



Recommendations Report
for
The City of Seattle

following
The Storm on East Marginal Way South
April 5, 2019

prepared by

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November 15, 2019

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1. Details of the Incident

On Friday, April 5, 2019 an afternoon summer storm occurred in the Seattle area with high winds and rain. At approximately 3:50 PM, Seattle City Light experienced a downed section of power line consisting of 26 poles located north and south of the Museum of Flight at 9404 E. Marginal Way South in Tukwila, WA. The map in Appendix A shows the location of the 26 poles. Security camera footage and news reports showed that one pole landed on a moving vehicle with two occupants inside. The vehicle passengers were treated and released shortly afterward from a local hospital.

Seattle City Light quickly responded with 7 crews and about 40 workers to assist with the safety of people near the scene. Subsequent efforts were focused on clearing debris and restoring power to approximately 16,500 customers impacted by the outage. By 6:00 pm all but 300 customers had power restored and only 13 customers were not restored by Saturday morning.

Seattle City Light called for a third-party review of the incident and asked the City Attorney's Office for assistance in contracting with multiple experts and overseeing the on-site inspection. The recommendations of that expert review are contained in this report.

2. Pole design and loading

The original designs of the 26 poles when installed surpassed the loading requirements of the National Electrical Safety Code (NESC). Both the requirements in Rule 250B District Loading (Medium Grade C) and when required Rule 250C Extreme Wind (85 mph Grade C) were exceeded by the designs.

Recommendation:

There is no recommendation related to design and loading as Seattle City Light designs exceeded the requirements of the NESC.

3. Classification of wood poles with remaining strength below NESC requirements

The National Electrical Safety Code (NESC) sets the requirement for when wood poles need to be rehabilitated or replaced due to loss of bending strength from decay, insects or mechanical damage; these poles are referred to as "*reject*" poles:

NESC Table 261-1 Footnote 2

"Wood and reinforced concrete structures shall be replaced or rehabilitated when deterioration reduces the structure strength to 2/3 of that required when installed. When new or changed facilities modify loads on existing structures, the required strength shall be based on the revised loadings."

Since an actual loading analysis on wood poles is not normally part of a wood pole groundline inspection program, common practice is to reject poles when the remaining strength is 2/3 (67%) or less of the original strength of the pole that was installed, not the pole that was required. The original strength is based on the groundline circumference.

The current requirements for categorizing poles following groundline inspection are specified in Seattle City Light Standard 160812 – Inspection Procedures for Wood Pole Assessment. Table 2-1: Priority Rating (below), explains how poles are currently to be classified depending on the remaining strength results during the “Inspect & Treat” program.

Table 2-1: Priority Rating

Priority Rating	Maintenance Required	Description
P1	Replace	RSM is 25% or less – Pole requires Replacement – Immediate Action Required – Notify CITY LIGHT if pole poses an imminent public safety hazard
P2	Replace	RSM is 75% or less than and greater than 25% – Pole requires Replacement – Maintenance Required within Practical Timeframe – Not a candidate for truss reinforcement.
P3	Reinforce	RSM is 75% or less and greater than 40% – Maintenance Action Required within Scheduled Timeframe. Candidate for truss reinforcement.
P4	None	RSM is greater than 75% – Pole is Serviceable based on an above ground level sound and bore inspection only (non-excavatable). No Remedial Maintenance Required – Inspect next cycle.
P5	None	RSM is greater than 75% – Pole is Serviceable – No Remedial Maintenance Required – Inspect next cycle.

The P3 classification is not currently used as an option for decayed poles but it should be reinstated going forward as explained in the recommendations at the end of this section.

The P1 classification is for poles with 25% or less remaining strength and requires:

“Replacement – Immediate Action Required
Notify City Light if pole poses an imminent public safety hazard”

The P2 classification is for poles with remaining strength greater than 25% up to 75% and requires:

“Replacement – Maintenance required within Practical Timeframe”

The P2 range is conservative on the high end as the NESC allows poles including their supported facilities extending less than 60 feet above ground to be reduced to 67% of its required bending strength before restoration or replacement is necessary. The low end of greater than 25% remaining strength is non-conservative. This includes poles with 26% to 40% remaining strength that should be remediated in much more specific and shorter timeframes than “Within Practical Timeframe”.

This broad range of remaining strength for P2 classified poles is one of the core issues in this incident. The Seattle City Light records for maintenance only show the P2 classification, not each pole’s remaining strength so personnel would not know whether the remaining strength of a pole was closer to 25% or 75%.

When multiple weak poles are sequential in a section of line, there is at greater risk of causing line failures than when a single weak pole which has stronger poles on either side that help to support it. The current standard does not assign any greater urgency to remediation when multiple P2 poles are identified sequentially in a line.

Recommendations:

1. Divide the remaining strength range for P2 poles (currently from greater than 25% to 75%) into ranges that are not as broad. The corresponding remediation requirements also need to align better with pole remaining strength by stating more specific time frames. There are multiple ways to consider different granularity for reject poles and more targeted specifications for remediation.

The process for replacing poles usually takes several months to get through permitting, design, crew scheduling and other requirements. Pole restoration on the other hand can be accomplished in very short time frames which along with significantly lower costs are the drivers for Recommendation 3.

