Interim Report Field Evaluation of Airepel® HC to Reduce Woodpecker Damage to Utility Poles – Year 2

3002026613

Interim Report Field Evaluation of Airepel® HC to Reduce Woodpecker Damage to Utility Poles – Year 2

3002026613

Technical Update, April 2023

EPRI Project Manager

A. Bennett

EPRI
3420 Hillview Avenue, Palo Alto, California 94304-1338 ▪ USA
800.313.3774 ▪ 650.855.2121 ▪ askepri@epri.com ▪ www.epri.com

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITIES

THE FOLLOWING ORGANIZATION, UNDER CONTRACT TO EPRI, PREPARED THIS REPORT:

EDM International, Inc.

This is an EPRI Technical Update report. A Technical Update report is intended as an informal report of continuing research, a meeting, or a topical study. It is not a final EPRI technical report.

NOTE

For further information about EPRI, call the EPRI Customer Assistance Center at 800.313.3774 or e-mail askepri@epri.com.

Together…Shaping the Future of Energy®

ACKNOWLEDGMENTS

The following organization, under contract to EPRI, prepared this report:

EDM International, Inc.
4001 Automation Way
Fort Collins, CO 80525-3479

Principal Investigators
R. Harness
J. Cummings

This report describes research sponsored by EPRI. All images in this document are courtesy of J. Cummings and R.E. Harness, EDM International.

EDM International, Inc. would like to acknowledge the following contributors to the research presented in this report:

Power South: Josh Hilburn, Mike Grimes, Jud Patterson, and Heath Williamson.

Arkion Sciences: Ken Ballinger and Billy Hackett.

This publication is a corporate document that should be cited in the literature in the following manner:

Interim Report Field Evaluation of Airepel® HC to Reduce Woodpecker Damage to Utility Poles – Year 2. EPRI, Palo Alto, CA: 2023. 3002026613.

ABSTRACT

A 2014 Electric Power Research Institute (EPRI) study evaluated a variety of approaches to address woodpecker problems and identified Airepel® HC, an Arkion Life Sciences anthraquinone (AQ) product, as a potential repellent. A two-year field study with PowerSouth Energy Cooperative (PowerSouth) was designed to evaluate the effectiveness of a topical treatment of AQ to reduce Pileated Woodpecker damage to utility poles. PowerSouth identified areas with historic woodpecker damage and poles in need of replacement due to severe woodpecker damage. February 2020, EDM International, Inc. (EDM) treated 20 new poles (17 for the trial plus three spares) at a PowerSouth pole yard. Poles were treated with Airepel® HC 50% AQ combined with Kilz Premium Primer at a 50/50 mixture. By diluting Airepel® HC with the same amount of Kilz Premium Primer, the final mixture contained 25% AQ. April 1-7, 2020, the treated poles (n=17) were installed as pole replacements for severely damaged woodpecker poles. The first field inspection was conducted 128 days post-treatment, August 13, 2020. Pileated Woodpeckers were present as noted by direct observation and responses to playback calls. Woodpecker damage to non-treated control poles increased significantly from pre-treatment to post-treatment ($F = 4.51$, d.f. = 1, $P = 0.04$). New woodpecker damage was significantly greater on non-treated control poles compared to AQ treated poles ($F= 7.74$, d.f. = 1, $P = 0.0086$). The second post inspection was conducted 752 days post-replacement, April 23, 2022. Pileated Woodpeckers were again present and damage to non-treated control poles increased significantly ($F= 25.82$, df = 1, $P = 0.00006$) from the prior assessment on August 13, 2020. Like the previous inspection, woodpecker damage was significantly greater to non-treated control poles compared to AQ treated poles ($F= 29.62$, df = 1, $P = <0.00001$). The first seasons were promising and the cost of using AQ in trial was comparable to wire wrapping poles. The longevity of the AQ treatment will be an important consideration for its potential use in the utility industry. The U.S. Department of Agriculture, National Wildlife Research Center, Chemistry Section, Fort Collins, Colorado, analyzed residue samples collected from treated poles. The overall mean AQ residues for 2020 and 2022 treated pole samples were 18.5% and 18.1%, respectively. Residue sub-samples were tightly grouped within sampled poles but varied by pole. Treated pole samples from 2020 ranged from 15.8% to 27.7% AQ and samples from 2022 ranged from 12.6% to 25.2% AQ. One more post-treatment inspection is scheduled for fall 2023, damage will be recorded and additional pole shaving samples will be collected to further assess the AQ degradation rate.

Keywords

Pileated Woodpecker
Anthraquinone
Airepel® HC
Repellent
Electric utility
Wood pole

Deliverable Number: 3002026613

Product Type: Technical Update

Product Title: Interim Report Field Evaluation of Airepel® HC to Reduce Woodpecker Damage to Utility Poles – Year 2

PRIMARY AUDIENCE: Asset managers at electric utilities

SECONDARY AUDIENCE: Environmental staff at utility companies

KEY RESEARCH QUESTION

Can Airepel® HC, an Arkion Life Sciences anthraquinone (AQ) product, be used as an effective repellent to deter Pileated Woodpeckers from damaging wood utility poles?

RESEARCH OVERVIEW

Severely damaged woodpecker poles were replaced with poles coated with topically treated Airepel® HC combined with Kilz Premium Primer at a 50/50 mixture. Subsequent field inspections were conducted 134 and 752 days post-treatment to document woodpecker damage to non-treated control poles over the study period. Additionally, new woodpecker damage was compared between the control poles and the AQ treated poles. The cost of treating poles with AQ was compared to the cost of wrapping poles with wire wrap, a traditional way of addressing woodpecker damage. Samples of AQ were taken for chemical analysis to determine longevity.

KEY FINDINGS

- Pileated Woodpeckers were present as noted by direct observation and responses to playbacks.
- The cost of using AQ in the trial was comparable to wire wrapping poles.
- After 134 days in the field, woodpecker damage to non-treated control poles increased significantly from pre-treatment to post-treatment ($F = 4.51$, d.f. = 1, $P = 0.04$).
- After 752 days in the field, damage to non-treated control poles increased significantly ($F= 25.82$, df = 1, $P = 0.00006$) from the prior assessment.
- After 134 days in the field, new woodpecker damage was significantly greater on the control poles than AQ treated poles ($F= 7.74$, d.f. = 1, $P = 0.0086$).
- After 752 days in the field, new woodpecker damage was significantly greater on the control poles than AQ treated poles ($F= 29.62$, df = 1, $P = <0.00001$).

WHY THIS MATTERS

Resolving woodpecker damage to wood poles is a high priority for many electric utilities, and no materials have been developed and commercialized that adequately protect new wood products from such damage.

HOW TO APPLY RESULTS

Preliminary results are promising and longevity of the AQ treatment will be an important consideration for its potential use in the utility industry. Long-term efficacy is unknown for this topical treatment, thus there is a need for continued monitoring. If successful, incorporating AQ in the wood treatment process should be investigated as a next step.

