check: improvement but many missing or incorrect notes
  - No corrections 30 days after feedback

***In Progress* Solution** (2024):

- Must be integrated into the revision process
- AF standards is non-negotiable, the route to AF standards IS!



NOTES

1) TANGENT WITH SIDE TIES SUITABLE FOR LINE ANGLES UP TO ANGLE SPECIFIED BY ANGLE LIMIT TABLES, AREA A, BASED ON RULING SPAN, CONDUCTOR SIZE, AND SYSTEM VOLTAGE.

2) MINIMUM POLE HEIGHT IS 45FT CLASS 2.

3) PREFORMED TIES ARE THE PREFERRED METHOD FOR SECURING BARE WIRE, FULL TENSIONED CONDUCTORS TO PIN AND POST INSULATORS. HAND TIES SHALL ONLY BE USED FOR COPPER CONDUCTORS, NON-TENSIONED WIRE, AND COVERED CONDUCTORS. HAND TIES WITHOUT LINE GUARD LIMITED TO 200FT SPANS, SEE OH-6464 FOR DETAILS.

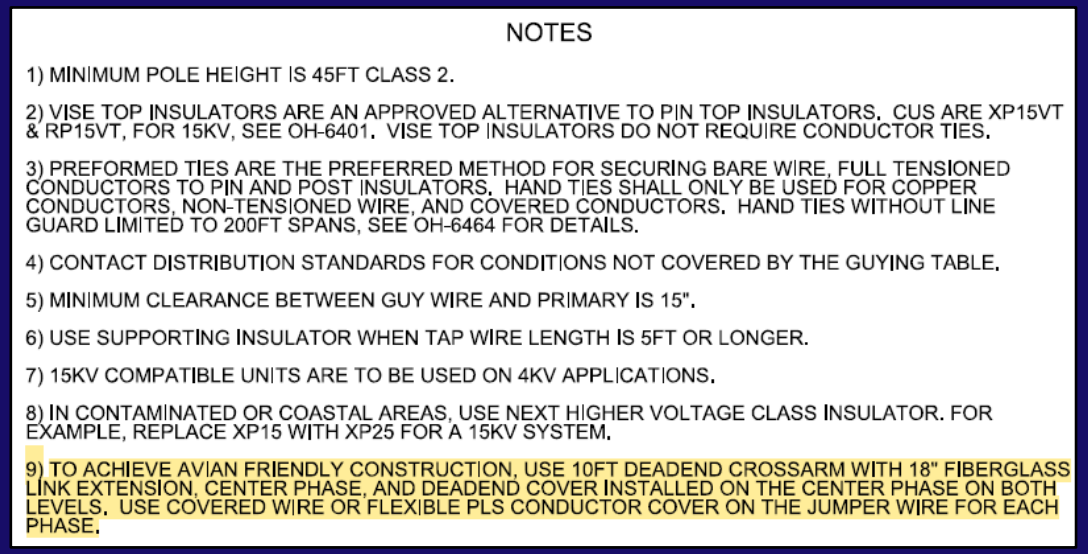
4) CONTACT DISTRIBUTION STANDARDS FOR CONDITIONS NOT COVERED BY THE GUYING TABLE.

5) VISE TOP INSULATORS ARE AN APPROVED ALTERNATIVE TO PIN TOP INSULATORS. CUS ARE XP15VT & RP15VT, FOR 15KV, SEE OH-6401. VISE TOP INSULATORS DO NOT REQUIRE CONDUCTOR TIES.

6) 15kV COMPATIBLE UNITS ARE TO BE USED ON 4KV APPLICATIONS.

7) IN CONTAMINATED OR COASTAL AREAS, USE NEXT HIGHER VOLTAGE CLASS INSULATOR. FOR EXAMPLE, REPLACE XP15 WITH XP25 FOR A 15KV SYSTEM.

8) THIS STANDARD PROVIDES AVIAN FRIENDLY CLEARANCES.



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4) CONTACT DISTRIBUTION STANDARDS FOR CONDITIONS NOT COVERED BY THE GUYING TABLE.

5) MINIMUM CLEARANCE BETWEEN GUY WIRE AND PRIMARY IS 15".

6) USE SUPPORTING INSULATOR WHEN TAP WIRE LENGTH IS 5FT OR LONGER.

7) 15KV COMPATIBLE UNITS ARE TO BE USED ON 4KV APPLICATIONS.

8) IN CONTAMINATED OR COASTAL AREAS, USE NEXT HIGHER VOLTAGE CLASS INSULATOR. FOR EXAMPLE, REPLACE XP15 WITH XP25 FOR A 15KV SYSTEM.

9) TO ACHIEVE AVIAN FRIENDLY CONSTRUCTION, USE 10FT DEADEND CROSSARM WITH 18" FIBERGLASS LINK EXTENSION, CENTER PHASE, AND DEADEND COVER INSTALLED ON THE CENTER PHASE ON BOTH LEVELS. USE COVERED WIRE OR FLEXIBLE PLS CONDUCTOR COVER ON THE JUMPER WIRE FOR EACH PHASE.

3

Future Applications

2024 Eagle Incidental Take Permit for Power Lines

- Immunity from prosecution for incidental eagle take
- Must proactively mitigate 2% of baseline poles in “high-risk eagle areas” (non-urbanized habitats), each year
- PHI would scale from ~200 poles/yr (reactive) to ~5,000 by April 2027
- Requires transition from afterthought to company-wide focus
- Foreseeable challenges are immense:
  - Leadership
  - Training
  - Planning, strategy & management
  - Budgeting and cost recovery
  - Supply chains and storage
  - Manpower
  - QA/QC
  - Recordkeeping & reporting
- Unforeseen challenges also are immense

To Successfully Scale, We Must:

1. *Seek partners' input*
2. *Communicate clearly…in the partners' language*
3. *Align asks with partners' goals; articulate benefits to partners*
4. *Seek solutions within partners' existing work-flows*
5. *Continue to learn from failures and successes*

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AN EXELON COMPANY

Thank you

Cristina Frank
Principal Environmental Program Manager
Cristina.Frank@pepcoholdings.com
302-454-4179

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PSE&G

Utilities and Managing Biodiversity

Opportunities for utilities to protect & promote Biodiversity

- Vegetation Management: Critical Songbird Habitat
- Facilities: Songbird Building Collisions
- Transmission ROWs: Pollinator Conversions
- Distribution: Avian Protection & Nesting

Vegetation Management – Critical Songbird Habitat

Opportunity:
Vegetation Management activities threaten critical golden-winged warbler breeding & nesting habitat.

- Vegetation management activities can be one of our most common impacts
- Methods & timing can be modified to protect wildlife and promote habitat

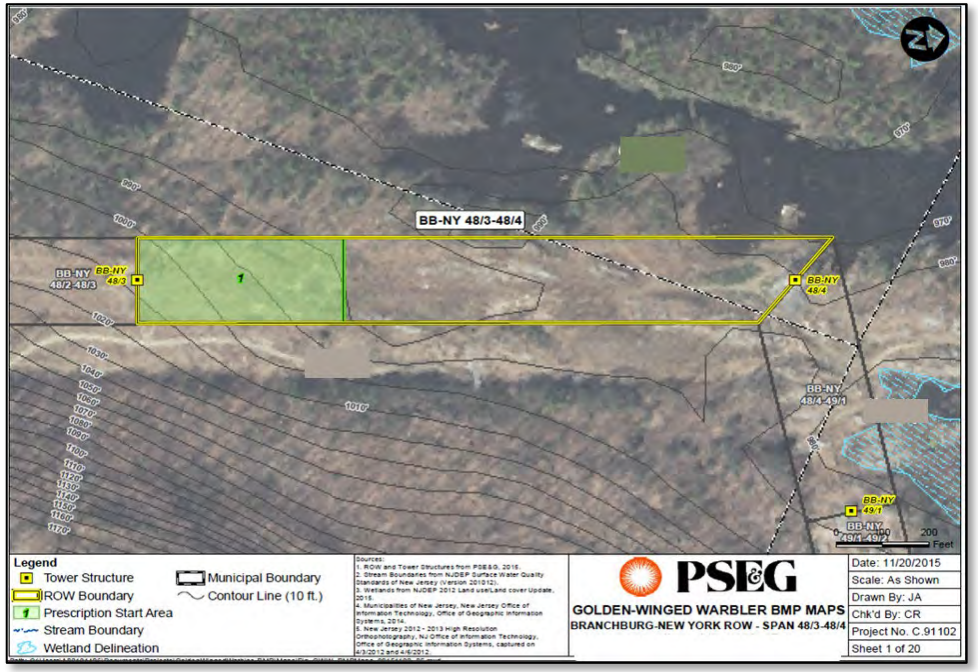
PSE&G

Vegetation Management – Critical Bird Habitat

Solution:

Vegetation Management activities altered to sustain habitat availability.

- Identify & document sensitive habitat areas
- Implemented IVM strategies and keep border zone vegetation
- Adjusted timing of maintenance activities outside the breeding/nesting season

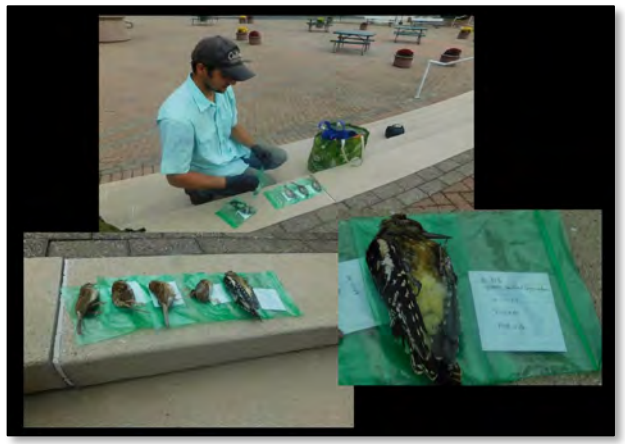


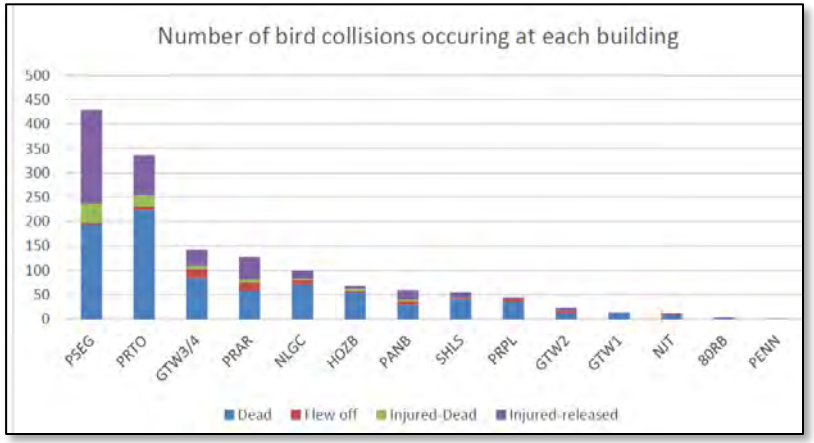
Facilities - Newark HQ Building Bird Collisions

Opportunity:

Hundreds of Songbirds each migration season striking our glass HQ Building.

- Utilities also typically have a large portfolio of facilities where opportunities may exist
- Building study helped identify problem areas and times of year.
- Collisions were also impacting local, employee and visitor morale
- Building owners were not receptive to window stickers or films





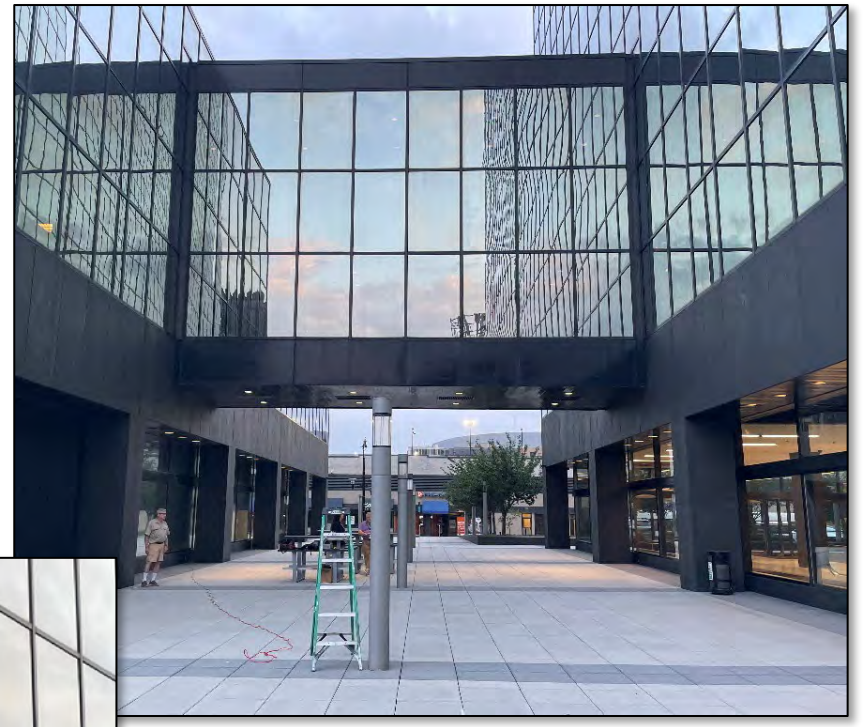
PSE&G

Facilities - Newark HQ Building Bird Collisions

Solution:

We worked with building owners to allow us to experiment with UV light to make the glass more visible to birds.

- EDM study on UV light reducing collisions on transmission lines
- Would it work on a building
- Retrofitted a light to add a UV light to shine on building
- From monitoring, we know collisions still occurred. Awaiting spatial data.
- Committed to continue on solutions



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Transmission ROW - Pollinator Conversions

Opportunity:

Transmission ROWs can relatively easily be converted to meadows providing valuable pollinator habitat.

- Large land areas traversing the landscape
- Excellent opportunities for land management and stewardship activities
- Important pollinator & wildlife corridors, especially in urban/suburban areas.

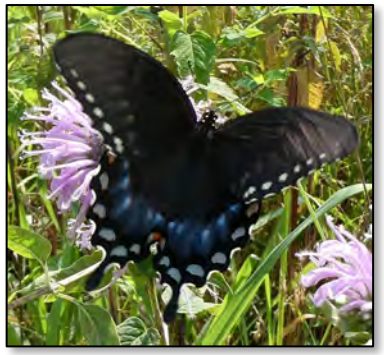
PSE&G

Transmission ROW - Pollinator Conversions

Solution:

Converted 2-acres of lawn to meadow, creating valuable pollinator & birds.

- Eliminated need to mow - reduced maintenance cost, intensity & emissions
- Educational outreach opportunity
- Monarch Conservation Agreement credit



Distribution – Osprey Nesting

Opportunity:

Distribution poles are susceptible to bird nesting. Impacts reliability and birds and their young can be harmed.

- Nests on poles can result in line trips and fires
- Birds can harmed by fire, electrocution & collisions
- Highly visible to the public

PSEG

Distribution – Osprey Nesting

Solution:

Osprey nest relocation and platforms to provide safer nesting options.

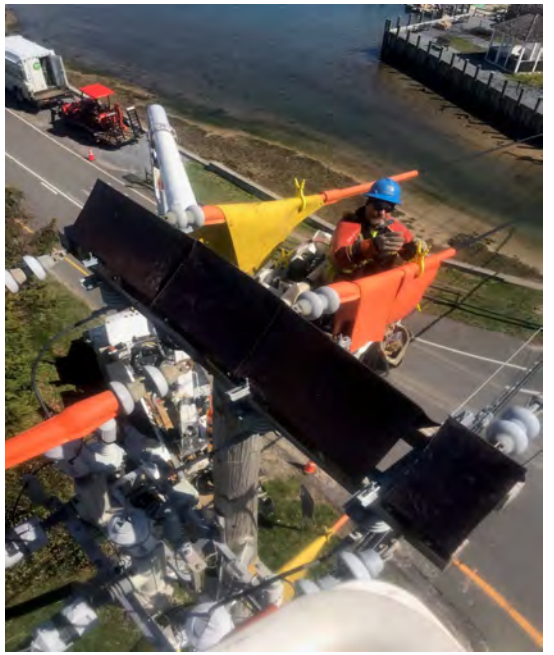
- Alternate nest poles – not always feasible
- Nest platforms above energized components
- Opportunity for nest cams

PSE&G

Distribution – Osprey Nesting

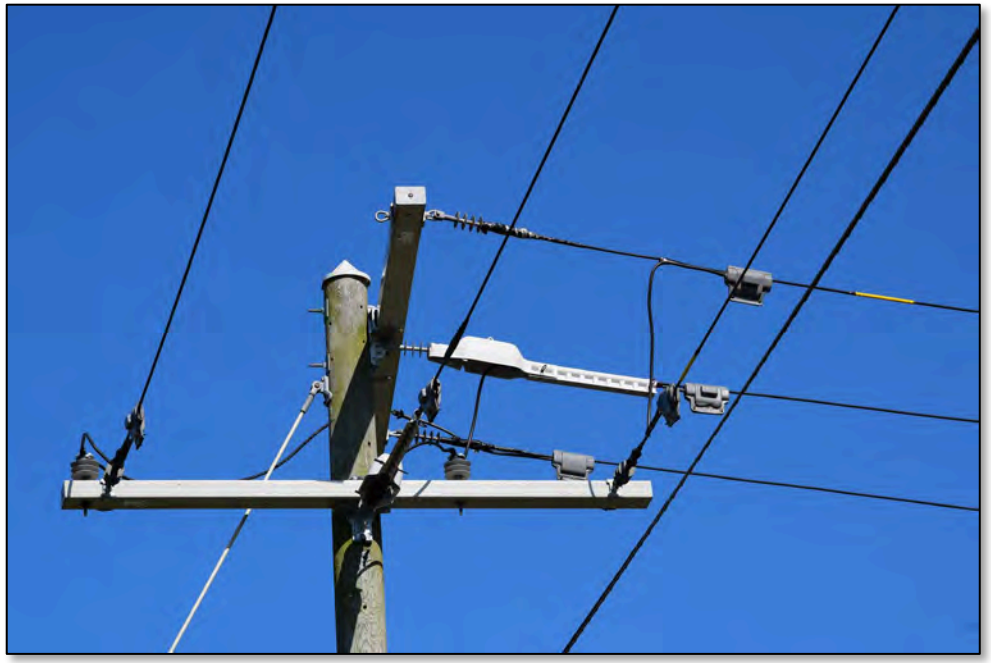
Solution:

Retrofit poles in high avian use areas to minimize collision and electrocution risk.



- Tool Box
  - Perch/nest deterrents (V-Guards)
  - Single cross-arms
  - Pole caps
  - Line & Insulator covers
  - Bird diverters

- Location, construction and species specific



Power Line Sentry
Sicame Group

Critical Factors for Success

Perspectives from Power Line Sentry

Important Factors to Consider

- Majority of cost is actually crew cost & system down time.
- Most solutions are very specific.
- Products are not interchangeable, will not work for other issues even if they seem similar.
- Talk with your vendors.
- Distributors often push in-stock products.

Be clear about the root problem that needs solved

The problem is not “birds on the pole”

Bird issues:

- Nesting
- Perching
- Collisions
- Electrocutions

Need to Know:

- Species
- Where the incident took place on the structures

Structure design:

- Specific spacing
- Specific configurations
- Sizes
- Insulation ratings

➢ **Provide as many drawings or pictures as possible**

14

Crew Discipline + Installation

- Crews should NOT manipulate, cut or arrange a device.
- Request pictures of the installed products on structures.
- Clear written instructions
- Quick videos to view on site
- QR code linking for easy use

Other Considerations

- Flame retardant rating (UL-94 V-0 should be required!)
- Quality standards (IEEE 1656 guidelines)
- Line life expectancy and maintenance requirements
- Options to install while energized
- Timing – lead times can impact which solution is available
- Inquire which utilities may be using the solution in the region

16

Power Line Sentry
Sicame Group

PSEG

Thank you

Claudia.Rocca@pseg.com

Jason.Jones@powerlinesentry.com

Results and Recommendations for Marking High Voltage Lines in Bird-Dense Areas

Anne Lacy

International Crane Foundation

anne@savingcranes.org

Funding for this project provided by American Transmission Company

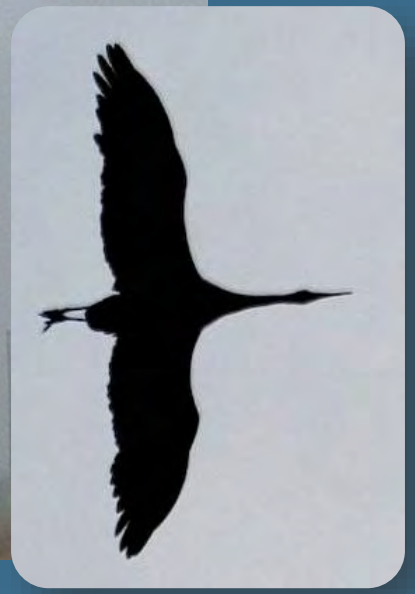
International Crane Foundation

- 300-acre HQ in Baraboo, Wisconsin
- Global project involvement
- Research and presentation by Anne Lacy
- Director of Eastern Flyway Programs in North America

As endangered species recover, the need for additional protection has increased

As energy requirements increase so does the need for additional power lines, which increases risk

Cranes are particularly vulnerable to collision risk



Increased risk factors:

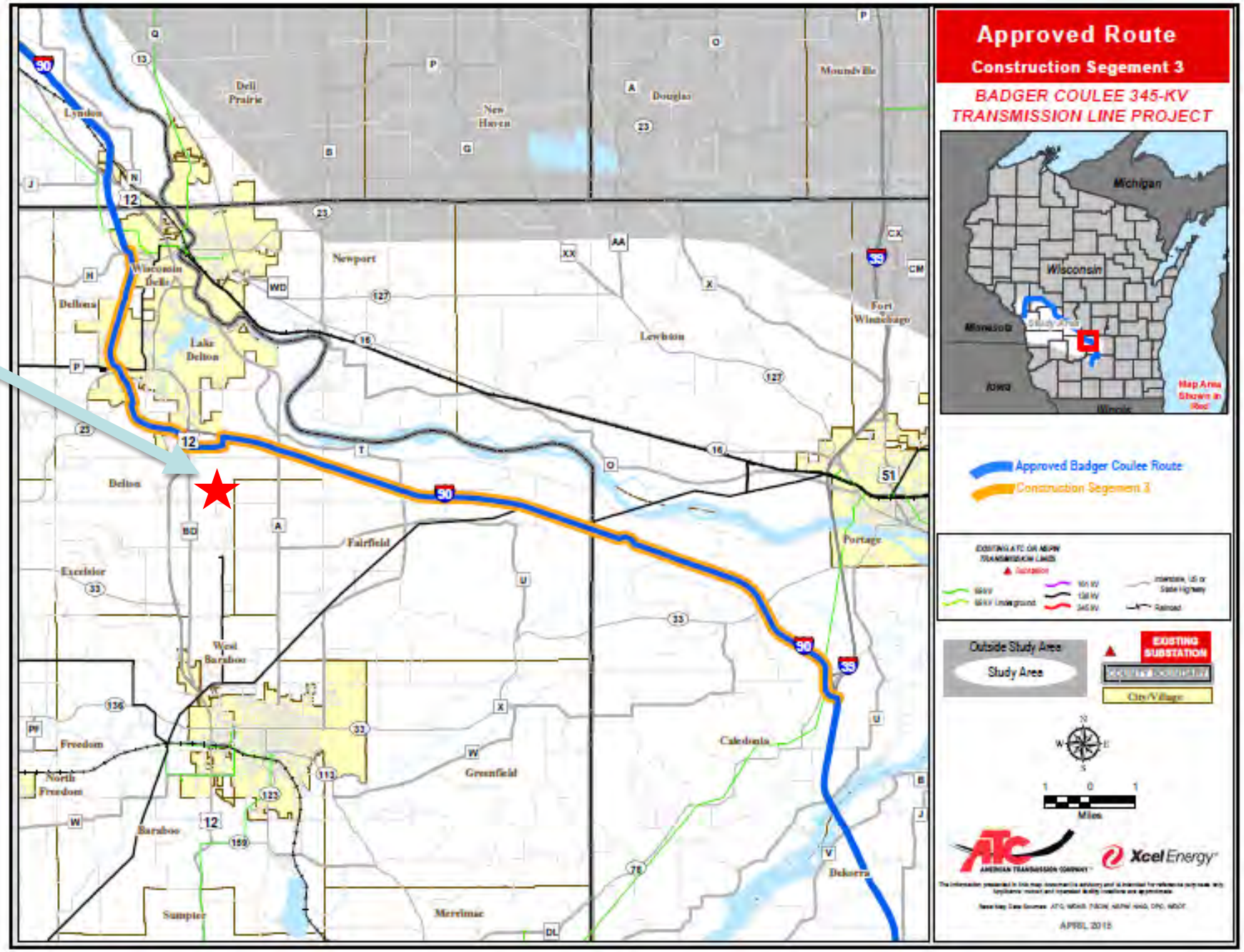
- Bird size
- Age of bird
- Visibility condistions
- Unfamiliarity with area
- Distractions

Project Location:

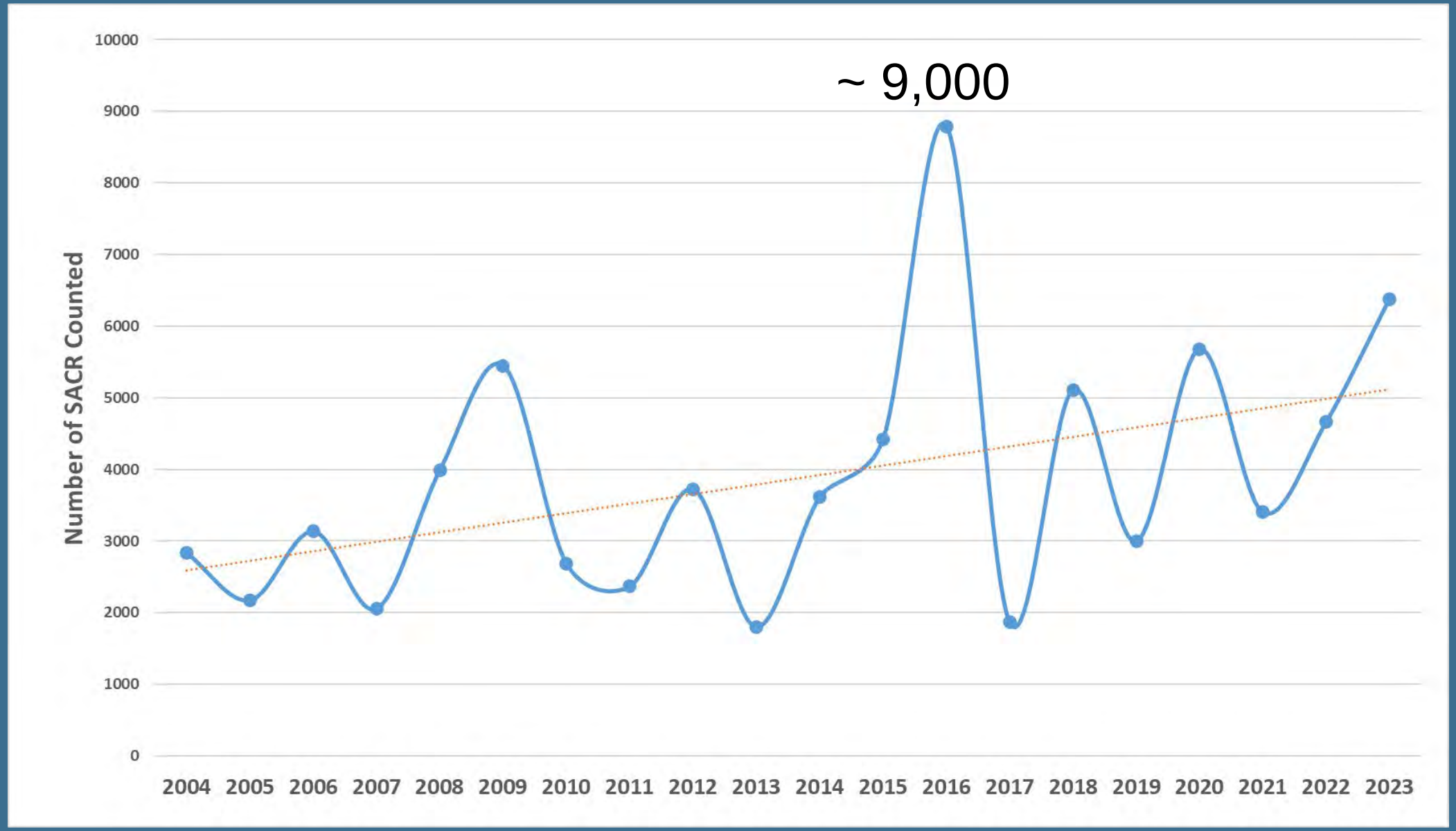
Southwest Wisconsin watershed

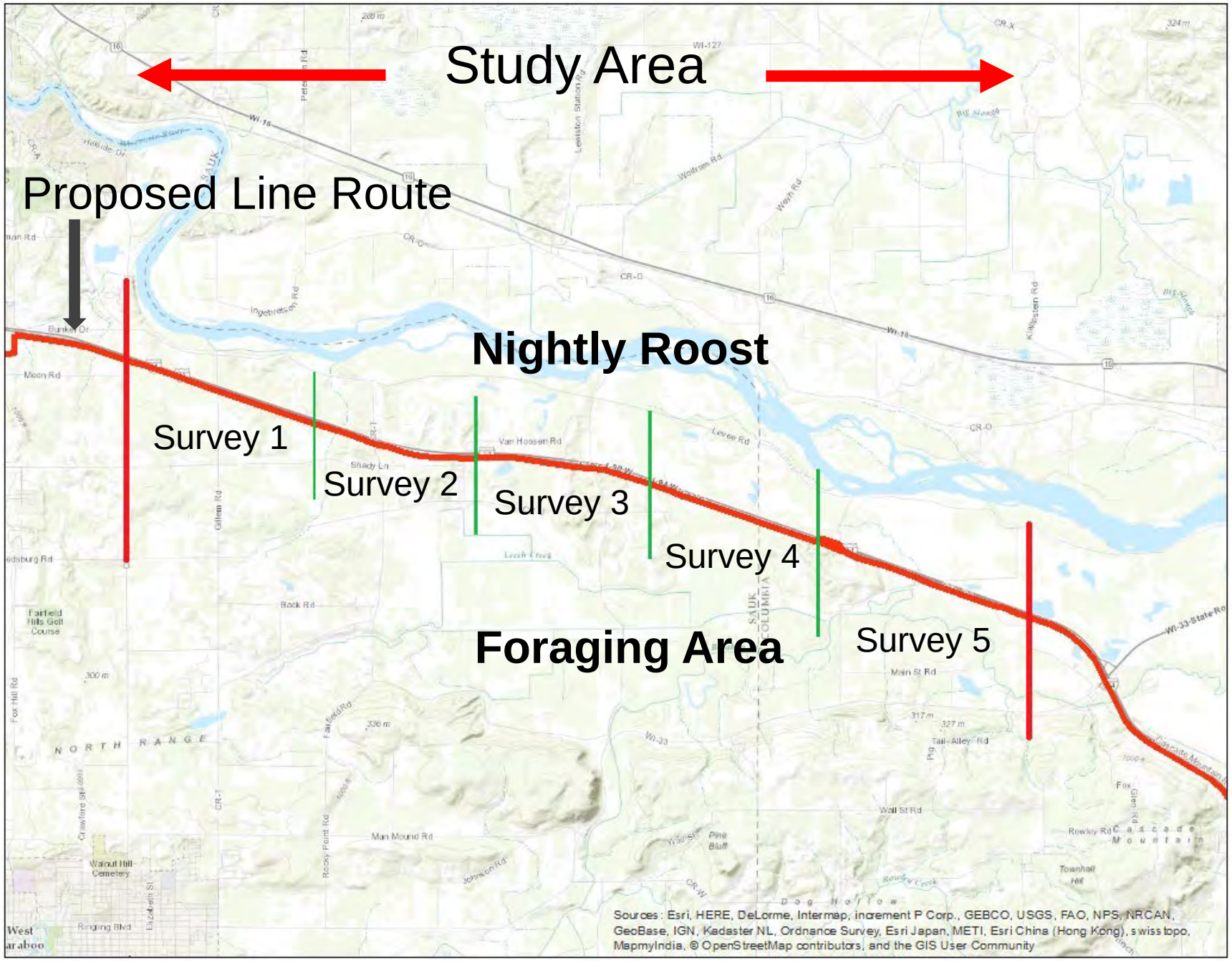
Partners:

ATC, ICF, and local conservation groups



Sand Hill Cranes FWS Annual Survey





2 phase study:

