
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.

GRIDVISION®

Powered by eSmart SYSTEMS

The long-term value of AI-assisted virtual inspections

2024 INTERNATIONAL OVERHEAD LINE CONFERENCE


“A picture is worth a thousand words”
But quality matters.

How many of you have applied drones as part of your inspection programs today?

How many of you have considered or are using AI as part of your inspection process?

Why consider this change

Typical approach

- Using drones to capture data for routine inspections
- Inspection is still time-based
- You are only using some of the data you collect
- Inspection data mainly remains in the inspection and maintenance teams

Outcome:
safer inspections, maybe cheaper and adopting new technology!

Scaling and long-term value

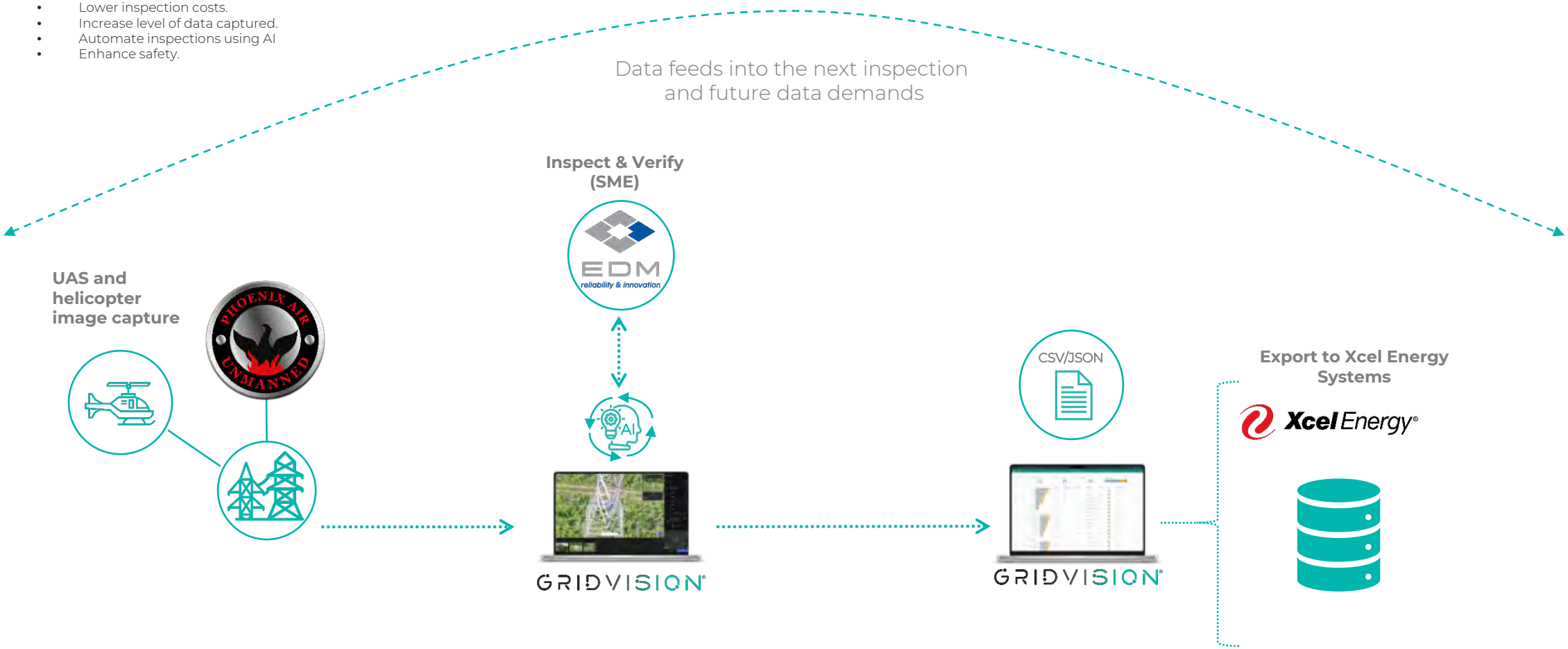
- Utilize the visual data you are collecting
- Capture your entire grid
- Scale by adopting the right data capture strategy
- Adopt AI to process data and support virtual inspection
- Push the visual inspection data through your core business processes.

Outcomes:
Decisions based on risk, inspection objectivity & reducing O&M

Xcel Energy's 4-year transmission program overview

- **22k+ miles** of transmission lines inspected
- **4.4 million+** images processed
- **181K +**structured inspected
- **37k+** defects identified

Original program goals
- Identify high-priority issues within 24-48 hours.
- Lower inspection costs.
- Increase level of data captured.
- Automate inspections using AI
- Enhance safety.



ACHIEVED
60% more defects detected than traditional methods

ACHIEVED
100% of total program costs treated as CAPEX

Collaborative Artificial Intelligence

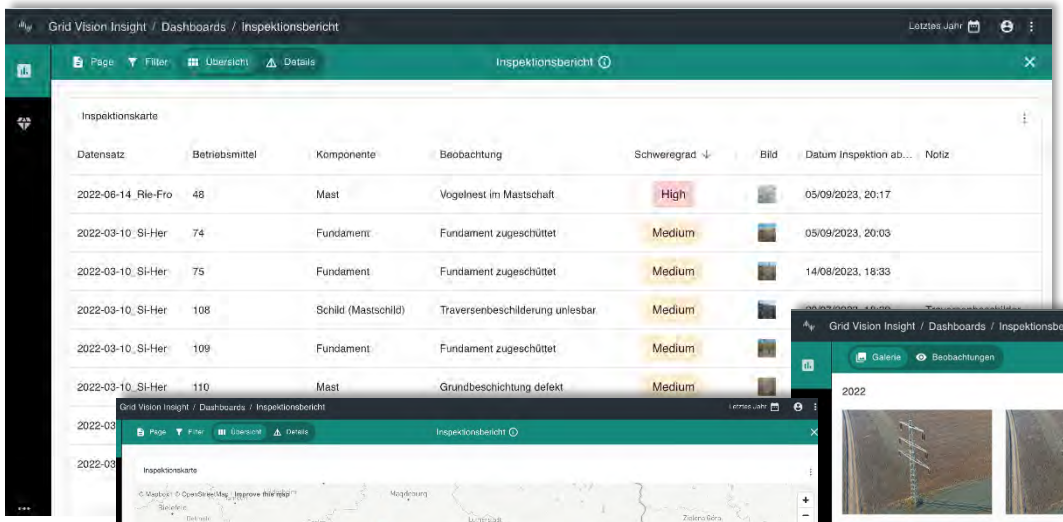
Subject matter experts & Grid Vision ®

eSmart' Systems Grid Vision® software

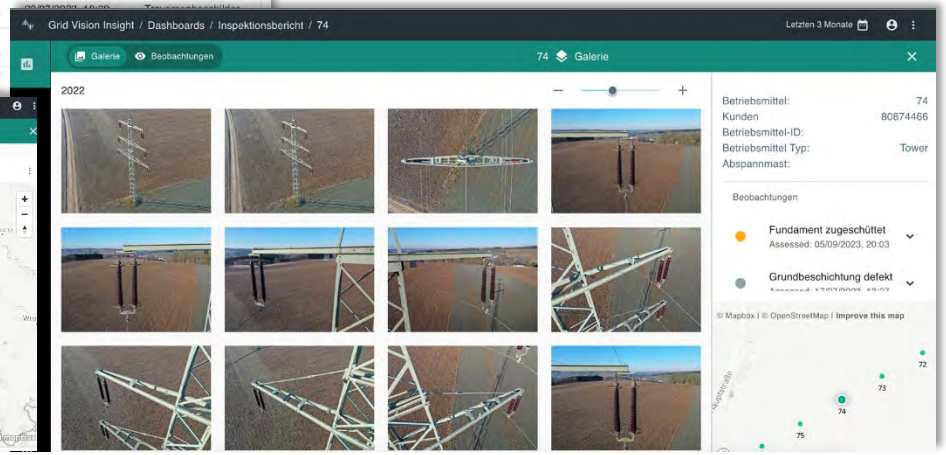
Human subject matter experts in Grid Vision

How did Xcel Energy scale and get value beyond the inspection?

What is an image-based digital asset?



360 view of all assets

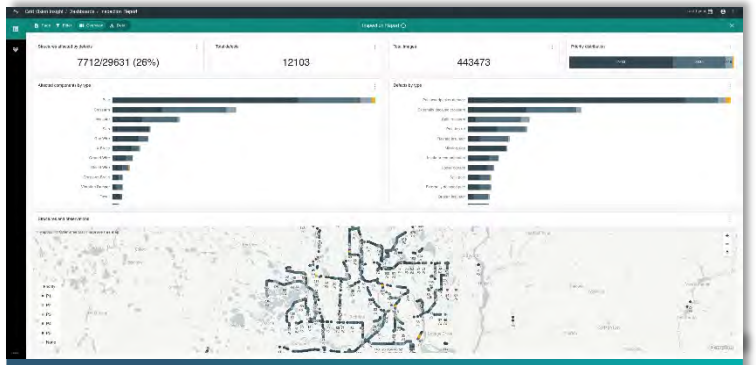


Holistic view of all of our inspections with the asset linked to:

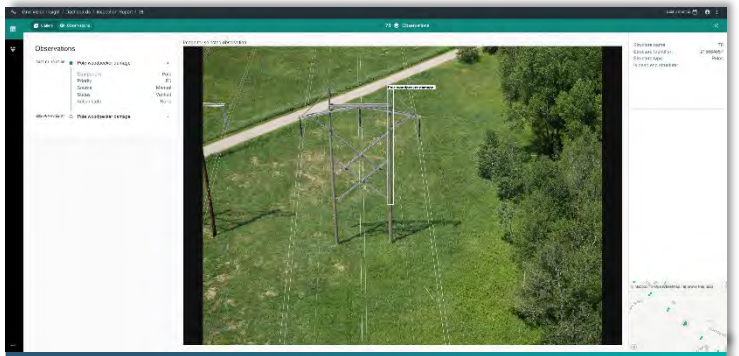
- Metadata
- Visual Data
- Inspection Data
- Grid Topology

Image-based digital asset representing Xcel Energy's physical grid

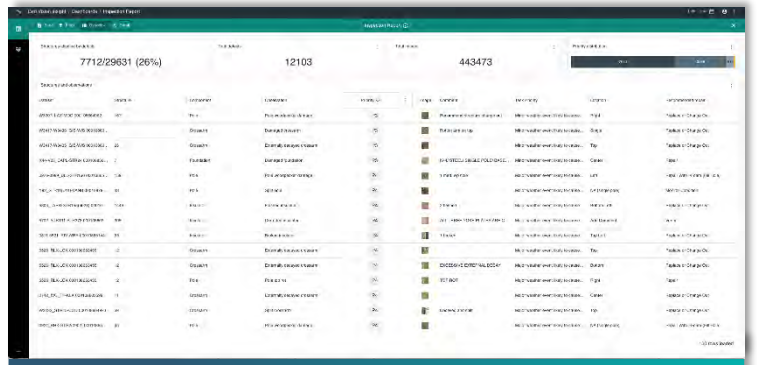
Saving teams time, improving safety and reducing costs by leveraging accurate imagery & inventory data



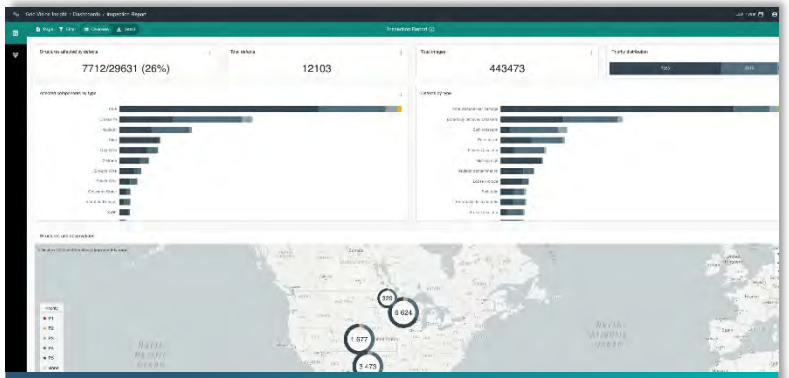
Overall defects represented by a map with grid topology



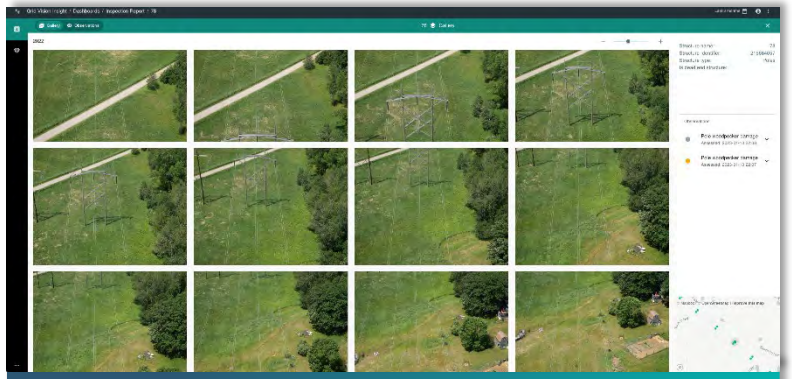
Asset linked to image, inspection data, metadata & grid topology



Filter results based on area of interest e.g., defect , components, severity etc



Overall defects represented by type and map view



Drill down in an Individual asset with access to quick access to high resolution image

Leveraging data captured through years of inspections in entirely new ways

SAVING TIME ACROSS MULTIPLE DEPARTMENTS, IMPROVING SAFETY, PROCESSES, AND REDUCING COSTS BY LEVERAGING ACCURATE IMAGE-BASED CONDITION & INVENTORY DATA

Maintenance & planning support

Utilizing the images to identify inventory, material & tool requirements, right of way etc.

✓ **Reduced verification visits with improved planning**

Capital planning

Prioritization based on defect density scores/circuit, inventory

✓ **Savings as projects were moved into capital projects and based on accurate data**

Supporting major incidents

Images from digital asset used as evidence of pre-event status for major incident investigations and reporting

✓ **Risk mitigation, supporting legal teams with image-based evidence with clear audit trail**

Improving business decisions

Utilizing the digital asset in virtual meetings with decision makers to demonstrate challenges with projects.

✓ **Improved reporting and situational awareness of sites & quicker decision making**

Wildfire mitigation

Utilized digital asset to identify assets at risk based on inventory, component detection & geolocation

✓ **Improved safety, extend asset life**

Inspection schedule optimization

The frequency of inspections could be optimized based upon the condition and criticality of a circuit,

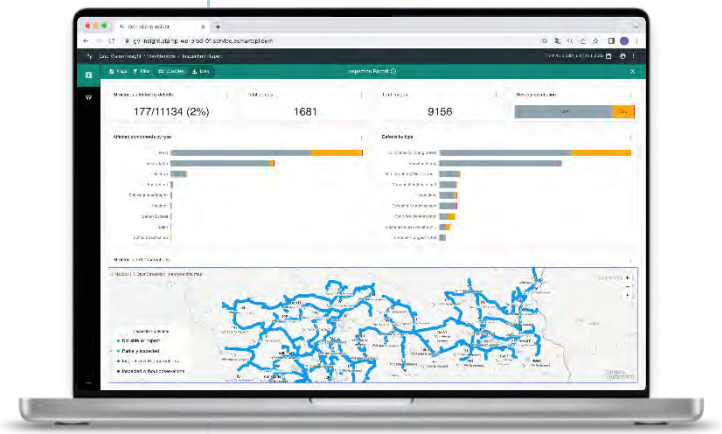
✓ **Reduced O&M, time saved**

Breaking down silos

Utilizing the image-based data across your organization for downstream value

Utility Departments

Grid Operations	Grid Planning	Grid Construction	Data Analytics	Major Incidents
Asset Management	Strategy	Compliance	GIS	R&D
Risk Mitigation	Finance	HR	Grid Maintenance	Innovation



- Reduce reactive maintenance.
- Further reduce O&M across your organization, while leveraging the accurate data for capital planning

2024 International Conference on Overhead Lines
Design, Construction, Inspection, and Maintenance
April 15-18, 2024, Fort Collins, CO

The Use of Remote Sensors in Electric Utility Grid Management

CLINTON Y. W. CHAR, P.E.
WEST POWER ENERGY

MEHROOZ ZAMANZADEH, PHD.
MATERGENICS, INC.


JUN 28 2005
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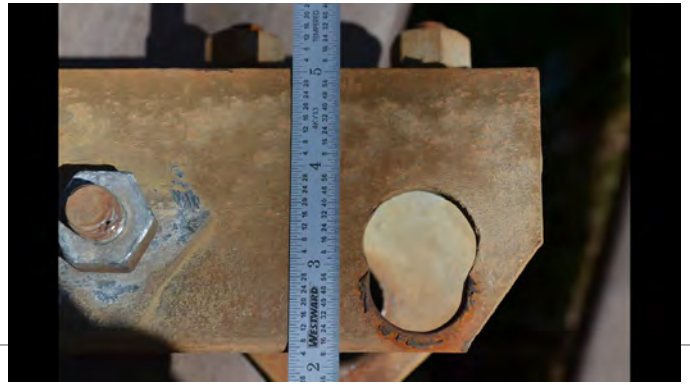
A Disaster to Remember 2018 and 2023

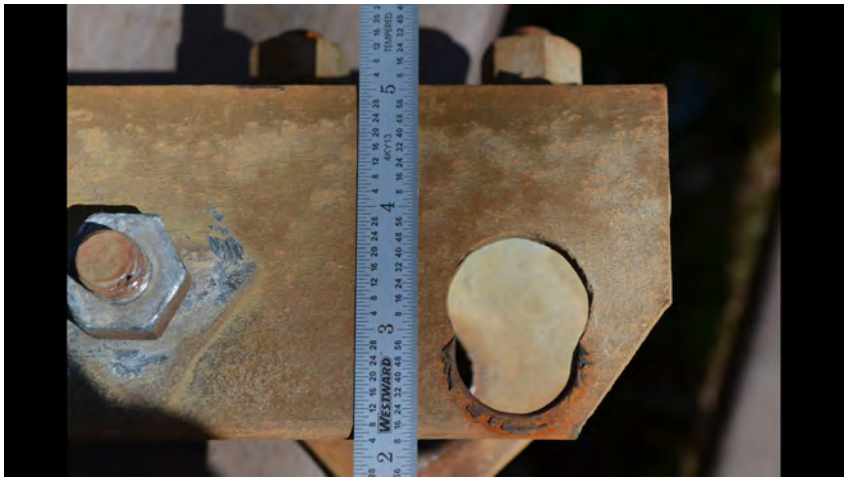
- The fire caused 85 civilian fatalities
- The towns of **Paradise and Concow** were almost completely destroyed, each losing about 95% of their structures.
- It covered an area of 153,336 acres
- It destroyed more than 18,000 structures,
- Most of the destruction occurring within the first four hours.
- By January 2019, the total damage was estimated at $16.5 billion;
- A nearly 100-year-old electrical transmission line owned and operated by Pacific Gas and Electric was identified as the cause of the Camp Fire after an investigation by California's Department of Forestry and Fire Protection, or Cal Fire.

2023 Hawaii Wildfire in Lahaina : 2,200 building destroyed: $ 5.5 billion- and 150-year-old Banyan Tree

The wind-driven fires prompted evacuations, caused widespread damage, killing at least 99 people in the town of Lahaina on Maui's northwest coast. 17,000 acres. The proliferation of the wildfires was attributed to dry, gusty conditions created by a strong high-pressure area north of Hawaii and Hurricane Dora to the south.



97year hook fractured due to fatigue



Hanger Plate

A broken hook on the line sparked the fire

Utility practice of running parts to failure coincided with cuts to inspection policies and budgets.

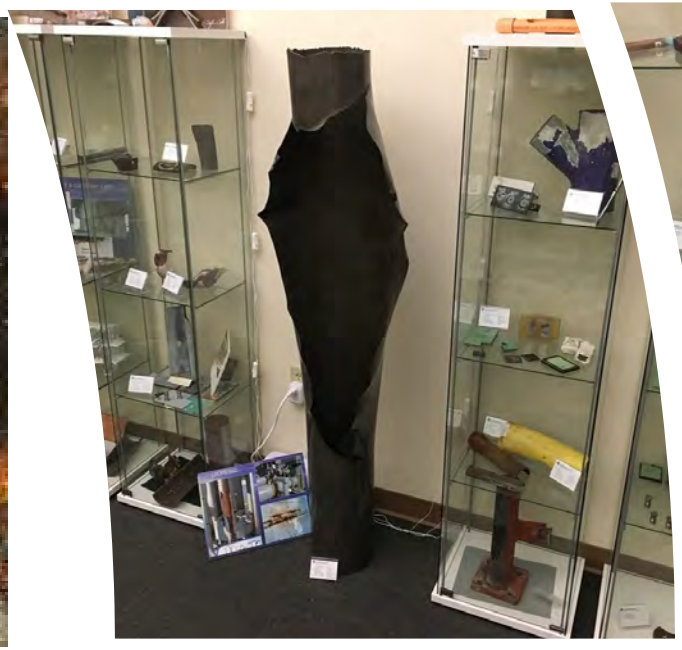
Aging Infrastructure in United States:

- 2.900,000 miles of pipelines
- 730,000 miles of aging cast iron water mains
- 250,000 watermain breaks per year
- 45, 000 poor condition ”defective” bridges
- 7-8 Millions of Aging T&D structures
- Over 100,000 leaking storage tanks

Silver Bridge Failure

Matergenics Museum of Failures

Corroded Watermain



Exploded Gas Line

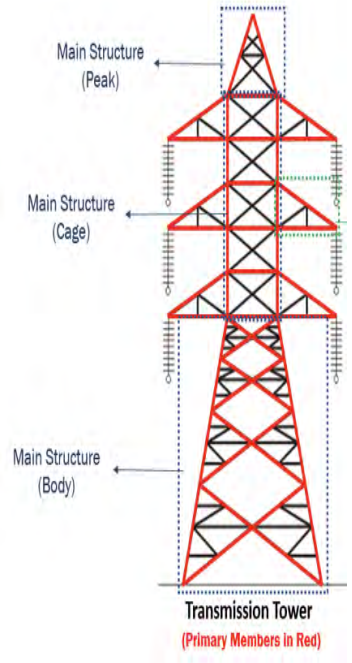
Five Years Old Galvanized Pole

Background: Why Sensors?

- Load bearing capability could change by either corrosion activity or wildfires
- Remote Sensors can provide real time status of corrosion activity conditions in a utility's service area
- Alarms could provide a utility with warnings when conditions out of the ordinary occur
- More likely Corrosion and Wildfire Detrimental effects can not be seen visually

- Hundreds of thousands of baby boomer aging structures
- They Follow laws of nature
- Life limiting mechanisms: corrosion, wind loading
- Wildfires can affect phase structure

2nd law of thermodynamic and Murphy's law; disorder



- Galvanized Steet: Galvanic action
- Weathering Steel: Goethite
- Concrete: Passivating

Wildfire Exposed Towers
May Exhibit Degradation:

- Low elevation
- Mid elevation
- High elevation
- Overhead hardware
- Insulators

This is true for

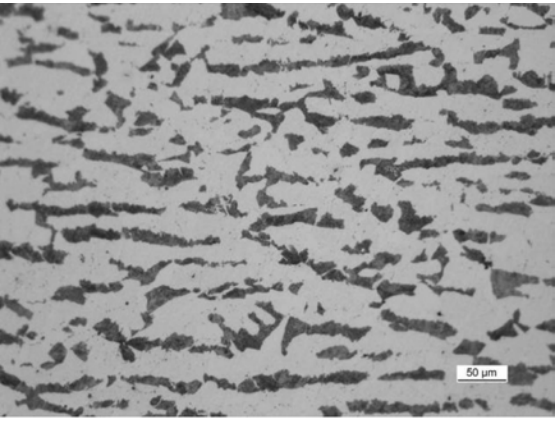
- Lattice / Towers
- Poles
- Communication Towers
- Overhead Conductor Lines

Background

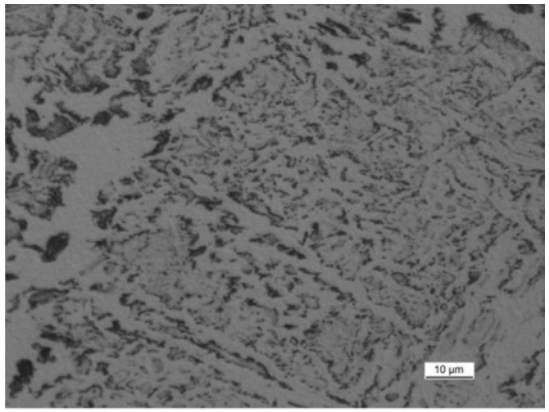
Mechanical properties of steel exposed to heat

- Temperature > 200° C (>392° F) – modulus of elasticity decreases
- Temperature > 400° C (>752° F) – yield strength decreases, zinc starts to melt
- Temperature > 600° C (>1,112° F) – 50% of steel strength is lost
- If the temperature does not exceed 600° C (1,112° F), and there is no prolonged exposure, the mechanical properties return to their initial values after cooling down.
- If steel is exposed to temperatures above 600° C (1,112° F), for about 20 – 30 minutes, oxidation will appear on the surface, as well as pitting and a loss of cross-sectional thickness.
- If steel exposed to high temperature and fast cooling takes place due to fire water / chemicals quenching, embrittlement & loss of ductility is the result.

