Lightning Damage to Residences, A Guide to Homeowners

Dr. Carlos Mata[a] and Dr. Dustin Hill[a]
[a]Scientific Lightning Solutions, LLC, Merritt Island FL, USA

Abstract

This paper explores the multifaceted challenges posed by lightning-related damages to residential properties and the ensuing legal complexities in insurance claims. Lightning strikes, inherently unpredictable, pose significant risks to residential structures, particularly those outfitted with advanced electrical and electronic systems such as smart home automation, solar power generation, and backup power systems. The complexity of modern homes, often featuring large square footage and incorporating various HVAC, boiler, and plumbing components, amplifies their susceptibility to lightning-induced hazards. A significant challenge in insurance claims is the discrepancy between the location reported by lightning detection networks and the actual coordinates of the residence. Insurance providers frequently exploit this misalignment to dispute claims, especially in the absence of physical evidence of a lightning strike. The responsibility of determining whether lightning caused damage often falls to an individual appointed by the insurance company, who may not possess the requisite expertise in identifying lightning-related damages. This scenario can result in erroneous conclusions that discount lightning as the cause, attributing homeowners' claims to their pursuit of insurance benefits. Furthermore, the issue of latent damages exacerbates the challenge, as these damages may not be immediately evident but can lead to gradual failures in electrical and electronic equipment, and even cause leaks in copper piping after the lightning event. This paper provides a comprehensive examination of lightning-related damages, their legal ramifications, and proposes strategies to address the complexities of residential litigation following lightning-induced losses. By clarifying these intricacies, the study aims to arm homeowners and legal professionals with the necessary knowledge to effectively manage lightning-related insurance claims, ensuring fair and equitable resolutions for all parties involved.

1 Introduction

In an era where residential structures are increasingly sophisticated and interconnected, the impact of natural phenomena like lightning strikes extends beyond physical threats to present complex challenges, including legal disputes. This paper explores the multifaceted issues arising from lightning-induced damages to residential properties, exploring the intricate relationship between technical evaluations and the legal complexities encountered in insurance claims. The unpredictable nature of lightning, capable of causing extensive damage through direct or indirect strikes, renders it a formidable threat, particularly to homes equipped with sensitive electrical and electronic systems. These systems include smart home automation, solar power generation, and advanced backup power systems, all of which are vulnerable to lightning's deleterious effects.

Modern homes are more than living spaces; they are complex networks of technology and infrastructure. Their expansive design incorporates crucial components like HVAC systems, boilers, extensive plumbing, network equipment, computers, and a range of sensitive electrical and electronic devices, including surveillance and home automation systems. While architectural and technological advancements provide comfort and efficiency, they also increase these structures' susceptibility to lightning-related hazards. The challenges intensify when such damages lead to insurance claims, involving intricate policy coverage, damage assessment, inspectors' limited expertise, and the determination of damage extent and cost.

A primary issue for homeowners after lightning strikes is the discrepancy between the locations identified by lightning detection networks and the actual strike sites on residences. This mismatch often becomes contentious, with insurance companies using it to challenge or deny claims, especially when the exact point of lightning attachment is unclear. Furthermore, the task of determining the cause of damage typically falls to individuals appointed by insurance companies, who generally lack the necessary expertise to accurately identify and comprehend the subtleties of lightning-related damages. This situation risks misinterpreting or underestimating the damage, leading to potentially unjust claim denials based on the assumption that homeowners are unjustly seeking insurance benefits.

Another layer of complexity is the phenomenon of latent damages. These damages, not immediately apparent post-lightning event, become evident over time and may pose significant fire risks. They can manifest as failures in electrical and electronic equipment or as leaks in copper piping systems, causing delayed yet severe impacts on the property. Addressing latent damages in insurance claims is challenging, requiring a thorough understanding of lightning's long-term effects on residential infrastructure. Notably, one of the most significant latent risks involves damage to low voltage transformer windings, potentially leading to high impedance faults that short circuit the windings and create hot spots. These hot spots can cause fires from currents insufficient to trigger circuit breakers.

