BEYOND BUCKLING UP

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Bonanzas are legendary for their structural integrity. Walter Beech and his team certainly held to their end of the bargain when it comes to Beech strength, especially where it counts the most—in the cabin area. In reality, though, all of that structural strength is useless if the airplane comes to a stop and the occupants don't.

No one likes to think about the possibility of an off-airport landing. Good pilots prepare for this and other flight-related challenges by actively involving themselves in recurrent training that deals with such situations.

Bonanza owners are blessed with having access to the high quality training of BPPP. Taking your skills for granted is risky, and the training to maintain proficiency goes a long way in the interests of safety. In addition, good aircraft maintenance is elemental to safety management. It is crucial that an owner be knowledgeable and pro-active in the maintenance of his or her airplane.

Without a doubt, the most safety-enhancing component you can purchase for a Bonanza or related airplane is a good passenger restraint system to complete your safety program. Speaking from unwanted personal experience where I have been first on the scene (more than once) of an ugly incident, I can't tell you how hard it is to see seriously or fatally injured people who would have suffered far less if only a good shoulder harness had been used.

In this article I will review *what is good, how to get these products installed, inspection and maintenance, and how to use these life-saving devices properly.*

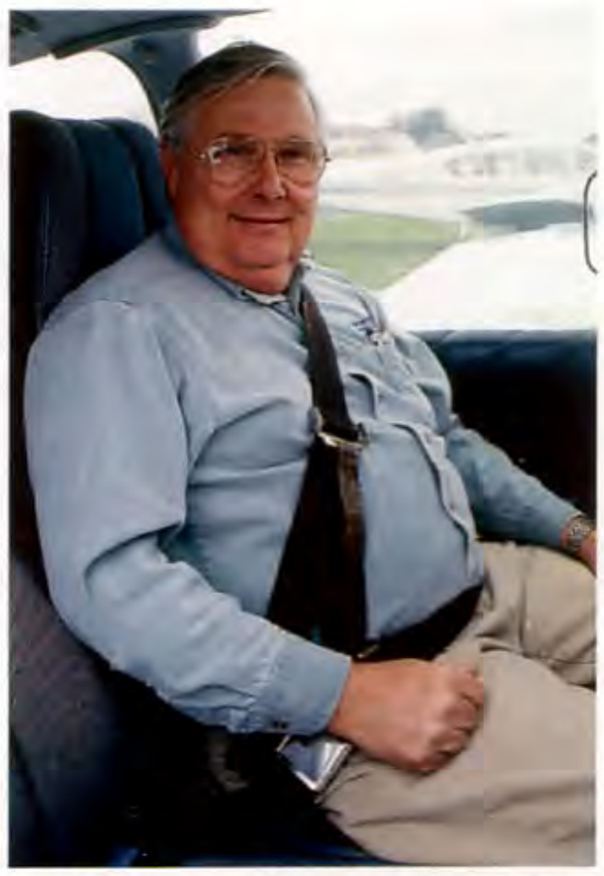
What is good

The whole point of a restraint system is to safely keep a seat occupant out of harm's way. It sounds simple enough, and it is, as long as some basic principles of physics and physiology are adhered to during the design and installation of these systems.

Seat belts do only part of the job. The part of your body that a seat belt protects from injury best is your derriere. While that might seem important, having only a lap restraint unfortunately allows critical upper body parts to flail about, greatly increasing the potential for serious injury.

The addition of a harness can certainly add to your safety. Not all shoulder harnesses, however, are created equal. Inertia reel systems are definitely better than fixed. Not only are they more convenient to use, allowing freedom of movement, but they also ensure that the harness is properly resting over the shoulder (or shoulders) with a comfortable pressure, in the right place if needed.

Some shoulder harness systems, be they factory installed or not, can protect part of the body at the expense of other areas. A Y-type shoulder harness system that holds both shoulders symmetrically and keeps the back from twisting prevents the probability of spine or nerve damage.



Middle-age spread causes diagonal-type shoulder harnesses to ride too high up on the chest and increases the potential for occupant to slide under the lap belt.