LEARNING AND ENGAGEMENT OPPORTUNITIES

- *Mitigation of Animal-Caused Outages for Distribution Lines and Substations*. EPRI, Palo Alto, CA: 1999. TE-114915. Project Manager B.S. Bernstein.
- *Performance Evaluation of Woodpecker Damage Repair Systems*. EPRI, Palo Alto, CA: 2004. Principal author: Rob Nelson.
- *Investigation into Wood Pole Restoration Techniques*. EPRI, Palo Alto, CA: 2005. Principal author: Rob Nelson.
- R. E. Harness and E. L. Walters. "Knock on Wood: Woodpeckers and Utility Pole Damage." *IEEE Industry Applications Magazine*, March/April 2005: pp. 68-73.
- T. Whitecar, "Woodpecker Maintenance--Southern Style," EPRI conference proceedings: Mitigation of Woodpecker Damage to Utility Lines, Charlotte, NC (May 14-15, 1997).
- M. L. Avery, J. S. Humphrey, T. M. Primus, D. G. Decker, and A. P. McGrane. "Anthraquinone Protects Rice Seed from Birds," *Crop Protection.* Vol. 17, No. 3, pp. 225-230 (1998).
- M. L. Avery, J. S. Humphrey, and D. G. Decker. "Feeding Deterrence of Anthraquinone, Anthracene, and Anthrone to Rice-Eating Birds," *Journal of Wildlife Management.* Vol. 61, pp. 1359-1365 (1997).

EPRI CONTACT: Ashley Bennett, PhD, abennett@epri.com

PROGRAM: T&D Environmental Issues, P51

EPRI
3420 Hillview Avenue, Palo Alto, California 94304-1338 • USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com

LIST OF ACRONYMS

AQ	anthraquinone
CNP	CenterPoint Energy
EDM	EDM International, Inc.
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
PowerSouth	PowerSouth Energy Cooperative

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1
BACKGROUND

Woodpeckers can cause severe damage to utility poles resulting in significant annual economic losses to utility companies. Central Missouri Electric Cooperative reported replacing 2,114 poles because of direct or indirect damage caused by woodpeckers, and a power company in Alabama spent more than $3 million in a single year addressing this issue [1, 2]. A regional study in the southeastern United States estimated that as many as 65% of premature utility pole replacements are the result of woodpecker damage. CenterPoint Energy (CNP) has spent over $1 million on repairs to poles damaged by woodpeckers (Jeff Dalla Rosa, CNP, personal communication, 2022).

Damage to poles caused by woodpeckers presents a safety hazard to workers, may promote further degradation due to decay fostered by water trapped in holes, and may lead to collapse under adverse conditions. One example occurred near Tampa, Florida, when a pole snapped because of woodpecker damage. The incident caused a cascading failure and overloaded a transmission substation. More than 100,000 people lost power for over an hour [2]. Woodpecker damage is not uniformly distributed within transmission or distribution systems; rather, damage is localized depending on the species, number of woodpeckers, and presence of available foraging and nesting habitat.

Although several species of woodpecker damage utility poles, Pileated Woodpeckers (*Dryocopus pileatus*) cause some of the most severe damage (Figure 1–1). The most extensive damage occurs when birds are excavating nesting or roosting cavities and when birds are searching for insects or drumming to announce their territory. In southern regions, nesting typically occurs from March to May [3]. Their territory size may be inversely related to tree, log and stump volume, and canopy cover within territories. Territories range in size from 106 to 173 acres (43 to 70 hectares; 0.43 to 0.70 km^2) in the southeastern regions of the United States [4, 5].

Figure 1-1
Pileated Woodpecker nesting cavity in a utility pole.

Several techniques are available to alleviate woodpecker damage, including exclusion, mechanical and pyrotechnic devices, chemical repellents, and lethal removal [1, 6, 7, 8, 9]. Each of these techniques has limitations because of cost, logistics, effectiveness, public relations, or a combination of these factors. For example, means for excluding woodpeckers (wire or wraps) are difficult to install or interfere with lineman access. In some cases, Pileated Woodpeckers have defeated exclusion materials (Figure 1-2). A 19-gauge galvanized welded wire mesh (0.5 x 0.5 inches [1.25 x 1.25 centimeters]) is the pole wrap most used by the utility industry to reduce woodpecker damage to poles. However, under controlled testing of various wire wraps, Pileated Woodpecker damage was greatest to poles wrapped with 19-gauge wire. Woodpeckers were capable of bending or breaking welds and/or wires in a brief time. The least damage occurred on poles wrapped with 16-gauge welded wire (Cummings et al., unpublished data, 2001).

Figure 1-2
Wire wrap defeated by a Pileated Woodpecker

While resolving woodpecker damage to wood poles is a high priority for many electric utilities, no materials have been developed and commercialized that adequately treat new wood products or remediate in-service products. Most chemical pole treatments, such as creosote, ammoniacal copper zinc arsenate, and methyl anthranilate, have proven ineffective in deterring woodpeckers [6, 7].

A 2014 Electric Power Research Institute (EPRI) study evaluated a variety of approaches to address the woodpecker problem, including exclusions, coatings, alternative materials, hazing, and repellents. The study identified Airepel® HC, an Arkion Life Sciences anthraquinone (AQ) product, as a potential repellent [10]. This product causes adverse physiological effects when ingested by birds (e.g., illness, pain, gastrointestinal effects, regurgitation). The physical side effects, in turn, result in strong avoidance of the chemical and/or treated material. This type of chemical is considered a secondary repellent, which is avoided because an animal associates it with an adverse experience.

AQ is a naturally occurring compound found throughout the plant kingdom and was first patented in 1944 as a bird repellent. The chemical occurs in many invertebrates and is used as a defense against predators [11]. AQ is registered and sold under the product name Flight Control, Airepel®, or AV1011 (Arkion Life Sciences, New Castle, Delaware) as a feeding deterrent against several species of birds on agricultural crops, lawns, and turf.

2
INTRODUCTION

This two-year study was designed to evaluate the effectiveness of a topical treatment of AQ to reduce Pileated Woodpecker damage to utility poles (Figure 2–1) in the service areas of two utilities. The U.S. Environmental Protection Agency (EPA) approved testing of up to 100 treated poles without an experimental use permit (Mark Suarez, EPA, personal communication, 2015). PowerSouth Energy Cooperative (PowerSouth) and CNP agreed to participate in the study.

Figure 2-1
Adult male Pileated Woodpecker

In 2019 EDM International, Inc. (EDM) implemented the PowerSouth field study. Poles were also selected for the CNP field trial, but implementation of the CNP field study has been delayed. In addition to determining the effectiveness of AQ (Airepel® HC combined with Kilz Premium Primer at a 50/50 mixture) as a woodpecker repellent, the study was also designed to determine the degradation of AQ residues on treated poles over time, plus cost effectiveness of AQ compared to wire wrapped poles. To summarize, this study has three main objectives:

1. Determine the effectiveness of AQ in reducing woodpecker damage to wood poles
2. Quantify the degradation of AQ on treated wood poles
3. Compare the cost of AQ treated poles to wire wrapped poles as a method to deter woodpecker damage

3
METHODS

To evaluate the effectiveness of a topical AQ treatment, areas with persistent woodpecker problems were identified and poles needing replacement were selected for a trial. Woodpecker damage was quantified as a baseline and post-treatment inspections of replacement AQ poles were used to test efficacy. The field trial was designed to continue for two years, or less if the chemical treatment failed to reduce/prevent damage to poles. The first post-treatment inspection occurred in August 2020, the second in April 2022. An additional post-treatment inspection is proposed for Fall 2023.