Regarding residential wiring, the assessment post-lightning strike is problematic due to the difficulty in testing and the lack of standardized methodologies to evaluate insulation health. Existing standards like [1] and [2], which cater to electrical power equipment and systems, are not suitable for this context. Inexperienced technicians might rely on instantaneous insulation resistance measurements, which do not accurately reflect insulation health. A true assessment requires time-consuming and costly time-resistance insulation tests. The concealed nature of residential wiring behind walls further complicates this, leaving the insulation's condition uncertain until proper testing is conducted.

This paper aims to thoroughly examine the impacts of lightning on residential properties, the ensuing legal challenges in insurance claims, and effective strategies to navigate these complexities. Our goal is to illuminate these issues, providing insights that enable homeowners and legal professionals to more effectively handle lightning-related insurance claims. In doing so, we aim to contribute to a more informed and equitable approach in resolving disputes related to lightning-induced losses, ensuring fair outcomes for all involved parties.

2 Lightning Reports and Limitations

Understanding the limitations of lightning reports generated by lightning location and detection networks (LLDNs) is essential for accurate interpretation and application in research and practical settings. These networks often encounter significant shortcomings due to their extensive sensor baselines, suboptimal detection efficiencies, and variable detection accuracies. Moreover, the methodologies employed to estimate these efficiencies and accuracies carry inherent limitations. Typically, detection efficiencies are derived from a relatively small sample size collected from a few sites, primarily through triggered lightning experiments and monitored towers. However, these events may not fully capture the behavior and characteristics of natural cloud-to-ground lightning strikes. Despite these limitations, the calculated detection efficiency and location accuracy are often extrapolated to represent the entire network coverage area, a practice that may not accurately reflect the network's performance.

It is critical to acknowledge that no LLDN has been comprehensively validated against a ground-truth benchmark for lightning detection and location accuracy. As a result, the claimed detection efficiencies and location accuracies might be optimistic when compared to the actual capabilities of these systems.

Concluding that lightning activity did not occur at a specific location and time based solely on the absence of documented strikes in a lightning report is an oversimplification. Such an assertion may suggest a lack of depth in the investigator's analysis. While lightning reports provide valuable evidence of lightning activity within an area, they should not be the sole basis for conclusively determining the absence of lightning at a particular location and time. Investigators are encouraged to incorporate meteorological data, including Doppler radar reflectivity, into their assessments to evaluate the likelihood of lightning occurrences.

A common oversight among investigators is dismissing lightning as a cause of damage when reports place lightning activity at a distance from the damage site. This approach misunderstands the nature of lightning documentation, which often identifies the center of an "error ellipse" or "confidence ellipse" rather than providing an exact strike location. These ellipses represent the 50 %, 95 %, or other percent probability (depending on the provider and the customer's request) that the strike's location is within the ellipse, indicating that there is a significant chance that the actual strike point lies outside this ellipse as well. Furthermore, research conducted by Dr. Mata and Dr. Hill at the Kennedy Space Center in Florida, USA, indicates that the error ellipses have not been tuned using statistically significant ground-truth data, perhaps because of the lack of ground-truth lightning location and detection networks that covers large areas.

Similarly, additional research conducted by Dr. Mata and Dr. Hill at the Kennedy Space Center utilizing high-speed camera monitoring ([3], [4]), has shown that approximately 50 % of lightning flashes can have multiple ground termination points, with about 20 % of strokes within a flash exhibiting this behavior. It is important to recognize that current commercial lightning location and detection systems are not equipped to accurately detect or report the presence of multiple ground termination points. In cases of multiple terminations, these systems may either miss the event entirely or report it with substantial inaccuracies.

These insights underscore the need for a nuanced understanding of LLDN reports and the complexities of lightning behavior, highlighting the importance of comprehensive analysis in the accurate assessment of lightning-induced damages.

3 Lightning Claims

In the US, over the past few decades, residential lightning insurance claims have exhibited a notable increase, driven by several pivotal factors. Primarily, the growing complexity and value of home electronics and smart home technologies have heightened the financial repercussions of lightning-induced damages.

