C1 480 Volt Downed Electrical Power Line Causes Multiple Human Electrocutions (Including a Dog) in a Puddle – A Tropical Storm in Florida, Vegetation Management, and the Electrical Power Circuit Configuration and Characteristics Were All Factors in the Incident

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The goals of this presentation are to study the effects of poor vegetation management on overhead electrical power lines, and phenomena associated with power lines breaking. Also included is a technical study of the electrical power system configuration impact on hazardous ground fault currents. Methodology for investigation of a downed power line incident scene and examination of the evidence will also be discussed.

This presentation will impact the forensic science community by study- ing the cause of downed power lines allows electrical power utilities to better manage and allocate resources to prevent future occurrences. The method- ology is also important to assist the forensic investigator. Proper electrical circuit configurations and protection may prevent lines from remaining energized once on the ground.

A tropical storm blanketed Florida with severe winds and rain in the fall of 1999. The storm carried winds of approximately 70 mph.

An incident occurred at a residential "T" intersection. A mother, her two boys, a friend, and a dog were out taking a walk after the storm had passed. Everyone except the mother was in bare feet since the weather was warm. The boys and the dog walked through a large puddle of water approximately 3 inches deep at the intersection. The three were electrocuted, including the dog. An overhead 480 volt street lighting power line had fallen into the puddle. The mother tried to go into the puddle to save the boys and also succumbed to electrocution.

The overhead power line was used exclusively for the 480 Volt street lighting system. The 480 Volt circuit originated from a 7200 volt, 25 kVA transformer. The transformer was allegedly protected with a 15K fuse. The energized conductor was #4 AWG AAAC[1], located 1 foot above the 3/0 ACSR neutral conductor. There were a total of 43 or 52 street lights connected to this lateral circuit. The lights drew a load current of 1.16 amps each, and power of 400 watts at 480 Volts. The ampacity of the energized #4 AAAC conductor is 148 amps.

The line was suspended at either side of the intersection to concrete hydro poles with an assumed 1 foot of initial sag according to utility design. The high growing vegetation in the area below the line consisted of ficus trees. The ficus tree is considered a fast growing deciduous tree, which can grow at an average rate of 1.5-2 feet per year. Upon first examination of the scene, two ficus trees were noted to have been cut down to small hedges. There were reports that the two subject ficus trees were much larger and may have been growing into the power line prior to the accident.

The first inspection of the subject line was carried out in a long ballroom at a local hotel. This allowed easier manipulation of the 260 foot conductor. A special proprietary conductor inspection jig was used for this inspection. The jig facilitated inspection of every inch of the conductor with a zoom stereo microscope. The inspection revealed the following anomalies and insults:

- Corrosion
- Contamination
- Presence of Tree Bark
- Wear
- Significant Electrical Arcing Damage

The type of corrosion found was typical crevice and pitting corrosion. The contamination consisted of ficus matter on the conductor at various locations. Wearing had also occurred along strands at certain locations. The electrical arcing damage was extensive and occurred at many locations beyond those where the conductor was lying in the puddle; it had also caused strands of the line to sever in various locations. Each insult was recorded by means of a description, photograph, and measured location from the end of the line. After the inspection was completed, the insult locations were trans- ferred to a rope model copy. The 3/0 ACSR neutral conductor was later examined using the same methodology when it became available.

The scene was then examined using the rope model which was laid between the two subject poles on the ground. This allowed one to determine the location of the various insults with respect to the scene and ficus trees. Most interesting was the location of contamination and electrical arcing damage at locations where the east ficus tree had been cut down to a hedge, and at locations where the subject west ficus tree existed at the wire fracture.

Electrical tests were carried out in our high voltage laboratory to gain an understanding of the conductivity of ficus branches at 480 Volts. The tests indicated (as expected) that insignificant currents conduct at 480 Volts along a ficus tree. There is also additional ground resistance through the ground and back to the source. The electrical arcing damage on the con- ductors could not have been caused from the line contacting the ficus tree.

After inspecting the 3/0 ACSR neutral conductor, an interesting discovery was made. The neutral conductor was found to have electrical arcing damage as well. The locations of the damage were matched to the locations on the energized #4 AAAC phase conductor. It was then deter- mined that the neutral conductor must

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have contacted the phase conductor at some point. It was determined that this contact was likely from the ficus tree growing and pushing the neutral conductor into contact with the phase con- ductor at various locations during moments of high winds. Eventually the #4 AAAC energized conductor severed and fell to the ground. Unfortunately, it severed at a location which left the upstream section energized and lying in the large puddle. Further tests were conducted to obtain an understand- ing of the conductivity of the energized conductor in various solutions of storm water and other mixtures which included grass fertilizer. The ground fault current from the live conductor in the puddle was eventually estimated by means of tests and calculations.

The ground fault current in water created a condition of dangerous step potential close to the conductor. Unfortunately the boys probably did not see the conductor under the water at night, and as they approached lost control of their leg muscles causing them to fall forward facedown into the water. After falling, the voltage potential between head and foot led to electrocution.

In summary, this accident could have been avoided if the trees had been properly trimmed and maintained. In addition, the fuse used was 15K which was considerably higher than the 4K prescribed for this circuit. After careful analysis of the time-current curves of various fuses, and ground fault current calculations, it was determined that a 4 or 6 amp fuse may have been cleared the circuit prior to the family entering the puddle and the electrocutions may not have taken place. The utility and the estate have since settled this case.

Reference:

[1] All Aluminum Alloy Conductor.

Electrocution, Power Line, Storm

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