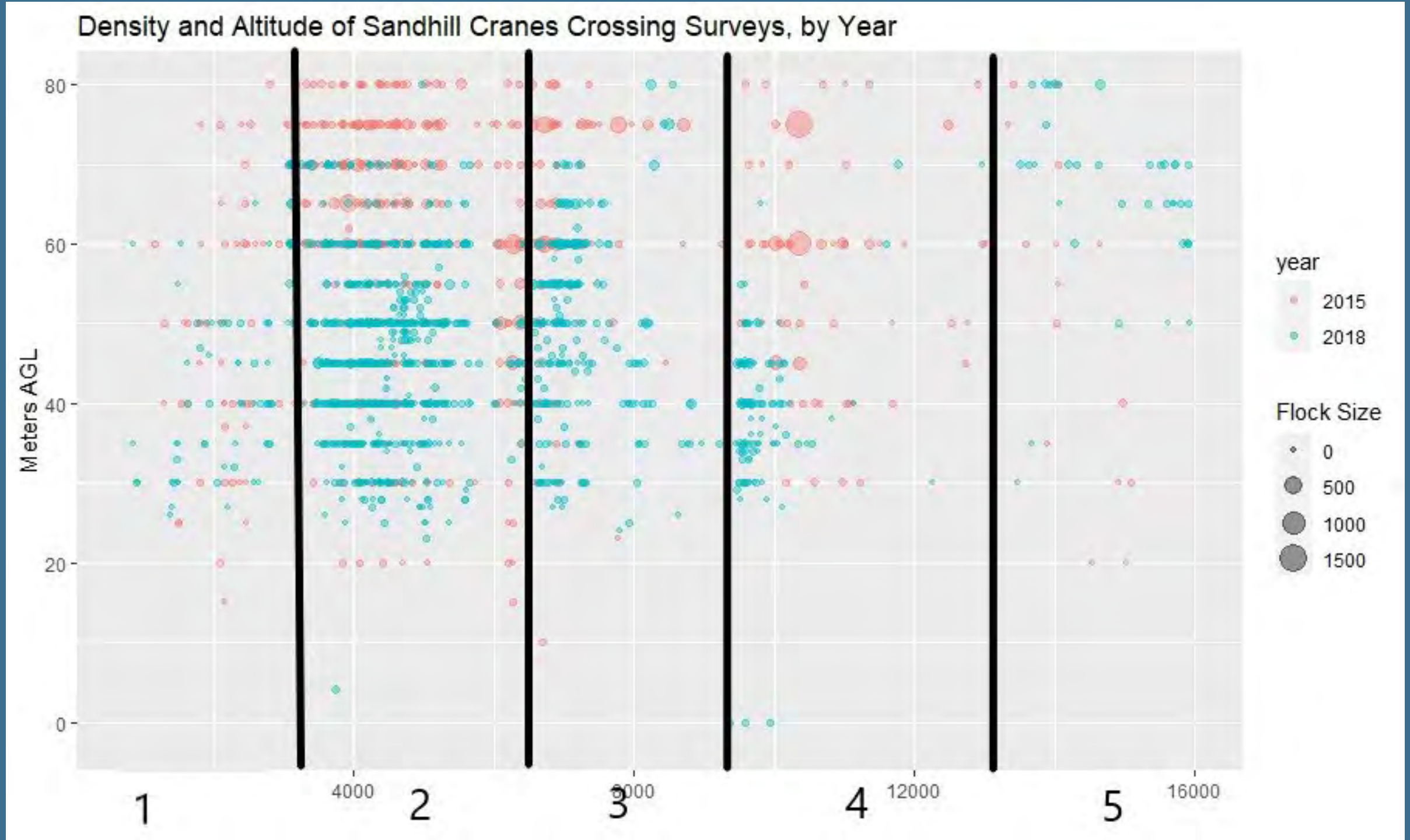
- Pre-construction use patterns
- Post-construction use patterns

Pre-Construction Observations

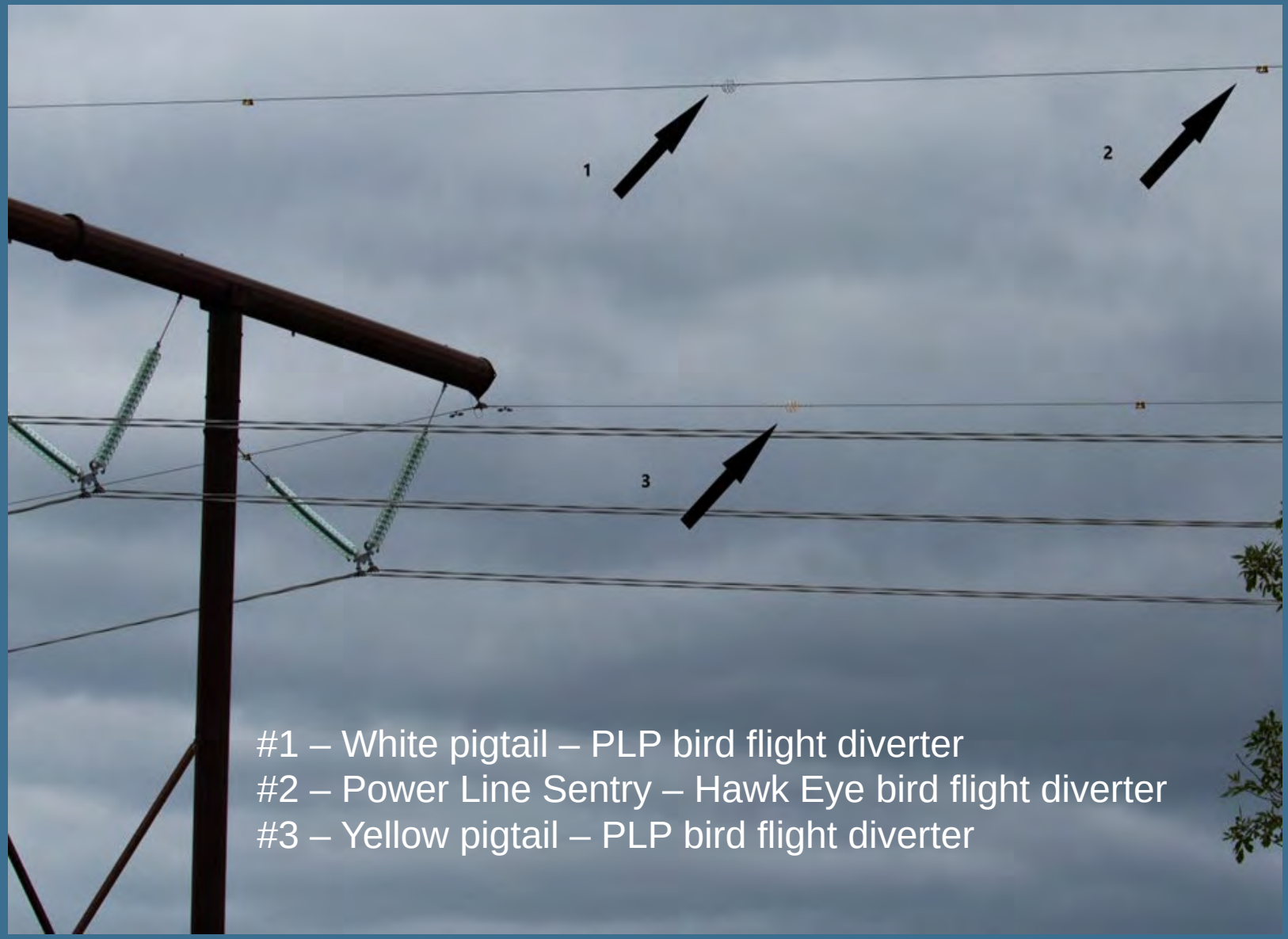
- 14 weeks in 2015
- 25,255 Sandhill Cranes
- 1 Whooping Crane
- 11 other bird species

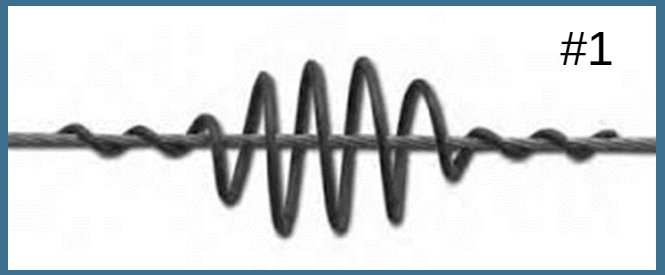
Post-Construction Observation

- 14 weeks in 2018
- 15,642 Sandhill Cranes
- 2 Whooping Cranes
- 9 other bird species


Density and Altitude of Sandhill Cranes Crossing Surveys, by Year
Meters AGL
80
60
40
20
0
4000
12000
16000
1
2
3
4
5
year
2015
2018
Flock Size
0
500
1000
1500

Is crane use of the area altered by transmission lines?






Holiday Inn Express
DEFOREST

Conclusions & Recommendations

- Involvement in beginning of planning stages assured best placement and design for bird safety

- Keep apprised of new technologies that will help determine risk ongoing (e.g. UV line markers and collision detectors)

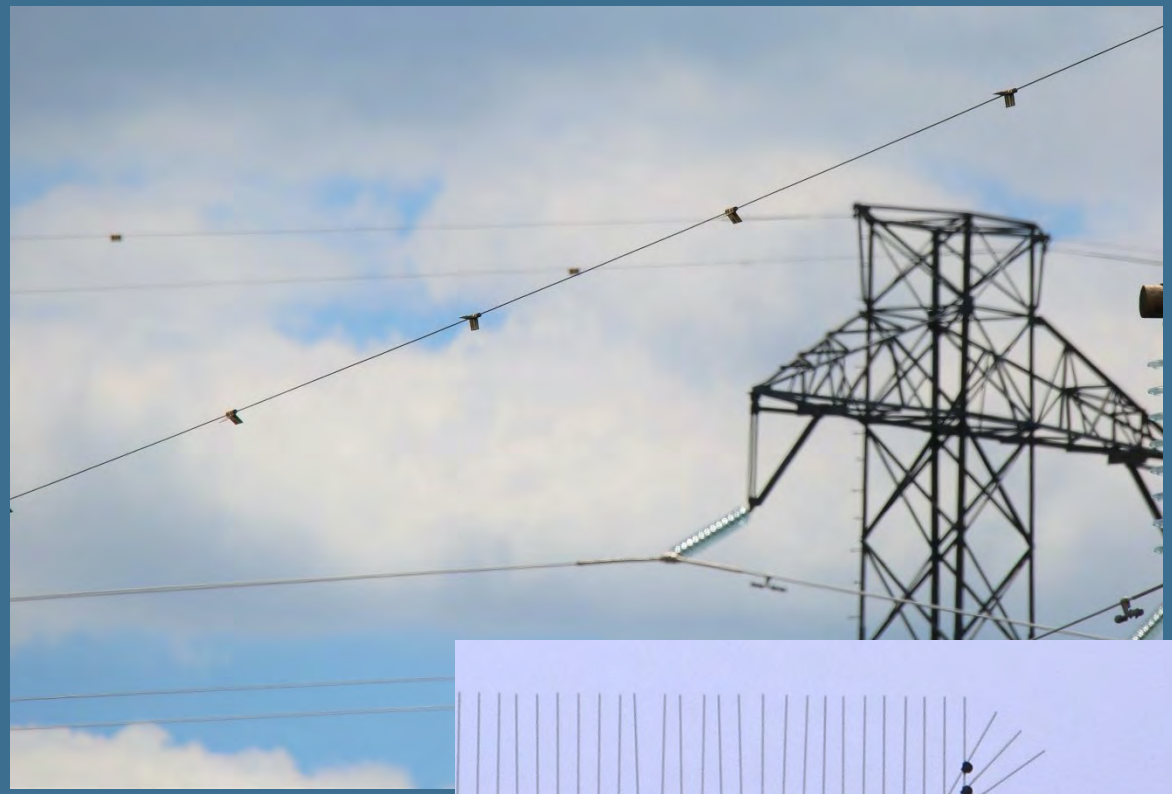
- Increase awareness of the implications of filling airspace with structures that may alter life cycle of organisms using it

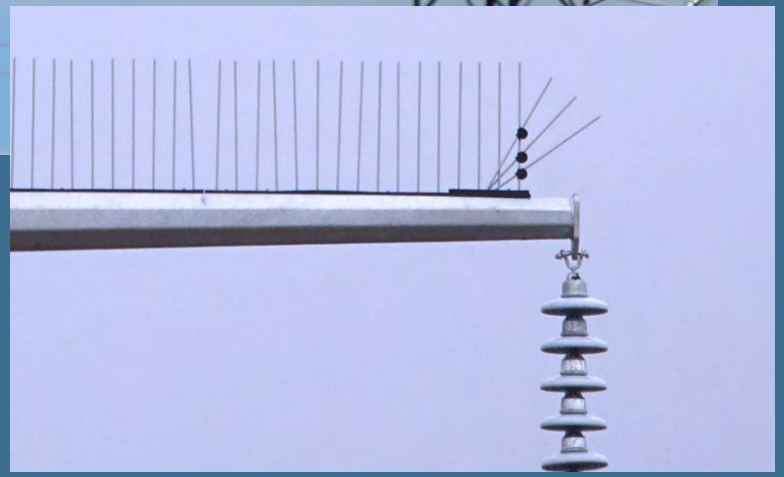
Critical Factors

(Additional input from Power Line Sentry)

Critical Factors for Success

- Vendors vs. distributors
- Root problem identification
  - Collisions - i.e., bird flight diverters
  - Perching - i.e., perching deterrents
  - Nesting – i.e., nesting diverters
- External factors
  - Species, habitat, wire size
  - Distribution vs transmission
  - Installation options
- Risk and appropriate spacing





Visibility Footage

Anne Lacy
International Crane Foundation
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Jason Jones
Power Line Sentry
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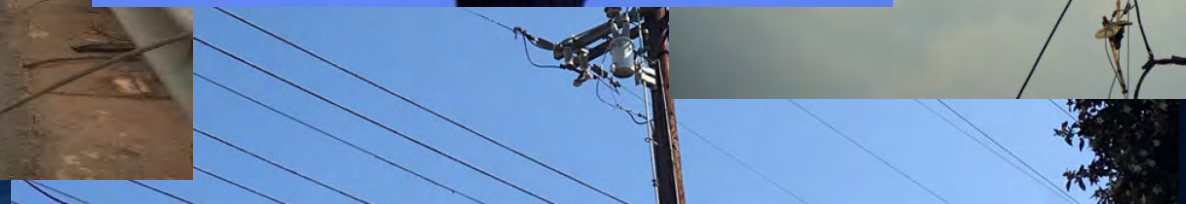
Grid Analytics for T&D Pole Fire Mitigation

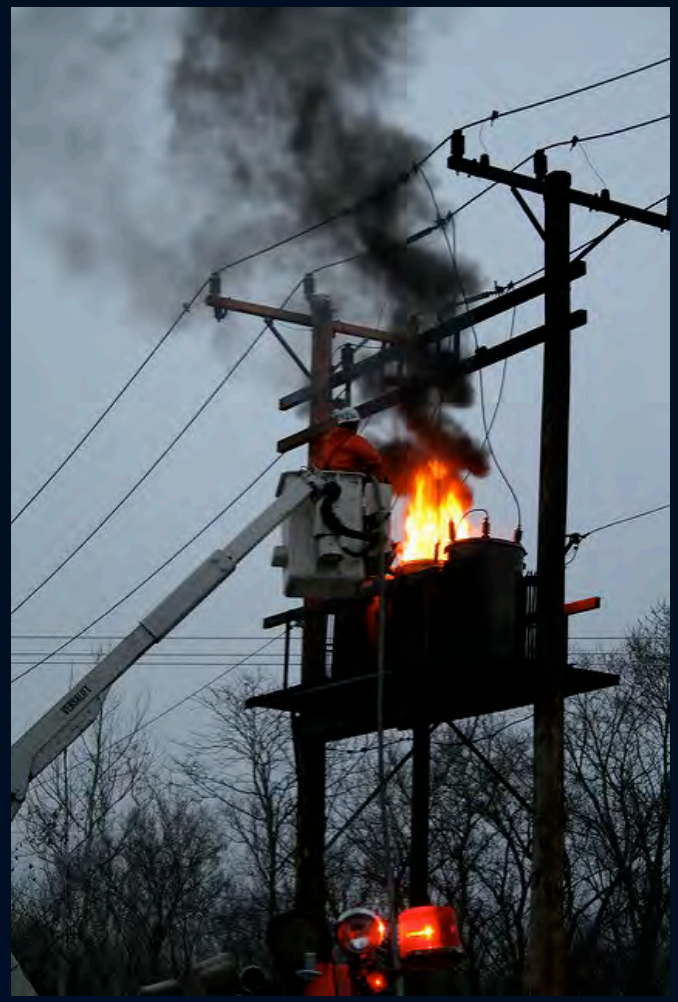
JOHN L. LAULETTA
EXACTER, INC.
JLAULETTA@EXACTERINC.COM

Pole Fires Happen



Pole Fire Causes and Concerns

- Pole Fires are not Typically Caused by Major Equipment Failure
- Pole Fires Often Result in Collateral Damage
- Pole Fires Create Hazardous Work Environments
- The Frequency of Pole Fires is on the Rise



A Brief – Non-Scientific – Cause Analysis

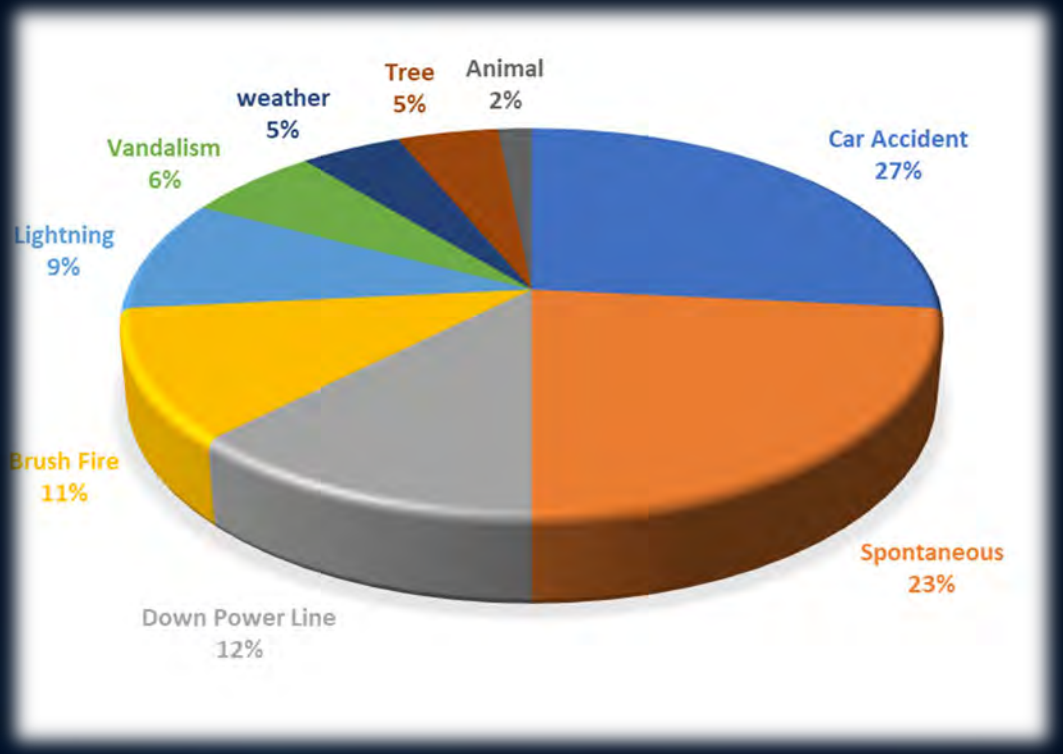
- Google Alert Search started in June 2018
  - Pole + Fire
  - Power Line + Fire
  - Electric Line + Fire

Results: 11,836 Total Reports

4,113 Unique Reports

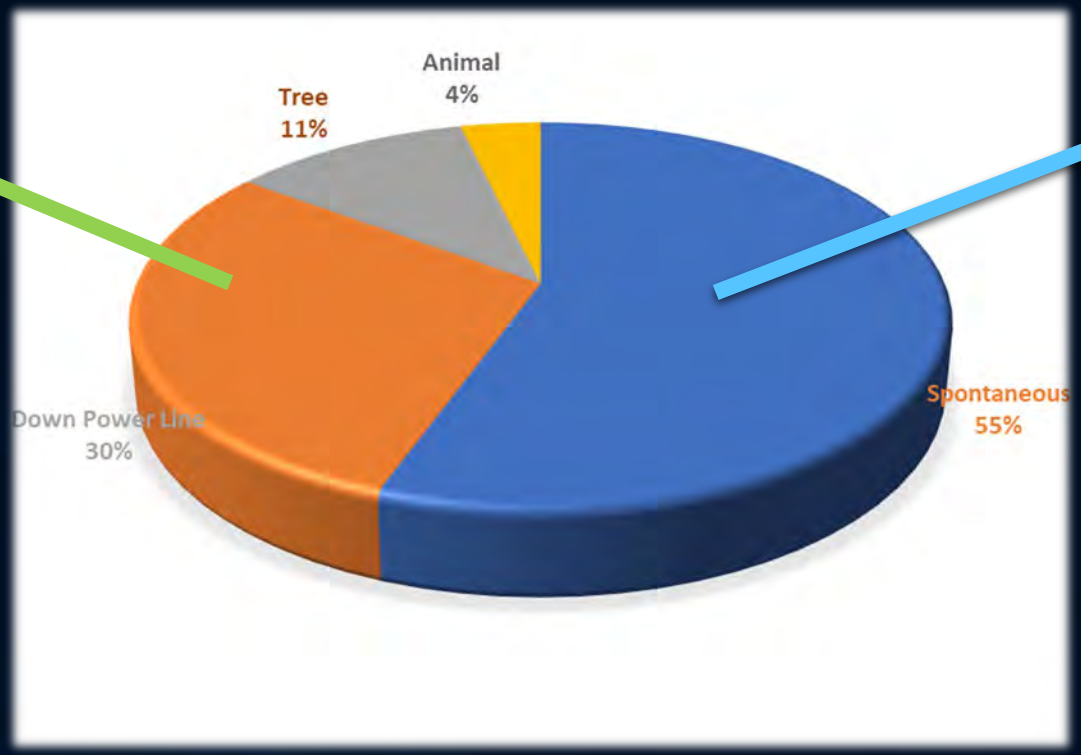
9 Common Causes Sighted

A Brief – Non-Scientific – Cause Analysis



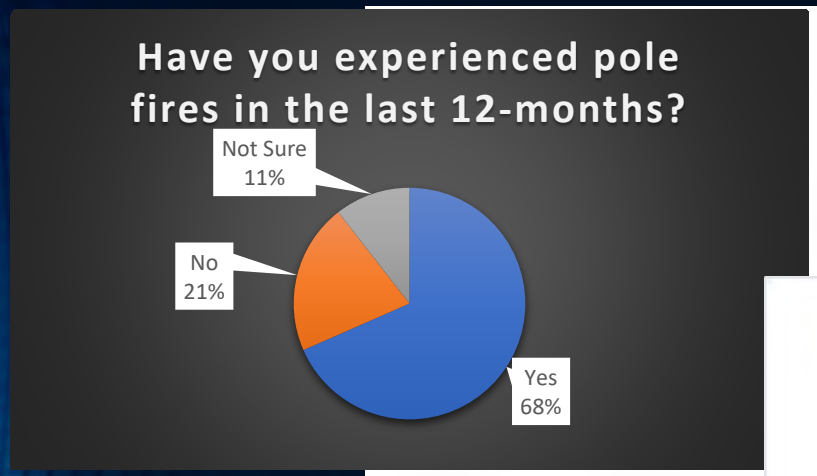
Eliminating Unavoidable Causes = Avoidable Causes

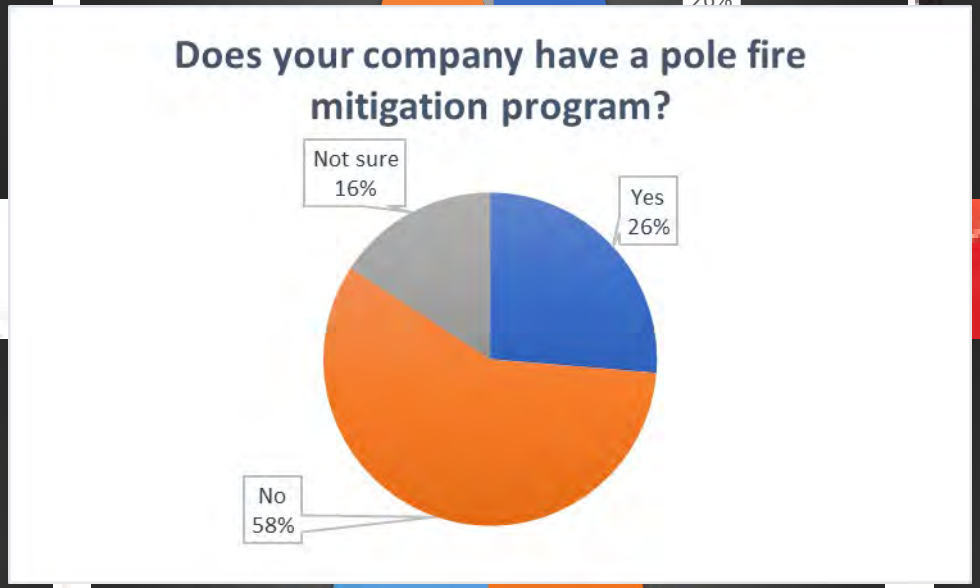
- Broken Insulators
- Loose Ties
- Broken Crossarms
- Other Mechanical Failure

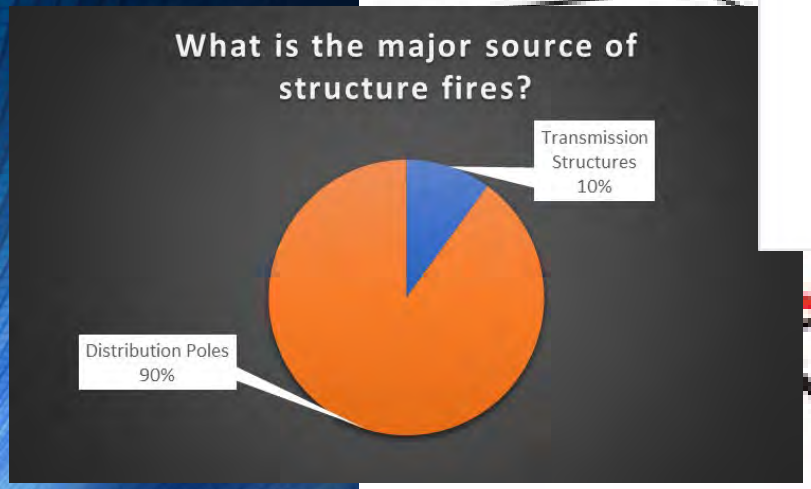


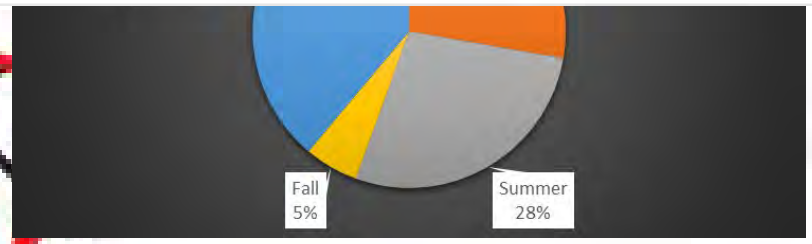
- Cracked Insulators
- Contamination
- High Leakage Currents

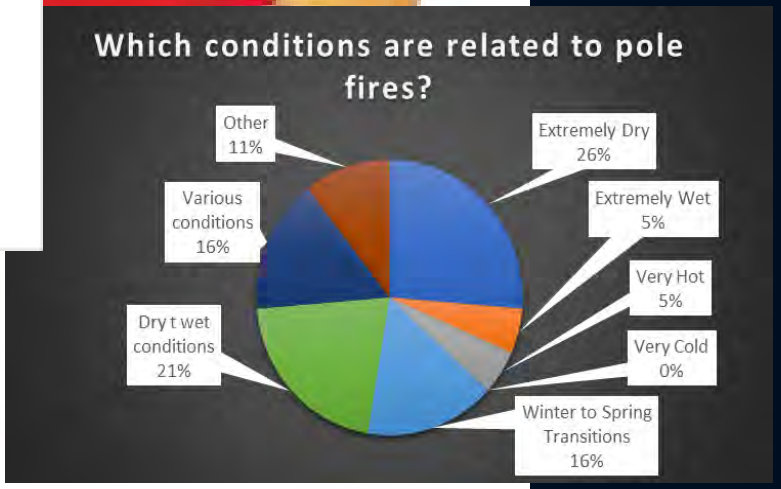
CIGRE: Working Group on WildFire Caused by Overhead Lines - Exacter Utility Survey











Using Partial Discharge RF Emissions to Identify Pole Fire Threats

IEEE 454 Categorizes 4 Types of PD in Distribution Equipment

1. **Internal PD** such as material voids, manufacturing issues, delamination and others
2. **Surface PD** where the field are parallel to the surface of the dielectric material such as in the case of Dry Band Arcing

Ideal for Pole Fire Mitigation

3. **Corona PD** which has unique characteristics and is influenced by high humidity
4. **Floating Component PD** where materials have separated such as a connector from a lightning arrester

PD Current Characteristics

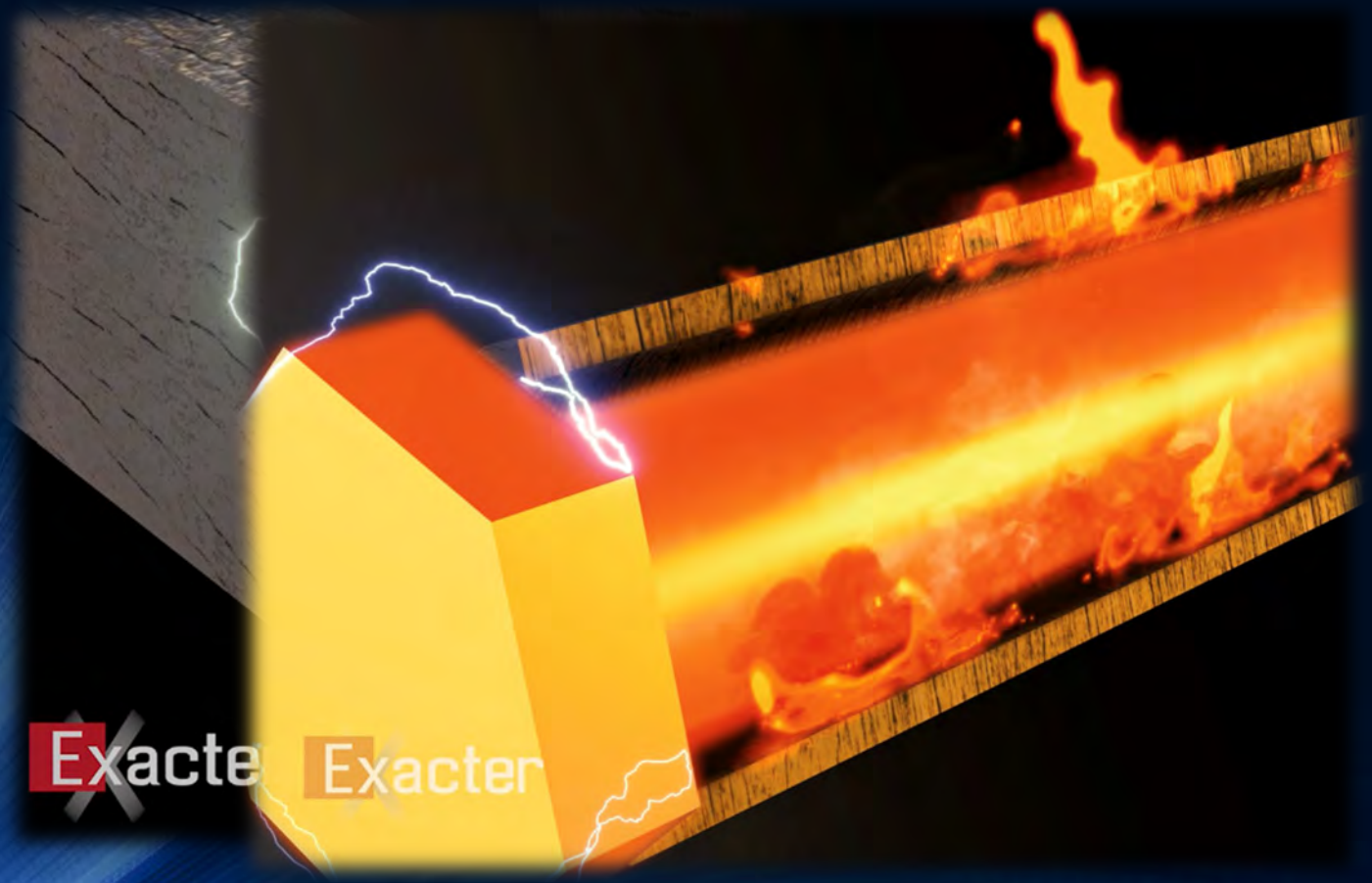
- Normal Leakage Current is Capacitive in Nature and Low level
- Capacitive Currents typically are less than 4 mA
- Currents Generated During Surface PD are Resistive in Nature
- Surface PD Currents Can Exceed 500 mA
- Continuous Currents of More Than 10 mA Have Been Shown to Initiate Pole Fires

Pole Fire Process

Contamination

Scintillation

Through Bolt or King Bolt Often Initiate Pole Fires



Hidden Arcing in the Bolt Hole Continues to Deteriorate the Wood

A Sharp Breeze Can Create a Hazard

Brush Fires Result When Conditions Are Dry

Insulator Condition May Be The Biggest Concern

- ". . . transients caused by lightning strikes, switching surges, and temporary system overvoltage results in outages from insulators which are compromised by damage, surface contamination, and the process of scintillation reducing the overall BIL of the insulator."