2. Add a requirement to standard 160812 and Table 2.1 to increase the urgency of remediation when any combination of two or more P1, P2, or P3 poles are located sequentially in a line. A consecutive series of weak poles is at greater risk of causing line failures than a single weak pole that has stronger poles on either side.
3. Reimplement pole restoration for the P3 poles in lieu of pole replacement. The steel truss system is widely used across the country as a permanent repair for weakened wood poles. More specifically, pole restoration is broadly applied at Puget Sound Energy, PG&E, SCE, Portland General Electric, and other west coast utility companies that have a large portion of their system in urban areas. Virtually all steel truss restoration in the country is performed by outside contractors having highly experienced, specialized crews with a single purpose of restoring poles. Similarly, utility crews are more accustomed to replacing poles and are very adept and efficient at pole replacement.

Seattle City Light personnel explained that they instituted a program where Seattle City Light crews installed trusses for a time in lieu of replacement. However, crews expressed concern about crew exposure to the noise of an air hammer driving the truss and thought some homeowners may not be in favor of having a truss installed. However trussing poles has been widely accepted by homeowners everywhere and the process is much less intrusive for the homeowner than pole replacement.

Seattle City Light is not alone in ending a restoration program where in-house crews install the trusses. The equipment is very specialized, and the installation method is different from normal field work that crews are familiar with. In addition, the restored pole should be treated with effective supplemental preservatives which requires a pesticide applicators license. No other utility around the country has been able to sustain an in-house steel truss restoration program.

When wood pole restoration is performed by an outside contractor, the work is completed by a qualified and experienced crew so that the hard to reach “reject” poles that are candidates for restoration will be restored and treated with supplemental preservatives to help control future decay. Most utility companies have the installed truss painted brown which blends with the pole. See Appendix B.

When an inspector rejects a pole due to groundline decay, he will evaluate the pole further to see if it is a candidate for restoration. First it must fit in the remaining strength range for P3 poles. Secondly, the condition of the pole from groundline to 5 feet above ground is evaluated to determine if the remaining sound shell is adequate for restoration.

In addition, the pole top needs to be in good condition. If the pole meets the requirements to be a restoration candidate, it would be classified as a P3 as opposed to a P2. Poles that are effectively treated and restored are re-inspected on the same cycle as all other poles.

The life extension resulting from restoring poles varies but is usually due to issues outside of the truss system like pole top decay, woodpecker damage or uncontrolled groundline decay. However, The average life extension of poles that are restored and effectively maintained during future inspections can be expected to reach 30 years. In addition, when a restored pole is removed from service, the truss can be reinstalled on another pole for only the cost of labor and banding.

There are a range of additional aspects that Seattle City Light should explore before initiating a system wide restoration program; issues like reviewing union contracts, contractor crew safety, city regulations and permitting, etc.

There is an existing backlog of 6,000 poles that have been classified as P1 or P2 that call for replacement. The P2's will likely need to be reinspected to consider them for restoration and change the classification to P3's. Typically, 50% to 70% of "reject" poles will be candidates for pole restoration. Therefore, even with incorporating a restoration program, Seattle City Light crews will keep very busy replacing the remaining "reject" poles.

As mentioned in Recommendation 1, there are two significant drivers to restore poles instead of replacing them:

1. Poles can be restored at a much faster rate than replacement can occur
 - a. No time required for designing, scheduling with other line work
 - b. Power stays on during restoration
 - c. A contract crew may average 5 to 8 restorations per day or possibly more
2. Poles can be restored for less than 10% of the cost to replace
 - a. The full cost of restoration can be capitalized so no O&M expense is incurred
 - b. For pole replacement, some portion of the cost (10% - 15%) incurs an O&M expense

Restoring some poles set in concrete can incur excessive costs for concrete restoration and ADA curb ramps. Outside of those kinds of excessive costs, the price of restoration in urban environments should be expected to be well less than 15% of pole replacement costs.

4. Method for determining wood pole remaining strength

Estimating wood pole remaining bending strength due to internal decay is not an exact science. The Seattle City Light standard 160812 Inspection Procedures for Wood Pole Assessment includes section 2.4.11 Reporting of Priority Rating. However, the standard does not explain how the inspector should determine a pole's remaining section modulus which in turn determines remaining strength and is then used to classify poles during the "inspect & treat" program.

Recommendations:

1. It is important for Seattle City Light to specify in standard 160812 the process for determining remaining strength. The most accurate procedure for poles with internal decay in all quadrants is to input the individual remaining shell thickness in all four quadrants rather than boring once or twice and projecting that or those shell thickness values around the rest of the circumference.
2. The software currently used to determine remaining strength calculates remaining strength in both the transverse and longitudinal direction and the lesser value is used. However, the initial pole failure in a line virtually always occurs in the transverse direction due to wind loading or other outside forces. The attached wires limit the ability of a pole to fall longitudinally. It is recommended that Seattle City Light should only use the transverse remaining strength to classify poles.
3. Seattle City Light needs to ascertain whether the current remaining strength software accounts for reduced remaining strength that is the result of advanced internal decay creating a thin-walled cylinder that fails in localized buckling. The local buckling results in a remaining strength that is less than the calculated bending capacity. If the software does not account for local buckling, there needs to be a way that this is accounted for. Otherwise the remaining strength of thin walled poles will be overestimated.
4. It appears that the remaining strength value is delivered to Seattle City Light along with the other pole data following inspection. However, that value is not stored in the database that is used to schedule follow up maintenance and remediation. Bringing the remaining strength value into the maintenance database will provide more specific information on a pole by pole basis; especially for pole restoration and replacement scheduling.

