Airborne Airbags?

None of us plan to crash, but stuff happens. When it does, your seat belt/harness may not keep you from hitting the panel but an AmSafe airbag probably will.

BY JOSEPH E. (JEB) BURNSIDE

There's an old joke about stepping off a tall building: It's not the step itself that hurts; it's the sudden stop at the bottom. So it is when considering the crashworthiness of general aviation aircraft—we want to eliminate or minimize deceleration forces to maximize survivability. Automobile designers learned this long ago, helped along by federal standards. Unfortunately, an aircraft's very nature makes adopting some of the automobile's engineering to enhance general aviation crashworthiness either impossible or too much of a compromise.

But one popular and proven automobile safety enhancement has made its way to general aviation in recent years: the airbag. Many manufacturers offer them as standard or optional equipment—AmSafe, the company manufacturing the devices, says almost 80 percent of new GA aircraft are equipped with them. They also can be retrofitted to the average personal airplane. But do they work? How are they installed and mounted? Given the effects of turbulence and bad landings, how do they "know" when to deploy and when not to? How much do they cost and what's involved in maintaining them? Finally and perhaps most important, what is their track record, both involving accidental deployments and scenarios in which they were designed to deploy? Did they work as advertised? For answers to these and other questions, we sat down with representatives from AmSafe.

HOW THEY WORK

The AmSafe airbag works on the same basic principle as those found in automobiles: When a sensor determines a deceleration threshold has been met or exceeded, the unit rapidly inflates a cushion to protect an occupant from impacting the vehicle's structure. Unlike automobiles, however, the AmSafe airbag is not mounted in the instrument panel, the yoke or on the interior sidewalls. Instead, the bag itself is incorporated into specially designed harness and seat-belt straps. The airbag is stored in the lap belt portion of the two- and three-point restraints and in the torso section of four- and five-point systems. One reason for Amsafe's in-the-belt design instead of mounting them in the instrument panel is motor vehicle safety standards require an airbag to protect the occupant even when a seat belt isn't worn. That's not necessary in aircraft. It's impractical, also.

But the belt-mounted device is only the most-visible portion of the AmSafe airbag installation. Additional components include an inflator, which stores compressed gas until it's needed to inflate the airbag, plus an electronics module assembly (EMA), which determines when to initiate the inflation sequence. These latter two devices are mounted near the seat, perhaps under the airplane's floor, and are wired together. The inflator connects to

the airbag-equipped belt/harness with a hose. The EMA includes its own power source—a battery—so it is completely independent of the aircraft's systems and will function in the event of complete electrical failure. The image at the bottom of this page depicts the typical components of an AmSafe airbag for a GA aircraft prior to installation.

There isn't a set "G-limit" at or beyond which the airbag will deploy. Instead, according to Thomas Barth, Ph.D., director of research and development for AmSafe Aviation, "It's a combination of a G threshold and impact energy. In a typical general aviation crash, the airbag will deploy at approximately 9Gs." Put another way, the sensor deploys the airbag when there is "massive longitudinal deceleration for a sustained period of time," according to the company's Web site. Barth added, "The crash sensor is designed to read the forward longitudinal component of the impact vector." That means, for example, that severe turbulence or a hard landing won't trigger deployment because the G-force isn't sufficiently high and isn't aligned with the airplane's longitudinal axis.

Of course, a minor accident is in the eye of the beholder. According to AmSafe, a minor-injury accident generally does not involve sufficient impact force to trigger deployment. However, that doesn't mean the airplane might not be substantially damaged, or even totalled. Instead, the airbag system is designed to deploy when the airplane's deceleration is great enough to threaten serious injury.

A typical airbag for a three-point harness is shown at left. Below are the three basic components of an AmSafe airbag installation: The electronics module assembly is at upper right, an airbag-equipped harness in the middle and an inflator at bottom left. Both images provided courtesy of AmSafe.

INSTALLATION, MAINTENANCE

If you're buying, say, a new Cirrus and want airbags, there's no worry: AmSafe's airbags presently are standard equipment. The same is true for many manufacturers of new aircraft. For the rest of us, the airbags can be retrofitted, either under a supplemental type certificate (STC) or a field approval. A sizeable number of STCs exist for popular aircraft.

