Lightning Safety Guide

FOR SPORTS AND SPECIAL EVENTS

MAY 2026

CONTENTS

EXECUTIVE SUMMARY

Lightning poses a significant risk to outdoor sports and special events, endangering participants, spectators, and staff. Given the unpredictable nature of thunderstorms, it is essential to have a comprehensive lightning safety plan in place to protect everyone involved.

This *Lightning Safety Guide* outlines critical measures and considerations to ensure safety and reduce the risks associated with lightning strikes, including tear-away pages on lightning safety considerations for small and large events. The preparation, education, and clear procedures outlined in this Guide will minimize lightning-related injuries and disruptions, creating a safer environment for your outdoor event.

CISA does not endorse any nonfederal entity, product, company, or service, including any entities, products, or services linked within this document. Any reference to specific nonfederal entities, products, processes, or services by service mark, trademark, manufacturer, or otherwise, does not constitute or imply endorsement, recommendation, or favoring by CISA.

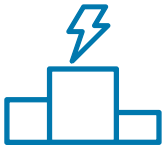
Mission Statement

The mission of this Guide is **to enable and empower venue managers and event organizers to prioritize lightning safety at outdoor events.** Through strategic collaboration with business-oriented and data-driven approaches, we aim to cultivate advocacy and address critical challenges, ensuring the well-being of all participants and attendees.

We recognize both the unique opportunities and challenges of lightning safety. By embracing the complexity of existing information, **we aim to put forth a comprehensive lightning safety guide that demystifies the science of lightning, identifies various ways to access real-time and predictive lightning safety resources, provides potential mitigation strategies, and helps establish safety and security protocols for outdoor events on all scales.** Our goal is to bridge gaps in knowledge and provide practical solutions, thereby enhancing safety practices across small- to large-scale sports and special events.

We aspire to bring the world of sports and outdoor events together with **a centralized operational planning structure.** This approach provides reasonable mitigations across various programs and creates a credible, consistent method that unites business and safety decisions. Through these efforts, we aim to **provide a pathway for scalable resources and incident statistics to event owners and venue operators, facilitate informed decision-making, and help create a safer and more harmonized landscape for sports and outdoor events globally.**

Needs Assessment for Lightning Safety Support



According to the Centers for Disease Control (CDC), **lightning strikes are the most common and dangerous weather threat** encountered by the general population in the United States, **occurring about 40 million times a year.**

National Weather Service (NWS) storm data records **an average of 43 reported lightning fatalities per year** in the United States, using data from the last 30 years (1989–2018).

Lightning poses a considerable risk to outdoor sports and special events such as professional, intercollegiate, amateur, and recreational contests, as well as other entertainment events (e.g., music festivals, parades and fairs, youth league sports).

Lightning can occur within clouds or between clouds and the ground. Lightning that strikes the ground can cause injuries and fatalities. Most outdoor events occur during warmer weather and seasons when lightning activity is more likely, increasing lightning risks to event participants.

The **National Center for Spectator Sports Safety and Security (NCS[4])** conducted a Needs Assessment for 182 sector participants between July and September 2023 to explore sports and special event lightning safety capabilities and vulnerabilities. This online assessment was developed in collaboration with researchers, weather experts, and practitioners and was comprised of a 19-question survey related to demographics, lightning safety planning challenges, detection capabilities, mitigation measures, and communication strategies.

Most survey participants represented professional, intercollegiate, and interscholastic sports, as well as the entertainment sector (e.g., concerts, festivals). Primary specialties involved:

- Venue/event security
- Facility management
- Emergency management
- Law enforcement
- Operations
- Medical services
- Fire/hazmat

The locations of the participants' venues/events were predominantly in central business districts or suburban areas.

Understanding lightning and safety concerns can inform policy development and resource needs and help develop best practices for lightning safety in the sports and entertainment industries.

Key findings from the Needs Assessment include:

- 97 percent of respondents indicated that lightning affects their events, with 80 percent describing the threat of lightning to their event as moderate to high.
- 95 percent of respondents have a lightning safety plan; however, **only 77 percent feel their lightning safety plan covers their event appropriately.**
- Participants' lightning safety plans include weather monitoring, shelter-in-place and evacuation protocols, communication protocols, coordination with police/fire/Emergency Medical Services (EMS), defined roles and responsibilities, and emergency supplies and equipment notice.
- Most respondents gather weather information from open sources such as the National Weather Service (NWS), lightning prediction systems, or an off-site meteorologist.
- Lightning mitigation and response measures include installed lightning rods and designated primary and secondary shelters; however, **25 percent of participants indicated no lightning mitigation measures.**
- Shelter-in-place and evacuation communications to fans/guests primarily occur via public announcements (92 percent), social media (73 percent), video boards (67 percent), and mass mobile communications (52 percent).
- Challenges faced in lightning preparations and mitigation include leadership buy-in, finalizing a realistic plan, disparate or conflicting information about lightning safety (e.g., trigger points for various lightning-strike distances, when to postpone or cancel an event), inadequate shelter space, and ensuring the crowd follows directions.
- **90 percent of respondents believe lightning safety best practices would be helpful to their organization.**