Phase Transformation in Wildfires



(a)

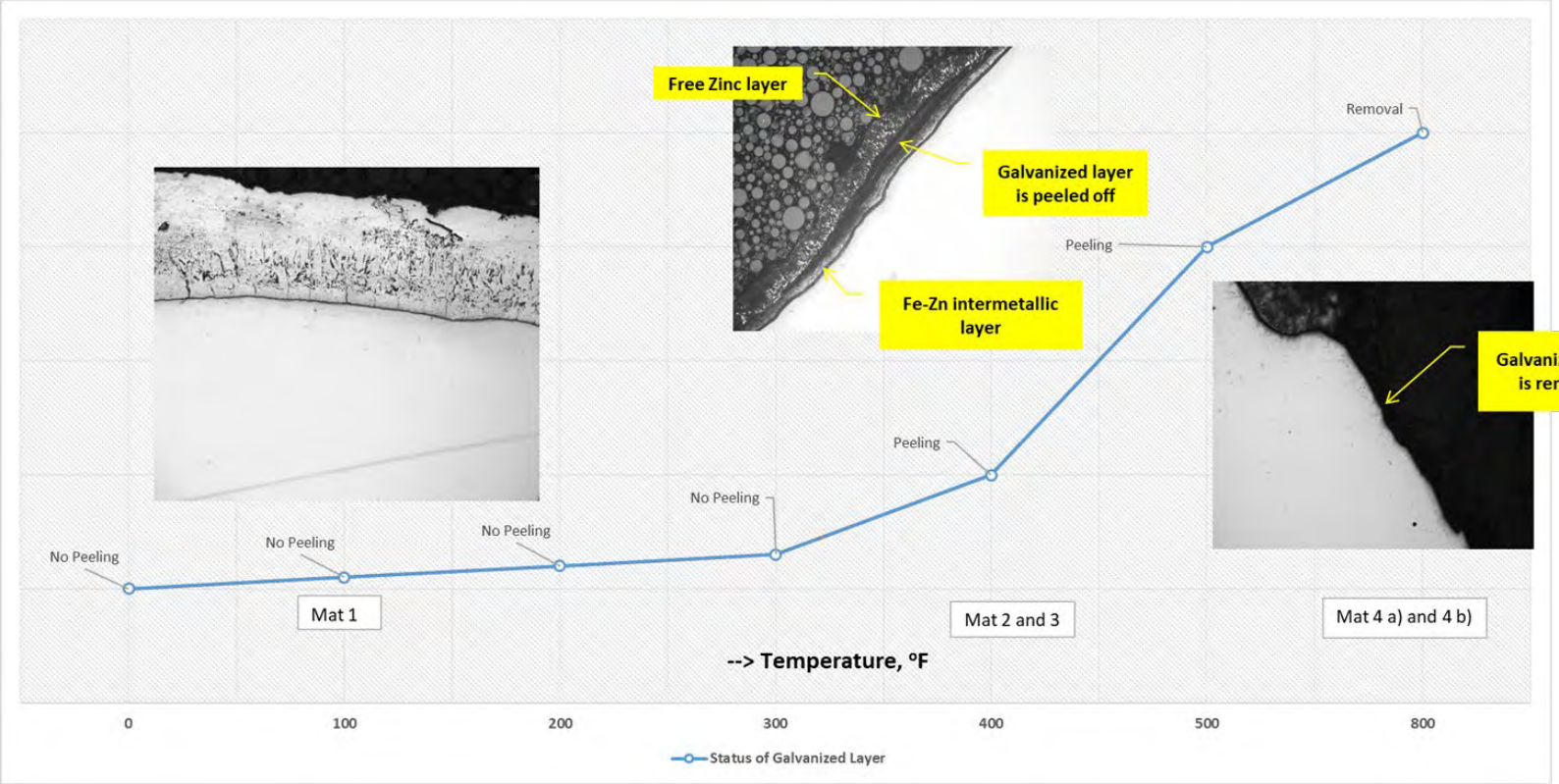


(b)

Cross section photomicrographs of pearlite (a) versus bainite (b); bainite being indicative of high-temperature exposure

Background

Damage to Galvanizing Due to Wildfires



Condition Assessment by NDT Techniques

Test	Readings
Corrosion Resistance Loss	-0.80 Volts (Acceptable) vs -0.40 Volts (Not Acceptable)
Concrete Strength Loss	4000 PSI (Acceptable) vs 1,500 PSI (Not Acceptable)
Metallography	Pearlite (Accptable) vs Martensitic Structure (Not Acceptable)
Hardness and Strength	90 HV (Accptable) vs 70 HV (Not Accptable)

Considerations for condition assessment and wildfire materials assessment of transmission and distribution structures

- Site documentation at the top of the structure, mid elevation and ground level by a metallurgist and drone pilot.
- Thermal imaging at the top of the structure and at a low elevation by drone.
- Dimensional measurement by drone pilot to determine presence or absence of deformation, corrosion products and risk analysis.
- On-site NDT measurements to determine mechanical integrity.
- On-site metallurgical inspection and surface potential measurements to determine any possible microstructure and corrosion issues. This includes on-site metallurgical hardness testing and electrochemical corrosion performance parameters: ER, EIS, on-site NDT metallurgical replica evaluation

Advantages of a Remote Sensor System

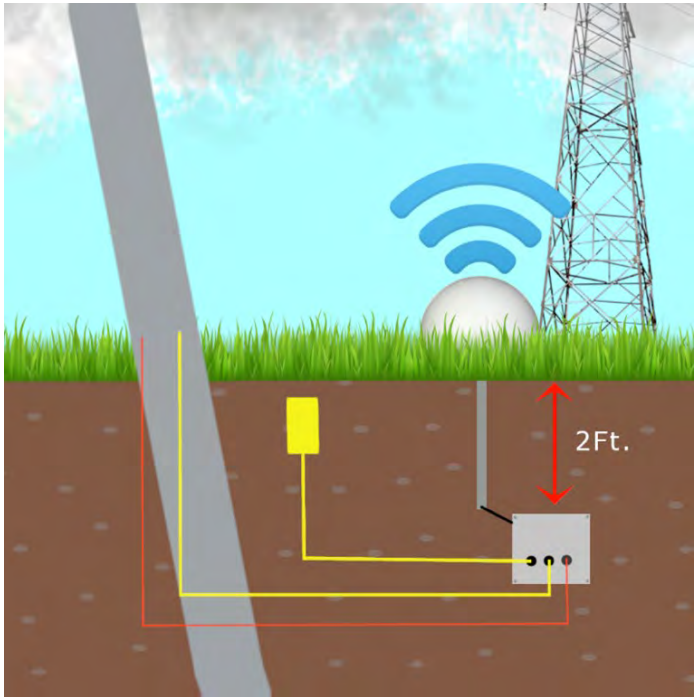
- Remote sensors could alert a utility of severe environmental conditions in real time
- Utilities could immediately implement emergency operations to minimize damage to system
- Remote Sensors could provide a record of temperatures which structures were exposed to determine the extent of damage

Advantages of a Remote Sensor System

- Remote sensors could monitor other conditions
  - Windspeed
    - Public Safety Power Shutoff (PSPS)
    - Provide data to design structures for nown local wind conditions
  - Corrosion activity at a structure
    - Corrosion mitigation measures
    - Cathodic Protection

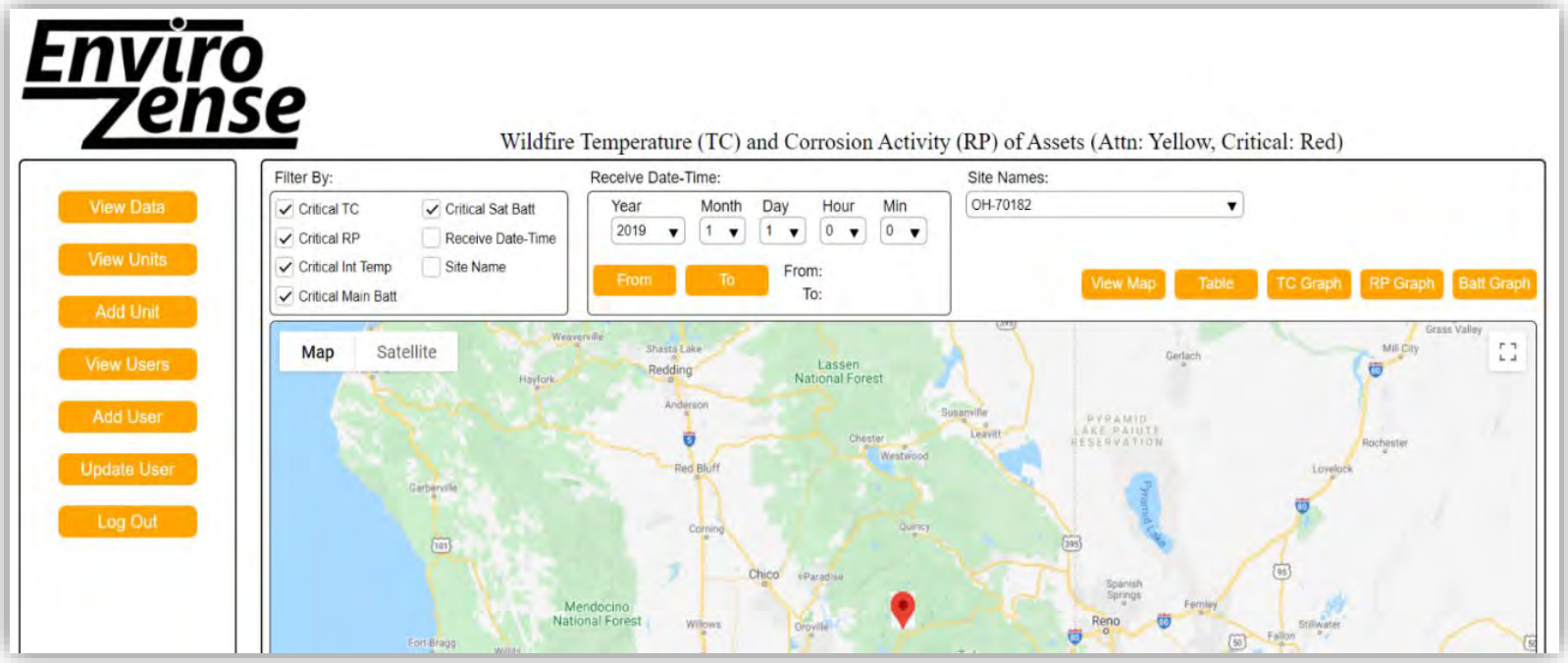
What is a Remote Sensor System?

- Autonomous system
- Programmed to monitor specific conditions



What is a Remote Sensor System?

- Data collected and sent by satellite to web based system
- Data displayed in real time on GIS map

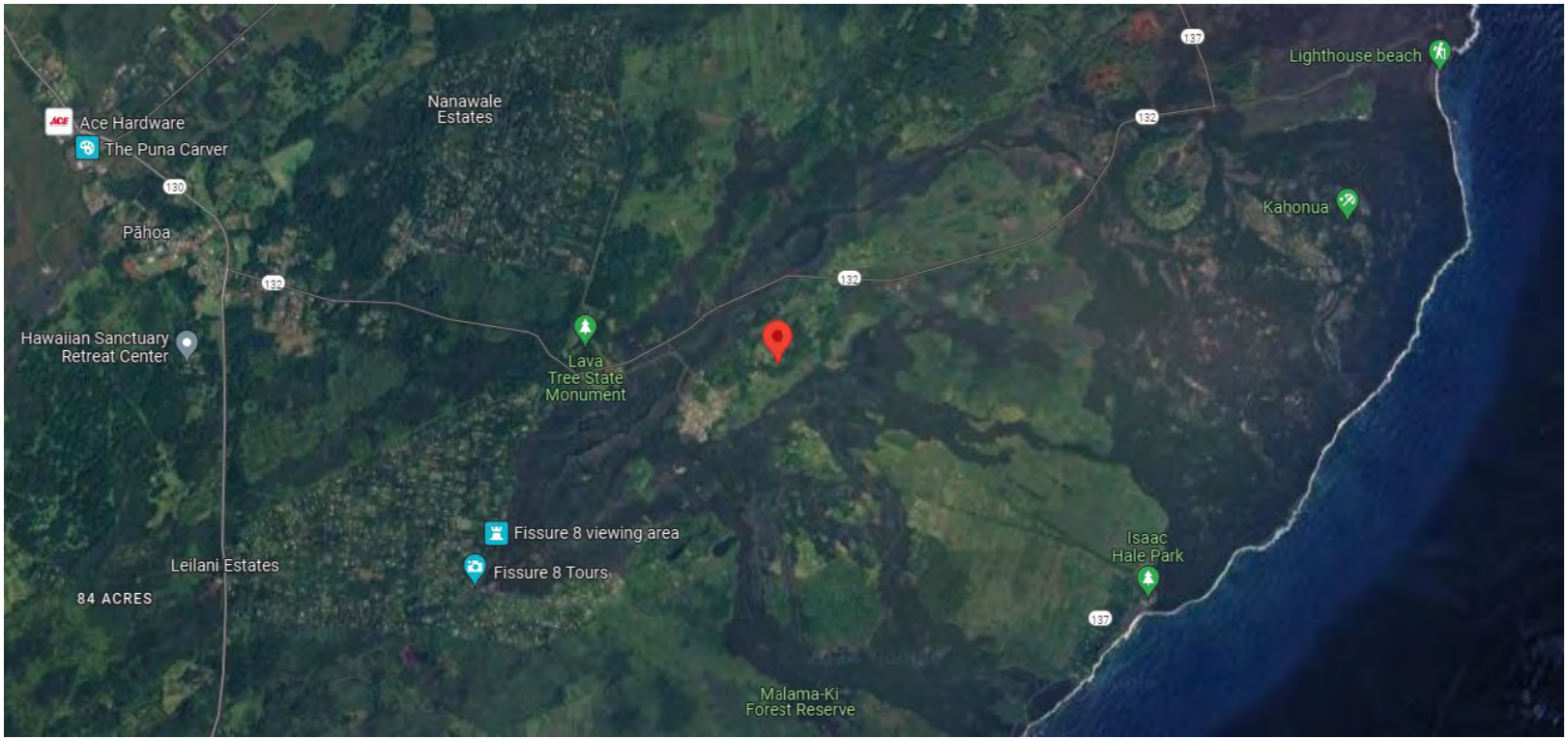


Case Study

- Telecommunications Company has several cell towers in remote locations in Hawaii
- Remote sensors were installed at key locations in May 2023
- One tower is located in Pahoa on the Big Island of Hawaii

Case Study

- Tower surrounded by 2018 lava flow



Case Study

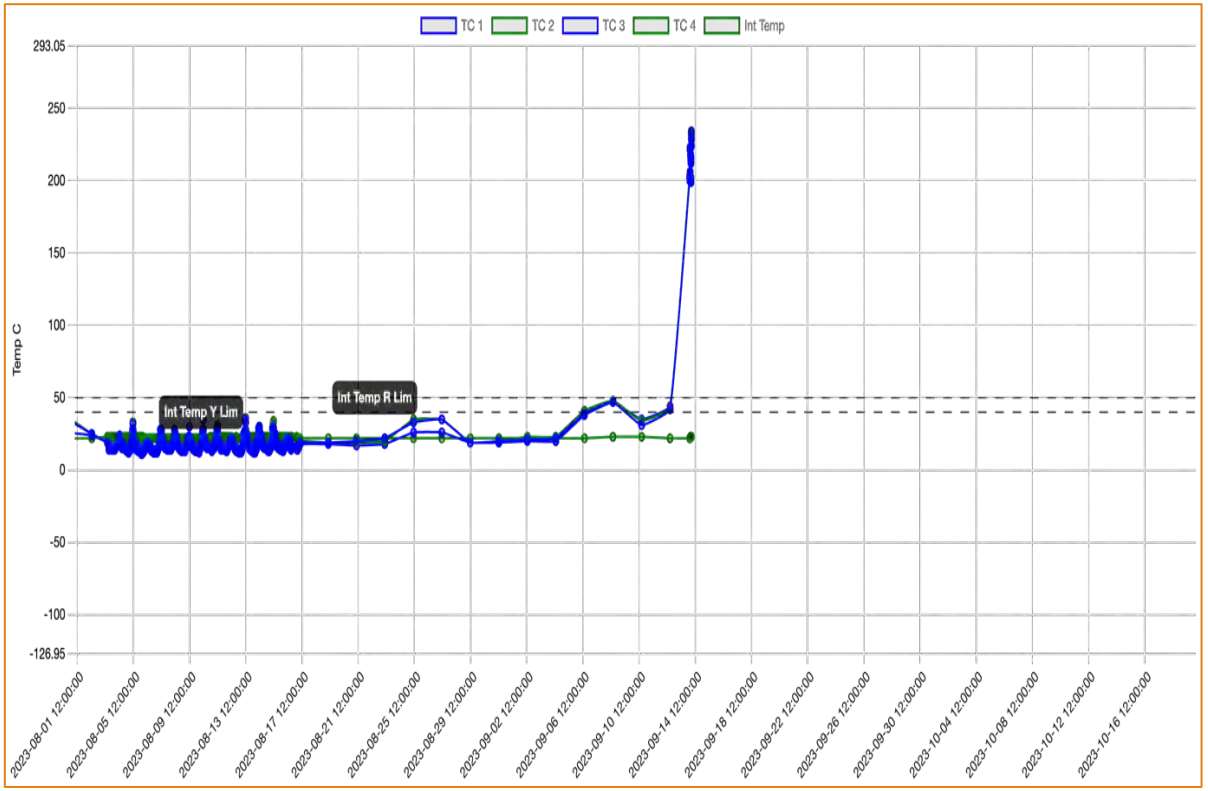
- Location of Tower

Case Study

- Matergenics Installed Remote Sensor
- Remote Sensor monitored
  - Environmental temperature
  - Ground temperature
  - Electrochemical potentials (to estimate ground corrosion activities)

Case Study

- Sep. 13, 2023 Remote Sensor reported spike in ground temperature



Case Study

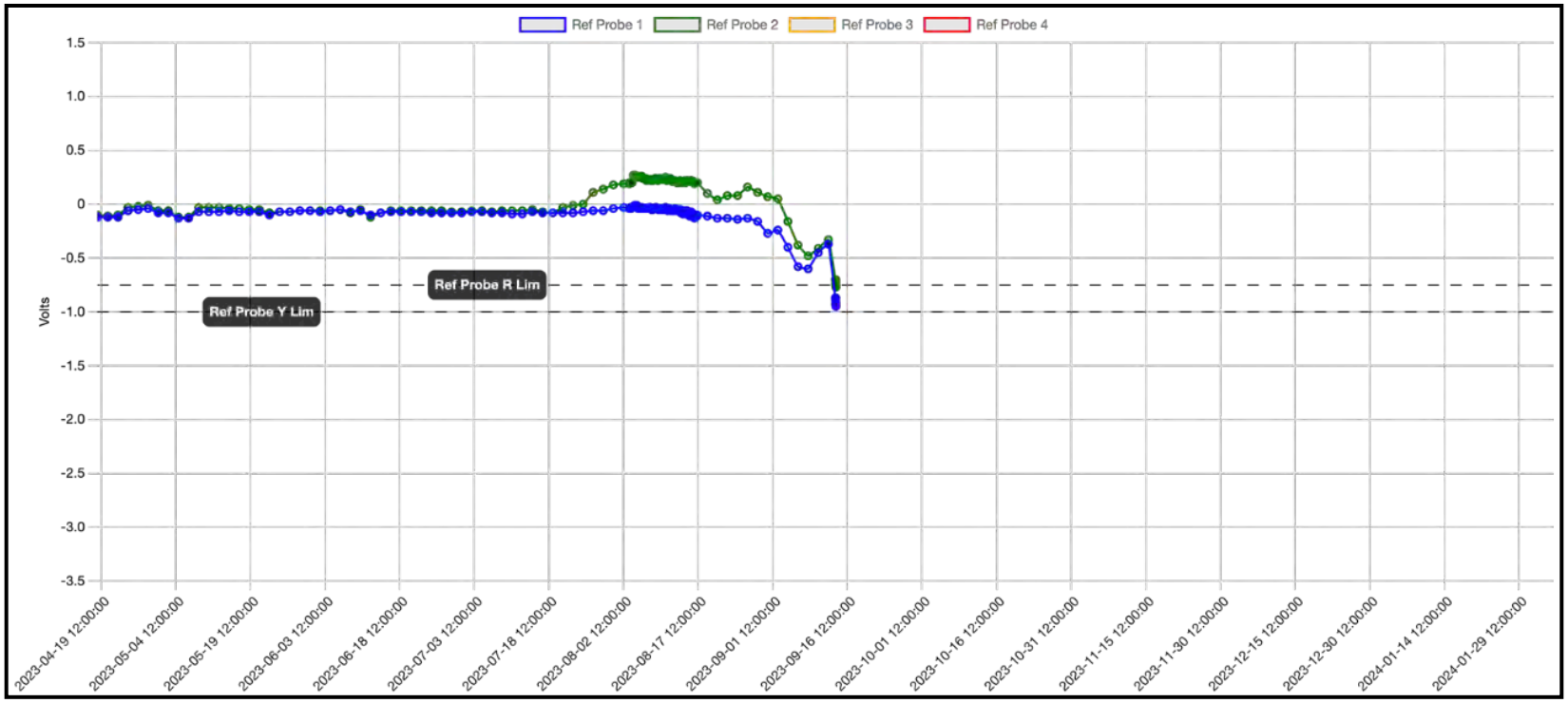
- In researching activities in Hawaii, Kilauea volcano erupted on that day.

Case Study

- Telecommunications Company was immediately notified of the temperature spike and they mobilized a team to inspect the tower
- Ground temperature spike was due to lava movement under ground at the tower location.

Case Study

- Change in Electrochemical Potential



Summary

- Remote Sensors can provide real time status of environmental conditions in a utility's service area
- Alarms could provide a utility with warnings when conditions out of the ordinary occur
- Uitlities can provide a proactive response to minimize damages to its system

Causes of Failures….

1. Materials do not fail. They follow the laws of nature, physics and chemistry perfectly.

2. All failures are caused by human errors.

3. Corrosion and Fatigue are long Term Life Limiting Mechanisms

Causes of Failures….

All failures are due to human errors

There are three basic types of human errors:

a) Errors of knowledge

b) Errors of performance (negligence)

c) Errors of intent (greed)

Training Course Makes a Difference

Questions?

West Power Energy

MATERGENICS
Materials and Energy Solutions

The Science of Tower Painting and Maintenance

Presented by: Michael MacDougall

“ Experiences with T&D Asset Corrosion Mitigation”

EDM
reliability & innovation

INTERNATIONAL CONFERENCE ON OVERHEAD LINES
April 15-18 2024 | Fort Collins, Colorado U.S.A.

towerpowergroup.com

Your Presenter:
Michael MacDougall

NACE Certified Coatings Inspector
Certified Corrosion Technician
35 Years Experience
Painting and Inspecting
Transmission and Radio Towers

Tower Painting Science....Simplified

The Reality...and Problem

The Clarity...and Solution...

Next Steps...?

The REALITY

- **Average age of towers > 40 yrs.**
- **Galvanizing applied at 4 mil ablates on average at 1mil per 10 Years (typ.)**
- **Surface corrosion progresses to material loss rapidly**
- **Very High replacement cost values**

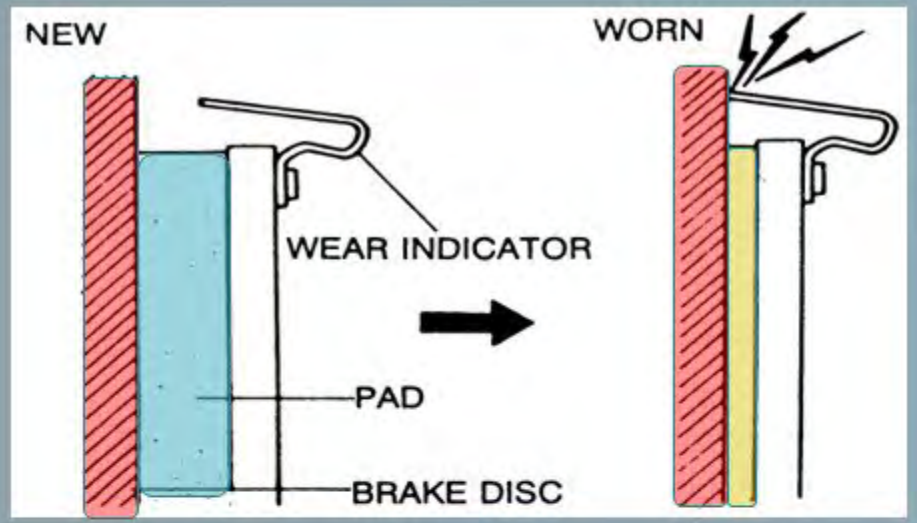
...and even more REALITY

1. Cost to Paint Tower Prior to Assembly/Erection: $5,000

2. Cost to Paint Tower in Field post Erection: $50,000

3. Cost to Replace Tower: $500,000

4. Cost to Replace Tower because we didn’t do 1, 2 or 3 : $5,000,000



The Importance of Timing

Clarity...
When to Paint?