Diesendorf, W. *Insulator Co-ordination in High-voltage Electric Power Systems*. London, England (printed in Hungary): Butterworth & Co (Publishers) Ltd. Copyright 1974. ISBN 0408704640, LOC TK1005.D53.

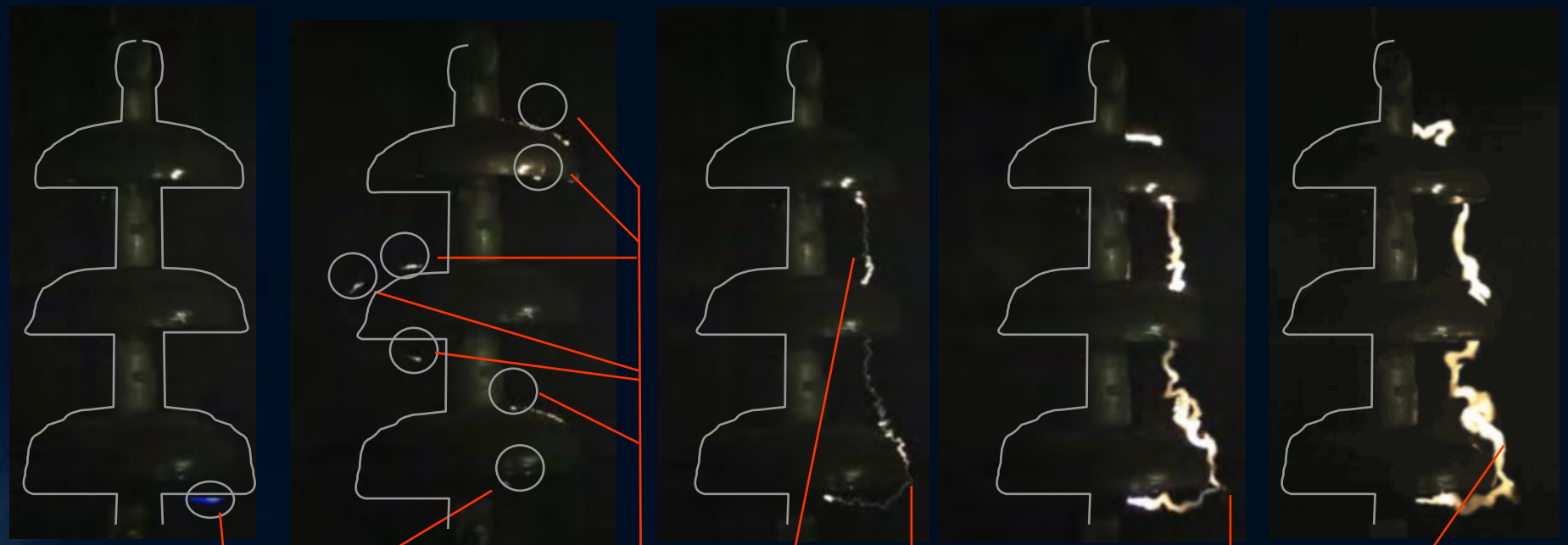
The Dry Band

- Diverged axial currents will cause the growth of the dry layer across the flow of current lines and the dry band is formed
- Most of the applied voltage appears across the dry band
- At a critical value, surface partial discharges appear across this dry band
- This surface partial discharge is called Scintillation

Scintillation → Flashover

- Typical leakage current is capacitive and low level
- Scintillation shortens the creepage length and resistive leakage current increases dynamically
- Increased resistive leakage current leads to formation of another dry band and increased Scintillation
- If the number of scintillations at a given time crosses a critical number, then flashover occurs

Scintillation Process In the Lab



Conditions That Lead to Pole Fires

- Very Dry, Drought Conditions Followed by Fog, Moisture, and Drizzle
- Wetness, Even Light Rain Makes Wood Structures Less Resistant to Leakage Current
- Two High Risk Periods for Pole Fires:
  - During the First ½ Hour of a Rain Event
  - **During the First Hour After a Rain Event**
- The End of a Dry Season is the Time Poles are Most Susceptible to Fires
- High Leakage Currents are Produced when the Relative Humidity is Greater than 70%
- Poles and Structures Older than 35 Years are Most Susceptible to Fires

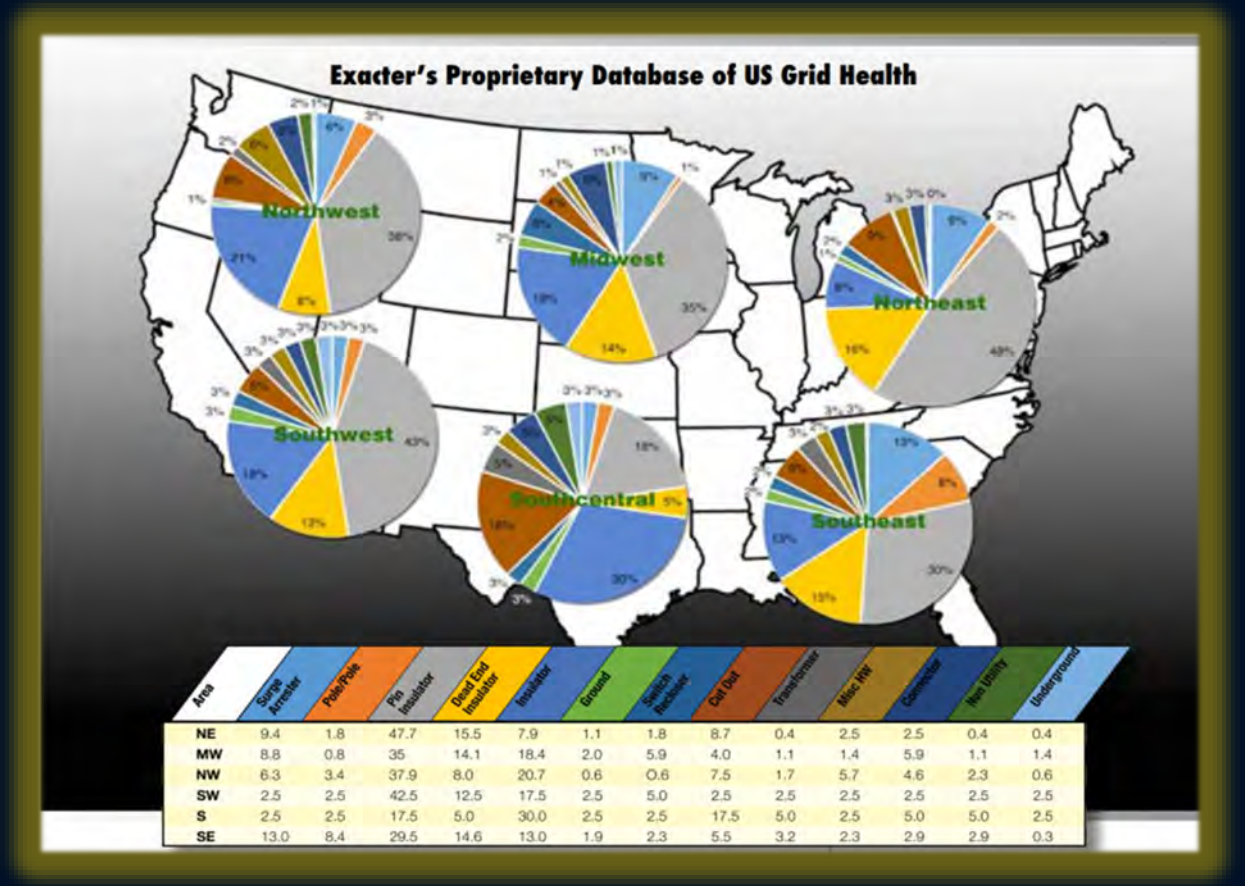
Pole Conditions that Exacerbate the Problem

- Wood Shrinkage and Cracking around Bolt Holes
- Age of the Pole
- Wetness of the Wood
- Moisture of Wood Accelerates Burning at Points of Highest Electric Field

Pole Fire Mitigation

- Detecting Partial Discharge (PD) Emissions That Indicate Insulator and Wood Pole Arcing
- Pole Fire Process Can Take 3 to 4 Months from Onset of Leakage Current to Fire Event
- Bonding the Crossarms Can Reduce Damage
- Bonding Bridges or Wraps Can Reduce Pole Damage
  (Some studies indicate that Bonding Increases Lightning Damage by 60%)
- Fiberglass King Bolts May Reduce Electric Field Concentration
- Insulators with Dry Bands Must Be Power Washed or Replaced to Mitigate the Issue
- Polymer Post Insulators with High Silicone Content Are Effective

Exacter Regional Findings



Area	Surge Arrester	Pole/Pole	Pin Insulator	Dead End Insulator	Insulator	Ground	Switch Recloser	Cut Out	Transformer	Misc HW	Connector	Non Utility	Underground
NE	9.4	1.8	47.7	15.5	7.9	1.1	1.8	8.7	0.4	2.5	2.5	0.4	0.4
MW	8.8	0.8	35	14.1	18.4	2.0	5.9	4.0	1.1	1.4	5.9	1.1	1.4
NW	6.3	3.4	37.9	8.0	20.7	0.6	O.6	7.5	1.7	5.7	4.6	2.3	0.6
SW	2.5	2.5	42.5	12.5	17.5	2.5	5.0	2.5	2.5	2.5	2.5	2.5	2.5
S	2.5	2.5	17.5	5.0	30.0	2.5	2.5	17.5	5.0	2.5	5.0	5.0	2.5
SE	13.0	8.4	29.5	14.6	13.0	1.9	2.3	5.5	3.2	2.3	2.9	2.9	0.3

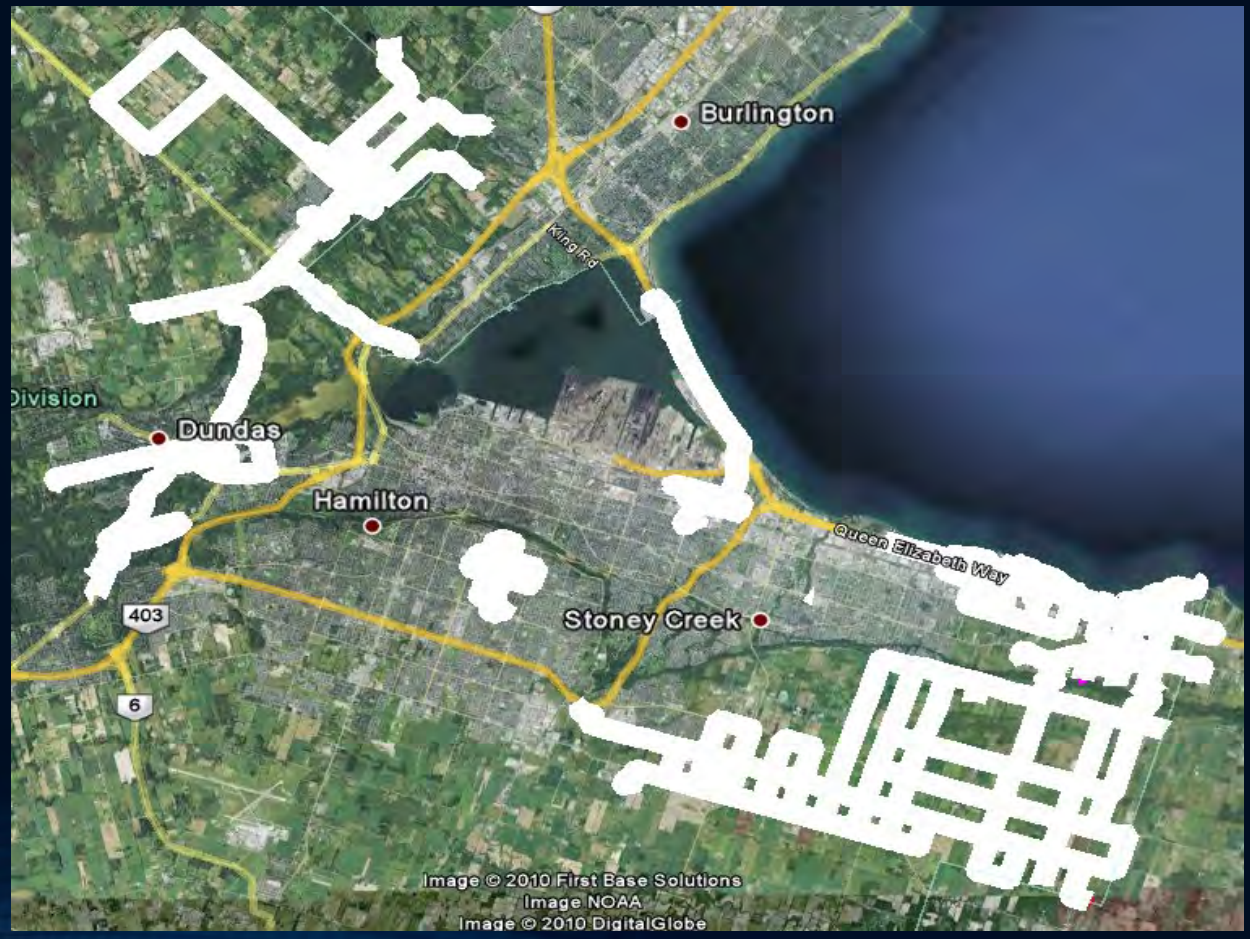
Condition Assessment: Monitor Survey Progress

Survey Quality Control

- **The white lines show that routes have been completely covered**

While the survey is underway, the path of the survey vehicle is monitored to ensure that the circuits being assessed are completely studied.

Accuracy of results is improved by multiple passes of the same route over a four-week period.



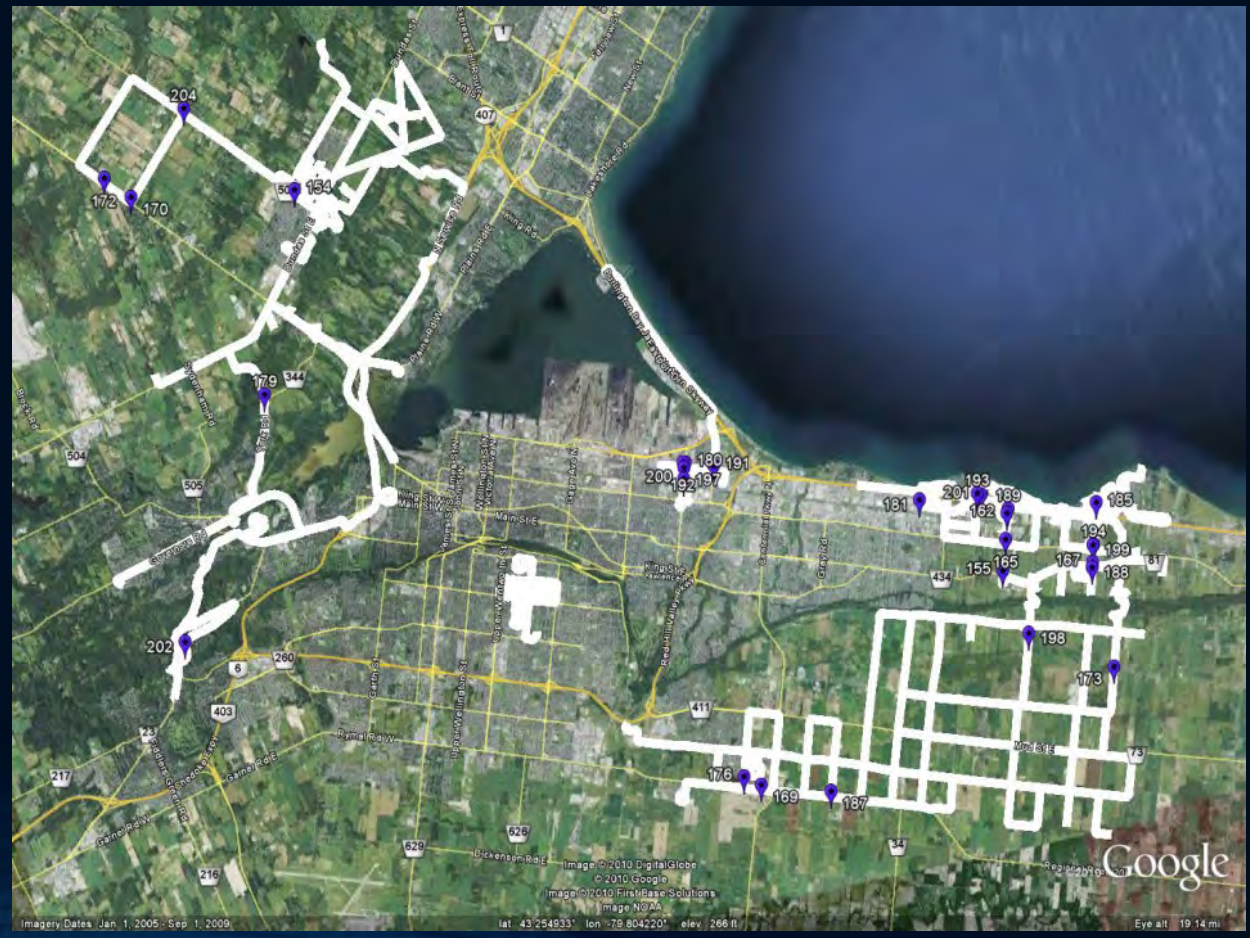
Empirical Measurements During Survey

Condition Assessment: Real-time Failure Signature Analysis

Whenever the EXACTER Sensor locates a line emission that correlates to a Failure Signature a real-time study is completed. The **986 RED** markers show all of the studies from the four-week survey process.

Condition Assessment:
EXACTER Condition Assessment Results

The **986 RED** Failure Signature Events are studied by EXACTER Servers to create this result: **25 Blue** Maintenance Groups where a structure includes at least one deteriorated component.



Insulator Involvement from a Research Perspective

High Voltage Laboratory

Case Studies

Western Municipal Serving 228,000 Customers

Exacter

Case Study: Mitigating Pole Fires

Background:

Pole fires are an expensive and dangerous result of long-term leakage current from deteriorated electrical equipment. Studies have shown that pole age, climate, wet to dry weather transition periods, and as little as 4 mA of current flow can combine to cause a spontaneous combustion event.

In 2020, Exacter was contacted by an electric utility to study and recommend a mitigation strategy in a particularly vexing case.

Problem:

For 10-years, an electric utility experience between 8 to 12 pole fires a year. The fires were contained to an area covering 200 pole miles. The area statistics were:

- 6,000 medium voltage power poles
- 30,000 pieces of electrical equipment
- An average of 10 fires per year
- Typical recovery costs to the utility of $35,000 per fire event

Exacter completed a 5-week analysis of the grid using its mobile survey technology. Exacter technology can detect, discriminate, and locate specific RF emission signatures that are indicative of deteriorated equipment that will lead to incipient circuit failures. Deteriorated equipment can include cracked or damaged insulators, punctured lightning arresters, arcing transformers, loose pole line hardware, damaged line splices, and equipment surface contamination. These conditions can result in flashover or mechanical failure events and power outages. Many conditions are accompanied by higher-than-normal leakage currents that over time can result in spontaneous wood pole ignition. Results of a pole fire can be costly and often devastating. Brush or ground fires can be a direct effect of embers from pole ignition. Costly failures pole failures and outages can result as well as public and personnel safety issues.

Results of Mitigation Strategy:

Exacter technology locate 65 deteriorated components in the study area. The utility replaced these devices. Visual inspection of the equipment led investigators to believe the cause of the RF emission Failure Signatures detected and located a by the Exacter technology were related to air contamination from nearby airfields and heavy, low-level air traffic.

Statistics resulting from the pole fire mitigation were:

- 0.7% of the medium voltage power poles had deteriorated equipment
- 0.2% of all electrical equipment was in a deteriorated state that could contribute to a pole fire
- O (zero) pole fires occurred in the 18-months following the predictive maintenance program
- $0 was expended by the utility to recover from pole fire events following the program

The success of this strategy for pole fire reduction is easily deployed and has immediate average payback of less than 6 months. However, a wildfire avoided is the societal win.

 www.exacterinc.com

A 200-Mile Problem for 10-Years

10 to 12 Pole Fires per Year

Project Highlights

- The Exacter assessed 6,000 MV Poles in a 200-Mile area
- Over 30,000 pieces of electrical equipment were evaluated for deteriorated conditions
- Exacter found:
  - 0.7% of all poles had deteriorated equipment
  - 0.2% of all equipment was in a state that could contribute to a pole fire
  - 0 (ZERO) pole fires occurred in the 30 months following the project
  - $0 was expended by the utility to recover from pole fires following the project

What the Customer is Saying

"Following our predictive maintenance program guided by Exacter findings we saw pole fires in the problem area cease."

Measuring The Condition of Grid Equipment

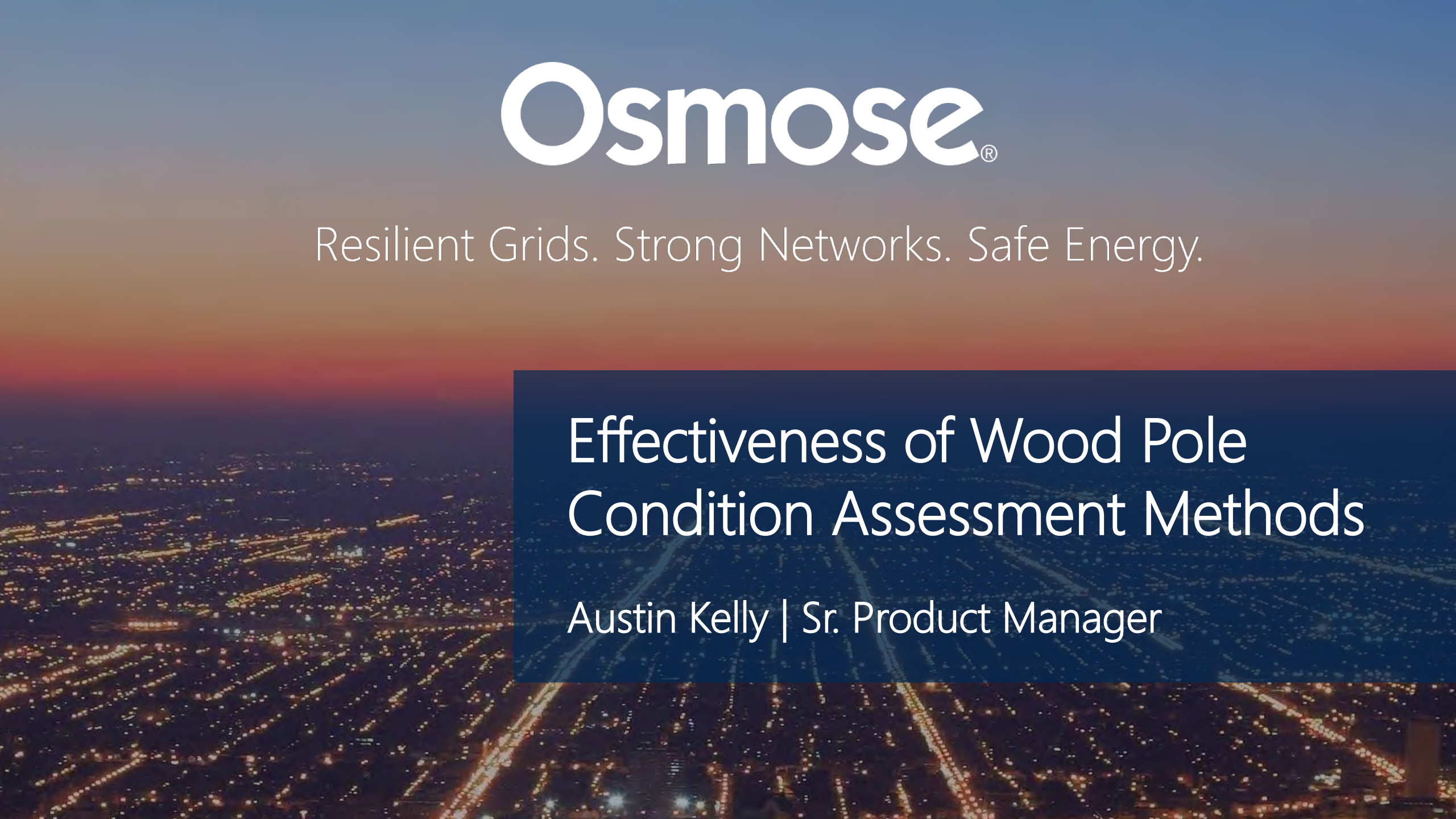
- Creates the Analytics for Planning
- Minimizes the Maintenance Expense
- Pinpoints Deteriorated Equipment
- Enables Predictive Maintenance (PdM) – Mitigates the RISK
- Mitigates the Causes of Pole Fires
- Reduces the Cost and Damage of Pole Destruction
- Reduces Customer Minutes of Interruption (CMI)
- Improves Worker Safety

PdM Plan

Restoration Plan

Grid Analytics for T&D Pole Fire Mitigation

JOHN L. LAULETTA
EXACTER, INC.
JLAULETTA@EXACTERINC.COM



Effectiveness of Wood Pole Condition Assessment Methods

Austin Kelly | Sr. Product Manager

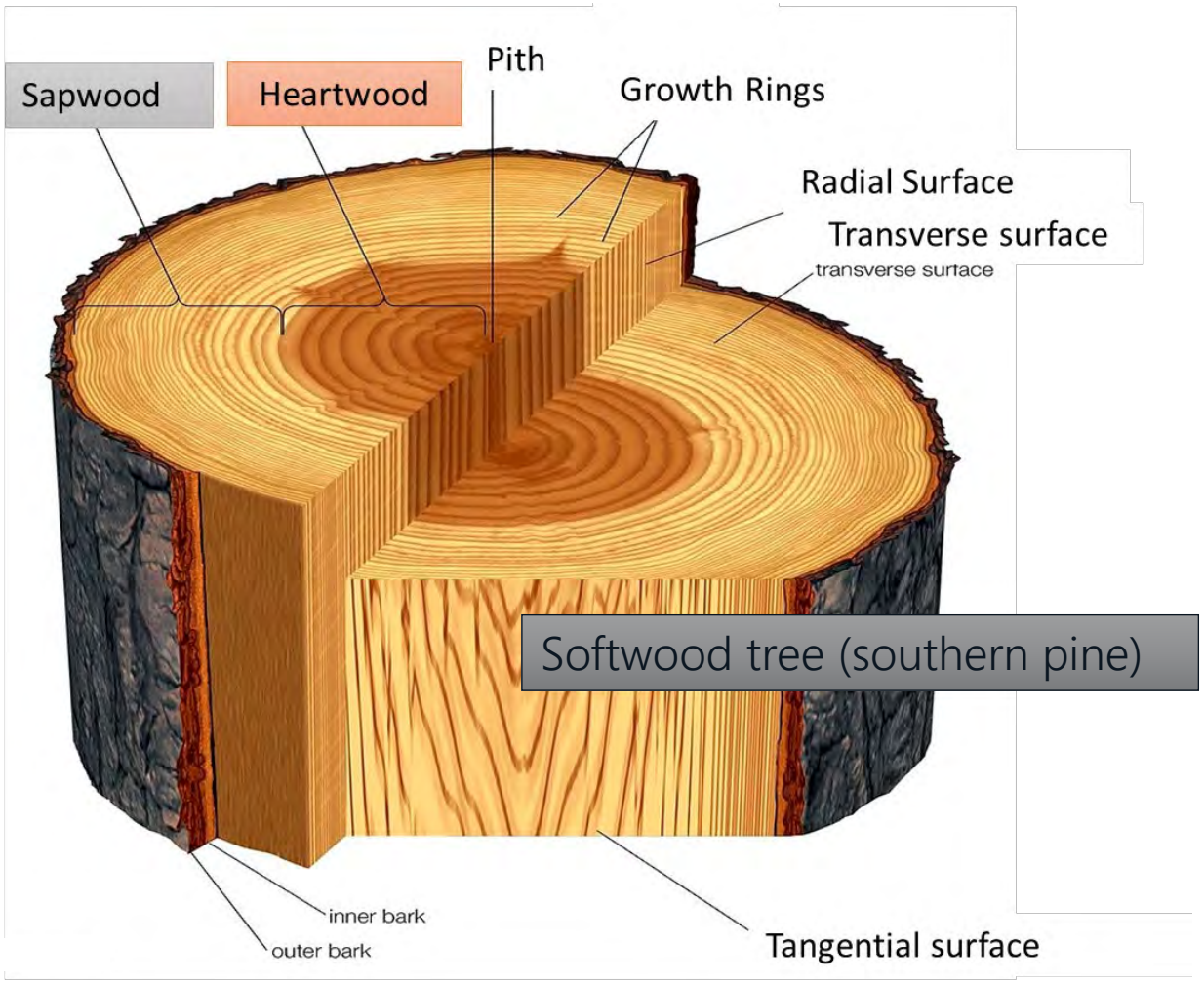
Agenda

1. Wood Anatomy
2. Background
3. Procedure
4. Results
5. Assessment Program Selection

Wood Anatomy

Notable attributes for wood utility pole assessments

Wood Anatomy | Sapwood vs Heartwood



Sapwood (living portion)

- Non-durable
- Susceptible to decay and insect attack
- Easily penetrated with wood preservatives

Heartwood (non-living portion)

- Durable
- Resistant to decay and insect attack
- Not easily penetrated with wood preservatives

Wood Anatomy | Thin vs Thick Sapwood

Thin Sapwood Species

Douglas Fir	Lodgepole Pine	Western Larch
Western Fir	Ponderosa Pine	Western Hemlock
Western Red Cedar		Easer Cedar

