Why Protecting Wind Turbines from Lightning is Critical

I. Lightning Vs. Wind Turbines

Exactly when and where lightning will strike is an unpredictable act of nature. If scientists could calculate the exact location of future lightning, the United States would be able to avoid the $2 billion in annual property damage due to this awesome yet terrifying natural phenomenon. However, the fact that lightning usually strikes the highest point is indisputable. Height, shape and isolation are all leading factors in determining the place where lightning will choose to strike. One of the worst possible courses of action during a storm is to stand under a tree; in fact, this is the number one leading cause of death or injury from lightning strikes. Wind turbines act in a similar manner, as they are the tallest point and sustain a high probability of being struck by lightning. Therefore, it is often not a matter of “if” but “when” a wind turbine will be struck by lightning or experiences other types of overvoltages and currents.

With the US presently ranking as the world leader in both wind energy generation and new wind energy capacity installation, it is now more important than ever to mitigate the chance of lightning strikes to wind farms. A properly installed lightning protection system will dramatically improve both the cost-effectiveness and reliability of a wind turbine. Without the system a lightning strike on an unprotected blade can lead to temperature increases up to 54,000 degrees Fahrenheit and result in an explosive development of air within the blade. According to the updated National Fire Protection Association handbook, “While physical blade damage is the most expensive and disruptive damage caused by lightning, by far the most common is damage to the control system.” Wind turbines
have a concentrated amount of very expensive technology installed in a relatively small space and the presence of many different voltages in a wind turbine installation, which can easily lead to overvoltages and surges within the system.

II. **Recent Case Studies**

Wyoming Rancher Ralph Brokaw, who owns both cattle & wind turbines, describes what he has witnessed in the past when lightning hits a wind turbine: “It will explode those blades, and they’ll throw chunks of blade several hundred feet!” he exclaims. “There’s oil and gearboxes and a tremendous amount of wiring (in the generator) so even though the turbines are very well-grounded they can sometimes light up” (New York Times December 2008). He, along with many other wind farm owners, has experienced the costly and dangerous complications that can accompany an unprotected wind turbine. The following are recent examples of wind farm damage in the United States:

- At a southwestern USA Wind Farm lightning damage exceeded $50,000 in the first year of operation. Damage occurred to blades, generator, controller, control cables, SCADA, etc.
- 85% of downtime experienced by a 2nd southwestern USA commercial wind farm was lightning-related during the startup period and into its first full year of operation. Direct equipment costs were some $55,000, with total lightning related costs totaling more than $250,000.

III. **Potential Problems**

Possible paths of lightning current to the wind turbine generator are as follows:

- Strike to Tower
- Strike to Nacelle
- Strike to Blade
- Strike to Power Line
- Strike to Transmission Line
A strike to a tower or nacelle can induce voltages and current in the power cables and generator windings. A strike on a blade could lead currents to the generator through the blade and downstream equipment. Surges from lightning and switching on the power lines may also damage the generator. A properly installed lightning protection system intercepts the lightning bolt between the cloud and ground and effectively and safely conducts it to the earth without risking the complete physical destruction of the wind turbine or the likelihood of it catching on fire. A low-resistance, low-impedance grounding system is important for wind farms in that it links all turbines together forming a common ground grid.

Even without the possibility of being struck by lightning, wind turbines contain sensitive electronic equipment: they are motor-driven technologies using internal gear boxes or direct drives, as well as sensors to monitor wind directions. The internal switching and inductive loads within these applications make wind turbines particularly susceptible to power disruptions. Properly installed Surge Protection Devices (SPDs) act as an envelope and control power eliminating electronic confusion which is the leading cause of system downtime. Protecting wind energy systems from lightning damage and power quality issues is essential in maintaining the dependability and overall cost-efficiency of these highly sensitive power-driven systems.

IV. **Systematic Solutions**

The time to review possible lightning effects upon wind turbines is during the site selection and design stages. However, it is often overlooked until later (when problems arise) and then requires a specialized lightning safety engineer to analyze the effects of lightning during operations and provide a rationale for “safety-through-redesign” modifications to the wind farm facilities. Overall, the cost of creating a stable lightning mitigation system for wind turbines is merely 0.50%-0.75% of the total capital costs. Please see the Alltec Website for more information on lightning protection for wind farms [http://www.allteccorp.com](http://www.allteccorp.com). Additionally, the following graph illustrates
locations where properly surge protection devices are required to safeguard all aspects of the wind turbine, from base to nacelle.

The Department of Energy’s “20% Wind Energy by 2030” report examined the realistic achievability of using wind energy to generate 20% of the nation’s demand for electricity by 2030. With wind turbine projects accounting for nearly 42% of all new energy generation in the United States, it is becoming more probable that the United States will make that goal a reality. For this reason, it is now more important than ever to carefully consider lightning protection, grounding, and surge suppression technologies companies. Alltec Corporation has the knowledge, experience, reputation, and superior quality products to provide the optimal solution for your wind farm’s power quality, grounding, and lightning protection needs.
Since 1991 Alltec has focused continuously on innovating new technologies, improving product quality, and enhancing customer service. As an ISO 9001: 2008 certified company, quality products and services are Alltec’s chief priority and focus. Known as “Solution Providers for an Energized World™” Alltec offers a complete facility protection approach to the world’s most difficult grounding, power quality, and lightning protection needs. Please visit the website: www.allteccorp.com to learn more about Alltec’s extensive line of product and services for wind turbines, or email pr@allteccorp.com.