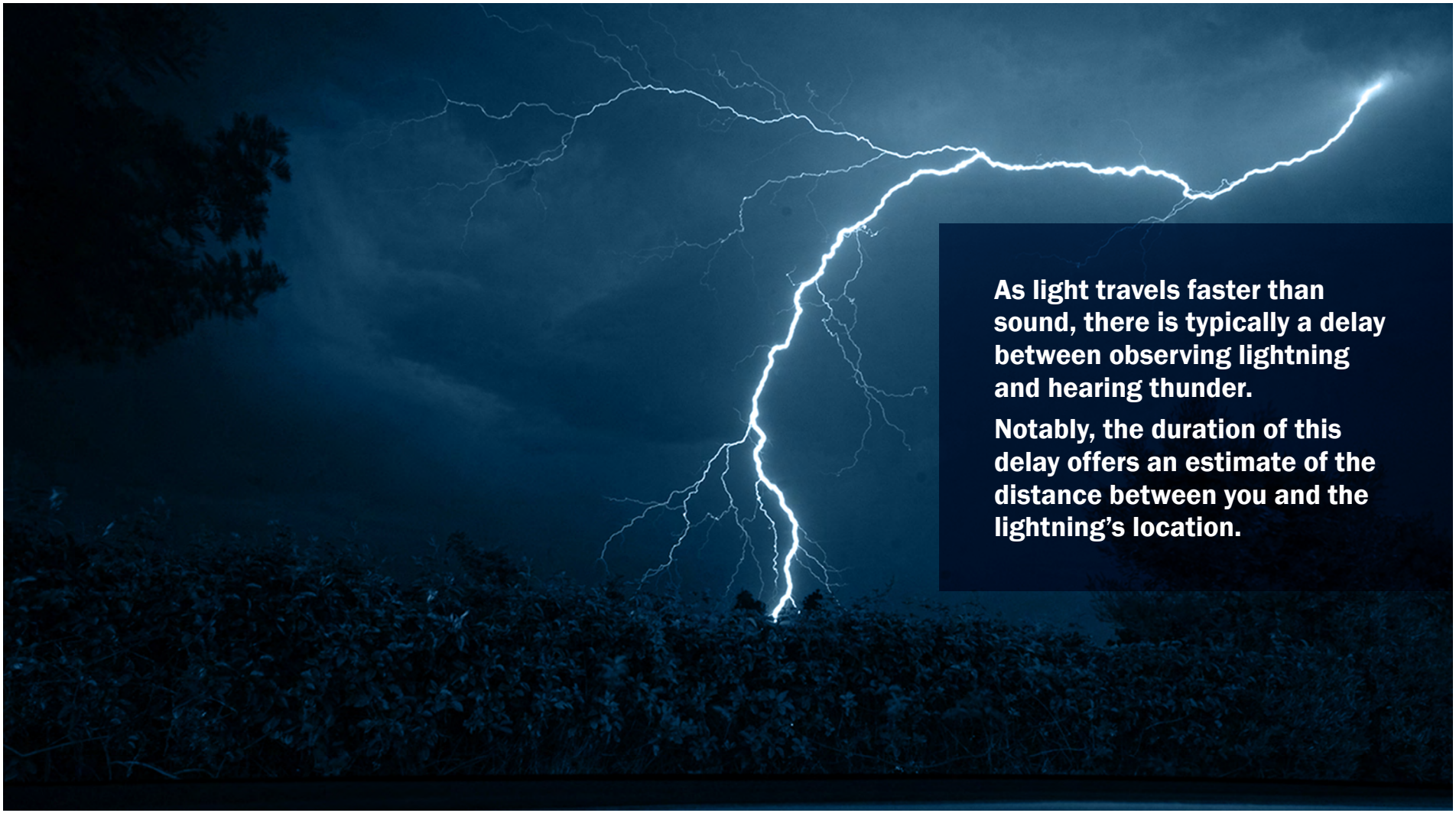
Overall, the Needs Assessment highlighted critical areas of concern and challenges in managing lightning threats at sports and special events.

Safety and security professionals should work in tandem with weather experts to develop best practices to guide industry standards and mitigation measures.

The Needs Assessment highlighted that the industry would benefit from additional resources that address lightning safety topics such as detection vs. prediction, debunking myths, current and future trends of lightning mitigation, evacuation/shelter-in-place procedures, understanding proper grounding for shelter-in-place options, technology support, medical coverage, and liability protection.

These topics are addressed in this *Lightning Safety Guide* to provide foundational knowledge for venue and event owners and operators.

KNOWLEDGE BASE



As light travels faster than sound, there is typically a delay between observing lightning and hearing thunder.

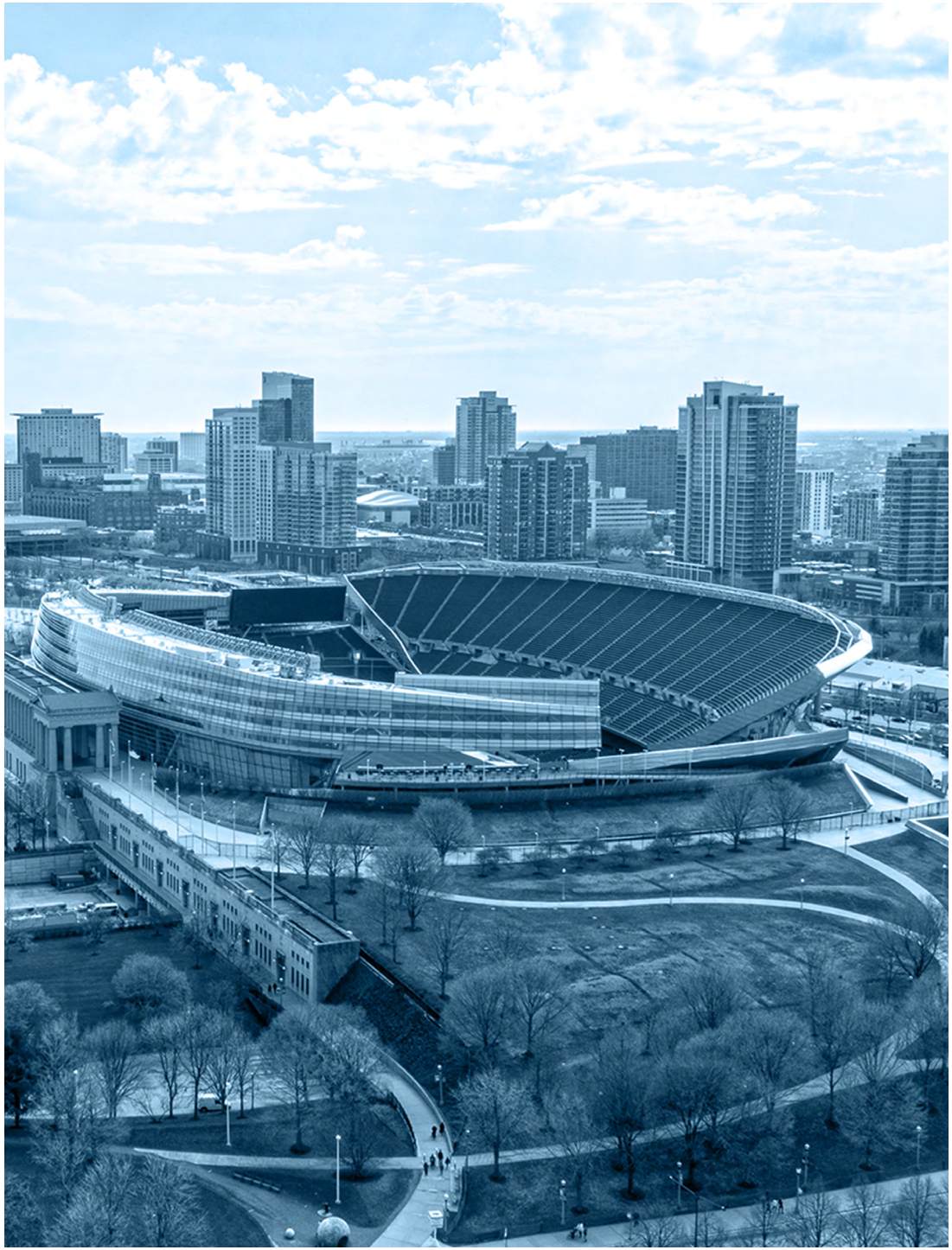
Notably, the duration of this delay offers an estimate of the distance between you and the lightning's location.

Definition and Science of Lightning

Inclement weather events typically occur in response to an imbalance of the properties of our atmosphere. In other words, inclement weather is nature's attempt to restore that balance. For example, a large-scale storm, while disruptive or potentially frightening, plays a vital role in balancing temperature disparities across continental regions through the advancement of warm and cold fronts.