The effectiveness of a diagonal harness (automotive type) can often be compromised by the vertical and lateral center of gravity of the occupant's torso. The result can be twisting of the back, or even the possibility of a person tunneling out under or even lofting over the harness. Most of us don't have the bodies we had in high school; middle age spread definitely affects vertical CG.

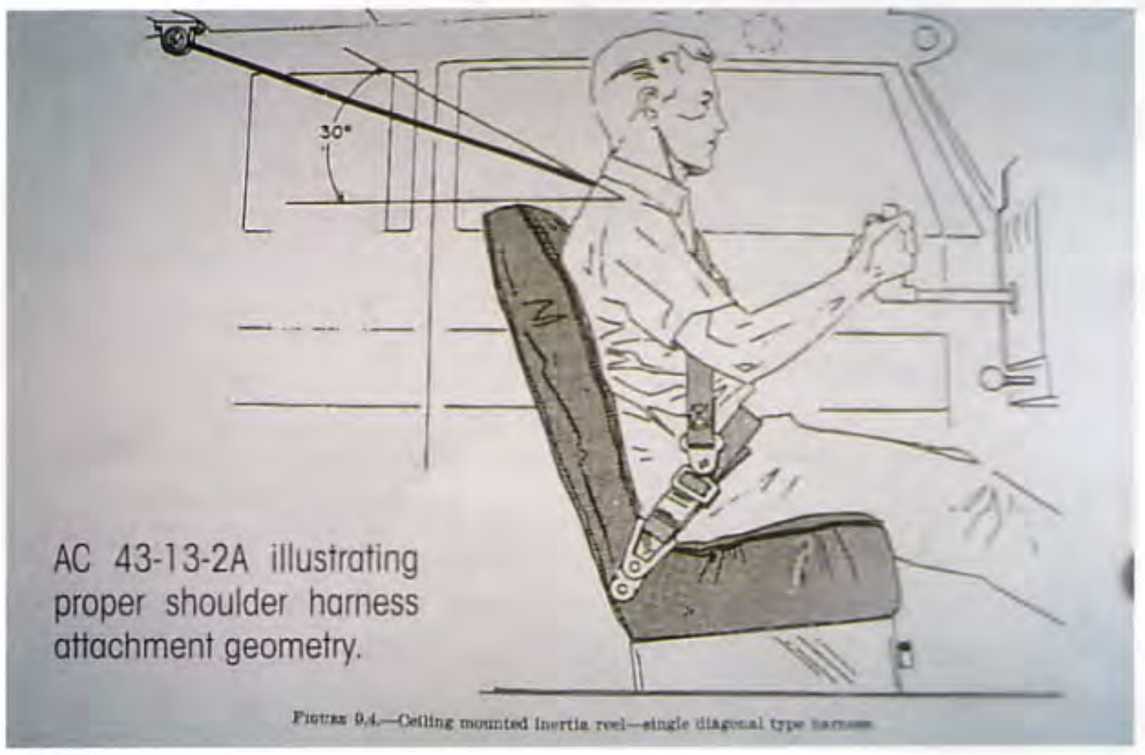
Types of installations

Good installations don't always come easily. The FAA (and good engineering) requires that a seat belt be capable of restraining 12 Gs, which is 12 times the weight of a standard 170 lbs. FAA person, or 2,040 pounds. A shoulder harness must be rated at 9 Gs, or 1,530 pounds.

Most people will suffer severe internal injuries when exposed to stresses in excess of 12 Gs, and as we age the tolerance usually goes down. These numbers can and do present an engineering challenge.