The Insurance Information Institute (Triple-I) noted in a press release that lightning-related insurance claims exceeded $1 billion in payouts in 2021 (see Table 1). The record payout in 2020 was partly due to the CZU Lightning Complex fires in California, sparked by lightning. Over time, there has been an increase in the number of residences, the average cost per claim, and the quantity of sensitive electronic equipment within homes, while the number of claims per year has shown a decline.

Interestingly, the highest cost claims, along with a significant volume of them, occur in California, where the ground flash density is considerably lower than in the Southeast US. In 2021, the average cost per claim in California was

Table 1 Homeowners Insurance Claims And Payouts For Lightning Losses, 2017-2021.

Year	Claims ($ M)	# of claims	Avg $ per claim
2017	916.6	85,020	10,781
2018	908.9	77,898	11,668
2019	920.1	76,860	11,971
2020	2,066.7	71,551	28,885
2021	1,313.1	60,851	21,578

$154,574, in stark contrast to Florida's average of $16,552 per claim, as reported by the Triple-I, likely due to the higher real state costs in California and more complex residences. That year, Florida saw 5,339 claims, compared to 3,817 in California. These statistics highlight the substantial number of homeowners affected by lightning-related issues. It's important to note that this data does not account for the numerous lightning-induced damages that go unclaimed.

4 Types of Lightning Damage

Understanding the types of damage lightning can cause to residential structures is crucial. These damages significantly vary between nearby (indirect) strikes and direct strikes.

4.1 Nearby (Indirect) Lightning Strikes

Nearby strikes do not hit the structure directly but can still cause significant damage:

4.1.1 Electrical Surge Damage

Nearby strikes can induce electrical surges in power lines, leading to overvoltages that damage plugged-in electronics. Lightning can compromise the insulation of wiring (fire hazards). It stresses components, potentially shortening their lifespan and leading to failures either immediately or over time. Residences with solar panels and inverters can be particularly vulnerable as lightning's electromagnetic field induces power surges. A residence with many solar panels faces a compounded risk from surges that can damage the solar panels, inverters, and connected electrical equipment. Household circuit breakers will not respond quickly enough to prevent damage, and typical surge protectors on solar panels and inverters may be likely inadequate.

4.1.2 Structural Damage

Minor structural damage like cracks in the foundation or walls may occur.

4.1.3 Fire Hazards

Surges can overheat electrical systems and wiring, posing fire risks. Wiring insulation damage can result in high impedance faults, igniting materials post-strike.

4.1.4 Electrical System Damage

Lightning striking the ground nearby can generate ground currents, leading to electrical shock risks, and affecting external systems like garage door openers, irrigation systems, HVAC system, pool equipment, and pumps.

4.1.5 Piping System Damage

Ground or induced lightning currents can damage piping systems.

4.2 Direct Lightning Strikes

A major challenge arises from direct lightning strikes to complex residential structures, which may not leave "clear evidence" of the attachment point(s). Consequently, a considerable amount of time—ranging from months to years—might elapse before a lightning damage expert inspects the residence. During this interval, roof components might have been repaired or replaced, and exposure to weather can alter the condition of roof-mounted metallic objects. These factors complicate the identification of the lightning attachment point(s) significantly. Direct lightning strikes are characterized by at least one direct connection to the structure, typically resulting in extensive damage. In addition to the damages caused by nearby lightning, direct lightning strikes can cause the following damage:

4.2.1 Structural Damage

4.2.1.1 Roof and Walls

The intense heat and electrical charge can lead to immediate disintegration or melting of roofing materials, shingles, and walls.

4.2.1.2 Foundation and Retention Walls

The enormous currents can produce intense heat and pressure, causing significant cracks in the foundation, walls, and retention walls as water vaporizes.

4.2.1.3 Chimneys and Antennas

Being common strike targets, these can be shattered or severely damaged.

4.2.2 Fire Hazard

The intense heat from a lightning strike can ignite building materials, creating fire hazards, especially if it strikes wooden components or flammable substances. Damage to wiring insulation can lead to high impedance faults, potentially igniting materials hours, days, or weeks after the strike (see Figure 1).