Pole Selection

PowerSouth identified areas with historic woodpecker damage. Problem areas included Graceville/Chipley Junction, Florida (seven poles), Victoria/Ariton, Alabama (26 poles), Oak Grove/Chumuckla, Florida (four poles), and Belleville/Eliska Junction, Alabama (four poles). In some cases, newly inserted poles in these areas were replaced within one to two years, due to woodpecker damage. The general rule for PowerSouth is when a pole has a hole completely through it or has a nesting cavity, it must be replaced (Figure 3–1).

Figure 3-1
Severely damaged transmission pole identified for replacement

December 12-13, 2019, PowerSouth and EDM inspected the Victoria/Ariton H-structure transmission line near Andalusia, Alabama. This area was selected because of the number of historically damaged poles and their proximity to each other, maximizing post monitoring efficiency. The field inspection identified 25 poles in need of replacement due to severe woodpecker damage.

Damage Assessment

During the December 12-13, 2019, Victoria/Ariton H-structure inspection, the number of woodpecker-caused holes on each H-structure pole was documented and photographed to establish a baseline (Figure 3–2). Photos of the poles were taken from each cardinal direction. Woodpecker damage was recorded as small (less than 1-inch [2.54-centimeter] opening hole) or a scrape, medium (1- to 3-inch [2.54- to 7.62-centimeter] opening hole), or large (greater than 3-inch [7.62-centimeter] opening hole). A numerical value was assigned for each hole; small, medium, and large holes were given a value of 1, 2, and 3, respectively. These values were summed for each pole. For example, if a pole had 3 small holes and 1 scrape, 5 medium holes, and 2 large holes, the value for that pole was (4 x 1) + (5 x 2) + (2 x 3) for a value of 20. This process was repeated for the post-treatment inspections. A One-Way Analysis of Variance was used to compare woodpecker damage among control, AQ treated, and wire wrapped poles.

Figure 3-2
Two woodpecker holes classified as 3-large (top) and 1-small (bottom)

The specific time the woodpecker damage occurred on this line was unknown; thus, damage age was not included in the evaluation. Installed bird barrier materials (e.g., wire, woodpecker filler kits) were noted. A recording of Pileated Woodpecker calls/drumming was played at each pole site for up to three minutes or until a Pileated Woodpecker responded to the call. Playing recorded calls/drumming was performed to verify Pileated Woodpeckers were present in the area.

Treatment and Application

February 2-3, 2020, EDM treated 20 new poles (17 for the trial plus three spares) at a PowerSouth pole yard. Poles were treated with Airepel® HC 50% AQ combined with Kilz Premium Primer at a 50/50 mixture applied manually with a paint roller (Figure 3–3). By diluting Airepel® HC 50% AQ with the same amount of Kilz Premium Primer, the final mixture contained 25% AQ. A primer was needed to make the formulated product adhere to the pole. Kilz Premium Primer is a superior primer and out preformed the other primers in a previous wood pole test conducted at the National Wildlife Research Center (Cummings et al., unpublished data, 2001). It also provides excellent adhesion and a mildew resistant coating. Tom Jerrell, VP Research and Development, Arkion Life Sciences, LLC recommended the use of Kilz Premium Primer. The final application was based on previous repellency testing with pileated woodpeckers. No treatment was applied to the pole within six feet (1.8 meters) of the ground surface as part of the EPA approved testing (Mark Suarez, EPA, personal communication, 2015). When exposed to or handling Airepel® HC, applicators and linemen are required to wear a long-sleeved shirt, long pants, socks, appropriate footwear, and chemical-resistant gloves. Although the product dries within two hours at 70º Fahrenheit (21º Celsius), the treated poles were air dried for at least 24 hours before installation.

Figure 3-3
New transmission poles coated with Airepel® HC combined with Kilz Premium Primer at a 50/50 mixture

Pole Replacements

April 1-7, 2020, treated poles (17 AQ and eight wire wrapped[1]) were delivered to the Victoria/Ariton H-structure transmission line near Andalusia, Alabama, as pole replacements. The standard PowerSouth replacement poles identified were 65- to 75-foot (20- to 23-meter) southern yellow pine, class 2. “Southern yellow pine” is a commercial classification primarily made up of four tree species: loblolly pine (*Pinus taeda*), longleaf pine (*Pinus palustris*), shortleaf pine (*Pinus echinata*), and slash pine (*Pinus elliottii*). Damaged poles were removed by PowerSouth line crews and replacement poles installed (Figure 3–4). Placement of AQ poles (n=17) was determined by what pole lengths were needed, and utility crew preferences. Planned replacement poles not treated with AQ were installed with wire wrap (n=8). Additionally, previous wire wrapped poles (n=5) and untreated control poles (n=20) were included in the study design (Table 3-1, Figure 3–5 through Figure 3–7). At the initiation of the study, the total number of replicates for each treatment were believed to be 17 AQ treated poles, 13 wire wrapped (new + existing), and 20 untreated control poles (Table 3-1). During the 2022 pole inspections, it was discovered that 10B and 82B were not wire wrapped, they been replaced with wood poles, thus were control poles. In addition, two control poles 14B and 87B were replaced with wire wrapped poles due to woodpecker damage. Because damage assessment data were not collected on the two control poles replaced with wire wrapped poles, they could not be included in the 2022 data analysis, meaning the total number of replicates was reduced by a total of 2 poles (Table 3-1).

[1] Eight wire wrapped poles were delivered. Although monitoring in 2022 discovered that two wire wrapped poles were not installed at location 10B and 82B. Instead two control poles were inserted.

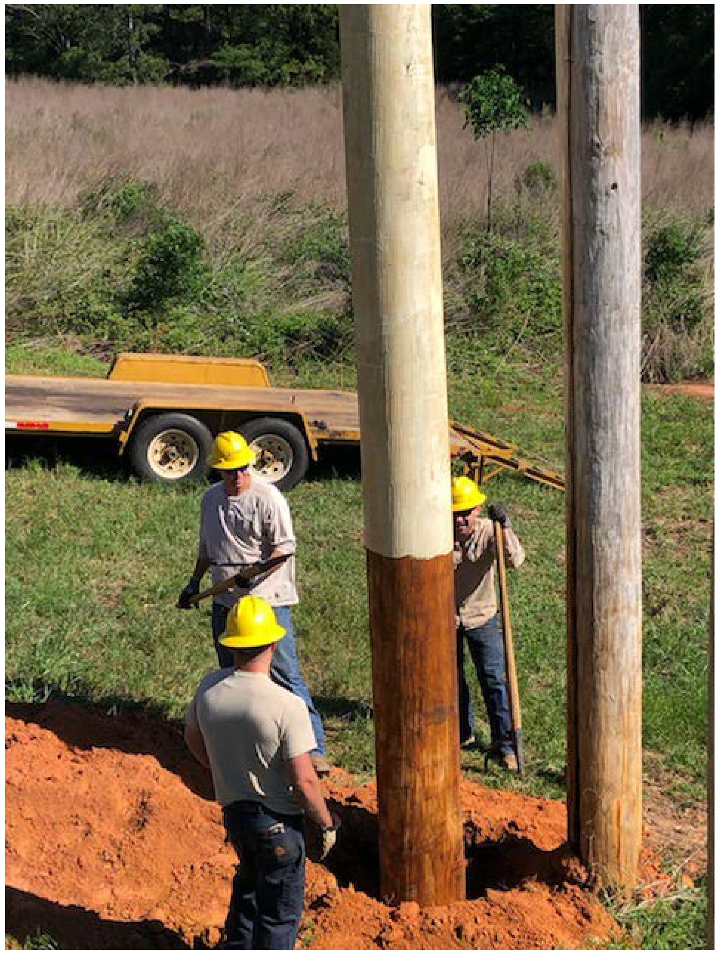

Figure 3-4
PowerSouth crew installing AQ treated pole. Note the base is untreated.