5. Golden buprestid beetle infestation

Several poles were found with evidence of Golden Buprestid Beetle infestation. Exhibit L of the Storm Report, Wood Pole Strength Report includes the following:

"This species of beetle lays its eggs in living trees, especially Douglas fir, and as the larvae bore around within the living tree they create both tunnels and larger cavities. Upon maturing, the beetles emerge from the living tree and the life-process repeats.

If such an infected tree is harvested while the larvae inhabit the wood, they will continue to bore and usually fungally infect the wood within that pole unless they are killed. That is why AWPAs Pole Standard M1 (AWPA 2016c) specifically mandates sterilization of the wood poles either before or during preservative treatment. Such sterilization most often consists of either initial kiln drying or a pre-treatment thermal process capable of achieving a core temperature of 150°F at the pith center of the pole for at least 1-hour.

It has been rumored that some copper naphthenate treaters do not properly sterilize their poles because the diesel co-solvent used with some AWPA HSC carriers (AWPA 2016d) used for copper naphthenate is not compatible with high-temperature pre-treatment thermal (i.e., Boultonizing). It is impossible to tell without specific treating plant reports, but we suspect that such treaters back off on the Boultonizing cycle to avoid pulling too much diesel co-solvent into their condenser tanks.”

It is apparent that many of the poles that failed had infestation of these beetles so they could not have been properly sterilized back in the 1990’s.

Recommendations:

See combined recommendations in section 6.

6. New pole conditioning specifications

Seattle City Light standard number 5082.00 – Wood Poles, Pressure-Treated, Douglas Fir establishes the manufacturing requirements when purchasing new poles. Section 6.1 calls for full-length incising to a minimum depth of ½ inch while 6.2 calls for through-boring that extends 15 inches above groundline and 24 inches below groundline. In the case of incising, a ½ inch depth is not likely to reach into the heartwood which is where penetration is required to provide enhancement of treatment. At the same time, going deep enough to reach the heartwood may cause structural bending strength issues. It is not common to require both full length incising and through-boring.

Recommendations:

1. Eliminate the full-length incising requirement due to poor effectiveness and only require through-boring which is very effective in the groundline zone.
2. Consider extending the range of the through-boring pretreatment process beyond 15 inches above groundline and 24 inches below ground. This would help to keep the actual groundline zone protected if a pole is set deeper or shallower than the specified setting depth.

7. New pole preservative treatment specification

The original treatment specified in section 6.3 of 5082.00 is copper naphthenate (CuNap) which has been used at Seattle City Light since 1991. This chemical is not widely used as an original treatment and many species of Brown Rot fungi are copper tolerant and will not be controlled by CuNap. It would be worthwhile to reconsider creosote or pentachlorophenol (Penta) as a preferred preservative treatment because they are almost always subjected to high-temperature pre-treatment thermal conditioning (i.e., Boultonizing) and have a long history of proven long life. Almost all other utility companies on the west coast use Creosote or Penta.

The Seattle City Light specification 5082.00 refers to several standards published by the American Wood Protection Association (AWPA) that address the issues related to new pole preservative treatment. Sterilization requirements are part of these standards which is an important aspect for controlling golden BUPRESTID beetles.

Based on processing details received from McFarland Cascade, the current supplier of wood poles, it appears that the Douglas-fir poles for Seattle City Light are conditioned using the Boultonizing process so that the internal temperature of the poles is raised enough to address the beetle larvae.

Recommendations:

1. Now that Seattle City Light has implemented CuNap poles for almost 30 years, there is likely enough data on those poles to begin to evaluate field decay performance. That data should be analyzed to see when poles begin to decay and try to learn the age band when the decay rate begins to significantly increase. This is useful for learning whether any aspects of the pole maintenance program should be modified.
2. Seattle City Light should work with its respective QA/QC agencies conducting pole treatment inspections at the plant to assure that the thermal pretreatment achieves sterilization and verification of treatment penetration and retention.
3. Add to standard 5082.00 the requirement that no bio-oils or diesel oil be used with CuNap until they can be proven to maintain fully thermal stability when pre-treatment drying and/or sterilization procedures are used.
4. Reconsider the use of Creosote and Pentachlorophenol (Penta) as original pole treatments. They are very widely used across the country and are the predominant choices on the west coast since chromated copper arsenate (CCA) is not an option for Douglas fir poles.
5. Consider a trial pilot program to study the performance of new poles treated with an oil-based preservative named UltraPole NXT containing DCOI as the active ingredient (see Appendix B). It is not a restricted use pesticide and has low to no odor. However, this is a new preservative treatment for wood poles and has limited real world experience at this point.

8. Supplemental preservatives

Boron rods have been found to be less effective for controlling internal decay compared to other internal remedial treatments. The travel of threshold levels of boron, the active ingredient, is limited to inches. Thus, the dispersal range of boron rod treatments from the point of application is many times less than with vaporized fumigants.

