

Reassessing airport tower lightning protection systems

Checklist

According to a recent Associated Press story, a lightning strike on the airport tower at Baltimore/Washington International Thurgood Marshall (BWI) Airport injured an air traffic controller and revealed a potential vulnerability that could affect towers at other U.S. airports. Most airport towers are built with Lightning Protection Systems. However, in the BWI incident that system failed, most likely because the cable was cut during a construction project several years earlier.

The air traffic controller is recovering, but the incident was serious enough to prompt the Federal Aviation Administration (FAA) to make plans to assess the Lightning Protection Systems at the 440 U.S. air traffic control towers it manages. Special attention will be focused on the 200+ towers built before 1978, when the FAA first established its lightning protection requirements for:

- Airport control towers
- Navigation and Approach Lighting Systems (ALS), including airport beacon, PAPI, VASI, RAIL, REIL, VOR, ILS and MALSR systems
- Weather and airport advisory systems, including RVR, ATIS, AWOS, and ASOS
- High and low voltage electrical and communication cabling systems; fiber optic placement, splicing, and testing; and airport grounding systems



Ensuring reliable lightning protection:

**STEP
1**

Assess existing grounding system, measure soil resistivity

**STEP
2**

Measure ground impedance, continuity and take other preventive maintenance steps

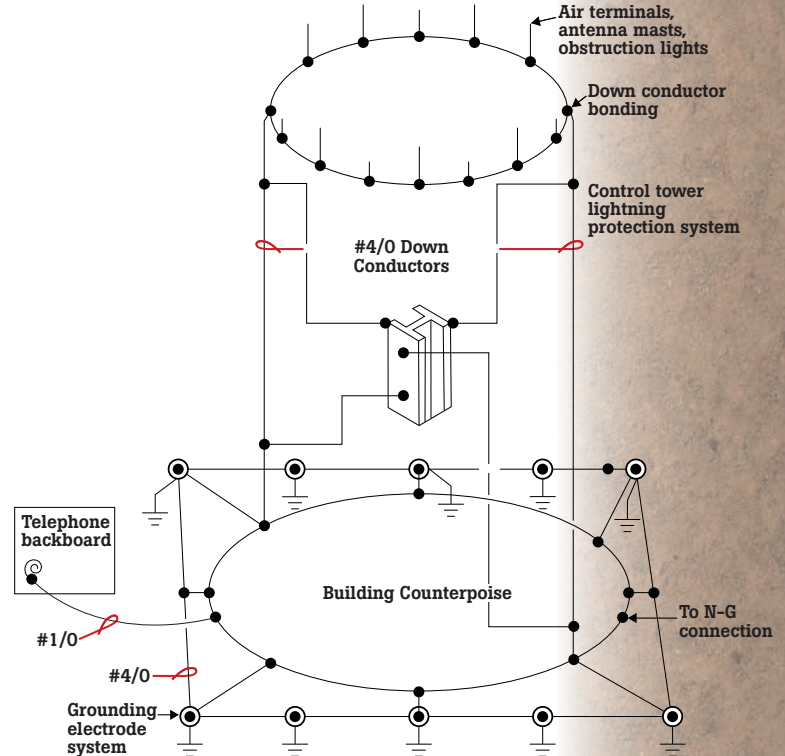
**STEP
3**

Troubleshoot problems

Lightning protection components at a glance

- An air terminal, down conductor, and at least one ground plate or rod for each beacon tower, should be installed.
- The air terminal should be installed at the top of the tower with the tip of the rod extending not less than 150 mm (6 in) above the top of the beacon.
- Down-conductor cables should be securely fastened to the surface of the tower leg at 150 cm (5 ft) intervals with suitable bronze fasteners having bronze or noncorrosive metal bolts. Sharp turns or bends in the down conductor are not permitted.
- All connections of cable-to-cable, cable-to-air terminals, and cable-to-ground plates or rods must be made with solderless connectors or noncorrosive metal.
- The down-conductor cable shall be securely attached to ground rods or plates placed at least 60 cm (2 ft) away from the tower foundations. The ground rod shall be driven into the ground so that the top is at least 150 mm (6 in) below grade. The down-conductor shall be firmly attached to the ground plate or rod by means of a ground connector or clamp.

If an airport is located in an area with a high incidence of lightning, the Catenary System (used to protect the Space Shuttle) can be used but would be very costly. Sandia National Laboratories (SNL) recommends a less costly (but equally effective) alternative. SNL recommends installing a ground ring complemented with ground rods and radials.