Table 3-1
Poles used in the study design

Action	Number of Poles
AQ Treatment	17
New Wire Wrap	8
Existing Wire Wrap	5
Control (No Treatment)	20*
Sum	50

* While the total number of poles remains consistent between 2020 and 2022, four study poles were modified with two wire wrapped poles becoming control poles and two control poles being replaced with wire wrapped poles. The replaced control poles were not included in the data analysis of the current report because no damage assessments were collected at time of removal, reducing the total number of replicates by two (n=18).

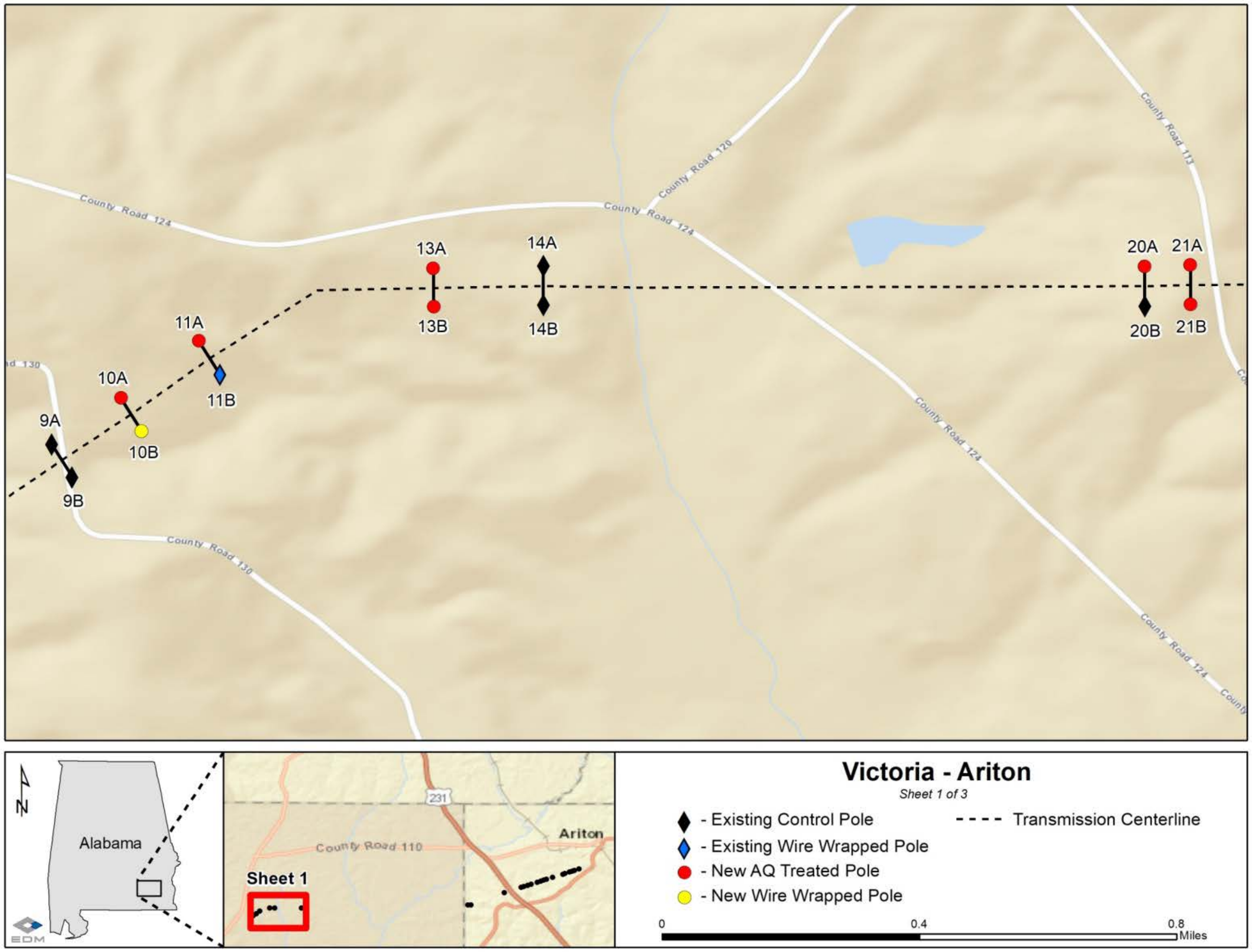

Figure 3-5
Victoria/Ariton transmission line power pole replacements. Note in 2022 it was discovered 10B was not wrapped and became a control pole. In addition, 14B, a control pole, was replaced due to damage with a wire wrapped pole.

