



## ELEMENT LIGHTNING TECHNOLOGIES

Element Lightning Technologies in Pittsfield, Massachusetts is an international leader in the development and verification of successful lightning protection for customers in the Aerospace, Wind, Solar, Maritime, Electric Power Generation and transmission, Oil and Gas, and many other industries.

Founded in 1977 as Lightning Technologies ("LTI"), Element Lightning Technologies in Pittsfield has been a leader in the development and updating of lightning simulation and testing standards for aircraft and wind turbine protection ever since. We developed the aircraft lightning transient analysis ("LTA") testing method now in wide use worldwide.

Our 20,000 square foot facility is one of the most complete lightning-simulation laboratories in the world with generators capable of producing up to 2.4 million volts and 200,000 amperes and others - capable of simulating all the standard lightning-induced transients applicable to aerospace and ground-based equipment and systems.



### ELEMENT LIGHTNING TECHNOLOGIES CENTER OF EXCELLENCE

We house one of the most complete lightning-simulation laboratories in the world and rank as an international leader in the development of sophisticated lightning protection systems for customers in the aerospace industry as well as for industrial complexes, golf courses, wind turbine farms, theme parks and other high-risk locations.

### DESIGN PROTECTION FOR ALL KINDS OF AIRCRAFT & OTHER COMPLEX SYSTEMS

We provide lightning protection design services for all kinds of aircraft including fixed wing, helicopters and eVTOL as well as wind turbines, ships employing carbon fiber and any facility that can experience damage from lightning strikes. We have long standing experience with compliance with applicable airworthiness regulations and test standards published by FAA, EASA, RTCA, and the IEC standards applicable to wind turbines. We also know how to design for compliance with the IEC and NFPA standards for ground-based facilities.

#### Analysis and Testing of Systems and Subsystems to Determine Optimum Protection

Our engineers are experienced in all aspects lightning interactions with complex systems and the ways to provide effective protection.

We have found that to study the effects of lightning upon a structure or system, it is most efficient to isolate the components of the lightning waveforms and electrical/magnetic fields and to evaluate their effects through individual simulations. Our lab includes specialized and unique equipment to simulate all the electrical characteristics of natural lightning as well as the transients it induces in electrical and electronic systems.

From avionics to military equipment, our lightning testing gives manufacturers the data they need to produce robust components and systems designed to remain operational when vehicles or structures are struck by lightning.

#### Simulation and Modeling for Direct & Indirect Effects Lightning

Simulation and Modeling of structures and systems complement our testing capabilities. We use the COMSOL Multiphysics platform. This is useful when we are assisting with designs of protection for as-yet unbuilt structures or equipment. We have the advantage that we have everyday familiarity with how lightning currents behave throughout airframes and other structures so can validate our models (and know when modeling is not needed).

## PROVIDING LIGHTNING PROTECTION DESIGN AND CERTIFICATION SOLUTIONS

Our finite element analysis capabilities allow us to perform complex simulations to accurately model the interaction of lightning with a variety of aircraft and avionics components for our customers. By decomposing complex CAD-generated objects into meshable geometrical shapes, we are able to accurately portray the lightning environment on high fidelity renditions of real objects.

### Multiple Stroke and Multiple Burst

The flickering seen in a lightning strike to the ground actually is caused by a series of current strokes, called multiple strokes. On the other hand, inter- and intracloud lightning has very different electrical characteristics, referred to as multiple and multiple burst, and require that aerospace electronic systems that perform critical or essential functions be tested against the effects of both types of lightning. We can perform both multiple stroke and multiple burst testing on complete systems.

### Static Electricity

We perform many types of static electricity tests. These procedures simulate the range of static effects: from those occurring on aircraft that can exceed 100,000 volts to the small, but potentially hazardous voltages, produced by manufacturing and material handling operations.

### Research And Development

Our capabilities include R&D for protection designs of new lightning protection methods and products for advanced air vehicles, systems, equipment and materials. We have collaborated with several small businesses in seeking funding and support for US Government Small Business Innovation Research (SBIR) grants through Phase II and beyond. We look forward to working with you to achieve similar success.

### DIRECT EFFECTS LIGHTNING TESTING AT ELEMENT LIGHTNING TECHNOLOGIES

Lightning Physical (Direct Effects) Test to determine the effects of lightning on a wide variety of materials, structures and fuel systems can be conducted in our high voltage (HV) and high current (HC) laboratories in Pittsfield, Massachusetts. These are conducted in accordance with the SAE ARP 5416 and EUROCAE ED 105 standards and are applied for protection design and development as well as certification.

Two basic types of generators are used for direct effects testing: High voltage, Marx-type impulse generators produce voltages and electric fields up to 2.4 million volts to simulate lightning leader attachment and surges induced on power transmission lines. The high current generators produce up to 250,000 amperes and include three units adapted to duplicate the lightning stroke, and intermediate and continuing current waveforms of a typical lightning strike.

To accommodate very large test specimens, direct effects tests are performed in facilities like Lightning Technologies' indoor high-bay laboratory that has floor space of 80 x 100 feet (25 x 30 m).

### Indirect Effects Lightning Testing

Indirect effects are most commonly induced into system interconnecting cables and may damage or upset electronic components. Element Lightning Technologies has been at the forefront of indirect effects test method development for many

years. These methods are defined in IEEE, ANSI, SAE, EUROCAE, US MIL-STDs and many industry and company standards and specifications.

We conduct Lightning induced transient (Indirect Effects) tests of functioning electronic systems and equipment for aircraft and other systems performing critical functions at our facility in Pittsfield, Massachusetts as well as at our customers' facilities around the world, since it is sometimes more efficient for us to transport our test equipment, which is configured for travel, than to transport customer systems to our laboratory. We conduct these tests at all of the standard waveforms and transient levels. We can apply both the individual transient tests to equipment and the Multiple Stroke/Multiple Burst waveform sets to systems or subsystems. Whereas other testing companies also perform these tests, we bring knowledge of the physics of indirect effects coupling mechanisms, the origins of the test methods, and the protection design methods. We offer test planning services that help our customers apply the correct tests and often avoid unnecessary testing, or failures. We have many years of experience with real-world lightning strike experience of aircraft and ground-based systems.

Typical indirect effects tests include pin injection, transformer injection, capacitive injection, ground-circuit injection and field immersion techniques.

### EDUCATION AND TRAINING

We have prepared a series of in-depth courses to assist engineers and technicians in designing effective lightning protection for facilities, aircraft, and avionics. We currently offer three in-person courses:

- Lightning Protection of Aircraft
- Lightning Protection of Avionics
- Lightning Protection of Wind Turbines.

Training events are presented at our facility in Pittsfield, Mass and vary from three to five days. We also conduct training at our customers' facilities worldwide. The aircraft courses are based upon our 500-page textbook "*Lightning Protection of Aircraft*" 3rd Ed. The wind turbine Both courses have their own notebooks.

### BUILD CONFIDENCE BEFORE LIGHTNING FINDS THE WEAKNESS

Lightning qualification is more than running a test. It requires understanding how lightning interacts with structures, materials, avionics, electrical systems, and protection architecture. Element Pittsfield combines decades of lightning expertise with advanced simulation, modeling, direct-effects testing, indirect-effects testing, and certification support to help engineering teams identify vulnerabilities before they become costly program issues.

Engage our experts early to develop the right test approach, avoid unnecessary testing, reduce qualification risk, and generate the technical data needed to support design validation and certification.

**Talk to a Lightning Expert**