4.2.2.1 Electrical System Damage

Direct strikes can severely damage electrical wiring, leading to short circuits, melted wires, and potential fires that can spread throughout the property. Direct strikes can induce transient power surges, damaging electronic devices that are temporarily or permanently connected to the residence electrical system. Devices connected to services that can carry current (like ethernet cables) may be damaged

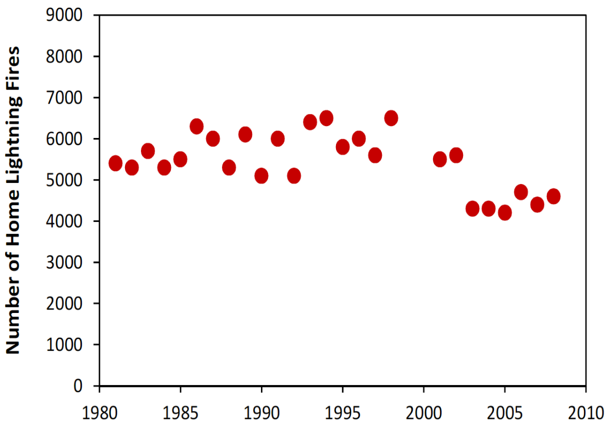

Figure 1 Number of home fires caused by lightning in the United States from 1980 to 2010, adapted from [5].

even if not directly plugged into power outlets.

4.2.3 Piping System Damage

Lightning can cause damage to conductive and non-conductive piping systems. It is recommended to conduct pressure test, per [8], to minimize the probability of a future leak that may cause significant damage to the household and its residents.

4.2.3.1 Copper Pipes

Lightning can create pinholes in copper pipes [6], leading to leaks and potential damage to the plumbing system and appliances connected to it. At times, lightning may weaken the pipe walls, and leaks won't be noticed until days, weeks, or months after the lightning strike.

4.2.3.2 Corrugated Stainless Steel Tubing (CSST)

Similarly, lightning can create pinholes in the CSST thin walls, resulting in leaks that may lead to fires and explosions [7].

4.2.3.3 Polyvinyl Chloride (PVC)

Documented cases also exist of polyvinyl chloride (PVC) pipes bursting, especially in scenarios where PVC pipes are utilized in irrigation systems that accumulate mineral residues on their interior walls. These residues can form thin, slightly conductive films along the inside of the PVC pipes. When lightning currents traverse these conductive paths, the resultant heat and pressure increase can cause the PVC pipes to burst.

4.2.3.4 Fiberglass

Similar to PVC pipes, fiberglass pipes can also sustain damage from lightning, primarily due to the intense heat generated during a lightning event and the presence of moisture within the fiberglass material. This damage occurs when the pipes are not adequately protected against lightning-induced effects. A prevalent misconception is that non-conductive materials, being insulators, do not necessitate lightning protection. Another widespread but incorrect belief is that installing a lightning protection system attracts lightning strikes, leading some to decide against installing or even to remove existing systems. Both of these notions are erroneous. Lightning protection systems do not increase the likelihood of a lightning strike; instead, they provide a controlled path for lightning's electrical discharge, mitigating potential damage.

4.2.4 Shock Wave Damage

The explosive shock wave from a lightning strike can shatter glass windows and other fragile materials.

4.2.5 Secondary Damage

Falling trees or poles hit by lightning can cause secondary damage to residences.

5 Steps to Follow After a Suspected Lightning Event

This comprehensive approach guides homeowners through the process of assessing, documenting, and handling potential damages from a lightning strike for insurance claims and, if necessary, legal action.

5.1 4.1 Initial Safety Measures

5.1.1 Ensure Safety

Prioritize safety by assessing the risk of fire and structural damage. Evacuate immediately if there's evidence of fire or serious structural compromise.

5.1.2 Document Immediate Observations

After a lightning strike, it's crucial to meticulously document the event, whether you witness it directly or suspect it occurred in your absence. Record the time, date, weather conditions, and any visible damages immediately after the strike. Take time-stamped photos and videos for documentation.

