Multi-layer Protective Covering for Lightning Strikes

Multi - layer protective coverings proven to withstand consecutive lightning strikes and allows underlying surfaces to remain undamaged

Lightning strikes are a leading destructive force for the wind turbine industry, and are the root cause of damage to not only blade structures, but inflict damage to control systems and electrical components as well. The average costs to repair or replace a gearbox component or a damaged turbine blade are $380,000 and $240,000, respectively.

While existing lightning protection systems are currently in use, they are unable to safely and effectively transfer the lightning current, and the subsequent deactivation is required until the damaged components are repaired or replaced. Wind turbines can be expected to be struck by lightning once a year, and in some cases are struck multiple times in a single storm event. Researchers at Wichita State University have created an enhanced multi-layer covering to protect blade surfaces from consecutive lightning strikes and have fabricated a cost-effective system to retrofit the covering onto existing turbines and quickly perform field repairs. This covering allows an improved transfer of lightning current to the grounding connection and minimizes the damage to underlying surfaces and sensitive electrical components. The capability to sustain and effectively transfer multiple lightning strikes reduces the time need for maintenance repairs, therefore decreasing the amount of time the wind turbine is not in operation and increasing the total amount of wind energy generated.

Application

These coverings can be applied to any surface that have a need to improve the transfer of lightning current to a grounding connection.

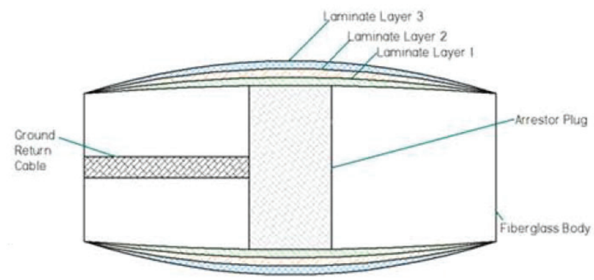
The U.S. Wind Energy industry is expected to produce 113.43 GW of energyby 2020, an 86% increase from the 60.72 GW produced in 2013. By 2030, that number is projected to reach over 224 GW, an increase of 260% since 2013 and will possess 20% of the wind energy capacity internationally.

Advantages

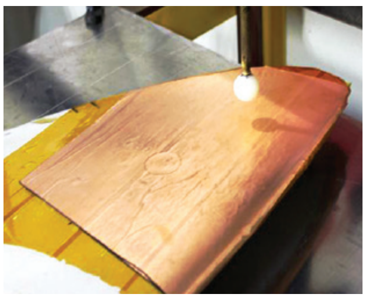
- Enhanced capabilities to direct lightning current from surface to grounding connection
- Preliminary testings (April 2017) withstood seven consecutive lightning strikes (images from testing shown on reverse side)
- Allows for continual operation of the wind turbine blade after being struck
- Ability to be integrated into the manufacturing process of the blade, or easily retrofitted onto existing turbine blades operating in the field
- Repair of the multi-layer protective covering has been performed under thirty minutes

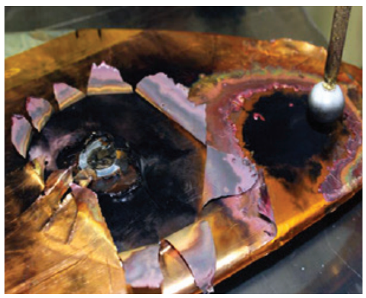
Multi-layer Protective Covering

This system was designed and tested to prove the validity of the multi-layered laminate lightning protection system using a wind turbine blade. Wind turbine blades make use of a lightning arrestor plug connected to a cable that lies within the fiberglass body of the blade as a ground return for lightning strikes. The multi-layered system protects the structure of the fiberglass while utilizing the existing arrestor plug and ground return by transferring the current to the arrestor plug with the top layer while simultaneously protecting the structure of the fiberglass from the degrading effects of the electric field with the bottom layer. This system was designed to absorb multiple strikes of lightning. When the top layer becomes physically damaged, the bottom layer is still capable of transferring current from an additional strike to the ground return while protecting the underlying structure.



While the average lightning strike discharges 30-50 kA, NASA has recorded strikes above 100 kA and there are other reports of lightning strikes exceeding 200 kA. Testing was performed at these high amplitude conditions to prove the validity of the system.


Initial test set up


Test strike 1


Covering repaired, strike 2


Test strike 3

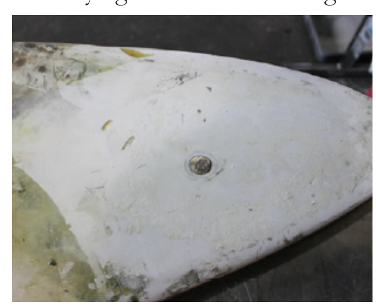
Testing Environment:

- Seven high amplitude strikes at 200 kA.
- Covering repaired after first test strike performed in under 30 minutes.
- This test blade has endured over 20 test strikes, ranging from 50 kA to 200 kA without suffering damage

Test strike 5


Test strike 6


Test strike 7


Underlying surface after testing


Inventor

Billy Martin is a senior research scientist at WSU's National Institute for Aviation Research (NIAR) and is the Director of the Electromagnetic Energy Lab. Martin is one of the most knowledgeable technical experts on high intensity radiated fields (HIRF) and lightning in the United States, with 30 years of industry experience in the practical aspects of compliance to HIRF and lightning standards.

Martin is the chair on the SAE AE2 Lightning Committee, is the U.S. representative on EUROACAE WG-31 Lightning Committee, and also sits on the RTCA SC-135 and ARAC HIRF Committees.

This technology is patent pending. For additional details or information regarding this technology, please contact:

Gael Tisack
Director of Technology Evaluation & Industry Engagement
gael.tisack@wichita.edu | (316) 978-6980