Fumigants treat and sterilize sound wood to prevent decay from establishing and is the recommended treatment for Douglas-fir poles due to the prevalence of internal decay. The superior performance is partly because the effective ingredients travel 1 to 2 feet up and down and many inches in and out from the point of application.

When decay has already advanced to create a void, there are other internal preservative treatments that are effective at stopping the decay from destroying more wood surrounding the void.

Recommendations:

1. Fumigants migrate through sound wood to sterilize the sound wood but are not as effective for treating existing voids. Fumigants are now available in a variety of formulations that include liquid, solid material, granular, and pressed sticks.

Seattle City Light should consider pressed sticks of dazomet, the newest development in the fumigant realm. Dazomet is largely used in the agricultural and turf realms. The chemical is used to control pests that inhibit plant growth through gaseous degradation. Dazomet is also used as a soil sterilant for golf courses, nurseries, turf sites and potting soils.

The granular form of dazomet went through extensive testing at Oregon State University and was shown to be very effective in wood poles. This granular form of the fumigant has been used for many years to treat wood poles.

Pressing the granular form into sticks for wood pole application reduces handling and dusting risk and eliminates local spills. This is very similar to the application of boron rods. At the same time, these sticks provide the superior decay protection of fumigant preservatives that travel 1 to 2 feet from the point of application and can remain effective through a full 10-year cycle. See Appendix D.

2. Another supplemental preservative that Seattle City Light should consider is a new foaming internal treatment for controlling decay in existing voids. This application method is in lieu of applying liquid treatment into existing voids with a pressure pump. This new application method of the treatment is more environmentally and operator friendly and still very effective at keeping an existing void from continuing to destroy the surrounding wood. See Appendix E.
3. There has always been a concern that the active ingredients in supplemental treatments may be released to surrounding ground water, surface water or soil. A study was conducted in the wetland area of the New York State Adirondack Park to evaluate this concern in 1992. The conclusion was that supplemental wood pole treatments did not present a significant health risk to biota or humans.

The formulations of effective ingredients in today's supplemental preservatives are different as manufacturers have moved to more environmentally friendly formulations. Even though the changes have been made with more environmentally friendly ingredients, a new study was conducted in 2017. Even using tap water exposure of bathing 42.6 minutes a day, drinking 2.5 liters a day for 350 days a year for 26 years, predicted surface water and potable well water concentrations remained below environmental and human health thresholds established by the EPA. Appendix F is an overview of these studies.

9. Pole top protectors

Groundline decay is the primary cause for the need to restore or replace poles. However, the next most vulnerable section of the pole is the top. At some point a pole top may begin to split. Utility companies establish allowable limits of splitting. Decay may also occur at the pole top which can create safety risks if the decay moves down to where a crossarm or equipment is attached.

Pole top protectors are now available in a variety of configurations and provide significant life extension for pole tops. Seattle City Light is not currently using pole top protectors.

Recommendations:

1. Conduct an evaluation of current pole top protector options. Some are metallic, others are manufactured with mastic material and still others are made of plastic and some include a preservative agent.
2. Consider adding pole top protectors to in-service poles as well as on all new poles.

10. Coordination with Century Link

Century Link has inspected 40,000 poles in the past two years that are jointly owned with Seattle City Light. However, collaboration with Century Link has been limited and to date, coordination of the programs is lacking.

Century Link solely owns or jointly owns over 2 million poles in 34 states. They inspect 10% of the poles in each state every year. Their program has a high level of efficacy so there is likely to be a lot of synergy with the Seattle City Light program. It doesn't seem necessary for poles inspected by Century Link to also need inspection by Seattle City Light.

Recommendations:

1. Century Link inspections are conducted by Osmose Utilities Services, Inc. That program currently restores solely owned reject poles but does not apply restoration to poles jointly owned with Seattle City Light. The Century Link program does provide "P" ratings according to the Seattle City Light specification.

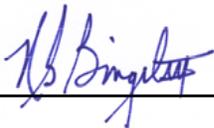
Meetings should be scheduled by Seattle City Light with the appropriate people from Century Link and Osmose to discuss a variety of issues:

- a. Comparison of the inspection procedures for both programs
 - b. Comparison of supplemental preservatives used
 - c. Comparison of the application of steel truss pole restoration
 - d. Integration of Century Link inspection and maintenance data into a Seattle City Light database including pole restoration
 - i. Is the current data delivery from Century Link useful?
 - ii. How could the data delivery be made more useful and more easily integrated with Seattle City Light data?
2. Seattle City Light should work with Century Link to find better ways to coordinate the inspection programs so that the entire Seattle City Light plant can be inspected more efficiently and in shorter time frames.

This report is based on a reasonable degree of engineering and wood science certainty, based on forensic review in the Seattle City Light pole yard, based on my expertise in the National Electrical Safety Code (NESC), based on the documents reviewed and cited in this report, and based on my experience with wood utility pole inspection and maintenance.

I reserve the right to add, amend, or change details or opinions should further information be made available for my review or come to my attention.