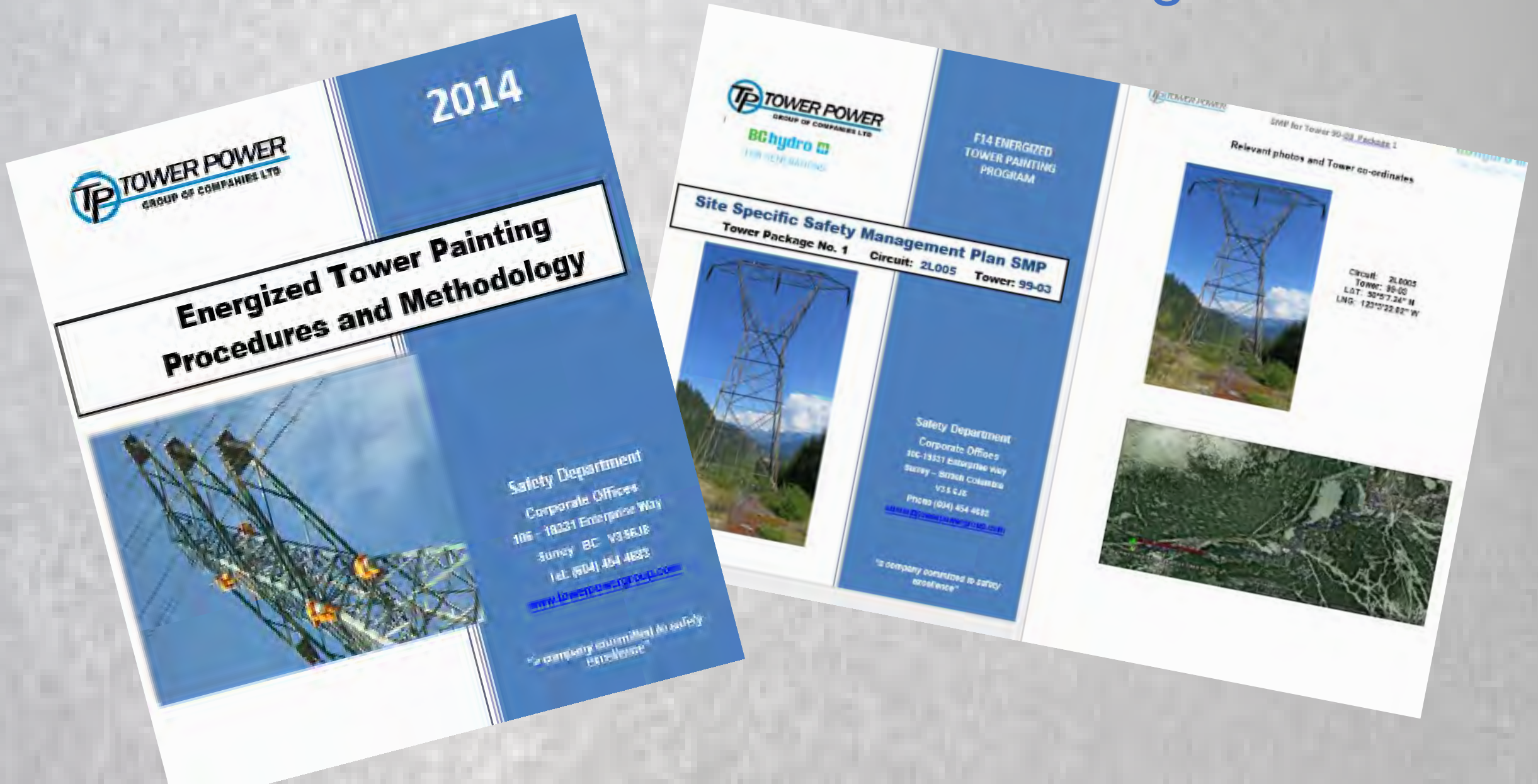
"Who ya gonna call?"

- **What makes a company?**
- **Linemen vs Tower Painters**
- **Training Programs**
- **Affiliations and Certifications**
- **Planning for:**
  - **Quality – Safety - Environmental**

Considerations for Qualified Painters

- Certifications in Safe Climbing, Rigging and Rescue
- NACE – SSPC - AMPP Accreditations
- Corrosion and Product knowledge

Procedures and Methodologies



Did anyone think of?

- 3RD PARTY INSPECTION & QUALITY CONTROL TEAM
- LEAD / HAZARDOUS COATINGS
- COATING SYSTEMS
- SPECIFICATIONS

The Science of Tower Painting and Maintenance

GO AHEAD AND ASK...

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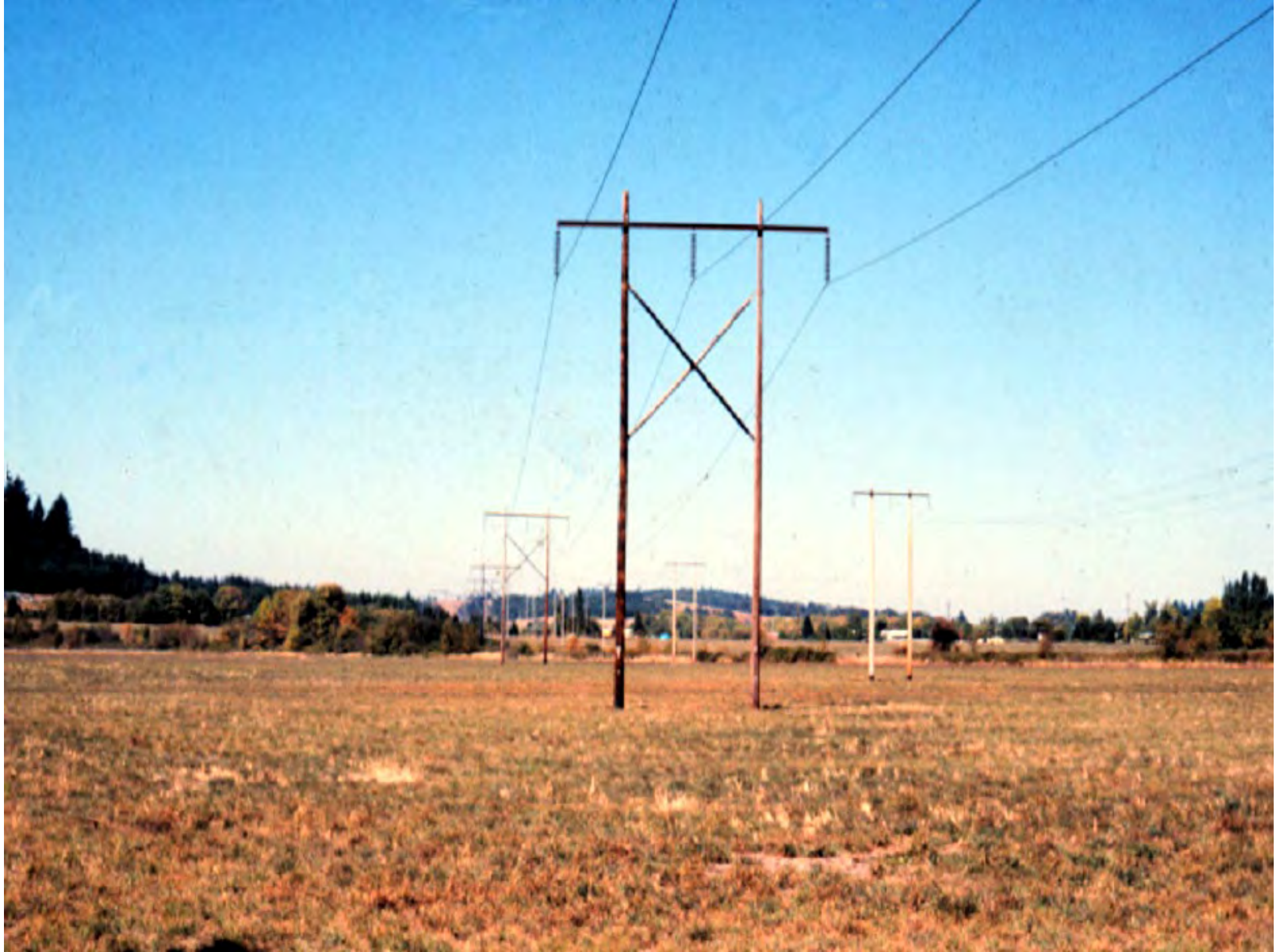


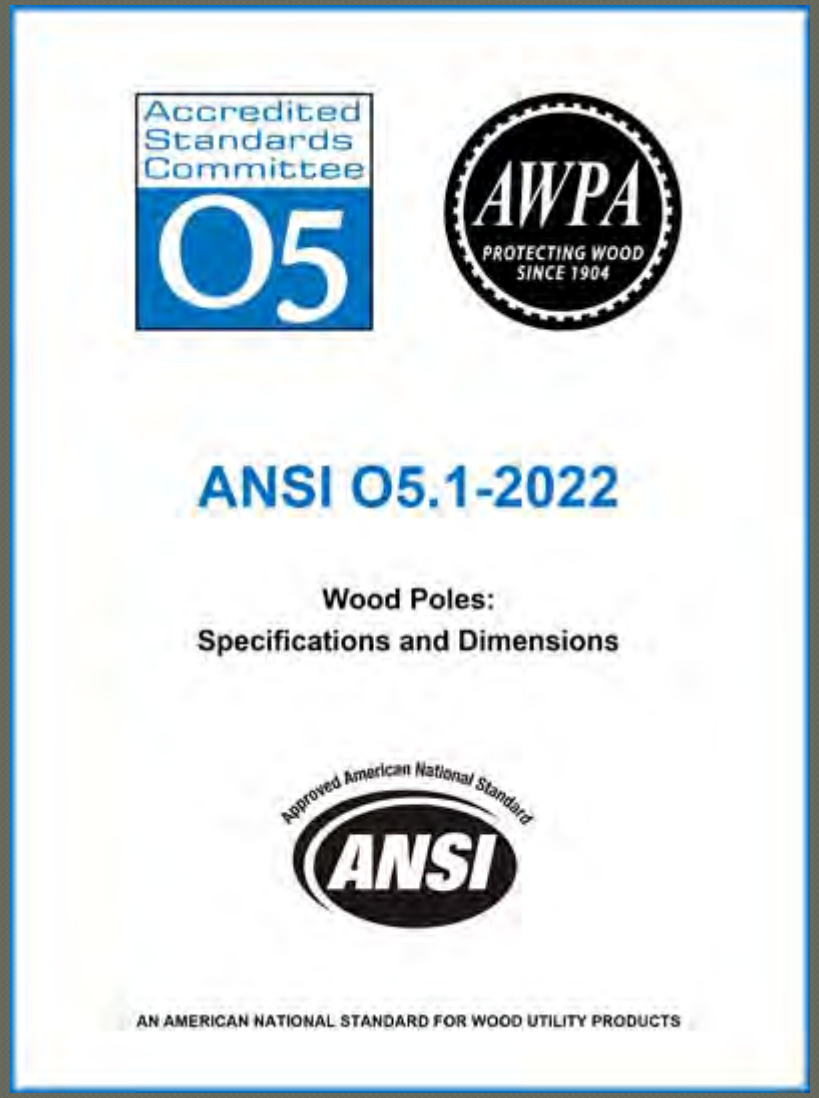
AFTER PENTA: WHAT COMES NEXT?

University of the Sunshine Coast Australia

Oregon State University

Initial Specifications

- Material
- Pre-treatment handling
- Preservative
- Process limits/BMP’s
- QC/Inspection


Accredited Standards Committee
O5
AWPA
PROTECTING WOOD SINCE 1904
ANSI O5.1-2022
Wood Poles:
Specifications and Dimensions
Approved American National Standard
ANSI
AN AMERICAN NATIONAL STANDARD FOR WOOD UTILITY PRODUCTS

American National Standards Institute (ASC 05.1)

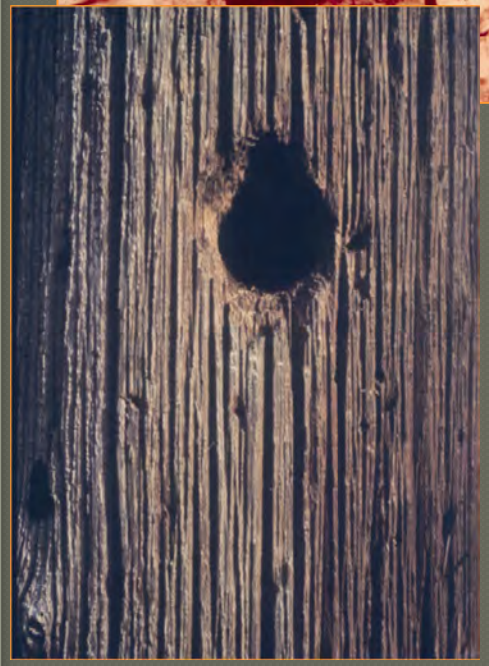
- Sets white wood standards
- Defines strength properties
- Pole classes/lengths
- Defines defect limits (knots, checks, grain etc)

Southern pines (*Pinus* spp.)

Pseudotsuga menziesii
Douglas-fir

Thuja plicata
western redcedar

Deteriorating Agents



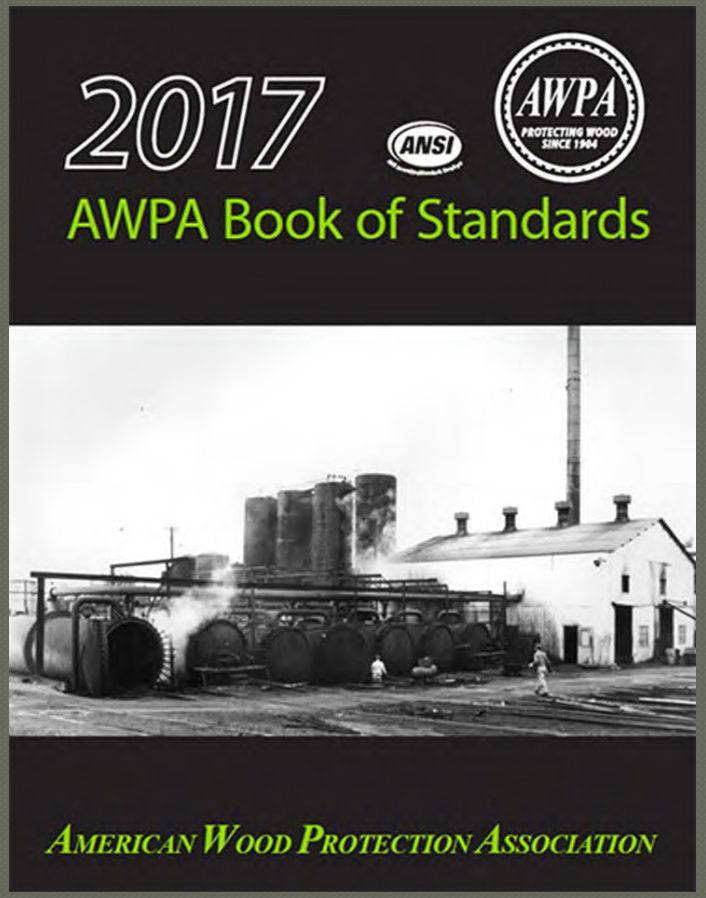
Most Poles are Preservative Treated

Treatment Goals

- Protect sapwood
- Create protective shell
- Enhance water repellency
- Sterilize

AWPA Standards

- Voluntary
- Consensus
- Results oriented
- Protect consumer
- ANSI accredited



AWPA Standards

- Preservatives
- Treatments
- Analytical methods
- Test methods
- Protocols for Standardization

AWPA Use Category System

Category	Application	Examples
UC1	Interior- insects only	Framing
UC2	Interior- but can be wetted	Framing
UC3A/3B	Above ground exterior	Decking/Joists/Crossarms
UC4A/4B/4C	Ground contact	Timbers, Poles, Piling
UC5A/5B/5C	Marine (Salt water)	Piling/Bulkheads

In-Ground Decay Hazard

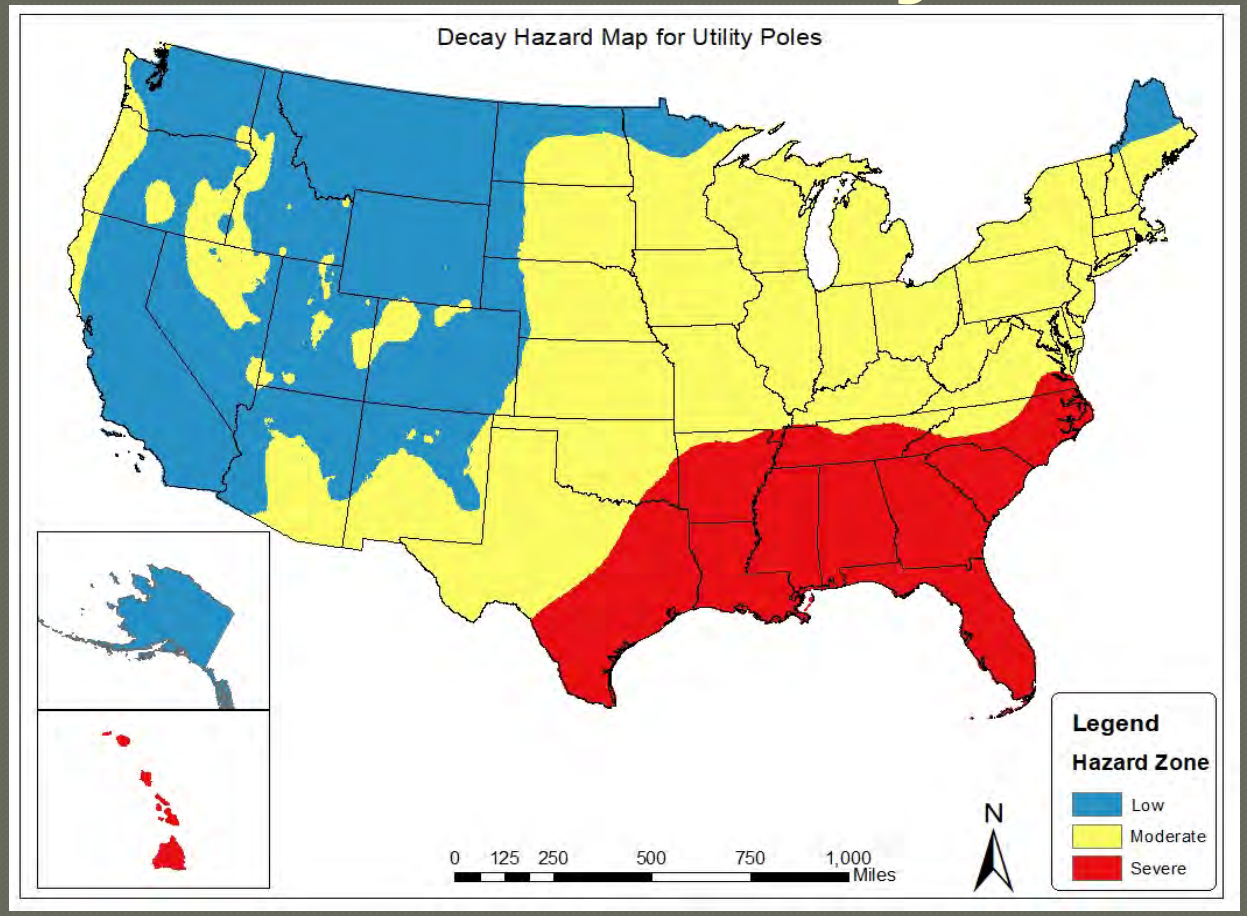


Figure 1. Major regional differences in potential for deterioration of wood poles used in contact with the ground. In certain modified environments such as banks along irrigation canals or irrigated residential or agricultural lands, a higher degree of protection might be needed than would be required in the local natural environment. It must also be recognized that within individual regions, certain natural environments such as river valleys or coastlines may present greater potential for wood pole deterioration than the region as a whole. Refer to Section 1.4.1 above for further discussion of ground contact decay hazards.

Oil vs Waterborne Systems

OILBORNE

- Some water repellency
- Reduced checking (?)
- Easier to climb
- Reasonable fire resistance
- Solvents (oil) expensive

WATERBORNE

- Preservatives fix to wood
- No water repellency
- Harder to climb
- Copper systems can combust
- Solvent (water) is less expensive

Preservative Options

- DCOI (oil)
- Creosote
- Copper naphthenate (oil)
- ~~Pentachlorophenol~~
- Chromated copper arsenate
- Ammoniacal copper zinc arsenate
- Ammoniacal copper quat
- Copper azole

Oilborne Preservatives

	%	
Creosote	~10	Highly effective, can sensitize skin
~~Pentachlorophenol~~	~~30~~	Highly effective but removed from the market
Copper naphthenate	5	Highly effective, lower toxicity
DCOI	~	Developed in 1980's but only recently used for poles

Waterborne Systems

System	%	Characteristics
Chromated copper arsenate (CCA)	40	Highly effective, fixes to the wood, combustion issues
Ammoniacal copper zinc arsenate (ACZA)	<2	Highly effective, used for Douglas-fir, combustion issues
Alkaline copper quaternary (ACQ)	?	Effective, but not used
Alkaline copper azole (CA)	?	Likely effective, but not used

How are chemicals standardized?

How are chemicals standardized?

Sundance Investments, LLC

AWPA Standardization Process

- Users, Producers & General Interest
- Standardize chemical
- Standardize treatment by use/species
- Voluntary minimum results standards
- Goal is to protect consumer

Treatment Standards

- Examine decay hazard
- Assess treatment by species
- Confirm lack of negative treatment effects
- Retention/penetration specific for use and species
- Identify process variables (steaming, fixation, etc)

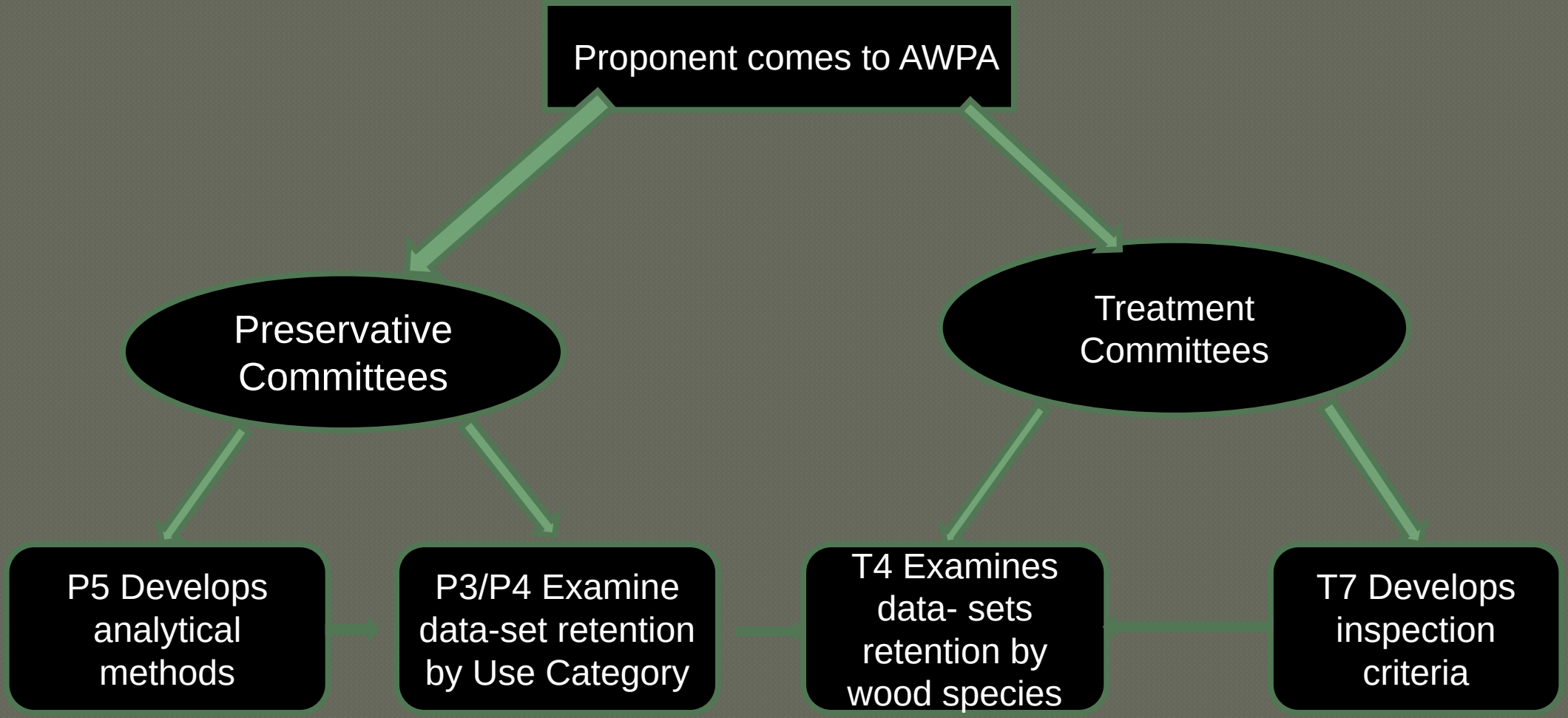

Proponent comes to AWPA
Preservative Committees
Treatment Committees
P5 Develops analytical methods
P3/P4 Examine data-set retention by Use Category
T4 Examines data- sets retention by wood species
T7 Develops inspection criteria

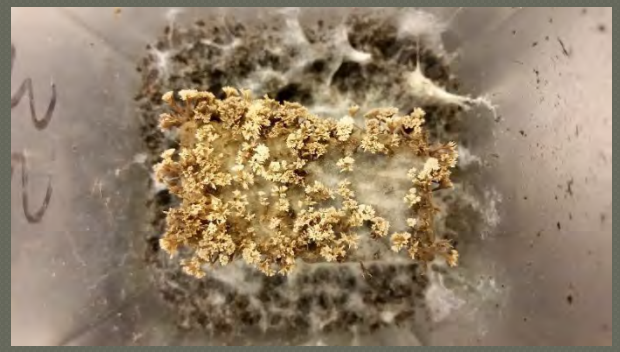
Table 1. Data required to support a proposal to list a new wood preservative system in the AWPA Standards, make major or minor modifications to an AWPA-listed preservative, or expand the applications for a listed wood preservative into new use categories (Source: AWPA Guidance Document A).