5.2 Preliminary Assessment

1) Check circuit breakers, note which breakers have tripped to identify affected circuits. Do not attempt to reset them yourself, 2) inspect appliances and equipment, check for visible damage or malfunction in electrical and electronic devices. Be alert to unusual odors or sounds, indicating potential damage.

5.3 Disconnection of Systems

Disconnect low voltage systems, safely disconnect systems such as home automation, security, and telecommunications to prevent further damage.

5.4 Professional assessment

Hire a licensed electrician for an initial evaluation of the residence's electrical system. They should attempt to restore power to affected circuits, documenting their actions and observations, including issues like persistent breaker tripping. Request a written report of the electrician's work, observations, and findings.

5.5 Engage a Lightning Expert

Seek the expertise of a qualified lightning damage consultant for a comprehensive inspection aimed at uncovering damages that may not be immediately visible. This consultant should be a lightning Subject Matter Expert (SME). A lightning SME is an individual who possesses extensive knowledge, expertise, and experience in the field of lightning physics, protection systems, electrical engineering related to lightning, and the impacts of lightning strikes. This expertise typically covers a broad range of topics including, but not limited to, the mechanisms of lightning formation, characteristics of lightning strikes, methods for protecting structures and electronic systems from lightning damage, the analysis of lightning-induced failures, and lightning location and detection networks and technologies.

Such an expert often has a strong foundation in electrical engineering or physics, complemented by hands-on experience in designing, implementing, and evaluating lightning protection measures. They may also be involved in research, development of standards, forensic analysis of lightning damage, and providing expert witness services in legal cases involving lightning damage claims.

When engaging with potential consultants, conduct a thorough vetting process to confirm their expertise in the field of lightning and electrical surge damage. Key points to inquire about include:

5.5.1 Formal Education

Ask about the expert's educational background, ensuring it includes specialized training or degrees in relevant fields such as electrical engineering, meteorology, or a related discipline that covers aspects of atmospheric sciences and electrical systems.

5.5.2 Professional Experience

Inquire about the expert's professional experience, particularly in diagnosing and assessing lightning damage. Experience with similar cases will indicate a practical understanding of the various forms of damage lightning can inflict.

5.5.3 Certifications and Qualifications

Determine if the expert holds any certifications or memberships in professional organizations related to lightning protection, electrical safety, or forensic analysis. Such credentials can be indicative of a commitment to ongoing education and adherence to industry standards.

5.5.4 Expert Witness Experience

Verify whether the SME has experience serving as an expert witness in court. This involves assessing the expert's ability to effectively communicate technical information in a legal context, a critical skill for litigation related to lightning damage claims.

5.5.5 References and Case Studies

Request references or case studies from previous consultations that demonstrate the expert's ability to identify and address complex issues related to lightning damage.

5.6 Contact Insurance Adjuster

Hire an insurance adjuster to collaborate with your insurance company on damage assessment and repair cost estimation. Ensure they liaise with the lightning expert to accurately convey findings.

5.7 File a Claim with Your Insurance Company

Notify your insurance provider promptly and allow your adjuster to manage communications. Discuss temporary housing arrangements if needed.

5.8 Documentation

5.8.1 Evidence Collection

Maintain a comprehensive record of all related communications and documents. Request and document the qualifications of any experts sent by the insurance company, ensuring you receive copies of their reports.

5.9 Itemize Damaged Property

Compile a detailed list of damaged items, including their make, model, and age. Preserve damaged equipment for evidence.

5.9.1 New Equipment Inventory

Keep a list of any new equipment purchased for restoring functionality to your home.

5.9.2 Expert Testing

Wiring Inspection: Engage a qualified electrician to perform insulation resistance testing on your home's wiring to evaluate insulation integrity.

Equipment Inspection: Engage qualified individuals to thoroughly test equipment in your house. Request written test procedures and reports.

Copper Pipes Testing: Contract a professional to test copper piping according to ASME B31 standards.

5.10 Ongoing Monitoring

Latent Damage Vigilance: monitor for new electrical, appliance, or structural issues in the aftermath. Report any new equipment failures or random circuit breaker tripping to your lightning expert and insurance adjuster for further action. If newly installed equipment fails, disconnect circuit from the residence power and report the problem to the SME.

