

Airbag Seatbelts: Pricy, But Effective

Airbag seatbelts are now available for retrofit in 150 different types of general aviation airplanes. We think the added occupant protection is worth the cost.

by Rick Durden

We've long urged aircraft owners to retrofit shoulder harnesses for all seats of their airplanes if at all possible. The simple reason is that a restraint system that keeps your head and upper torso from smacking into the instrument panel or seat in front of you during an accident sequence is the single most effective mod you can make to your airplane to radically increase the chance of everyone aboard surviving an accident.

As technology has improved, we're now strong advocates of a system that goes further to protect occu-

pants during an impact—the airbag seatbelt from AmSafe (www.amsafe.com), a Phoenix, Arizona, manufacturer that specializes in occupant protection testing and products for cars and aircraft.

Before we go into details of retrofitting airbag seatbelts—they're now standard features for most seats of nearly all new general aviation aircraft—we'll take a look at the realities of accident dynamics and how to reduce your risk of injury.

THE QUICK STOP

We'll start out by pointing out that

the “thrown clear and survived” reports that are sometimes made after accidents are nonsense. A human being, even in excellent condition, cannot survive hitting the ground at 60 MPH. He or she will either stop instantly or bounce across the surface like a rag doll, suffering repeated impacts that will cause massive trauma to internal organs and the brain that is not survivable. For example, one of the chief causes of death in automobile rollover accidents is that occupants who aren't wearing seatbelts get thrown out of the vehicle and come to a quick stop against the ground or an obstruction.

After World War II there was extensive research into airframe crashworthiness. By the 1960s Cessna, Piper and Beech were doing full-scale impact testing. Cessna and Piper gave NASA some airplanes for it to crash under varying conditions for the in-depth studies it was doing on impact dynamics and modeling what went on during a given crash sequence to help develop ways to keep aircraft occupants alive.

LESSONS LEARNED

Simplified, the testing demonstrated that: The slower the impact, the better. The longer in time and distance the deceleration can be spread over, the better (airbags use this fact). The more impact load that can be absorbed by a progressively collapsing aircraft structure and not transmitted to the occupants, the better. Occupant restraint is essential—keeping the full torso restrained to the seat during the impact sequence vastly improves the odds of survival—the FAA says shoulder harnesses cut fatality rates by 20 percent and injury rates by a whopping 80 percent. Finally, designing the cabin area in front of the occupants to be free of objects that can hurt the occupants as they go forward during airframe deceleration and the panel comes back due to impact forces improves survivability (airbags also take advantage of this fact).

The AmSafe seatbelt airbag deploys when impact is sensed, providing occupant protection in addition to the shoulder harness.



In a three-point restraint system, the airbag is installed in the seatbelt, above right. For a four-point restraint, there is an airbag in each shoulder harness, below right.

Because of constraints of weight and keeping cabins small to minimize frontal area to reduce drag and maximize speed, most general aviation aircraft cabins have limited “flail space.” Flail space is the area in front of an occupant’s seat in which his or her arms, legs and head are going to flail around—uncontrollably—in an impact sequence. If there’s something in that space, the occupant is going to hit it, *hard*.

While it seems beyond foolish, we keep running into people who claim they can “brace” and protect themselves from getting hurt in a crash. It’s not possible. You cannot keep your head off the panel if you don’t have a shoulder harness—the impact forces will either overpower you in an instant or snap your locked elbows, adding to your injuries and stunning you or rendering you unconscious, delaying your exit. Further, jackknifing over the seatbelt can give you a spinal injury that can cause paralysis. Do we have your attention?

TECHNOLOGY EVOLVES

Shoulder harnesses provide good protection in the general aviation environment of limited flail space. The next step up is a five-point belt restraint system—two lap belts, two shoulder harnesses and a crotch strap that keeps you from submarining under the belts. The top tier, under current technology, of occupant protection is a combination of a two-, three-, four- or five-point restraint system and a smart airbag that deploys when an impact is sensed.

In the world of general aviation, the only purveyor of FAA-certified airbag restraint systems is AmSafe. Using a two-, three-, four- and five-point restraint with airbag(s), inflator(s) and sensor, the AmSafe system positions the occupant with the seatbelt and shoulder harness(es)—without the occupant