Thick Sapwood Species

Southern Yellow Pine

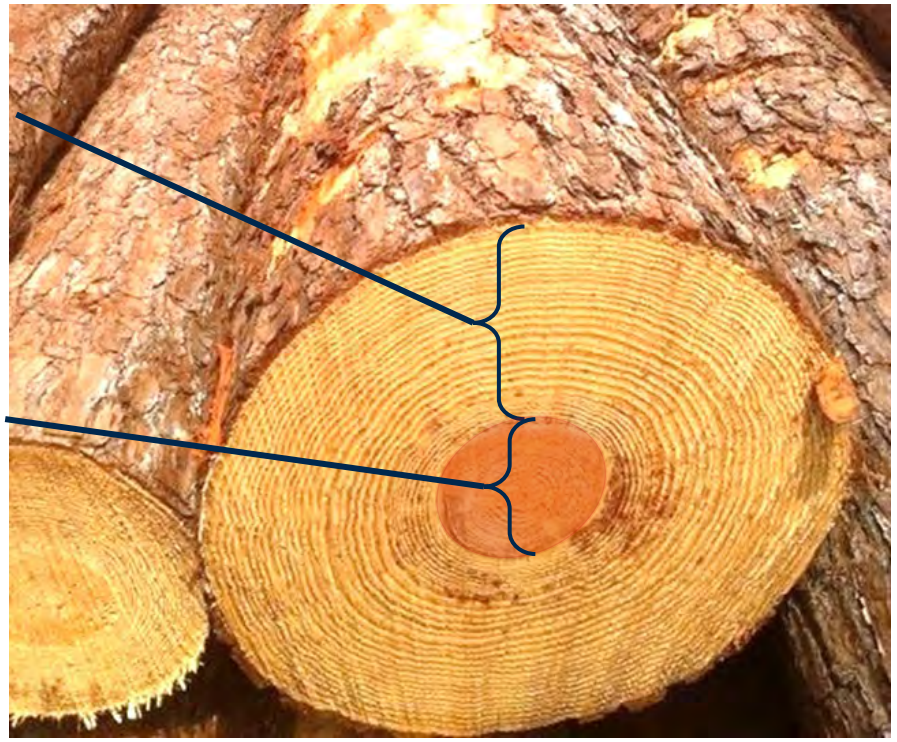
Northern Pine

Red Pine

Douglas-fir

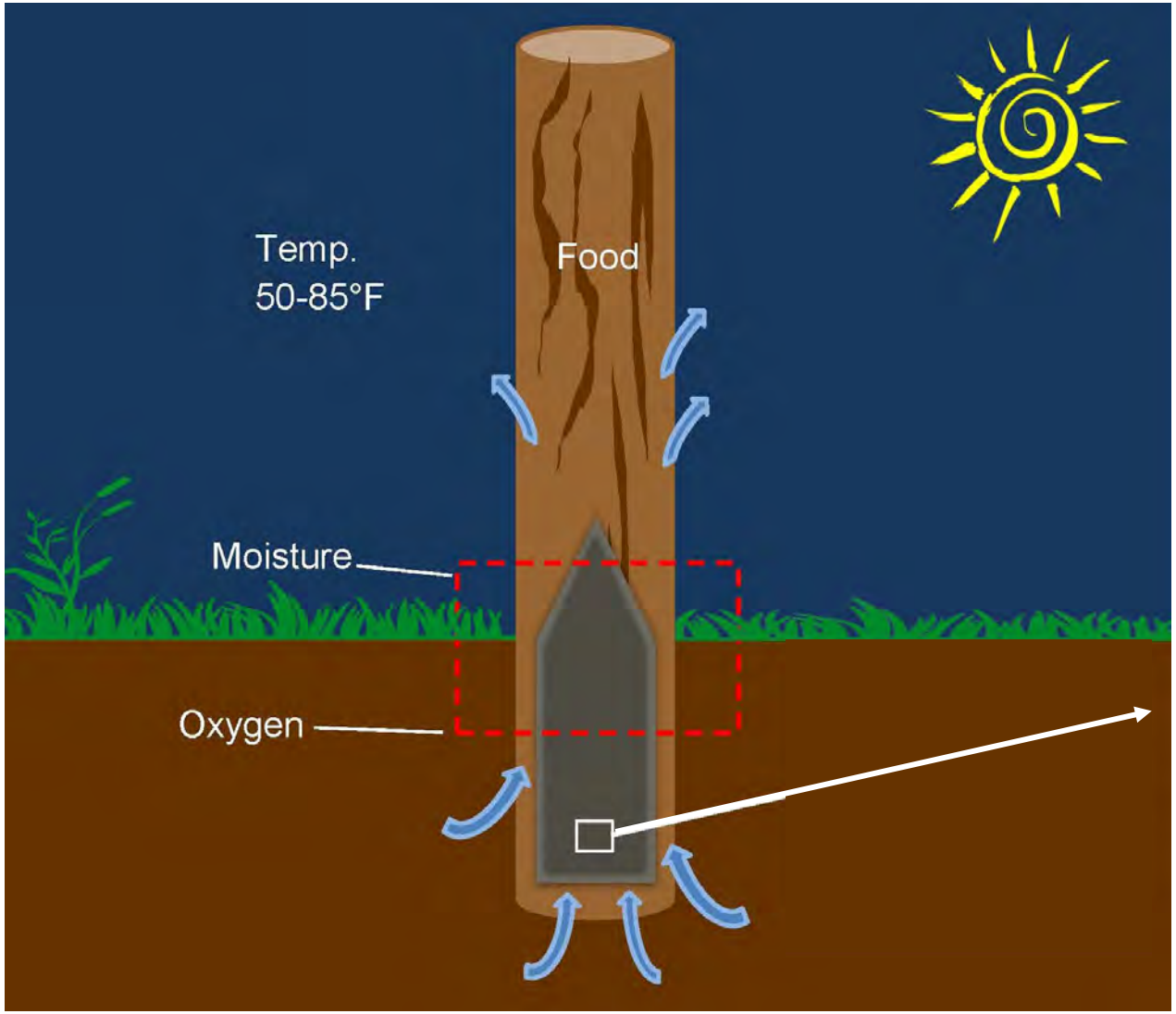
Sapwood

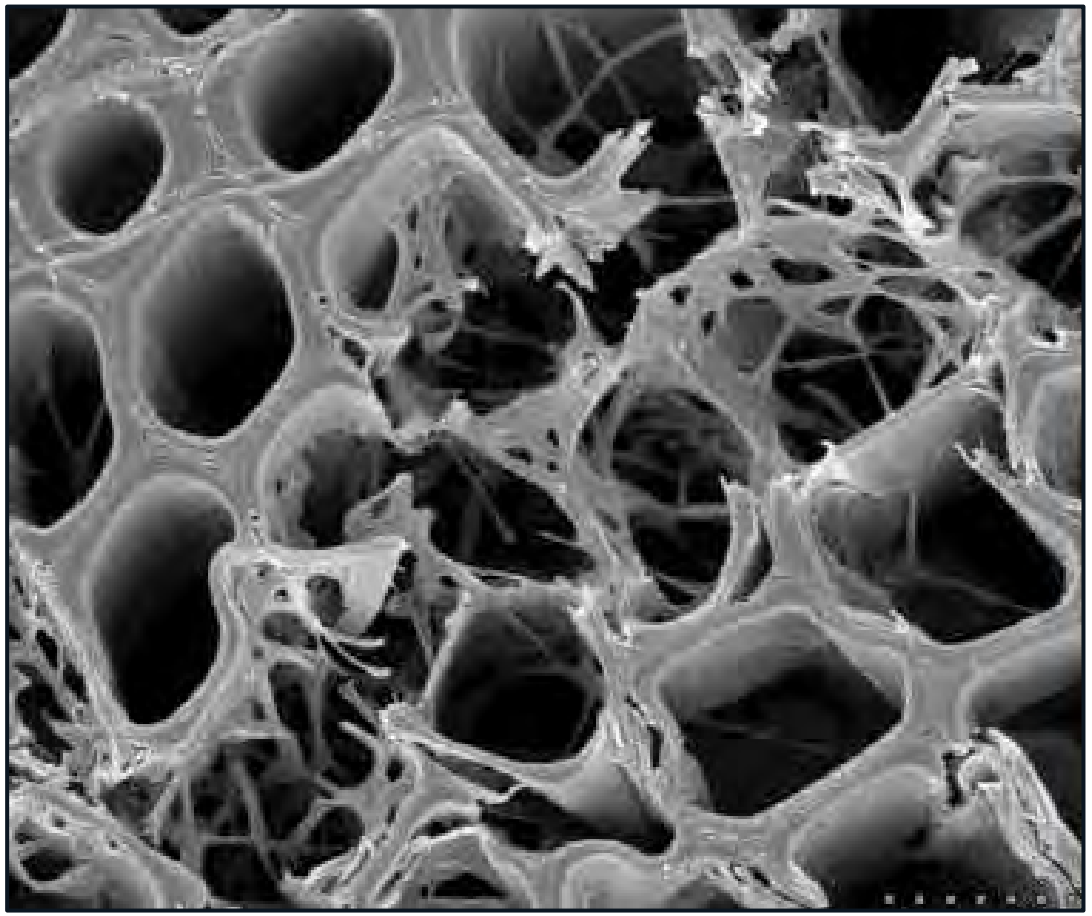
Heartwood



Southern Pine

Wood Anatomy | Decay





Wood Anatomy | Species Characteristics

- Thick Sapwood
  - ~75% of assessed poles assessed annually
  - 3.6m assessed in 2023
  - Typically decays from the outside-in
    - Shell Rot

- Thin Sapwood
  - ~25% of poles assessed annually
  - 1m assessed in 2023
  - Typically decays from the inside-out
    - Enclosed Pockets
    - Hollow Poles

Background

Nelson Research & Osmose Large-scale Wood Pole Assessment Effectiveness Study

Background | Overview

Wood Species in the US:

- Thick & Thin Sapwood

Assessment Methods:

- Visual
- Sound & Bore
- Various Partials - (4”x6”) / (8”x8”) / (8”x18”)
- Full Excavate
- Resistance Drill

Processes:

- Combinations of Methods
- Non-Condition-Based & Condition-Based

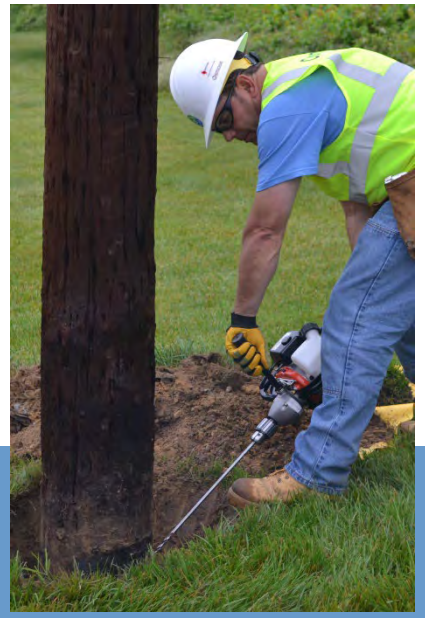
Decay Categorization:

- No Decay
- Decayed but Serviceable (DBS)
- Reject

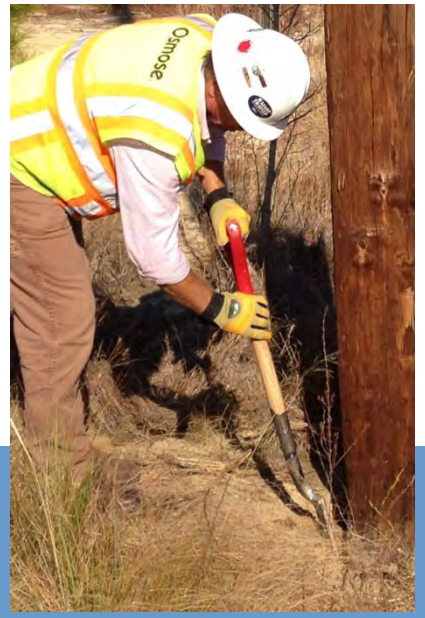
Background | Assessment Methods

Visual

Sound



Bore



Partial Excavate

Full Excavate

Least Effective — **Reject Identification Effectiveness** — **Most Effective**

Each assessment technique, or program type, has a different level of **effectiveness** with respect to **identifying rejects**

Background | Visual

1,000,000+ Assessments by Osmose Annually

Advantages

- Quick and inexpensive
- Effective for new poles with obvious above ground defects

Disadvantages

- Reject liability
- No life extension
- 100% cost, no return as earnings

Background | Sound & Bore

700,000+ Assessments by Osmose Annually

Advantages

- Quick and inexpensive
- Primary choice for poles in concrete

Disadvantages

- Reject liability
- Cannot identify external decay
- Little-to-no life extension

Background | Partials

1,000,000+ Assessments by Osmose Annually

Advantages

- Effective on thin sapwood species (CB)
- Quicker & cheaper than full excavate
- "Targeted" program mix

Disadvantages

- Reject liability
- Little-to-moderate life extension

Background | Full Excavate

2,000,000+ Assessments by Osmose Annually

Advantages

- Reject liability
- Highest possible reject effectiveness
- Full life extension
- Lower total cost of ownership

Disadvantages

- Pace per pole
- Higher upfront cost

Background | Resistance Drill

Engineered tool requiring routine maintenance & calibration

20-50 *Poles before needle replacement*

Advantages

- Good option for poles in concrete

Disadvantages

- Cannot identify external decay
- Frequent & expensive repairs
- Little-to-no life extension (fumigants)

Background | Assessment Criteria

No Decay	Decayed but Serviceable (DBS)	Reject
		
no observable decay identified for a given assessment method	Measurable decay that is determined to have a remaining strength of MORE than 67%	Measurable decay that is determined to have a remaining strength of Less than 67%

Background | Method & Processes

Combination of Methods – add the results from multiple assessment methods i.e., Visual + Sound + Bore + Partial

Process Type:

- **Non-Condition-Based (NCB) Assessment:** make a pole condition determination based only on the partial assessment specified.
- **Condition-Based (CB) Assessment:** upon identifying decay during the partial, a full excavation is performed to identify and measure the decay below groundline

Background | Conditioned vs Non-Conditioned

1-Sided Partial (8in x 8in)

Location 1

Sufficient decay found to identify reject with either process

Location 2

Non-condition based partial process would only identify some decay. Could not identify as a reject without condition-based process

Location 3

No decay identified in excavated location

Partial	Non-Condition-Based	Condition-Based
Location 1	Reject	Reject
Location 2	DBS →	Reject
Location 3	No Decay	No Decay

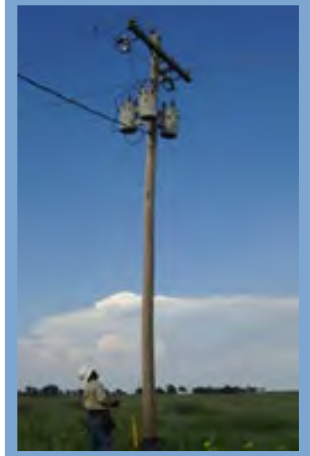
Procedure

Nelson Research & Osmose Large-scale Wood Pole Assessment Effectiveness Study

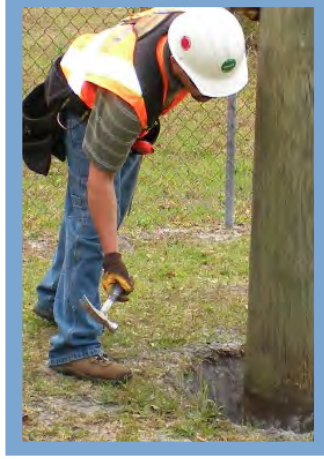
Procedure | Assessment Method

Crew 1 Methods tested individually

Visual

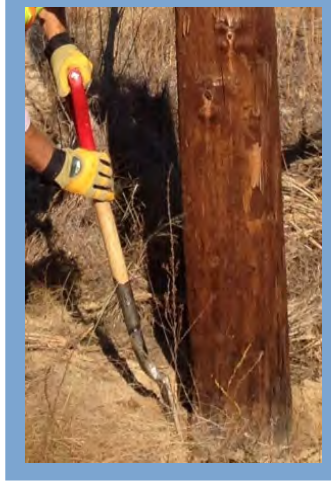


Sound



Bore

Partials



Result following All **Partial** assessments

Result following **Bore** assessment

Result following **Sound** assessment

Result following **Visual** assessment

Crew 2

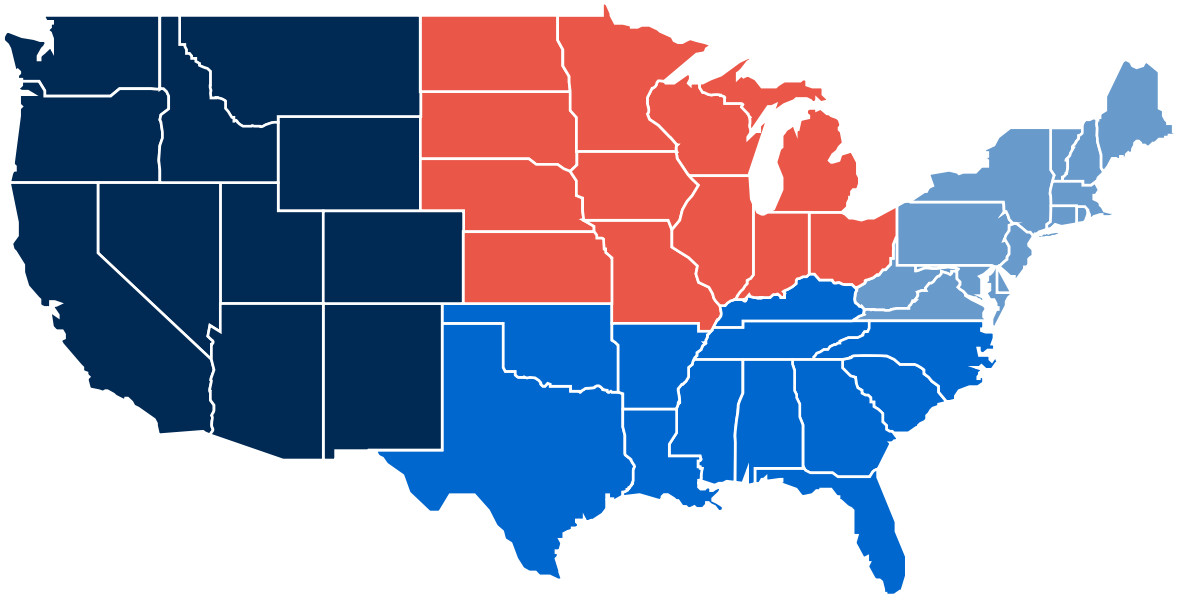
Full Excavate

Full Excavate Assessment

Procedure | Geographical Distribution

18,000+
Poles visited

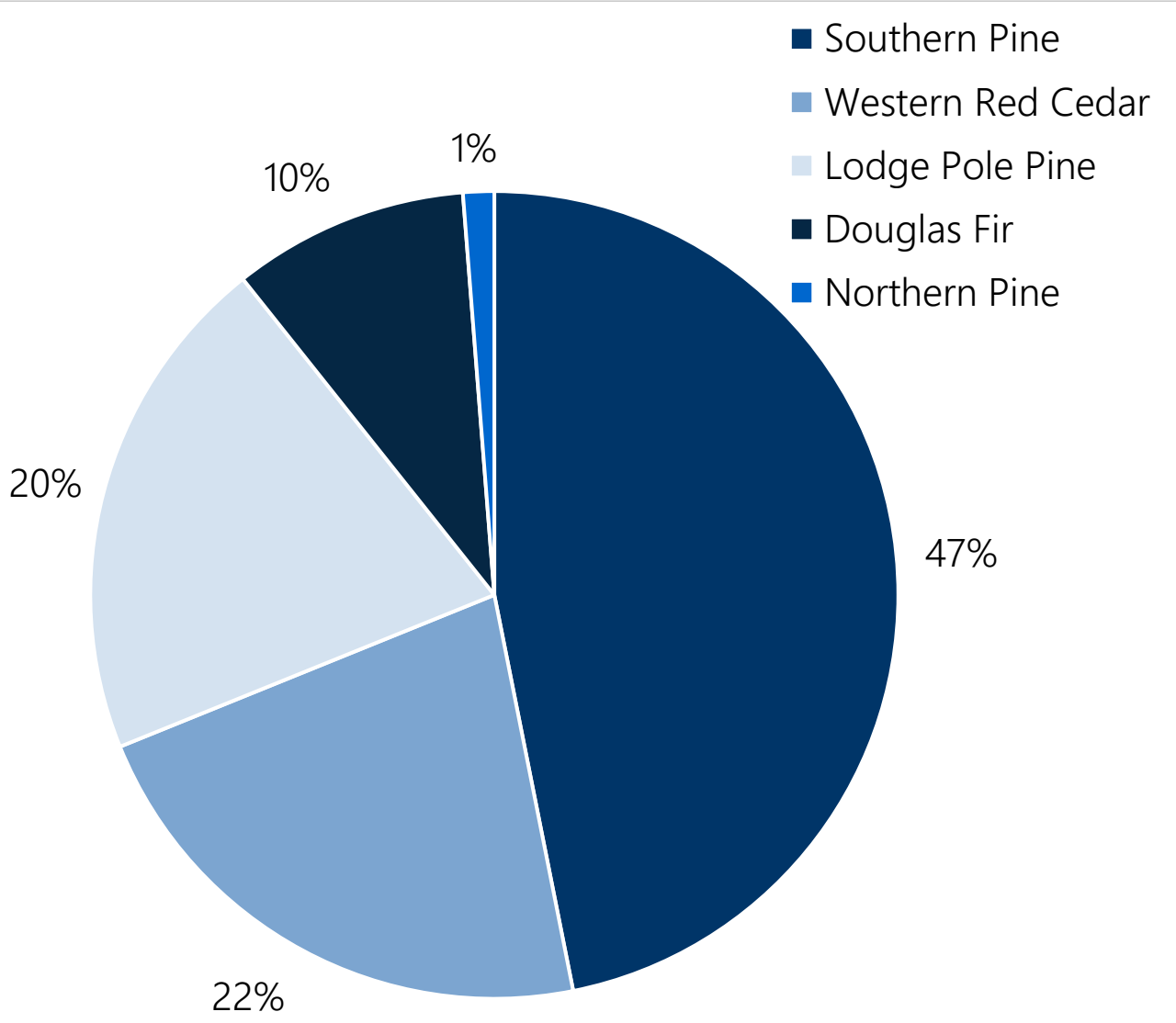
90,000+
Assessments performed



	Poles	*Assessments*
West	6,100	33,100
South	3,500	26,100
Midwest	2,100	12,100
Northeast	1,600	12,000

Procedure | Species Breakdown

- Thick Sapwood
  - Southern Yellow Pine
  - Northern Pine
- Thin Sapwood
  - Western Red Cedar
  - Lodge Pole Pine
  - Douglas Fir



Results

Nelson Research & Osmose Large-scale Wood Pole Assessment Effectiveness Study

Results | Overview

The White Paper [clickable link]:

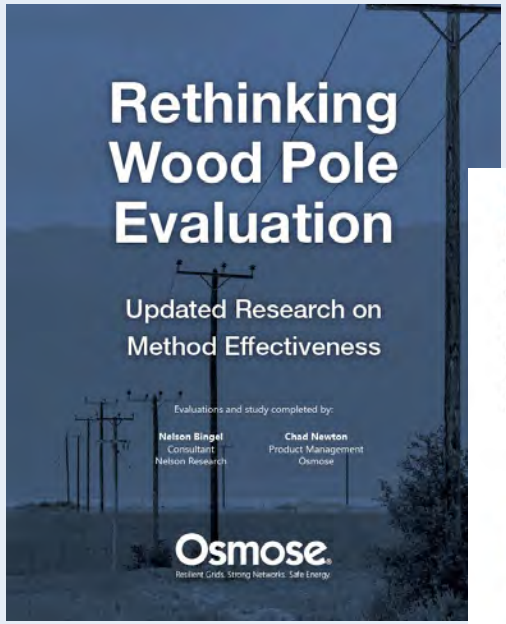
Rethinking Wood Pole Evaluation: Updated Research on Method Effectiveness

90,000+ assessments

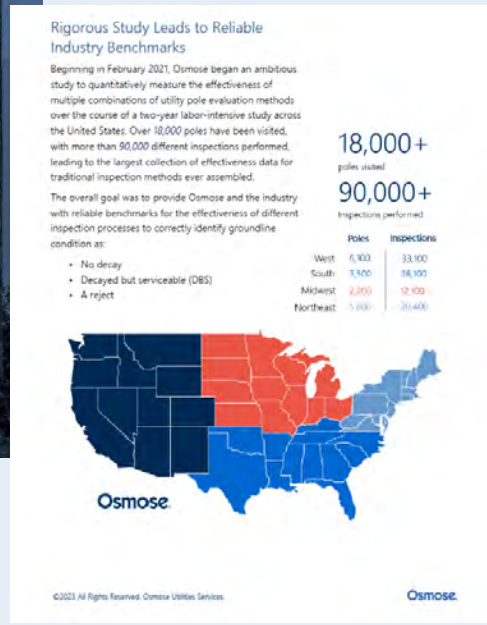
18,000+ poles

1000+ rejects

Inspection Type	Thick Sapwood Reject Effectiveness	Thin Sapwood Reject Effectiveness
Full Excavate	98%	98%
Partial w/ Condition-Based Full Excavate	73%	96%
Partial Stand Alone	30%	72%
Sound & Resistance Drill	25%	35%
Sound & Bore	17%	47%
Visual	6%	8%

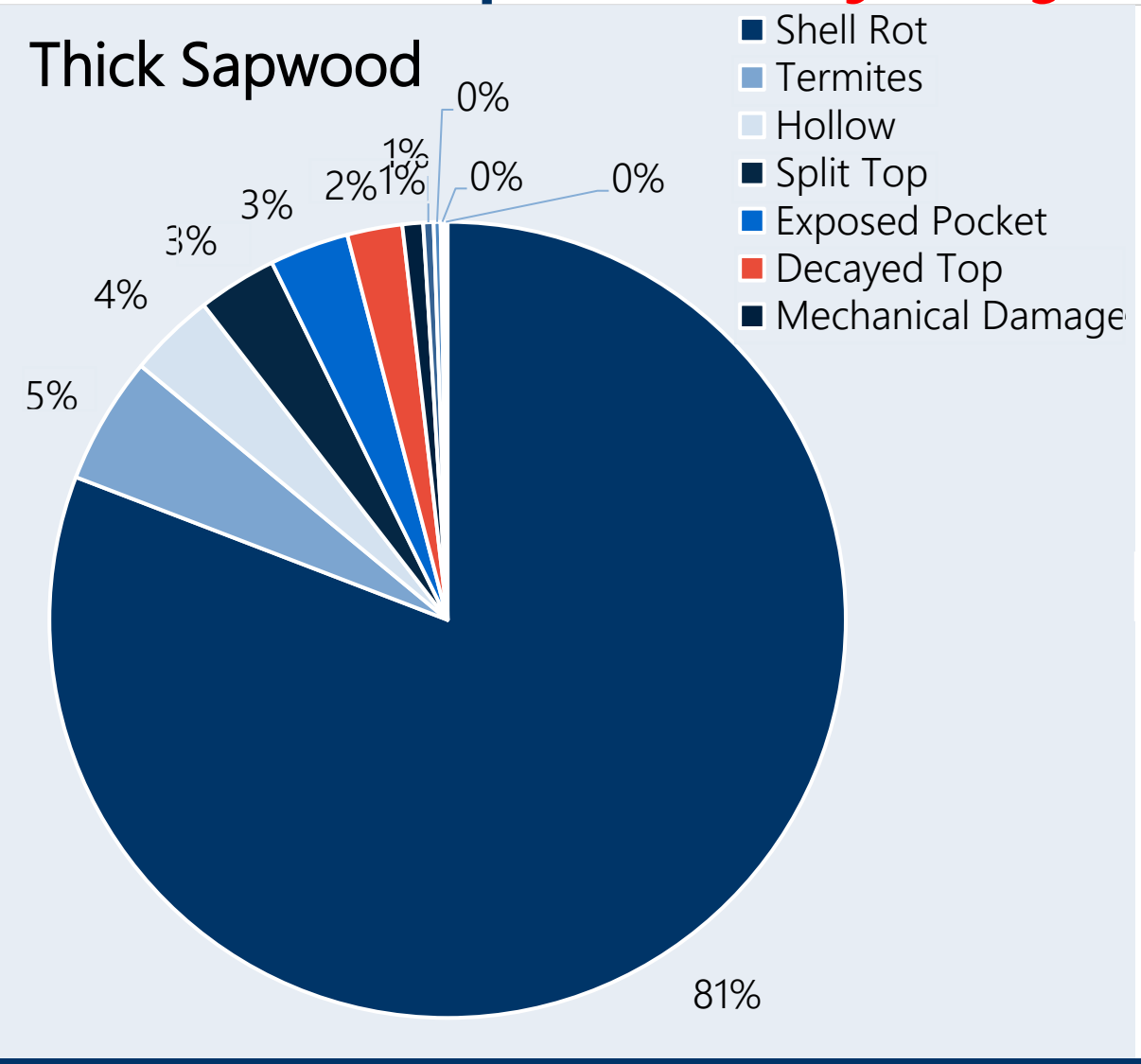


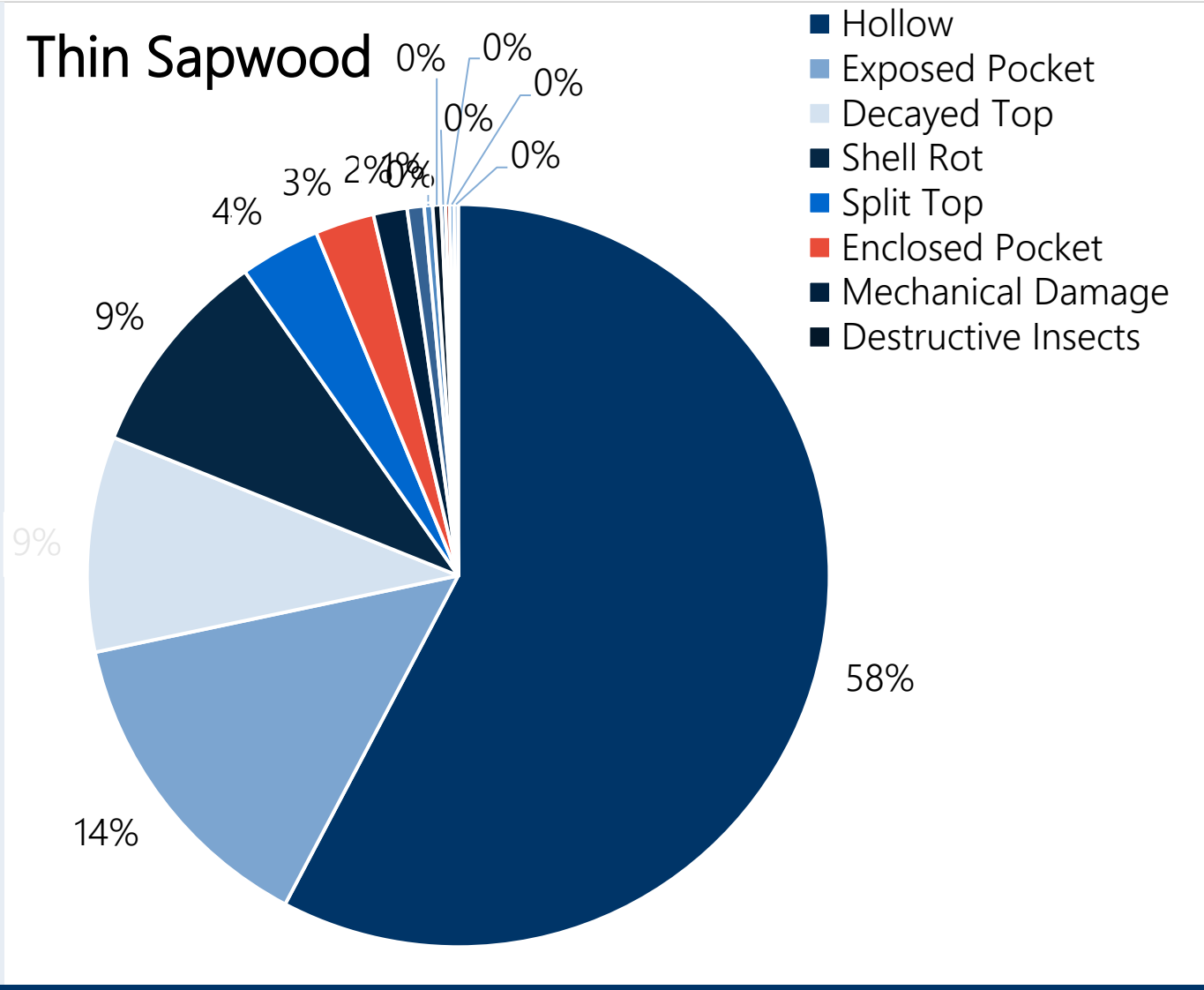
Study Duration ~20 Months



Strong assessment with treatment programs can be capitalized expenses!