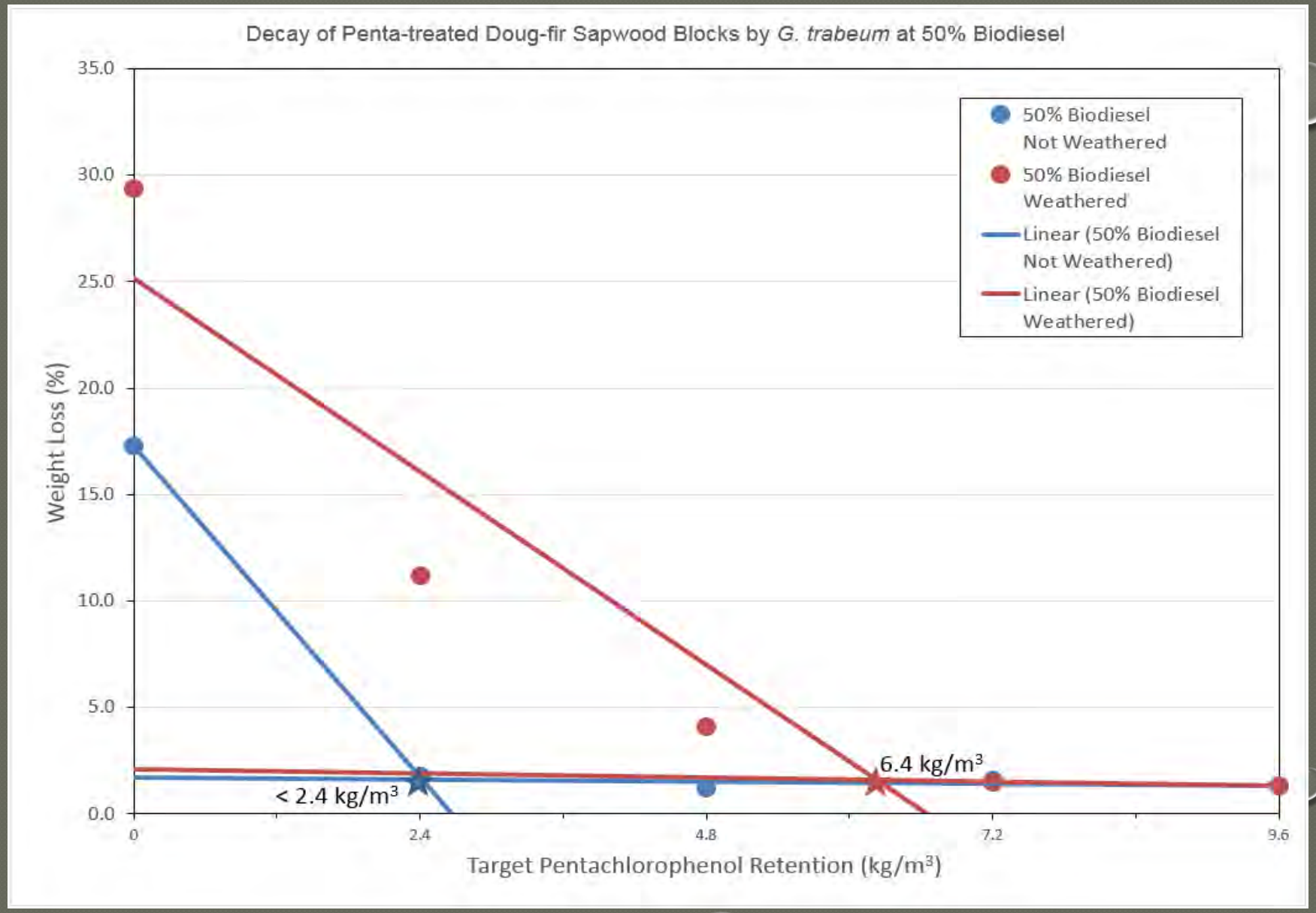
Requirement	Use Category					
	UC1	UC2	UC3A	UC3B	UC4A-C	UC5A-C
Preservative Efficacy						
Laboratory Efficacy						
Basidiomycetes		M	M	M	M	M
Soft rot	-	-	-	-	M	M
Termites	M	M	M	M	M	M
Simulated field tests						
Fungus cellar	-	-	R	R	R	R
Field Testing						
Field stakes	-	-	R	R	M	M
Posts	-	-	-	-	R	R
Above-ground	-	-	M	M	-	-
Termites	M	M	M	M	M	M
Marine	-	-	-	-	-	M
Preservative Depletion						
Laboratory tests						
Water leaching	-	R	M	M	M	M
Soil leaching	-	-	-	-	R	M
Evaporative aging[a]	M	M	M	M	M	M
Field Depletion						
Field Stake	-	-	-	-	M	M
Above ground	-	-	M	M	-	-
Marine panels	-	-	-	-	-	M
Physical Properties						
Strength	M	M	M	M	M	M
Electrical conductivity	-	-	-	M	M	-
Hygroscopicity	M	M	M	M	M	M
Corrosion	M	M	M	M	M	M
Preservative corrosivity	M	M	M	M	M	M
Preservative fixation rate[b]	R	R	R	R	R	R

Data required to support a proposal to list a new wood preservative system in the AWPA Standards (Source: AWPA Guidance Document A).						
Requirement	Use Category					
	UC1	UC2	UC3A	UC3B	UC4A-C	UC5A-C
Preservative Efficacy						
Laboratory Efficacy						
Basidiomycetes		M	M	M	M	M
Soft rot	-	-	-	-	M	M
Termites	M	M	M	M	M	M
Simulated field tests						
Fungus cellar	-	-	R	R	R	R
Field Testing						
Field stakes	-	-	R	R	M	M
Posts	-	-	-	-	R	R
Above-ground	-	-	M	M	-	-
Termites	M	M	M	M	M	M
Marine	-	-	-	-	-	M
Preservative Depletion						
Laboratory tests						
Water leaching	-	R	M	M	M	M
Soil leaching	-	-	-	-	R	M
Evaporative aging[a]	M	M	M	M	M	M
Field Depletion						
Field Stake	-	-	-	-	M	M
Above ground	-	-	M	M	-	-
Marine panels	-	-	-	-	-	M
Physical Properties						
Strength	M	M	M	M	M	M
Electrical conductivity	-	-	-	M	M	-
Hygroscopicity	M	M	M	M	M	M
Corrosion	M	M	M	M	M	M
Preservative corrosivity	M	M	M	M	M	M
Preservative fixation rate[b]	R	R	R	R	R	R


EXIT 7
40
Laboratory
1/4 MILE

Source: Jed Cappellazzi, OSU





Source: Jed Cappellazzi, OSU

Stake Tests

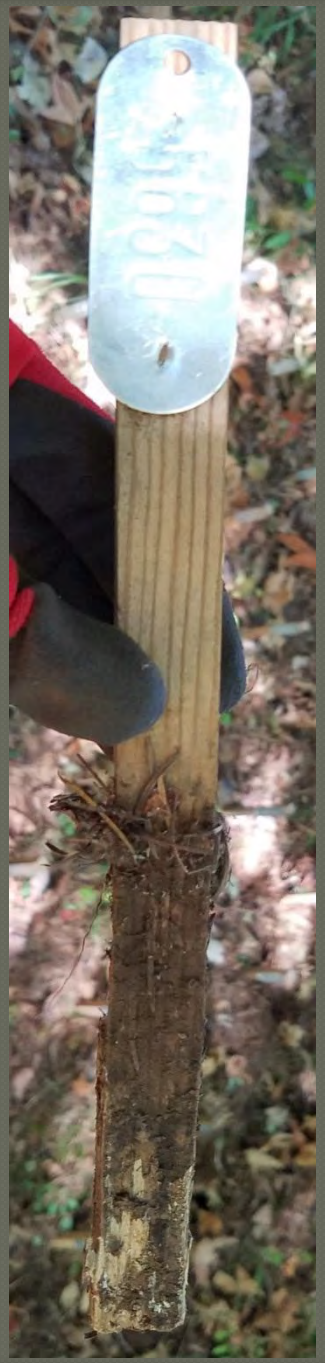
Penta (kg/m^3)
0.0, 2.4, 4.8, 7.2, 9.6

CuNaph (kg/m^3)
0.00, 0.66, 0.99, 1.33, 1.66

Source: Jed Cappellazzi, OSU

Test sites

Source: Jed Cappellazzi, OSU

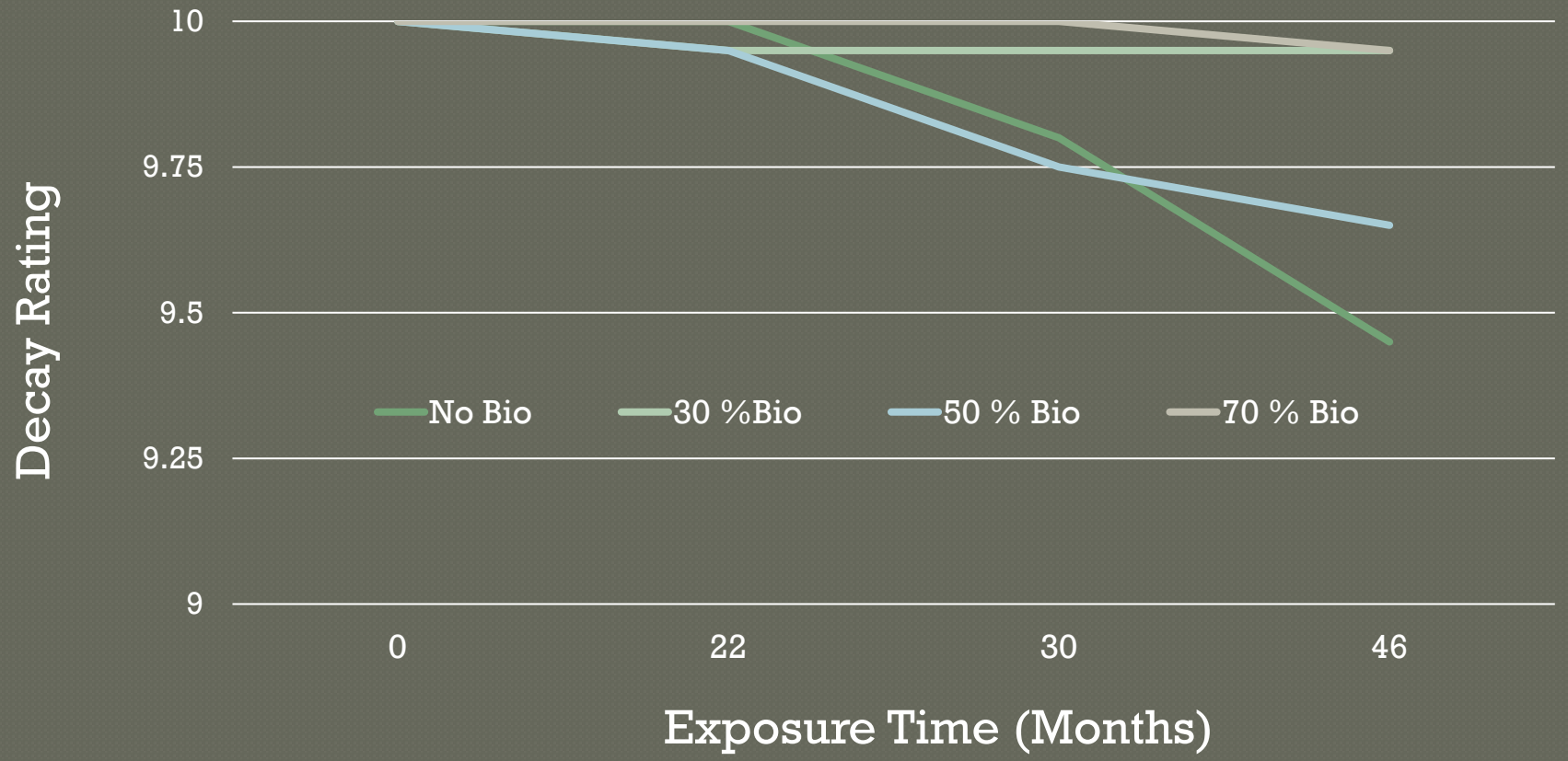







Source: Jed Cappellazzi, OSU

Penta in Biodiesel (Field)



Source: Jed Cappellazzi, OSU

Oregon State University
College of Forestry

1906
2006

Legacy of Excellence • Future of Possibilities

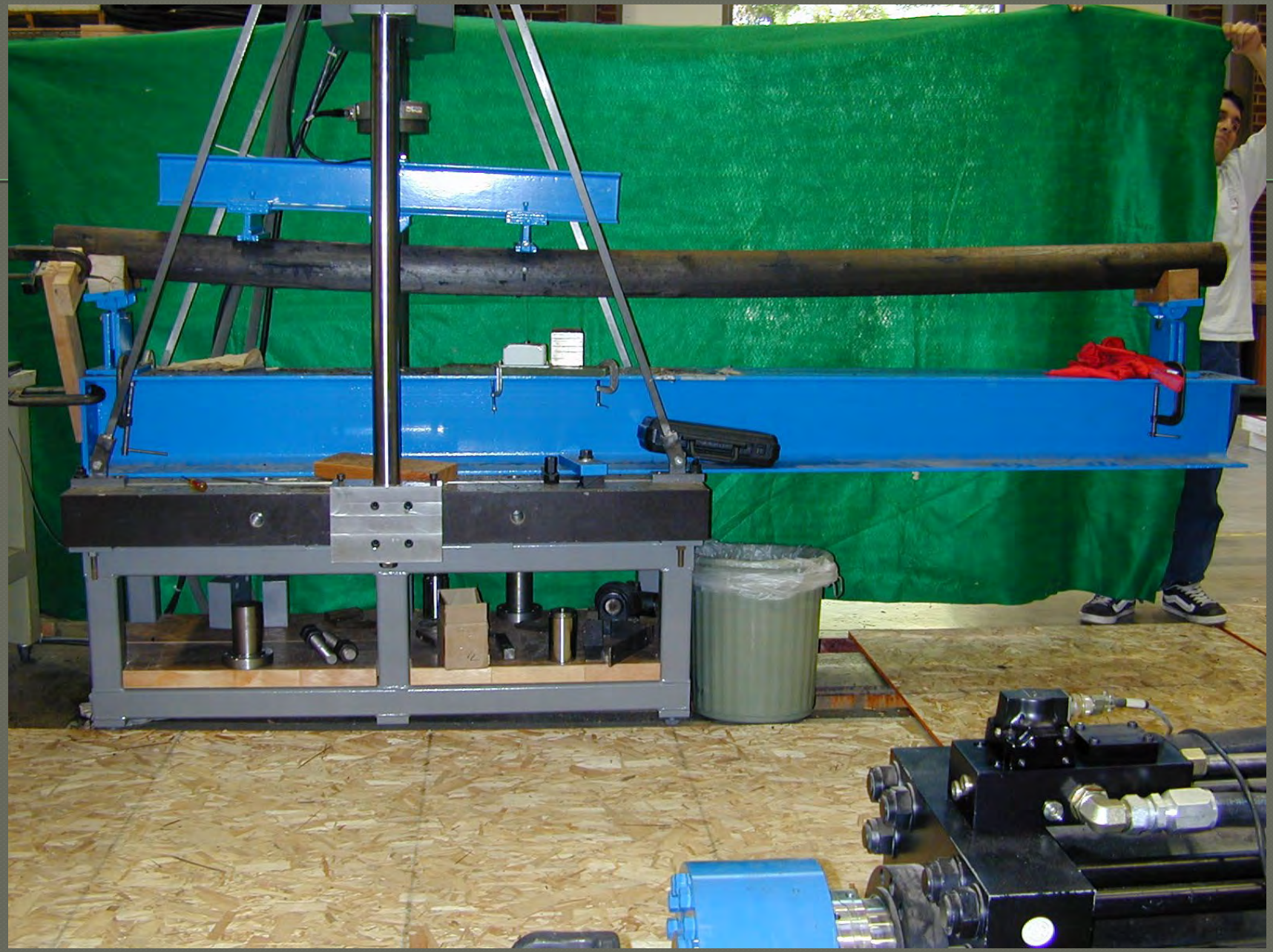
Post Tests

Pole Tests

Source: Jed Cappellazzi, OSU

Other Tests

Corrosion
Climbing/Hardness
Strength effects
Fire resistance



Pole Fire Retardants

Burning

Standardising Chemicals

- Laboratory efficacy
- Field testing
- Leaching studies
- Corrosion studies
- Strength studies
- Chemical analysis
- Other attributes

Data required to support a proposal to list a new wood preservative system in the AWPA Standards (Source: AWPA Guidance Document A).						
Requirement	Use Category					
	UC1	UC2	UC3A	UC3B	UC4A-C	UC5A-C
Preservative Efficacy						
Laboratory Efficacy						
Basidiomycetes		M	M	M	M	M
Soft rot	-	-	-	-	M	M
Termites	M	M	M	M	M	M
Simulated field tests						
Fungus cellar	-	-	R	R	R	R
Field Testing						
Field stakes	-	-	R	R	M	M
Posts	-	-	-	-	R	R
Above-ground	-	-	M	M	-	-
Termites	M	M	M	M	M	M
Marine	-	-	-	-	-	M
Preservative Depletion						
Laboratory tests						
Water leaching	-	R	M	M	M	M
Soil leaching	-	-	-	-	R	M
Evaporative aging[a]	M	M	M	M	M	M
Field Depletion						
Field Stake	-	-	-	-	M	M
Above ground	-	-	M	M	-	-
Marine panels	-	-	-	-	-	M
Physical Properties						
Strength	M	M	M	M	M	M
Electrical conductivity	-	-	-	M	M	-
Hygroscopicity	M	M	M	M	M	M
Corrosion	M	M	M	M	M	M
Preservative corrosivity	M	M	M	M	M	M
Preservative fixation rate[b]	R	R	R	R	R	R

Time to Standardisation

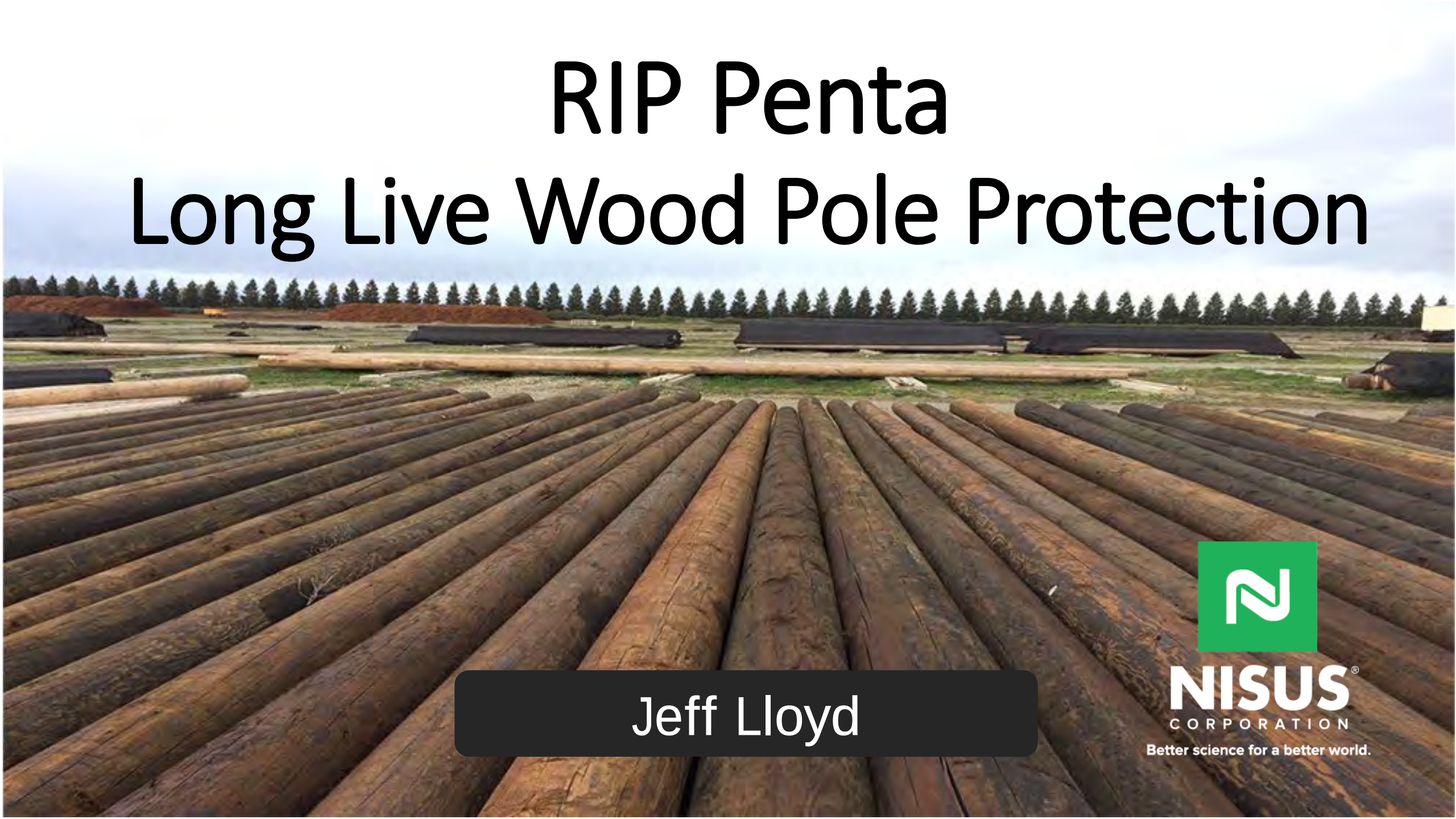
Application	~Time (Yrs)
Interior (UC1/2)	1-3 years
Exterior Above Ground (UC3A/3B)	>3 years
Exterior in Ground (UC4A)	3-6 years
Exterior in-Ground-Critical (UC4A-C)	>6 years
Marine (UC5A-UC5C)	>6 years

Take-aways

- All AWPA Standardised systems for poles will work
- Chemical choice based upon utility preferences and prior experience
- Many options for penta replacements
- Wood poles remain a reliable, sustainable option for supporting overhead lines


FEELING
POWER
HUNGRY
?

RIP Penta
Long Live Wood Pole Protection



Jeff Lloyd

NISUS® CORPORATION
Better science for a better world.

EPA DECISION ON PENTA

- Registration Review started in **2014**
- Final Decision announced in early **2022**
- “pentachlorophenol causes an unreasonable **adverse effects** on the human health and therefore does not meet the FIFRA registration standard”
- EPA “is requiring the **cancellation** and phase-out of all registered products containing chlorophenol…”
- “penta **causes cancer** by breathing penta or by having it exposed to the skin.”
- Cancellation 2/29/2024 effective date
- Sale and distribution allowed until **2/29/2024**
- Use permitted until **2/28/2027**

PROVEN ALTERNATIVES

Creosote QNAP Penta CCA

Typical colors for treated pine poles

WHICH SHOULD YOU CHOOSE?

1. Independently demonstrated performance (> **65** years in service)
2. Safety (e.g. no **DANGER** label not a **Sensitizer** or **Carcinogen**)
3. Completed EPA **re-registration** & risk assessment
4. Reliability of Supply (e.g. **Made in USA**)
5. End-of-life options (e.g. meets EPA legitimacy criteria and **NHSM** rule)

EXPERTS YOU COULD ASK

Ken Laughlin
Former AWPA President
Treatment plant manager, sales VP Pacific Wood & Nisus corporation (Rtd)

Patrick Durham
Environmental Program Manager, Sacramento Municipal Utility District (Rtd)

Dave Koch
Pole Treater & Supplier
General Manager Timber Division, Wheeler Lumber

OTHER PROPERTIES TO CONSIDER

- Easy gaff penetration?
- Non-conductive/good BIL?
- Non-corrosive to utility line hardware?
- Proven on Douglas Fir and Southern Pine for 65 years?
- Recycled and recyclable?