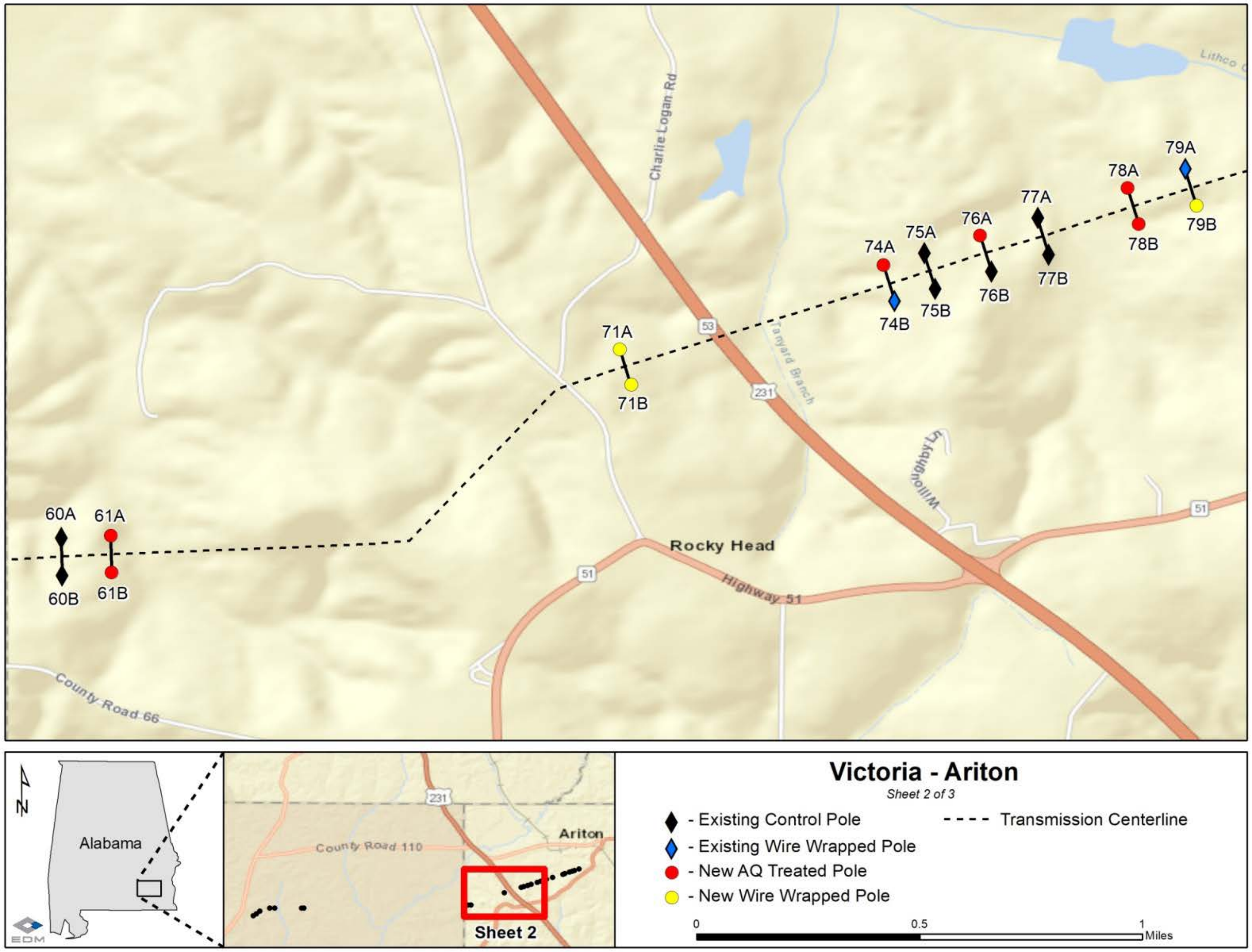

Figure 3-6
Victoria/Ariton transmission line power pole replacements

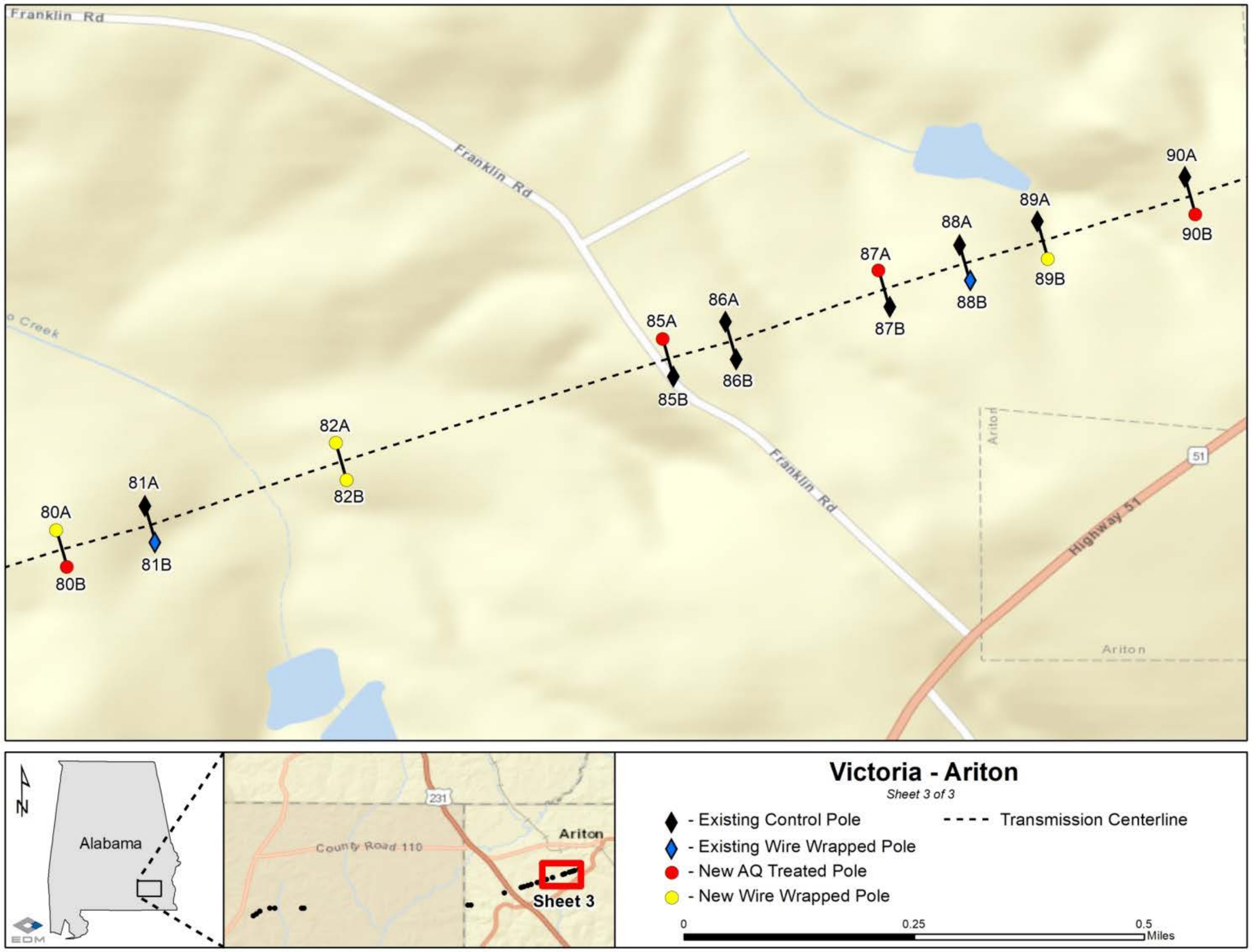

Figure 3-7
Victoria/Ariton transmission line power pole replacements. Note in 2022 it was discovered 82B was not wrapped and became a control pole. In addition, 87B, a control pole, was replaced due to damage with a wire wrapped pole.

Because this is an H-frame transmission line, poles are paired. During installation of treated poles, PowerSouth placed four AQ treated poles next to each other, and seven AQ treated poles next to a non-AQ treated pole (i.e., next to a control pole or wire wrapped pole) (Table 3-2).

Table 3-2
Location of treated poles

H-Frame Pole Number Left	Status	H-Frame Pole Number Right	Status
10A	AQ Treated	10B	Wire-New*
11A	AQ Treated	11B	Wire-Exist
13A	AQ Treated	13B	AQ Treated
20A	AQ Treated	20B	Control
21A	AQ Treated	21B	AQ Treated
61A	AQ Treated	61B	AQ Treated
74A	AQ Treated	74B	Wire-Exist
76A	AQ Treated	76B	Control
78A	AQ Treated	78B	AQ Treated
80A	Wire-New	80B	AQ Treated
85A	AQ Treated	85B	Control
87A	AQ Treated	87B	Control
90A	Control	90B	AQ Treated

*Pole discovered in 2022 to not be wrapped and became a control pole.