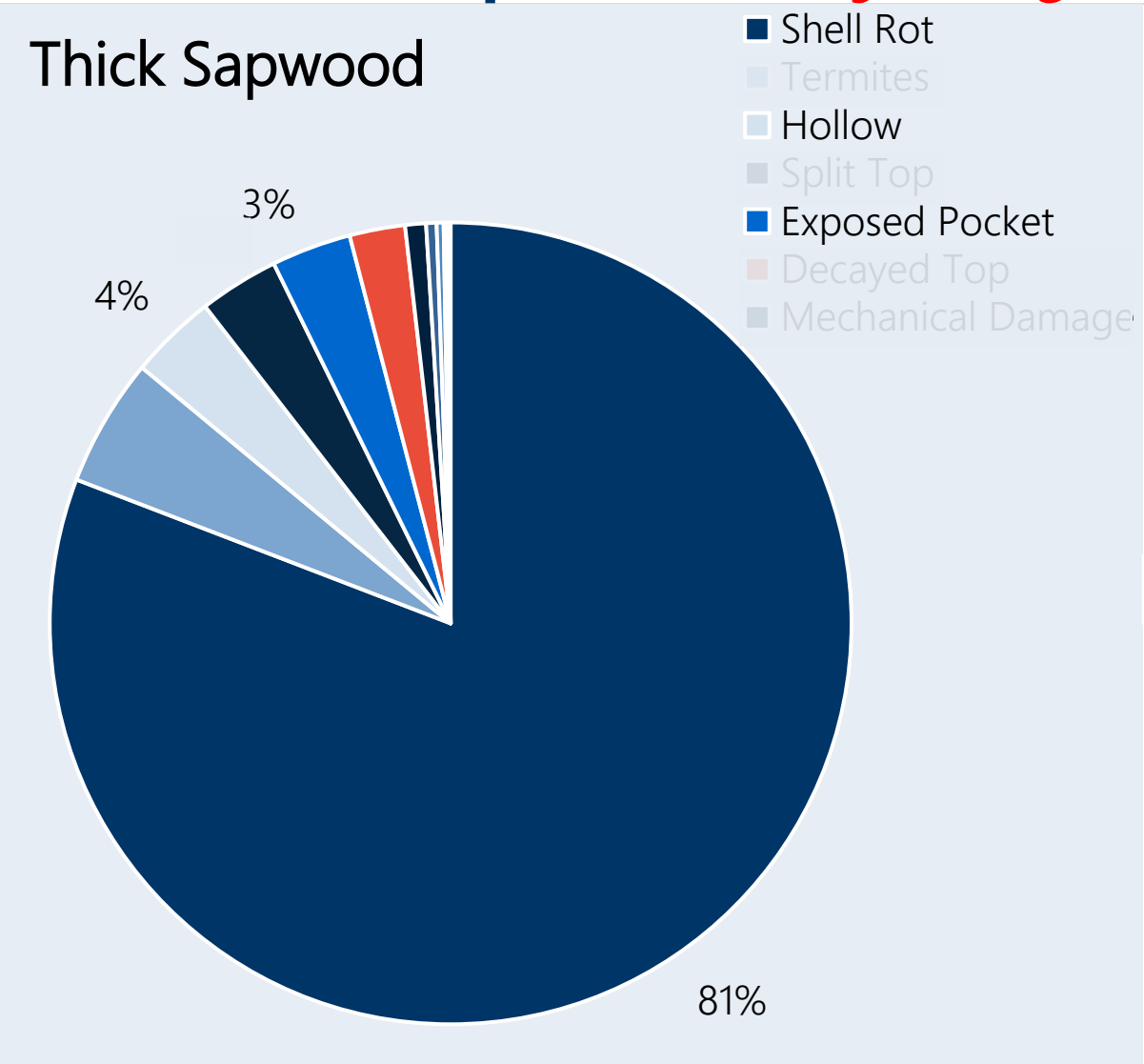
Results | Primary Reject Reason



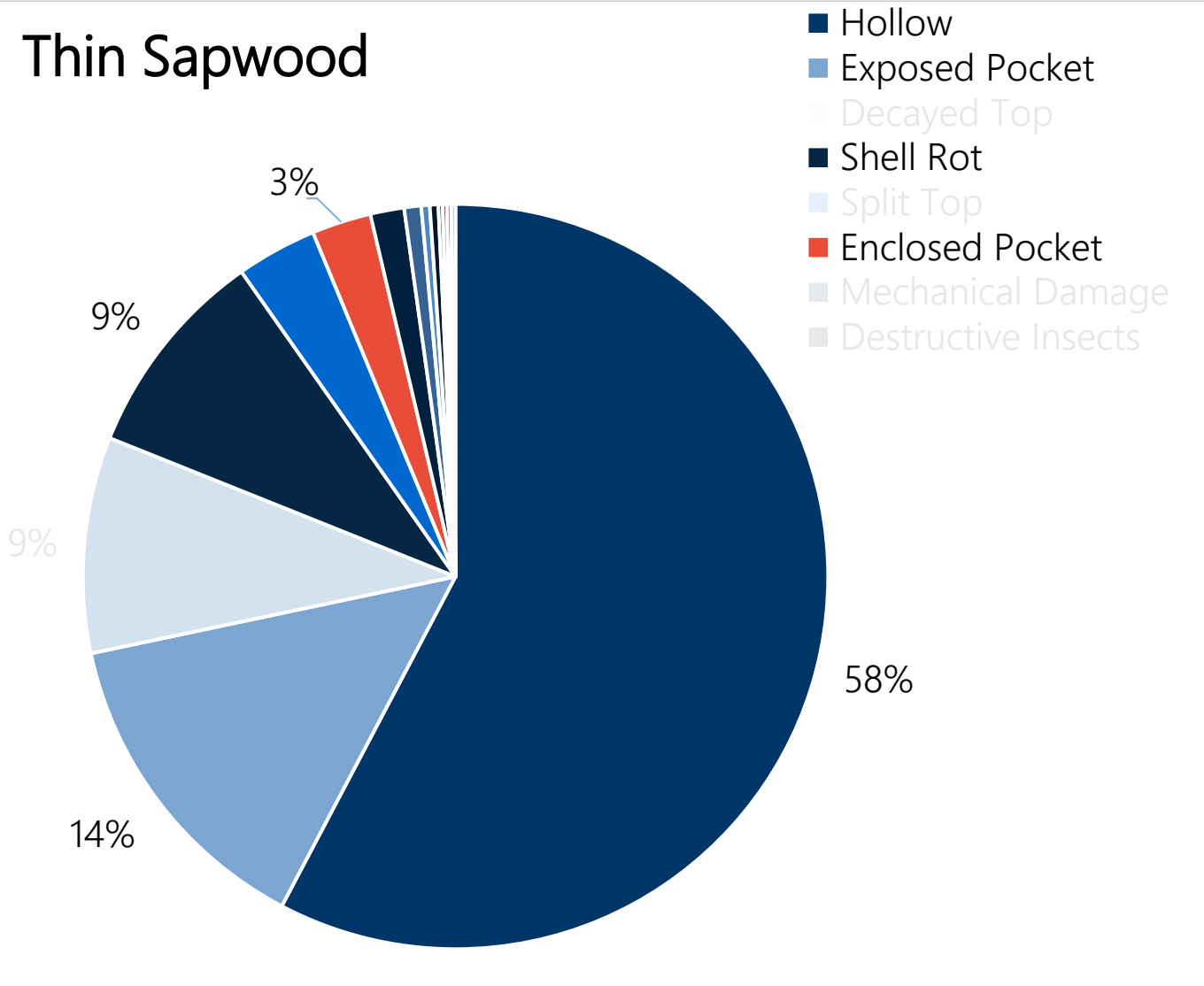


Results | Primary Reject Reason

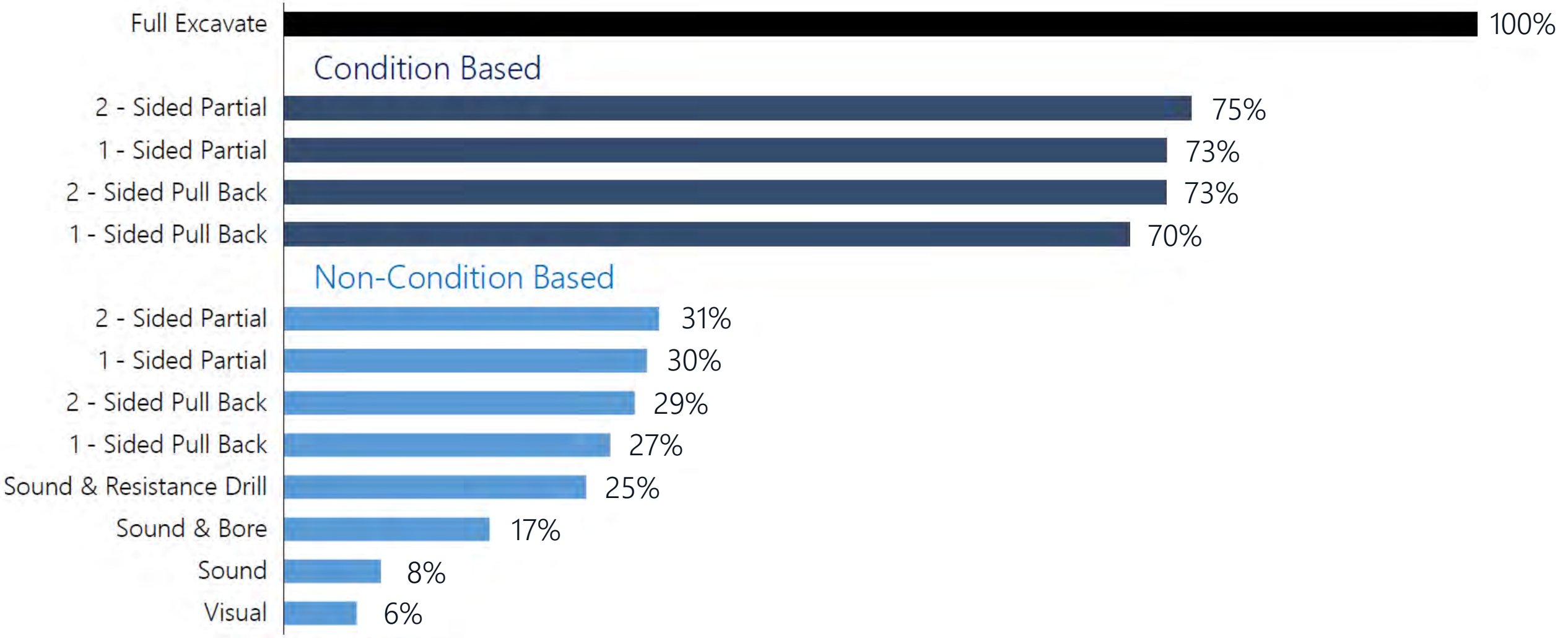
Thick Sapwood



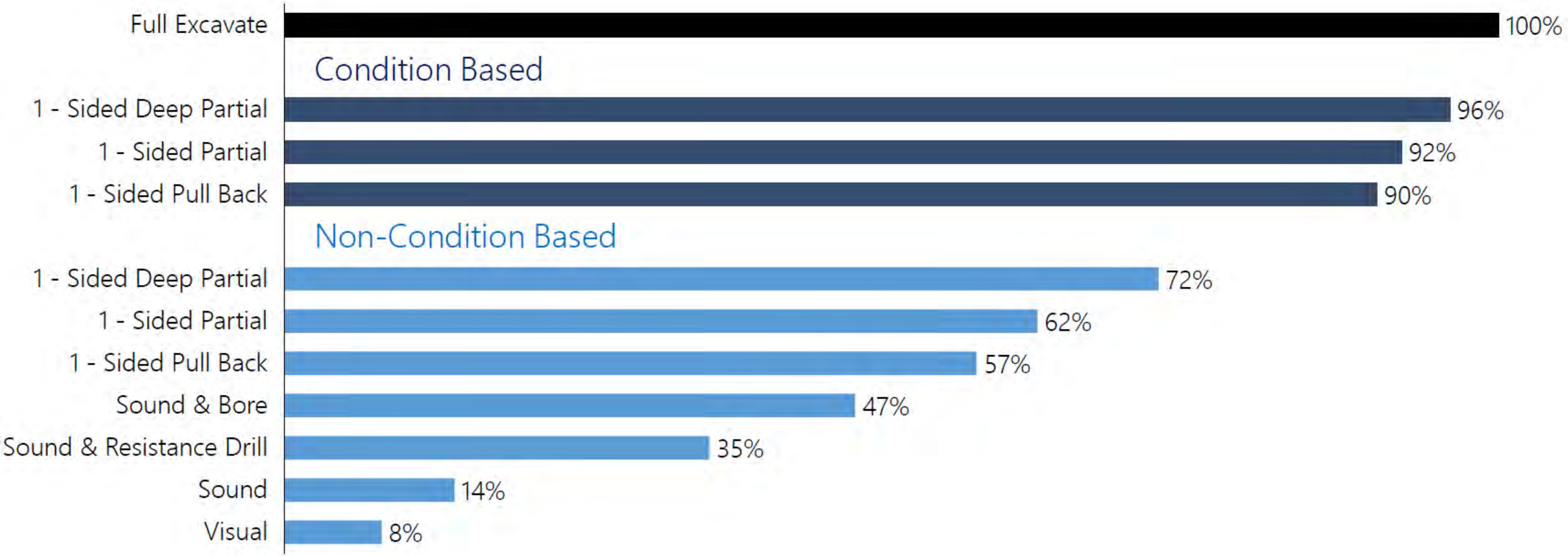
Thin Sapwood



Results | Thick Sapwood



Results | Thin Sapwood



Results | Efficacy of Assessment Methods

90,000+ assessments 18,000+ poles 1000+ rejects

Assessment Type	Thick Sapwood Reject Effectiveness	Thin Sapwood Reject Effectiveness
Full Excavate	98%	98%
Partial (Conditioned-based)	73%	96%
Partial (Non-Conditioned)	30%	72%
Sound & Resistance Drill	25%	35%
Sound & Bore	17%	47%
Visual	6%	8%

Results | Comparison Summary





	Visual	Sound & Bore	NCB Partial Excavate	CB Partial Excavate	Full Excavate
Thick Sapwood	6%	17%	30%*	73%*	98%
Thin Sapwood	8%	47%	72%**	96%**	98%

* 1-Sided Partial ** 1-Sided Deep Partial

Assessment Program Selection

Program Selection | The Significance

- **Risk Reduction**
  - Correctly Identify Decay & Rejects
  - Missing decay leads to continued strength loss
  - Finding decay leads to risk mitigation
- **Life Extension**
  - Reduce total cost of ownership

45 to 50 years

average wood pole service life without assessment and treatment

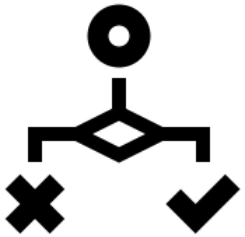
42 years

average age of wood utility pole infrastructure in the U.S.

Program Selection | Types

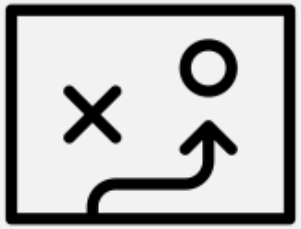
Monitor Programs: Only monitor condition, typically with less accurate assessment methods. No Treatments applied.

- Recommend short cycle 1-3 years



Reactive Life Extension Programs: Proceed only to full excavate if decay is detected. Treat only poles with detected decay.

- Cycle 8-12 years, but only addresses detected decay



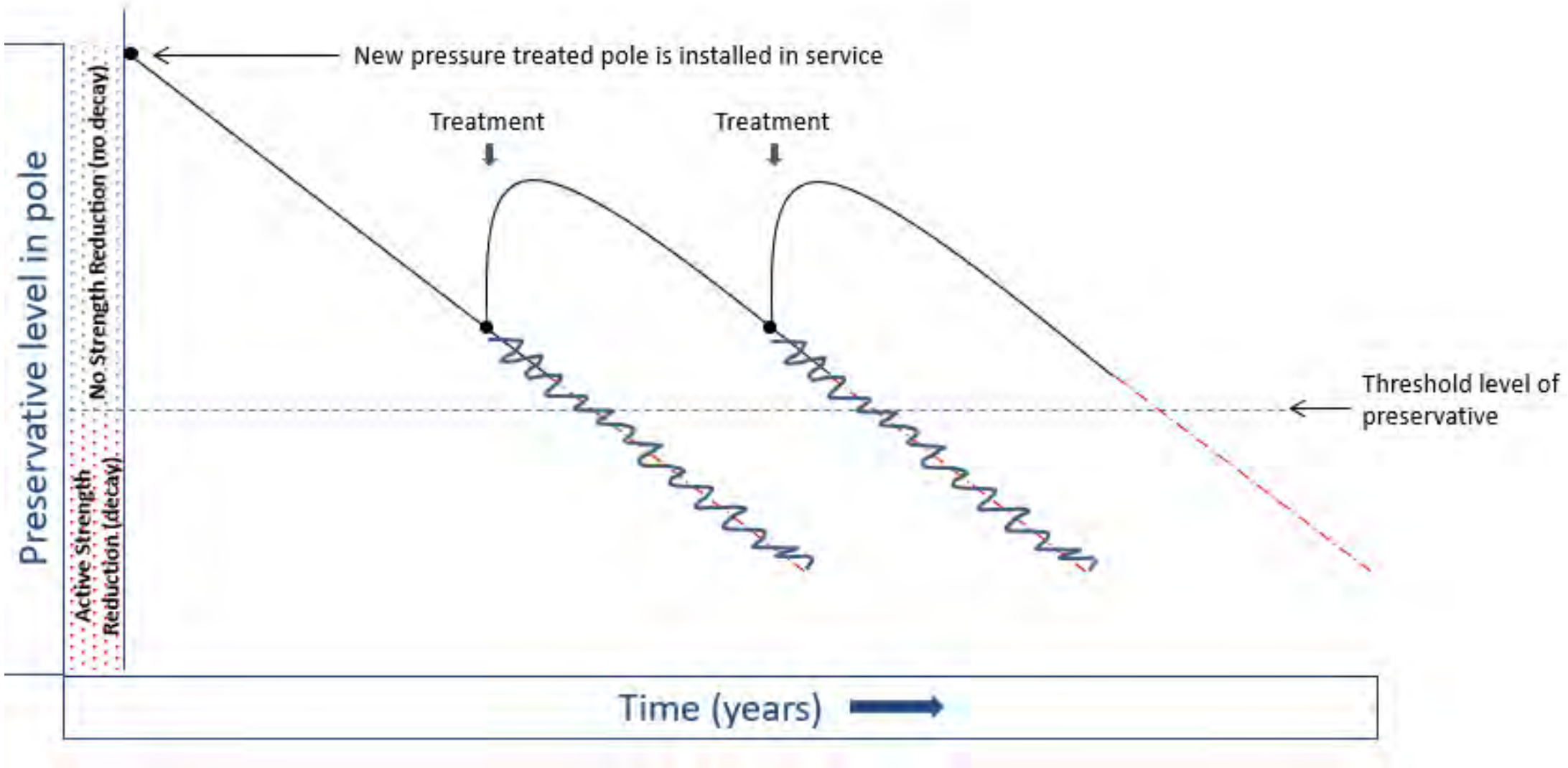
Proactive Life Extension Programs: Execute full excavate on all poles, where possible over 10 yrs old. Treat ALL groundline assessment poles

- Cycle 8-12 years. Greatest impact on wood pole health

Program Selection | Efficacy & Type

Program Type	Assessment Type	Thick Sapwood Reject Effectiveness	Thin Sapwood Reject Effectiveness
PROACTIVE	Full Excavate	98%	98%
REACTIVE	Partial (Conditioned-based)	73%	96%
	Partial (Non-Conditioned)	30%	72%
MONITOR	Sound & Resistance Drill	25%	35%
	Sound & Bore	17%	47%
	Visual	6%	8%

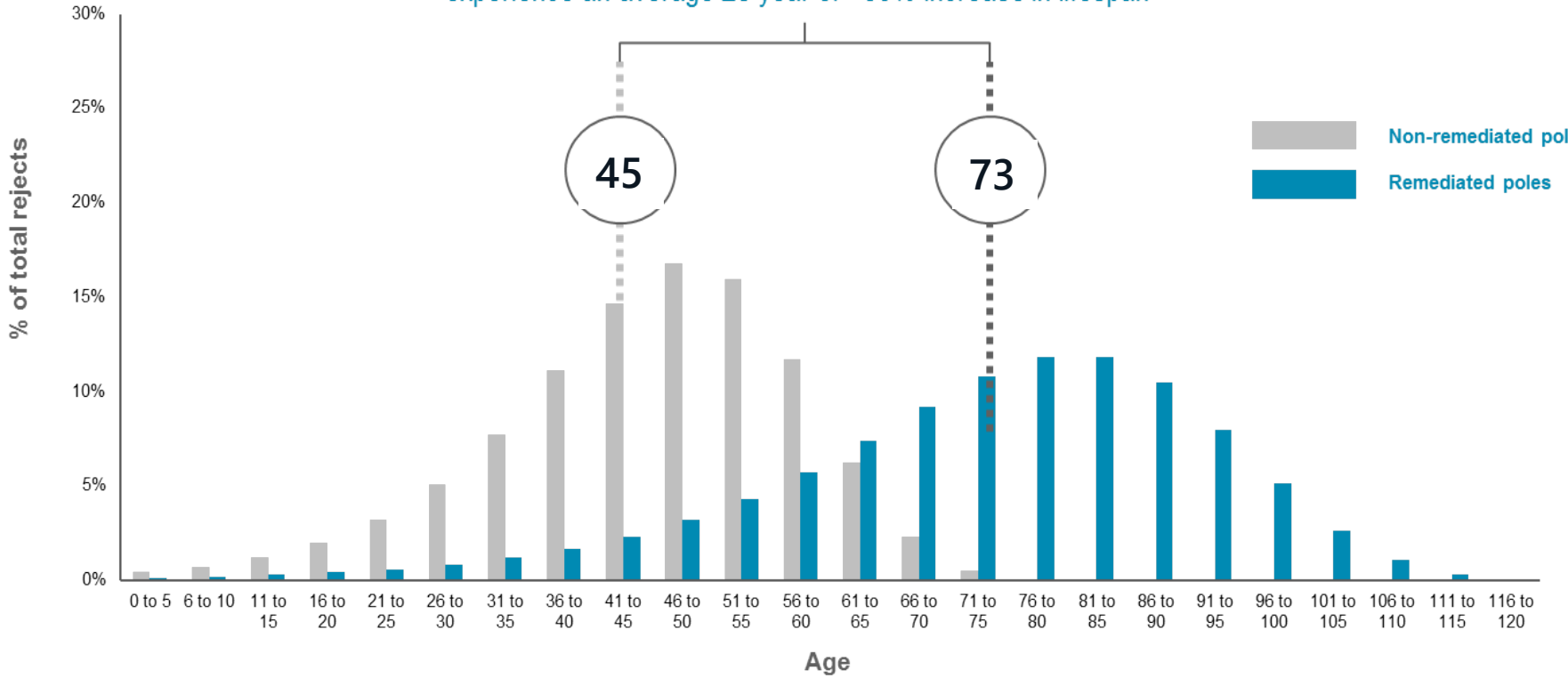
Program Selection | Treatment Impact



Program Selection | Life Extension

Projecting reject rates for poles past age 50 shows an even larger life extension due to pole assessment and remediation

Poles in pole inspection and remediation programs experience an average 28 year or ~60% increase in lifespan

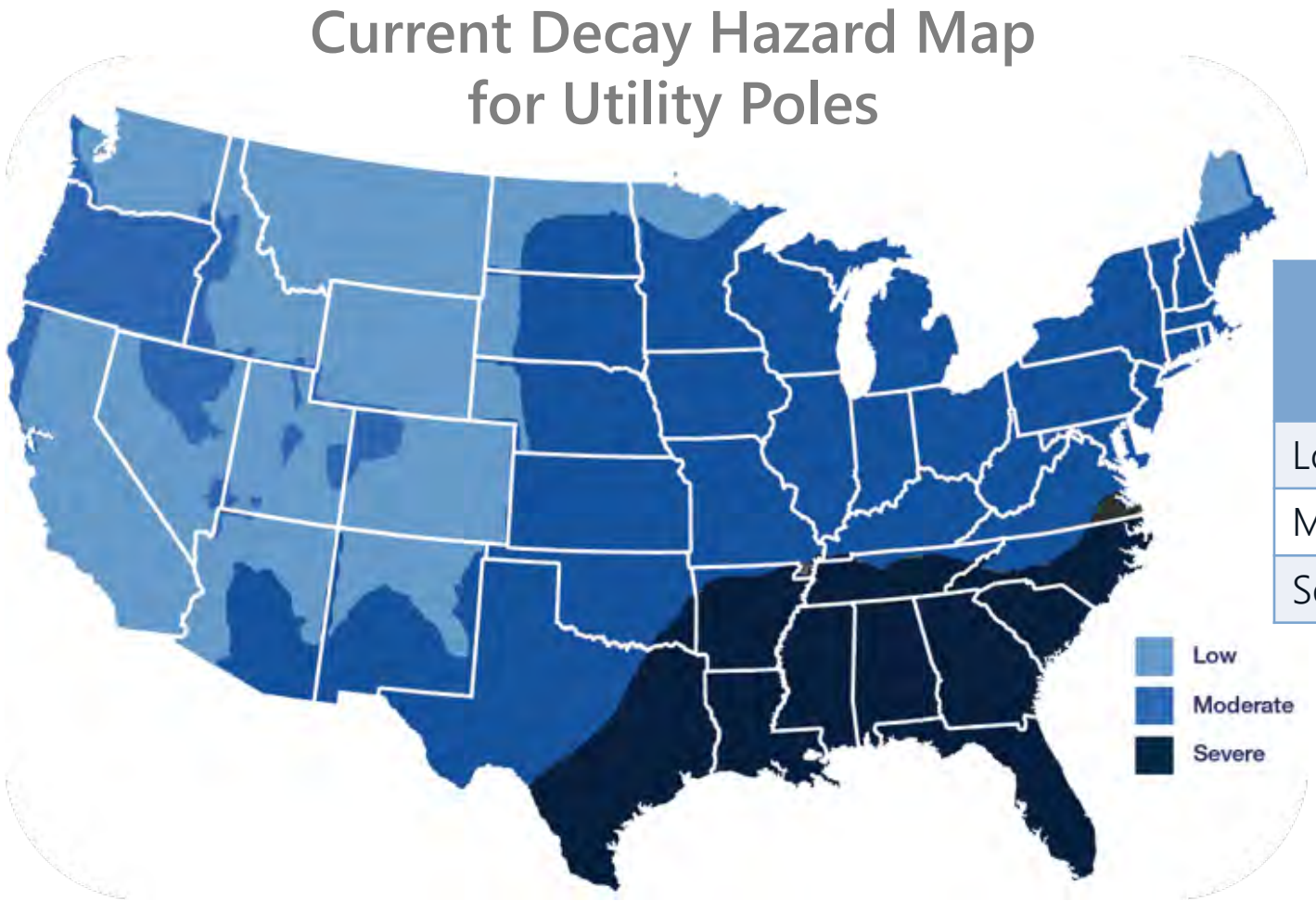


450,000 in-service poles with NO remedial treatment

150,000 in-service poles with previous remedial treatment

Reject rates were modeled using a best fit general linear model based on decay rates for poles ages 0 to 50

Program Selection | Decay Zones & Cycling



Decay Zone	Initial Assessment (years)	Subsequent Reassessment (years)	Annualized % of Total
Low	12-15	12	~8%
Moderate	10-12	10	~10%
Severe	8-10	8	~12%

Program Selection | Species-based Life Extension

Key Program Aspects

- Comprehensive groundline evaluation
- Species Dependent
  - *Full Excavate* - Thick sapwood 10 years old and older
  - *1 sided 18" Deep Partial* - Thin Sapwood 10 years old and Older
- Treatments Included:
  - External Paste
  - Internal Fumigant
  - Liquid Internal Treatment (for voids)

Most comprehensive and greatest impact on *pole plant health*

Species Based Life Extension Program

This specification is intended as a basis for the inspection and application of remedial preservative treatment of in-service wood poles. Poles less than 10 years old will only be visually evaluated and reported if the visual inspection warrants no further action. All other poles are to be evaluated both above and below the ground line area based on pole species as described in the tables below.

Species Type	Pole Age	Inspection Method
All Types	Pole Age < 10	Visual
Thick Sapwood	Pole Age ≥ 10	Full Excavate
Thin Sapwood	Pole Age ≥ 10	1 Sided 18" Deep Partial

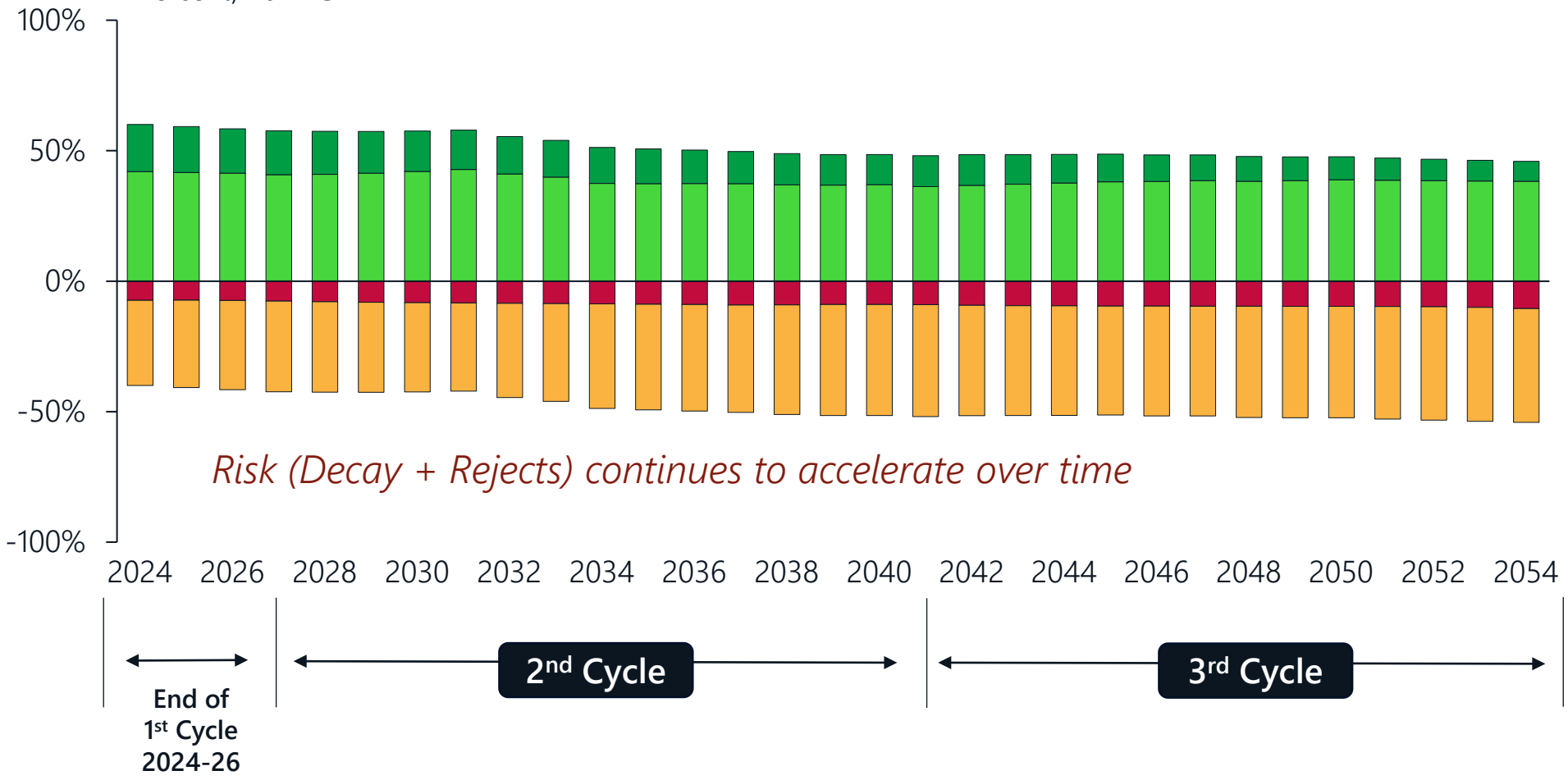
Approved remedial treatments for use include:

Preservative Type	Preservative Product	When Used
External Paste	MP500-EXT® Or Cu-Bor	All full excavated poles
Fumigant	WoodFume	All thin sapwood poles 10 years old and older All poles exhibiting internal decay All poles over 10 that cannot be excavated
Liquid Internal	Hollow Heart® CB	All internal decay pockets Detected

Program Selection | Example Scenario 1

Population Conditions Evolution (Weaker Program)

