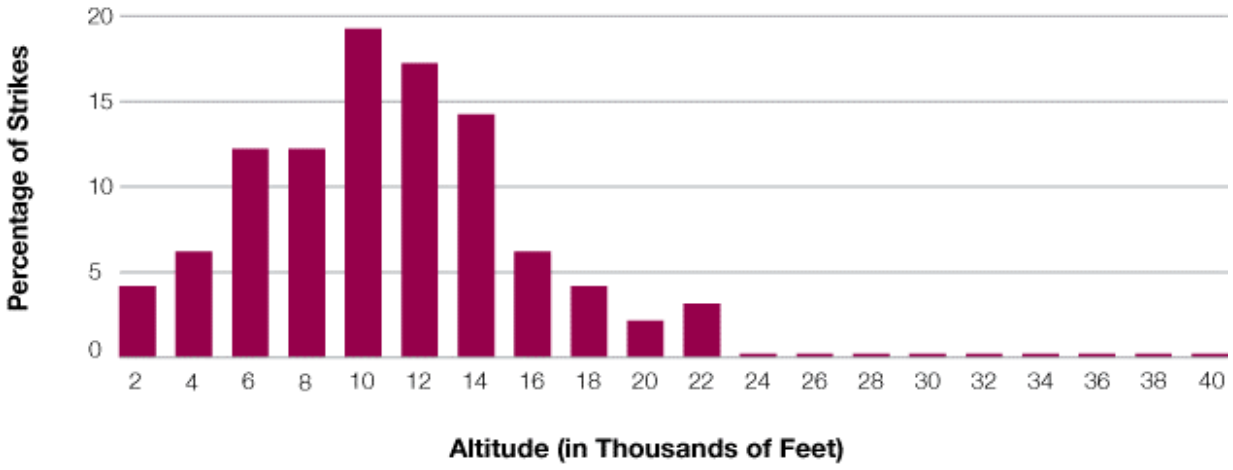
HAZARDS OF LIGHTNING STRIKES IN AVIATION

By Lt. Jason Whiteman, VP-45

Hazards of Lightning Strikes in Aviation

Lightning is a well-known but poorly understood weather phenomenon. While the specifics are still a mystery, the general idea is that collisions between particles causes them to ionize. Lighter particles, such as ice crystals, become positively charged and are lifted by updrafts toward the tops of a cloud or storm cell. Heavier particles, like graupel and hail, gain a negative charge and remain around the bottom and middle of the cloud because they are harder to lift. This allows for a charge separation, which along with the atmosphere's resistance to a free flow of current, satisfies the two main conditions necessary for lightning to occur. An aircraft flying through the atmosphere is also colliding with particles, ionizing the air and becoming potentially attractive to lightning "leaders" – the initial stages of a lightning strike.

There are strong correlations between certain flight conditions and lightning strikes. Most strikes are reported during the climb and descent phases of flight, between 5,000 and 15,000 feet, with the chance of a strike drastically reduced above 20,000 feet. Lightning strike reports are also mostly associated with rain, temperatures near freezing, and while flying inside a cloud. The typical seasons associated with an aircraft being struck by lightning are spring and summer. It is important to note the lightning strikes do not require convective activity or thunderstorms. Almost half of all lightning strikes reported by airline pilots occurred with no thunderstorms in the immediate area.



Graph from AERO QTR_04.12 shows the relationship between reported lightning strikes and the altitude at which the aircraft was flying when the reported strike occurred.

Cloud Orientation	Percent of Total Reported*
Above	<1%
Within	96%
Below	3%
Between	<1%
Beside	<1%

The above table comes from "Boeing AERO QTR_04.12," *which was adapted from* "Airlines Lightning Strike Reports Project: Pilot Reports and Lightning Effects" *by J. Anderson Plummer, Lightning Technologies Inc., Aug. 2001. Data was gathered from airlines with 881 strikes reported.*

Hazards of Lightning Strikes in Aviation

Some lightning strikes can deliver up to one gigajoule of energy; that is enough to power a standard refrigerator for up to 30 weeks. This huge amount of energy can be destructive to internal components of the aircraft, melting metal components, sparking fuel vapors or frying electronics. The Federal Aviation Administration has many regulations governing how well aircraft can withstand lightning strikes now, so it's possible we could experience a lightning strike in flight and not even realize it.

The P-8 has a composite skin, which includes a built-in conductive layer to help redirect that energy from the strike. Inner components are built with shielding to prevent induced currents and surges and to keep the lightning from sparking fires. Since the radar would not work properly if surrounded by the conductive layer in the rest of the aircraft's skin, the radome is designed with special strips on the outside that act as lightning rods so the radome is protected and still radiates properly. That radar can be used in the WXR mode to detect cells of convective activity and help crews avoid lightning. Pilots can also gain situational awareness by communicating with air traffic control (ATC) for their radar coverage and pilot reports, or by contacting a flight service station for more detailed information.

Unfortunately, even with these tools available, P-8s are still at risk of being struck by lightning. Previous hazard reports, or HAZREPs, cite a variety of causal factors leading to lightning strikes. Some of the lessons learned from those HAZREPs were:

- ATC is looking at a different picture than the flight deck. Some crews requested multiple times for deviations to avoid weather, but clearance was too late due to lack of urgency or confusion resulting in a lightning strike. Crews should make every effort to be clear in what they need and why they need it.
- Some hazard flight decks did not check their weather radar. If there is not a mission crew with a dedicated radar sensor operator, flight decks should have the WXR mode up to identify areas of convective activity. If there is a radar sensor operator, the flight deck should work closely with them to help avoid lightning.
- Perceived pressure may have kept some crews in the vicinity of weather capable of producing lightning longer than they should have stayed. Whether continuing to bounce for pilot proficiency or out on station for a mission, "the juice may not be worth the squeeze;" a lightning strike can potentially be downing for weeks as maintenance personnel must then inspect the aircraft for damage.
- The capability for the P-8 to download weather data and produce some sort of overlay in-flight would greatly increase situational awareness. Ideally, data would still be able to be downloaded without a mission crew so pilots on a bounce flight can still access the information.

To help determine if there was a lightning strike, crews have previously noted visual flashes of light or balls of fire, as well audible pops, cracks and booms. Lightning typically enters at a point on the extremities of the plane: either the nose radome, wingtips, engine nacelles or the tips of the vertical and horizontal stabilizers of the tail. It then exits somewhere in those same regions, and can manifest as scorch marks, pits, and small holes on the fuselage skin. Post-flight inspections of those areas can help identify lightning strikes.

To help avoid lightning strikes, crews should stay clear of clouds or climb above 20,000 feet if feasible. Crews should also identify potential lightning conditions early and communicate among themselves and with ATC to remain clear of those conditions if possible.

References:

1. “Lightning Strikes: Protection, Inspection, and Repair” *Boeing AERO QTR_04.12*
2. Previous P-8 lightning HAZREPs