

ArcGuide™ Lightning Protection Coating

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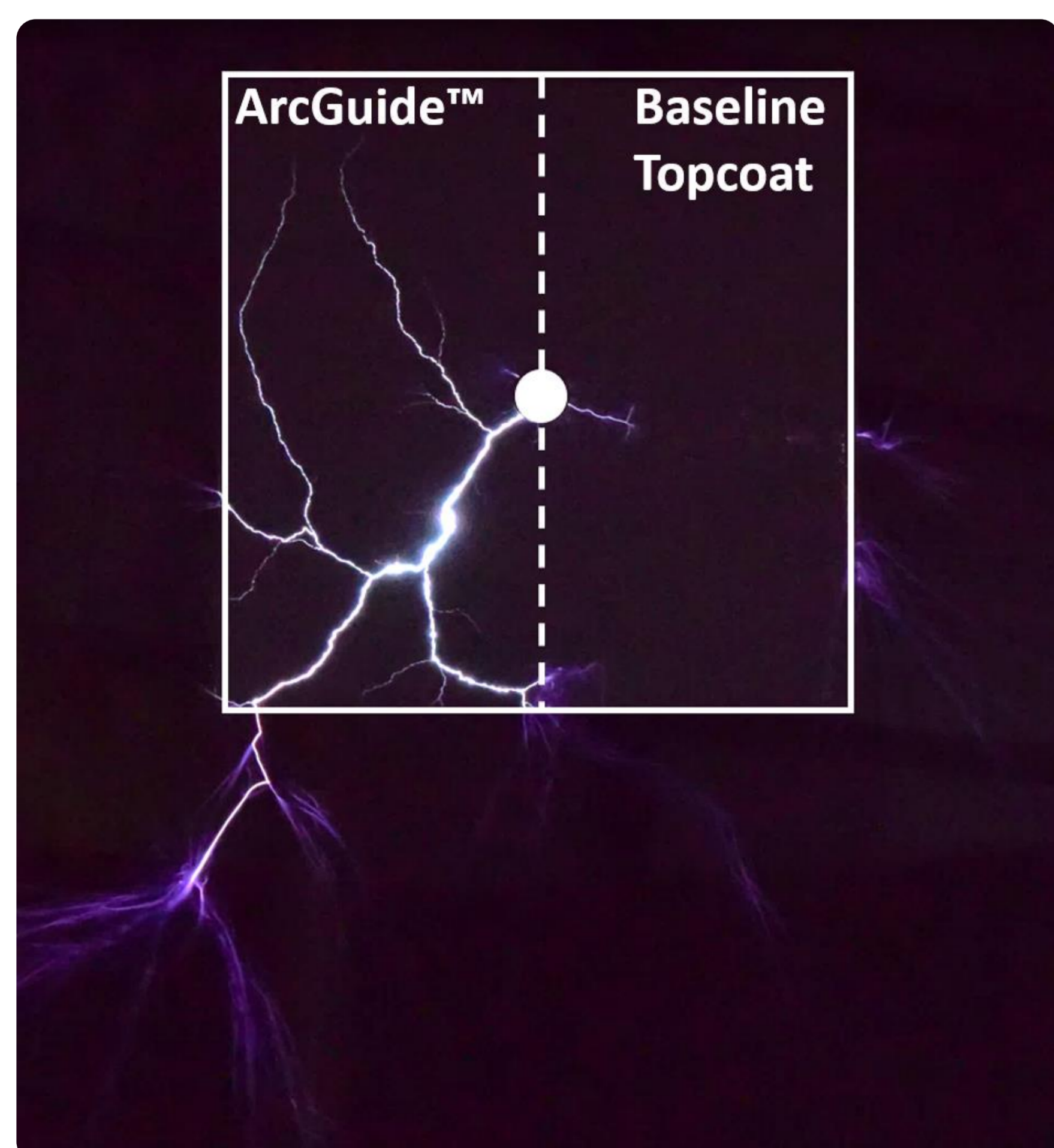
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MOTIVATION

- Lightning damage to wind turbines is one of the largest O&M expenses for wind farm operators^[1].
- Many existing lightning protection systems provide inadequate protection leaving the blade vulnerable to damaging punctures.

