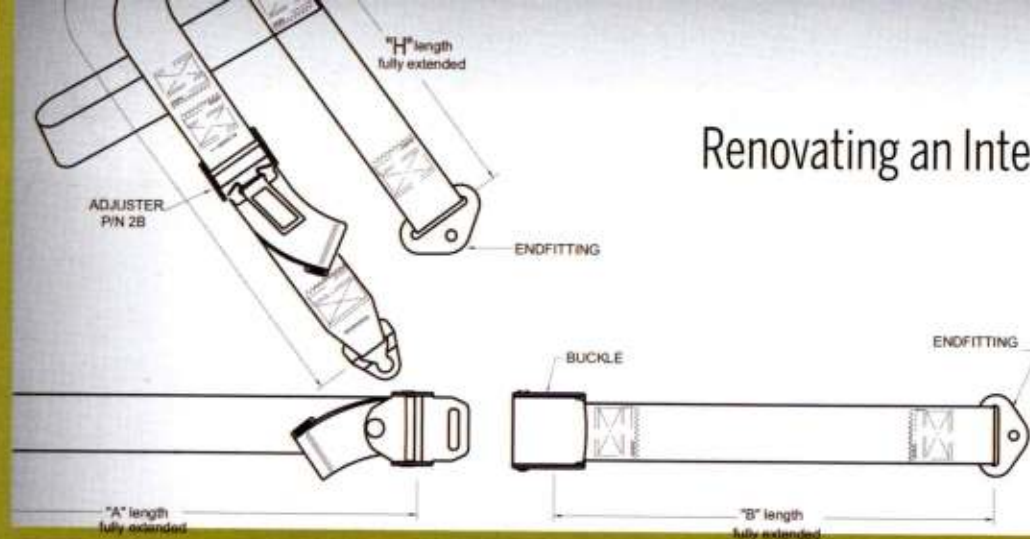




Four-point B.A.S. Inc. inertia-reel shoulder harness comfortably and symmetrically supporting both shoulders.



# PASSENGER RESTRAINTS

Aircraft interiors expert **DENNIS WOLTER** discusses shoulder harnesses and their crucial role in keeping light aircraft occupants safe.

**H**ave you ever had a salesperson convince you to buy something with the sales pitch “I hope you’ll never have to use this product!”? That sounds like possibly the worst investment you could consider making with your hard-earned bucks. But that is precisely what I am trying to convince anyone who is reading this article to do.

## Crashworthiness concerns

In my much younger, pre-Air Mod days, I worked for an aircraft metal repair shop. We often found ourselves heading off to some field or woods to recover a wrecked airplane. In a very short time, it became graphically obvious to me that two things have a significant effect on the outcome of an off-airport landing.

The first is airframe structural integrity. Cessna singles really shine in this area. A lot of structure is needed in a high-wing airplane between the wings and the landing gear. That means that those massive forward and rear door posts have to be hefty enough to absorb both landing and flight loads. This substantial cabin structure creates a “roll cage” that protects the occupants, even if the airplane is inverted. Let me tell you, as light airplanes go, these things are tough.

We recovered several upside-down Cessnas during my time at that shop. In many cases, the only injury was a scratch the pilot received when he caught his pants on a barbed-wire fence while going to the farmhouse to call for a ride home.

The second area of concern is one that lags behind the safety enhancement curve; namely, shoulder harnesses. Growing up in an airport environment, I was more than once the first person to get to the scene of a serious accident. I have removed seriously or fatally injured front seat occupants from three badly crashed airplanes.

Back in the early 1970s, most light airplanes were not equipped with shoulder harnesses. There could have been a far better outcome if state-of-the-art shoulder harnesses had been installed in those airplanes. Somewhere in the past, I read a statistic stating that wearing a shoulder harness in a light airplane has approximately the same fatality-reduction benefit as wearing a helmet when riding a motorcycle.

If you are flying an older Cessna that does not have shoulder harnesses, particularly

This photo shows the massive door post that is part of the structure that makes up the strong cabin “roll cage.”



