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SIMPLE CHANGES TO LIGHT PLANE WING INCREASE SAFETY

Up to 20 percent of all fatal light airplane accidents may be preventable with a wing modification developed through NASA research.

The modification, a simple but effective reshaping of part of an airplane wing, is a product of several years of research at NASA's Langley Research Center, Hampton, Va., and Ames Research Center, Mountain View, Calif.

Wind tunnel and flight tests of the reshaped wings reveal greatly increased resistance to airplane spins, a potentially dangerous flight condition that can result from wing stall (loss of lift). Aircraft stalls sometimes occur during improper takeoff, landing, and low-speed maneuvers.

"Light airplanes flying today are certified to federal aviation regulations — they are safe airplanes. NASA's goal is to make them safer," said Paul Stough of Langley's Flight Dynamics Branch. Present guidelines grant certification if a new airplane can be quickly brought under control after a one-turn spin. The Federal Aviation Administration is expected to decide in 1985 if special certification credit is to be issued for airplanes that are highly spin-resistant.

Langley is providing its research results to light aircraft manufacturers and to the FAA. NASA's approach to reducing the threat of spin in light planes has evolved to spin resistance because light plane spins typically occur at low altitudes with little time to recover.
"This wing modification," added Stough, "is something that prevents the pilot from going out of bounds, so to speak, but doesn't interfere with the normal utility of the airplane. The only performance penalty we've seen is a negligible loss of one to two miles-per-hour in cruise speed, a difference most pilots are not likely to notice."

The wing modification is a carefully designed "glove" placed over the outer portion of the wing leading edge, covering about the first six inches of the upper surface and the first 18 inches of the lower surface. The glove is lightweight, has no moving parts and requires no maintenance.

At the glove juncture, there is an abrupt transition from the original leading edge to the recontoured area. The glove extends about two inches forward of the original wing. The extended leading edge area is drooped and more rounded than usual with a flattened undersurface where it fairs into the original wing, as developed for the three airplanes flight tested to date.

"With this wing design, Langley research pilots have pressed their light planes to (wing) angles of attack almost twice as high as normal before encountering any spin tendency. When the airplane gets to about 18 degrees angle of attack, instead of stalling and departing from controlled flight it gives the pilot indications that 'Hey, you shouldn't be operating up here,' yet it must be pushed beyond about 35 degrees angle of attack before the airplane will actually depart," said Stough.

Before they were modified, the three test airplanes would enter a spin about 18 of every 20 times the wings were stalled and pro-spin controls were applied. With Langley's wing leading edge design, the same planes entered a spin only once in every 20 attempts. The spins that did occur required improper airplane loading or extremely aggravated inputs by the pilot. The pilot generally had three to four times as long — measured in seconds — to make a correction before the plane entered a spin.

"The recontoured wing has greatly reduced the tendency for the airplane to spin and has given the pilot more time to take corrective action those few times when it is
needed," concluded Stough. "We're not saying this wing leading edge design is the only way to provide spin resistance. Someone else may come up with a simpler, better or just different means of achieving the same thing, but this is a simple solution that works now," he says.

NASA's ultimate goal is to provide airplane designers with the ability to incorporate the modification as an integral part of a wing, rather than an add-on, and to provide the analytical tools to determine the amount of spin resistance for new airplanes — generalizing the solution for all conventional light airplanes.

The research is being expanded beyond the present series of unswept, low-wing airplanes to include high-wing airplanes and those with different airfoil shapes.

The first use of a spin-resistant wing design is expected to be on a new airplane design, not a modification added to existing airplanes. Wind tunnel model tests have been done at Langley to ensure the concept's compatibility with one promising wing design concept, called natural laminar flow, that may set new efficiency standards for the next generation of light airplanes. The tests indicate that the new natural laminar flow (low-drag) wings can also incorporate Langley's spin-resistant "discontinuous wing leading edge" without loosing their laminar (very smooth) air flow.

Other wind tunnel work is proceeding for NASA at the University of Maryland, College Park, Md., to define the exact flow mechanisms responsible for making a modified wing so much more spin resistant. Researchers know that, at high angles of attack, the abrupt transition between standard and modified wing regions creates a horizontal tornado-like flow called a vortex that acts like a wall to prevent stalled (separated) air at the wing root from disrupting the flow on the outer part of the wing. The drooped leading edge tends to keep the flow attached longer to the all-important wing tip areas.

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