*On a local scale, storms produce **lightning** in order to neutralize an imbalance in the electrical fields that develop inside clouds associated with inclement weather.*

According to the American Meteorological Society (AMS) Glossary of Meteorology, the bright flash of **lightning** that people witness is the discharge of an electric current; the energy produced from this electric current heats the nearby atmosphere so intensely that it rapidly expands and produces a loud shockwave known as **thunder**. Therefore, a "thunderstorm" is any precipitating cloud (even those precipitating snow) with lightning.



While not all thunderstorms produce severe weather (e.g., damaging winds, hail, tornadoes), **all thunderstorms pose a safety risk due to lightning**. The edges of thunderstorms may produce calmer types of precipitation but can still carry the threat of lightning strikes further away from the main storm cell.

Most lightning comes from cumulonimbus clouds, particularly tall clouds in the shape of an anvil, and depending on visual obstacles (such as skylines or topography), can be seen over 100 miles away, while thunder is rarely heard beyond 10 miles due to the atmosphere effectively dampening the sound.

This explains why we sometimes see lightning without hearing thunder. This phenomenon is common when storms are:

Stationary and further than 10 miles away

Long-lived systems approaching your location from a far-away distance

Passing your location beyond 10 miles

Thus, lightning without thunder is further away than lightning with audible thunder, which may or may not affect your location after a period of time. A professional on-site or remote meteorologist may assist with support.

Types of Lightning

Intracloud (IC): the most frequent type of lightning that remains in the air within a cloud. It often resembles a flash and not a bolt or arc.

Cloud-to-cloud (CC): travels from one cloud to another and remains in the air. It may resemble horizontal bolts or arcs.

Cloud-to-air (CA): travels from a cloud and extends through the surrounding air in any direction without making contact with the ground. It may resemble horizontal bolts or arcs.

Cloud-to-ground (CG): travels between a cloud and objects on the ground, often resembling bolts. This occurs when the electrical imbalance in clouds leads to an enhanced charge field imbalance between the cloud and ground.

"A bolt from the blue:" a CG strike that travels horizontally away from the cloud before making contact with the ground. "A bolt from the blue" can strike the ground despite relatively clear or calm conditions above and has been observed up to 20 miles away from thunderstorm systems. **Importantly, this is why a thunderstorm just 8 miles away can still be dangerous and require a lightning safety response.**

KEY TAKEAWAY:

Regardless of type and distance, **all lightning poses a potential threat to safety.** While some forms of lightning may appear safer given the lack of ground contact (e.g., IC, CC), the mere existence of lightning indicates that all types of lightning are possible at any given moment. Unfortunately, we cannot predict the type or precise location of lightning. Given these challenges, **all lightning is considered dangerous**.

FIGURE 1 Types of Lightning

Debunking Lightning Myths

As with many weather phenomena, the societal perception of weather knowledge and behavior is often shaped by various factors, including personal experience, consumption of misinformation, and confirmation bias. Our goals or expectations can then alter these perceptions. Given its frequency, lightning is one weather phenomenon that often lends itself to misguided interpretations and poor decisions surrounding lightning safety plans and response efforts for outdoor events.

Below are some commonly believed lightning myths that have been demonstrated to negatively affect plans and decisions during outdoor events and should be avoided.

HEAT LIGHTNING

Myth: *Heat lightning happens when it is hot outside, does not have thunder and, often, no rain. Therefore, it is safe since it is not related to a thunderstorm.*

TRUTH: No form of lightning is safe. Recall from earlier, we commonly experience lightning without thunder since the atmosphere effectively dampens the sound of thunder beyond nearly 10 miles. Best practices should focus on lightning monitoring to help guide the appropriate next steps.

ONLY CLOUD-TO-GROUND LIGHTNING IS DANGEROUS

Myth: *Intracloud (IC) and cloud-to-cloud (CC) lightning types are safe since they do not make contact with the ground.*

TRUTH: The mere existence of any form of lightning indicates that all types of lightning are possible at any given moment. Therefore, all lightning is considered dangerous.

NO RAIN, NO PROBLEM

Myth: *You are safe from lightning if it is not raining.*

TRUTH: As described with "bolt from the blue," lightning can extend for miles beyond where rain occurs. Precipitation has no bearing on lightning safety.

LIGHTNING DOESN'T STRIKE IN THE SAME SPOT TWICE

Myth: *Lightning never strikes the same location twice. Once lightning strikes, you should be safe.*

TRUTH: Lightning has been observed to make multiple strikes on the same object or at the same location worldwide, sometimes during the same thunderstorm.

LIGHTNING ONLY STRIKES THE TALLEST OBJECTS IN YOUR AREA

Myth: *You are safe from lightning if you are not near tall objects or at least lower than objects around you.*

TRUTH: Lightning has been observed to strike people and objects worldwide at lower heights than other objects in the surrounding area.

LIGHTNING IS ONLY UNSAFE AROUND METAL OBJECTS

Myth: *You are safe from lightning if you aren't touching metal or near metal objects.*

TRUTH: Lightning has been well-documented to strike non-metal objects (e.g., trees, concrete, water, non-metal rooftops, telephone poles, turf field).

VEHICLES ARE NOT A SAFE SHELTER FROM LIGHTNING

Myth: *Vehicles have a lot of metal and are not safe shelter spots for lightning.*

TRUTH: If an indoor shelter is available, you should seek safety indoors first. Otherwise, if you are exposed outdoors and have access to a fully-enclosed metal vehicle, it is recommended to stay inside the vehicle for safety.

While vehicles exposed to thunderstorms are susceptible to lightning strikes, their occupants are usually safe inside. This is not, as is commonly believed, because the the rubber tires on vehicles offer protection from electrical charges, but instead because the electricity usually passes safely around the vehicle's metal frame.

STORMS ALWAYS MISS US, SO I'M NOT WORRIED ABOUT THE LIGHTNING

Myth: *The local feature (e.g., hill, river, cellphone tower, new road) keeps storms from hitting our location or even protects us from storms, so lightning is not a real concern.*

TRUTH: Thunderstorms are a complex process that often shifts movement and behavior in decay and growth. People often mistakenly associate this process to a local feature when, in reality, that same location still receives inclement weather during the year. Remember that lightning can extend for miles beyond where rain is occurring. Precipitation has no bearing on lightning safety.

In summary, the lightning myths described above should be recognized upfront during the planning stages and avoided as safety considerations during real-time decisions. The fundamental science of lightning indicates that lightning, regardless of type, history, and location, occurs during inclement weather, and the presence of lightning should always require monitoring as a safety protocol.

Spatial and Temporal Characteristics of Lightning

Lightning not only poses a risk of disruption to event operations, but it is also particularly hazardous to athletes, coaches, officials, spectators, and event performers, potentially leading to serious injuries or fatalities.

Because lightning is a frequent disrupter and hazard to outdoor events, venue managers and event coordinators should become better acquainted with the fundamental characteristics and environmental influences of lightning to improve awareness of lightning behavior and expectations.

By recognizing lightning patterns and implementing effective safety protocols, organizations can take proactive steps to better protect everyone involved.

Environmental Factors

Thunderstorms that produce lightning typically share a common balance of ***environmental ingredients***:

MOISTURE (in the form of water vapor) is largely provided to the atmosphere from the ocean, especially warmer waters.