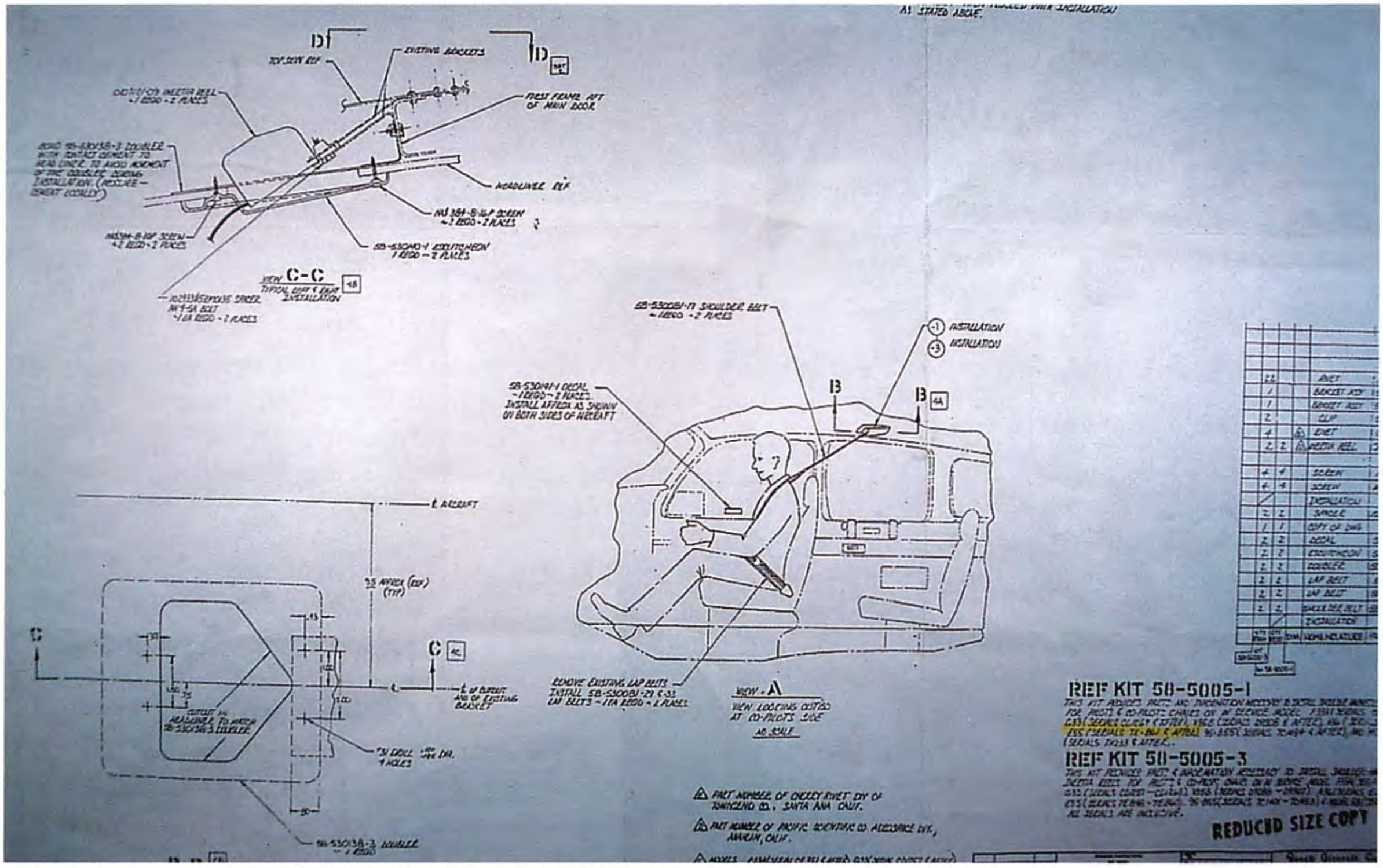
Is there an attach point strong enough for these belts and harnesses? Referring to AC 43.13-2A (my favorite FAA document and an airplane owner's best friend), chapter 9, section 2, figure 9.6, it is obvious that design geometry is very important.

Look at this drawing. You'll see that the optimum angle



AC 43-13-2A illustrating proper shoulder harness attachment geometry.

FIGURE 9.4.—Ceiling mounted inertia reel—single diagonal type harness



Installation drawing for the Beech kit showing heavy truss, mounting bracket and external riveting.

between the occupant's shoulder and the shoulder harness attach point is between 0° and 30°. As inertia tries to move a person forward, too-low an attach point of the harness would result in a downward force on the spine, increasing the possibility of spinal compression injuries. Too high an angle could increase the potential of one or both harnesses slipping off the shoulder laterally. Not good.

