BARTLETT TREE RESEARCH LABORATORIES
CHARLOTTE, NC
Technical Report

Lightning Protection

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INTRODUCTION

Each year in the United States nearly 1000 people are struck by lightning; about 100 die as a result. Most of these fatalities are people taking refuge under trees. The number of trees struck exceeds a million a year. Few of these trees die immediately due to the strike. Many, however, are weakened and predisposed to attack by wood boring insects, decay, canker or root rotting fungi and die within a few years. Some trees are hit with seemingly no damage at all.

Lightning striking

The electric charge in a lightning strike is between 10,000 and 30,000 amps at 10 to 100 million volts. As lightning approaches the ground the leading stroke travels at a speed of 450,000 feet per second. When a tree is struck, water within the tree is instantaneously heated far beyond the boiling point. Steam is created, usually in the outer sapwood and cambium, resulting in an explosion, which blows off a bark strip. If lightning penetrates the tree more deeply, the entire tree may be blown apart.

Tree struck by lightning

Occasionally, when trees are struck, the electricity will travel part way down the trunk, then arc over to objects of lower resistance. This is called a sideflash and is one of the main reasons to protect trees near buildings.

When current stays within the tree it will seek ground through the roots, especially if the soil is dry. Trees growing in rocky or dry soil are therefore most susceptible to root damage. Since rock is a poor conductor,

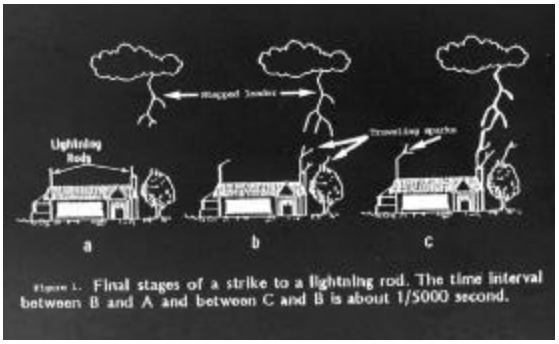


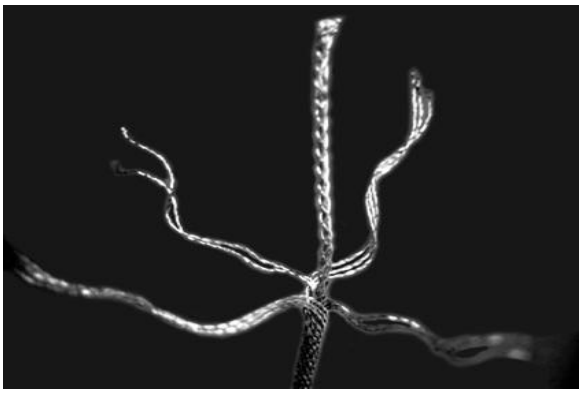
Figure 1. Final stages of a strike to a lightning rod. The time interval between B and A and between C and B is about 1/5000 second.

the charge will travel greater distances within the root system. Major root damage from electricity may cause the tree to decline without significant above ground damage.

LIGHTNING PROTECTION SYSTEMS

Air terminal for highest branches

Benjamin Franklin first devised lightning protection systems in 1749. From their inception there has been controversy whether lightning rods dissipate the electrical charge prior to a strike or conduct strikes harmlessly to ground. Professional opinions still differ slightly on this point. There may be some dissipation, or slow release of electrical charge. This can be heard as cracking if standing under a lightning protected tree in a storm. However, the major method of operation is to conduct the lightning strikes harmlessly to ground. The main element in a lightning protection system is a braided copper conductor. This is connected to an air terminal near the top of the tree and



Braided lightning cable

fastened to the tree all the way down to ground level. A trench is dug between the trunk and the tree's dripline, the conductor is placed in the trench and the end of the conductor is connected to a ground rod.

For larger trees, smaller diameter conductors are attached to major limbs and then connected to the primary conductor. Trees over 36" in diameter require two primary conductors.

PRIORITIZATION

Not all trees need to be protected from lightning. Several factors, which should be considered, are the number of people who may be under the tree during a storm, the proximity of buildings, the height of the tree, the species of tree (Table 1) and the frequency of storms in the area. Tall susceptible trees, which are close to houses or may have people taking refuge under them during a storm need to receive the highest priority. Other high priority trees include large historic trees, especially on hills, rocky or wet area.

Table 1. Lightning Strike Frequency of Selected Tree Species

High Frequency of Strikes	Low Frequency of Strikes
Ash	Beech
Black Locust	Birch
Catalpa	Horsechestnut
Elm	
Maple	
Oak	
Pine	
Poplar	
Spruce	
Sycamore	
Tulip Poplar	