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How Lightning Safety Practices Differ in Wind Energy, Sports and Construction Applications

Don Leick, Director of Product Management, Telvent DTN

Introduction

Lightning safety concerns and practices can differ considerably in different applications. The response to the same thunderstorm by a wind farm, a construction company, and a baseball team can be quite different. This paper will compare and contrast real-world concerns and practices of wind farms, collegiate athletics, and the construction industry. This includes differing lightning notification times, considerations for resuming activity, and risk profiles. It will also include discussion of special factors such as the pressure to resume activity when fans are present. Some possible reasons for differences are provided, along with some recommendations to improve the adoption of safety practices and tools in commercial applications, and reduce the risk of death or severe injury from lightning.

Telvent DTN has years of experience providing lightning safety tools to most of the leading wind farm operators and turbine manufacturers in the US, several hundred American colleges and universities, and is the leading provider of specialized weather services for construction in the US. This experience will provide the basis for discussing actual issues and practices in these safety applications.

Lightning Notification Procedure

This paper assumes the availability of best-practice tools: an effective national lightning detection network and the ability to communicate that lightning danger directly to the affected people. This communication can occur via a text message, which can also trigger an audible alarm on the phone.

This paper further assumes a best practice procedure as follows:

1. An "Advisory" notification when lightning is in the area but not close enough to require evacuation. This enables the affected parties to begin necessary preparations, be aware of the need to diligently watch for a warning, or avoid starting activities that may increase risk.
2. A "Warning" notification when suspension of activities must occur and a safe location must be sought.
3. An "All-clear" notification when there has been no lightning within the area for a prescribed period of time.

The distance that one sets for the advisory and warning notifications varies based primarily on how long it takes to evacuate, that is, how long it takes to suspend activities and reach safety.

Overview of the Different Applications

Three different common lightning applications have been selected to illustrate how different lightning safety practices can be-- even when using the same lightning safety tools. Following is a brief description of each to help understand the risk with each application. Then the applications will be compared and contrasted.

The three applications discussed are:

1. Wind farms: This primarily involves maintenance workers up in the turbine. The height of the wind turbine increases lightning strike risk. The long time it takes to get down from the tower also increases risk, and increases the needed evacuation time.
2. Construction: Of special concern are cranes and cement boom trucks, but the risk applies to any construction worker, especially those at heights, such as roofers.
3. Collegiate athletics: This involves any outdoor sports, both for the safety of participants and fans: baseball, track & field, football, and so on.

Each of these safety applications will be discussed further, as follows.

Wind farm safety

Wind farms are booming worldwide. With that is a booming need to keep maintenance workers safe. Wind turbines are notoriously "high-maintenance", and on any given day a maintenance crew will typically be up in the turbine (the nacelle or turbine housing) at the top, or hub, of a tower. The turbine is typically 80 meters (over 250 feet) above ground. This poses a special lightning risk in two ways:

1) The towers are also essentially large lighting rods. There is even some suspicion that turbines are even more prone to lightning strikes than other structures of similar height.
2) The evacuation time the towers represents is also significant. The turbine is reached by steep winding stairs inside the tower. When a worker needs to evacuate, typically it can take up to 20 minutes to get down, with equipment & safety harnesses involved, and into the safety of their truck.

Further some operations want employees out of the wind farm entirely due to possible danger of turbine blades exploding when struck by lightning. So the lead time required here is significant. There is also the factor that it is inefficient and tiring to start and stop and work when you have to climb such a tower. So turbine

maintenance workers really want to avoid having to suspend work – but at the same time are acutely sensitive to the lightning danger and will suspend work immediately if needed.

Here are typical wind farm lightning alert procedures[1]:

Notification range: 50 miles. Workers will go up in the turbines (will not start work) when lightning is within 50 miles of the wind farm.

Warning (evacuation) range: 30 miles. Stop work in turbines and come down.

All clear range and time: 50 miles and 15 minutes. Work in turbines can resume when there has been no lightning within this time distance for 15 minutes.

The lightning safety risk at wind farms is widely known. The use of lightning safety measures is widespread. We believe most US wind farm maintenance organizations have lightning safety tools and similar practices as described here.

Construction safety

Especially as we look ahead to spring and summer, lightning can be a serious risk for exposed construction crews. Work is often occurring in open areas, such road construction and excavation. Roofing and high rise construction crews are also at increased risk due to heights. Operators of tall equipment, such as cranes and cement pumps, are at additional risk. This equipment often has an open cab leaving the operator exposed and vulnerable to lightning.

The National Lightning Safety Institute recommends that construction workers be aware of the threat when lightning is 20-40 miles from the site, and suspend activities and evacuate when lightning is within 10 miles[2].

However, from our experience there are relatively few risk management guidelines. Most construction companies do not have standard lightning safety policies. However, typically the larger the organization, the greater the awareness and the greater the likelihood that the organization has standard safety practices and tools.

Collegiate Athletics

Clearly outdoor athletics pose a greater risk for lightning. You have open athletic venues with light poles, flagpoles, metal fences and little or no shelter. Baseball dugouts don't provide lightning protection for players as they are not fully enclosed. Open, metal bleachers are contributing factors to the lightning risk for fans.