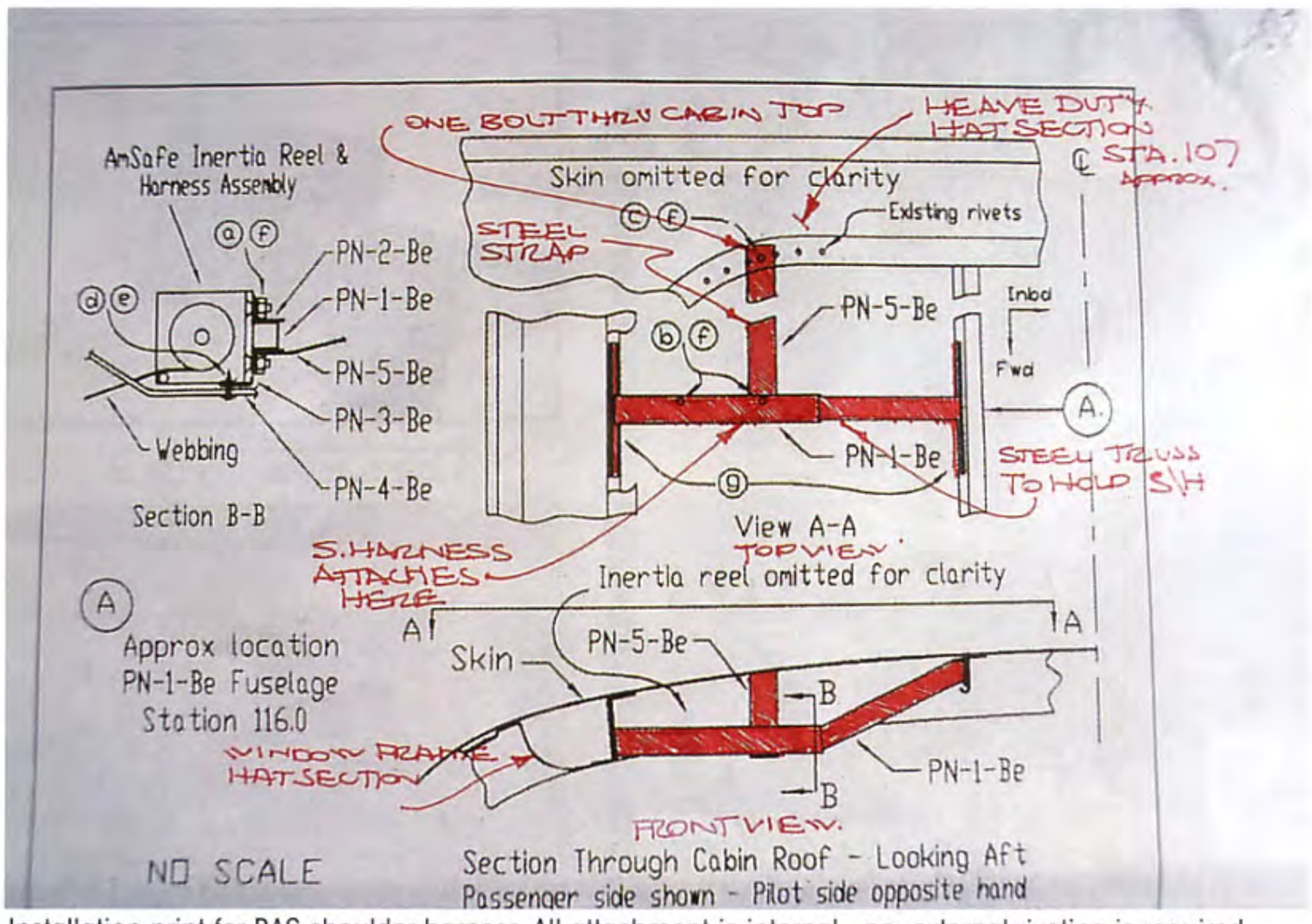
Chapter 9 in 43.13-2A covers this whole seat belt/shoulder harness design and installation thing. It's good information for an owner to become familiar with.