Moisture may also be provided by vegetation and larger bodies of water (e.g., the Great Lakes). The amount of moisture in the atmosphere depends on temperature; warmer air has a greater capacity for moisture to exist.

INSTABILITY provides a measure of storm strength.

The combination of warm air and moisture sets the stage for instability.

LIFT is a process that brings warm, moist air near the ground upward into the unstable portion of the atmosphere.

Lift can be caused by fronts, sea breezes, terrain features, and heated ground areas, among others.

Together, the balance of moisture, instability, and lift governs cloud formation, precipitation, and, at times, thunderstorms.

Geography and Topography

Coastlines with warm vs. cool water, land-locked locations downstream of winds that routinely carry moisture, and high vs. low elevations are just a few examples that help explain spatial patterns of lightning occurrence across the United States.

Vaisala's most recent lightning review showcases **Texas and Florida** for the greatest rates of activity:

Texas had more lightning than any other state in 2023 with **42,388,860 lightning events** in total.

Florida experienced the **highest lightning density in the country** with **112.6 events** per square kilometer.

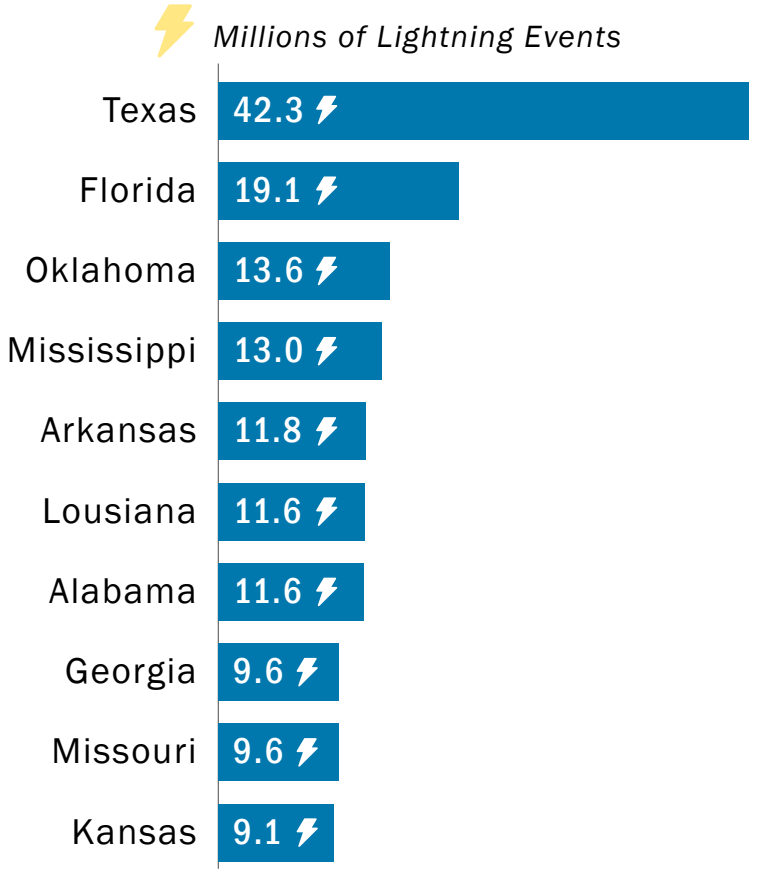


FIGURE 2 Vaisala lightning events in 2023

The spatial pattern of lightning in 2023 (Figure 3) resembles patterns from **flash density averages** in previous years.

For example, **the greatest frequency of lightning occurs along the Gulf Coast states** and generally decreases as the distance from the coast increases. The two exceptions are along the higher terrain in the High Plains east of the Rockies and, due to the monsoon season, the desert southwest.

Another geographical point to highlight is the concept of an urban heat island (UHI). UHIs (e.g., Atlanta, Dallas, Houston, Chicago, Louisville) have been widely researched, and studies have linked UHIs to an increased frequency of thunderstorms and lightning in these locations.

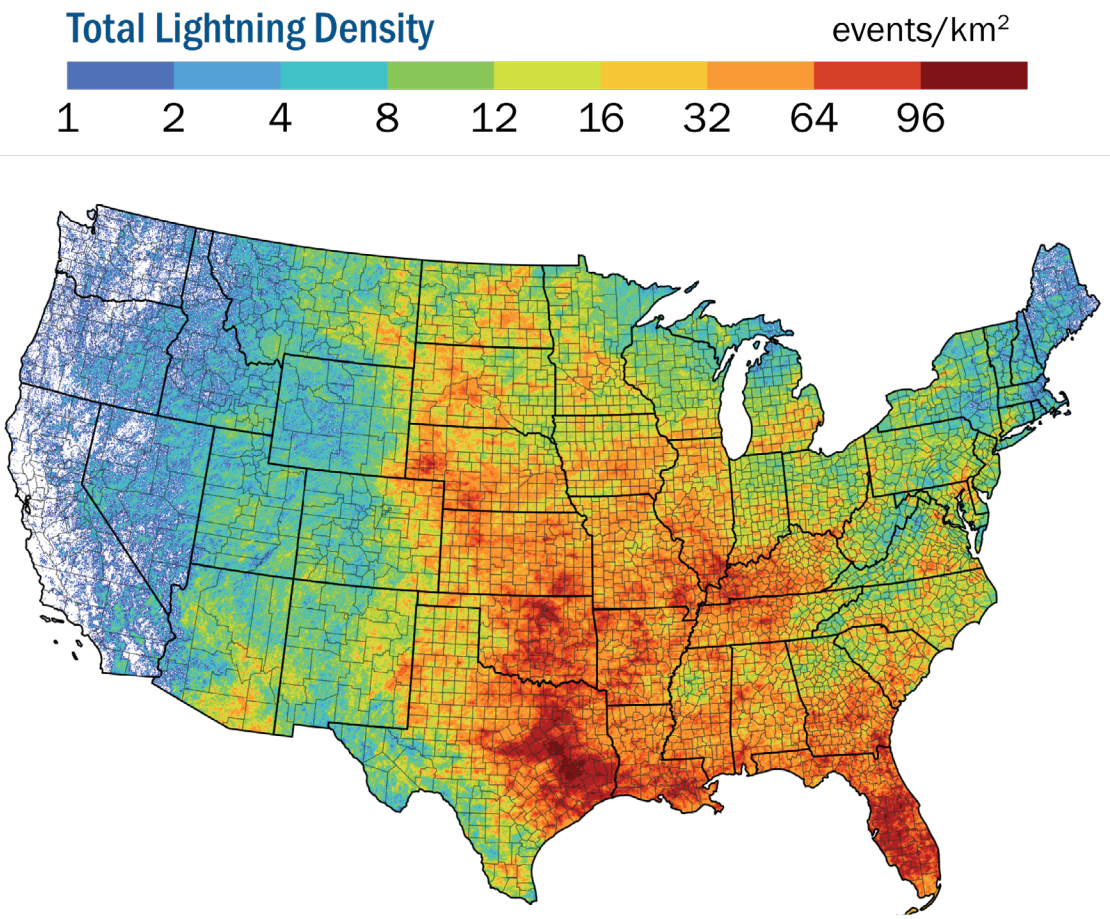


FIGURE 3 Vaisala lightning events per square kilometer in 2023

Probability of Lightning

As warming patterns shift, thunderstorm activity will also shift in seasonality and daytime prevalence. Since lightning is inherently linked to thunderstorm events, we expect these events to occur predominantly during the warmer months of March-September, with **peak lightning activity** during June and July. On daily time scales, peak lightning activity tends to occur during the late afternoon hours before sunset.

