Rollover Protection

Innovation that saves lives

BY MARK PHELPS

THE REAR COCKPIT OF Bill Greenwood's two-seat Spitfire is a tight spot, and with Bill flying from up front, we were headed for Grand Junction Airport in Colorado. It wasn't our first choice of destinations, but on short final at Bill's home airport in Aspen, the Spitfire's air pressure system sprung a loud and raucous leak. Without air pressure, he knew instantly we would not be able to A) fire the guns or B) use the brakes. Problem A was not of great concern, but landing a narrow-legged Spitfire in a gusty crosswind without brakes was not on either of our bucket lists.

So Bill got on the radio and checked the runway alignments and winds at airports within range. He decided we'd head for Grand Junction, where the wind was advertised as right down the middle of one of its long runways. It also gave us some time to discuss the coming landing. Everything looked good for a brakeless landing, but Bill wanted to be cautious and reviewed the evacuation procedure for me—just in case. That was when I asked if he wanted to slide the canopies back for the landing, to prevent them from being jammed shut. I'd read about Spitfires and other fighters taking off and landing open-cockpit style for that exact reason. Bill had not heard that bit of trivia

"So that's what the notch is for," he sai
Then it was my turn to learn something n
What notch? Bill explained how the small
access door of each cockpit had two latch
positions, one of which was offset so the
door stayed cocked open a half inch or so.
The left track for the canopy slide ran alo
the top of the door, so with it open that lit
bit, the canopy would be unable to slide fo
ward. It was a safety innovation designed
into the Spitfire to protect RAF fighter
pilots, who became a precious national as
during the Battle of Britain.

History does not record how many Spitfire pilots were able to escape a crash thanks to that little trick with the door, bu

PHOTOGRAPHY BY RODNEY_X (WWW.THINKSTOCK

it saved one life, it was worth the extra rivets, pins, and ingenuity to put it in. And how many Spitfires were upended by inexperienced pilots who lived to fly another day thanks to the added crashworthiness of R.J. Mitchell's masterpiece?

Fortunately for me, we didn't have to test the system, and Bill made an excellent landing and rollout. But having faced the prospect of a flip-over firsthand, I've since looked at a new aircraft design with this question in the back of my mind: How would you get out if it flipped over?

The risk varies with aircraft configuration, of course, with nose-wheel-equipped, high-wing designs on the low end of the hazard scale. With the more remote risk of a nose-over and the main strength of the structure above the pilot's head, chances of being trapped underneath the airplane are pretty slim. In many post-accident photos involving high-wings, you can see the airplane lying supine with its wheels extended skyward—but the side doors are open, indicating a relatively easy exit for the occupants.

Low-wing taildraggers are another story, however. I remember attending my first EAA fly-in at Plum Island Airport in Massachusetts back in the 1970s. A Spezio Tuholer flared to land and promptly nosed up and over onto its back. The vertical stabilizer held up, and the uninjured pilot was able to crawl out, dust himself off, and immediately start thinking of excuses to fill in on his insurance claim form.

Any low-wing aircraft design worth considering has to have adequate rollover protection, especially if it has the third wheel in the back. Taildraggers are disturbingly prone to nosing over on landing, especially in challenging wind conditions. There's a fine line between aggressive braking and extreme embarrassment.

The good news is that most flip-over scenarios occur at very slow speeds. Also, the lighter the airplane, the less force applied to the airframe on impact. Many EAAers recall the tragic loss of Charlie Hillard at Sun 'n Fun in the flip-over of his Hawker Sea Fury, though it involved a much heavier aircraft than a homebuilder will be flying. The lessons learned in that accident have probably saved several lives. The loss of Charlie has spurred countless discussions on rollover protection that might never have happened otherwise.

I looked over one of those discussions online while thinking of writing this article. One thread involves a designer/builder's concern about rollover protection in the low-wing airplane that was taking shape in his mind's eye. It was interesting to see how the discussion evolved, and how the

contributors addressed the key design issues one at a time.

The obvious goal is to ensure there is a sufficiently strong structure that will keep the weight of the airplane off the occupants in a flip-over. "You'll need to visualize how the airplane will sit upside down" was one contribution to the discussion. Consider the geometry of the front fuselage, vertical tail, and canopy structure. If you can draw up a structure that maintains sufficient clearance, you have the first step.

A spokesman for Van's Aircraft said that in 25 years, he could remember only one fatality involving a flip-over accident. The builder had modified an RV-4 with a turtledeck and a lowered rollover structure to achieve a more pleasing visual line. Unfortunately, the airplane experienced a forced landing, flipped over, and the pilot did not survive.

One question that comes up is whether or not to rely on the vertical stabilizer to support the airplane after a flip. Some builders recommend adding reinforcement to the structure to enhance its chances of holding up under impact. The variable, of course, is the violence of the force as the tail comes crashing down. That force is affected by several factors, mostly the speed at which the tumble begins. The trade-off in adding weight to the structure is amplified by the large moment arm of the tail, which is obviously far from the CG. In my old V-tail Bonanza, the tail's ruddervators could not be converted from magnesium to aluminum due to the slight difference in weight that far aft.

Taking a page from the auto racing industry, most designers incorporate roll structure in the cockpit area itself. Van's has researched the requirements extensively, and structural roll protection is built into the design. It starts up front, with the windshield bow. Fabricated from robust steel tubing, it has been tested to standards Van's has determined to be within the range of most likely rollover scenarios. The Van's spokesman said builders can count on the windshield bow to support the front end of the fuselage in an otherwise survivable rollover incident.

The cockpit rear structure is made up of heat-treated aluminum, and varies in configuration with each model. The side-by-side designs have the beefed up structure built into the rear turtledeck. Tandem designs such as the RV-8 incorporate carefully configured roll protection at the rear of the aft seat area—enough to keep the rear-seat passenger's head protected from terra firma.

Of course, surviving the impact of the flip-over is primary, but what happens afterward can be equally vital. In one forced landing on a beach, the aircraft flipped over, and the passenger drowned before help could arrive. Any hinged or sliding canopy will be rendered unusable when the airplane is sitting on it. Gull-wing doors are more likely to permit an easier escape, but in most cases, the only way out will be by busting through the Plexiglas. Chances are good that the impact of the airplane crashing down will take care of a lot of that chore, but it makes good sense to plan for the day when you might have to claw your way through. Peter Vollheim, who built his Glasair back in the 1980s, had a commando-style knife strapped to the inside of his cockpit within easy reach. Other pilots keep a hatchet stowed nearby for the same reason. (It can also come in handy later, for chopping firewood if your forced landing lands you far from civilization. Just be sure it is secured in flight, for obvious reasons.)

Finally, the importance of adequate seat restraint systems cannot be overemphasized. Even if the airplane's structure is as strong as a bridge, it won't help if the bodies inside are free to bounce off instrument panels, side rails, sharp switches, and knobs. The most important tool in escaping from a forced landing is a conscious, uninjured pilot. EAA

Mark Phelps, EAA 139610, is an aviation writer living in New Jersey. He is the former editor of EAA's *Vintage Airplane* magazine.