A HAIR'S BREADTH

ICING AFFECTS ALL AIRCRAFT IN FLIGHT. BUT HOW MUCH ICE IS TOO MUCH? ■ By Thomas P. Turner

Approximately 13 minutes after departure, the pilot reported the airplane was accumulating ice. He requested and was cleared to descend from 5,000 to 4,000 feet MSL. Subsequently, the pilot requested and was cleared to descend to 3,000 feet, and to proceed direct to the initial approach fix for the RNAV (GPS) 36 approach for landing at a nearby airport. No distress call or additional ATC communications with the pilot were recorded. The airplane impacted trees and terrain approximately 17 miles south of the airport. Tree deformation, ground scars and craters were consistent with a near vertical impact.

Instrument meteorological conditions with low ceilings, reduced visibility, light rain, mist and drizzle prevailed at the departure airport and along the flight route. The temperature profile in the accident area was +1 degree Celsius at the surface, -3 degrees C at 3,000 feet, and above freezing at 7,000-8,000 feet. Super-cooled large droplet moisture (SLD) was likely present in the accident area at and below 5,000 feet and produced moderate to severe clear icing on the airframe in the minutes prior to the accident. Propeller blades exhibited physical evidence (blade bending and twisting) consistent with high power (at or near the low-pitch/high-rpm range) and rotation (symmetrical energy) at impact. No evidence of an in-flight mechanical or flight-control malfunction was found that would have rendered the airplane uncontrollable prior to the impact.


HB-FVG

NTSB probable cause: The pilot's inadvertent flight into severe icing conditions. A contributing factor was the pilot's inadequate preflight planning.

Two pilot reports (PIREPs) from the immediate accident area were filed in the hour before the accident airplane's departure. FAA records confirmed the pilot received both of these PIREPs when he briefed and filed for his departure just before his 0918 (local time) departure. At 0838, a Beech BE58 at 7,000 feet MSL reported sky overcast 1,000 feet with top of overcast at 6,000 feet, temperature 10 degrees Celsius, wind 221 degrees at 39 knots, light icing at 3,000 to 4,000 feet during climb. At 0905, a Mitsubishi MU2 at 7,000 feet MSL reported sky overcast 900 feet with top of overcast at 5,000 feet, light icing at 2,300 to 3,300 feet during climb.

It was Christmas Eve. The airplane had a broken alternator switch, and the pilot's final flight was an attempt a hop to nearby Jonesboro, Ark., to have the switch replaced before flying to meet his family for the holiday. Weather near the departure airport was 200 overcast, visibility 1½ miles and +1 degree C surface temperature. Jonesboro (KJBR) was reporting 700 overcast, visibility 10 miles, with a 15-knot wind, +1 degree C surface temperature and rapidly falling barometric pressure. The pilot may have thought he could rapidly climb through the ice (after all, PIREPs called it "light") into an inversion above the clouds, and then descend rapidly through the clouds in the approach to his destination. The holiday may have increased his perceived stress to make the flight despite the adverse conditions.

PC-12s are certified for flight in icing conditions — so called known-ice approval. But in what conditions exactly does known-ice approval permit you to operate safely? There is more than a full page of icing limitations in the Pilot's Operating Handbook for your PC-12. Take a look because known-ice certification is not license to operate in any type of freezing conditions.

Most pilots don't know that ice certification provides a relatively small amount of ice protection. When is ice accumulation too much

Condition	Cloud Type	Maxiumum Droplet Size			Maximum Exposure
		Microns	Inches	Millimeters	
Continuous maximum	Stratus	40	0.0019	0.05	17.4 nm
Intermittent maximum	Cumulus	50	0.0020	0.05	2.6 nm

Icing Certification Maximum Exposure Criteria (FAA)

THE FREEZING RAIN MYTH

We're taught that conditions resulting in freezing rain involve a shallow band of freezing air near the surface, perhaps only a few hundred feet thick, over which lays a band of warm air with above-freezing temperatures. Far higher, a second freezing layer marks the boundary, above which the air is below freezing again. Snow forms in the cold air at altitude. As snow falls through the above-freezing layer of air, it melts, with water droplets coalescing into larger, super-cooled raindrops. These large raindrops, upon striking surfaces chilled to below freezing by the cold air near the surface, flash-freeze onto those surfaces. This creates a thick and irregular coat of clear ice — freezing rain.