The factory-installed mounting point located directly behind each front seat in the cabin top spar carry-through.



Aft seat shoulder harness mounting point located outboard and above the aft seat of a 1960 Cessna 182 Skylane.



for the front seats, I would advise that you work with your maintenance technician to purchase and install an approved system. Here's the good news: every Cessna single-engine airplane built after 1946 (except for a few 210s and early 177 Cardinals) left the factory with shoulder harness attachment hardware for front-seat passengers already installed in the aft spar carry-through. Starting in the early 1970s, all Cessna singles also have factory-installed shoulder harness mounting points for all other seating stations. Let's look at various shoulder harness design options.

### Three-point harnesses

The most common option chosen by airframe manufacturers and some aftermarket suppliers is a three-point fixed shoulder harness that is secured to the airframe in three places. There is an attach point at each end of the lap belt, and one where the single-strap shoulder harness is secured to the upper outboard cabin structure behind the pilot or co-pilot seat.

For increased comfort and safety, an aftermarket three-point inertia-reel harness can be installed that allows the occupant free movement while performing pilot duties such as switching fuel tanks or leaning forward while looking for traffic.

An inertia reel always keeps the harness comfortably and correctly located diagonally across the occupant's upper body by automatically extending and retracting during movement. If a sudden deceleration force is sensed by the mechanism in the inertia reel, it instantly locks up and holds the occupant in place.

If you have a fixed three-point system, you may want to consider replacing it with

an approved aftermarket inertia-reel system. History has shown that pilots using a fixed shoulder harness will be tempted to loosen it or take it off in flight and not remember to put it back on before a time of need arises.

One can purchase FAA-approved three-point aftermarket shoulder harness kits from CFA supporters Aircraft Spruce, Alpha Aviation, and Wag-Aero, and also from Hooker Harness and most airframe manufacturers.

### Four-point harnesses

Next on the list of shoulder harness designs is a four-point system that is secured to the upper cabin structure directly above and behind the occupant, not off to the side. In all strut-braced Cessnas, these systems are installed on the aft spar carry-through truss using either the factory-installed nut plate, or a purpose-designed bracket supplied with an approved kit. (*Kits are available from CFA supporter B.A.S. Inc. —Ed.*)

A four-point harness system creates additional restraint by having two shoulder straps that symmetrically support both shoulders. This does two important things. First, it eliminates any twisting of the upper body during what engineers call a "high g load deceleration event" (I call that a crash!).

Second, the effectiveness of a three-point single-strap harness mounted on one side is affected by the direction of the impact. If the impact force vector is from the same side where the harness is attached to the upper cabin, the resulting force is working to tightly hold the upper half of the occupant's body in the harness.

Conversely, if the impact force vector

is from the opposite side of the harness attachment, the resulting deceleration force could pull the occupant out of the harness. Many sudden stops do not always result in a forward impact; there can be multiple impacts where the initial force is off-center, the airplane spins to one side, hits another immovable object, and the momentum pulls the occupant out of the harness. Yikes!

### Three-point harnesses with airbags

Last, but certainly not least, are the AmSafe air bag three-point inertia-reel harnesses and belts. This system adds air bag protection to a three-point restraint system. The kit cost is approximately \$5,000, includes both pilot and co-pilot seats, and requires eight hours of installation labor. Once installed, the system requires ongoing inspection and testing, and has the potential need for component replacement.