Respectfully submitted,



Nelson G. Bingel, III
Nelson Research, LLC

APPENDIX A

Map of Failed Poles



E Marginal Way

- DRG Pole Data
- SCL Owned, SCL Inspected
- CL/SCL Owned, SCL Inspected
- CL/SCL Owned, CL/SCL Inspected

CL = Century Link, SCL = Seattle City Light

0 100 200 400
Feet

Print Date: 4/26/2019



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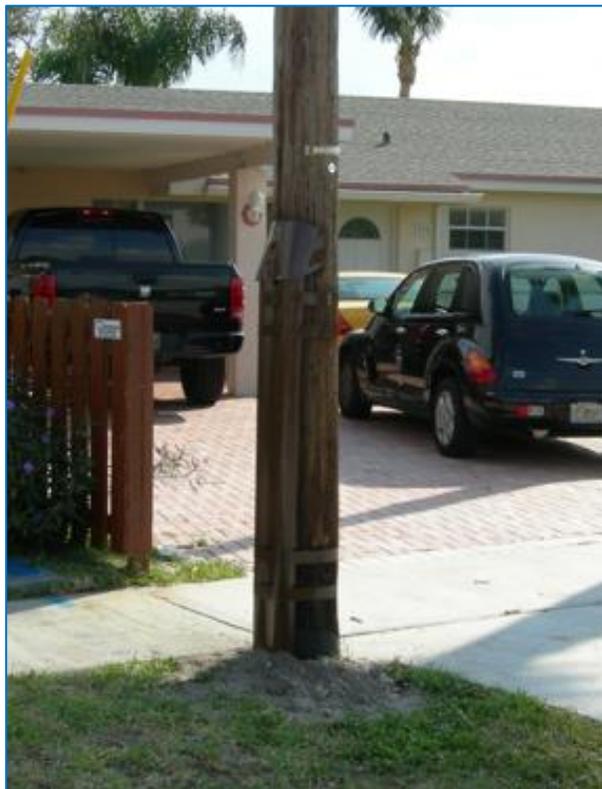
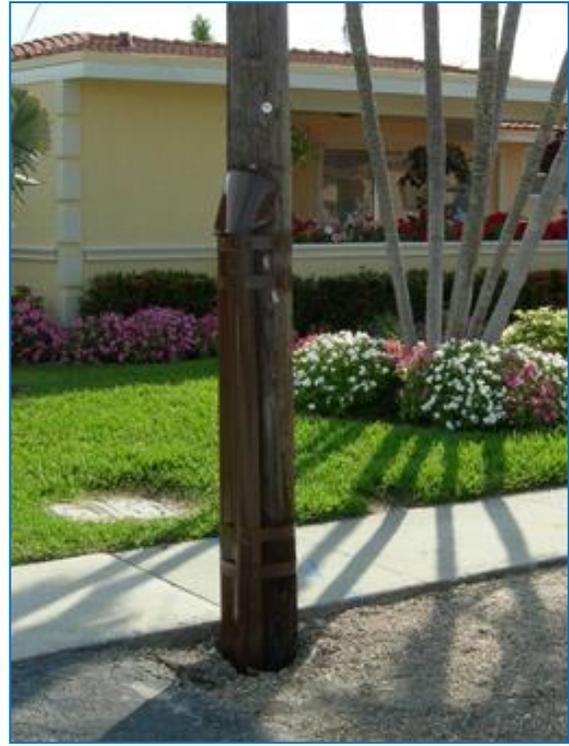
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

