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Editors Note: This is a reprint of a News Release from 1983. At the end of the Lightning Program, in 1986, total cloud penetrations were more than 1400 and total strikes were more than 700.

NASA STUDIES EFFECTS OF LIGHTNING ON AIRCRAFT

After more than 700 storm cloud penetrations and 400 direct lightning strikes to a specially-instrumented jet airplane, scientists at NASA's Langley Research Center, Hampton, Va., are beginning to understand more about lightning at flight altitudes and how it affects aircraft and aircraft flight.

Today's airliners are struck by lightning more than 2,000 times each year, or about once per airline aircraft, with little effect. These aircraft are protected by their aluminum skins, which are natural conductors, and by the use of mechanical-hydraulic control systems which are immune from the electromagnetic effects of lightning.

Future aircraft skins, however, may be made of composite materials, which are non-conductors, and may need some form of additional protection from lightning. Lightweight composite materials -- woven fibers impregnated with epoxy resins -- promise a substantial savings in fuel expenditures and reduced operating costs.

Future aircraft also will use electronic control systems and digital avionics systems for improved flight efficiency and further savings of weight and fuel. However, lightning protection techniques need to be defined to avoid possible damage or upset to these low-voltage, highly sensitive electronic systems.

It had been generally accepted that lightning activity is concentrated in a narrow altitude range where the air temperature is at or near the freezing level. Aircraft that encountered storms were usually advised to fly above this level -- above 4,600 meters
Recent aviation articles have suggested that pilots avoid flying in temperatures between 0 and -5 Celsius (32 and 23 Fahrenheit) when the atmosphere is electrically charged. Records kept on lightning strikes to aircraft indicate that this is where most strikes occur.

This information can be misleading, however, as explained by Langley's Norman Crabill, Storm Hazards project manager: "Most strikes occur at low elevations (3,050 to 4,600 m -- 10,000 to 15,000 ft.) because there is a lot of traffic there, and deviations around storms are restricted by air traffic control and the need to depart or approach the runway location. At higher altitudes (7,600 to 9,150 m -- 25,000 to 30,000 feet), deviations around storms are the rule and, hence, there is less exposure to the hazard."

Flights by the Storm Hazards F-106B into thunderstorms at various altitudes indicate that, although some lightning strikes at lower altitudes may be stronger and pack more punch, lightning strikes at higher altitudes seem to occur more frequently.

In 1980 and 1981, flying near the freezing level, the aircraft took "only" 10 hits each year. In 1982, flying at higher altitudes, Crabill's team logged more than 150 direct hits. In the 1983 storm season, flying at these same higher altitudes, the team reports more than 250 direct strikes to the airplane.

Langley researchers are also learning more about the fundamental characteristics of lightning, perhaps the single most important element of the Storm Hazards program. The physics of lightning has been studied for years by many scientists, but relatively little is known about lightning at typical operating altitudes of airliners.

Felix Pitts of Langley's Fault Tolerant Systems Branch is principal investigator for the Direct Strike Lightning Experiment, which can record more than one million individual measurements of the characteristics of each lightning strike.

Though much is yet to be learned about the internal micro-mechanisms of
lightning, Pitts has already reported significant findings. "Current rates of rise that approach 100 billion amperes per second have been recorded on the F-106B nose boom, for example. Such data, Pitts says, "will be used by the technical community in establishing updated lightning protection criteria for aircraft."

Research in the Storm Hazards program at Langley and NASA's Wallops Flight Facility, Wallops Island, Va., is proceeding on a broad front, looking at all aspects of lightning pertaining to aircraft flight. The F-106B airplane also collects data supporting research studies of turbulence, wind shear, heavy rain effects and other storm factors.

For the next several thunderstorm seasons, the craft will continue to be flown purposely into selected thunderstorms with the intent of being struck by lightning -- all in the interests of safe, efficient flight.

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