Updating *Lightning* Protection for Trees

By Ariana Ziminsky

Multiple cloud-to-cloud and cloud-to-ground lightning strikes caught using time-lapse photography during a nighttime thunderstorm. Courtesy of National Oceanic & Atmospheric Administration Photo Library, NOAA Central Library; OAR/ERL/National Severe Storms Laboratory (NSSL) .

In August 2002, TCIA's Accredited Standards Committee A300 finalized a document that redefined the way those in the tree care industry deal with one of nature's most powerful facets – lightning.

The new industry standard *ANSI A300 (Part 4) – 2002, Lightning Protection Systems* incorporates significant research in the field of atmospheric meteorology. This relatively new information has a profound impact on the requirements and recommendations for all arborists who sell tree lightning protection systems.

Since there are an average of 25 million strikes of lightning from the cloud to ground every year in the United States[1], arborists who provide lightning protection for trees have their work cut out for them. Those who adhere to the ANSI A300 standards will be happy to find out that it is now easier and less expensive to install safe, effective lightning protection systems on valuable trees.

Who's ANSI, and what is an ANSI standard?

The American National Standards Institute (ANSI) is a private, non-profit organization that administers and coordinates the U.S. voluntary standardization and conformity assessment system.[2] ANSI accredits organizations that aim to produce ANSI standards, such as TCIA.

Closing drive fastener: The conductor is installed starting near the top of the tree. From this point downward the conductor is fastened to the tree with drive fasteners.

ANSI standards are created by qualified industry volunteers. TCIA's ANSI-accredited standards committee (ASC) A300, formed June 28, 1991, set out to create several standards for tree care operations before working down its checklist to the lightning protection standard. In 2000, the ASC A300, which includes about 25 members and alternates, began to put together the current requirements and recommendations for companies that install lightning protection for trees.

After gathering all the recent research and writing up the draft, the committee presented the standard to the public for input. With all public comment taken into account, the committee then created the final document, which was approved Aug. 30, 2002.

Compliance with ANSI A300 standards is not mandatory, however adherence to ANSI standards indicates a tree care company is making every attempt to follow the best known tree care practices. ANSI A300 standards provide the minimum performance parameters that arborists need to work within. They also are a guideline for writing work specifications.

The old standard vs. the new standard

Prior to the publication of the ANSI A300 Lightning Protection Systems standard, the general industry guidelines were outlined in TCIA's (formerly NAA's) Lightning Protection Installation Systems Standard, last revised in 1987.

"The old ... standard is really a lightning system for a house, put on a tree, without any additional research," says Bob Rouse, TCIA's director of accreditation who also serves as secretary of the ASC A300. "It's not necessarily appropriate for a tree."

This now obsolete standard presented a brief description of how lightning functions; which types of trees are most susceptible to lightning; and when lightning protection systems should be used.

In addition, it called for several very specific hardware recommendations for effective systems. For example, the thickness of copper down conductors – "the vertical portion of a run of conductor which ends at the ground" – was recommended to be "32 strands of 17 gauge copper wire"; the placement of the grounding connections were suggested to be "beyond the dripline of the branches"; and the points on the air terminals at the top of the down conductors were shown to be sharp.

Lightning damaged oak. Classic lightning damage showing a centerline of damage into the xylem, flanked by damaged bark on either side. Unless otherwise noted, all pictures courtesy of Dr. E. Thomas Smiley.

Some of the most significant changes from the old standard to the new guidelines involve these very items. The new ANSI A300 standard calls for "14 strands of 17 AWG copper wire" – not the 32-strand type originally specified. New studies have helped researchers conclude that ground rods need to be a minimum of 10 feet from the tree – with the actual distance depending upon the type of soil – but not necessarily beyond the drip-line of the tree.

A third critical difference between the old and new standards is the "sharp-vs.-blunt" air terminal tip debate. For decades, a pointed terminal on the end of a grounding wire was believed to be the best method of lightning protection. In the past several years, however, studies have shown that a blunt terminal works more effectively. Manufacturers are still catching up and haven't started producing blunt tips in any measurable amount.

Dr. Tom Smiley, an arboricultural researcher at the Bartlett Tree Research Lab, said that at Bartlett, tree care workers who install lightning protection systems are foregoing the sharp air terminals.

"We're switching to blunt terminals, but there isn't a manufacturer making them yet," says Smiley. "So now we're just cutting and bending wire" to simulate a blunt terminal. "It's probably not quite as good as a manufacturer's blunt terminal," he quips, "but we're a little bit ahead of the manufacturers on this."