APPENDIX B

Reinforcing Truss Installation and Final Installations





APPENDIX C

New DCOI Original Pole Treatment

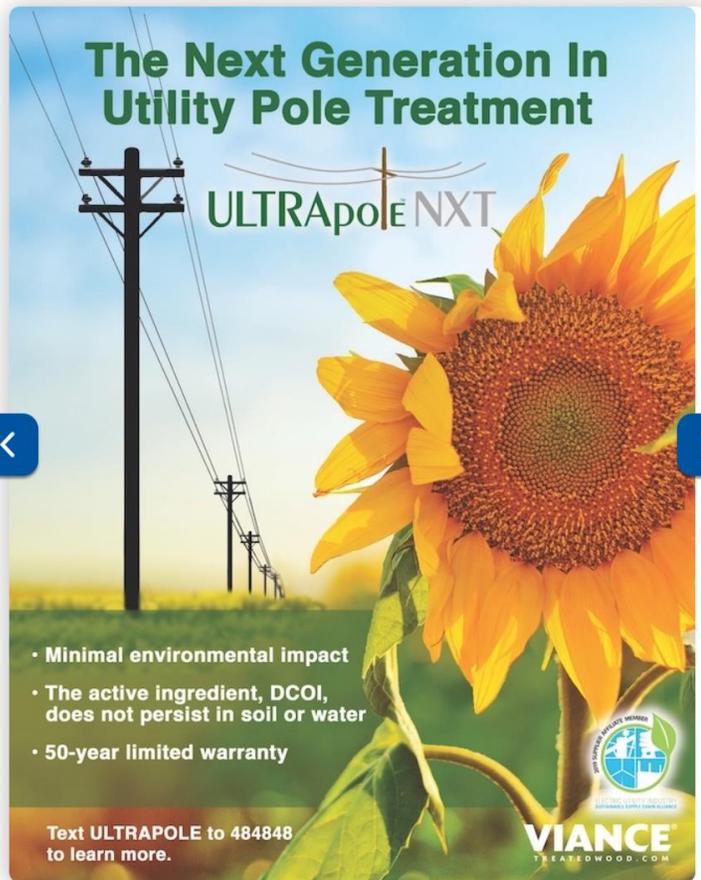


<https://treatedwood.com/products/ultrapolenxt>



Long-term efficacy combined with low environmental impact

- UltraPole™ NXT is an oil-borne preservative that makes poles easy to climb.
- The active ingredient in UltraPole NXT and UltraArm NXT is not a Restricted Use Pesticide and is not persistent in soil.
- UltraPole NXT and UltraArm NXT have low to no odor.
- UltraPole NXT and UltraArm NXT use less energy, fossil fuels, and water to produce; with lower ecotoxicity than other materials used in poles.
- UltraPole NXT and UltraArm NXT have a wider range of disposal options at the end of life.
- UltraPole NXT and UltraArm NXT are the only oil-borne preservative-treated poles and crossarms with a 50-year limited warranty.
- DCOI, the active ingredient in UltraPole NXT and UltraArm NXT, earned the EPA's President's Green Chemistry Challenge Award in 1996 for its use as an alternative to tributyltin (TBT) compounds in marine antifoulant coatings.
- DCOI is also the active ingredient in Ecolife®, the best performing, non-metal based, above-ground residential deck preservative on the market.



The first major innovation in treated wood pole protection with decades of stake performance data

- DCOI – Oil-borne preservative for the utility industry
- Standardized by the American Wood Protection Association (AWPA)
- UltraPole NXT and UltraArm NXT are the only oil-borne wood pole and crossarm preservative in the industry with a 50-year warranty.
- Perfect for industrial wood pole and crossarm applications in all ground contact decay hazard zones
- Crossarms – both Southern yellow pine and Douglas fir
- Utility poles – Southern yellow pine
- Barn poles – Southern yellow pine
- Posts (guardrail and fence) – Southern yellow pine

APPENDIX D

New Pressed Dazomet Stick Supplemental Fumigant Treatment



OsmoFume is a patented solid body fumigant. Its stick-like design makes for an easy, clean, and safer application. The compact design of the OsmoFume stick allows room for triple the amount of accelerant to be used (when compared to granular/powder fumigants).

OsmoFume performs best in conjunction with Hollow Heart® CB as an accelerant. The water and propylene glycol in Hollow Heart CB help improve the mitc production by acting as a wetting agent, and the co-biocides of copper and boron thoroughly migrate through the application zone, and go to work immediately to fight internal decay.



Copper migration



Boron migration

An Advancement in Fumigant Technology

- ✓ **Less Risk**
 - Dusting and the risk of accidental release are virtually eliminated, reducing exposure to the applicator and the environment
- ✓ **Effective**
 - Compact stick design provides controlled dose with triple the room for accelerant
 - Increases dazomet contact with copper-based accelerant
 - Boron and copper go to work immediately
 - Propylene glycol serves as a wetting agent, promoting preservative migration
- ✓ **Environmentally Preferable**
 - Eliminates localized spills
 - Packaging system reduces plastic consumption and waste disposal



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Fumigant Comparison



Product Name	WoodFume®	DuraFume® II	OsmoFume™	MITC-FUME®
Name of Active	Metam-sodium	Dazomet	Dazomet	Methylisothiocyanite (mitc)
Form	Liquid	Powder/Granular	Solid-dazomet stick	Solid-melt tube
Amount of Accelerant Possible	n/a	< 1 oz per hole	3 oz per hole	n/a
Controlled Dose	No	No	Yes	Yes
Applicant Exposure	High	Medium-High	Low	Low-Medium
Risk of Accidental Release	High	Medium-High	Low	Low-Medium
Cost	\$	\$\$	\$\$\$	\$\$\$

Ordering & Application Information

OsmoFume is packaged 375 sticks per pail.

Hollow Heart CB is available in 1-gallon jugs (4 per case), 5-gallon pails, and 16 oz. bottles (box of 12)

Pole Circumference	Number of Application Holes & Drilling Pattern (apply up to 3 sticks per hole unless otherwise noted)
Less than 16"	2 holes 6"-7" deep at groundline spaced 120 degrees apart with 12" vertical spacing; apply only one stick per hole
16" - 28"	2 holes 8"-10" deep at groundline spaced 120 degrees apart with 12" vertical spacing; apply only two sticks per hole
29" - 40"	3 holes 14" deep at groundline spaced 120 degrees apart and 6"-8" higher than the previous hole
41" - 49"	4 holes 14" deep at groundline spaced 90 degrees apart and 6"-8" higher than the previous hole
50" - 59"	5 holes 14" deep at groundline spaced 70 degrees apart and 6"-8" higher than the previous hole
60" - 69"	6 holes 14" deep beginning at groundline spaced 60 degrees apart and 4"-6" higher than the previous hole
70" - 79"	7 holes 14" deep, the first 2 at groundline 180 degrees apart, the remaining 5 spaced 60 degrees apart and 4"-6" higher than the previous hole
80" - 90"	8 holes 14" deep, the first 2 at groundline 180 degrees apart, the remaining 6 spaced 50 degrees apart and 4"-6" higher than the previous hole
Greater than 90"	9 holes 14" deep, the first 2 at groundline 180 degrees apart, the remaining 7 spaced 45 degrees apart and 4"-6" higher than the previous hole