No After-Glow

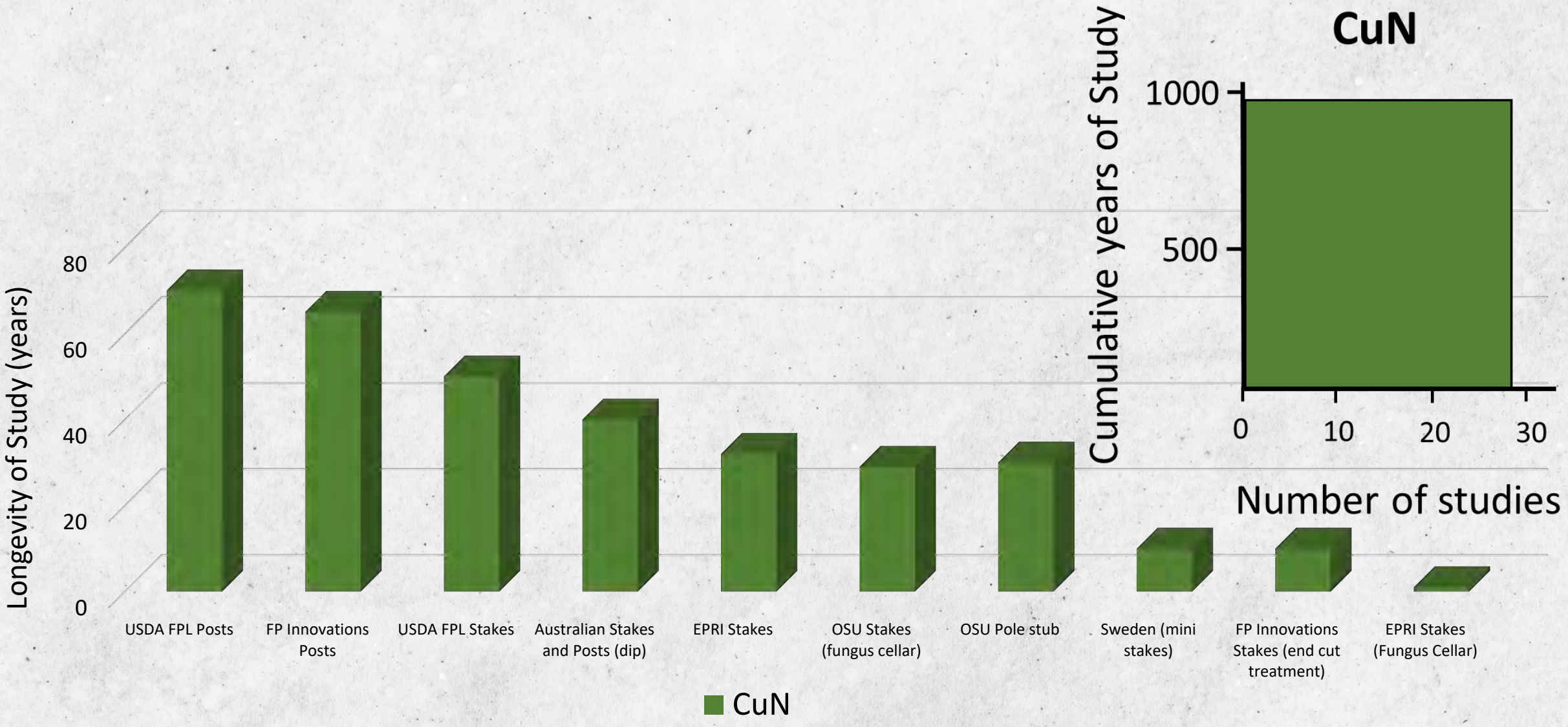
PICK ONE THAT IS WELL PROVEN

OLDEST FIELD TESTS

73 year Posts in Test

Stirling et al. (2017)

1000 YEARS OF EFFICACY STUDIES



50 DIFFERENT WOOD PRESERVATIVES TESTED BY USDA

AMERICAN WOOD-PRESERVERS' ASSOCIATION

A Comparison of Wood Preservatives in Posts in Southern Mississippi: Results from A Half-Decade of Testing

Mike H. Freeman
Independent Wood Scientist

Douglas Crawford
USDA Forest Products Lab

Patricia Lebow
USDA Forest Products Lab

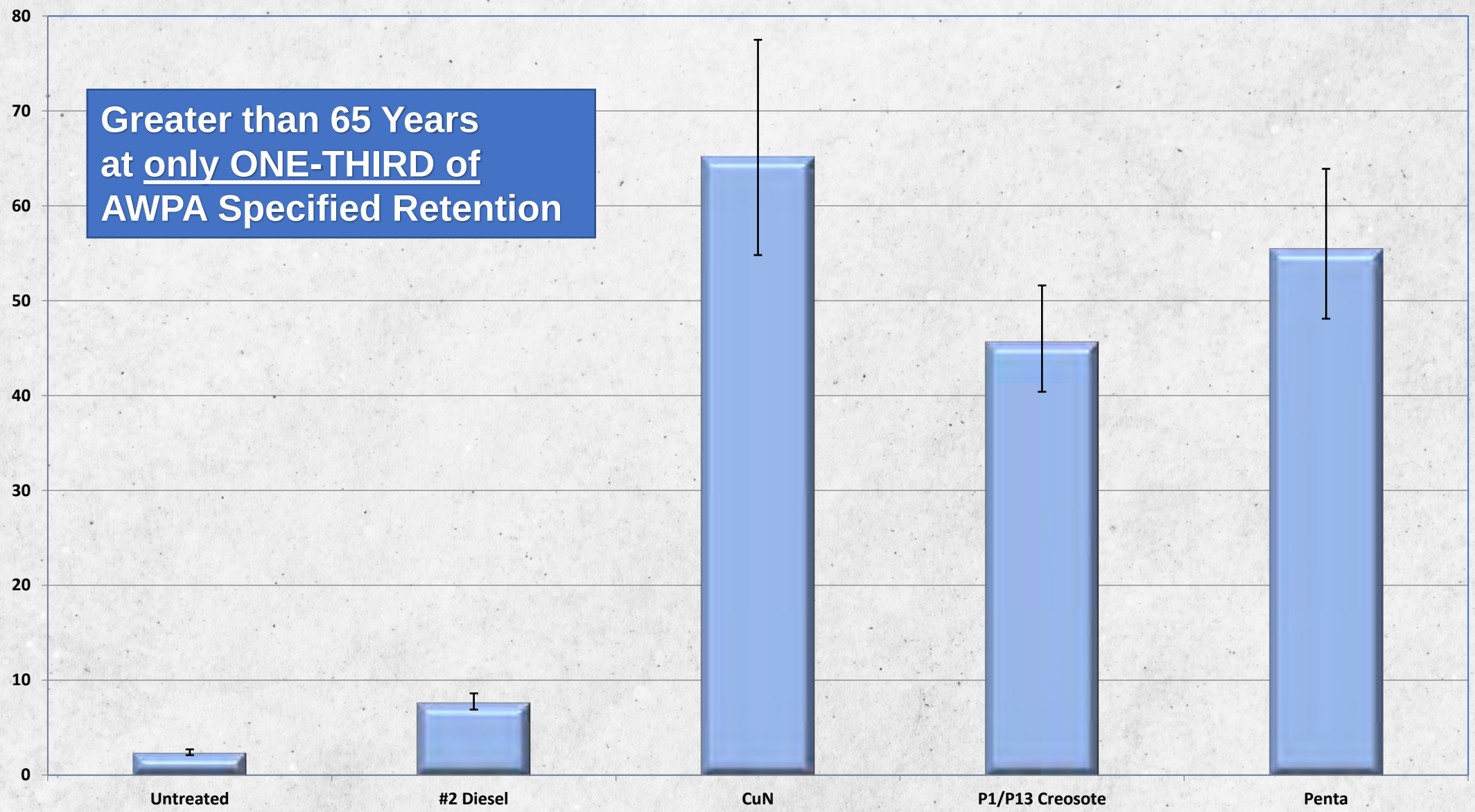
James A. Brient
Merichem

Abstract: Wood preservatives extend the useful service life of all wooden commodities used above ground and in ground contact. Over 50 years ago, the USDA-Forest Products Lab established tests in a high decay and high termite hazard zone in southern Mississippi. During the last five decades, periodic reports have been issued by researchers located at the USDA-FPL, in Madison, WI, on the efficacy and performance of southern pine fence posts treated with a variety of wood preservatives. Since 1977, no report has been issued by the USDA-FPL on the performance of these various preservatives in southern pine posts. This study was undertaken to evaluate the long-term efficacy of over 50 wood preservatives in southern pine wood in ground contact.

This study reassessed the condition of the treated wood posts in southern Mississippi, and statistically calculated the new expected post life span. It was determined that commercial wood preservatives, like pentachlorophenol in oil, creosote, and copper naphthenate in oil, provided excellent protection for posts, with life spans now calculated to exceed 60 years. Surprisingly, creosote and penta treated posts at 75% of the recommended AWPA retention, and Copper Naphthenate at 50% of the required AWPA retention, gave excellent performance in this AWPA Hazard Zone 5 site. Untreated southern pine posts lasted 2 years in this test site.

ESTIMATED AVERAGE SERVICE LIFE

(60th Percentile with 90% CL; USDA FPL RN-01)



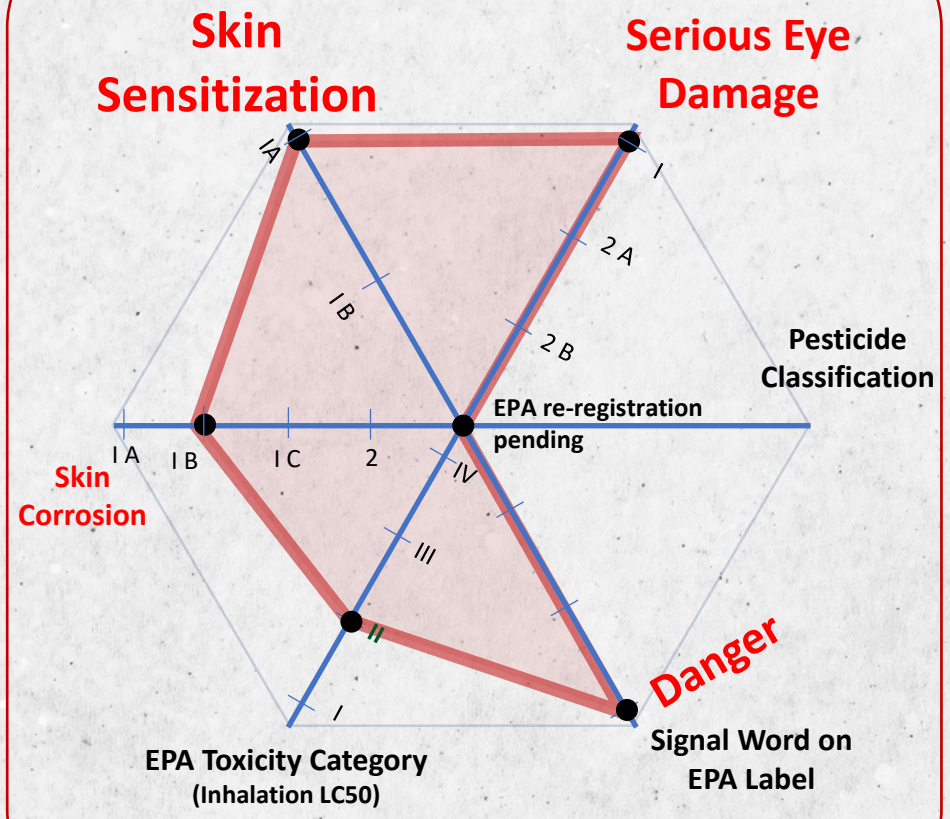
WHICH WOOD IS SAFEST FOR YOUR EMPLOYEES AND CUSTOMERS?

NISUS CORPORATION

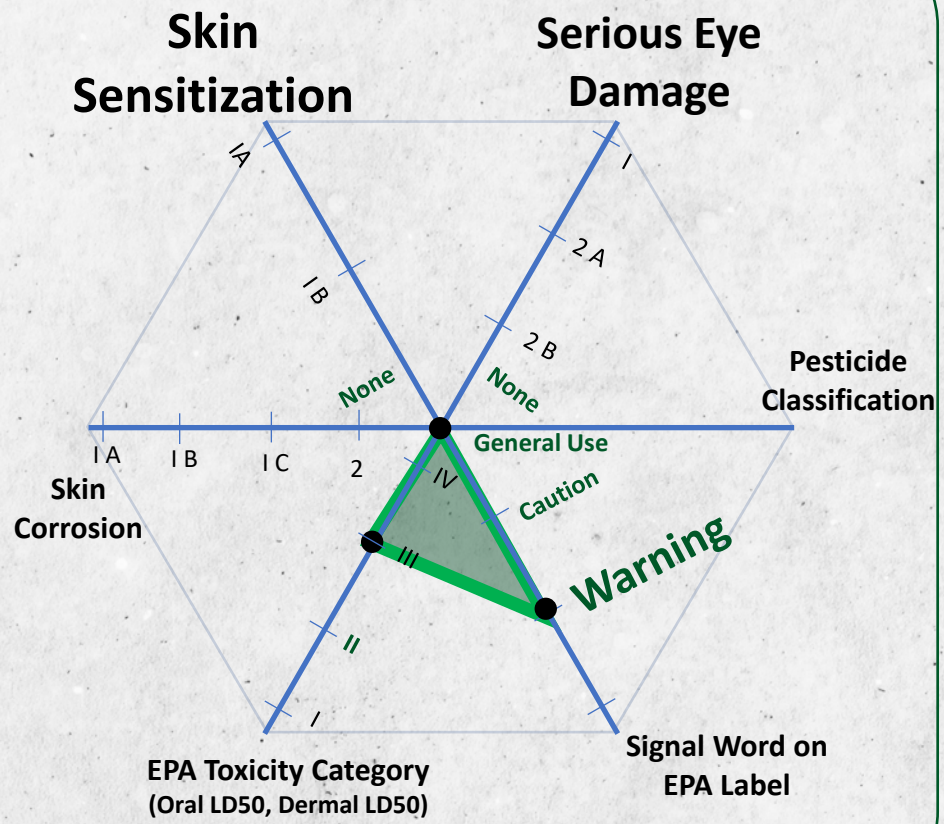
- No DANGER label
- Not Corrosive to eyes
- Not a skin Sensitizer
- Not a carcinogen or mutagen

RELATIVE EH&S FOOTPRINT

DCOI (46.2%)



QNAP (3.7%)

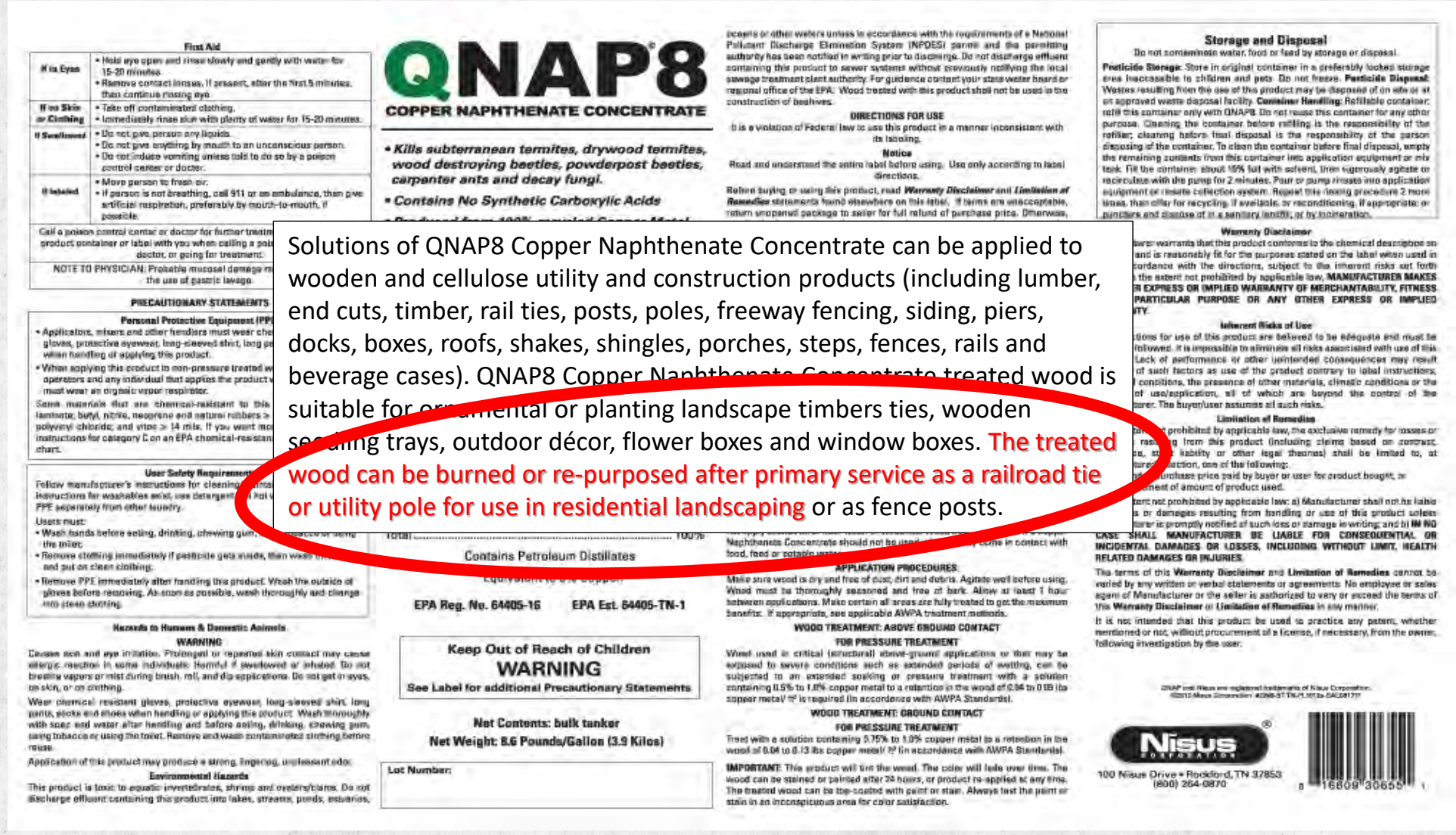


PRESERVATIVE SOLD IN RETAIL?

MADE FROM RECYCLED MATERIALS?

MADE IN THE USA?

EPA LABELLED FOR END-OF-LIFE OPTIONS ?



QNAP®8

COPPER NAPHTHENATE CONCENTRATE

- *Kills subterranean termites, drywood termites, wood destroying beetles, powderpost beetles, carpenter ants and decay fungi.*
- *Contains No Synthetic Carboxylic Acids*

Solutions of QNAP8 Copper Naphthenate Concentrate can be applied to wooden and cellulose utility and construction products (including lumber, end cuts, timber, rail ties, posts, poles, freeway fencing, siding, piers, docks, boxes, roofs, shakes, shingles, porches, steps, fences, rails and beverage cases). QNAP8 Copper Naphthenate Concentrate treated wood is suitable for ornamental or planting landscape timbers ties, wooden seedling trays, outdoor décor, flower boxes and window boxes. The treated wood can be burned or re-purposed after primary service as a railroad tie or utility pole for use in residential landscaping or as fence posts.

Contains Petroleum Distillates

EPA Reg. No. 64405-16 EPA Est. 64405-TN-1

Keep Out of Reach of Children

WARNING

See Label for additional Precautionary Statements

Net Contents: bulk tanker

Net Weight: 8.6 Pounds/Gallon (3.9 Kilos)

Lot Number:

Nisus Corporation

100 Nisus Drive • Rockford, TN 37853

(800) 264-0870

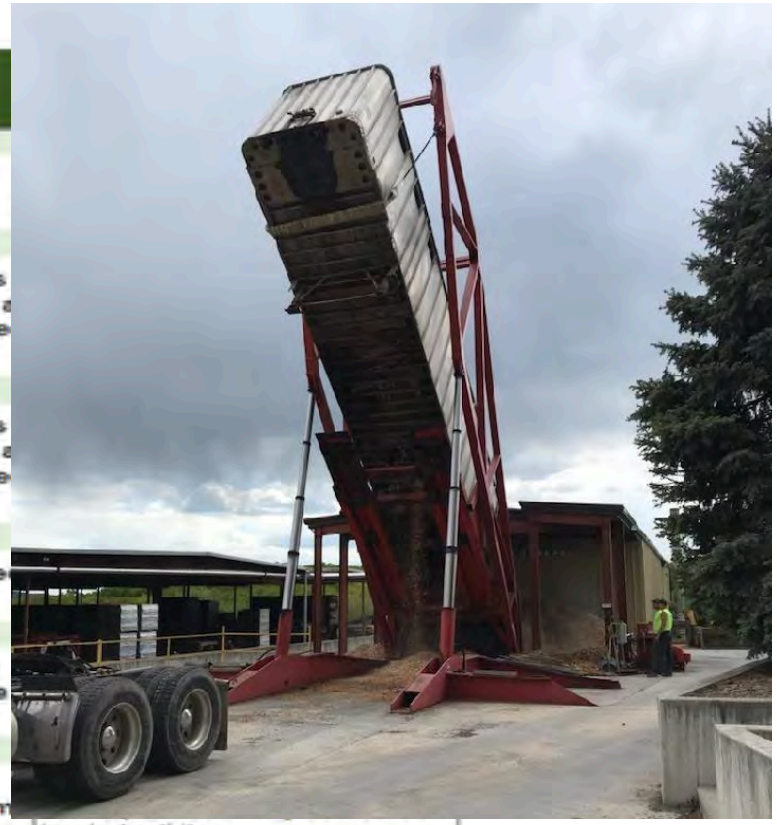
REUSE

QNAP TIE MULCH & LANDSCAPING

EPA NHSM BOILER RULES

NISUS CORPORATION

	Copper Naphthenate Only	Copper Naphthenate/Borate	Creosote Only	
Preparation	Metal removal and shredding or grinding	Metal removal and shredding or grinding	Metal removal and shredding or grinding	
General Design	Any unit designed to burn biomass, biomass and fuel oil, or biomass and coal	Any unit designed to burn biomass, biomass and fuel oil, or biomass and coal	To burn biomass and fuel oil as normal operations and not just a start up or shut down or modifie from oil to gas	
ONLY for Paper Mills or Power Production Boiler Design	Any unit designed to burn biomass, biomass and fuel oil, or biomass and coal	Any unit designed to burn biomass, biomass and fuel oil, or biomass and coal	To burn biomass and fuel oil as normal operations and not just a start up or shut down or modifie from oil to gas	
Date Restrictions	NO RESTRICTIONS EVEN NEW BOILERS	NO RESTRICTIONS EVEN NEW BOILERS	Boilers construction commence before April 14, 2014	
Boiler types	NO RESTRICTIONS. ALL BOILERS	NO RESTRICTIONS ALL BOILERS	Stoker, bubbling bed, fluidized bed, or hybrid suspension grate boilers	
Limits	NO RESTRICTIONS UP TO 100% OF AVAILABLE HEAT INPUT	NO RESTRICTIONS UP TO 100% OF AVAILABLE HEAT INPUT	No more than 40% of annual heat input basis may come from treated rail ties	treated rail ties
Rule Date	2/7/2018	2/7/2018	3/9/2015	2/7/2018



Non-Hazardous Secondary Materials Rule (40 CFR 241 as amended)
https://www.federalregister.gov/documents/2018/02/07/2018-02337/additions-to-list-of-categorical-non-waste-fuels-other-treated-railroad-ties

QNAP is by far the best material for end-of-life planning!

Stella-Jones Corporation

Mellott wood preserving inc.
CROSSTIES
SWITCH TIES
BRIDGE TIMBERS

RECYCLED PRESERVATIVE & BIOCHAR

CRC
Center for Renewable Carbon
The University of Tennessee Institute of Agriculture

UTEXTENSION
INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

QNAP TREATERS

Conrad Forest Products

Mellott wood preserving inc.
CROSSTIES
SWITCH TIES
BRIDGE TIMBERS

KOPPERS

HOOVER TREATED WOOD PRODUCTS, INC.

LAYTON'S Ozark Timber SAWMILL & FENCING, LLC.

MIXON BROTHERS WOOD PRESERVING, INC.

AmeriTies

PERMAPOST PRESSURE TREATING AND FABRICATED WOOD PRODUCTS

Bell LUMBER & POLE SINCE 1909

Wheeler

Stella-JoneS Corporation

MAJOR ELECTRIC UTILITIES USING QNAP

Seattle City Light

nationalgrid

SUB
SPRINGFIELD UTILITY BOARD

LCRA
ENERGY • WATER • COMMUNITY SERVICES

GRIDLEY
CALIFORNIA

ELECTRIC
CITY OF LODI
CALIFORNIA
UTILITY

SMUD®
Sacramento Municipal Utility District

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1

ALAMEDA MUNICIPAL POWER

DOUGLAS
ELECTRIC COOPERATIVE
A Touchstone Energy® Cooperative

Erwin Utilities

MEA
MATANUSKA ELECTRIC ASSOCIATION

GREEN MOUNTAIN POWER
Generating Possibilities

Clark Public Utilities

CITY OF PORT ANGELES
PUBLIC WORKS & UTILITIES

elcon
CORPORATION
ELECTRICAL INFRASTRUCTURE CONTRACTORS

LPEA
La Plata Electric Association, Inc.
A Touchstone Energy® Cooperative

A Member-Owned Cooperative
MOUNTAIN VIEW ELECTRIC ASSOCIATION, INC.
Your Touchstone Energy® Cooperative

REU | City of Redding Electric Utility

TRICO
AN ENERGY COOPERATIVE

TNMP

Wasco Electric Cooperative
A Touchstone Energy® Cooperative

Salem Electric

SAN MIGUEL POWER ASSOCIATION
Touchstone Energy® Cooperatives

City of Ukiah
ELECTRIC UTILITY DEPARTMENT

TECHNICAL OPINION

NISUS CORPORATION

- Wood is far better environmentally than non-wood alternatives.
- Creosote, CCA and Copper Naphthenate are all well proven replacements for Penta – But consider all the other attributes.
- Which is best performing with longest track record and field test data?
- Which is safest - no DANGER label, not a Sensitizer?
- Which is made in the USA ?
- Which has Best end-of-life options?

QNAP®
COPPER NAPHTHENATE

The Sustainable Choice

NISUS®

THANK YOU!

Dr. Mark Manning
MarkM@nisuscorp.com
(805) 312 0442

Dr. Jeff Lloyd
jeffl@nisuscorp.com
(865) 406-9704

A Finite Element Model for Evaluating the Effects of Drilling on Cross-Sectional Modulus and Overall Strength of Wooden Utility Poles

By

Yishi Lee, Ph.D.