On the subject of lap belts, Bonanzas are blessed with a geometrically very good seat belt attach system. These lap belts are attached to the seat frames, facilitating an almost always perfect 45° angle for the lap belt as it restrains the pelvic area. Because the belt is attached to the seat, this optimum angle is maintained, regardless of where the seat is positioned on the rails.

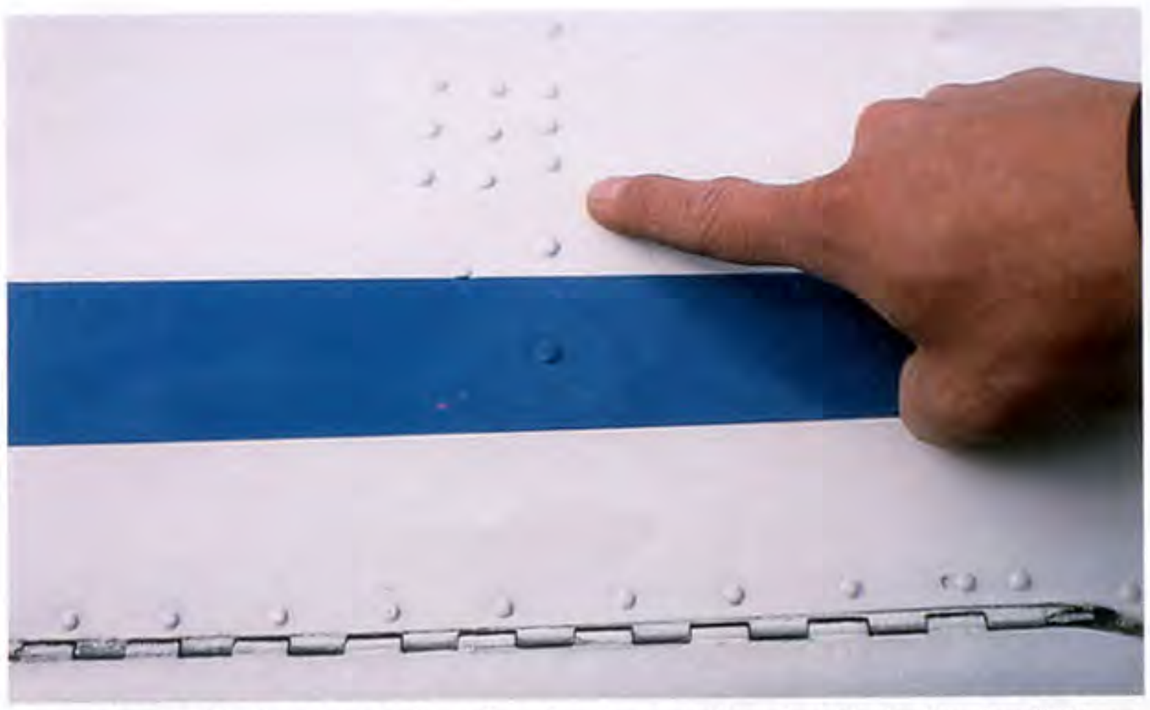
So much for geometry class, it's time to move on to the engineering of structural integrity. In college we called it bend-and-break class.

Bonanza and related airframes have a strong upper cabin structure in the form of very beefy window frames. Thanks to this, finding and attaching a Y-type shoulder harness is possible and available. Feel sorry for owners of some other brands of aircraft who can only hope for a barely strong enough automotive type diagonal harness.

It's not all a bed of roses, though. Beech aircraft built between 1947 and 1971 have a very strong outer cabin structure, but do not



Installation print for BAS shoulder harness. All attachment is internal - no external riveting is required.



An airplane with these rivets has the structure and brackets to bolt in the "Y" type inertia reel shoulder harness. It cuts installation time to 4-5 hours.

have a truss strong enough to support a 9 G shoulder harness attachment in a place that is geometrically correct. Not to worry: Beech, BAS Inc. and Wag Aero all offer approved kits that do a great job of solving this problem.