Residue Analysis

Analysis of the Airepel® HC product and AQ formulation was required to verify concentrations used on the treated poles. Initially a raw sample collected directly from the product container of Airepel® HC product 50% and two samples of AQ/Kilz formulation 25% (AQ mixed with the primer to achieve a 25% rate of AQ) were collected to verify the base concentrations. Next, surface pole shavings were collected to determine target concentrations on treated poles coated with a mixture of Airepel® HC product and Kilz (AQ/Kilz 25% formulation, Figure 3-8). Seven treated poles were randomly selected (Poles 10A, 11A, 20A, 21A, 21B, 78A, and 90B) and scraped to remove AQ from a small pole section (approximately 6 inches by 6 inches, 15 centimeters by 15 centimeters). Each scrape was taken near the transition between treatment and the untreated pole butt. Last, three samples of untreated wood were also randomly collected. Subsequent samples were taken in proximity to the first sample. Samples were collected August 13, 2020 and March 23, 2022.

The U.S. Department of Agriculture, National Wildlife Research Center, Chemistry Section, Fort Collins, Colorado, conducted the residue analysis using Method 181A [12]. Each sample was divided into three subsamples, when possible. Method 181A was altered in two ways: First, the wood samples were extracted with pure chloroform to improve recovery of anthraquinone from the samples. Second, the temperature parameters of the gas chromatograph were modified to increase the separation between other compounds present in the wood samples and AQ.

Figure 3-8
Pole shavings collected for residue analysis

4
RESULTS

Post Inspection #1 - Woodpecker Damage

The first post inspection was conducted 134 days post-treatment, August 13, 2020. Pileated Woodpeckers were present as noted by direct observation and responses to playbacks. A One-Way Analysis of Variance was used to compare woodpecker damage among control, AQ treated, and wire wrapped poles.

Woodpecker damage to control poles (Figure 4–1) increased significantly from pre-treatment to post-treatment ($F = 4.51$, d.f. = 1, $P = 0.04$). The total numerical woodpecker damage value increased from 160 to 338, or 52% on the unwrapped control poles (n=20).

Figure 4-1
Control Pole 81A with fresh woodpecker damage noted during inspection

After treatment, new woodpecker damage was significantly greater on control poles compared to AQ treated poles ($F= 7.74$, d.f. = 1, $P = 0.0086$). Whereas the numerical woodpecker damage increased by 178 (from 160 to 338) for the 20 unwrapped control poles (8.9 per pole), the 17 AQ treated poles increased from zero to 1. One small hole was noted at the top of one AQ treated pole.

There was no significant difference in woodpecker damage between AQ treated and wire wrapped poles ($F= 3.98$, df = 1, $P = 0.055$). As previously noted, the numerical woodpecker damage value increased to 1 for the AQ treated poles (n=17). For wire wrapped poles collectively, damage increased by 8 (n=11, 0.7 per pole). From 2020 to 2022, damage that occurred to wire wrapped poles was mostly on the existing wrapped poles (n=5). Only one newly wrapped pole had new damage, a small woodpecker hole (value 1). The baseline survey of this right-of-way line section noted three poles where woodpeckers defeated wire, going completely through the wrap (Figure 4–2). In other locations, woodpeckers exploited gaps in the wire coverage at a total of three poles (Figure 4–3).

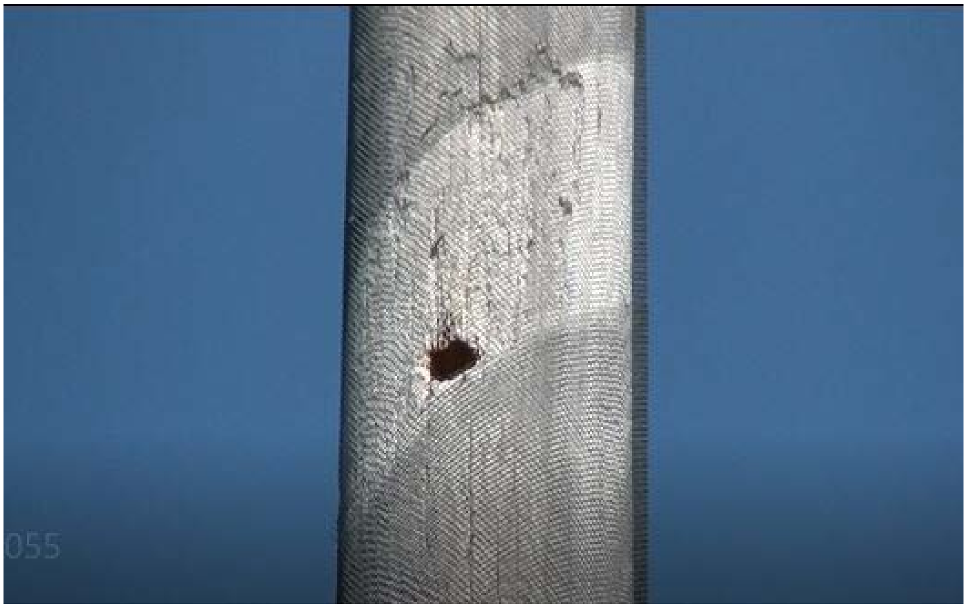

Figure 4-2
Woodpecker damage through a PowerSouth wire wrapped pole

Figure 4-3
Woodpecker damage above the wire wrap on a PowerSouth pole

Post Inspection #2 - Woodpecker Damage

Following the first post-treatment 2020 inspection, PowerSouth replaced poles 14B and 87B, which were control poles, with wire wrapped poles due to extensive woodpecker damage. Thus, these two poles could not be included in the 2022 evaluation. In addition, as previously mentioned, 10B and 82B were never wire wrapped so their designation was changed to control poles (Table 4-1). Note, two poles that were supposed to be wrapped became two control poles; two existing control poles subsequently became two wrapped poles. Thus, totals remained the same.

Table 4-1
Post inspection #2 – Treatment Pole Numbers

Action	Number of Poles
AQ Treatment	17
New Wire Wrap	8*
Exist Wire Wrap	5
Control (No Treatment)	20*
Sum	50

*While the total number of poles remains the consistent between 2020 and 2022, a total of four study poles were modified with two wire wrapped poles becoming control poles and two control poles being replaced with wire wrapped poles.

The second post inspection was conducted 752 days post-replacement, April 23, 2022. Pileated Woodpeckers were present as noted by direct observation and responses to playbacks. Results from the second inspection found woodpecker damage to control poles increased significantly ($F = 25.82$, $df = 1$, $P = 0.00006$) from the prior assessment on August 13, 2020. The numerical woodpecker damage value increased from 292 to 541 on unwrapped control poles (n=18). Note, the pre-treatment control poles had a value of 160 and a value of 338 after the first inspection. However, when EDM made the year two assessment, linemen had removed 14B and 87B and converted them to wire poles. Thus, an adjustment was required (338 minus 46 with 46 being the damaged on the 2 replaced control poles) which equaled 292. This was the starting value used for the year two assessment for control poles (292 start and 541 final).

Woodpecker damage was significantly greater to control poles compared to AQ treated poles ($F = 29.62$, $df = 1$, $P = <0.00001$). The numerical woodpecker damage value to AQ treated poles was 29, or 95% less woodpecker damage compared to untreated control poles. Ten of 17 treated AQ poles had no damage whereas damage to the remaining treated AQ poles consisted of very shallow hole cavities or scrapings, ranging from 0.25 to 1 inch deep. There were no deep holes or cavities observed on any AQ treated poles.

