Emergency Systems Enhance Safety in Spin Test Aircraft

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Three emergency in-flight systems have been incorporated in the modified Piper Cherokee Arrow shown below. This airplane is currently being used by the NASA Langley Research Center in a comprehensive research program to improve stall/spin characteristics of light general aviation airplanes. During this research, flight conditions may be encountered in which the pilot may not be able to terminate a spin using normal aircraft controls, and must exercise the emergency systems listed below to save the airplane and/or himself.

1. Spin-recovery parachute — This system provides a tail-mounted parachute to stop the spin and place the airplane in a dive from which it can be recovered.

2. Quick-release door. — This system provides a method of quickly opening and jettisoning the door on the right side of the airplane to allow the pilot to manually bailout in a left-turning spin, should all efforts at spin recovery fail.

3. Pyrotechnic egress panel. — Since there is no door on the pilot's side, this system provides a method of creating an opening in the left side of the airplane to allow for manual bailout in a right-turning spin.

Spin-Recovey Parachute

Pulling the parachute deployment handle mounted at the front edge of the seat fires an aft-directed pyrotechnic slug gun (0.8-pound slug) to withdraw a standard 3-foot diameter, non-spring, pilot chute. This pilot chute has a 29-foot bridle to insure that the pilot chute is deployed outside of the non-uniform wake above and behind the spinning airplane. At full extension of the pilot chute bridle, pins are pulled to release the parachute deployment bag and steel knife line cutters open the end of the bag. The main parachute, a 10.5 foot diameter ring-slot canopy, is deployed by a line-first method; that is, the pilot chute extracts the deployment bag which contains the main canopy, deploying first the riser, then the suspension lines, and finally the parachute canopy. After parachute deployment, the airplane is recovered to a dive condition. The parachute is then jettisoned by means of a tail-mounted lock release mechanism. This mechanism is actuated by the parachute arm/jettison handle.

The system incorporates several features to insure safety during both ground and flight operations. Two safety pins,
one in the parachute deployment handle, and one in the slug gun firing lanyard, prevent inadvertent firing of the gun. The parachute deployment handle requires a 7-pound pull, through a two-inch stroke to actuate the system. Except during tests, the arm/jettison handle is positioned in the “jettison” position, so that the parachute will pull free of the airplane in the event of inadvertent parachute deployment. The pilot “arms” the system, prior to initiating stall/spin tests, mechanically locking the parachute riser shackle to the airplane.

The parachute system (including tail cone structural reinforcement) weighs approximately 23 pounds. The same system, installed on two other research airplanes, has been used successfully 20 times to recover the airplanes from otherwise unrecoverable spins.

Quick-Release Door
The right-side door can be released by pulling two handles. Pulling the first handle, mounted on the door, releases the upper latch. Pulling the second handle, mounted on the forward door frame, withdraws the two hinge pins. The door is then pivoted outboard on the aft latch under the force applied by the pilot, centrifugal loads caused by airplane spinning, or aerodynamic loads. The door is fully released from the aircraft within a pivot angle of approximately 20°.

Inadvertent jettison is precluded by use of breakwire to secure each handle and an approximate 10-pound, 1.5 inch stroke to actuate.

Pyrotechnic Egress System
This is an add-on system that cuts and jettisons the airplane’s skin and structure to create an opening of approximately 30 x 30 inches. The metal cutting is accomplished by small quantities (less than 0.4 ounce) of explosive, flexible linear shaped charge, which is a 0.2 inch wide metal tube, filled with explosive. The system is actuated by pulling a pyrotechnic egress handle. The handle pivots on forward attachment points and directly pulls firing pins to initiate the explosive. On initiation, the explosive cuts the skin around the window to the floor, including a central stringer. The explosive pressure wave then strikes the external frame to provide a jettisoning force. All inboard products of the explosion (fragments and pressure/sound) are contained by a continuous internal structure. This structure allows the explosive pressure to expand and attenuate within the 1.5 inch depth of the existing stringers and frames. A 1.5 x 1.5 inch wire mesh, stretched across the window, prevents the plexiglass window, that flexes and breaks on actuation, from entering the cockpit.

The explosive is completely insensitive to mechanical abuse, radio/radar transmissions, lightning and static electricity. It can be damaged by gunfire or fire, but will not be initiated by these inputs. Inadvertent initiation is precluded by securing the handle with a safety pin, a breakwire, and a 16 pound, 0.5-inch stroke to actuate.

No maintenance or inspection is required, except for five-year replacement of the initiators. The total add-on weight is 20 pounds. The panel that is cut from the aircraft weighs approximately 14 pounds, and is jettisoned at a velocity of 45 feet/second (30 mph). The opening is neat and smooth, presenting a minimal interference to the pilot on egress.

This Piper Cherokee Arrow has been operational, as modified, since June, 1981.