Jan	Feb	Mar	Apr	May	June
July	Aug	Sept	Oct	Nov	Dec

A comprehensive tool to visualize the probability of lightning across the United States by the time of day and year is freely accessible from the The National Oceanic and Atmospheric Administration (NOAA) Storm Prediction Center: https://www.spc.noaa.gov/climo/dataviewer/.

Overall, venue managers and event coordinators should investigate this site to develop a relative awareness of lightning risk based on location as a starting point for understanding local lightning risk.

Severe Weather Resilience

Given the basic thunderstorm ingredients described earlier, researchers suggest that a shift toward warmer and more humid conditions may increase the favorability of thunderstorm development. As such, the spatial and temporal distributions of lightning described in Figures 2 and 3 may change toward increased activity in higher latitudes and increased UHI effects, among other locations.

Research does not show these types of changes in all locations, and more work is needed to better understand how lightning activity may change in the future. Venue managers and event coordinators should work with a professional meteorologist to plan for improved resilience against lightning hazards.

DETECTION AND PREDICTION

Lightning Detection

Lightning detection methods are essential for monitoring and understanding lightning activity to improve safety, weather prediction, and scientific research.

Lightning Detection Systems

With modernized technology and mobile communications technology, it is no longer necessary to rely only on observation to determine where lightning is occurring. This technology allows end-users to quickly access where the closest lightning strike is located, where lightning activity is occurring, how it is evolving, and the chances of it occurring at a specific location by a certain time.

There are a variety of lightning detection methods, ranging from ground-based to satellite-based lightning detection networks. While their integrated sensors and methods vary, these lightning detection systems share a **fundamental process.**

FIGURE 4 Lightning Detection Process

Lightning Detection System Considerations

Today, venue managers and event coordinators have sophisticated data-driven resources readily available to help better inform lightning-based decisions for outdoor events. Whether lightning data is provided by venue-specific lightning detection infrastructure or mobile software applications, there is a spectrum of options to receive critical, high-quality, and real-time lightning information and alert notifications at a range of costs.

When considering lightning detection systems, venue managers should carefully assess key features to ensure the system meets alerting, interface, coverage, and integration needs. Venue managers should also consider the need for real-time augmentation with support from a professional meteorologist or weather specialist.

Last Resort: Flash—Bang Method and 30/30 Rule

Before lightning detection or meteorological support was available, many people used a popular approach to estimate the distance of lightning known as the Flash—Bang method. According to this method, you can count the number of seconds between seeing lightning flash and hearing thunder, then divide this number by five to determine how many miles away the lightning is occurring.

For example, as shown in Figure 5, if it takes 15 seconds after seeing lightning flash to hear thunder, the lightning activity is approximately three miles away.

Lightning can travel 10 to 12 miles from a thunderstorm cell. If someone can hear thunder, they are close enough to be struck by lightning.

While not all thunderstorms may be severe, all thunderstorms produce lightning. If the distance from the storm is too significant, it is possible that lightning may not produce audible thunder.

As another last resort, the "30/30" rule can be applied. This rule states that an outdoor event can be resumed 30 minutes after the last observation of 30 seconds or more between a lightning strike and the sound of thunder.

Flash—Bang Method

Because light travels faster than sound, the Flash—Bang method can provide a rough estimate of how far away a lightning strike is.

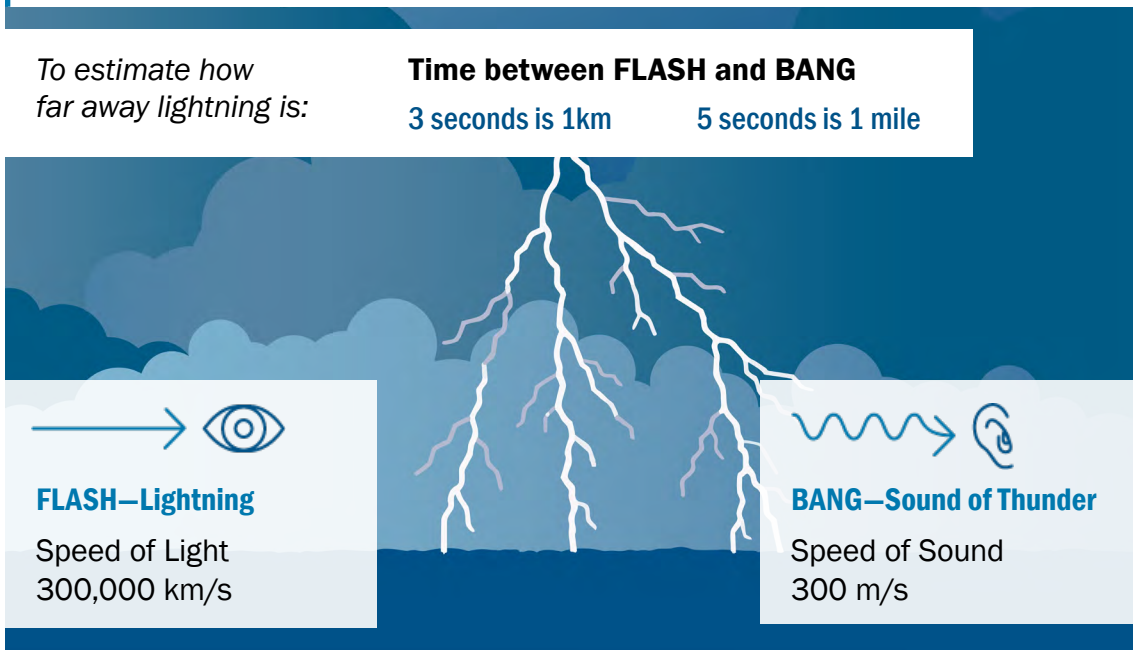


FIGURE 5 Flash—Bang Method

Put more simply, this rule advises waiting 30 minutes after no observed thunder or lightning before resuming activities. If the venue is not consulting with a professional meteorologist, this may be the best course of action. However, given the advancements in atmospheric research and lightning detection methods, the use of the 30/30 rule is no longer the safest or most accurate method.

This method should only be used as a last resort. It can lead to delayed responses, misheard thunder, and miscalculated, forgotten, and recalculated attempts that put people in harm's way.

Lightning Prediction

Unlike lightning detection, which identifies lightning strikes after they occur, lightning prediction aims to estimate the potential for lightning activity before it happens.

Lightning prediction involves forecasting the likelihood of lightning strikes in a specific area based on weather conditions and atmospheric patterns. The capability to predict thunderstorm cell development as the cells are forecast allows for the assumption that lightning will occur in certain areas, though cloud-to-ground lightning can vary.