Additions to the new standard

Aside from several changes made from the old standard, there are also several items introduced in the new ANSI A300 standard.

Soil dependency: As stated in A300, "Soil type and the physical character of the surrounding area shall be considered before grounding the system."

"The new standard is very soil-dependent," Smiley elaborates, "so you need to know something about your soil depth and

Installing the ground in a trench.

Driving the ground.

quality before you bid the job, or before you put (the system) in."

According to A300, if you are installing ground rods in sandy soil, you need twice the amount of rod that you would need if the soil were not sandy. Multiple ground systems in typical soil require "a minimum of 8 feet of total ground rod length;" multiple ground systems in sandy or gravelly soil require "a minimum of 16 feet of total ground-rod length."

Before this new standard, Smiley explains, it didn't make any difference what type of soil an arborist was dealing with: one ground rod outside the drip-line, or "two to four multiple grounds ... driven as deep as possible,"[3] was all that was called for – and in some cases, that might not provide proper protection.

"It's more likely under the old system that there would be damage to the trees," Smiley adds. Under the new standard, he notes, "there still could be damage – but it would be a pretty rare thing."

Ground plates: The introduction of the ground plate – "A copper plate used to form a ground terminal in shallow soils" – is also an integral part of the new specifications.

Closing the drive fastener: Drive fasteners are used to secure the conductor to the tree. After it is driven into the xylem, the crimp connector portion of the fastener is closed over the conductor using either a large pair of pliers or as shown in this photograph, fence pliers.

The old standard recommended dealing with shallow soils only by using several shorter grounding rods. The new standard outlines a "horizontal ground system" in areas where rods cannot be driven more than 2 feet into the ground. The typical horizontal system would be terminated with a ground plate.

Protecting trees – not people, cars, buildings, boats, ammunition: "The single biggest thing in the new standard is that a tree lightning protection system is only designed to protect that tree," Rouse emphasizes. "Arborists really need to put a disclaimer that lightning protection doesn't provide any personal protection or protection of any property." A lightning protection system on a tree will not protect a person, house, car – or anything else under the tree, he adds.

This key point is stated clearly in the ANSI A300 standard: "Lightning protection systems are used to reduce the risk of damage to trees from lightning strikes. Protected trees shall not be considered a safe haven from lightning strikes."

In contrast, the old standard somewhat implied that a tree with a lightning protection system can offer shelter or safety during a thunderstorm:

"Trees ... with branches overhanging buildings, ... in a recreational or park area, particular trees under which children might play or people congregate during a lightning storm, isolated trees on a golf course where golfers may seek shelter during a rainstorm, isolated trees within a pasture under which animals may gather during a thunderstorm, ... should be equipped with lightning protection systems set forth herein."

This dangerous and potentially fatal assumption that a lightning protection system on a tree could be a safe haven for anyone or anything underneath is a potentially fatal mistake to make.

Major difference between the obsolete NAA standard and the new ANSI Standard:

Prior to the current ANSI A300 Lightning Protection Systems standard, the guidelines for protecting trees from lightning was outlined in TCIA's (NAA) Lightning Protection Installation Systems Standards. The research incorporated into the new ANSI A300 standard includes several significant changes:

1.

THE NEW ANSI STANDARD

Lightning protection systems are used to reduce the risk of damage to trees from lightning strikes. Protected trees shall not be considered a safe haven from lightning strikes.

THE OLD NAA STANDARD:

Trees ... with branches overhanging buildings, ... in a recreational or park area, particular trees under which children might play or people congregate during a lightning storm, isolated trees on a golf course where golfers may seek shelter during a rainstorm, isolated trees within a pasture under which animals may gather during a thunderstorm, ... should be equipped with lightning protection systems set forth herein."

2.

THE NEW ANSI STANDARD

Conductors shall be at least 14 strands of 17 AWG copper wire.

THE OLD NAA STANDARD:

Copper consisting of 32 strands of 17 gauge copper wire, .. shall be used from the air terminal on top of he main trunk of the branch, down the trunk of the tree, to the grounding connections. ... Substandard (sic) diameter copper wire can be expected to vaporize during a lightning discharge of any magnitude, resulting in destruction or severe injury to the supposedly protected tree.

3.

THE NEW ANSI STANDARD

Branch conductors should be installed so that no aerial portion of the tree is farther than 35 feed from a conductor.