ArcGuide™

- A novel coating to enhance the performance of existing lightning protection systems.
- Industry standard topcoat mixed with a proprietary formulation of small conductive particles.
- Enhances the electric field in the air adjacent to the coating, facilitating early streamer and leader formation along the surface to the lightning receptors.
- Not damaged by full-threat (200kA) lightning currents.



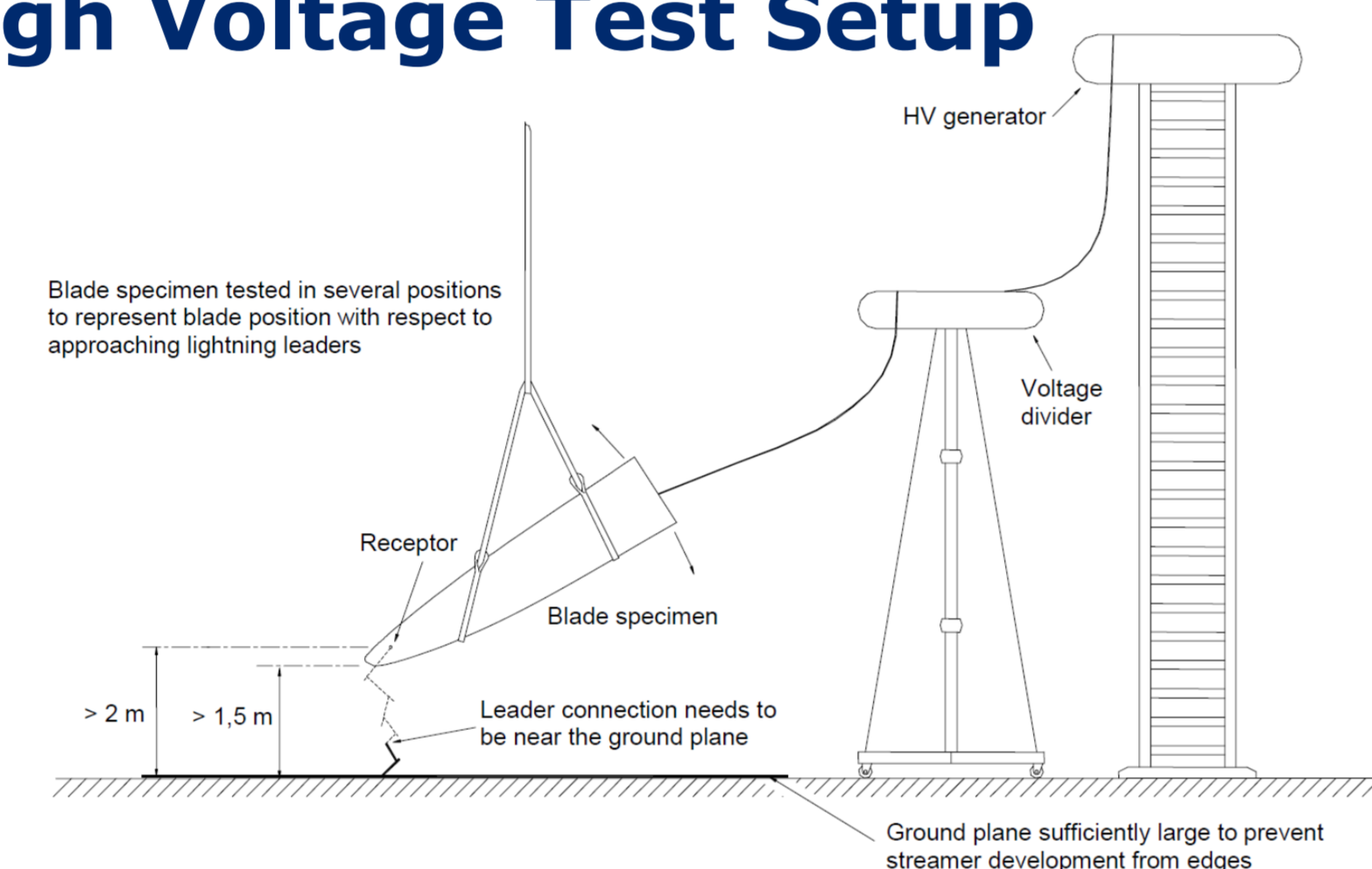
METHODS

Compared field-used blades with and without ArcGuide™ using high voltage initial leader attachment tests (IEC 61400-24)^[2]