Percent, 2024-54



Rejects

Actively Decaying

No Decay

Not Actively Decaying

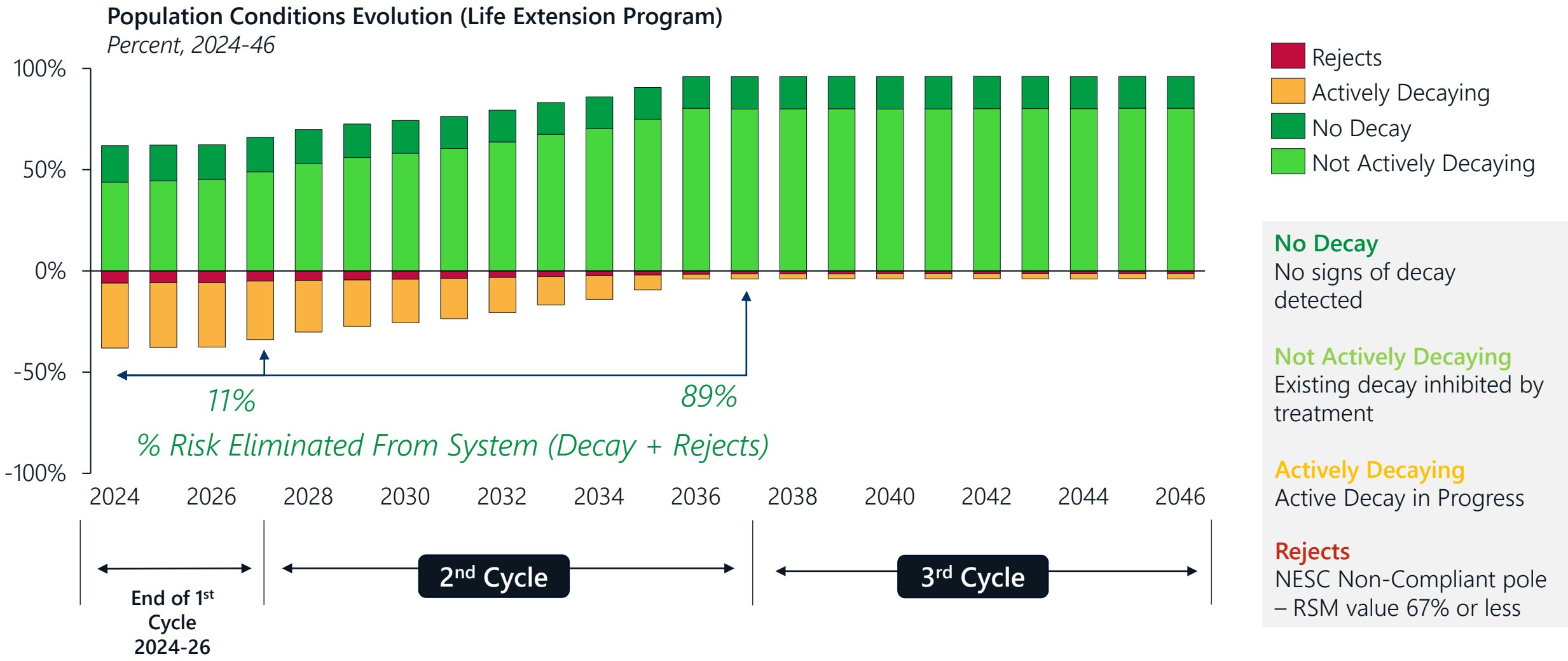
No Decay
No signs of decay detected

Not Actively Decaying
Existing decay inhibited by treatment

Actively Decaying
Active Decay in Progress

Rejects
NESC Non-Compliant pole – RSM value 67% or less

Program Selection | Example Scenario 2



No Decay
No signs of decay detected

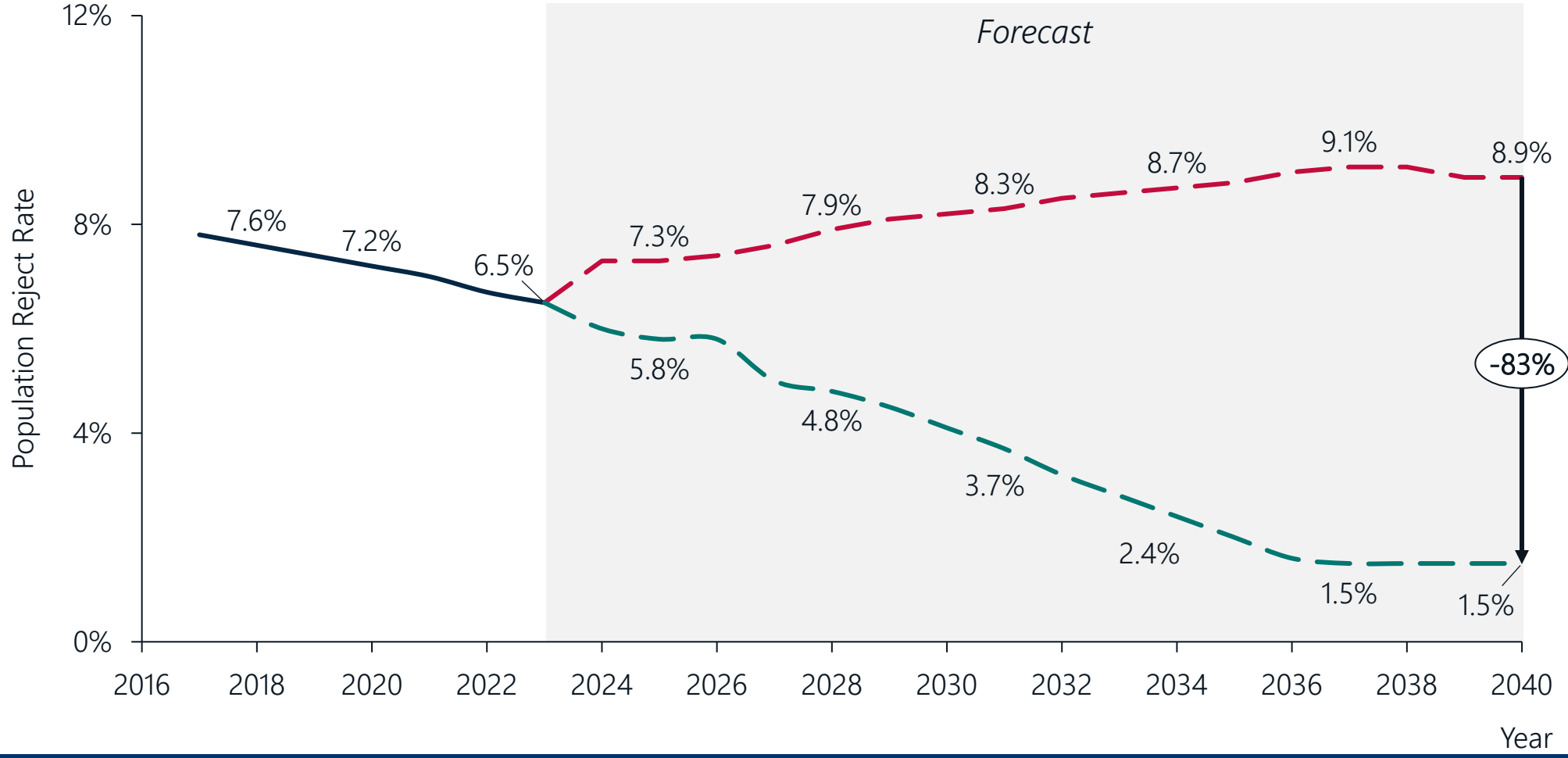
Not Actively Decaying
Existing decay inhibited by treatment

Actively Decaying
Active Decay in Progress

Rejects
NESC Non-Compliant pole – RSM value 67% or less

Program Selection | Scenario 1 vs Scenario 2

Population Reject Rate Evolution
Percent, 2017-40



Scenario #1 (Weaker Program)
Decay and Risk continue to increase

83%
% Difference in Reject Risk

Scenario #2 (Life Extension Program)
Rejects mitigated system-wide

ACCESS THE WHITE PAPER!!

Thank you!

Austin Kelly
Sr. Product Manager
akelly@osmose.com

MATERIALS TESTING

- PRESENTED BY: Andrew Rees

Purpose & Learning Objectives

The purpose of this program is to help engineers in developing a strategy for controlling the risk of poor performance of materials installed on an overhead transmission line.

At the end of this presentation you will be able to:

- *Describe a plan for materials quality assurance and quality control*
- *At a high level, quote some of the relevant test names and test standards*
- *Explain the different types of tests that are carried out and…*
  - *give a feel for the number of tests needed for sample testing regimes*

Types of Testing

- Type Testing
  - Design Testing
  - Prototype Testing
- Sample Testing
  - Factory Acceptance Testing
- Routine Testing
  - Factory Acceptance Testing
  - 100%

Type Testing

- Purpose
  - prove the design performance
  - done in advance of production
- Who does the tests?
  - manufacturers
  - independent laboratories
  - who pays
- Quantities
  - most often only three component tests

Sample Testing

- Purpose
  - confirm production quality
  - done in the factory during production
- Quantities
  - IEEE C135-61 Testing for the Testing of Overhead Transmission and Distribution Line Hardware
  - ASQ Z1.4 Sampling Procedures and Tables for Inspection by Attributes *(ASQ is the **A**merican **S**ociety for **Q**uality)*
  - Component specific standard requirements

Routine Testing

- Purpose
  - confirm production quality
  - done in the factory during production
- Quantities
  - all components are tested
  - (so, the test must be non-destructive)

Sample Test Quantities – IEEE C135-61

- In practice it is recommended to **investigate all failures**, with an option for the project to reject as unsatisfactory. There is usually a root cause that is illustrative of a risk factor or concern to address.

Table 1—Minimum sample size

Lot size	Sample size
1–29	3
30–150	5
151–1200	13
1201–10 000	20
10 001–35 000	32

Sample Test Quantities - ASQ

- Inspection Level
  - options are 1, 2, 3 (the default is 1)

Lot Size (level I)	Sample Size Normal Sampling Plan
< or = 8	2
9 to 15	2
16 to 25	3
26 to 50	5
51 to 90	5
91 to 150	8
151 to 280	13
281 to 500	20
501 to 1200	32

Inspection level I

Lot Size (level II)	Sample Size Normal Sampling Plan
< or = 8	2
9 to 25	3
16 to 25	5
26 to 50	8
51 to 90	13
91 to 150	20
151 to 280	32
281 to 500	50
501 to 1200	80

Inspection level II

Lot Size (level III)	Sample Size Normal Sampling Plan
< or = 8	3
9 to 15	5
16 to 25	8
26 to 50	13
51 to 90	20
91 to 150	32
151 to 280	50
281 to 500	80
501 to 1200	125

Inspection level III

Sample Test Quantities - ASQ

- Sampling Plans
  - normal sampling plan (default)
  - tightened sampling plan (same quantities as normal, different criteria)
  - reduced sampling plan (most desired by manufacturers)

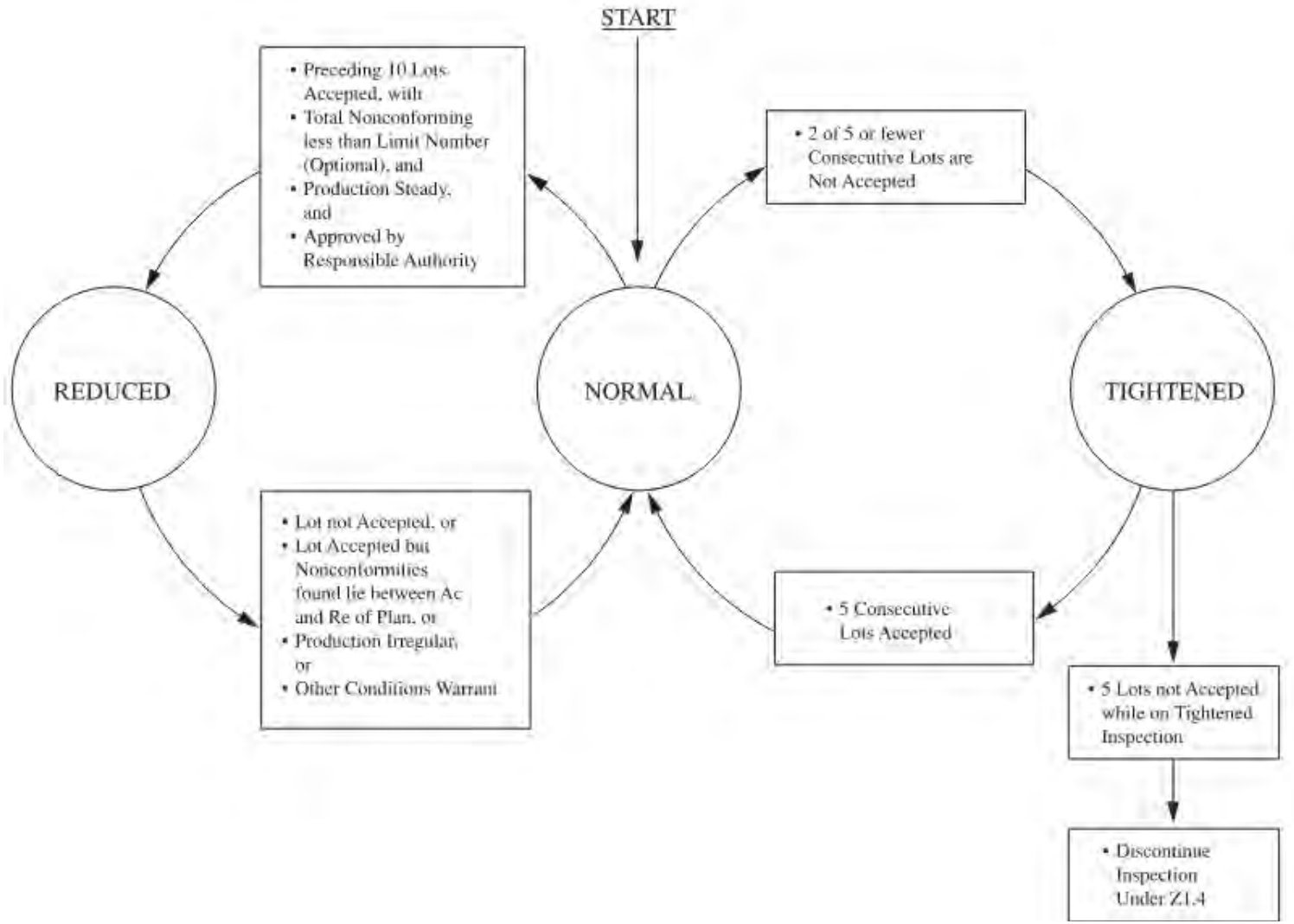
Lot Size (level I)	Sample Size Reduced Sampling Plan
< or = 15	2
16 to 25	2
26 to 90	2
91 to 150	3
151 to 280	5
281 to 500	8
501 to 1200	13

Reduced Sampling Plan

Lot Size (level I)	Sample Size Normal Sampling Plan
< or = 8	2
9 to 15	2
16 to 25	3
26 to 50	5
51 to 90	5
91 to 150	8
151 to 280	13
281 to 500	20
501 to 1200	32

Normal Sampling Plan

Sample Test Quantities - ASQ



Sample Test Quantities - ASQ

- **Reduced Sampling Plan** is the least onerous, and reserved for proven good performance and trusted long term manufacturers.
- **Normal Sampling Plan** is the starting point and the default for most relationships between utilities and manufacturers supplying to them.
- **Tightened Sampling Plan** is the most exacting, and intended where there have been test failures and increased vigilance is needed. *(But only effects allowed number of failures and re-test criteria.)*

Sample Test Quantities - ASQ

- Acceptance Quality Limit (AQL)
  - re-test options

Table 2—Acceptance/rejection criteria

Test sample	Sample size	Cumulative sample size	Accept	Reject
Single	3	—	0	1
Single	5	—	0	1
First Second	13 13	13 26	0 1	2 2
First Second	20 20	20 40	0 3	3 4
First Second	32 32	32 64	1 4	4 5

In practice it is recommended to **investigate all failures**, with an option for the project to reject as unsatisfactory. There is usually a root cause that is illustrative of a risk factor or concern to address.

Documentation

Cut sheets

- *dimensions*
- *materials*
- *strength*
- *finish (incl galv)*
- *reference standard*

ITPs*

- *test name*
- *reference standard*
- *quantity (freq)*
- *pass/fail criteria*

Test Reports

- *date*
- *lot ID*
- *laboratory (incl location)*
- *surpervisior's name*
- *test title*
- *quantity*
- *reference standard*
- *result (pass/fail)*
- *list of witnesses*
- *calibration certs*
- *special notes*

* Inspection and Testing Plan

Test Report Example

Title Page

Bazet, May 02nd, 2019

TEST REPORT
N° 1950-19

RIV / CORONA TESTS ON SPACER DAMPER FOR 500 kV OHTL

signature
Test Supervisor

signature
Laboratory Manager

Test ref.: 4391

Customer: Salvi S.p.A. (Milan, Italy).

The tests were performed in Centre d'Essais de Bazet (Zone Industrielle, 65460 Bazet, France) on April 29th and 30th 2019 and were witnessed by Mr Joe Haliman and Mr James D. Higgins (Pacificorp, USA), Mr Erich Gnandt (Quanta Service QA Inspector, Canada), Mr Aniello Iovino and Mr Giovanni Sangalli (Salvi, Italy) and Mr René Tabouret (Sediver / Salvi Advisor, France).

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Independent Lab

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Signatures of responsible persons

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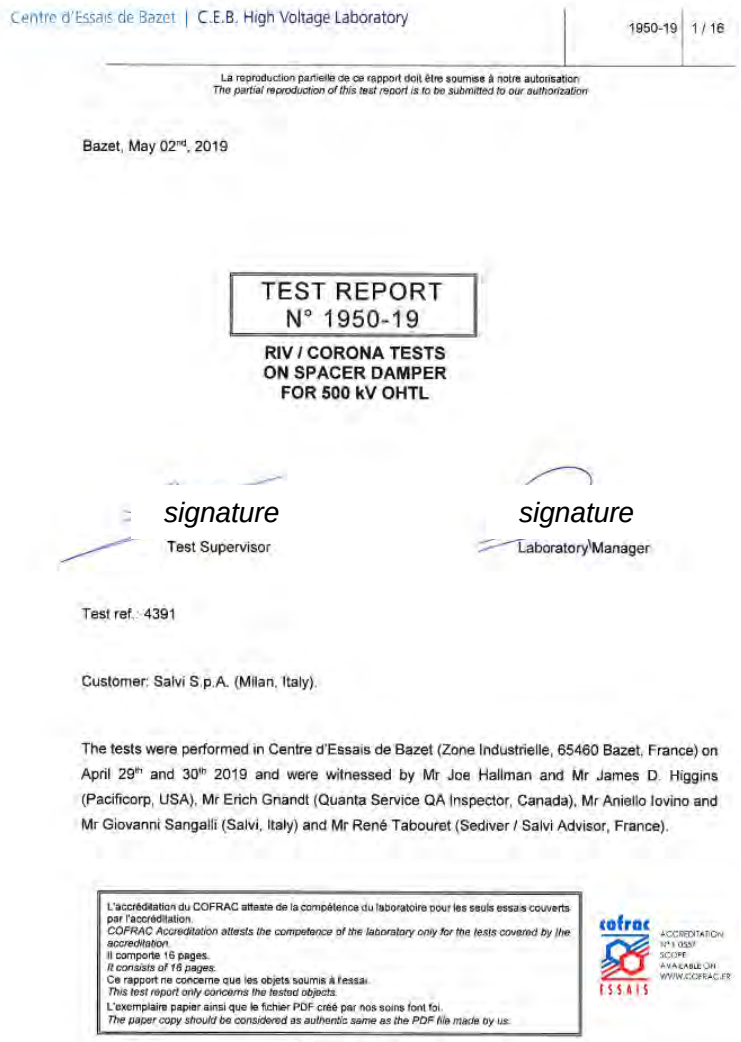
Laboratory Accreditation



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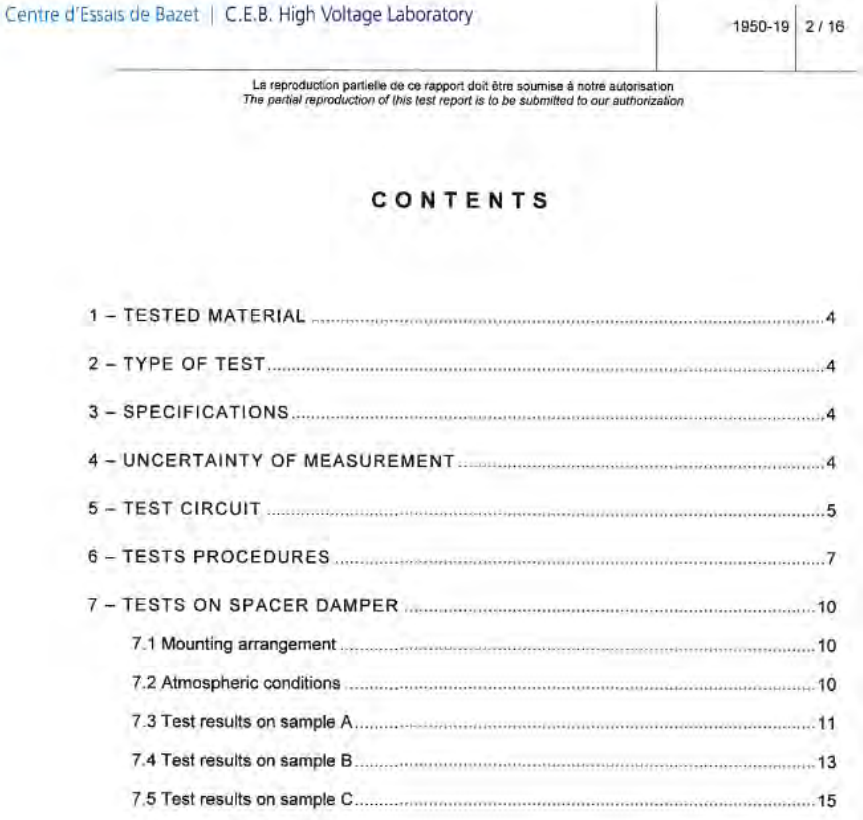

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Laboratory Accreditation

CONTENTS

Test Object Details → 1 – TESTED MATERIAL .....

Nature of Test → 2 – TYPE OF TEST .....

Reference Standards → 3 – SPECIFICATIONS .....

Test Accuracy → 4 – UNCERTAINTY OF MEASUREMENT .....

5 – TEST CIRCUIT .....

6 – TESTS PROCEDURES .....

7 – TESTS ON SPACER DAMPER .....

Set up → 7.1 Mounting arrangement .....

7.2 Atmospheric conditions .....

Procedure → 7.3 Test results on sample A .....

7.4 Test results on sample B .....

Ambient Conditions → 7.5 Test results on sample C .....

Results

Test Report Example

Trescal
www.trescal.us

Trescal Inc.
11090 Industrial Rd
Manassas,VA 20109,US
703-369-3090

Calibration Certificate

Presented To:
AFL TELECOMMUNICATIONS LLC
260 PARKWAY EAST
DUNCAN,SC 29334

Equipment Calibration Details

Manufacturer	ANRITSU	***Test Result***	Pass
Model Number	MT9083B2	***Performed On***	1/10/2023
Description	OTDR	***Due Date***	1/31/2024
Serial Number	6C60064100	***Temperature***	21.2 C
Asset Number	5087-64100	***Humidity***	47 %
Customer Asset	A1054	***Calibrated By***	TIM GILLESPIE
Options:		***Location/Dept***	
Purchase Order	670771	***PERFORMED AT:***	Calibrated at Customer Facility MCL5
Complies with the requirements of Customer PO # stated above.		***Line Number***	
Received Condition:	Received in Tolerance Left in Tolerance		
Procedure Used	MANUFACTURER'S MANUAL		
Acceptance Criteria:	MANUFACTURER'S SPECIFICATIONS		

Received Notes:

7 – TESTS ON SPACER DAMPER

7.1 Mounting arrangement

See Salvi Code N° 3930T641M036 on page 8
See photo on page 9

The spacer damper is mounted on the middle of a bundle of three conductors simulated by metallic tubes (∅ **33.5 mm**, length = **16.00 m**), located **6.00 m** above the ground plane simulation (dimensions: **4.00 m x 3.00 m,** mesh: **50 cm x 50 cm**), connected to the High Voltage and protected at each end by rings (∅ **800 mm x 80 mm**).

The distance between the spacer damper and the voltage infeed electrode (double ring **Ø 2.12 m**) is **11.6 m** (longer than 5 x 2.12 m).

Distance between conductors: **635 / 457 / 457 mm**.

All these distances were confirmed by inspector's measurements.

According to the specification, there is no reflection plane because the centre-line spacing ***(11.125 m)*** *is more than 7.5 m.*

Notes on Standard Interpretation

7.2 Atmospheric conditions

	Sample A	Samples B and C
Barometric pressure (hPa)	987.6	987.6
Ambient temperature (°C)	14.3	17.3
Relative humidity %	59.0	47.6

No correction was applied.

Test Report Example

Unexpected events
and their resolution

Result not in accordance with the specified value but agreed by the customer and the inspector because the corona is located on the setup facilities and not on the spacer damper

7.3 Test results on sample A

R.I.V test result

Voltage (kV)	dB(µV)	µV
421	78-81	7943-11220
386	68	2512
351	60	1000
316	35	56
281	28	25
246	23	14.1
211	19	8.9
176	17	7.1
140	17	7.1
105	17	7.1
50	17	7.1
0	17	7.1

See curve on page 12

Specified value: radio noise level < 60 dB(µV) at 351 kV (318 x 1.104).

Result not in accordance with the specified value but agreed by the customer and the inspector because the corona is located on the setup facilities and not on the spacer damper.

Corona test result

Voltage (kV)	Observations on the spacer damper
414 *	Positive corona inception
410	Positive corona extinction
351 (specified value)	No visible positive corona

* *See photo on page 12*

Specified value: positive corona extinction ≥ 351 kV (318 x 1.104)

Result in accordance with the specified value.

Test Report Example

Photos!

Test Report Example

7.4 Test results on sample B

R.I.V test result

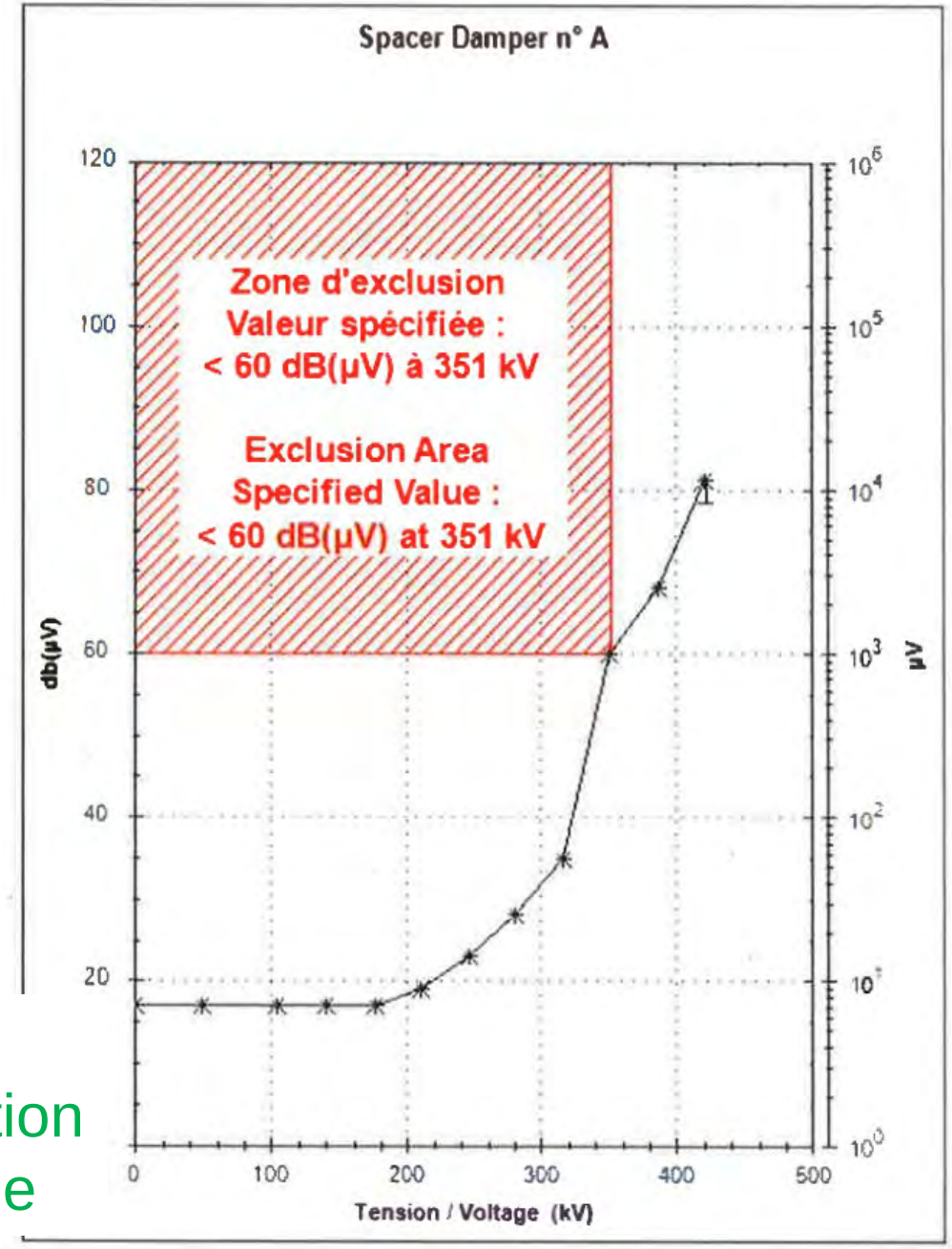
For samples B and C, we fixed the problem of corona located on the setup facilities and the RIV value goes back within the limit.

Voltage (kV)	dB(µV)	µV
421	67 ! 78	2239 ! 7943
386	40	100
351	17	7.1
316	17	7.1
281	17	7.1
246	17	7.1
211	17	7.1
176	17	7.1
140	17	7.1
105	17	7.1
50	17	7.1
0	17	7.1

Specified value: radio noise level < 60 dB(µV) at 351 kV (318 x 1.104).

Result in accordance with the specified value.