Metropolitan State University of Denver

Problem Statement and Motivation

- Examine RUS 1730B-121 and M13-07 standards on how the Sound and Bore could impact the original structure strength if any.
  - Areas around the inspection points
  - Above, at and below ground regions.
  - Contribution to the overall pole strength.

M13-07 and RUS 1730B-121

4.5 Boring

Inspector should bore the pole with a 3/8" or ½" bit. The bored hole should be located at either 1.) Groundline if the pole is not excavated or 2.) Areas where the inspector expects to find decay. Excavated poles should be bored at least once below ground level. If multiple borings are taken care should be taken to insure they are not on the same plane. The hole should be drilled at a 45-degree angle to a depth of the centerline of the pole. Shell thickness indicator should be used to measure existing shell thickness and detect the extent of the interior decay.

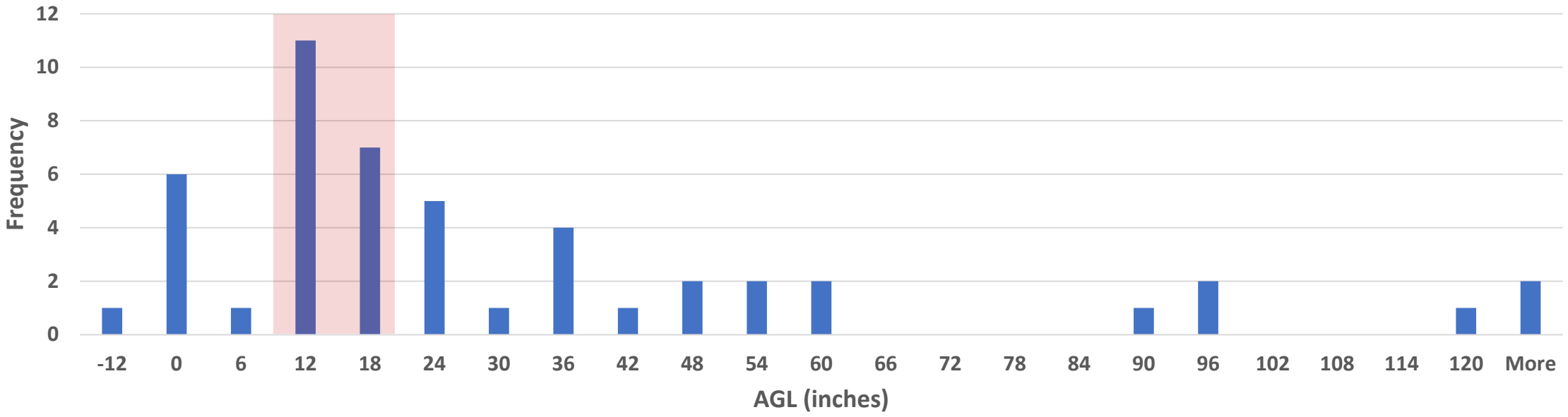
If heart rot or enclosed decay pockets are evident in a pole, a minimum of three (3) borings will be taken to determine the size and extent of decay. An inspector is not able to determine the size of an internal void with less than 3 borings. Multiple borings should not be taken on the same plane. Bored holes should be plugged with tight-fitting treated wood or plastic plugs.

4 INSPECTION METHODS

b Sound and Bore. This method involves striking a pole with a hammer from groundline to as high as the inspector can reach and detecting voids by the hollow sound. An experienced inspector can obtain significant information about a pole by listening to the sounds and noticing the feel of the hammer. The hammer rebounds more from a solid pole than when hitting a section that has an internal decay pocket. The internal pocket also causes a sound that is dull compared to the crisp sound of a solid pole section.

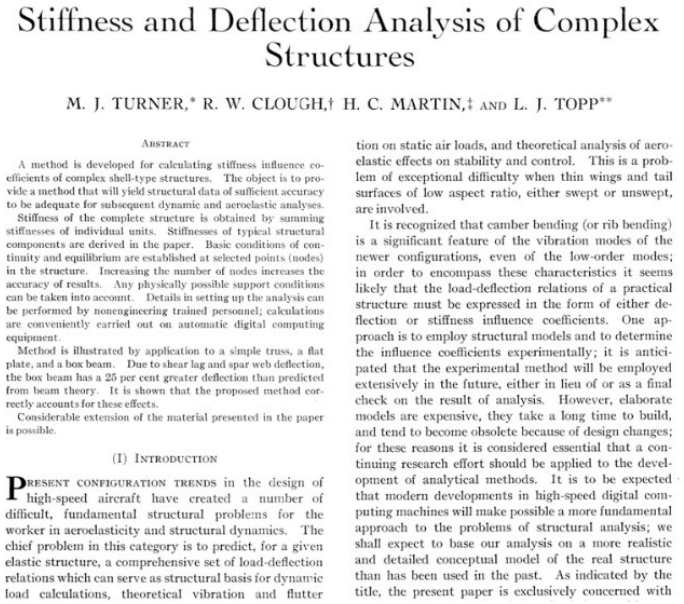
Some contracts require all poles to be bored, while others require boring only when decay is suspected. Boring is usually done with either an incremental borer or power drill with a 3/8" bit. An experienced inspector will notice a change in resistance against the drill when it contacts decayed wood. The shavings or the borings can be examined to determine the condition of the wood, and the borings can be analyzed for preservative penetration and retention.

Histogram of the break point plane



Methodology

- FEM
  - First developed in **1956** by M.J. Turner for analyzing Delta wing structure for aircraft.
  - Considered one of the **well-established and convenient analysis** tools by engineers and applied scientists.
  - Applications expand from Nuclear engineering to the space industry
  - The global finite element analysis (FEA) software market was valued over $ **4.1 B in 2020** and is expected to reach **$ 11 B by 2030**.



Stiffness and Deflection Analysis of Complex Structures

M. J. TURNER,* R. W. CLOUGH,† H. C. MARTIN,‡ AND L. J. TOPP**

ABSTRACT

A method is developed for calculating stiffness influence coefficients of complex shell-type structures. The object is to provide a method that will yield structural data of sufficient accuracy to be adequate for subsequent dynamic and aeroelastic analyses.

Stiffness of the complete structure is obtained by summing stiffnesses of individual units. Stiffnesses of typical structural components are derived in the paper. Basic conditions of continuity and equilibrium are established at selected points (nodes) in the structure. Increasing the number of nodes increases the accuracy of results. Any physically possible support conditions can be taken into account. Details in setting up the analysis can be performed by nonengineering trained personnel; calculations are conveniently carried out on automatic digital computing equipment.

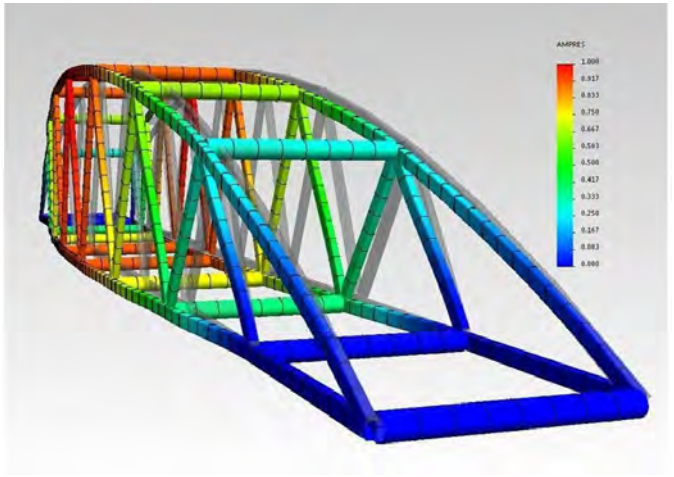
Method is illustrated by application to a simple truss, a flat plate, and a box beam. Due to shear lag and spar web deflection, the box beam has a 25 per cent greater deflection than predicted from beam theory. It is shown that the proposed method correctly accounts for these effects.

Considerable extension of the material presented in the paper is possible.

(I) INTRODUCTION

PRESENT CONFIGURATION TRENDS in the design of high-speed aircraft have created a number of difficult, fundamental structural problems for the worker in aeroelasticity and structural dynamics. The chief problem in this category is to predict, for a given elastic structure, a comprehensive set of load-deflection relations which can serve as structural basis for dynamic load calculations, theoretical vibration and flutter tion on static air loads, and theoretical analysis of aeroelastic effects on stability and control. This is a problem of exceptional difficulty when thin wings and tail surfaces of low aspect ratio, either swept or unswept, are involved.

It is recognized that camber bending (or rib bending) is a significant feature of the vibration modes of the newer configurations, even of the low-order modes; in order to encompass these characteristics it seems likely that the load-deflection relations of a practical structure must be expressed in the form of either deflection or stiffness influence coefficients. One approach is to employ structural models and to determine the influence coefficients experimentally; it is anticipated that the experimental method will be employed extensively in the future, either in lieu of or as a final check on the result of analysis. However, elaborate models are expensive, they take a long time to build, and tend to become obsolete because of design changes; for these reasons it is considered essential that a continuing research effort should be applied to the development of analytical methods. It is to be expected that modern developments in high-speed digital computing machines will make possible a more fundamental approach to the problems of structural analysis; we shall expect to base our analysis on a more realistic and detailed conceptual model of the real structure than has been used in the past. As indicated by the title, the present paper is exclusively concerned with



ANSYS FEM capability

- *“ANSYS structural analysis software is trusted by organizations around the world to rapidly solve complex structural engineering problems with ease”* - Wilde Analysis Ltd
- 2,200 engineering firms in the world use ANSYS to perform FEM analysis –Readycontacts.com
  - Some of the well-known engineering companies include
    - ABB, Alstom, Blue Origin, Raytheon, Delphi, Ford, GE, Kirloskar, Whirlpool, Reliance Infrastructure, and Xerox

FEM workflow

- Geometry selection
  - Class 2-55

Table 8 - Dimensions of Douglas-fir (both types) and Southern Pine Poles (Fiber Strength 8000 psi)

Class		H6	H5	H4	H3	H2	H1	1	2	3	4	5	6	7	9	10
Minimum circumference at top (in)		39	37	35	33	31	29	27	25	23	21	19	17	15	15	12
Length of pole (ft)	Approximate Groundline[1] distance from butt (ft)	Minimum circumference at 6 ft from butt (in)														
20	4	42.0	40.5	38.5	36.5	34.5	33.0	31.0	29.0	27.0	25.0	23.0	21.0	19.5	17.5	14.0
25	5	46.0	44.0	42.0	40.0	38.0	36.0	33.5	31.5	29.5	27.5	25.5	23.0	21.5	19.5	15.0
30	5.5	49.5	47.5	45.5	43.0	41.0	38.5	36.5	34.0	32.0	29.5	27.5	25.0	23.5	20.5	-
35	6	53.0	50.5	48.5	46.0	43.5	41.5	39.0	36.5	34.0	31.5	29.0	27.0	25.0	-	-
40	6	56.0	53.5	51.0	48.5	46.0	43.5	41.0	38.5	36.0	33.5	31.0	28.5	-	-	-
45	6.5	58.5	56.0	53.5	51.0	48.5	45.5	43.0	40.5	37.5	35.0	32.5	30.0	-	-	-
50	7	61.0	58.5	55.5	53.0	50.5	47.5	45.0	42.0	39.0	36.5	34.0	-	-	-	-
55	7.5	63.5	60.5	58.0	55.0	52.0	49.5	46.5	43.5	40.5	38.0	-	-	-	-	-
60	8	65.5	62.5	59.5	57.0	54.0	51.0	48.0	45.0	42.0	39.0	-	-	-	-	-
65	8.5	67.5	64.5	61.5	58.5	55.5	52.5	49.5	46.5	43.5	40.5	-	-	-	-	-
70	9	69.0	66.5	63.5	60.5	57.0	54.0	51.0	48.0	45.0	41.5	-	-	-	-	-
75	9.5	71.0	68.0	65.0	62.0	59.0	55.5	52.5	49.0	46.0	-	-	-	-	-	-
80	10	72.5	69.5	66.5	63.5	60.0	57.0	54.0	50.5	47.0	-	-	-	-	-	-
85	10.5	74.5	71.5	68.0	65.0	61.5	58.5	55.0	51.5	48.0	-	-	-	-	-	-
90	11	76.0	73.0	69.5	66.5	63.0	59.5	56.0	53.0	49.0	-	-	-	-	-	-
95	11	77.5	74.5	71.0	67.5	64.5	61.0	57.0	54.0	-	-	-	-	-	-	-
100	11	79.0	76.0	72.5	69.0	65.5	62.0	58.5	55.0	-	-	-	-	-	-	-
105	12	80.5	77.0	74.0	70.5	67.0	63.0	59.5	56.0	-	-	-	-	-	-	-
110	12	82.0	78.5	75.0	71.5	68.0	64.5	60.5	57.0	-	-	-	-	-	-	-
115	12	83.5	80.0	76.5	72.5	69.0	65.5	61.5	58.0	-	-	-	-	-	-	-
120	12	85.0	81.0	77.5	74.0	70.0	66.5	62.5	59.0	-	-	-	-	-	-	-
125	12	86.0	82.5	78.5	75.0	71.0	67.5	63.5	59.5	-	-	-	-	-	-	-

[1] The figures in this column are not recommended embedment depths; rather, these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

ANSI O5.1-2002: Wood Poles: Specifications And Dimensions

- Material selection
  - Douglas-fir
  - Orthotropic mechanical properties

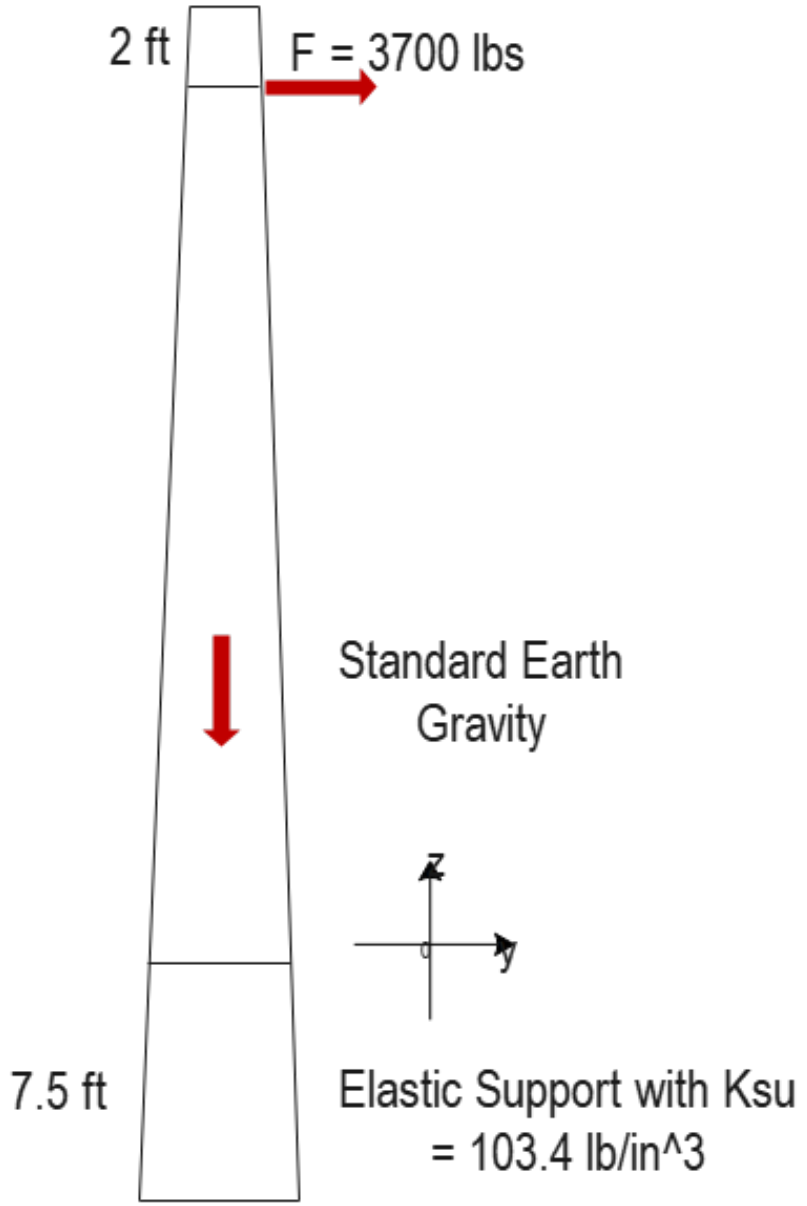
Properties of Outline Row 4: Douglas-fir

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	0.0159	lb in^-3
4	Orthotropic Elasticity		
5	Young's Modulus X direction	1.3396E+05	psi
6	Young's Modulus Y direction	98500	psi
7	Young's Modulus Z direction	1.97E+06	psi
8	Poisson's Ratio XY	0.374	
9	Poisson's Ratio YZ	0.029	
10	Poisson's Ratio XZ	0.036	
11	Shear Modulus XY	10000	psi
12	Shear Modulus YZ	1.5366E+05	psi
13	Shear Modulus XZ	1.2608E+05	psi

Kretschmann, D. E. (2010). Mechanical properties of wood. Environments, 5, 34.

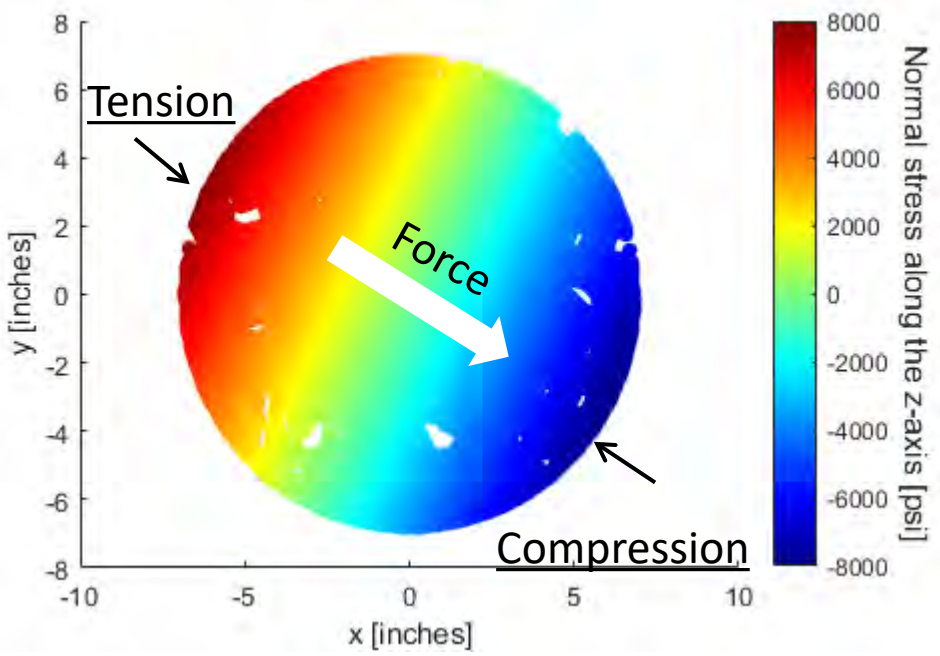
FEM workflow

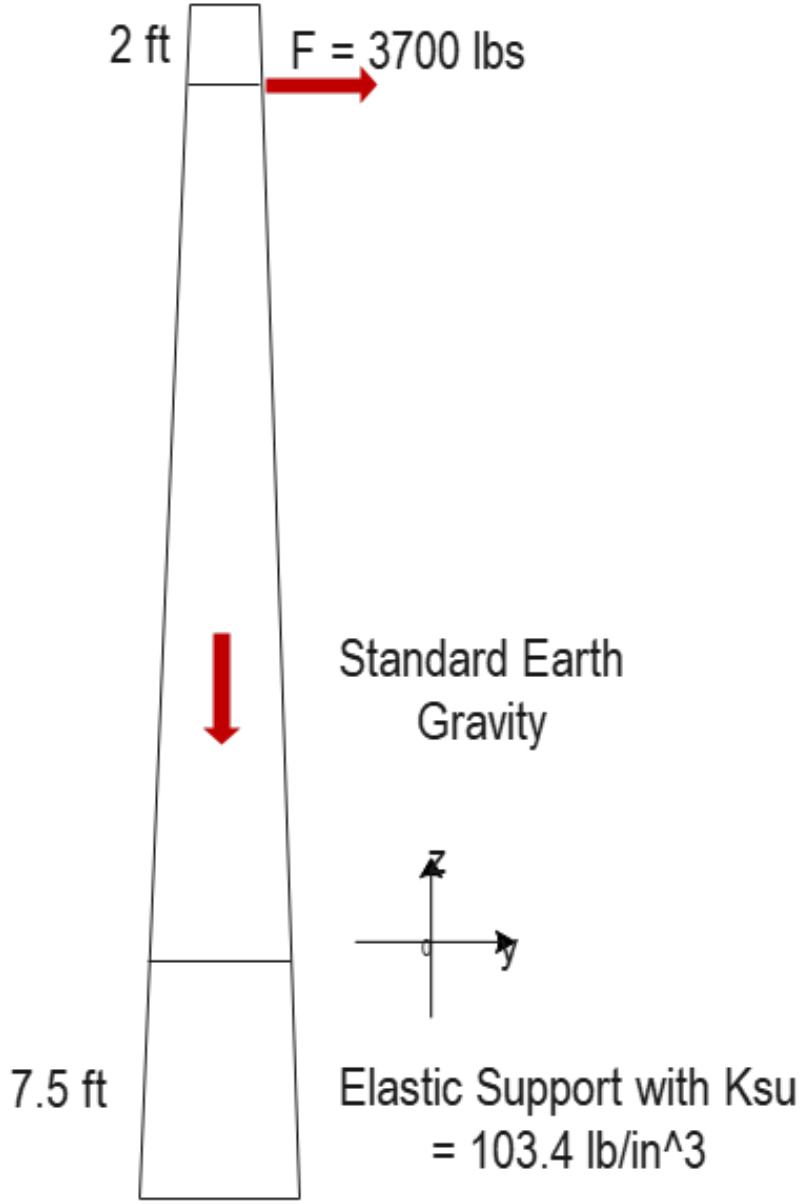
- Boundary condition
  - Foundation stiffness is based on the Modulus of Subgrade Reaction[1], Ksu with an average stiffness value of ~ 103.04 lb/in^3.
  - Force = 3700 lbs at 2 feet from the top of the pole[2].
  - Standard Earth Gravity



[1] Chakrabarti, Subrata. *Handbook of Offshore Engineering (2-volume set)*. Elsevier, 2005.
[2] ANSI O5.1-2002 Annex B

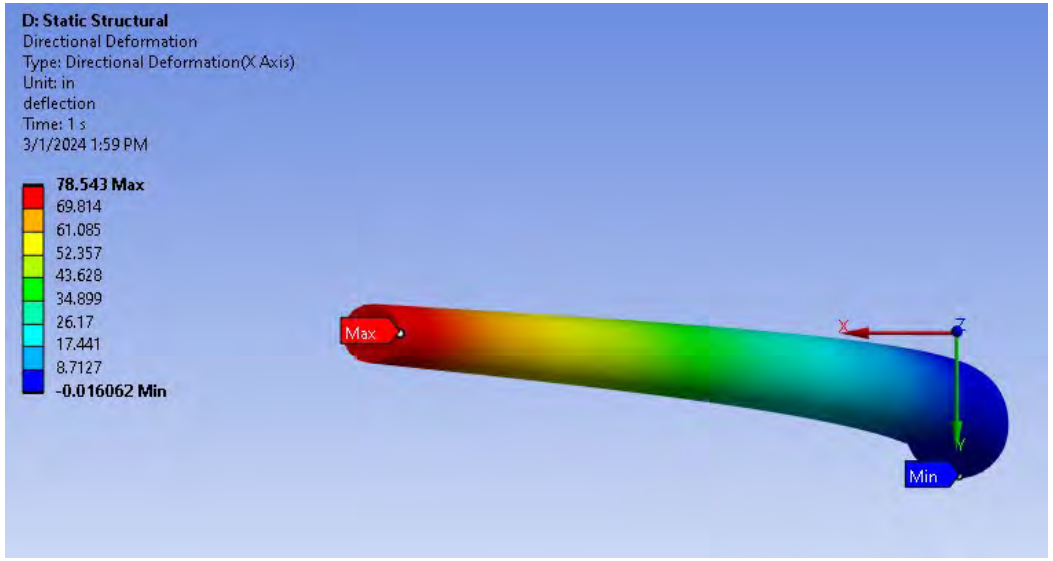
Result validation

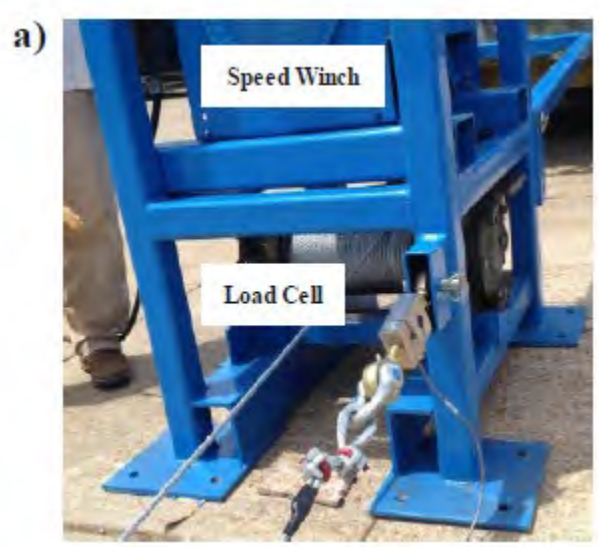


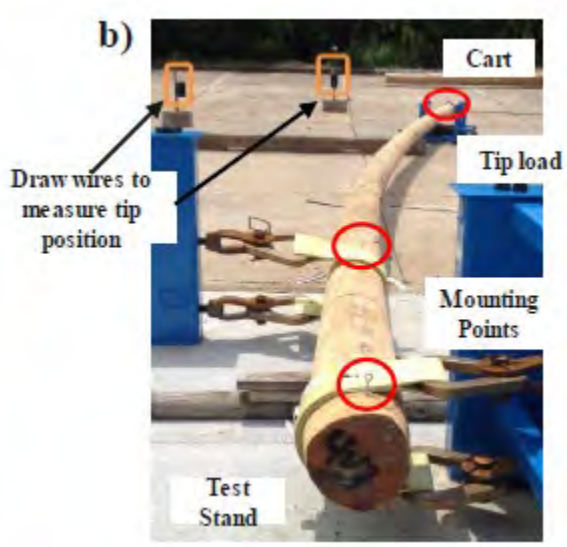


[1] Equation 2 from D1036-99 (2012) for fiber stress calculation.

