Providing Lightning Protection

The Live Oak Allee at Bray's Island Plantation in Sheldon, S.C., has 20 massive trees 60 feet apart, creating a cathedral of foliage, with driplines overlapping. Nine of the largest trees have been protected against lightning, and there is a good degree of protection for all. Courtesy of Michael Murphy, Preservation Tree Care.

By Guy Meilleur

Arborists have been installing lightning protection since the 1800s. In 1933, J. B. Whitehead at Johns Hopkins University observed 61 protected trees around the university campus in Baltimore, Maryland. Many systems in historic trees around landmarks such as Mount Vernon, Monticello and the Hermitage have been in service for more than 50 years.

In 2007, a veteran post oak (*Quercus stellata*) tree at Andersonville National Historic Site in Andersonville, Georgia, had to be removed due to irreversible lightning damage. Superintendent Fred Boyles does not want to lose any more. The region averages more than 10 lightning strikes per square mile annually, so the odds were good that another tree would get struck. He now has purchased enough material to protect at least 15 veteran trees from future lightning strikes.

Proving effectiveness

The Southeast U.S. may get more lightning overall than the rest of the country, but no place or tree is immune. Also, there are microsites elsewhere that receive numerous strikes. The west-facing slope of the Morris Arboretum, above the University of Pennsylvania's main campus in Philadelphia, is one such "hot spot." Because of the many strikes there, the university began installing lightning protection systems in the early 1980s. A metallic communication cable near one protected tree was burned out several times, presumably by lightning strikes, which demonstrated that system's effectiveness. The metallic cable was finally replaced with fiber optic cable. After studying the patterns of strikes and systems on this hillside for more than 33 years, arborist Bill Graham concluded that the protection zone, the distance protected by each system, was less than 65 feet.

Andersonville National Historic Site in Andersonville, Georgia, has purchased material to protect at least 15 veteran trees from future lightning strikes.

Lightning strikes have been recorded on four of the 75 protected trees at the Bartlett Tree Research Laboratory in Charlotte, North Carolina. Two exited the system according to plan, out the bottom end of the ground rod. One flashed over to a non-bounded wire in an irrigation system two feet away, destroying the electrical components of that system. One strike did not reach the ground conductor, which was in dry soil. Instead, it flashed over to a moist

buttress root, damaging the tree.

In Philadelphia, a red oak in a park had two systems with two grounds because of its girth, per the old NAA Lightning Protection Systems standard. The branch conductors were fastened with staples – no standoffs were used – so the cable was swallowed in places. Lightning struck 23 feet below the air terminal, where it melted part of the copper cable, i.e. the conductor, then burned some of the ivy growing on the trunk. Finally, it blew away soil that was covering the ground rod. The evidence indicated that the system successfully grounded the strike, even with several defects that fell short of the old NAA standard. The A300 standard was published in 2002, along with associated best management practices.

With lightning systems, blowing a fuse can be a good thing. The researchers at Bartlett wanted to know if their systems worked, so they shopped around for specially made lightning counters, devices designed to track and record the number of lightning strikes. The price of $100 per counter seemed a little high, so they designed an induction loop with low amperage fuses. Working with the Franklin Institute in Philadelphia, Graham developed a similar device, also using household-type electrical wire and a fuse made for vehicles. He noted that fuses "have great potential for improving sales. Imagine Mrs. Jones coming home after a horrific thunderstorm, finding that fuse blown, and knowing that her prized tree is fine," says Graham. "Not only will she consider protection for other trees, but she will be sure to repeat her testimonial to friends and neighbors."

Lightning sideflashed from a tree 30 feet away to the base of this pine. Popcorn-shaped globs of sap indicate pine beetle attack. The damaged area is small, but this tree was lost because it lacked protection. Guy Meilleur photo.

Inspecting and refastening old systems

The dormant season is best for inspecting lightning protection systems, because the leaves are off deciduous trees. Common faults are fasteners coming out and conductors not high enough or not repaired after breakage. When trees start to grow over the fasteners in existing systems, they can still be effective, but it's best to refasten the conductor before it is swallowed.