According to NOAA, ***"it is impossible to forecast individual strikes because lightning is so widespread, frequent, and random."***

While the operational predictability of lightning by type and precise location is currently unattainable, lightning prediction has a few considerations that offer a range of utility.

Examples include, but are not limited to:

Early Warning prediction systems provide early alerts regarding the potential for lightning in the area, which can be used to guide protective measure decisions.

Improved Communication prediction systems provide additional time for sending warnings to staff and attendees using available communication tools (e.g., public address systems, mobile apps, mass notification systems).

Planning prediction systems provide a valuable data point to assist venue managers in making decisions about whether to resume, postpone, reschedule, or relocate events due to the threat of lightning.

Lightning prediction is a complex process that relies on professional meteorologists using advanced data, models, and tools to forecast the likelihood of lightning based on atmospheric conditions. By monitoring **moisture, instability, lift,** and other factors, meteorologists can provide early warnings that help minimize the risks associated with lightning strikes. While predictions have become increasingly accurate with advancements in technology, the unpredictability of individual lightning strikes means that real-time detection and safety measures remain essential.

PREPAREDNESS

Lightning-Safe Structures

Although the best defense is to avoid lightning conditions altogether, that is not always possible. Prior to an event, venue managers should identify safe locations and understand how long it will take to get people to safety.

Figure 6 provides examples of locations to consider and avoid when selecting safe locations.

Venue managers should assign two key players for every event: a designated **Weather Safety Official** and a designated **Authorized Decision-Maker.**

The designated Weather Safety Official is responsible for monitoring weather conditions (including lightning) to provide the Decision-Maker with as much lead time as possible.

The designated Authorized Decision-Maker is responsible for determining when and how the venue's lightning safety plan is initiated, including delays, cancellations, and shelter-in-place or evacuation orders.

Depending on event needs and staffing, these responsibilities may be done by the same person

FIGURE 6 Where to Go and Where NOT to Go During Lightning

Lightning Mitigation

Lightning mitigation refers to the measures taken to reduce the risks and damages associated with lightning strikes. These measures can be applied to structures, outdoor environments, and even to individuals to prevent harm from lightning. The goal of lightning mitigation is to protect life, reduce property damage, and ensure system reliability in areas susceptible to thunderstorms.

Examples of lightning mitigation strategies include, but are not limited to:

Lightning Rods are metal rods installed at the highest point of a building or structure. They serve as the more likely point for lightning to strike and direct the electrical charge safely to the ground via a grounding system. However, they do not provide complete protection from a lightning strike, as lightning can still strike other nearby locations.	A good **Grounding System** is essential for dissipating the electrical energy from a lightning strike to the ground. This can involve a network of rods, plates, or grids buried underground that are connected to the lightning rod via conductors.
Conductors (Down Conductors) are copper or aluminum cables that connect the lightning rod to the ground.	**Electrical UL Surge Protectors** prevent lightning-induced power surges from entering the building's electrical system. This can prevent damage to electrical appliances and systems.
Lightning Arresters are installed at the ends of electrical lines and equipment to provide a path for the electrical discharge during a lightning strike, preventing damage to the system.	**Bonding** connects metal parts of a building, such as pipes, HVAC systems, and antennas, to the lightning protection system to avoid differential voltage that might cause electrical arcs and fires.

Lightning Safety Plans: Scalability and Flexibility

Lightning safety plans are NOT one-size-fits-all.

For example, the lightning safety plan for a recreational swimming facility will differ from a nearby sports stadium despite the likelihood of these venues being affected by the same lightning occurrence.

The lightning safety radius for a venue should be based upon multiple factors

Size of venue

Number and demographic of the patrons

Speed of the inbound lightning risk

Decision time needed for event stoppage

Time needed for egress from the spectator areas

Proximity of suitable available lightning shelters

Completion time needed for evacuation

Ingress into a lightning shelter

The varying scope and scale of outdoor events may also require information and decision-support services to help guide the appropriate lightning safety response.

Venue managers may consider:

- Professional onsite or remote meteorologist
- Grounding solutions with the installation of lightning rods
- Subscription to a lightning data notification service (perhaps multiple for redundancy)
- Onsite lightning detection infrastructure system

Further, venue managers/event coordinators with fixed staffing may consider annual lightning (or general weather) safety training as a force multiplier to enhance lightning forecasts, detection, decision-making, and safety response efforts.

A lightning safety plan should outline ways to allocate various resources based on the forecast or current lightning threat level. These resources may include pre-assembly of staff, increased information dissemination, the opening of shelters, and minute-by-minute monitoring. In addition, the unpredictable nature of lightning demands that safety plans account for the anticipation of lightning within a predetermined safety radius rather than waiting for the lightning to occur within a venue's safety radius.

A lightning safety plan should integrate seamlessly with existing infrastructure and safety systems. This integration ensures that lightning safety measures provide continuity with other safety protocols, eliminating conflicts or disruptions.

Protective Actions

A protective action is a specific measure or set of measures to safeguard individuals from harm during an emergency or hazardous situation. Protective actions aim to minimize the risk of injury or damage and ensure the safety and well-being of people affected by the emergency.

These actions are often part of a broader emergency management plan and can vary depending on the type of threat or hazard. Specific examples of protective actions often employed for lightning safety include:

EVACUATION: Removing people from a dangerous area to a safer location. This is typically used in situations where remaining in place is hazardous.

SHELTER-IN-PLACE: Staying indoors and securing oneself in a safe location to avoid outside threats.

RELOCATION: Moving people to a different location temporarily or permanently due to prolonged threats or damage to the current site. This could be used if a facility is no longer safe or operational.

Each strategy requires careful planning and clear communication to ensure the safety and well-being of all participants and staff involved in events.

Emergency Plans and Procedures

A basic premise of emergency preparedness is scalability, and the types of plans or procedures can vary based on the size and capacity of the venue. Smaller venues and events may only require procedures outlining steps to take in response to the threat of lightning, while larger venues will likely require a multi-faceted strategy.

However, regardless of complexity, lightning safety plans should incorporate key decision points, often referred to as trigger points, and designate a Weather Safety Official with knowledge of the decision trigger points. These decision points should be supported by detailed procedures to be implemented in response to the threat of lightning, including clearly identifying the Authorized Decision-Maker who will determine necessary actions to be taken.

Lightning Safety Decision Points

Distances can vary depending on the venue type, NOAA recommends utilizing 15/12/8-mile radii to determine lightning trigger points if lightning is witnessed, detected, or anticipated. However, distances can vary depending on the venue type and the time needed for an evacuation to move patrons to safety. Eight miles was determined as a minimum because while most lightning occurs within an 8-mile radius of a thunderstorm, 20 percent of strikes occur beyond the 8-mile radius, and bolts from the blue are also possible.

The radii are recommended based on best practices. NOAA's *Lightning Safety Toolkit for Outdoor Venues* allows for the flexibility of each individual venue. Thus, the radii can be changed to fit a specific venue's needs.