Result validation



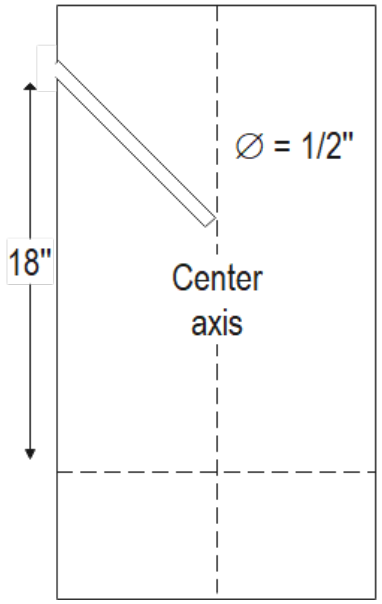




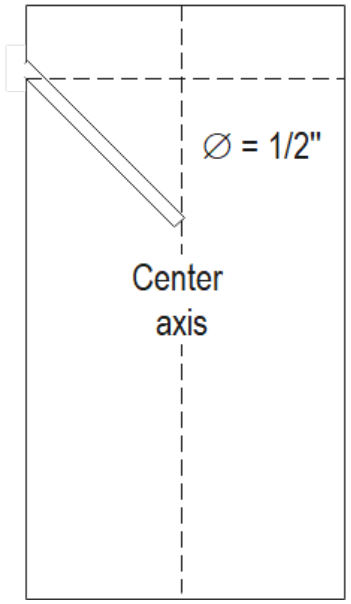
Sample No	Class	Max Load	Deflection	% diff
Empirical	2-55	2590.5 lbs	77.8	0.4%
Simulation	2-55	2590.5 lbs	78.5	

Numerical Result		Theoretical Calculation [1]	% Difference
Max Compression	7847.7 psi	8000 psi	~ 3%
Max Tension	7725.5 psi		

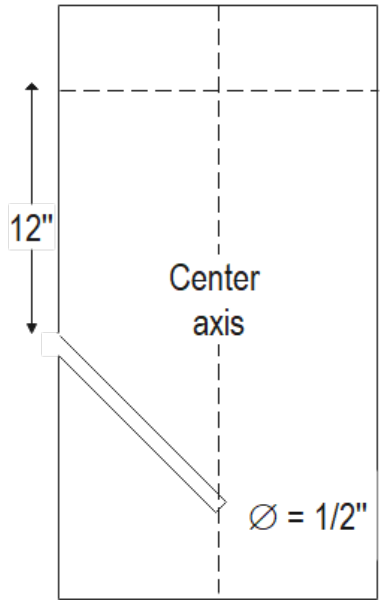
Inspection holes and specification



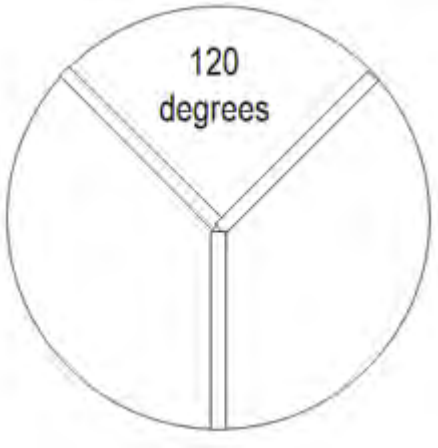
Hole at 18’’



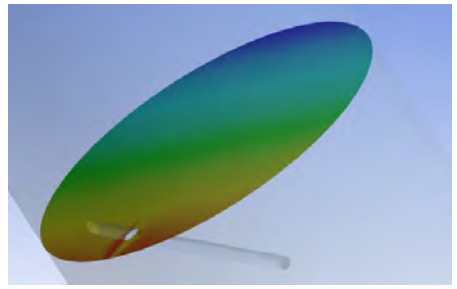
Hole at GL



Hole at -12’’



Comparative study

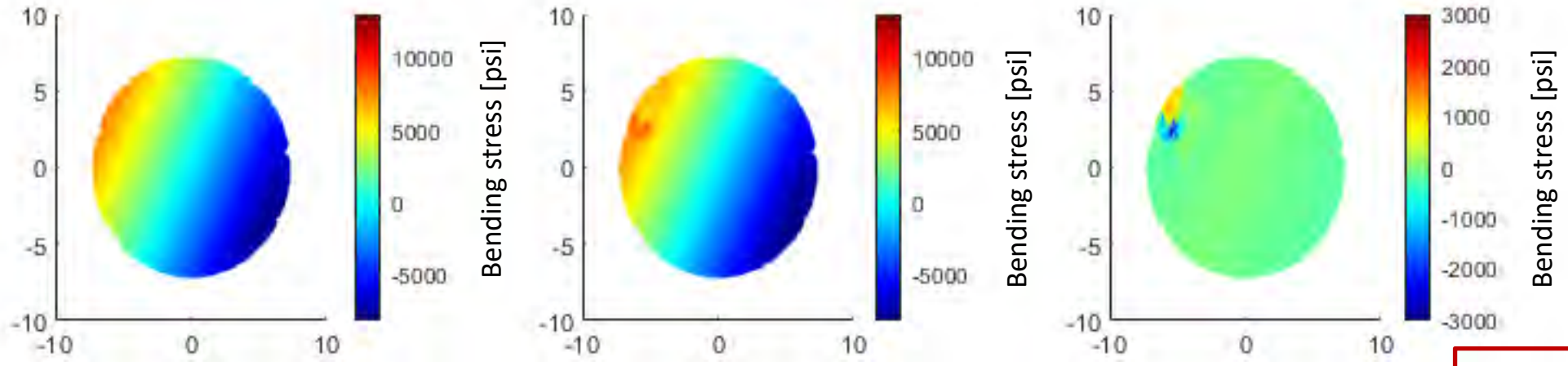


Without hole

With hole

Difference

17 inches

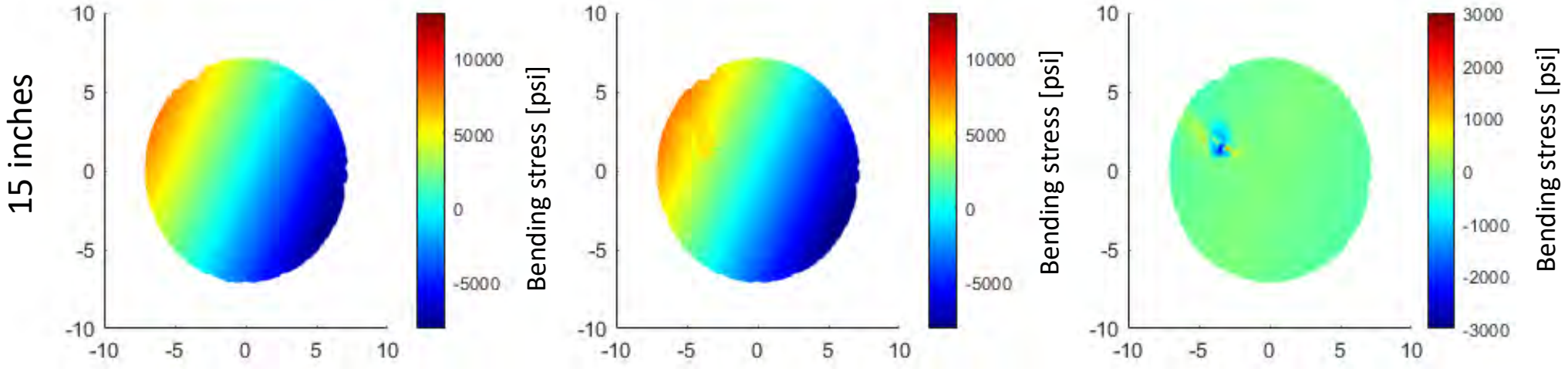


Without hole

With hole

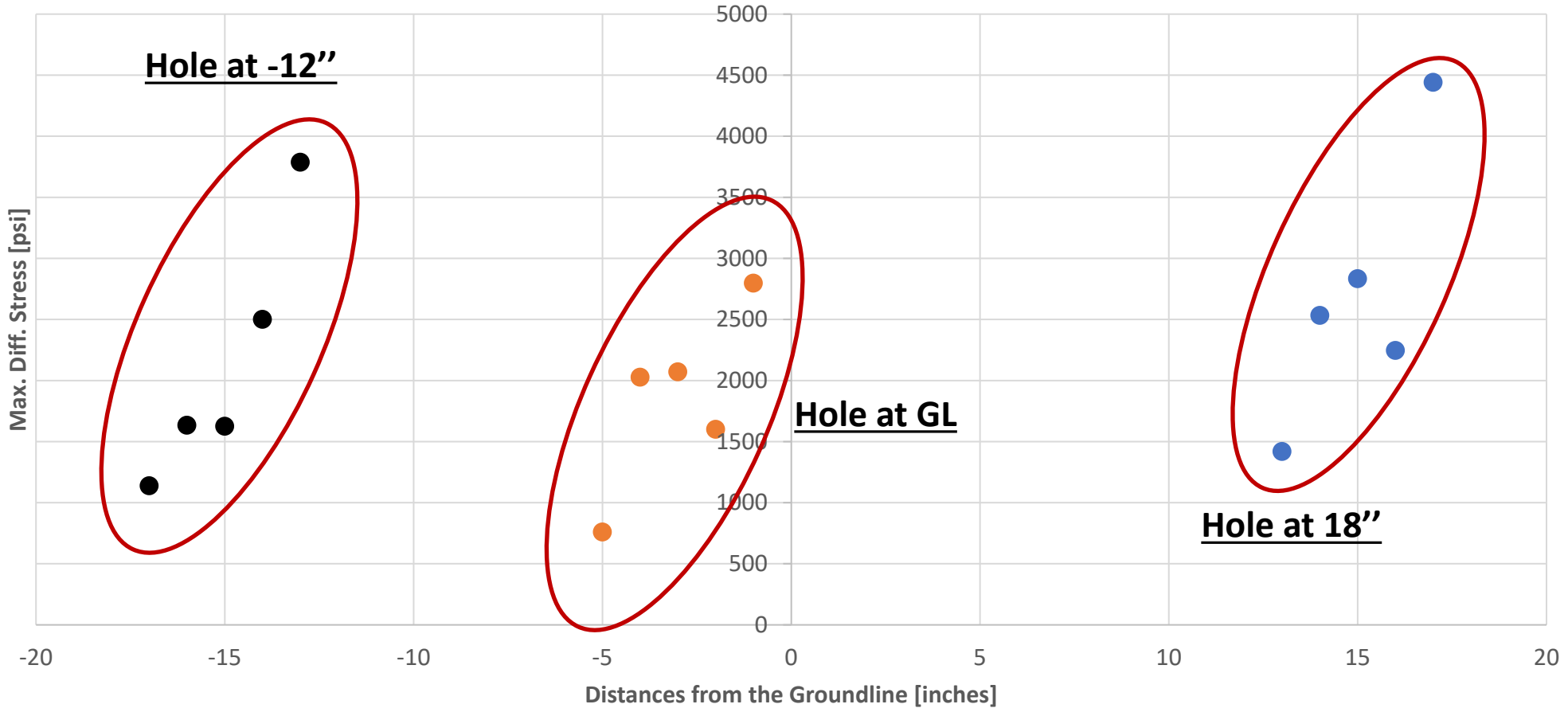
Difference

15 inches

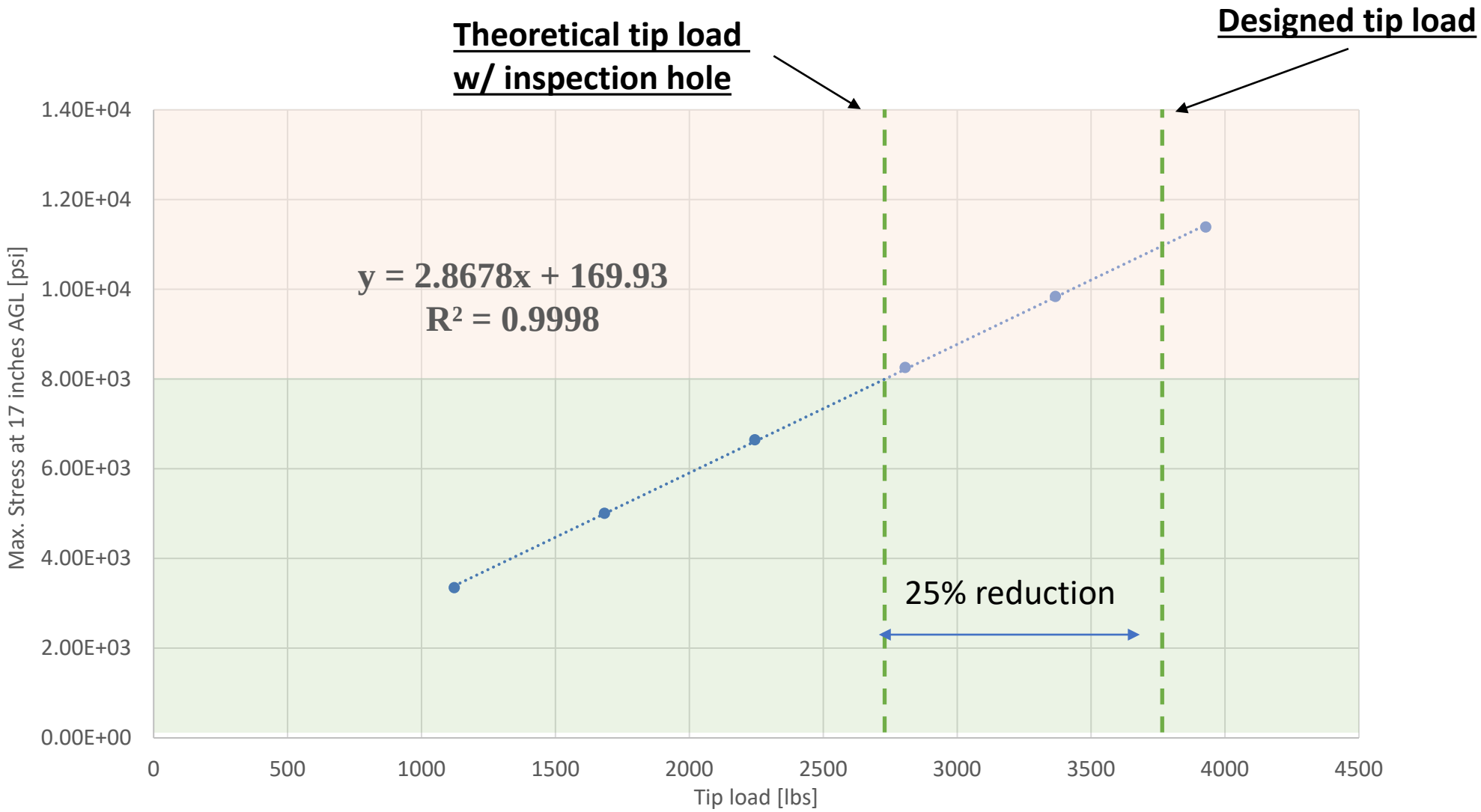


x and y are all in inches

Distance along the inspection hole vs. Max difference in stress



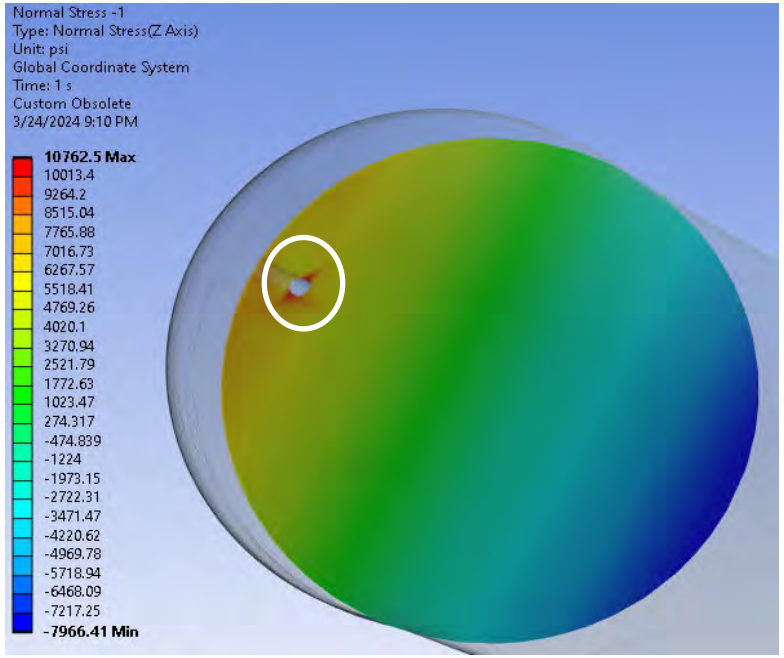
Tip load based at 17 inches AGL



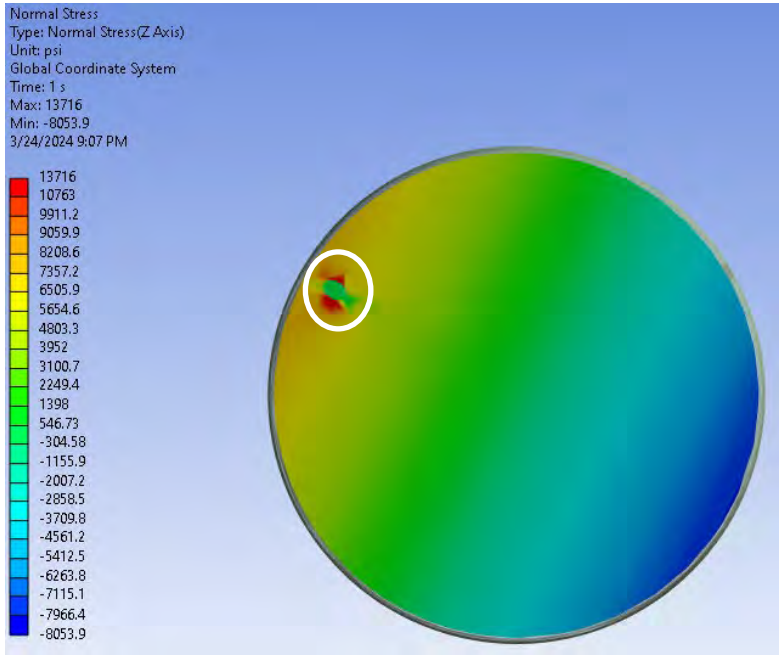
Stress distribution with a wooden plug

- Model setup:
  - Wood plug is set to be hardwood with average mechanical properties
  - Rough contact between the hole and the plug.
  - Length = 2 inches long

Without wooden plug



wooden plug



The use of wooden plugs can increase the local stress around the hole by roughly 27%.

Recommendations and Future work

- Study suggests that drilling holes can increase localized stress around the hole.
- NDE/Combine drilling using field technicians
- Drill along the line of lead of the conductors might reduce the possibility of the worst-case scenario.
- Provide pictures/measured heights of the broken poles at the rupture plane to help build a knowledge base.
- Monitor the pole vibration/load; MSUD is piloting with Colorado Utility to develop a real-time monitoring system.

Email: ylee24@msudenver.edu

References

- *ANSI 05.1-2002 Wood Poles: Specifications And Dimensions*
- *M13-07 Guidelines for a pole maintenance program*
- *Rules for Overhead Electric line construction from the State of California.*
- *RUS Bulletin 1730B-121*
- *Gabriel J. DeSalvo and John A. Swanson. ANSYS Engineering Analysis System User's Manual. Houston, Pa. :Swanson Analysis Systems, 1985.*

How Broadband Funding and New Attachment Regulation is Affecting Distribution Pole Construction and Maintenance

~

California's Joint-Use, ROW, and Broadband Journey

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Once in a Lifetime Broadband Funding

- Very Exciting Time
- RDOF - $20 Billion; $9.2 Billion Already
- BEAD – $42.5 Billion
- Middle Mile - $1 Billion
- American Rescue Fund – Billions More

Huge Increase in Make-Ready Activity

- Rural Utilities Starting to Get Bombarded
- FCC Considering Deadlines for >3000 Poles/Month
  - Envisions Requests to “tens or even hundreds of thousands of poles”
- Lack of Qualified Personnel Already a Very Big Issue
  - Utilities Reporting Numerous Issues
- Beginning to See Material Shortages
- Attachers Balking at Make-Ready Bills

Very Delicate Ecosystem

- Pole Attachment Act – Utilities Don’t Need to Replace Poles to Expand Capacity
  - Everything Easier Without Pole Replacements
  - Parties Need to Collaborate
- Make-Ready Deadlines
- Potential Refund Liability
- Utility Resources Diverted to Attachment Requests
  - At Expense of System Improvements

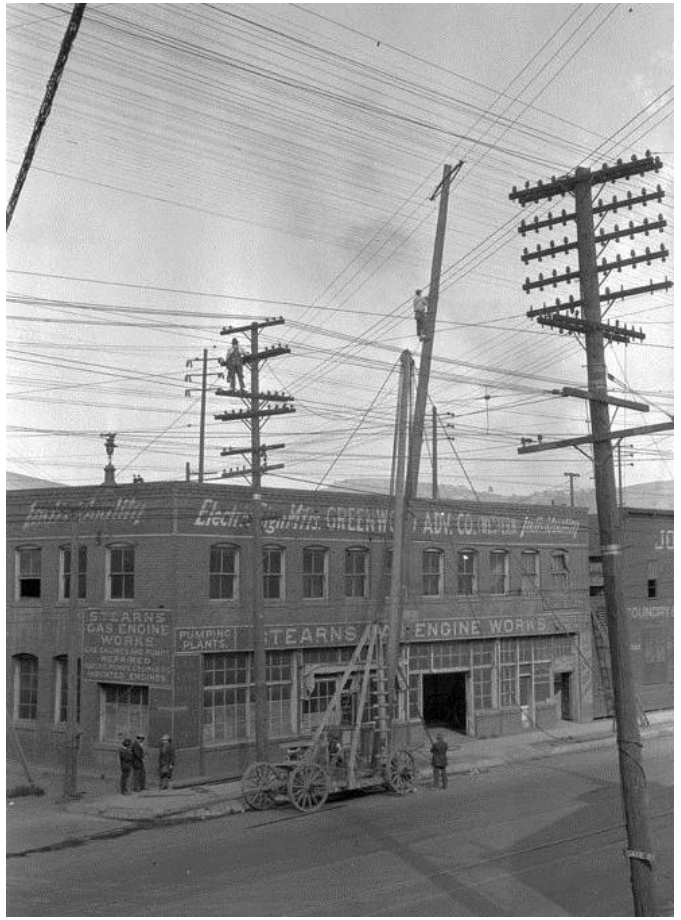
Protect Yourselves

- Attachment Process
- Trusted Contractors
- Pole Replacement Discretion
- Post-Construction Inspections
- Broad Indemnities
- Security Instruments
- Default Remedies
- Electronic Notification System
- Penalties

CA's Joint-Use, ROW, and Broadband Journey

Overhead construction laws/regulations

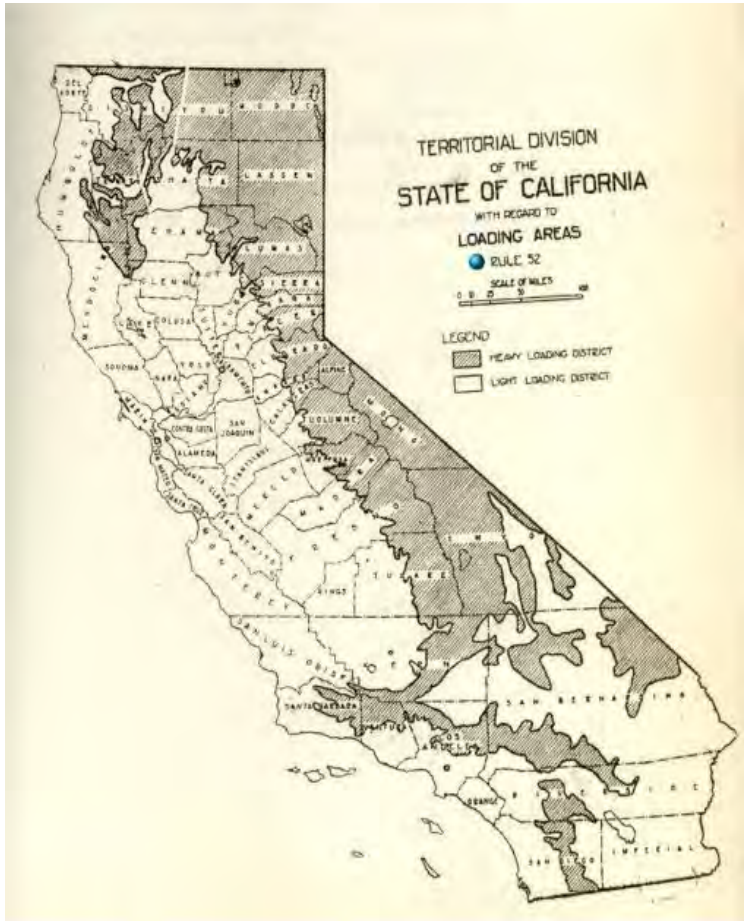
- CA Statutes 1911
- CA Statutes 1915
- General Order 64 (1922)
  - Applicable to electric and signal lines located outside of buildings
  - Construct according to accepted good practices for non-specified conditions
  - Joint-use of poles preferred but not required, no joint-use w/o consent
  - Strength/loading – Working Stress Design
- General Order 64-A (1928)
  - Tree trimming
  - Inspection of electric supply/ comm. lines
  - Clearances – wire/wire and wire/objects