Consult with the SME to evaluate options to install sophisticated instrumentation equipment to monitor the residence's electrical service.

5.11 Negotiations with Insurance Company

5.11.1 Review Insurance Offers

Carefully assess the insurance company's compensation proposal to ensure it adequately covers the damages.

5.11.2 Negotiate When Necessary

Work with your adjuster to negotiate with the insurance company, supported by expert assessments and evidence.

5.11.3 Legal Consultation (if Necessary)

If negotiations stall, consider hiring a legal professional specializing in property damage and insurance claims. Seek referrals from your adjuster or SME.

6 Conclusions

The authors highlight the increasing sophistication of residential structures, equipped with advanced electrical and electronic systems vulnerable to lightning strikes, which amplifies the financial impact of such incidents. The paper underscores the discrepancy between lightning detection networks' reported locations and actual strike sites, a gap often exploited by insurance providers to dispute claims. This situation is exacerbated by the appointment of individuals by insurance companies who may lack the necessary expertise to accurately assess lightning-related damages, leading to potential unjust claim denials.

Latent damages, which may not be immediately evident but can manifest over time, pose significant risks to electrical and electronic equipment and even infrastructure like copper piping, and more importantly to people living in the residence. Lightning may shorten the life expectancy of electrical and electronic equipment, which makes it increasingly difficult to establish a time window where equipment are allowed to fail to be covered, which drives extensive and exhausting tests of electrical equipment and wiring.

The paper calls for a nuanced understanding of lightning detection reports and a comprehensive approach to assessing lightning-induced damages, advocating for the engagement of qualified lightning damage consultants for in-depth inspections. It must be emphasized that inherit limitations and short comings of lightning location and detection networks do not make them suitable tools to disprove the presence of lightning strikes.

Careful consideration must be taken when selecting a lightning subject matter expert. And guidelines to conduct thorough vetting to confirm their expertise are provided.

Although the authors have served as SMEs to many homeowners, photographs or detailed case studies are not presented in this paper, because Scientific Lightning Solutions, LLC (SLS) respects the privacy of their customers and there are some litigation constraints that do not allow SLS to disclose pictures or additional information.

While this paper focuses on current challenges and solutions, the authors would also like to encourage research into improved lightning detection technologies, damage assessment methodologies, latent damage diagnostics & testing, and protective measures for residential properties.

This paper effectively illuminates the multifaceted challenges homeowners face in the aftermath of lightning strikes, from immediate safety measures to navigating insurance claims and legal disputes. It emphasizes the critical role of specialized knowledge in understanding lightning phenomena, accurately assessing damages, and ensuring fair and equitable resolutions in insurance claims. The proposed strategies for addressing these challenges are invaluable for homeowners, legal professionals, and insurance providers, promoting a more informed and judicious approach to managing lightning-related damages. This comprehensive guide not only advances the understanding of lightning-induced damages but also equips stakeholders with the knowledge to mitigate the financial and structural impacts of such events, advocating for a collaborative approach between homeowners, experts, and insurance companies to achieve just outcomes.

This paper addresses the complexities and financial repercussions associated with lightning strikes to residences, which are increasingly equipped with sophisticated electrical and electronic systems. A critical gap is identified between the locations of lightning strikes reported by detection networks and the actual sites of damage, a discrepancy that insurance companies often exploit to challenge claims. The issue is compounded by the employment of assessors by these companies who may lack the specialized knowledge required to accurately evaluate lightning-related damages, potentially leading to unjust denials of claims.

The concern over latent damages, which may not be immediately observable but emerge over time, is underscored. Such damages pose risks not only to electrical and electronic systems but also to the residence's infrastructure, like copper piping, and, critically, to the safety of occupants. These damages could reduce the lifespan of electrical devices, complicating the determination of coverage eligibility based on the timeframe of equipment failure, necessitating exhaustive testing of electrical systems and components.

The need for a nuanced interpretation of lightning detection reports and a thorough approach to damage assessment is advocated, highlighting the importance of engaging qualified lightning damage consultants for detailed inspections. The inherent limitations of lightning detection systems are emphasized, clarifying that they should not be used to negate the occurrence of lightning strikes.