THE OLD NAA STANDARD

For additional protection, two down conductors can be used on any size tree. ... On trees with broad heads, conductors shall be extended into the highest parts of side branches in order to fully cover the spread of the crown.

"Arborists need to write that disclaimer in their written specs and inform their clients," adds Rouse. "A tree lightning protection system is only designed to protect the tree."

Distance between air terminals: Back in the "old days," it was concluded that, when it came to air terminals connected to down conductors, more was merrier. The 1987 standard encouraged "two down conductors ... on any size tree," and that trees with trunks exceeding 3 feet diameter "shall be provided with two, standard down conductors placed on opposite sides of the trunk."

"On trees with broad heads," it continued, "conductors [and attached air terminals] shall be extended into the highest parts of side branches in order to fully cover the spread of the crown."

Not so anymore.

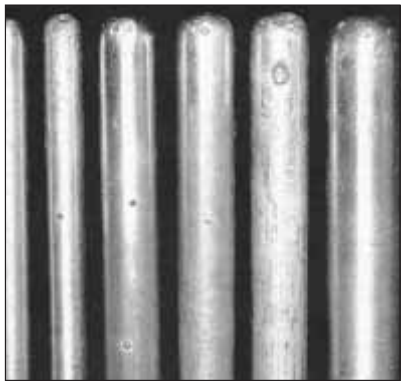
"The new standard specifies that air terminals don't need to be closer than 35 feet to one another,"[4] Smiley points out. "This saves a lot of money, because on a double-stem tree, under the old standard, you needed two wires all the way to the top. Now, you only need one, and that is independent of tree diameter."

What the new standard means to you

According to the National Oceanic and Atmospheric Association (NOAA), lightning causes about $5 billion of economic impact in the United States each year.[5] For homeowners, municipalities and others who previously could not afford a lightning protection system, losing a valuable tree to lightning's power could be devastating.

Under the new ANSI A300 standard, however, tree lighting protection systems are more affordable than those used in the past.

"The new standard provides the same level of protection as the old standard but (at) about one-third to one-half the cost – which means that more people are willing to purchase lightning protection, resulting in more trees being saved," Smiley explains.



These six blunt aluminum rods used in experiments by Dr. Charles Moore, et. al., show that blunt-tipped rods are better lightning receptors than sharp-tipped rods. In these experiments, done on South Baldy Peak, N.M., 13 blunt-tipped rods were struck by lightning, but none of the nearby sharp-tipped rods took a strike. The two rods on the left were 12.7 mm in diameter, the rod on the right was 25.4 mm in diameter, and the other rods were 19mm in diameter. Source: The Case for Using Blunt-Tipped Lightning Rods as Strike Receptors, C.B. Moore, G.D. Aulich, and William Rison. Journal of Applied Meteorology, Volume 42, page 992.

Dick Jones, of Davey Tree Experts, agrees: "The reduction in the size of the cable, the (reduction in the required) distance from the tree (and the) reducing of the materials ... (all) reduce the cost of the installation."

"You might spend the same amount of time installing the system, but the materials cost less," Jones adds, meaning that ultimately, more people can afford to purchase lightning protection.

How lightning and lightning rods work

The National Weather Service Office of Climate, Weather, and Water Services offers a brief explanation of how lightning happens[6]:

A moving thunderstorm gathers (a) ... pool of positively charged particles along the ground that travel with the storm. As the differences in charges continue to increase, positively charged particles rise up taller objects such as trees, houses, and telephone poles. ...

The negatively charged area in the storm

will send out a charge toward the ground called a stepped leader. It is invisible to the human eye, and moves in steps in less than a second toward the ground. When it gets close to the ground, it is attracted by all these positively charged objects, and a channel develops. You see the electrical transfer in this channel as lightning. There may be several return strokes of electricity within the established channel that you will see as flickering lightning.

This understanding of lightning has led to thorough research regarding lightning rods.

Dr. Charles Moore, a retired professor of physics at New Mexico Tech, has studied the best way to improve lightning rods that are used in lightning protection systems. The conclusions drawn by him and others emphasize that "using sharp lightning rods is a mistake. They ionize the area around them" – meaning that sharp rods create "electric field rates of intensification ... much greater than those over similarly exposed blunt rods for the initiation of upward-going leaders"[7] –or lightning. Thus, the sharp tips are, in effect, protecting themselves instead of discharging electricity from the storm. "Blunt rods," according to Moore, "are better receptor(s) for lightning."