The old ISA Best Management Practice recommendation was to install replacement fasteners about "… 1 foot or more from the old fastener." In 2007, British arborist and lightning system expert Ben Fuest argued that this practice contradicted the BMP by leaving unbonded metal in the tree. Fuest had designed an extendable fastener, the Arborbolt, which is screwed into the wood after predrilling. Using this device avoids damage by cracking, and also leaves no unbonded metal in the tree because new sections are added on to the old. The Arborbolt may be available in the U.S. this year. In 2008, the updated ISA Best Management Practice changed to "Install a new drive fastener near or touching the old fastener to reduce chances of sideflash." The ANSI A300 (Part 4)-2008 Lightning Protection Systems revision does not address this issue, as the threat from side flash to an old fastener needs further research before a standard practice can be developed.

A lightning damaged cedar. Courtesy of Guy Meilleur.

Installing new systems

Sideflash can also occur from kinks in the conductor, according to Joe Bones of Bartlett Tree Experts, so cable should be carefully untwisted before it is fastened. The conductor should also not be bent to an angle greater than 90 degrees. Bones also recommends locating the conductor where it will not interfere with future climbs. Drive fasteners can be easily dislodged when a rope is pulled across them.

If the tree is in a lawn or an area with a lot of activity, the cable should be in a val-

Blunt-tipped air terminals have been proven more effective at drawing lightning strikes than sharp tips. Suppliers have responded with these prototypes. Guy Meilleur photo.

ley between the buttress roots. The conductor's path through the ground is not that important, because root damage from ground conductors is rare. The function of the ground rod is critical, so it must be deep enough to be adequate. Bones uses an auger to start the hole for the ground rod. If an impenetrable object is hit, there are two options. The rod can be cut and another installed nearby, or it can be pulled out and driven at an angle.

Tips on tips

On the skyward end of the system, a change has been made in the industry.

Sharp-tipped air terminals have been used ever since Ben Franklin saw a spark jump to a needle in his laboratory, but recent research "points" to a more effective design. In one small experiment in Virginia, three different tips were installed in a tree, and only the blunt tip received a hit. C.B. Moore of New Mexico Technical College conducted a 12-year study that compared terminals with blunt tips and sharp tips and also Early Streamer Emission ("ESE") tips. Thirteen blunt tips were struck, but no sharp or ESE tips were. Tips in the ½-inch to ¾-inch range seem to work the best. Further ESE investigation at Langmuir Laboratories found no evidence that these systems are effective.

Michael Murphy of TCIA member company Preservation Tree Care has been installing lightning protection systems since 1972. He presents the facts, so the owner can make the right decision. Guy Meilleur photo.

Tips on marketing lightning protection

Michael Murphy of TCIA-member Preservation Tree Care in Beaufort, South Carolina, has been installing lightning protection systems since 1972, beginning in

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This paddock live oak is 60 feet tall with a 130 foot spread. The importance of this tree made the $4,730 for this installation worthwhile. Guy Meilleur photo.

his native New Jersey. He has installed many systems near the South Carolina coast, one of the regions with the highest frequency of lightning strikes in the U.S. Most of the strikes are in live oaks (*Quercus virginiana*) and loblolly pine (*Pinus taeda*). When a new house is being placed on a highly sensitive lot with many trees, Murphy is often part of the development team, along with the architect, owner and landscape professional. Murphy uses the stark facts of reality as a marketing tool to sell systems in advance of construction. A mention of lightning frequency and a reminder of the value of the tree cover usually results in an installation in one to three trees on site. Budgeting for protecting these assets is much easier when it is done in the planning stage of a new construction project.

On a larger scale, Murphy recalls that "In early 2000, we were consulting on tree protection and preservation during the construction on The Chechessee Creek Club, a golf club with a limited number of lots for upscale cottages in Okatie, S.C. We had a proposal for the installation of lightning protection in 38 'key' trees chosen by the developer and designer because of their value to the 'play' areas of the course. Budgetary issues came up, and the list was whittled down to 12, then to eight. A final decision was needed, because construction was moving along. Then one of the people responsible for the final decision had a tree struck by lightning in his neighborhood resulting in the total destruction of the tree and a subsequent side-flash fire. Monday morning we were given the approval to install the systems on all 38 trees plus four additional trees. Sometimes standing in silence once the true facts have been presented allows the owners to make the correct decision for their trees."