Selection criteria for a lightning subject matter expert are discussed, offering guidelines for verifying their qualifications effectively. The authors' direct experiences and case studies are not disclosed due to privacy and legal considerations, because of client confidentiality and constraints of ongoing litigation.

Future research directions are encouraged, including the development of enhanced lightning detection technologies, methodologies for damage assessment, and diagnostics and testing for latent damages.

In summary, this paper sheds light on the significant challenges homeowners face following lightning strikes, encompassing immediate safety concerns, insurance claim navigation, and legal disputes. It stresses the essential role of specialized expertise in understanding lightning phenomena, accurately assessing damages, and achieving equitable resolutions in insurance claims. The strategies proposed herein are invaluable for homeowners, legal professionals, and insurance providers alike, advocating for a more informed and equitable approach to managing lightning-related damages and promoting a collaborative effort among all stakeholders to ensure just outcomes.

7 Literature

[1] ANSI/NETA ATS-2021, American National Standard, Standard for Acceptance of Testing Specifications for Electrical Power Equipment & Systems, 2021

[2] ANSI/NETA MTS-2015, American National Standard, Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems, 2015

[3] Hill, D.: Mata, C.T.: Evaluation of the Performance Characteristics of MERLIN and NLDN based on two years of ground-truth data from Kennedy Space Center/Cape Canaveral Air Force Station, Florida, International Lightning Detection Conference, San Diego, USA, April 2016

[4] Mata, C.T.: Hill, D.: MERLIN Low Detection Efficiency Study Results: First Two Years, International Conference on Lightning Protection (ICLP), October 2022, pp. 471-474

[5] Ellison, A.D.: Morse, T.: Kytomaa, H.: Lightning Related Structure Fires, International Symposium on Fire Investigation Science and Technology (ISFI), 2012

[6] Dunham, R. A.: Russell C. A.: Electric Skies - Electric Pipes, Florida Water Resources Journal, Feb. 1997

[7] Goodson, M.: Hergenrether, M.: Investigating the Casual Link Between Lightning Strikes, CCST and Fire, Fire & Arson Investigator, October 2005, pp. 28-31

[8] American Society of Mechanical Engineers: ASME Code for Pressure Piping B31.3: Process piping, 2006

Dr. Mata received his Ph.D degree in Electrical Engineering from the University of Florida. He was the lightning subject matter expert and technical lead of Kennedy Space Center's Advanced Electronics and Technology Development Laboratory for 12 years. He directed the program that designed the lightning protection and lightning instrumentation systems for NASA's Launch Complex 39B, perhaps the most sophisticated lightning protection and monitoring system in the world. Dr. Mata is the recipient of many awards, including NASA's Distinguished Public Service Medal and the NASA KSC Engineer/Scientist of the Year Award. Dr. Mata has also worked extensively with the International Center for Lightning Research and Technology (ICLRT) to evaluate and refine lightning instrumentation systems used to monitor high-tech vehicles, payloads, and high-value assets at the Kennedy Space Center, Cape Canaveral Air Force Base, and other Department of Defense locations.

Dr. Hill received his Ph.D. degree in Electrical Engineering from the University of Florida. His research at the ICLRT focused on the mechanisms and physics of natural and triggered lightning leader propagation and ground attachment, including the related high-energy physics. Dr. Hill has authored or co-authored more than 60 articles in peer-reviewed journals, more than 45 conference publications, and more than 50 technical reports. Dr. Hill spent four years working in Kennedy Space Center's Advanced Electronics and Technology Development Laboratory, where he specialized in the design and implementation of robust, highly-accurate lightning location systems, custom lightning monitoring systems, high-speed photographic and biological imaging systems, and electromag-

netic sensors. He is now a Lightning Subject Matter Expert at Scientific Lightning Solutions, where he specializes in the design of state-of-the-art lightning instrumentation systems, design and testing of complex lightning protection systems, lightning damage mitigation, and standards compliance. Dr. Hill has extensive experience in custom software development with emphasis on lightning waveform and image analysis.