For more information on OsmoFume or to place an order:

CALL 770.632.6700 opt. 3

EMAIL products@osmose.com

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osmose.com/products

APPENDIX E

New Foaming Internal Supplemental Treatment for Existing Voids



Hollow Heart[®] CB

LIQUID INTERNAL TREATMENT

Hollow Heart CB (copper and boron) provides deep, long-lasting protection against decay. Diluted with water, Hollow Heart CB becomes a 2% copper as metal and 5.0% boron solution designed to be applied by internal injection, brush, or sprayer. Compared to other liquid internal treatments, Hollow Heart CB offers:

- ✓ **Better efficacy**
 - Hollow Heart CB features cobiocides - copper and boron compared to single biocides
 - Boron offers deeper penetration than copper which is primarily topical
- ✓ **Lower cost** (compared to internal treatments)
- ✓ **Reduced exposure risk for improved worker safety**
 - Carries a signal word of "Warning" versus "Danger" for copper naphthenate products
 - Easy to clean up and virtually odor free
 - Improved applicator hygiene
- ✓ **Better environmental profile**
 - Water-based rather than solvent-based like traditional copper naphthenate products
 - Low volatile organic compound (VOC) emission
 - UL Environmental Claim Validation

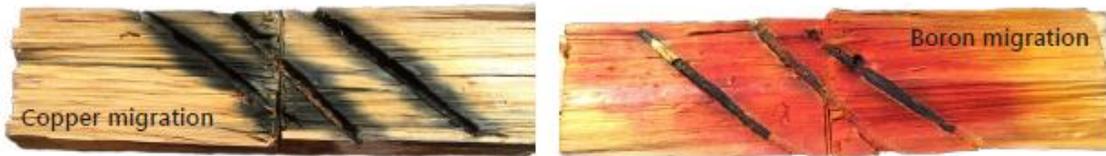
HOLLOW HEART CB VS. COPPER NAPHTHENATE

	Hollow Heart CB	Copper Naphthenate & Solvent Solution
Formulation	Waterborne	Oilborne
VOC Content (grams/liter)	< 100	> 750
UL Environment Validation	Yes	No
Meets SCAQMD Standards	Yes	No
Meets SMAQMD Standards	Yes	No
Meets LMADC Standards	Yes	No
Meets OTC Standards	Yes	No
Diesel Fuel/Solvent Free	Yes	No
Number of Active Ingredients	2	1
Easy Clean Up	Yes	No
Flammability (NFPA Code)	0 - not flammable	2 - flammable
Flash Point	212 F	104 F
Store Above 90 F	Yes	No



Application methods from the Hollow Heart CB label:

Internal Treatment: Using air or mechanical pressure pump, apply solution to interior cavity of wood structure through prepared opening. Apply one gallon (maximum per cu. ft. of wood) or to refusal. Product may also be applied as a foam by adding 3 to 8 ounces of foaming agent per gallon of mixed solution. Apply foam as to fill the void area and contact all wood surfaces in the void space.



HOLLOW HEART CB: THE ENVIRONMENTALLY PREFERABLE CHOICE

As the world's leading developer of wood preservatives designed for in-service poles, Osmose has established R&D priorities intended to maintain efficacy against decay and deterioration while reducing the volume of active ingredients, lowering the risks to non-target organisms, and eliminating petroleum-based carriers from our product line.



Hollow Heart CB holds an Environmental Claim Validation from UL Environment. This distinguished validation confirms that Hollow Heart CB exhibits volatile organic compound (VOC) content below the limits defined by South Coast Air Quality Management District (SCAQMD) for the wood preservative category of SCAQMD Rule 1113. Hollow Heart CB is the only liquid internal treatment that carries this distinguished validation. With a VOC level well below 350, Hollow Heart CB also complies with Sacramento Metropolitan Air Quality Management District (SMAQMD) Rule 442, Lake Michigan Air Directors Consortium (LMADC) standards, and Ozone Transport Commission (OTC) standards.



ORDERING INFORMATION

Hollow Heart CB concentrate is available in three sizes:

- 1-gallon jugs (4 per case)
- 5-gallon pails
- 16-ounce squeeze bottles (12 per case)

-The 16-oz squeeze bottle contains 6.4 oz of concentrate. Simply fill the bottle with water, shake, and the solution is ready-to-use.

For more information on Hollow Heart CB or to place an order:

CALL 770.632.6700 Opt. 3 | EMAIL products@osmose.com

APPENDIX F

Environmental Effects of Remedial Pole Treatments



An Updated Report on an Independent Study of the
**Environmental Effects of
Remedial Pole Treatments**



Osmose
The Structure Company

Study Conducted by O'Brien and Gere Engineers, Inc.