Clear Documentation of Outcome



Component Specific Testing

(Structures and Foundations are a separate topic)

- Conductor
- OHSW
- OPGW
- Stockbridge and Spiral Vibration Dampers
- Spacers and Spacer Dampers
- Glass Insulators
- Composite Insulators
- Assembly Hardware
- Suspension Clamps

- Compression Connectors
- Complete Insulator Assemblies
- OPGW hardware
- Spark Gap Insulators
- Surge Arresters

Conductor

- **ASTM B232 ACSR Conductors**
- ASTM B230 Aluminum Strands
  - Tensile Strength and Elongation
  - Resistivity
  - Bending (brittleness)
  - Diameter and Finish
- ASTM B498 Galvanized Steel Core Stands
  - Tensile Strength
  - Wrap test
  - Adherence of Coating
  - Diameter and Finish
  - Stranding direction and Lay Length
- ASTM B979 Non-Specular NS Surface
  - Reflectance measurement
- IEC 61395 Creep Testing for Stranded Conductors
  - Determination of creep stretch behavioural polynomial parameters
- IEC 61089 Round Wire Concentric Lay Overhead Electrical Stranded Conductors
  - Determination of load stretch behavioural polynomial parameters

OHSW

- **ASTM A363 Steel Overhead Ground Wire Strand**
  - Breaking Strength and Elongation
  - Ductility
  - Adherence of Coating
  - Diameter and Finish
  - Stranding direction and Lay Length

checking diameter

OPGW

- **IEEE 1138 Testing and Performance requirements for OPGW**
  - Optical Time Domain Reflectometer (OTDR)
    - Fiber continuity
    - Attenuation
    - Fiber length
  - Maximum Rated Design Tension
  - Ultimate Tensile Strain
  - Resistance
  - **Installation Type Tests**
    - Sheave
    - Crush
    - Bend
    - Twist

Optical signal trace

Measuring Apparatus

  - **Type tests for In-service** performance:
    - Aeolian vibration
    - Galloping
    - Short Circuit
    - Lightening Arc
    - Water ingress
    - Seepage of Water-Blocking Compound
    - Temperature Cycle
    - Salt Spray Corrosion

OPGW

IEEE 1138 Testing and Performance requirements for OPGW *(continued)*

- **Factory Acceptance** tests on Strands
  - Tensile
  - Elongation at failure
  - Diameter
  - Resistance
  - Zinc coating thickness (for steel wires)
  - Twist test for steel wires
  - Bending test for Aluminum wires

Tensile and Elongation testing

Lay length testing

- **Factory Acceptance** tests on Pipe and/or Spacers
  - Tensile Strength
  - Resistance
  - Elongation
- Routine Tests
  - Lay length and direction
  - Optical

OPGW

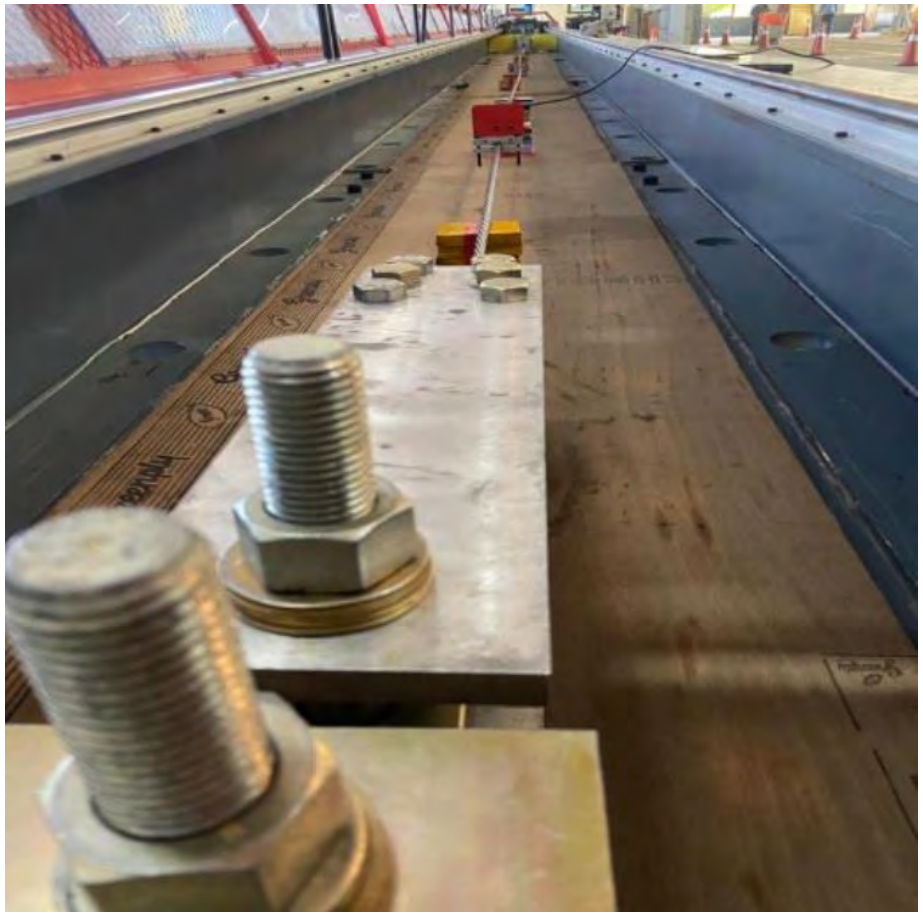
IEEE 1138 Testing and Performance requirements for OPGW ***(continued)***

IEC 61395 **Creep Testing** for Stranded Conductors

- Determination of creep stretch behavioural polynomial parameters

IEC 61089 Round Wire Concentric Lay Overhead Electrical Stranded Conductors

- Determination of **Load Stretch** behavioural polynomial parameters



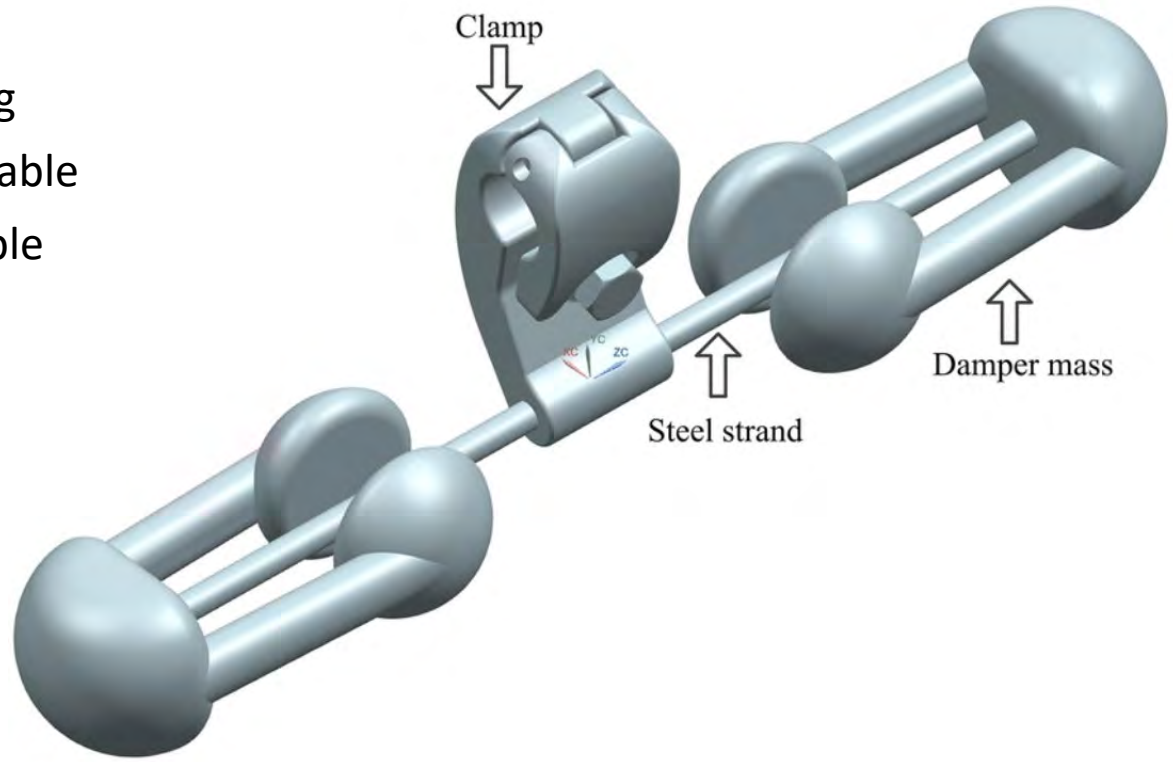
View along a tensile test bed.

Stockbridge Vibration Damper

- **IEC 61897 Requirements and Tests for Stockbridge Aeolian Vibration Dampers**
  - Dimensional, Visual and Mass
  - Zinc Galvanising Thickness
  - Clamp Slip
  - Breakaway bolt or Clamp bolt tightening
  - Attachment of Weights to Messenger Cable
  - Attachment of Clamp to Messenger Cable
  - Damper Characteristic test
  - Damper Effectiveness Evaluation
  - Fatigue Endurance

- IEEE 1829 Corona and RIV Testing

  (IEC 61284 is also a popular choice)
  - Corona test
  - RIV test

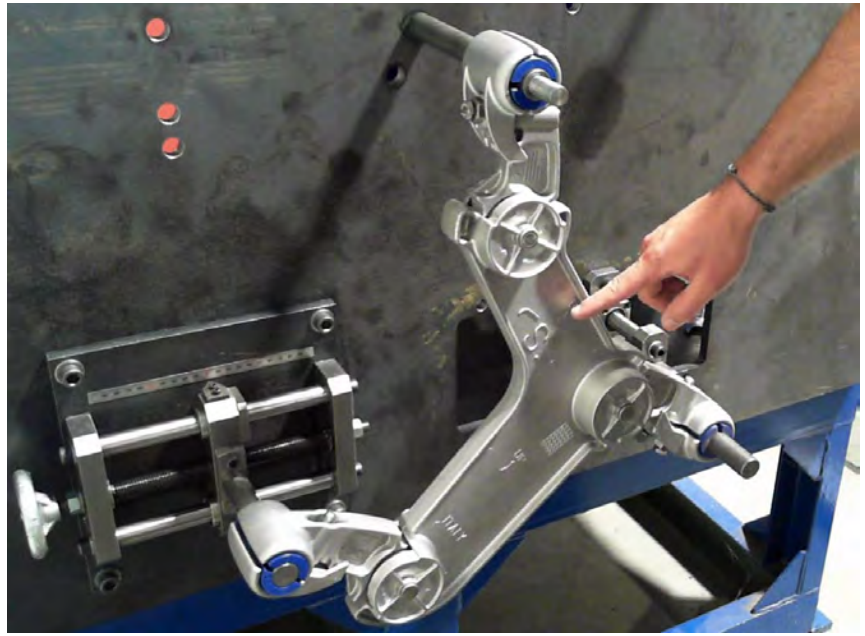


Spiral Vibration Dampers

- **IEEE 664 Power Dissipation Characteristics of Aeolian Vibration Dampers**
  - ISWR (inverse standing wave ratio) method or;
  - Power method or;
  - Decay method.

Spacers and Spacer Dampers

- **IEC 61854 Requirements and Tests for Spacer Dampers**
  - Dimensional, Visual and Mass
  - Zinc Galvanising Thickness
  - Clamp Slip Longitudinal and Torsional
  - Breakaway bolt or Clamp bolt tightening
  - Simulated Short Circuit (compression and tension)
  - Characterisation of Elastic and Damping properties (stiffness and damping)
  - Flexibility
  - Subspan Oscillation Fatigue
  - Electrical Resistance



Flexibility/Articulation testing

- IEEE 1829 **Corona and RIV** Testing

  (IEC 61284 is also a popular choice)
  - Corona test
  - RIV test

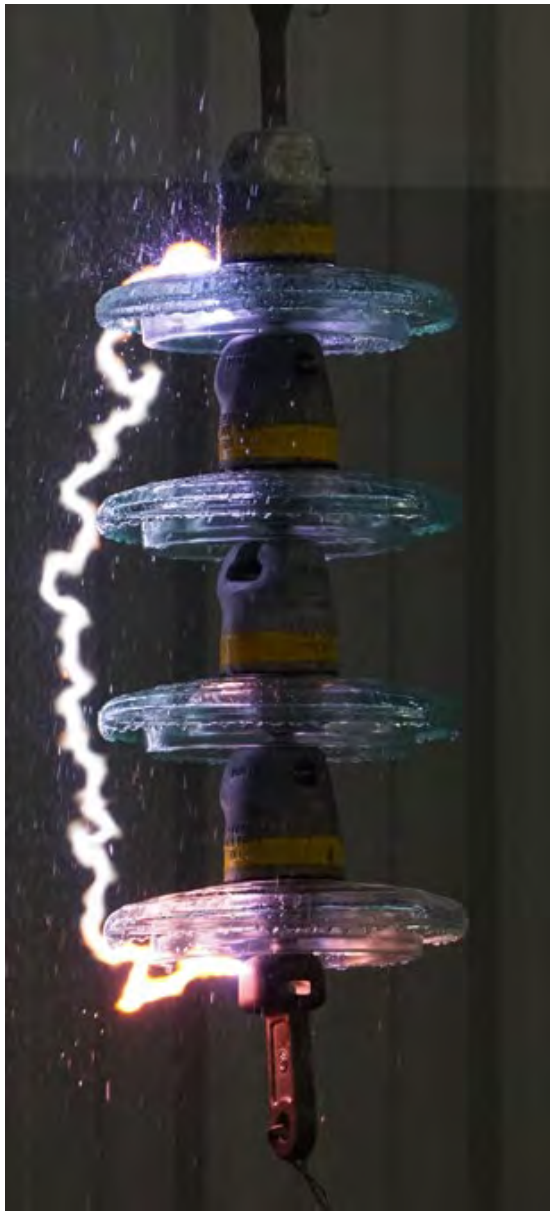
Glass Insulators

ANSI/NEMA C29.2 B Porcelain and Toughened Glass Insulators

- Mechanical and Electrical Strength
- Low-Frequency Dry Flashover
- Low-Frequency Wet Flashover
- Critical Impluse Flashover – positive and negative
- Radio-Influence Voltage (RIV)
- Thermal-Mechnical Load Cycle
- Thermal Shock
- Residual-Strength
- Impact
- Cotter Key
- Cement Expansion

ASTM A370 Materials Testing

- Charpy test
- Porosity
- Puncture
- Galvanising
- Coupling Lock System verification
- Visual and Dimensional
- Cold-to-Hot Thermal Shock
- Hot-to-Cold Thermal Shock
- Tension Proof
- Flashover



Flashover testing

Composite Insulators

- **ANSI C29.12 Transmission Line Composite Insulators**
  - Interfaces and Connections of End Fittings
  - Core Time-Load
  - House Tracking and Erosion
  - Dye Penetration
  - Water Diffusion
  - Flammability
  - Low-Frequency Dry Flashover
  - Low-Frequency Wet Flashover
  - Critical Impulse Flashover (+ve & -ve)
  - Radio-Influence Voltage (RIV)

  - Specified Mechanical Load
  - Dimensional
  - Galvanising
  - Tension Proof
  - Visual

Assembly Hardware

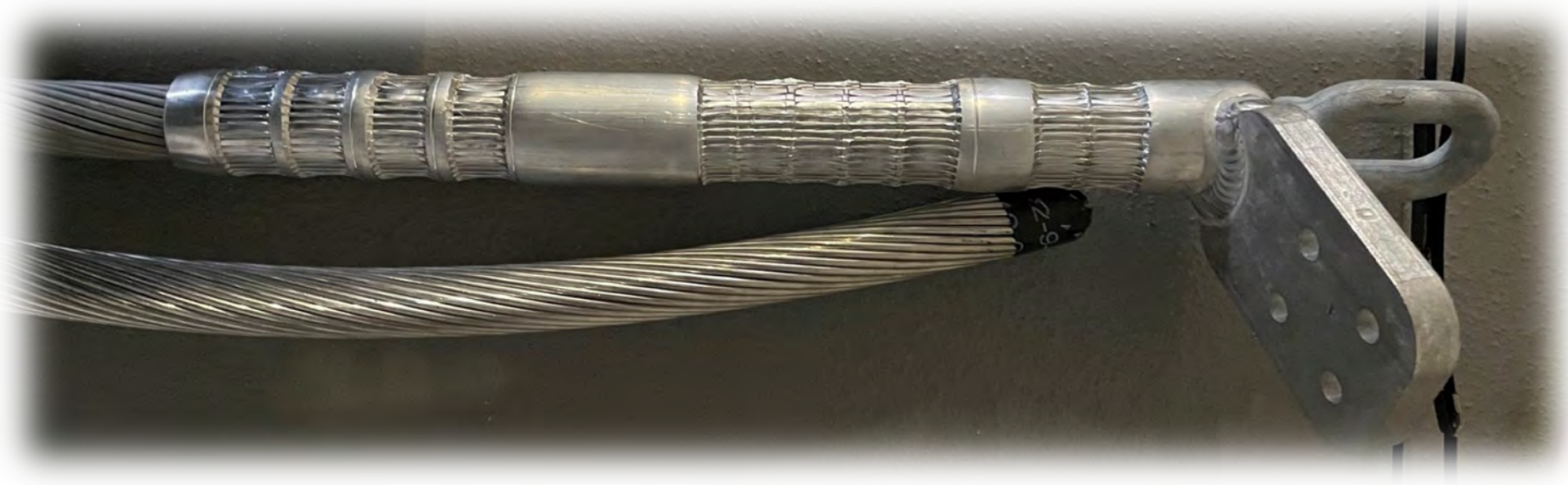
- **IEEE C135-61 Testing of Transmission Line Hardware**
  - Tensile Strength
- IEC 61284 Overhead Lines requirements & tests for fittings
  - Dimensional and Material
  - Visual
- ASTM A153 Hot Dip Zinc Coating on Iron & Steel Hardware
  - Galvanising
- ASTM A370 Materials Testing
  - Charpy test
- ASTM A275 Magnetic Particle Inspection
  - MPI

Suspension Clamps

- **IEC 61284 Overhead Lines requirements and tests for fittings**
  - Ultimate Strength
  - Slip Strength
  - Clamp Bolt Tightening
  - Dimensional and Material
  - Visual
  - Clamp bolt tightening
- ASTM A153 Hot Dip Zinc Coating on Iron and Steel Hardware
  - Galvanising
- ASTM A370 Materials Testing
  - Charpy test

Compression Connectors

- **IEC 61284 Overhead Lines requirements and tests for fittings**
  - Ultimate Strength
  - Dimensional and Material
  - Visual
  - Magnetic Losses
  - Heat Cycle
- ASTM A153 Hot Dip Zinc Coating on Iron and Steel Hardware
  - Galvanising
- ANSI C119.4 Electric Connectors
  - Ultimate Strength
  - Current Cycle



Complete Assemblies

- **IEC 61284 Overhead Lines requirements and tests for fittings**
  - Corona and RIV

- **IEEE 1829 Corona Tests on Hardware for Overhead Transmission Lines**
  - Corona and RIV

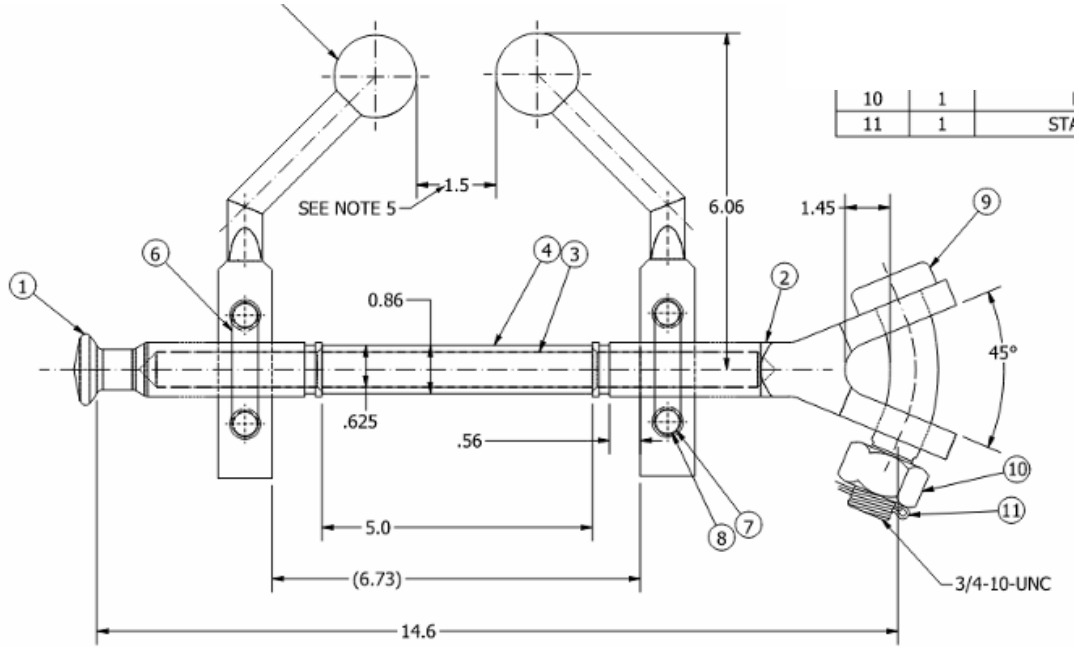
OPGW Hardware

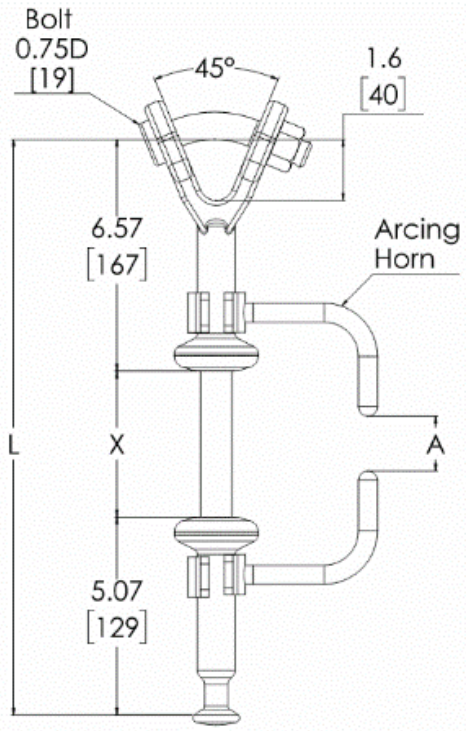
- **IEEE C135-61 Testing of Overhead Transmission Line Hardware**
  - Tensile Strength
- IEC 61284 Overhead Lines requirements and tests for fittings
  - Dimensional and Material
  - Visual
- ASTM A153 Hot Dip Zinc Coating on Iron and Steel Hardware
  - Galvanising
- ASTM A370 Materials Testing
  - Charpy test
- ASTM A275 Magnetic Particle Inspection
  - MPI

- **IEEE 1591 Testing and Performance of Hardware for OPGW**
  - Fault Current / Short Circuit
  - Crush

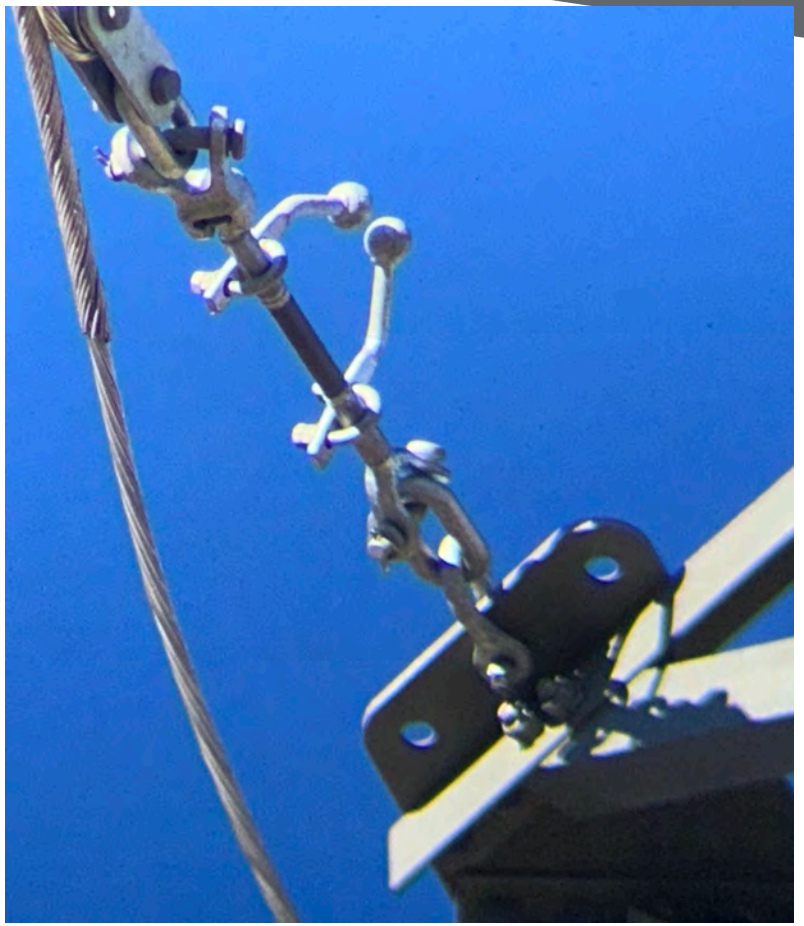
Spark Gap Insulators

- **Purpose:**
  - Supporting isolated OPGW systems – reducing transmission line losses
  - Holding impressed voltages in order of 2 kV





Spark Gap Insulators



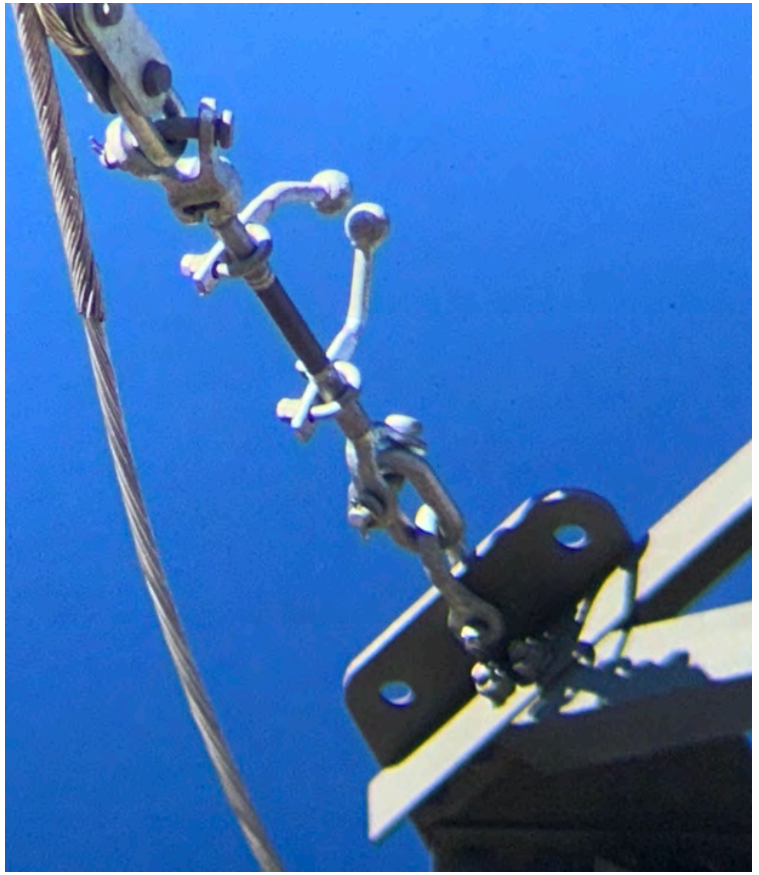
- **ANSI C29.13 Composite Insulators - Distribution Deadends**
  - Water Penetration *(100 hour boil of sheathed insulator)*
    Evaluation by:
    - Visual
    - Hardness
    - Steep-front Impulse
    - Power Frequency Voltage
  - Aging and Accelerated Weathering (UV test)
  - Dye Penetration
  - Water Diffusion *(100 hour boil of samples from core)*
  - Power Arc Test
    Evaluation by:
    - Moisture penetration
  - Tracking and Erosion Test *(cyclical wetting and voltage stress)*
    Evaluation by:
    - Visual
    - Steep-front impulse
    - Power frequency voltage

Spark Gap Insulators

- **ANSI C29.13 Composite Insulators - Distribution Deadends**

  (continued…)

  - Tensile Load
  - Torsional Load
  - Thermal Mechanical
  - Flammability of Shed and Housing
  - Low-Frequency Dry Flashover
  - Low-Frequency Wet Flashover
  - Critical Impulse Flashover – positive and negative
  - Galvanizing
  - Tension – proof test



- **IEEE 1591 Testing and Performance of Hardware for OPGW**
  - Fault Current / Short Circuit

    (modified power arc test to ANSI C29.13)

Surge Arresters

- **IEEE C62.11 Metal-Oxide Surge Arresters**

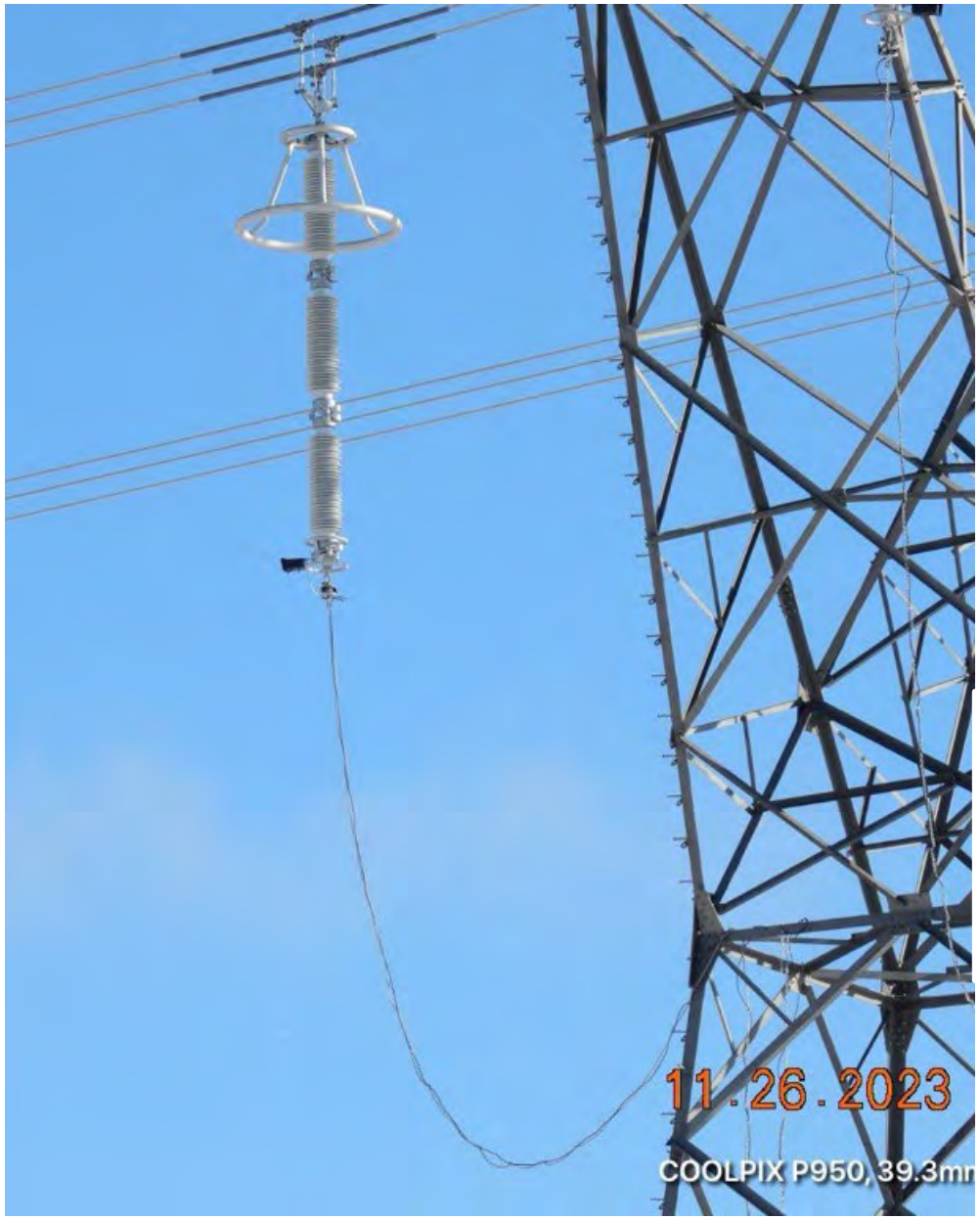
  (Design tests not covered in detail, following are routine tests.)

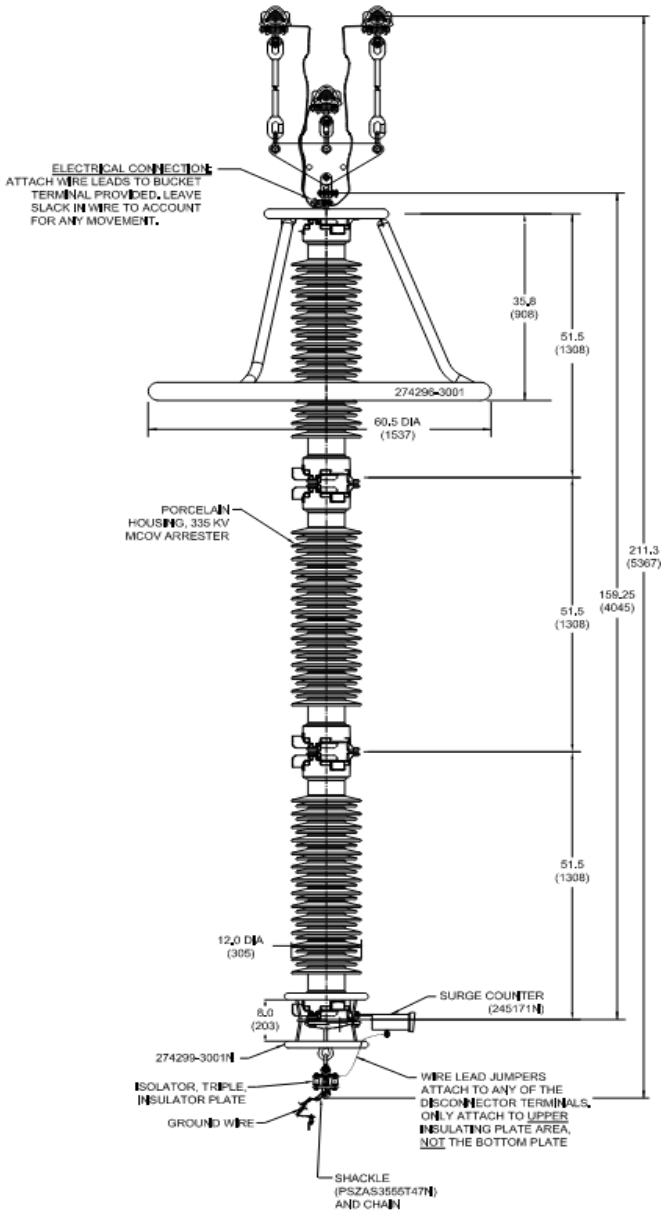
  - **Current Sharing** – only applies to arresters of two or more parallel columns of varistors
  - **Discharge Voltage** – may be performed on individual elements, sections, or full column
  - **Partial Discharge**
  - **Seal Test**
  - **Power-frequency**
  - **Power-frequency sparkover** – only applies to gapped arresters

- **IEEE 1829 Corona Tests on Hardware for Overhead Transmission Lines**
  - Corona and RIV testing of assembly

Surge Arresters

- **Strength Type Testing**
  - Tensile strength for arresters suspended from the conductor
  - Bending moment strength for arresters mounted standing on structures defined in IEEE C62.11 design tests





Questions?