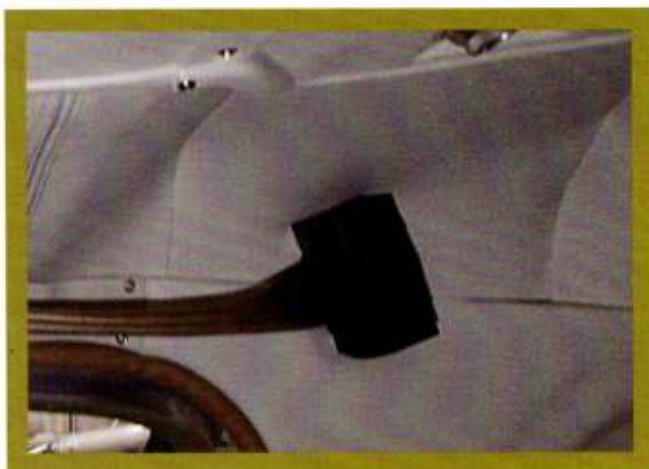
### Installation approval

When I started Air Mod in 1973, very few approved aftermarket four-point shoulder harness installation kits existed. I bought an old cabin section from a wrecked Beechcraft Bonanza to use as a design and testing tool for installing a four-point inertia reel harness that would be FAA-approved.

Back then, an FAA airworthiness inspector would observe a 9 g pull test, confirm that all materials, design, and processes were adhered to as outlined in AC 43.13, and issue a duplicatable field approval that could be used again for installations in the same make and model of aircraft.

Today, any major modification of a passenger restraint requires that a FAA

An aftermarket three-point harness with an FAA-approved inertia reel.



The B.A.S. Inc. four-point inertia reel and mounting bracket secured to the factory hard point on the aft spar carry-through.



DER (Designated Engineering Representative) be involved in the engineering process, and the resulting field approval would be a one-time use, non-duplicatable approval. The installation is approved for only the one airplane that was tested for the specific modification.

Luckily, there is an easier way. We can purchase FAA STC (Supplemental Type Certificate)-approved, well-designed three- and four-point fixed or inertia-reel harness kits. These kits can be installed by an airframe mechanic and signed off on an FAA Form 337 (Major Repair and Alteration) by a mechanic who holds an IA airworthiness inspector rating.

For more information on the design and field installation of shoulder harnesses, refer to Chapter 9 of FAA AC 43.13-2B. The FAA has done a great job explaining all the engineering, design,

and installation processes involved in installing this most important safety enhancement owners can add to their legacy Cessnas. Remember, you can't write the check on the way down!

#### How we upgrade our customers' airplanes

At Air Mod, we install four-point inertia reel STC'd shoulder harness kits for the front seats in most Cessnas that we bring in for renovation. We purchase these kits from B.A.S. Inc. Installation time is approximately eight hours. This product is available for all strut-braced airframes, as well as 210s and 177 Cardinals. The cost for the kit averages \$1,500-\$1,600, and includes lap belts (the kit includes everything for both pilot and co-pilot seats). Also, there are approximately 40 webbing color choices.

In most of our installations, we suggest having the old pilot and co-pilot fixed three-point harnesses and lap belts re-sized, re-webbed, and certified by an approved aircraft passenger restraint repair station. We then mount these three-point harnesses on the existing aft seat mounting points mentioned earlier. So, for a re-webbing charge and a half-hour of labor, each aft seat in most high-wing Cessnas will have the enhanced safety of shoulder harnesses.

#### Additional crash protection

One final note: if you fly over mountains or water, I highly recommend keeping a bicycle or motorcycle helmet in the back seat. Off-airport landings in mountainous terrain or on water will definitely put a good shoulder harness to the test. It's also possible that a side impact can temporarily incapacitate a person at a time when seconds may count in getting out of the airplane. A helmet can help eliminate this risk.

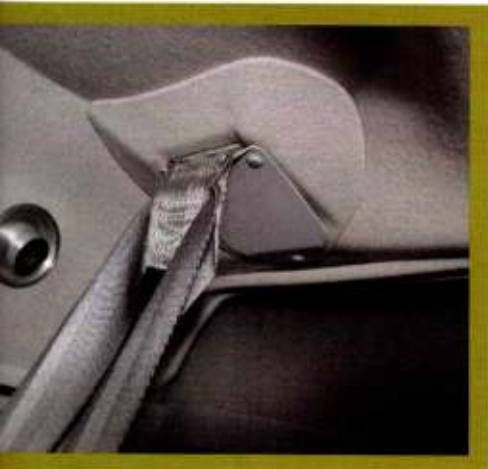
I love to take my 172 to the mountains every fall. Accessing as much altitude as possible allows me enough time to put on my helmet while selecting the best spot possible to put the airplane down if necessary.