Solving the budget problem was not so easy at the 5,500-acre Bray's Island Plantation development in Sheldon, South Carolina. The plantation and many of its live oak trees have been around since the early 1700s. The Live Oak Allee consists

The remains of a cherry tree that was struck by lightning and actually caught on fire and had to be put out by the local fire dept. Courtesy of Mary Beth Cirucci, A Cut Above Tree Removal, LLC, Monroeville, Pa.

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APPENDIX 3

TREE LIGHTNING RISK ASSESSMENT WORKSHEET

RISK FACTOR #1: TOPOGRAPHIC LOCATION IN LANDSCAPE = _____%

RISK FACTOR #2: RELATIVE TREE HEIGHT = _____%

RISK FACTOR #3: TREE OPENNESS = _____%

RISK FACTOR #4: RELATIVE NEIGHBORHOOD HEIGHT DIFFERENCES = _____%

RISK FACTOR #5: TREE TARGET PROXIMITY = _____%

ADD RISK FACTORS #1 - #5 TOGETHER TOTAL =

DIVIDE TOTAL BY 500 = COMPOSITE RISK FACTOR

RISK FACTOR #6: ANNUAL STRIKE PROBABILITY

COMPOSITE RISK FACTOR X ANNUAL STRIKE PROBABILITY = TOTAL TREE LIGHTNING RISK VALUE

_____ X _____ =

TOTAL TREE LIGHTNING RISK VALUE

TOTAL TREE LIGHTNING RISK VALUE	
> 0.05	severe risk (installation recommended)
> 0.03	high risk
> 0.02	moderate risk (consider installation)
> 0.01	low risk
< 0.005	very low risk (installation not recommended)

Remember risks are low, never zero, and lightning strikes can still occur.

This worksheet can be used to put a numerical value on the risk of lightning strike. Courtesy of Kim Coder.

The Andersonville site, where 33,000 prisoners were packed into 25 acres in 1864. The grove of trees on the hill overlooking the prison have historical importance, and will be protected. Courtesy of the National Park Service.

of 20 massive trees 60 feet apart, creating a cathedral of foliage – with drip lines overlapping – leading guests up to the inn. A consulting arborist recommended that all of the trees be protected, but the cost was astronomical. The plantation manager called Murphy, who designed a triangular grid pattern of nine of the largest trees for protection. The client spent about one-third the money, and there is a good degree of protection for all. There is no guarantee that the unprotected trees won't be hit, but the risk was affordably reduced to a level acceptable to the owners and the arborist.

On another job, installation was delayed because of a horse disease! Murphy was told that his crews could not enter a paddock area to access a tree until the disease was controlled, for fear that they might spread it to other horses. The paddock live oak is 60 feet tall with a 130-foot spread. An inspection showed at least one old lightning strike. The importance of this tree for the horses as well as the homes nearby made $4,730 for this installation worthwhile. Due to the enormous spread, there will be two main air terminals to ground with 32-strand cable, and eight additional air terminals with 14-strand cable. For extra protection, they chose to upgrade their system from the minimum standards set forth by ANSI A300 by using 32-strand cable.

When Murphy heard about the veteran trees at Andersonville and the park's commitment to protecting them, he immediately volunteered to help oversee the installations there, scheduled for October 25, 2008. He and Steve Tillitski of Rigguy, associate TCIA member and manufacturer of cabling and bracing components, will be sharing their related knowledge with arborists at that event who want to improve their ability to preserve veteran trees.

The grove on the hill overlooking the Andersonville site, where 33,000 imprisoned Union soldiers were packed into 25 acres in 1864, offers an excellent opportunity for arborists to practice cabling and electrical work – and to become part of history.

Guy Philip Meilleur is owner of Better Tree Care Associates in Apex, North Carolina.

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