No significant difference in woodpecker damage between AQ treated and wire wrapped poles was found ($F = 0.02$, $df = 1$. $P = 0.87$). The numerical woodpecker damage value for AQ treated poles was 29 (n=17, 1.7 per pole) and 17 for wire wrapped poles (n=11, 1.5 per pole). Note, n=11 was used for the wire-wrapped poles because although 13 poles were originally installed, in 2022, two poles had been replaced, resulting in 11 replicates for the wire wrapped pole treatment. Additionally, the two poles converted to wire wrapped (14B and 89B) could not be added since they only had one year of exposure. Most damage occurred on the existing wrapped poles. However, one newly wrapped pole which had sustained a small woodpecker hole (value 1) in the first assessment, was excavated further to a value of 2 and one additional medium hole (value 2) was documented (Figure 4-4).

Figure 4-4
Pileated Woodpecker damage to a new wired replacement pole 79B

Residues

In 2020, one sample of Airepel® HC product 50%, two samples of AQ/Kilz formulation 25%, seven samples of pole wood scrapings from AQ treated poles, and three samples of untreated wood were collected. Each sample was divided into three sub-samples for analysis. The same type and number of samples were collected for analysis on March 23, 2022. Residue tests were then performed to verify product percentages aligned with the stated concentrations (Table 4-2).

Airepel HC 50% product (n=1 with 3 subsamples) from 2020 averaged 45.7% compared to the stated 50% concentration. The AQ/Kilz 25% formulation (n=2 with 3 subsamples/pole) averaged 24.0% and 23.8%, respectively. Airepel HC 50% product from 2022 (n=1) produced an average AQ concentration of 46.5% and the AQ/Kilz 25% formulation (n=2) resulted in an average AQ concentration of 25.2%, respectively (Table 4-2). In conclusion, the product and formulation aligned closely with target concentrations.

Table 4-2
Chemical analysis of Airepel HC 50% and AQ/Kilz formulation samples 2020 and 2022

Anthraquinone in Product and Formulation Samples				
NWRC ID	**Sample Description**	**Sample Results (% w/w)**	**Descriptive Statistics**	
	2020			
S201028-01 A	Airepel Product 50%	43.6%	Mean =	45.7%
S201028-01 B		46.8%	s =	1.8%
S201028-01 C		46.6%	cv =	3.9%
S201028-02 A	Airepel Formulation 25%	23.5%	Mean =	24.0%
S201028-02 B		24.6%	s =	0.56%
S201028-02 C		23.9%	cv =	2.3%
S201028-03 A	Airepel Formulation 25%	23.9%	Mean =	23.8%
S201028-03 B		23.*%	s =	0.15%
S201028-03 C		23.^%	cv =	0.63
	2022			
S220331-01 A	Airepel Product 50%	46.4%	Mean =	47.0%
S220331-01 B		48.1%	s =	0.95%
S220331-01 C		46.5%	cv =	2.0%
S220331-02 A	Airepel Product 50%	45.7%	Mean =	46.1%
S220331-02 B		45.6%	s =	0.78%
S220331-02 C		47.0%	cv =	1.7%
S220331-03 A	Airepel Formulation 25%	25.3%	Mean =	25.2%
S220331-03 B		25.2%	s =	0.058%
S220331-03 C		25.2%	cv =	0.23%

Residue tests were also performed on AQ treated poles (Table 4-3). Wood scrapings from AQ treated poles (seven poles, three subsamples/pole) were analyzed in 2020 to ensure AQ was present. In 2020, two poles only had enough material to run two of the three collected subsamples. Scrapings were again collected from the same poles in 2022 to verify AQ persistence.

The overall mean AQ residues for 2020 (n=7) and 2022 (n=7) for treated pole samples were 18.5% and 18.1%, respectively (Table 4-3). Residue sub-samples were tightly grouped within a sampled pole but varied across the seven poles sampled. Treated pole samples from 2020 ranged from 15.8% to 27.7% AQ, and samples from 2022 ranged from 12.6% to 25.2% AQ.

Table 4-3
Chemical analysis of AQ/Kilz treated pole sampled in 2020 and 2022

2020 Results				2022 Results			
AQ Concentration				AQ Concentration			
Pole #10A	17.1%	Mean =	16.9%		12.6%	Mean =	12.6%
	15.8%	s =	0.97%		12.6%	s =	0.00%
	17.7%				12.6%		
Pole #11A	17.4%	Mean =	17.1%		18.7%	Mean =	18.7%
	16.8%	s =	0.42%		18.8%	s =	0.15%
					18.5%		
Pole #20A	20.0%	Mean =	24.3%		18.9%	Mean =	20.9%
	25.2%	s =	3.93%		19.5%	s =	3.02%
	27.7%				24.4%		
Pole #21A	19.4%	Mean =	20.0%		17.6%	Mean =	17.3%
	20.5%	s =	0.78%		17.5%	s =	0.38%
					16.9%		
Pole #21B	16.2%	Mean =	16.3%		15.4%	Mean =	15.3%
	16.4%	s =	0.12%		15.2%	s =	0.12%
	16.4%				15.2%		
Pole #78A	17.6%	Mean =	17.7%		18.5%	Mean =	18.7%
	17.9%	s =	0.15%		18.7%	s =	0.15%
	17.7%				18.8%		
Pole #90B	17.1%	Mean =	16.8%		20.4%	Mean =	23.6%
	16.4%	s =	0.49%		25.2%	s =	2.77%
					25.2%		

Variation in AQ concentration among year is attributed to sample location on the pole. For example, Pole 90B had a mean of 16.8% in 2020 but a higher value in 2022 (Table 4-3). Since the treatment was a topical application, there was overlap in treatment in some areas which is shown in the range of AQ residues (Figure 4-6). However, there was still consistency of AQ concentrations among pole treatments indicating the method is dependable for monitoring AQ residues from wood poles. Preliminary results suggest the concentration of AQ is persisting over the study period.