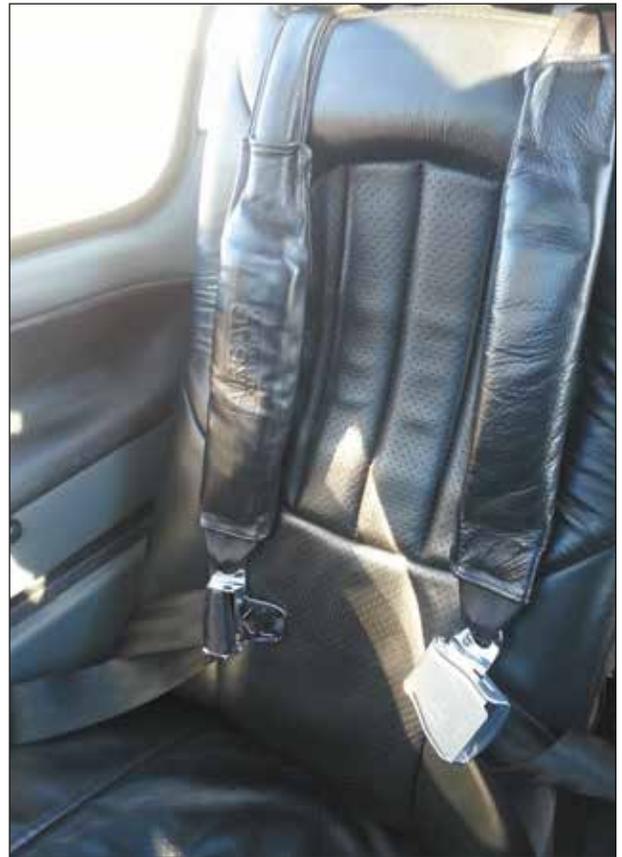


positioning provided by the belt and torso restraint an airbag system ranges from worthless to counterproductive—and protects against impact forces with an airbag specifically tailored for the shape of the space.

CABIN SHAPE

Because the shape of the space of general aviation cabins varies widely, seatbelt airbags are not one size fits all. They have to be developed for the individual seat in the individual airplane, including the degree of seat travel and occupant sizes—which means from the smallest five percentile adult female through the largest 95-percentile adult male. As might be imagined, the development process is complex; nevertheless, more than 150,000 AmSafe airbag seatbelts have been installed and are approved for installation in some 150 different types of general aviation airplanes, according to Jim Crupi, AmSafe’s business development and technology support manager.

During manufacture, each airbag



is sewn and folded onto one of the belts. A gas hose runs from the bag to the inflator. A wire runs from the inflator to a sensor that tells the system when to activate.

The airbag is designed to deploy some 50 milliseconds into an event that meets the design parameters for the sensor to trigger—longitudinal

AMSAFE'S NEW CHILD AVIATION RESTRAINT SYSTEM—CARES

While we were researching this article on AmSafe's aircraft seatbelt airbag restraint systems we came across a new product developed by AmSafe—its Child Aviation Restraint System, acronym: CARES. While it is not an airbag system, we are including it in this article because we are passionate about occupant protection during accidents and from what we've seen, CARES looks like a product that offers comparable impact protection to a car seat without the bulk and at a fraction of the weight.

CARES is FAA-certified for use in general aviation and airline aircraft. It's one of those creatively simple designs that causes folks to slap their foreheads and ask why they didn't think of it—upper photo.

The system includes a band that wraps tightly around the seat in which the child will be sitting at a level above the child's shoulders. A set of shoulder straps hang from the band. The regular seatbelt for the seat is threaded through the loop at the base of each shoulder strap and the seatbelt is then buckled at the child's waist and tightened. The next step is to fasten the clip connecting the two shoulder straps about midway between the child's waist and shoulders. Finally, the shoulder straps are tightened. If the seat the child is occupying has shoulder harnesses, they are not used; the CARES unit has its own, designed for the size of the child, built in.

That's it. We watched videos of one person settling a child into the seat and securing her with CARES within a minute.

In an emergency, all that's necessary to release the restraint system is to unbuckle the seatbelt and lift the CARES unit over the child's head. It looked to us to take about five seconds. We've used a number of car seats that took longer.

Priced at \$74.95 and sold through Kids Fly Safe (www.kidsflysafe.com), CARES is designed for children from two to four years old with a weight range of 22 to 44 pounds and who are less than 40 inches tall. It may only be used in forward-facing aircraft seats.

We were very impressed to see that AmSafe also developed versions of CARES it refers to as "Special CARES" for special needs children from 41 to 56 inches tall as well as

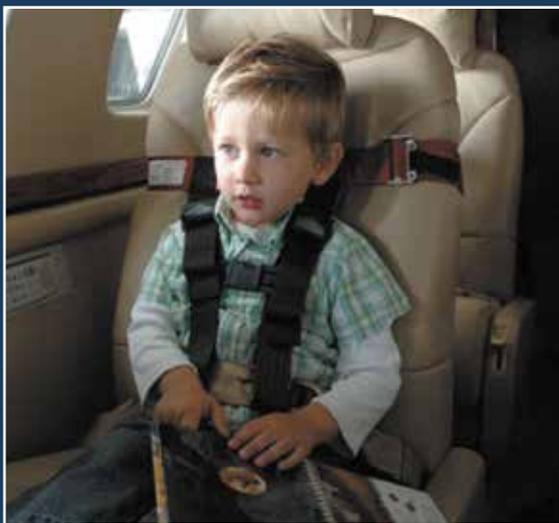
children and adults more than five feet tall. Using one of the Special CARES systems requires an exemption letter from the FAA; however, the Kids Fly Safe website explains how to apply for and get an exemption and provides a template for the application.