To accomplish all this and ensure installations are performed as the company specifies, AmSafe has established a large number of service centers at FBOs and aviation maintenance organizations throughout the world. There are 13 such centers in Australia, for example, doing the necessary engineering, mechanical installation and paperwork.

For the most part, the airbag system is an install-and-forget affair. Once the appropriate brackets are selected and installed, it's fairly simple and straightforward. One exception is the company's instructions for continued airworthiness require the system to be tested each year or every 1000 flight hours, whichever comes first. The testing requires an electronic diagnostic tool, which is plugged into the installed system. The diagnostic tool isn't something the average A&P-IA or FBO has in a toolbox, so the test usually is performed at one of the company's service centers. AmSafe also recommends a system diagnostic be completed any time a seat is removed or replaced. A failed diagnostic doesn't ground

the aircraft, according to the company.

Additionally, the inflator and EMA are life-limited. The inflators must be replaced within 10 years of manufacture—not installation—and the EMAs must be refurbished within seven years after production. In other words, the EMA's battery is good for at least seven years. Of course, once the airbag is deployed, it's time to replace the system, if not the airplane.

Meanwhile, the EMAs are replaced 14 years after they are manufactured. Remaining components, including the airbag itself and the system's wiring harness, are replaced on-condition.

Pricing for a typical three-point pilot/co-pilot seatbelt airbag kit runs around $3600, plus installation. Time required ranges from six to 12 hours, depending on the aircraft model. AmSafe tells us the typical cost for a three-point seatbelt/airbag kit including installation labor is less than $5000. AmSafe was unable to provide a ballpark price for the annual diagnostic test performed at a service center.

REAL-WORLD TESTING

AmSafe first began offering its airbags for GA aircraft during the 2004/2005 timeframe. Factory installations began with Cessna's 2005-model single-engine piston airplanes. These and other versions of AmSafe's airbag systems have been installed on more than 6000 aircraft worldwide, including scheduled airliners, as well as GA and light sport airplanes. According to the company, installations averaged 130 per month during 2008. How have they fared in the field? Have they deployed as-designed during crashes? What were the outcomes?

According to Barth, there have been approximately 180 total events involving aircraft equipped with his company's airbags, either classified as accidents or incidents. Of those events, about half involved substantial damage or serious injury, thus meeting the NTSB's definition of an accident. Of those accidents, the airbags have deployed roughly 50 times.

This Swiss-registered Cirrus SR20-G2 was equipped with airbags when it crashed after entering a blind canyon in the Alps on February 7, 2006. The solo pilot suffered only minor injuries. Image provided courtesy of AmSafe.

"I've gone out on dozens of aircraft investigations now, and I've seen a wide variety of accidents. In all the cases that I've seen, the airbags have deployed in instances where there was serious injury. In all the cases where the airbag has not deployed, where the impact was below the impact threshold of the crash sensor, there have been no serious injuries," Barth told us. "In all the accidents that I've gone to and expected the airbags to deploy, they have deployed. I've never seen it deploy in a minor accident where it wasn't needed," he added.

CONCLUSION

Not wanting to subject ourselves to what's necessary to field-test an AmSafe airbag, and based on the company's track record, we'll take its word these products work as advertised. Although AmSafe is currently the only vendor of a compatible product, neither kit nor installation prices seem exorbitant. We're not aware of any airworthiness directives or factory recalls involving AmSafe's products, nor have we heard of great dissatisfaction among customers. We'd certainly consider buying and installing an airbag kit in our airplane.

We've seen evidence and heard lots of stories about fatalities resulting from otherwise-survivable accidents. In one specific instance, the airplane remained largely intact, but the pilot didn't survive after his upper body pitched forward and his forehead hit the artificial horizon. Clearly, a lap belt alone isn't enough, and even the four-point aftermarket shoulder harnesses we installed aftermarket aren't guaranteed to keep us out of the panel, especially if the deceleration forces aren't straight ahead.

We all want to think we're good enough to avoid such an event. But the accident reports are littered with pilots who thought the same.