"With a blunt tip, electric forces get strong enough because there is not that ionization occurring," he adds. "Thus, the electricity in the air can be more easily discharged," resulting in a strike to the rod and not the tree or other high points nearby.

To order a copy of the ANSI A300 Lightning Protection Systems standard, call 1-800-733-2622 or order online at www.treecareindustry.org.

Although this recent breakthrough in understanding lightning has been incorporated into arboriculture in relatively recent years, scientists have actually been studying the phenomenon for more than 2,000 years. Few of us might recall that in 55 BC someone named Lucretius discovered that lightning bolts prefer elevated objects,[8] but most of us can envision Benjamin Franklin outside in a lighting storm with a key on his kite string.

Indeed, Franklin's research into lightning has had a lasting influence in the field of meteorology. In 1750, Franklin speculated that "the emissions from sharp-tipped rods would prevent lightning by discharging electrified clouds." In practice, however, he discovered that instead of discharging the clouds and preventing lightning strikes, the rods acted as a lightning receptor.

Franklin's discoveries regarding lightning – which he called a "most sudden and terrible mischief" – were held in high regard and for centuries were used as the basis of lightning protection systems. Although the recent studies by Moore and others have concluded that sharp-tipped rods are less ideal, it will take time before the new blunt-tipped-rod recommendation is commonplace.

"We're recommending that the National Fire Protection Association specify the optimum form for a lightning rod," Moore sums up. "Right now, it's still haunted by the memory of Franklin's suggestions."

Other research used in the ANSI A300 standard came from studies done by those who are tree care specialists. "At the Bartlett Tree Research lab, we have nearly 100 (lightning protection) systems installed that we monitor," says Smiley. These trees have fuses on them, and when they are struck by lightning, researchers are able to observe any damage to the tree, wires and roots. "We draw conclusions based on damage and the system that is in place," Smiley adds.

In addition, a lot of the new research used in the standard comes from work done in Florida, where a high count of lightning strikes makes for an ideal testing area.

"We learned a lot from sailboat lightning protection," Smiley explains. "They actually use a smaller wire on sailboats (than we use on trees)!"

Conclusion

With the thought in mind that at any given moment there are 1,800 thunder-

storms in progress somewhere on the earth, adding up to 16 million storms every year,[9] it's little surprise that lightning protection systems are an important factor in saving trees.

Clearly, the new ANSI lightning protection standard is a huge boon to the tree care industry. The new standard can make lightning protection a reality for homeowners and others who previously could not afford the heavy-duty hardware that was part of the process. In addition, arborists and clients alike can rest assured that lightning protection systems installed according to the ANSI A300 standard have the best chance of surviving a lightning strike.

And, after all, we aren't just in the tree care business, says Smiley; "We are in the tree protection business. What's the bottom line?" he asks rhetorically. "Protecting trees."

Ariana Zora Ziminsky is former assistant editor of Tree Care Industry magazine.

Not yet ready to change with the times?

The arborist uses ANSI A300 specs as a guide for writing work specifications. Your specs need to meet the requirements and recommendations of ANSI A300. Beyond that there is nothing wrong with over-specifying the system for those critical or high-end jobs. Over-specifying, with a reason, goes on in most industries – we are not an exception.

For the arborist, it is easy to get caught up in the actual "shoulds" and "shalls" of the standard. Don't forget that anything over and beyond the standard is fine. The important thing is that the client has a written spec to compare with others so they can make an informed decision. ANSI A300 Part 4 allows the arborist flexibility so that the needs of individual trees and individual clients can be met. A tree care company could even specify "deluxe" and "economy" lighting protection system designs. In this example, both the deluxe and economy system would meet the ANSI A300 Part 4 standard, but a deluxe system could use some of the recommendations from the obsolete NAA standard – such as the number or size of down conductors.

Proper marketing of these options could increase your client base for lightning protection systems to those who could not previously afford a lightning protection system for their trees and to those who want to protect more trees than they could previously (such as parks, cities, golf courses, private estates, etc.). Proper marketing can also reinforce the choice of a deluxe lightning protection system to your current and new exclusive clients.

What you should not do: Do not cite the old NAA standard. This is now obsolete. Aside for the legal problems this could cause you, the standard does not require you to consider the soil condition before grounding, which is a key component to the success of any lightning protection system.

Works Cited:

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