1992 ESEERCO STUDY

In 1992, a field study and associated risk assessment was sponsored by the Empire State Electric Energy Research Corporation (ESEERCO) and performed by O'Brien & Gere Engineers, Inc. (OBG) to evaluate the potential ecological and human health impacts related to the application of five supplemental, or remedial, wood preservatives to in-service utility poles. The field study involved post-application monitoring for active ingredients and biological impacts in a wetland area of the New York State Adirondack Park. The remedial preservatives and principal active ingredients evaluated were OsmoPlastic (fluoride, chromium, creosote); Dursban (chlorpyrifos); WoodFume (sodium methyl dithiocarbamate); Hollow Heart

(fluoride, chromium, arsenic); and Cop-R-Nap (copper, naphthenic acid). Each of these remedial preservative technologies was manufactured and/or distributed by Osmose Utilities Services, Inc. (Osmose) at the time of the ESEERCO testing.

The ESEERCO Field Study established that essentially no preservative active ingredients were released to surrounding ground water, surface water or soil in the 17 month post-treatment sampling period.

Researchers concluded that the supplemental utility pole treatments did not cause measurable post-application impacts to Adirondack Park wetlands. The absence of detectable residues was related to a combination of physical and chemical factors including

the small original mass of applied materials, a high affinity for adsorption to wood surfaces, and an ability of the preservatives to undergo volatilization or biodegradation.

Researchers also performed a risk analysis using computer generated estimates of preservative concentrations released from the remedially treated poles.

Predicted estimates of active ingredient concentrations were found to be significantly higher than actual measured levels in soil, surface or ground water, yet were still lower than USEPA drinking water criteria. Thus, the modelled analyses further supported the conclusion that the supplemental wood pole treatments did not present a significant health risk to biota or humans.

CURRENT STUDY

While Osmose's remedial preservative technologies have been reformulated to be even more environmentally responsible than those evaluated in the 1992 ESEERCO Study, Osmose engaged OBG to perform a risk assessment to establish the potential ecological and human health effects, if any, related to the application of the following remedial wood pole preservatives (Figure 1):

1. MP500-EXT*
2. Hollow Heart® CB
3. Pole Wrap™ CB
4. MITC-FUME®
5. OsmoFume™
6. WoodFume®

For this risk analysis, OBG Researchers utilized a ground water transport computer model similar to that utilized in the ESEERCO Study to generate "worst case" estimates

of preservative release in stormwater and groundwater at a 15 m distance downgradient from the pole.

Risk to human receptors from exposure to boron and copper was evaluated using USEPA Regional Screening Levels (RSLs) for tap water. A *mitc* tap water standard was derived by OBG Engineers using existing toxicological literature and RSL methodology. Risk to aquatic receptors from individual constituents was determined by comparing the modeled surface water concentrations to the USEPA's ECOTOX database (acute exposure), and BTAG* Freshwater Screening Benchmarks (chronic exposure).

**USEPA Region 3, Biological Assistance Technical Group (BTAG)*

As with the 1992 ESEERCO Study, predictive estimates of preservative release for this

computer modeled risk assessment are conservative. This is particularly true when considering the cautious nature of the USEPA RSL residential tap water exposure scenario of bathing 42.6 minutes/day; drinking 2.5 liters/day; for 350 days/year for 26 years. Even with this conservative approach, predicted surface water and potable well water concentrations remained below the environmental and human health thresholds established by EPA. Given these findings, OBG Researchers concluded that supplemental utility pole treatments MP500-EXT*, Pole Wrap™ CB, Hollow Heart® CB, MITC-FUME®, WoodFume® and OsmoFume™ provide minimal risk to the environment and human health when properly applied.

Figure 1: Remedial Preservative Technologies

Remedial Preservatives	Application	Active Ingredients
MP500-EXT*	External preservative paste	Micronized copper carbonate, sodium tetraborate decahydrate
Hollow Heart® CB	Internal liquid preservative	Copper ethanolamine complex, disodium octaborate tetrahydrate (DOT)
Pole Wrap™ CB	External dry preservative bandage	Copper carbonate, boric acid
MITC-FUME®	Internal fumigant, solid melt	Methylisothiocyanate (<i>mitc</i>)
OsmoFume™	Internal fumigant, solid body	Dazomet, decomposes to <i>mitc</i> at a conversion efficiency of 45%
WoodFume®	Internal fumigant, liquid	Metam sodium, decomposes to <i>mitc</i> at a conversion efficiency of 18%



Committed to Environmental Stewardship

Osmose is dedicated to the conservation of utility resources and strives to create a culture of environmental awareness both as a product developer and as a service provider. We support the research and development of products and services that extend the safe and reliable service lives of structural T&D assets for many years beyond what is typically expected. Osmose has established R&D priorities intended to maintain efficacy against decay and deterioration while optimizing the volume of active ingredients, lowering the risks to non-target organisms, and eliminating petroleum-based carriers from our product line.

MP500-EXT has the lowest toxicity profile of all registered external remedial preservative coatings for wood poles. It carries an Environmental Claim Validation from UL Environment and is the only 100% solvent-free remedial preservative paste on the market. Hollow Heart® CB also carries an Environmental Claim Validation from UL Environment. It is the first and only liquid internal treatment to receive this validation. UL Environmental Claim Validation demonstrates to the marketplace that MP500-EXT and Hollow Heart CB exhibit volatile organic compound (VOC) content below the limits defined by South Coast Air Quality Management District (SCAQMD) for the Wood Preservatives category of SCAQMD Rule 1113.