For lightning evacuation, the NCAA uses a standard warning of an 8 mile radius for all Outdoor Spring/Fall Regional and Championship events (such as baseball or track & field tournaments). Since the time it takes to get to safety – into a bus, car, or inside a

stadium - the 8 mile radius is generally a good distance. Golf events or large spectator crowds may require a longer evacuation time which would mandate a larger warning radius.

A 30-minute all-clear time is the standard operating procedure (play can resume when there has been no lightning within 8 miles for 30 minutes).

The adoption of lightning safety procedures and best practices in collegiate athletics is a priority and top concern for administration.

Compare and Contrast

Here is a compare and contrast view of the risk and practices in the different applications:

Application	**Lightning risk**	**Safety Tool Adoption**	**Advisory range**	**Warning (evacuation) range**	**All clear range & time**
Wind farms	Very high	Very high	50-60 miles	30 miles	50 miles, 15 minutes
Construction	High	Low	Varies	Varies	Varies
Collegiate Athletics	High	Moderate to High	Varies. 15 miles is common	8 miles	8 miles, 30 minutes

Here are a few observations on the practices.

Evacuation time should drive the warning range, and it does. For example, wind farms have a long evacuation time (up to 20 minutes) and thus a long warning range. Another factor is the size of some wind farms, which can be up to 25 miles. Athletics often have a short evacuation time, though not always, and thus have a much shorter warning range. One rule of thumb for warning range is to start with 6 miles and add a mile for each 2 minutes of evacuation time needed (thus never less than 7 miles). This rule of thumb starts with the fact that the National Weather Service recommends you already be to safety when lightning is within 6 miles. And secondly, the average thunderstorm travels at about 25 miles per hour (almost a half mile per minute).

When the all clear range is larger the all clear time can be shorter.

Why does one see such a large variation in the adoption of lightning safety tools, if the above is an accurate assessment? Following is some speculation on the reasons for the some of the differences in adoption of best tools and practices.

The lightning danger in wind farms is obvious. Even the wind turbines themselves are carefully designed to mitigate damage from lightning. So the personnel risk and the need to reduce that risk seems to be widely understood. Also, often the organizations that have personnel at wind farms are large, sophisticated companies. They recognize the need to watch out for their employees well being and they understand the potential litigation costs if their employees are killed or injured by lightning.

While not as great a risk as wind farms, Construction companies still have significant risk, but generally seem to have little concern about lightning safety. Wind farms and construction companies are both commercial entities -- why the great difference? Our speculation is that it is primarily an awareness issue. Construction companies appear to have less awareness of the risk and lower acceptance of the tools available to mitigate risk.

Collegiate athletics have historically had good awareness of lightning danger. The NCAA has communicated the risk well[3]. The long held and widely known threat of lightning on golf courses may also help. Also, athletic trainers play a key role. Here you have trained professionals on site at the events whose primary job is the health and welfare of the athletes. NATA, the National Athletic Trainer Association, has done a good job of promoting lightning safety practices with athletics trainers[4]. What has been sometimes lacking is the corresponding awareness of what to do about the lightning risk. The 30/30 flash bang method, has severe limitations. Frequently you will not be able to hear lightning when it is closer than 8 miles (depending on wind direction and terrain). And one can make mistakes when correlating the thunder to the right flash. So the availability of lightning safety tools and practices can improve safety.

One of the benefits of a lighting safety tool is having a non-subjective standard for making suspend/resume decisions. There can be great pressure from coaches, officials or fans to not suspend play. Similarly there can be pressure to resume play prematurely. Having a standard practice and an objective means to make those decisions can be invaluable. This helps take some of the personnel pressure off the trainer, and may be a factor in adoption too.

Overall Conclusions and Recommendations

Here are some general conclusions that perhaps can be drawn:

1. The *awareness* of risk is important in whether lightning safety tools are adopted.
2. The awareness of *tools* is also important. If the risk is known, but its' believed little can be done about that risk, you will see low adoption.

3. Having a *safety professional* involved helps adoption greatly.

No tool or practice can provide 100% lightning safety, but here are some recommendations to improve lightning safety in the applications discussed in this paper, and in commercial lightning safety applications in general:

For lightning safety organizations:

1. Promote the effectiveness of lightning detection networks and alerting tools. Often merely the flash/bang (count) method is cited to determine how near lightning is and to gage the risk. Safety organization recommendations today are lagging the technology and best practices for lightning safety.
2. Provide standard specific recommendations for advisory ranges, warning ranges and all clear times for different safety applications. Construction companies or universities should not have to determine these themselves. These recommendations should be based on sound scientific research, such as the typical speed of thunderstorms and the unpredictability of the specific location of lightning strokes from a cell. While some applications, such as wind farms and collegiate athletics, have usually developed good approximate guidelines, more standardized guidelines would help speed adoption of lightning safety tools, and help ensure they are being properly used.

For end-user organizations:

3. Take advantage of modern lightning safety tools, and have a standard for employees for advisory ranges, warning ranges and all clear times that is appropriate for the application. Make it known *in advance* that the standard will be adhered to if lightning occurs, so there is no debate later when prompt action needs to be taken.

REFERENCES

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[3]*2008-2009 NCAA Sports Medicine Handbook*, "Guideline 1d Lightning Safety", pages 13-15

[4]*National Athletic Trainers' Association Position Statement: Lightning Safety for Athletics and Recreation,* http://www.nata.org/statements/position/lightning.pdf *Journal of Athletic Training* 2000;35(4):471–477