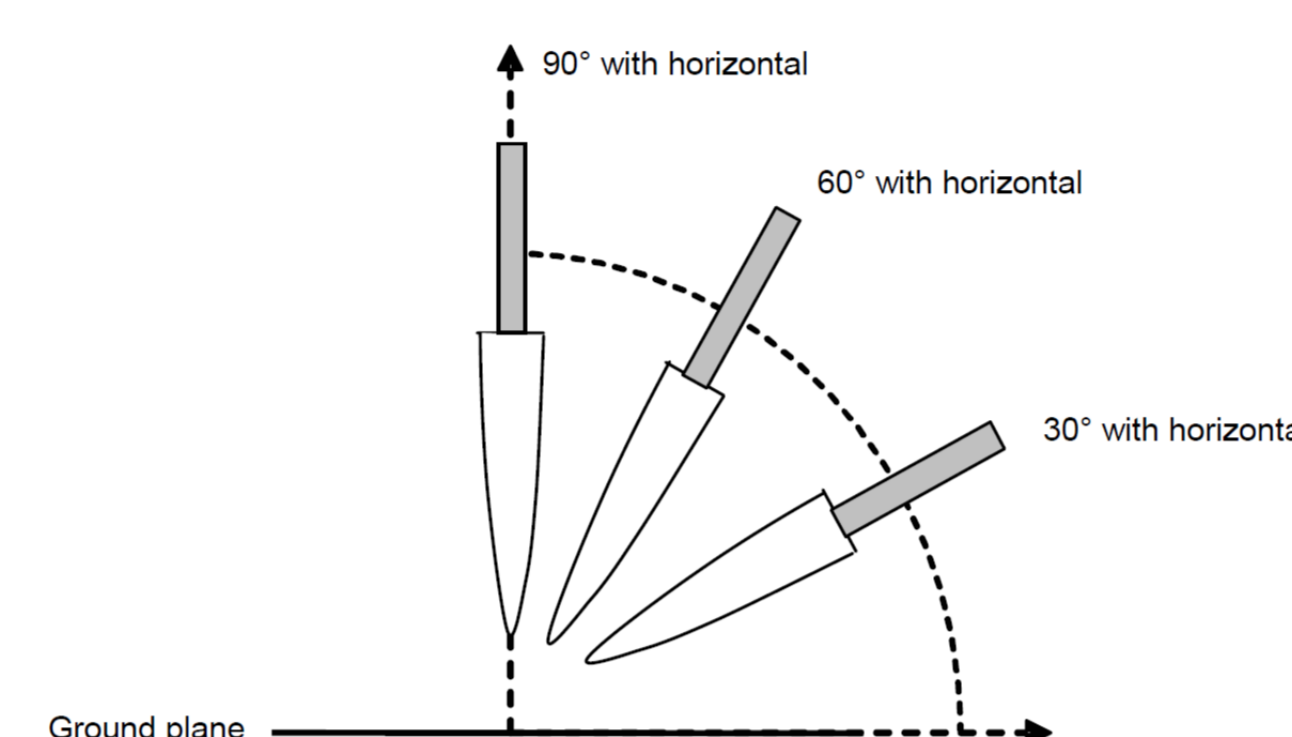
Test Matrix

- 3 blades (GE 37C)
- 2 configurations: ArcGuide™ & baseline
- 3 angles: 60°, 30°, and 10°
- 3-4 orientations per angle
- 3 strikes per orientation