Resuming an Event

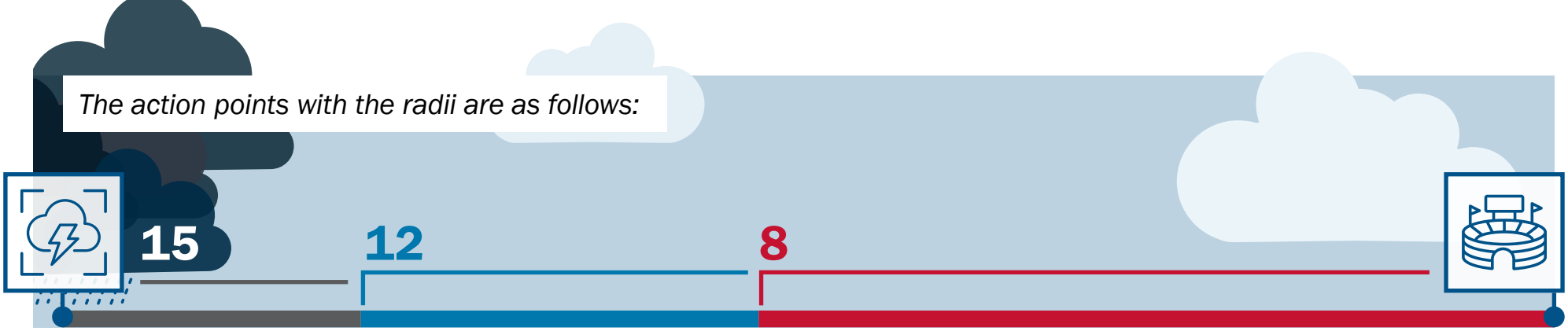
In addition to determining trigger points associated with the response to a threat of lightning, venue managers also identify when and how an event will be resumed or canceled. NOAA recommends the following criteria for resuming an event.

If the venue is consulting with a professional meteorologist who is using real-time cloud-to-cloud and cloud-to-ground lightning data, **the event may resume if ALL the following conditions are met:**

- Lightning has moved beyond 8 miles of the venue.
- The storm motion is taking the lightning activity away from the venue.
- The threat of new lightning strikes within 8 miles of the venue has ended.

If the venue **does not consult** with a professional meteorologist who is using real-time lightning data, **the venue will wait 30 minutes after no thunder or lightning is observed before resuming activities.**

The action points with the radii are as follows:



When Lightning is Detected...

Within 15 miles of the venue:

- Venue management is notified of increased lightning risk. Management notifies the event officials.
- Venue management notifies all event staff of the potential for a delay. Event staff, deployed to areas throughout the venue, will direct the crowd to safe structures.
- An evacuation of the facility may begin if it appears the thunderstorm is moving toward the venue.
- If an organized thunderstorm system is headed for the venue, a 30-minute lead time or more should be considered for an evacuation. Organized thunderstorms are major event-affecting storms with high lightning counts where an advanced delay or postponement of the event is justified. In these cases, the professional meteorologist should estimate the speed and direction of the storm movement to determine when it will enter an 8-mile radius of the venue.

Within 12 miles of the venue:

- Venue management is notified of the impending lightning threat. Management notifies the event officials.
- Venue management informs all event staff of an impending delay. Event staff are stationed to direct the crowd to safe structures.
- If there is high confidence that lightning will move within the designated minimum radius, evacuations of the facility may begin early at this distance if not already initiated.
- An evacuation is necessary if a more organized thunderstorm system is headed for the venue.

When 8 miles or less from the venue:

- An event delay is implemented when the weather watcher notifies venue management of a nearby lightning threat and, if applicable, the facility warning signal is activated.
- Management notifies the event officials and event officials suspend activities.
- Venue management informs all event staff that the event has been suspended due to lightning in the area. Event staff, deployed to areas throughout the venue, will direct the crowd to safe structures.
- An evacuation of the venue begins.
- All patrons are directed to the nearest lightning-safe structure (see designated shelters).
- All event participants, performers, and officials will be evacuated to pre-designated safe structures.

FIGURE 7 When Lightning is Detected...

Lightning Safety Plan Contents

According to the Event Safety Alliance, the most important factor to consider when making a tailored lightning safety plan is not whether an event can be defined as small or large, but the proportionate level and extent of facilities and safety management systems required to ensure the health, safety, and welfare of patrons, performers, and event staff.

Small and large events will have varying plan requirements, depending on their need and staffing; however, regardless of event size, a comprehensive lightning safety program should, at a minimum, include the following components:

Risk assessment: Conduct a risk assessment to identify areas prone to lightning.

Protective action planning: Identify safe areas and protective actions to be implemented in response to the threat of lightning.

Designate a Weather Safety Official: Identify and clearly designate a Weather Safety Official to monitor and report weather conditions (including lightning) to the designated Decision-Maker.

Designate an Authorized Decision-Maker: Identify and clearly designate an Authorized Decision-Maker to use information from the Weather Safety Official to determine when and how the lightning safety plan is initiated.

Weather monitoring: Pre-identify lightning detection sources and the process of notifying decision-makers when lightning is detected.

Communication planning: Develop a plan for rapidly alerting attendees to danger (e.g., use of loudspeakers, text alerts), supported by pre-scripted, concise instructions on how attendees should respond.

Event cancellation or resumption: Identify procedures for canceling or resuming the event.

Staff training: Designate specific roles and train staff responsible for executing plans.

Education: Provide venue and event occupants with lightning safety precautions and procedures.

Lightning Safety Operations Plan Considerations for **SMALL EVENTS**

This page outlines key lightning safety planning components for small events, such as youth sports events. It is designed as a tear-away checklist for staff to have accessible before, during, and after lightning incidents.

MONITOR

Designate a Weather Safety Official that will be responsible for monitoring and reporting potential lightning that may affect the event.

If not directly monitoring potential lightning threats, this individual should be receiving information regarding potential lightning that may impact the event and drive decision-making. Small events may have an individual that is responsible for monitoring potential lightning via a weather app.

NOTIFY

Once the designated Weather Safety official becomes aware of potential lightning that may impact their invent, they should notify the necessary people.

- Notify others (team managers, parents or those in positions of authority for the participants) of the potential of lightning.
- Where necessary, notify local authorities such as fire emergency, law enforcement, or medical emergency of the potential of lightning to the event.
- Make sure event officials are aware of the predetermined lightning distance (number of miles) from the event that will cause an evacuation or a shelter-in-place.

INITIATE

The designated Weather Safety Official should continue to monitor the lightning direction and speed so that once the lightning reaches the predetermined miles away from the event, the designated Authorized Decision-Maker can initiate a signal (bullhorns, whistle, etc.) to commence the evacuation or shelter-in-place.

Depending on event and staffing needs, the designated Weather Safety Official and the Authorized Decision-Maker and the Weather Safety Official may be the same person.

- Once the lightning safety plan is initiated, the designated Weather Safety Official should continue to monitor the lightning's path and speed and alert others (team managers, parents or those in positions of authority for the participants) of any pertinent information.
- The designated Weather Safety Official should be the individual that notifies emergency services if there is an injury or medical condition that occurs during the lightning situation. However, this does not preclude any individual from calling 9-1-1 if necessary.