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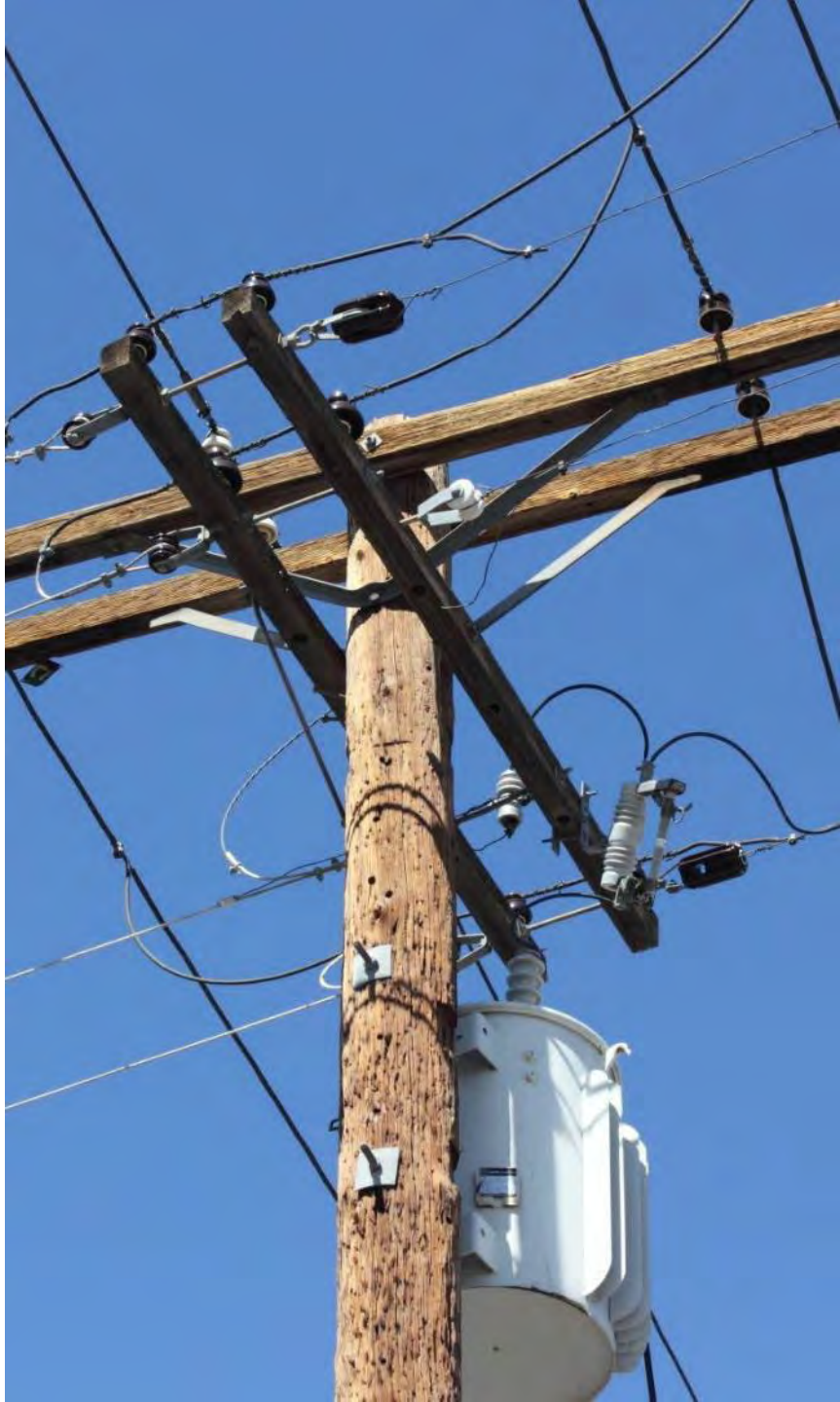
Effectiveness of Compressed Dazomet Sticks for Internal Remedial Treatments of Spotted Gum Utility Poles

Richa Tungal

Introduction

1. Spotted gum (hardwood) utility poles
2. Internal and external decay
3. Extensive testing for MITC movement in spotted gum
4. Discussion on effectiveness of compressed Dazomet sticks performance for spotted gum

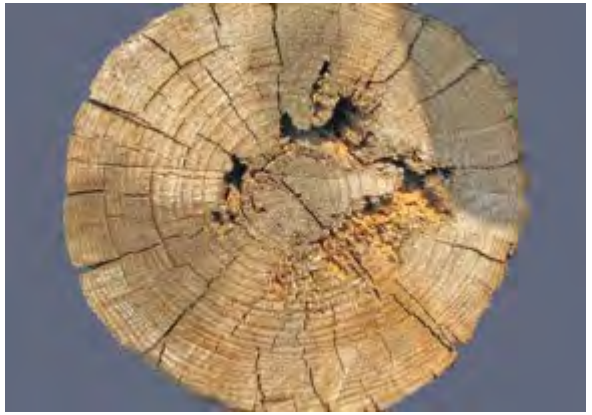


Australian Spotted Gum (Hardwood)

- Heartwood ranges from pale to dark brown with characteristic dark streaks or spots.
- Moderately coarse and often interlocked grain.
- Exceptionally durable (Durability Class 2).
- Strong and robust, resistant to impact and wear.
- Many hardwoods are denser than softwoods and have a more complex cell structure
- Applications in household, utility poles etc.

Internal and External Decay in Spotted Gum (Hardwoods)

Decay Pockets



**images are not of spotted gum species, but rather used to illustrated decay/insect damage types*

Termite Attack

External decay

- Spotted gum generally resistant to decay compared to softwood, however, not entirely resistant to decay
- Timber decay, including that of spotted gum, is a significant issue in the timber industry worldwide.
- Regular inspection and treatment can mitigate or slow down the decay.

Internal Remedial Treatments To Protect Sound Wood

(Currently used in the industry)

Metam Sodium (liquid)

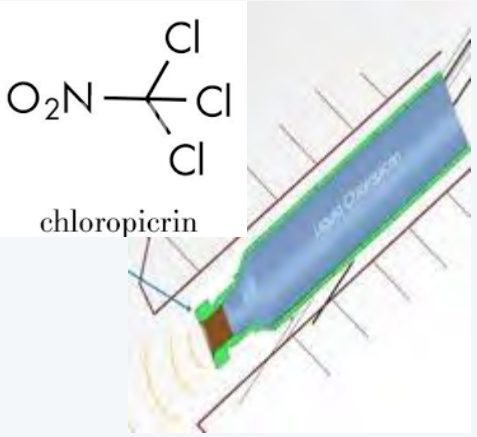
- Liquid – pours easily
- Decomposes to ~18% MITC
- NOT moisture dependent

MITC (solid melt)

- Pre-measured dose
- Sealed aluminum tubes
- MITC as active, >97%
- Not moisture dependent

Chloropicrin

- Pre-measured dose
- Ease of application
- Can give long term protection
- Hazardous material



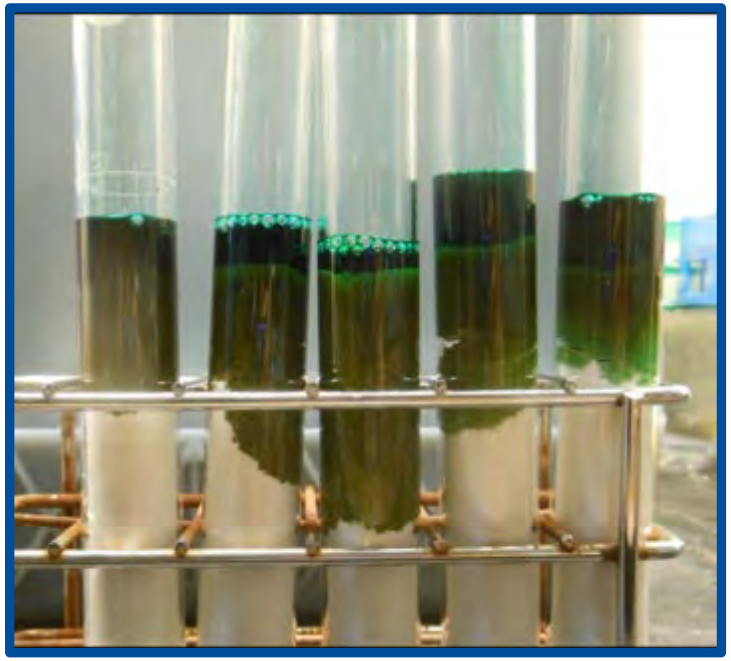
Boron Rods

- Pre-measured dose, ease of application
- Require moisture to solubilize
- Takes 2-3 years to reach protective levels
- Chances of decay until boron reaches to THF levels

Dazomet (Granular/Compressed sticks)

- ~45% MITC
- Requires moisture
- Copper solutions accelerate decomposition
- Acts immediately

What is the need for New Technology



Poor copper/dazomet interaction with granular/powdered dazomet- by OSU

Challenges with Dazomet powder

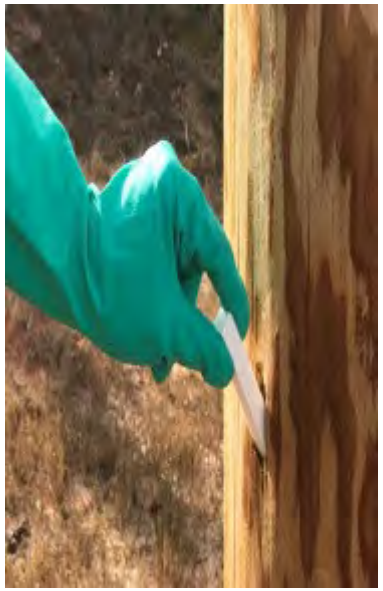
- Poor interaction of powder dazomet with copper solution
- Slower MITC production

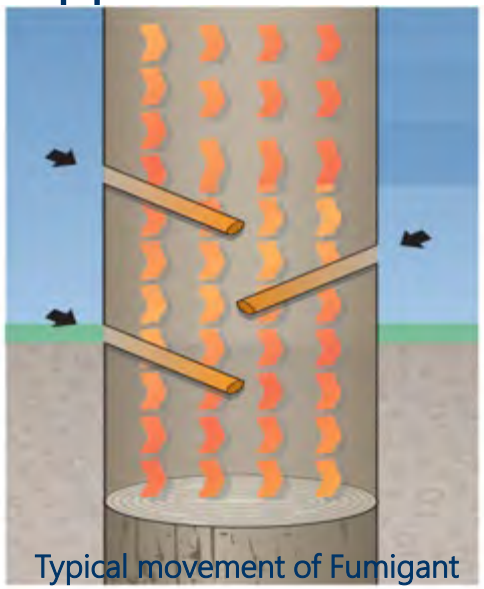
Boron Rods challenges

- Requires moisture to solubilize and diffuse
- Move inches from point of application, compared to feet for fumigants
- Takes 2-3 years to reach protective levels
- Chances of decay until boron reaches THF levels

Benefits of New Technology-Compressed Sticks

3-Hole Application





Typical movement of Fumigant

Benefits of Advancement in Technology

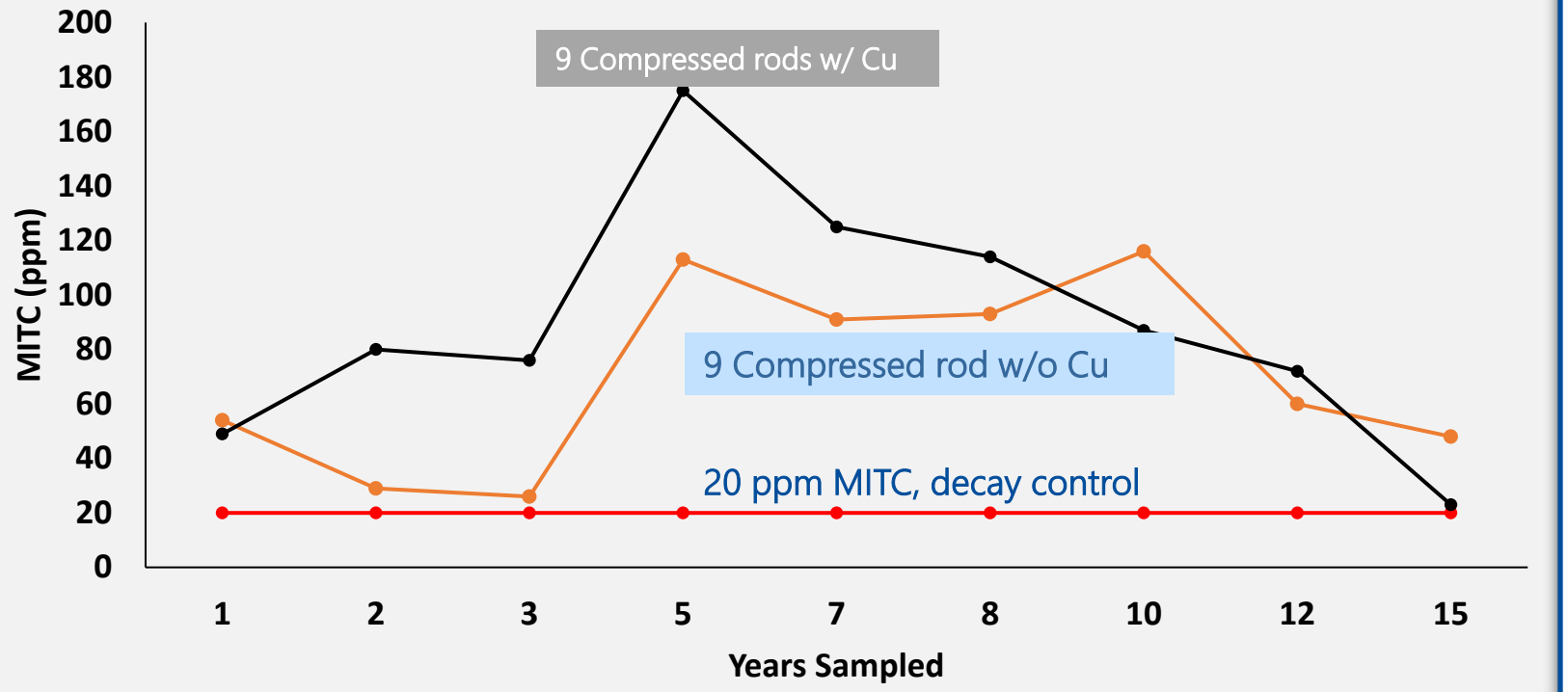
Benefits

- Improved copper-dazomet interaction
- Less Risk
  - dusting and the risk of accidental release is minimised
  - reduced applicator and environment exposure
- Effective
  - controlled dose for consistent MITC production.
  - Cu and B from copper solution accelerates MITC generation
  - sticks allow ample room for Cu to penetrate
- Environmentally Preferable
  - minimises localized spills

Fumigant Evaluations-Dazomet Efficacy on Softwood

Two components:

Dazomet Fumigant+ Copper (Cu) Accelerant



Oregon State University conducted research on dazomet rods with and without copper using *Douglas fir*.

Highest MITC was produced in the beginning years

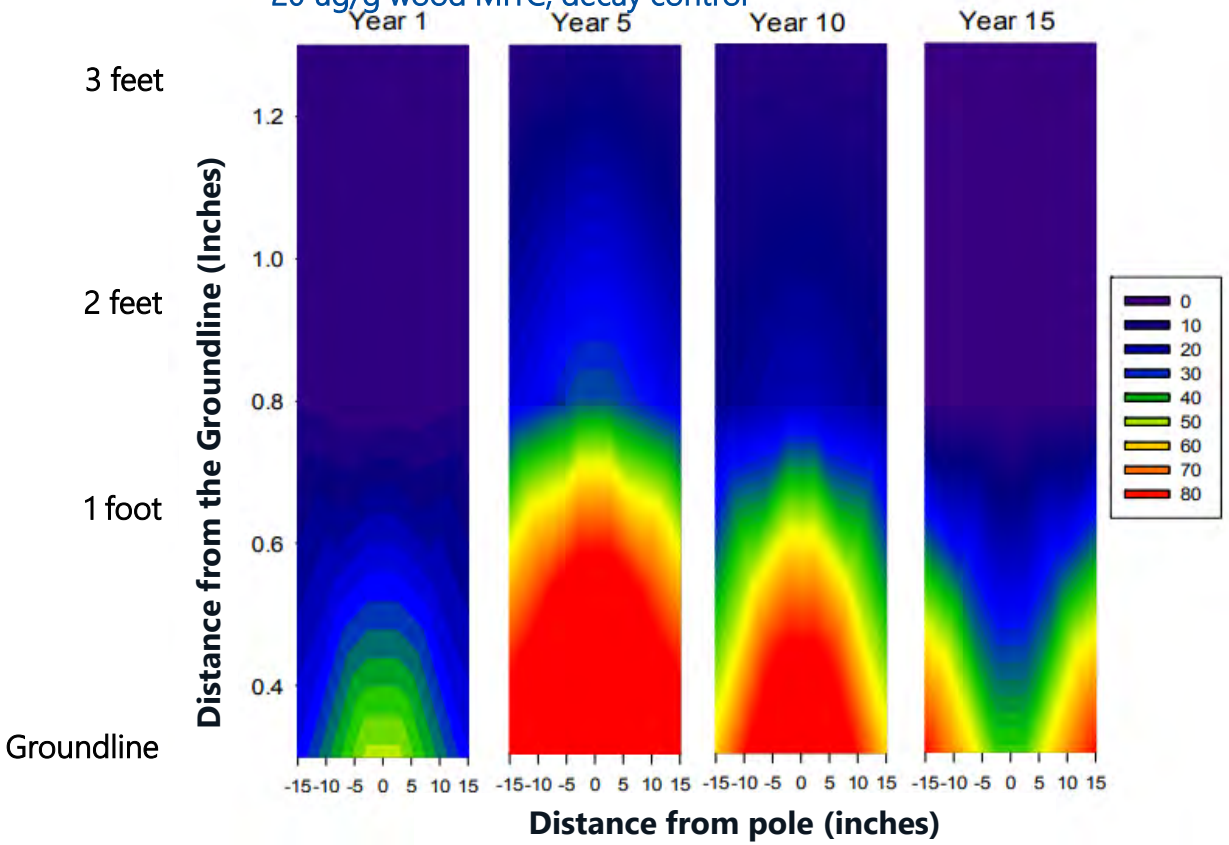
Higher MITC with Copper solution

Protection for >= 10 years

Fumigant Performance Data

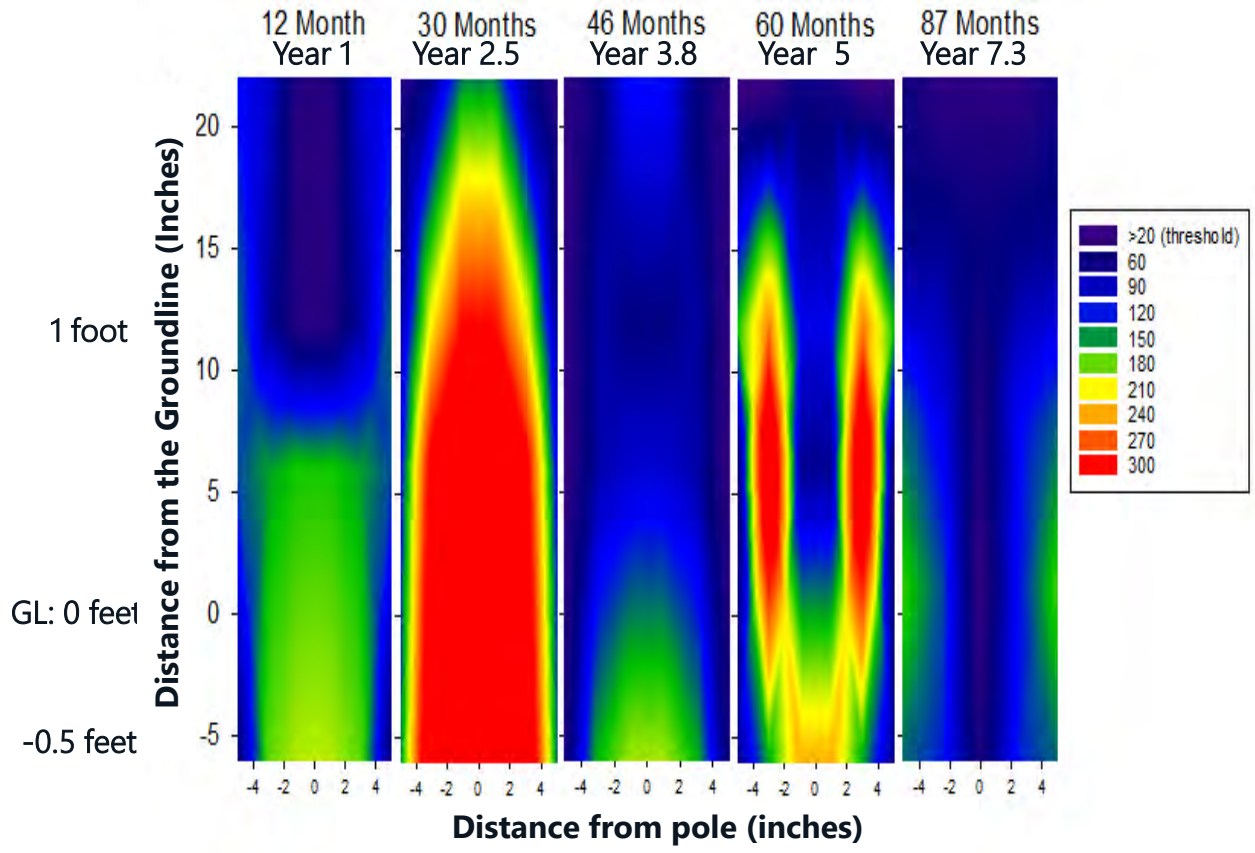
Dazomet Powder+ Cu Solution => MITC Conversion & Movement, 15-Year Exposure - Corvallis, OR

20 ug/g wood MITC, decay control



Oregon State University conducted studies on dazomet and showed efficacy for 15 years with copper accelerant

Compressed Dazomet Sticks



Osmose's ongoing studies on compressed dazomet with copper accelerant have shown efficacy for over 7 years.

Fumigants with Softwood vs Hardwood

- Hardwood performance may differ from Softwood for fumigants
- Testing Compressed Dazomet Sticks - Need to test compressed Dazomet sticks with Hardwood .
- Density difference - Hardwood poles used in Australia are denser than the US. softwoods
- Examining Movement of MITC - Need to test if fumigants like compressed dazomet sticks decompose to MITC and move in the same way

Hardwood Fumigant Experiment and Field Set up

Spotted Gum (Australian Hardwood), Wallaba (South American Hardwood)

Test Site and Installation of Pole Sections

Sites used for testing

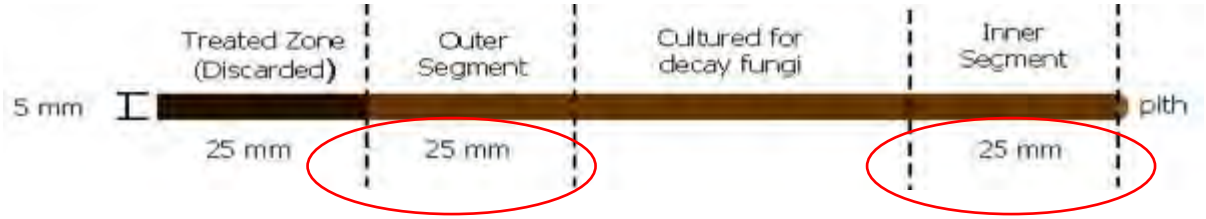
1. Central Florida at the Austin Carey Memorial Forest
   - 16 poles untreated Wallaba (*Eperua falcata*)
   - (50-300 mm diameter, 3 m long
2. The Department of Agriculture and Fisheries (DAF) Maroochy Field Facility in Southeast Queensland, Australia
   - 30 CCA treated spotted Gum (*Corymbia spp.*)
   - 250-300 mm diameter, 2.4 m long

Compressed Dazomet Sticks Application

- Dazomet sticks used as per industry standard at 9 sticks per pole
- 3 dazomet sticks (14 mm wide by 97 mm long) were inserted into each hole along with copper accelerant
- Each pole received 205 grams of dazomet on an active basis

Sampling of Hardwood Poles

Typical Sampling Pattern for fumigants by OSU Researchers



Sampling Heights

- 6″ below groundline
- At groundline
- 6″ above groundline

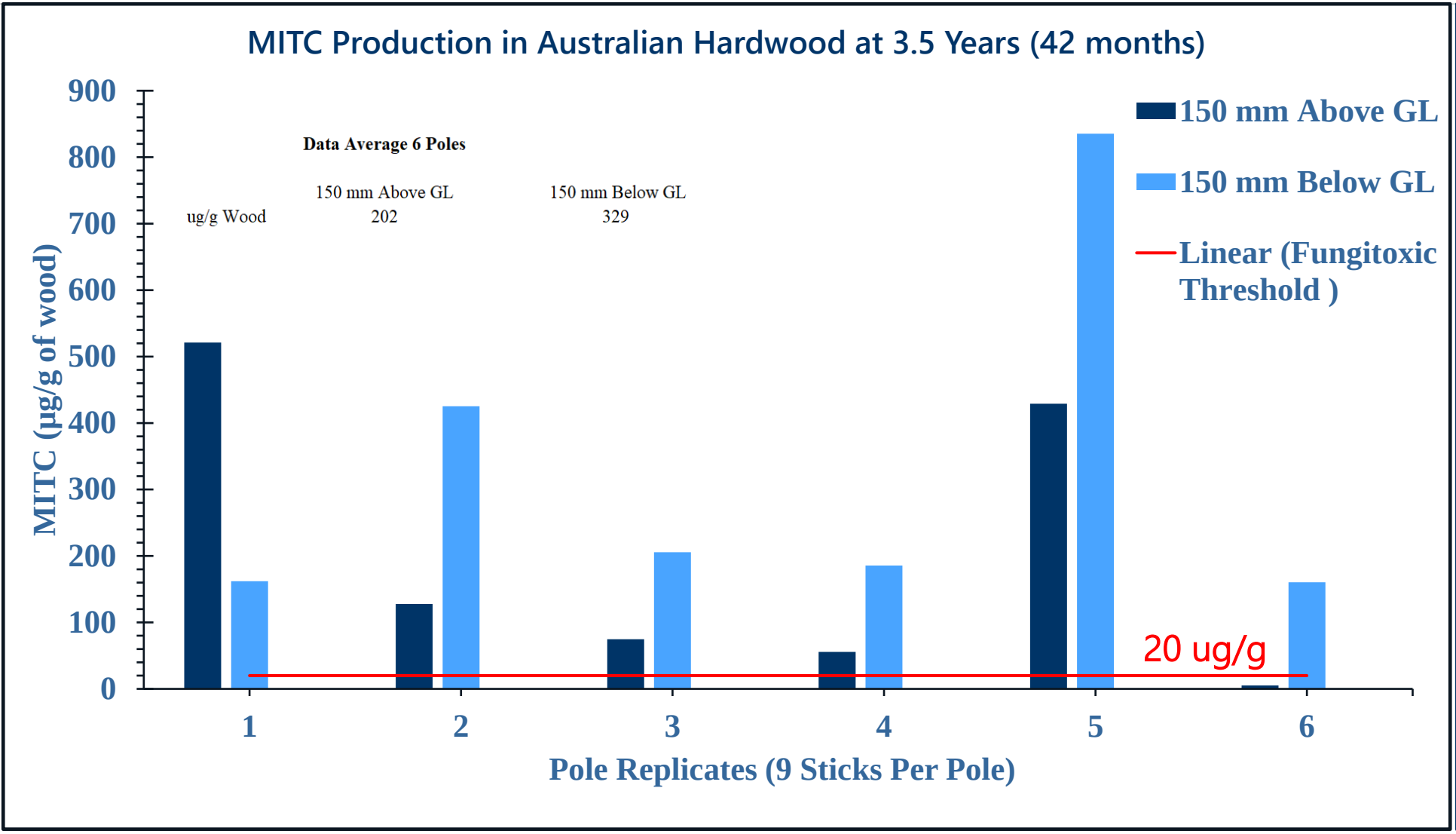
Chemical Analysis

MITC analyzed using Gas Chromatography Mass Spectrophotometer

Field Study Results on Residual MITC

Spotted Gum, Wallaba Hardwood

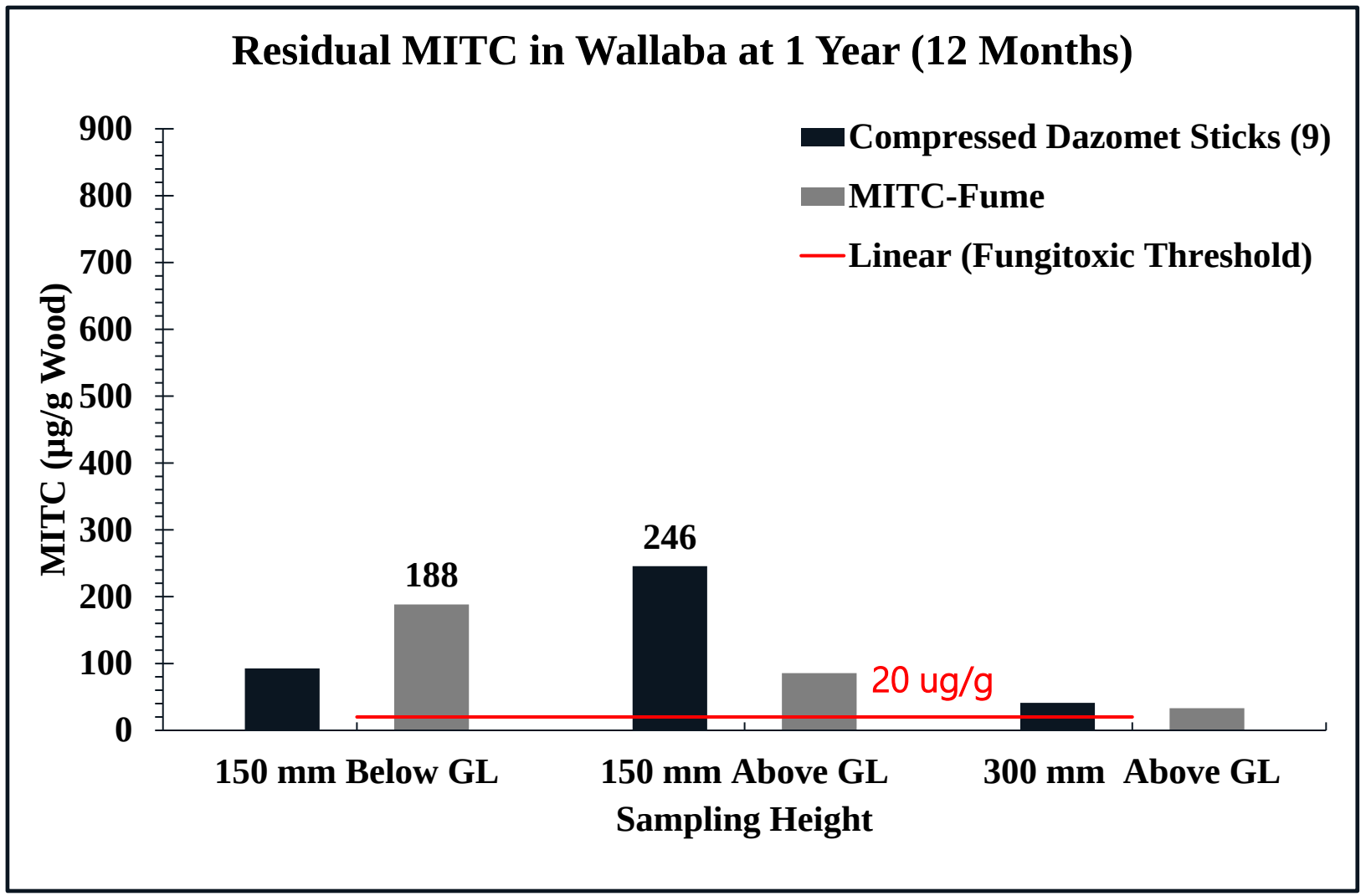
Fumigant Evaluations-Dazomet Efficacy – Spotted Gum Hardwood



MITC at 3.5 Years

- Above groundline MITC 5/6 poles above protective threshold levels (202 ppm average)
- Below groundline MITC 6/6 poles above protective threshold levels (329 ppm average)
- Data supports a 5 year treatment cycle

Residual MITC Data with Wallaba Wood



MITC at 1 Year

- Wallaba poles treated with dazomet showed significantly elevated MITC levels above and below ground.
- MITC was notably higher in denser hardwood, indicating effective decomposition of dazomet into MITC

Conclusion

- Pressed dazomet stick technology has been proven effective in Softwood poles with years of in-field test data.
- The data collected has revealed that MITC levels in spotted gum consistently surpassed established threshold at **3.5-years**.
- Dazomet compressed sticks are suitable for 5-year inspection cycle for spotted gum utility poles.

Acknowledgement

Special thanks for the team members for their continuous support to make this project a successful in studying the MITC movement in Spotted gum hardwood in Australia. Osmose initiated the study and Jefferey J. Morrell acts as independent observer.

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Thank you!

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