BAS Inc. has a number of inertia reel shoulder harness kits for older airplanes that can be installed in six to eight hours. They require no riveting through the outer skin and are readily available (obtaining the Beech kits can often take 12 weeks). The BAS kits come in about 20 webbing colors and cost around $1,000 for the two front seats.

Wag Aero has an approved shoulder harness kit for the Bonanza that is available in eight colors and the cost is about $630 for both seats. This kit is less expensive due to the fact that the harnesses are the fixed type, not inertia reel.

Last but not least are the Beech kits. They come in any color you want as long as it's tan or black, and cost approximately $1,500. In pre-1972 airplanes, they require the installation of a heavy-duty bulkhead or two riveted in place between and attached to the two upper window frame hat section structural members. This creates a very strong structural beam to which a steel bracket is riveted and bolted at the appropriate lateral location. A small inertia reel is then attached to the bracket, completing the installation.

Normal installation time is 20-24 hours. Beech, BAS and Wag Aero all use the original lap belt attachments. Note: It would be smart to install any kit requiring external riveting prior to having your aircraft painted.

Starting in 1972 Beech installed the heavy truss and steel shoulder harness brackets in all Bonanzas and Barons. If you're lucky enough to own one of these later airplanes, all you need to do is buy the Beech kit and commit to 4-6 hours of labor for the installation, a lot less than that required for the reinforced structure described above.

It's easy to determine if you have the proper structure and brackets. Look at the cabin top from the outside and see if there are two clusters of six extra rivets just above the center opening windows, about 5 inches inboard from the outer edge of the roof skin.

Inspection and maintenance

Fortunately, once properly installed, these systems require little maintenance. For both factory- or field-installed harnesses, it is important to inspect the installation to make certain that everything is in good condition and that proper installation procedures were followed. If your system was field-installed, confirm that it is an approved system with appropriate documentation.

Of the 20 or so Beech interior renovations our shop does each year, we find two or three airplanes with harness systems that were either poorly or improperly installed. The bad installations often have inaccurate or no paper work at all, a fact that really doesn't surprise me (I've seen a lot in 30 years of aircraft renovation). We find incorrect components, missing spaces, household hardware, missing certification tags and worn or faded webbing.

Due to the fact that Beech seat belts are attached to the seat frames, it is very important to confirm the condition of the seat rollers, roller feet, seat rails and seat latching mechanisms. Also, it goes without saying that you should verify the pedigree of all field installations during any pre-buy inspection. We

An often found problem. The bolt at the top is a not-very-strong non-aircraft type. The correct MS type aircraft bolt with its two washers, hardened-steel spacer and self-locking nut is shown at the bottom.

This is a properly connected shoulder harness/seat belt buckle with the shoulder harness webbing tongues facing outward.

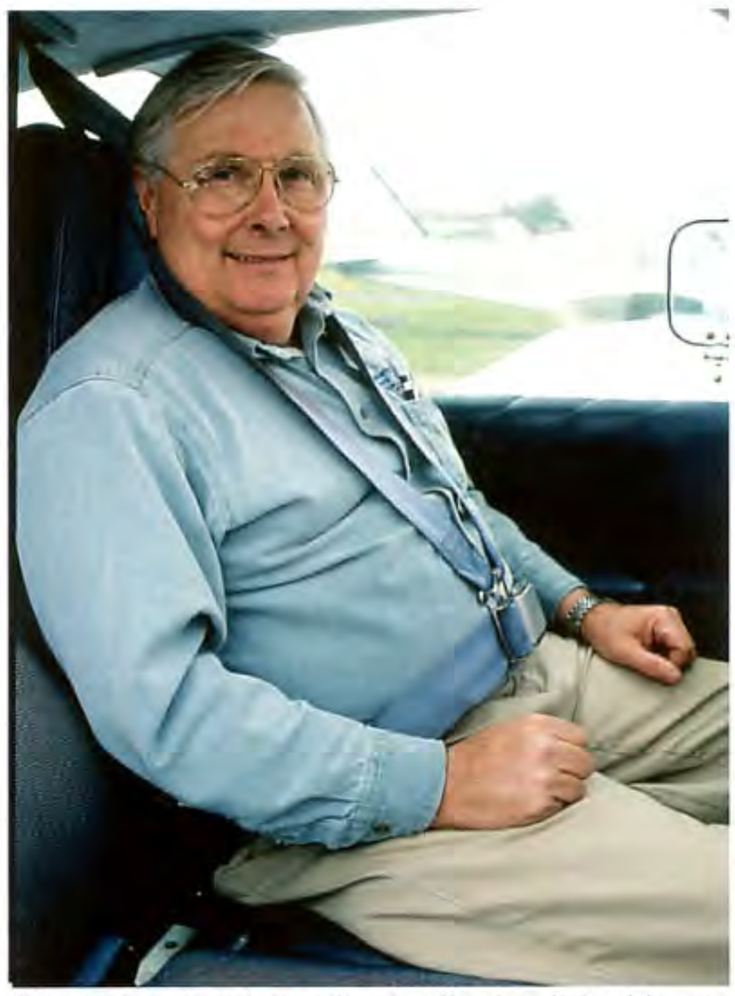
Incorrectly routed lap belt that is wrapped around the seat back frame.