We are pretty close to wrapping up our series on interiors. The next two articles will focus on cabin insulation and, finally, the process of drafting a logbook entry that thoroughly describes the fabrication and installation of your new interior. Next month, it's on to insulation—your cabin will be quieter, cooler in summer, and warmer in winter. Until then, fly safe!



The basic components that make up an AmSafe air bag three-point passenger restraint.

The aesthetically appealing, neat-fitting trim cover for the four-point inertia reel and mounting brackets.



Industrial designer and aviation enthusiast **DENNIS WOLTER** is well-known for giving countless seminars and contributing his expertise about all phases of aircraft renovation in various publications. Wolter founded AirMod in 1973 to offer private aircraft owners the same professional, high-quality work then only offered to corporate jet operators. Send questions or comments to [editor@cessnaflyer.org](mailto:editor@cessnaflyer.org).

## RESOURCES

### CFA SUPPORTERS

**AIRCRAFT SPRUCE AND SPECIALTY**  
[aircraftspruce.com](http://aircraftspruce.com)

**ALPHA AVIATION INC.**  
[alphaaviation.com](http://alphaaviation.com)

**AMSAFE**  
[amsafe.com](http://amsafe.com)

**B.A.S. INC.**  
[basinc-aeromod.com](http://basinc-aeromod.com)

**WAG-AERO INC.**  
[wagaero.com](http://wagaero.com)

**OTHER**  
**HOOKEE CUSTOM HARNESES INC.**  
[hookerharness.com](http://hookerharness.com)

### FURTHER READING

**FAA ADVISORY CIRCULAR NO. 43.13-1B**  
**"ACCEPTABLE METHODS, TECHNIQUES**  
**AND PRACTICES – AIRCRAFT REPAIR"**  
[https://www.faa.gov/documentLibrary/media/Advisory\\_Circular/AC%2043.13-2B.pdf](https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC%2043.13-2B.pdf)



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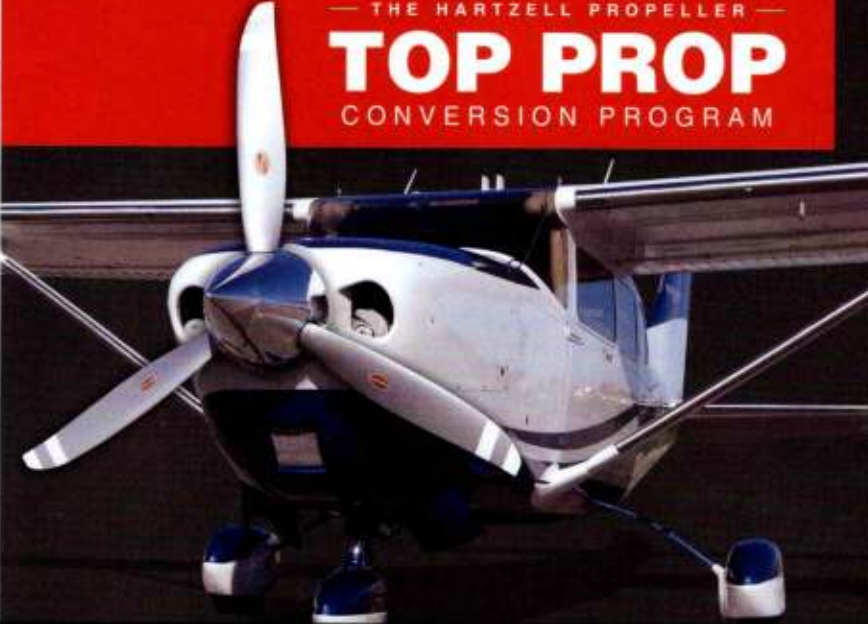
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