RECOVER

The Authorized Decision-Maker, in coordination with the Weather Safety Official, issues an all clear once the lightning danger is a safe distance beyond the event location and the incident is deemed over.

IMPORTANT: ***It is highly recommended that the Weather Safety Official take note of all actions taken during a lightning safety situation, including an accurate timeline and any injuries or medical issues that occurred.***

Lightning Safety Operations Plan Considerations for **LARGE EVENTS**

This page outlines key lightning safety planning components for large events, such as a football game, festival, or concert. It is designed as a tear-away checklist for staff to have accessible before, during, and after lightning incidents.

MONITOR

Designate a professional meteorologist or Weather Safety Official that will be responsible for monitoring potential lightning that may affect the event.

If not directly monitoring potential lightning threats, this individual should be receiving information regarding potential lightning that may impact the event and drive decision-making.

NOTIFY

Once the professional meteorologist or Weather Safety Official becomes aware of potential lightning that may impact their event, they should:

- Notify the Joint Operations Center (JOC) within the organization/entity.
- The JOC should notify designated security personnel and other predetermined individuals within the listed Incident Command structure, **including the designated Authorized Decision-Maker.**

INITIATE

The Authorized Decision-Maker, in coordination with Incident Command and the Weather Safety Official, should continue monitoring and assessing lightning, to include path, speed, and other determining factors that will impact the event.

Depending on event and staffing needs, the Incident Commander and the Authorized Decision-Maker may be the same person or the Authorized Decision-Maker and the Weather Safety Official may be the same person.

- Incident Command ensures 9-1-1/ Emergency Services are alerted of the impacting lightning event as well as actions being taken by the organization/entity.
- Incident Command assembles the Emergency Response Team (ERT) or designated security personnel to implement or prepare to implement safety procedures, including public address messaging, shelter-in-place directives, and dispatching security/ event services staff to assist in guests/ visitors to safe locations.
- Evacuations to "safe locations" could involve moving guests/visitors off property, so it is important to have coordination with traffic control entities supporting the event.
- Incident Command should monitor all actions being undertaken by ERT or designated security personnel to ensure all planning is happening as directed and is being notified of any medical emergencies or individuals requiring medical attention during this operational phase.
- Incident Command will coordinate any medical response where necessary to assist staff and guests/visitors.

RECOVER

The Authorized Decision-Maker, in coordination with Incident Command and the Weather Safety Official, issues an all clear once the lightning danger is a safe distance beyond the event location and the incident is deemed over.

- The Incident Commander should ensure post-event tasks are addressed, to include, debriefing of designated security personnel, preparation and review of any incident reports, and reporting of any structural issues that may present a safety hazard for continued operations.
- The Incident Commander should conduct a post-event review and prepare and After-Action Report.

GOVERNMENT SUPPORT FOR LIGHTNING SAFETY

National Weather Service

The **National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS)** continues to recognize the serious threat of lightning to outdoor venues across the United States. It is committed to raising lightning safety awareness. In doing so, the NWS implemented lightning safety toolkits and a voluntary recognition program to help larger outdoor venues and university campuses better protect staff and patrons from the dangers of lightning. The NWS also has lightning safety toolkits for golf facilities, wilderness areas, communities, lifeguards, and boaters.

The NWS shares the common goal of helping reduce the risk of lightning-related threats through improved preparedness by facility and event staff and emergency managers. Venue managers are encouraged to utilize the lightning safety toolkit to help develop lightning safety plans. The NWS will designate those who complete a plan as a NOAA-recognized lightning safety site.

To complete a plan, visit:
https://www.weather.gov/safety/lightning-toolkits.

The NWS recommends venues follow the guidelines below to protect staff and patrons from the dangers of lightning.

Information Reception: The venue should install a locally run lightning detection system with a display unit on-site and/or subscribe to a commercial service, both of which provide a lightning notification system. The facility should also have continuous access to information about NWS warnings during public events.

Decision-Support Standards: The venue should have a written lightning safety plan that includes written instructions on contacting local emergency management and a weather information provider (e.g., a provider from America's Weather Industry or NWS).

Public Notification Plan: The venue should have several means to notify its patrons of a lightning threat. Options include outdoor warning sirens, a public address system, internal television/radio broadcasts, text/email alerts, social media, and staff announcements.

Protection Program: The venue should have means to shelter patrons. A protection program should include providing direction to substantial lightning-safe structures or access to vehicles, a written emergency operations safety plan to evacuate the venue, and signs indicating shelter locations. The venue should investigate lightning protection equipment that intercepts lightning and diverts the electrical discharge away from patrons and staff.

Education: The NWS can provide lightning safety education materials. The venue should inform patrons of the lightning precautions in place and the appropriate actions when notified of a lightning threat.

National Lightning Safety Council

The **National Lightning Safety Council (NLSC)** is a working group that promotes lightning safety through data, statistics, education, and awareness. The council consists of members from academia, government, private sector, and the military who share the common goal to promote lightning safety and work to save lives, prevent injuries, and protect property.

For more information on lightning safety from the NLSC, visit their webpage at: http://lightningsafetycouncil.org/.

Concluding Remarks

While improvements in lightning safety are well-documented, until injury and death statistics from lightning reach zero, lightning safety for outdoor events will remain a priority. Challenges remain: keeping pace with emerging modern methods and technologies surrounding lightning monitoring, prediction, and mitigation strategies; modernizing actions and trigger points as events evolve in scope and size; and dispelling myths and other misunderstandings of lightning behavior.

The purpose of this *Lightning Safety Guide* is to centralize the information on lightning in a manner that guides venue managers and event coordinators with a credible, robust, and scalable best practices framework to consider lightning safety.

APPENDIX

Contributors

Catherine Abramson
CISA, Commercial Facilities Section Chief

Josh Durkee
Professor and University Meteorologist, Western Kentucky University

Michael England
Sr. Manager Emergency Management and Security, Walt Disney World Parks and Resorts

Greg Hale
Vice President and Chief Safety Officer, Walt Disney Parks and Resorts

Stacey Hall
Executive Director and Professor of Sport Management, National Center for Spectator Sports Safety and Security (NCS^4)

Ed Klima
Certified Emergency Manager, Event 2

Kevin Kloesel
Event Safety Meteorologist, Baylor University Department of Athletics and Drum Corps International, Inc., Board Member, Event Safety Alliance

Kim Migas
Senior Director, Security and Safety, Augusta National Golf Club

Jeannette Neyses
Founder and CEO, The Baghera Group

Donald Paisant
Vice President, Security & Guest Services, Texas Rangers Baseball Club

Michael Rodriguez
Formerly Senior Director, USTA & US Open Security

Michael Stewart
CISA, Commercial Facilities Sector

Daniel Ward
Former Director, Training & Exercise, National Center for Spectator Sports Safety and Security (NCS4)

Charlie Woodrum
Meteorologist, NOAA's National Weather Service, National Lightning Safety Council