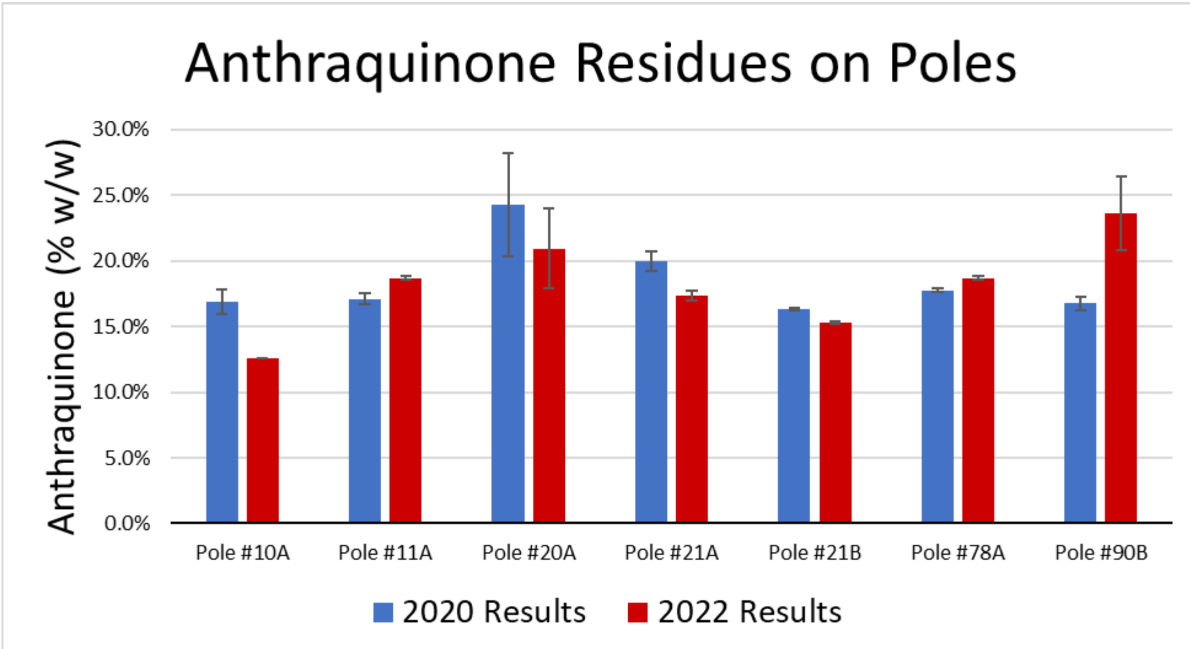

Figure 4-5
2020 and 2022 Anthraquinone residues on treated poles

Cost Analysis

The cost to treat an average 65-foot (20-meter) southern yellow pine pole from six feet (2.4 meters) above ground level to the pole top (approximately 50 feet [15 meters]) required two quarts (1.9 liters) of Airepel® HC totaling $125 and two quarts (1.9 liters) of Kilz premium totaling $10. Thus, the total chemical cost was $135 per transmission pole. Treatment time required was two man-hours per pole in this study. These costs are similar to wire wrapping a 65-foot (20-meter) pole with 19-gauge, 0.5-inch (1.3-centimeter) mesh with 48-inch-wide (122-centimeter-wide) welded wire. Wire costs approximately $117 for a 50-foot (15-meter) roll, and installation time is similar. Despite being similar in cost, completely covering a pole with wire is difficult, and as noted in this report, woodpeckers can defeat wire wraps and exploit gaps. There are also wire mesh concerns for worker safety and avian protection. Whether intentionally grounded or not, wire mesh increases pole conductivity. If grounded or in wet conditions, pole clearances are effectively reduced. Avian electrocutions caused by phase-to-grounded wire mesh contacts can occur and wire mesh can make poles difficult to climb [13].

5 DISCUSSION

Development of an effective chemical bird repellent for treating utility poles, especially in areas inhabited by Pileated Woodpeckers, is a critical issue. In 2014, testing of AQ in a laboratory setting was promising, which led to this field trial.

The study area continues to have Pileated Woodpeckers present and damage to poles continues. Control pole damage increased during the first and second post inspection periods. Woodpecker damage increased from 160 to 338 in the first period (n=20) and then to 541 in the second period (n=18). In comparison, the AQ treated poles (n=17) had two small holes at the end of the first post inspection period with a score of 1 each and in the second sampling period 14 holes with a score of 29. The AQ treated poles performed similarly to wire wrapped poles.

The AQ formulation has retained activity as shown by the residual analysis. The average AQ concentration from samples collected in 2020 was 18.5% and 18.1% in 2022, a difference of 0.4%. The change in AQ concentrations from 2020 to 2022 suggests, at least over the short-term, a small loss in AQ activity. While variability in AQ activity was found across samples, differences in the amount of product applied during the coating process may account for this variation. Despite AQ concentrations varying across poles, the AQ concentration of individual poles remained consistent across years, and the range of concentrations present significantly reduced woodpecker damage. As a topical treatment, results thus far demonstrate Airepel® HC may be a viable and economical option for utilities in reducing woodpecker damage to replacement poles.

The first two seasons of results are promising and longevity of the AQ treatment will be an important consideration for its potential use in the utility industry. Long-term efficacy is unknown for this topical treatment, thus there is a need for continued monitoring and one more season is planned for the fall of 2023. If successful, incorporating AQ in the wood pole treatment process should be investigated as a next step in developing a new mitigation strategy for woodpeckers.

6
REFERENCES

1. L. A. Stemmerman, "Observation of Woodpecker Damage to Electrical Distribution Line Poles in Missouri," *Proceedings of the 13th Vertebrate Pest Conference*. Vol. 13, pp. 260-265 (1988).
2. M. Abbey, A. Stewart, and J. Morrell, "Existing Strategies for Control/Remediation of Woodpecker Damage." *Investigation of Woodpecker Damage Prevention Methods*. Reliant Energy, Houston, TX, 2000.
3. Harry C. Oberholser and Edgar B. Kincaid. *The Bird Life of Texas*. University of Texas Press. Austin, TX 1974.
4. L. Kilham, "Winter Foraging and Associated Behavior of Pileated Woodpeckers in Georgia and Florida," *Auk*. Vol. 93, No. 1, pp. 15-24 (1976).
5. R. B. Renken, and E. P. Wiggers, "Forest Characteristics Related to Pileated Woodpecker Territory Size in Missouri," *Condor*. Vol. 91, No. 3, pp. 642-652 (1989).
6. U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center. *Evaluation of Potential Repellents to Prevent Pileated Woodpecker Damage to Utility Poles*. Research report QA-969-1. Fort Collins, CO, 2003.
7. U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center. *Evaluation of Potential Repellents to Prevent Woodpecker Damage to Utility Poles*. Research report QA-969-2. Fort Collins, CO, 2004.
8. S. K. Tupper, W. F. Andelt, J. L. Cummings, C. Weisner, and R. E. Harness, "Polyurea Elastomer Protects Utility Pole Crossarms from Damage by Pileated Woodpeckers," *Journal of Wildlife Management*. Vol. 74, No. 3, pp. 605-608 (2010).
9. S. K. Tupper, J. L. Cummings, W. F. Andelt, S. J. Werner, and R. E. Harness, "Evaluation of Sonic Dissuader® to Reduce Damage by Pileated Woodpeckers," *Wildlife Society Bulletin*. Vol. 35, No. 1, pp. 40-44 (2011).
10. M. Hilker, and A. Kopf, "Evaluation of the Palatability of Chrysomelid Larvae Containing Anthraquinones to Birds," *Oecologia*. Vol 100, No. 4, pp. 421-429 (1994).
11. Evaluation of Anthrahydroquinone (AHQ) Repellency to Pileated Woodpeckers. EDM International, Inc., Fort Collins, CO, 2014.
12. U.S. Department of Agriculture. National Wildlife Research Center. "Analytical Method 181A: Determination of Anthraquinone in Aqueous Samples by GC/FID*."* Unpublished report, 2016.
13. M. Brucato, "Reduced Woodpecker Damage in ACZA Treated Utility Poles," *Proceedings of the 90th Annual Meeting of the American Wood-Preservers' Association*. Vol. 90, p.114, San Antonio, TX (1994).

About EPRI

Founded in 1972, EPRI is the world's preeminent independent, non-profit energy research and development organization, with offices around the world. EPRI's trusted experts collaborate with more than 450 companies in 45 countries, driving innovation to ensure the public has clean, safe, reliable, affordable, and equitable access to electricity across the globe. Together, we are shaping the future of energy.

3002026613

EPRI
3420 Hillview Avenue, Palo Alto, California 94304-1338 • USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com