have found that a great source for technical information, repairs, rewebbing or replacement components is Aircraft Belts, Inc.

Be aware that if your webbing is severely faded or shows visible signs of wear, your restraint system has lost its rated strength and is not airworthy. It is important that legible certification tags are permanently attached to each webbed component of the system. No tag, no approval. This is an aircraft grounding situation. Ask your IA to check these things out at your next annual.

It is also a good idea to occasionally check the locking mechanisms of inertia reel harnesses. This is done by simply grabbing the harness webbing and giving it an abrupt pull to see if the reel locks up.

Also check that the webbing rewinds smoothly and completely back into the reel, confirming that the retraction springs are in good condition.



Wrong: Lap belt is too loose allowing it to ride up on the body, creating a great potential for tunneling under and out of the restraint system.

Correct: Lap belt is snug but comfortable. Lower shoulder harness attachment is properly secured in lap belt tongue. Everything is symetrically centered.

Using the system properly

Now that the seat belt/shoulder harness system is properly designed, installed and maintained, it's time to make sure everything is used and maintained correctly. There's more to optimum protection than just buckling up.

Once seated in the airplane, make sure the harness is properly secured to the lap belt. Some systems have separate shoulder harness attachments that must be connected to the lap belt buckle assembly with the webbing attachments pointing outward. Other systems have the harnesses permanently attached to the lap belts. All must be worn in such a way as to avoid twisting of the webbing when buckled.

It is also important that the lap belt webbing is not wrapped around the seat frame or other cockpit component. With a Y-type harness system, be sure to adjust the seat belt so the two harness straps meet in the center of the lap, and snug up the lap belt so it does not ride up on your abdomen. With a fixed harness system, keep both the lap belt and harness snug but comfortable.

With any system, get into the habit of resecuring the belt or harness if you have temporarily loosened or removed it to access something in the cabin. Many injuries have occurred simply because someone forgot to rebuckle or retighten.

Thanks to general aviation's good safety record, very few people will ever put one of these systems to the test, making all of the above seem to be a waste of good money and time.

An old friend once said that safety can be the hardest product to sell. I guess it's human nature to hesitate spending money on something we think we'll never need. But remember, you can't write the check on the way down.

SOURCES:

- Aircraft Belts, Inc. Kemah, Texas (800-847-5651)
- BAS Inc., Eatonville, Washington (360-832-6566)
- Elliott Aviation, Omaha, Nebraska (800-228-7088)
- Wag Aero, Lyons, Wisconsin (800-558-6868)

ABS member Dennis Wolter started Air Mod to bring innovative design and high quality renovations to the general aviation market. Dennis, his wife Cynthia and 10 dedicated employees complete about 40 renovations each year at their facility on the east side of Cincinnati. Dennis has a degree in industrial design from the University of Cincinnati. He is an A&P and an IA.