The entire CARES unit weighs a pound and folds into a small carrying case—lower photo. It is NOT to be used in automobiles—it does not replace the car seat in a car, but it does allow the car seat to be stowed in the luggage compartment of a general aviation airplane or checked as baggage on an airliner.

Having installed car seats into the back seats of a number of general aviation airplanes and experienced the gyrations required—and sometimes being unable to get one secured without a second person helping out—we think CARES may simplify life for general aviation pilots flying with kids.

Taking kids in general aviation airplanes requires some planning and effort to keep them safe and happy. We think AmSafe's CARES system just made things a little easier for

pilots who want to do so. For more information on flying with babies and kids, see our sister publication *AVweb* (www.avweb.com) and search on flying with babies and kids.



(and only longitudinal) deceleration greater than between 6 and 9 G (varies slightly with installation). A hard landing, no matter how impressive, won't cause a seatbelt airbag to deploy.

We are aware of unsuccessful testing carried out by an aircraft manufacturer exploring the idea of installing automotive-style airbags into agricultural airplanes starting in the 1970s. As with cars, they were

mounted in the instrument panel and deployment meant that the stick was forced aft violently. During an impact sequence there was concern that the aircraft was still moving fast enough that rapid up-elevator deflec-

A retrofit seatbelt airbag system laid out ready for installation.

tion could have unintended, and bad, consequences.

Inadvertent deployment of a panel-mounted airbag in flight that shoved the stick aft could be catastrophic. That led us to inquire about testing for inflight deployment of a seatbelt airbag.

As part of the testing for certification of the seatbelt airbag system under 26-G requirements of FAR 23.562 (and 18-G requirements for older seat designs), AmSafe had to demonstrate that an inadvertent inflight deployment would not adversely affect control of the aircraft and would not knock the pilot's hand off of the yoke or stick. Certification also required demonstration that the risk of inflight activation was so small that it approached zero.

AmSafe has numerous videos on its website of full-scale, dynamic crash testing. They show that the airbag deploys primarily upward to protect the occupant's head and chest. In describing how that works to protect the occupant as well as avoid hitting the controls, AmSafe says, "The occupant hitting the bag is resisted by increasing air pressure, essentially creating a pneumatic spring. The maximum compression of the bag occurs before the occupant's head hits the interior structure. The venting of the bag acts as a damper, reducing the rebound and dissipating the energy through the air flowing out of the bag."

Jim Crupi told us that AmSafe seatbelt airbag systems have logged more than 400 million hours of service and that there has not been a reported inflight activation.

RETROFIT

AmSafe's website has a full list of aircraft for which its seatbelt airbags can be installed as retrofit equipment. In general, if you own an all-metal or composite aircraft built after 1960, there's a good chance that you can have seatbelt airbags installed for at least the front seats. Often the rear-seat retrofits replace a seatbelt-only system, greatly improving occupant protection.

Prices for seatbelt airbags range from \$4000 to \$5000 per kit—a kit



retrofits two adjacent seats. Most installations do not require modification of the airframe. Scott Utz, director of maintenance of Arapahoe Aero on Denver's Centennial Airport, an AmSafe-approved service center, told us that installation times range from eight to 40 hours per seat and depend on the type of airplane and the options, notably TKS, installed. He said that retrofits on Pipers and Cessnas are the easiest—Mooneys take the longest.

There are ongoing maintenance requirements: The crash-sensing electronic module (one for each two seats) has a seven-year service life—it's currently \$1031 for replacement and \$385 for refurbishment—and it can be refurbished once. The inflators also have to be replaced at the 10-year mark—they are currently \$590 each. The seatbelts must be inspected at the annual inspection using a dedicated system diagnostic tool—which means going to one of the many AmSafe-approved service centers or buying or renting the tool from AmSafe.

AmSafe recommends that any time any component of the system is disconnected that the full system diagnostic be run after the system is reconnected.

FIRING IN ANGER

We were directed to a number of videos on AmSafe's website for

examples of seatbelt airbag deployments in general aviation aircraft. A CFI who was almost able to get a Cirrus to an airport after an engine stoppage and discovered the terrain where he touched down was rough enough to violently stop and flip the airplane after only rolling 100 feet walked away from the crash unhurt. Things happened fast enough, he said, that he was unaware of the airbags deploying. It was only during an inspection of the aircraft afterward that he learned they had functioned as designed. He credited the airbags with preventing injury to the occupants.

While individual reports and videos are anecdotal, they, combined with the hard data on impact loads, are powerful evidence of the value of seatbelt airbags in saving lives and reducing the level of injury.

CONCLUSION

We're strong supporters of retrofitting AmSafe's advanced-technology occupant restraint systems to reduce the risk of injury in a general aviation aircraft crash. We especially like the magnitude increase in occupant protection airbag seatbelts provide for seats that only have a seatbelt—no shoulder harness. We're watching to see whether they will eventually be made available for older airplanes in which it's not possible to retrofit shoulder harnesses.