This model, in which above-freezing air is just above the surface, suggests pilots employ these common avoidance and escape tactics for flight in areas of freezing rain:

1. Cruise a few thousand feet above the height of the freezing rain and you'll remain in ice-free air.

2. If you encounter freezing rain conditions, climb. Above-freezing air is just a few hundred feet above you.

The trouble is that this set of conditions is what's happening in only 8 percent of all freezing-rain events, according to Scott Dennstaedt, an instrument flight instructor and former National Weather Service research meteorologist now employed by ForeFlight LLC as its weather scientist. He also owns AvWxWorkshops.com, a subscription-based aviation-weather training website. In 92 percent of all freezing-rain events, Dennstaedt advises, below-freezing temperatures exist upward from the surface with no warm band of above-freezing air above the lowest layer.

Instead, this is how freezing rain usually forms: Above a boundary defined roughly by the height where the temperature is at -12 degree C, small super-cooled water droplets are suspended in the atmosphere. These droplets collide with one another and fall into the lower levels, where the temperature is still below freezing, but closer to the freezing point. Upon striking surfaces chilled to below freezing by the cold air near the surface, this creates a thick and irregular coat of clear ice — freezing rain.

The avoidance and escape techniques we're all taught won't work in 92 percent of all instances when freezing rain occurs. Since there is no band of above-freezing air overlying the freezing rain, flying at a higher altitude still exposes the airplane to SLD conditions for which no aircraft is certificated. Trying to escape by climbing out of freezing-rain conditions, hoping to melt off the ice accumulation (a freezing-rain strategy we're all taught), would only result in adding additional ice to the airframe.

for any airplane? *(See Chart on Page 38.)*

FAA certification for flight in icing conditions requires that the airplane's ice-protection systems be adequate to prevent and/or remove accumulations of ice in one of two conditions — continuous exposure and intermittent exposure. Known-ice airplanes are permitted to remain in continuous icing conditions only in stratus clouds, when water droplets are no more than 40 microns in diameter. That's 0.0019 inches (0.05 mm). Even then the certification assumes the pilot will exit icing conditions before traveling 17.4 nautical miles; any more exposure and the accumulation may exceed the system's ability to remove ice.

In cumulus clouds only very short, intermittent exposures are approved. The maximum droplet size under known-ice protection is 0.002 inches (0.05 mm). And then, exposure is limited to 2.6 nm and requires an immediate exit from icing conditions to avoid overwhelming the protection system.

Even in known-ice airplanes, the only workable strategy when freezing rain is reported, Dennstaedt tells us, is to avoid flight in clouds or precipitation anywhere near or above freezing rain unless the outside air temperature is colder than -40°C, the coldest temperature that supports SLD.

Any water droplet greater than 50 microns in diameter is considered a "large droplet." If the water is in liquid state, and the temperature is at or below freezing, it is a "super-cooled" large droplet or SLD. By definition, no ice-protection system is certified for flight in SLD conditions, in icing in stratus clouds for more than 17.4 nm of continuous exposure, or in cumulus clouds for more than 2.6 nm of exposure.

To put this in perspective, the diameter of a human hair is 90 microns, or 0.070 mm, nearly 150 percent of the maximum exposure limit. This means that, at or below freezing temperatures, if water droplets are large enough to be perceived as individual drops or "streams" on your windshield or wings, they are too big for even known-ice airplanes to be protected. No matter what you're flying, you need to exit visible moisture immediately.

Have a safe flight by keeping far more than a hair's breadth away from airframe ice.

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