General grounding requirements (From FAA AC 150/5340-30D)

The lightning protection system provides low resistance preferred paths for the energy from lightning discharges to enter the earth and safely dissipate without causing damage or injury. The safety ground protects workers from possible contact with an energized light base or mounting stake that may result from a shorted power cable or isolation transformer. Proper grounding is essential to both systems.

Control tower

A safety ground must be installed at each light fixture and connected to a ground rod. It is recommended that the resistance-to-ground range should be between 10 to 20 ohms.

The safety ground must be of sufficient ampacity and size and must be connected to an adequate electrode to dissipate the energy to ground.

Runway lighting

The power supply for airfield lighting consists of a properly grounded main isolation transformer and a properly grounded secondary isolation transformer for each lamp.

Basic Passenger Boarding Bridge (PBB)

The Passenger Boarding Bridge requires a lightning protection system and proper grounding and bonding to protect lives and equipment and ensure safe operation of airport systems. Without this protection, many passengers from Europe and Asia have endured several hours inside airplanes waiting for electrical storms to end before they can disembark.

Ensuring reliable lightning protection

The presence of sparks in the incident at BWI indicate a lack of equipotentiality. This problem can be identified with a ground resistance tester like the Fluke 1625-2 GEO Earth Ground Tester and other Fluke test tools.

STEP 1

Assess existing grounding system



- Measure soil resistivity in different areas and soil layers with the Fluke 1625-2 to identify the optimum low-resistive soil area in which to extend the grounding system.
- Use the resistivity values of different soil layers to determine the type of electrode to use and the depth it should be buried to obtain a lower ground resistance value.

Type of soil	Soil resistivity R_E ΩM	Earthing resistance					
		Ground electrode depth (meters)			Earthing strip (meters)		
		3	6	10	5	10	20
Very moist soil, swamplike	30	10	5	3	12	6	3
Farming soil, loamy and clay soils	100	33	17	10	40	20	10
Sandy clay soil	150	50	25	15	60	30	15
Moist sandy soil	300	66	33	20	80	40	20
Concrete 1:5	400	-	-	-	160	80	40
Moist gravel	500	160	80	48	200	100	50
Dry sandy soil	1000	330	165	100	400	200	100
Dry gravel	1000	330	165	100	400	200	100
Stoney soil	30,000	1000	500	300	1200	600	300
Rock	10^7	-	-	-	-	-	-

STEP 2

Preventive maintenance

- After the grounding system has been improved based on the measurements in Step 1, measure ground impedance with the 1625-2. This value is very important because lightning is a high frequency event and the ground impedance measurement will help to determine the grounding system's ability to properly dissipate the energy from lightning.
- Measure continuity of the lightning protection system Down Conductor. This will determine whether the Down Conductor is at the same potential as other components of the electrical system. All components need to be at the same potential during a lightning event to avoid catastrophic damage.

- Determine the equipotentiality of all grounding system components by using the 1625-2 to measure either dc resistance or ac resistance between components in the:
 - The Lightning Protection System
 - The Grounding Electrode System
 - The Bonding System (Safety Grounding Conductor/ Equipment Grounding Conductor)
 - The electronic equipment shielding (Approach and Navigation System)
 - Weather and Airport Advisory Systems (Including RVR, ATIS, AWOS and related systems).
- Install a surge suppressor with adequate current capacity per IEEE C62.41 to protect electronic equipment.

**STEP
3**

Troubleshooting problems

- Identify loose connections and overheated transformers and conductors using the 1625-2 to measure resistance values or the difference in potential between two points. You can also use an infrared camera such as the Fluke Ti400 to show temperature differences between components.
- Identify insulation breakdown by measuring insulation resistance with the Fluke 1587 Insulation Multimeter.



Lightning protection system codes and standards

The lightning protection system and grounding of airfield lightning for airport utility and electrical and communications systems must comply with:

- NEC, National Electrical Code
- NFPA (National Fire Protection Association) 780 “Standard for the Installation of Lightning Protection Systems”
- UL 96^a Underwriters Laboratories
- LPI 175 Lightning Protection Institute
- FAA-STD-19e “Lightning and Surge Protection, Grounding and Bonding and Shielding Requirements for Facilities and Electronic Equipment ”
- FAA AC 150/5340-30D 12.6 “Safety Equipment Ground”

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