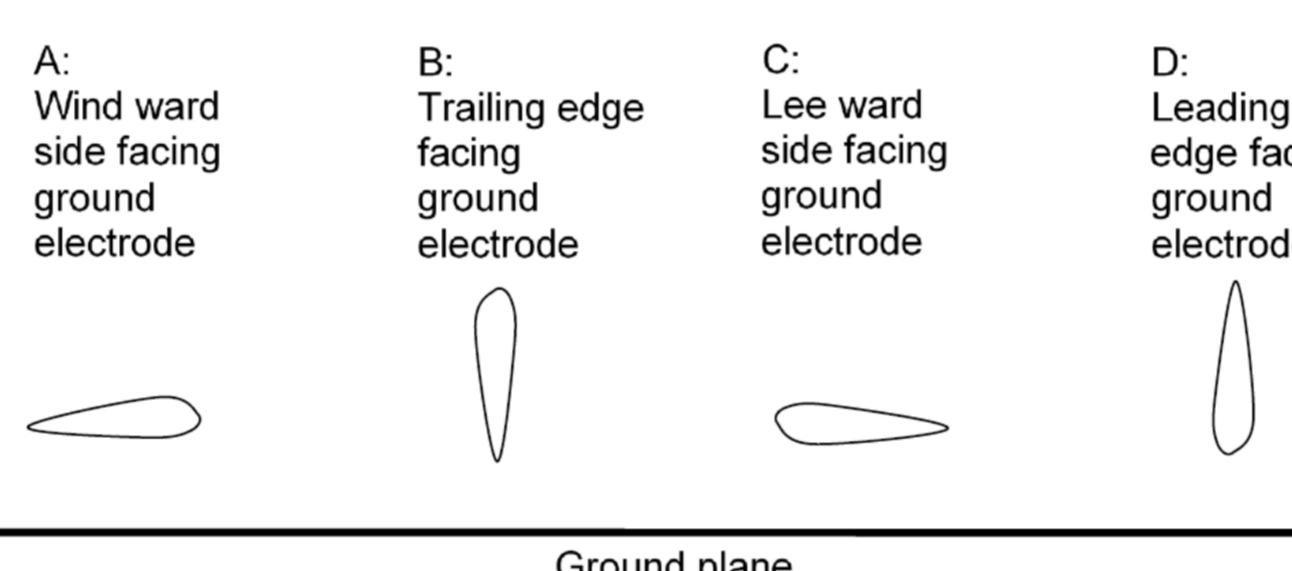
High Voltage Test Setup



Angles



Orientations



Laboratory Outcomes

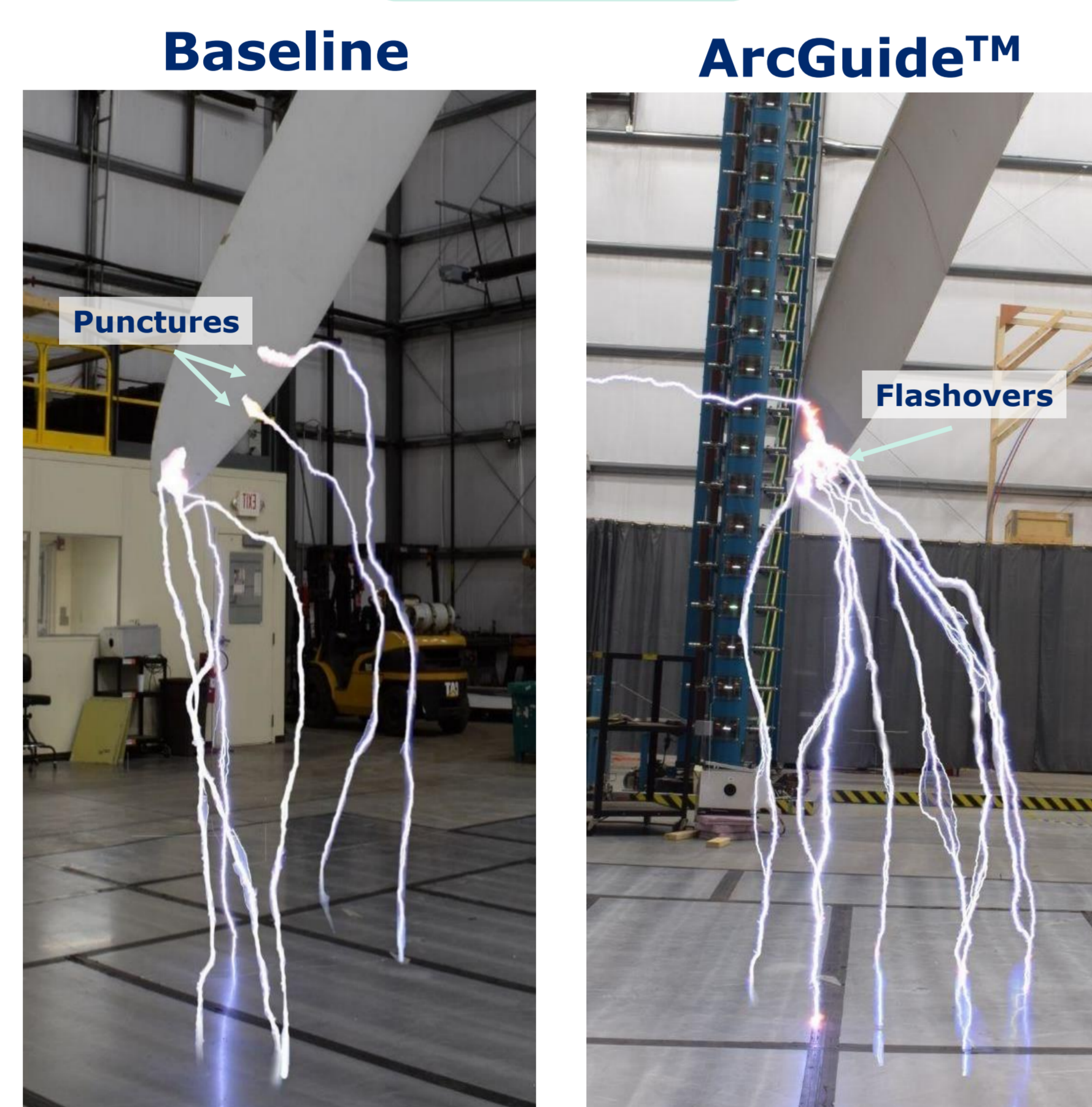


Bad result: puncture to down conductor



Good result: flashover to receptor

RESULTS



Composite image of all strikes to blade #1 at 60°

Of 154 strikes:

- ArcGuide™ protected against punctures in 100% of tests ≥30°.
- At 10°, ArcGuide™ reduced puncture rate by 50%.