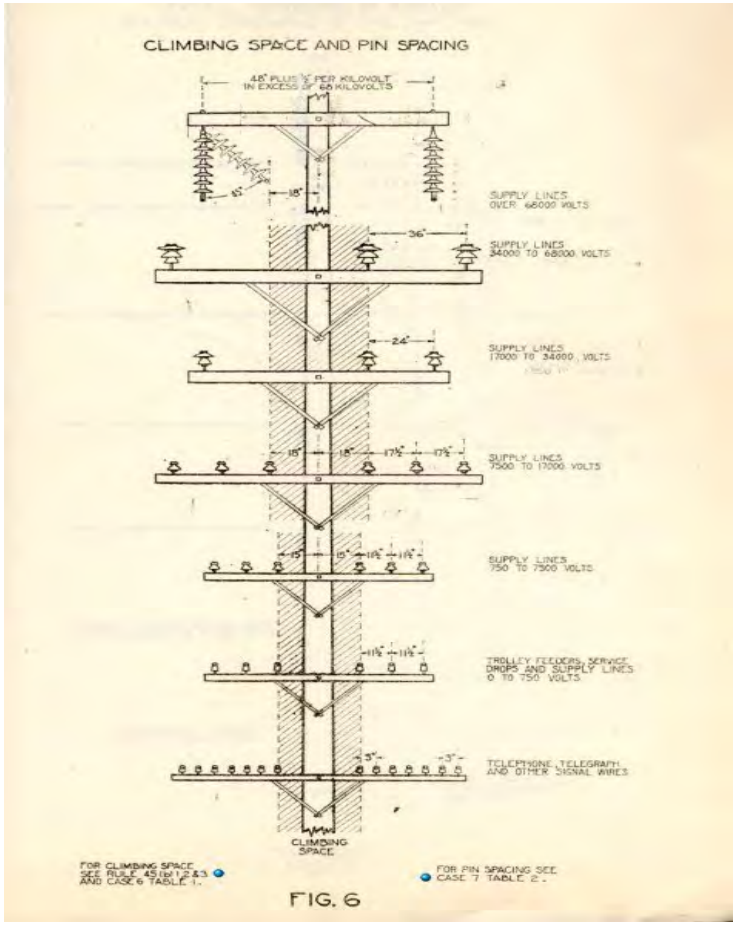
Los Angeles, Early 1900's

San Francisco, 1930-40's

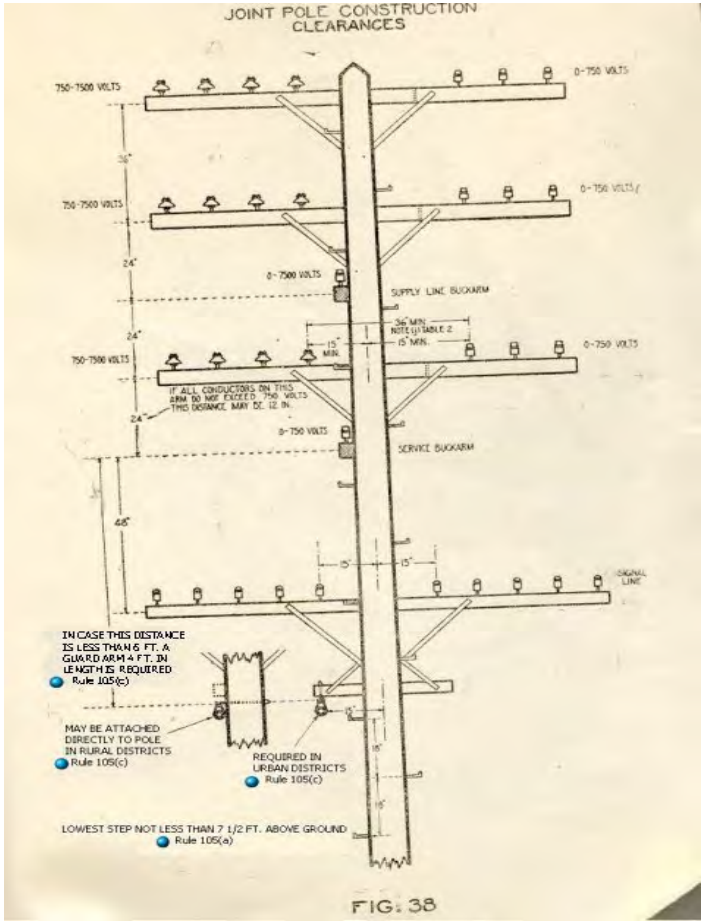
CA's Joint-Use, ROW, and Broadband Journey



GO 64 - Loading Areas



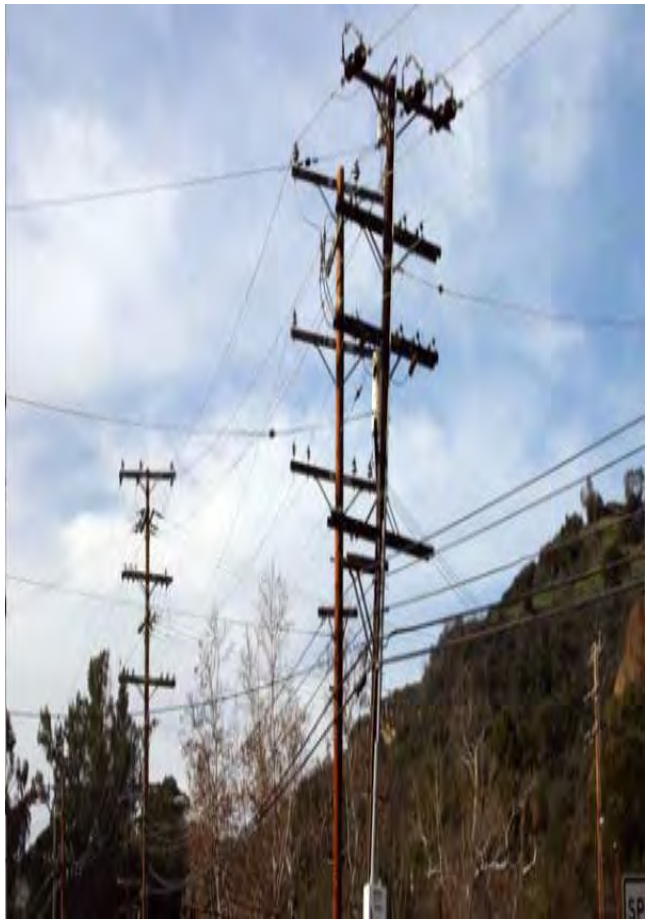
GO 64 – Figure 6, Climbing Space



GO 64 - Figure 38, Joint-Use

CA's Joint-Use, ROW, and Broadband Journey

1960-80's



1980 – 2000s

Overhead construction regulations

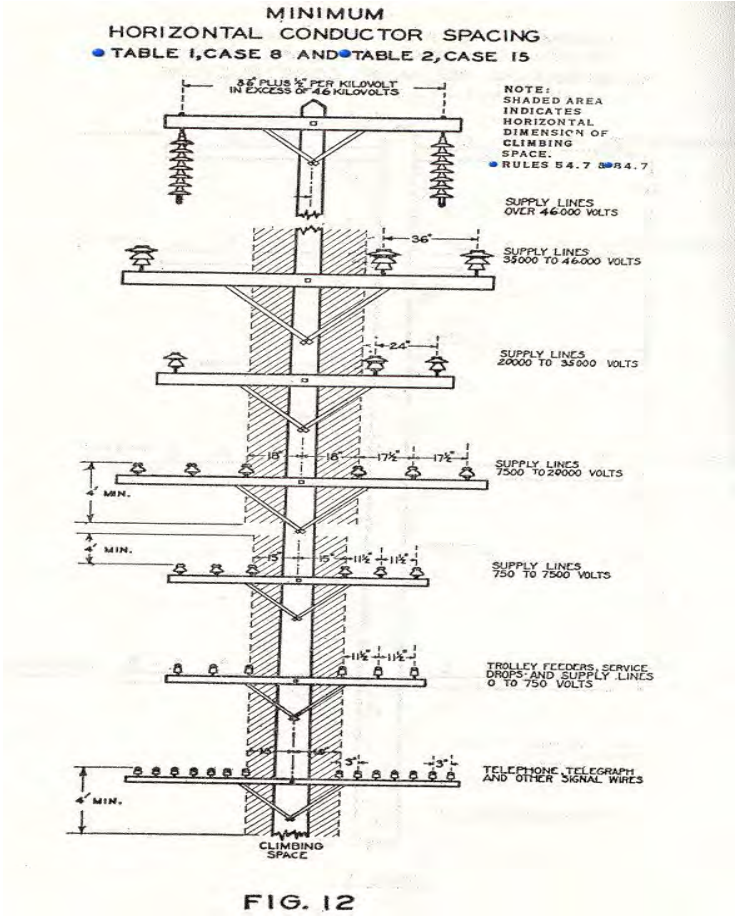
- **General Order 95** (1941 – 2005)
  - Amended 47 times
  - Revised strength/loading (1980s- 90s)
  - Min. tree-to-line clearances (1996 - 97)
    - Appendix 'E' added in 1992

- **GO 165** (1997)
  - Maximum inspection cycles for distribution OH and UG electric supply lines/equipment (not communications)

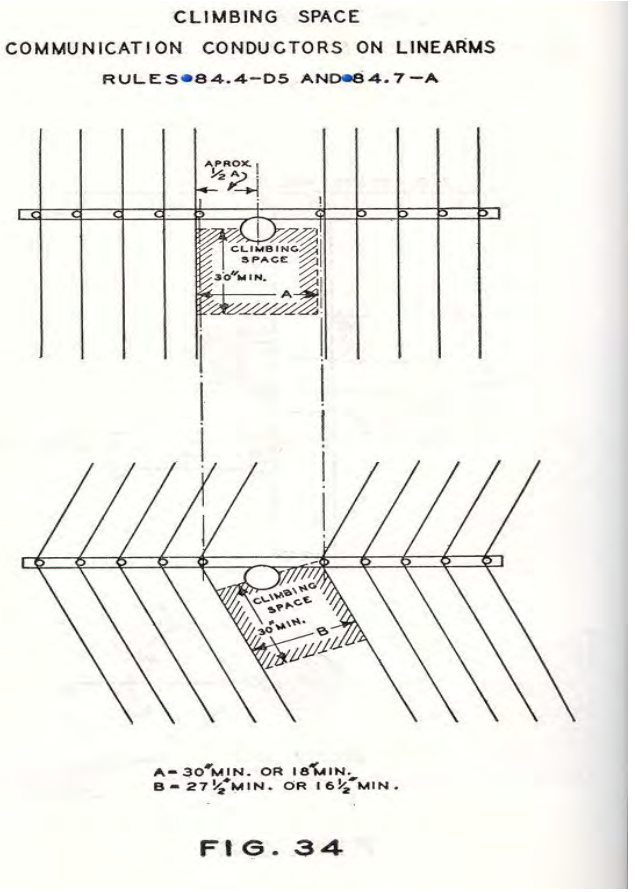
- **ROW Rules** (1998)
  - Applicable to CLECs, CATV, Broadband

CA's Joint-Use, ROW, and Broadband Journey

GO 95 – Appx. A, Loading Areas



GO 95 – Fig. 12, Horizontal Space



GO 95 – Figure 34, Climbing Space

CA's Joint-Use, ROW, and Broadband Journey

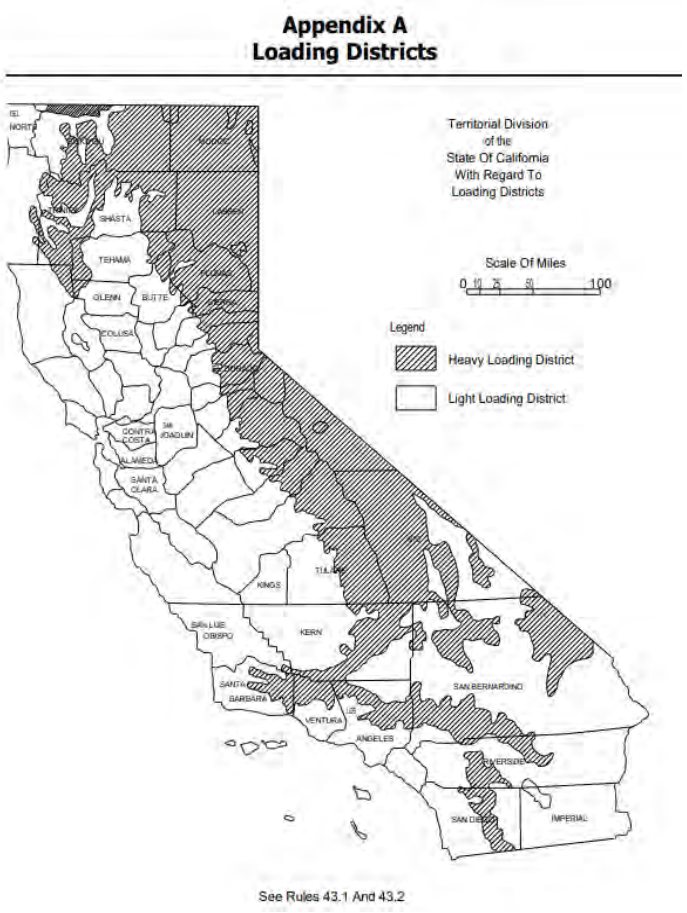
2000 - present

2000 - present

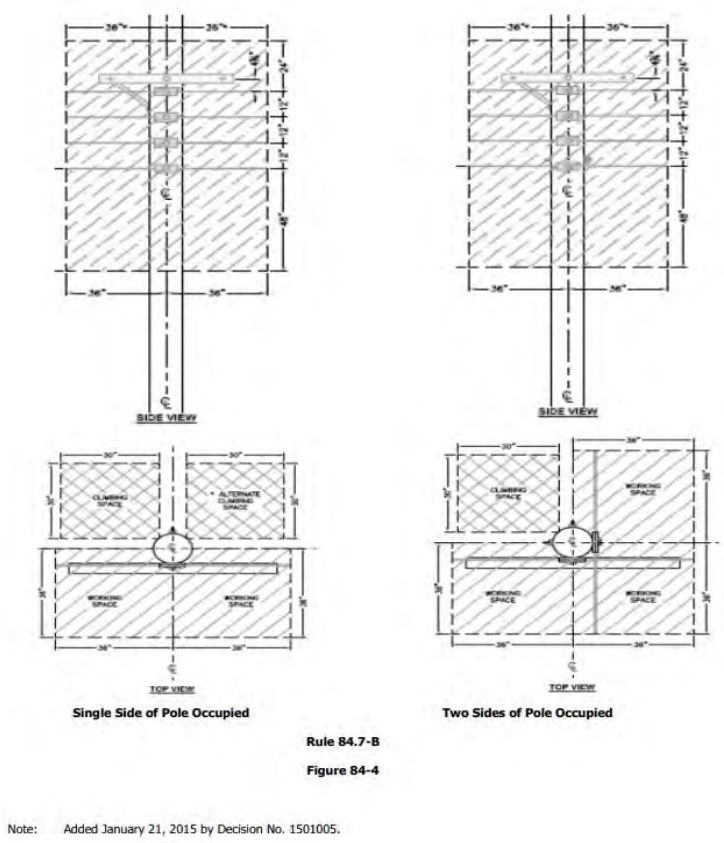
Overhead construction regulations

- General Order 95 (2006 – present)
  - Revised 12 times
  - New Rule 18 (2009)
    - Rev. – 2012, 2017, 2018
  - New Rule 80.1 (2012)
    - Rev. 2013, 2017
- GO 165
  - Revised 2009, 2012, 2013, 2017
- ROW Rules
  - Rev. – 2016, Com. Mobile Radio Service
  - Rev. – 2018, CLEC wireless
  - Rev. – 2022, OTMR
- GO 169 (2006)
  - Digital Infrastructure and Video Competition Act
- CA Advanced Services Fund (2007)
  - Rev. Mar. 2021

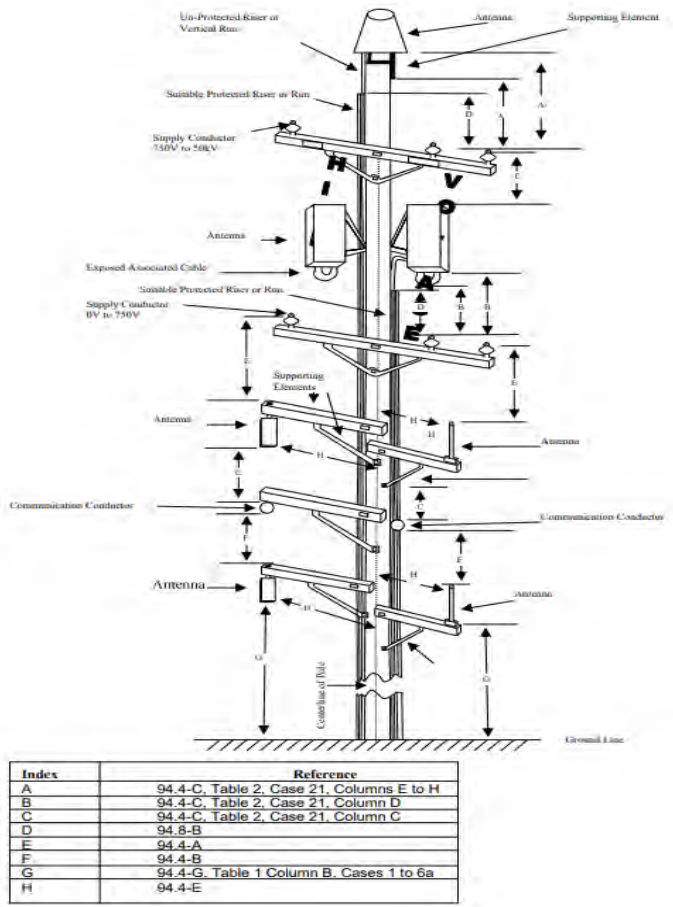
CA's Joint-Use, ROW, and Broadband Journey



GO 95 – Appx. A, Loading Areas



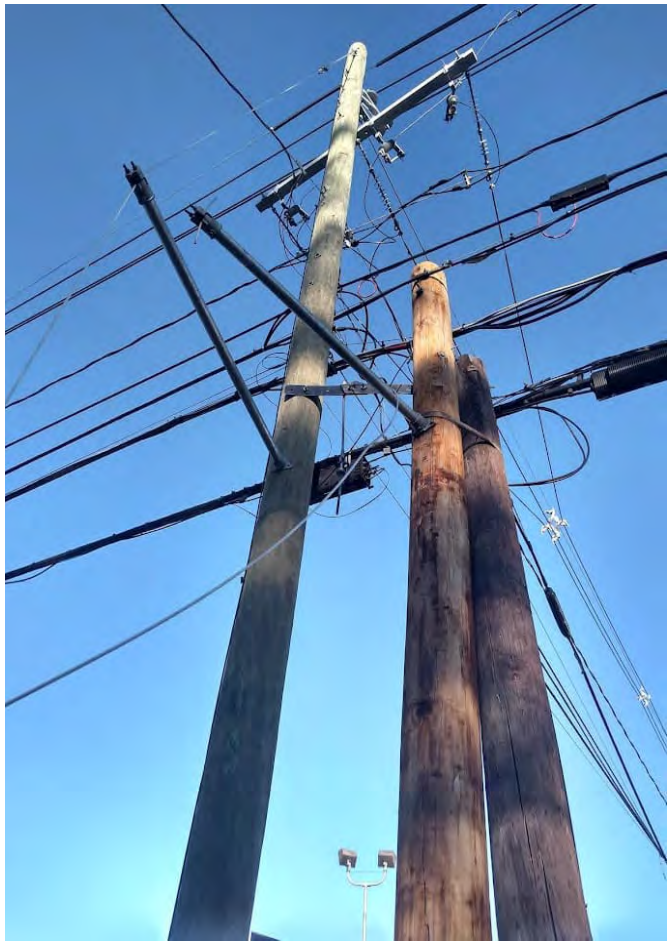
GO 95 – Fig. 84-4 Comm. Working Space



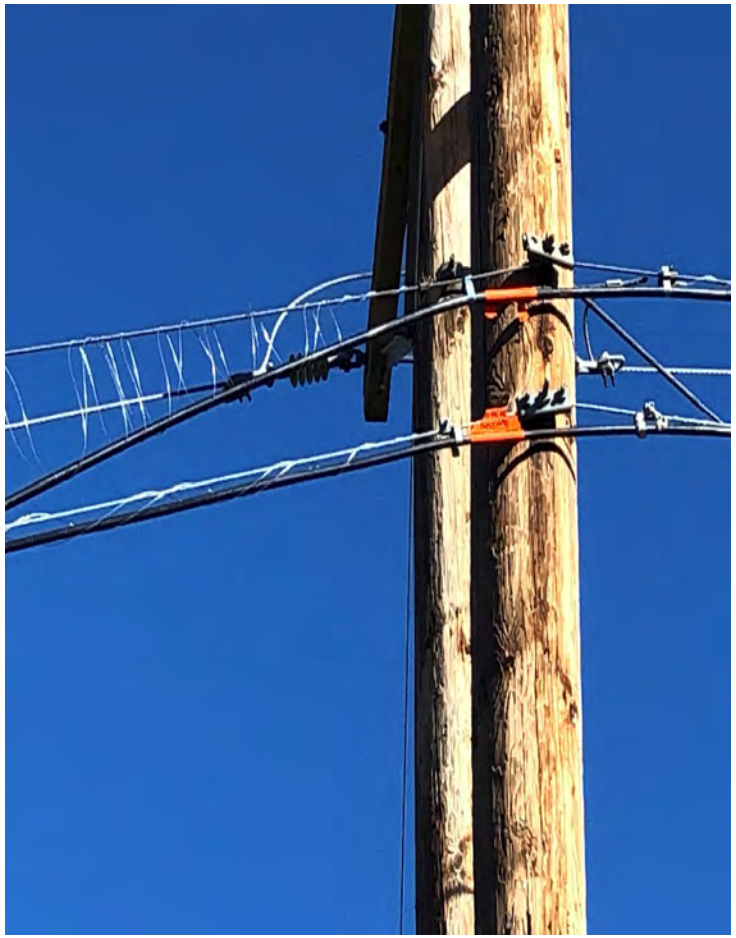
Index	Reference
A	94.4-C, Table 2, Case 21, Columns E to H
B	94.4-C, Table 2, Case 21, Column D
C	94.4-C, Table 2, Case 21, Column C
D	94.8-B
E	94.4-A
F	94.4-B
G	94.4-G, Table 1 Column B, Cases 1 to 6a
H	94.4-E

GO 95 – Figure 94-1, Antenna clearances

CA’s Joint-Use, ROW, and Broadband Journey



Buddy Poles



Comm. cables w/broken lashing

New electric utility equipment

CA's Joint-Use, ROW, and Broadband Journey

Challenges to operating and maintaining electric utility overhead lines/equipment

- Administering pole attachment requests
  - Driven in part by state and federal broadband deployment programs
  - Sporadic high volumes of Joint Pole Authorizations and/or Request For Access applications
    - Approval 'shot clock' imposed by CPUC for RFA applications (2022 - ROW /OTMR rules)
  - Volume of wood poles requiring supplemental intrusive inspection (GO 95, Rule 44.2)
  - Use of different pole loading tools with varying strength/loading inputs
    - Archaic rules based on Assumed/Working Stress Design engineering (GO 95, Section 4)
- Replacing or reinforcing poles and anchors for new/additional communication attachments
  - Utility focus is providing electric service to customers
  - Many Western US electric utilities also focused on system hardening to prevent wildland fire ignitions
    - Often includes coordinated, time sensitive, labor-intensive initiatives and the undergrounding OH lines
  - Coordination between electric utility and communication carrier of pole and/or anchor installation
    - Post-construction inspections to affirm new communication cables/equipment has not overloaded new pole/anchor
    - Electric utilities often make second trip to remove topped poles due to public/customer complaints
  - Timely transfer of communication facilities and removal of partial poles by communication carrier
    - Electric utilities often make second trip to remove topped poles due to public/customer complaints
  - Supplemental inspection program to identify unauthorized communication attachments to poles/anchors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