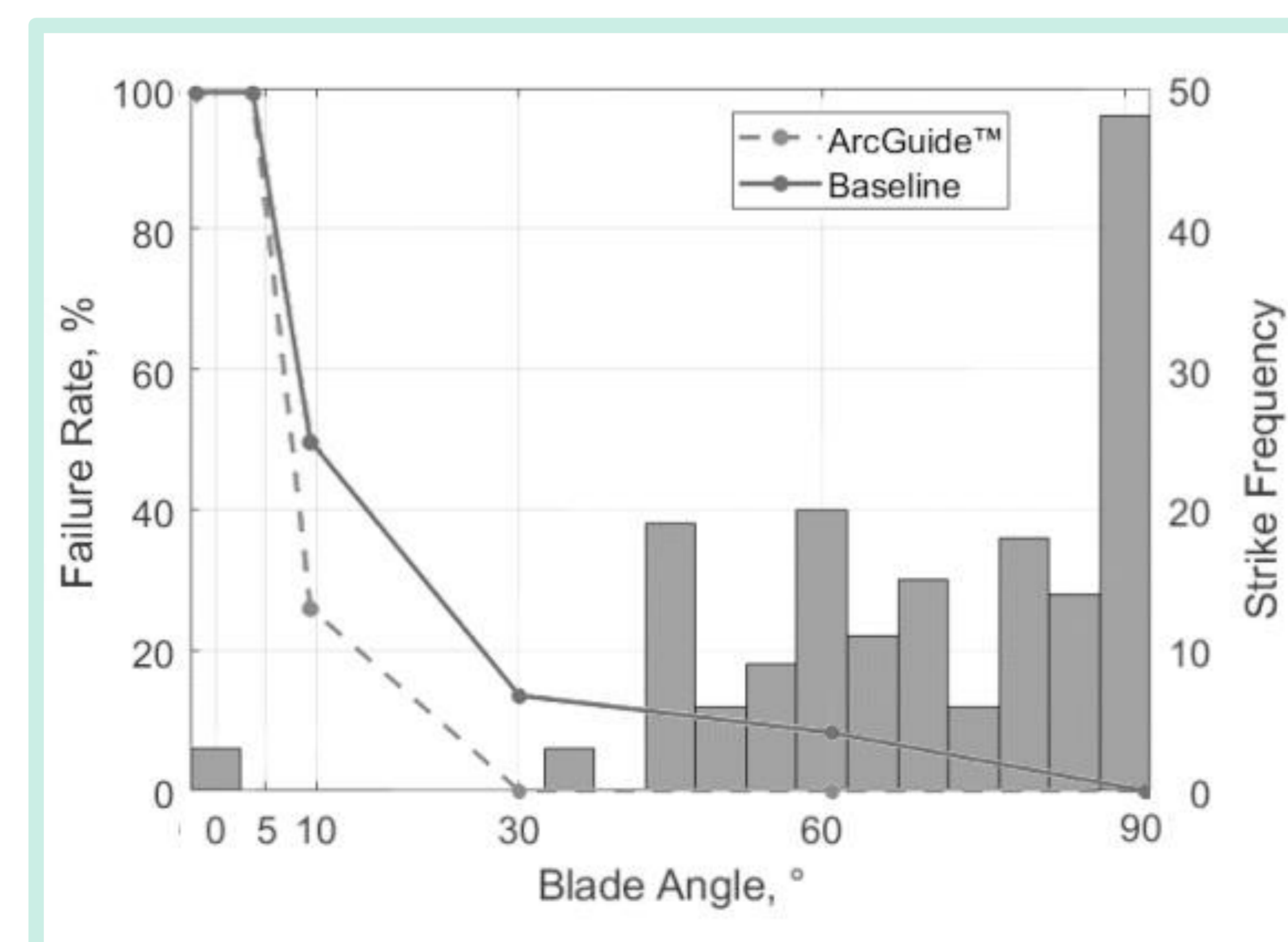
ANALYSIS

The number of punctures for each blade angle can be described by the failure rate:

$$\frac{N_{\text{punctures}}}{N_{\text{total strikes}}} * 100\%$$

- No punctures were observed at 90°
- Punctures always occurred < 10°

- A real-world attachment angle distribution was quantified from video footage of 172 winter lightning strikes on 12 turbines over 5 years^[3].
- 98% of lightning attachment in the field occurred at blade angles >30°.



- Applying the **baseline** failure rate to the field distribution:
 - 6.4%** of strikes are predicted to cause damage.
- Applying the **ArcGuide™** failure rate:
 - 1.7%** of strikes are predicted to cause damage.

- A **73% reduction**.

CONCLUSIONS

- ArcGuide™ provides a significantly increased level of protection against damaging punctures compared with uncoated blades in initial leader attachment tests.
- A 73% reduction in punctures is predicted^[4] in the field with ArcGuide™ applied to the GE1.5sle.
- Ongoing pilot studies on 6 turbines will verify coating performance in the field over 2+ years.

REFERENCES

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- IEC, "Wind energy generation systems – Part 24: Lightning protection", IEC 61400-24:2019, Annex D, 2019.
- S. Vogel, "Realistic Lightning Exposure System for Optimized Wind Turbine Reliability", Technical University of Denmark, 2018.
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ACKNOWLEDGEMENTS

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Key collaborators include NTS Lightning Technologies and our field test partners.

CONTACT

More information can be found at arcturawind.com/ArcGuide.

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