about air cushions

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Automatic Protection—READY NOW

Vehicle crash cushions—often called “air bags”—are superior lifesavers in the deadliest kinds of crashes.

For the majority of vehicle occupants who do not use conventional seat belts, air cushions provide crash protection vastly superior to no restraint. An occupant using a seat belt with an air cushion gets the best occupant protection available in any kind of crash. Especially in high-speed crashes, occupants with cushions and belts are better protected than occupants using only a lap/shoulder belt. The importance of air cushions has been proven over the years in studies showing that about 55 percent of all deaths and major injuries involve frontal and front-angle crashes—the kinds of crash in which air cushions work best.

Completely out of the way and out of sight until they are deployed in crashes, air cushion systems work in frontal crashes by inflating to keep occupants from slamming into steering wheels, instrument panels, windshields, and windshield frames.

Best of all, air cushions work automatically. Other automatic or “passive” occupant protection devices long have been in place and saving lives in motor vehicle crashes. Like these other passive measures—such as energy-absorbing steering columns and laminated windshields—air cushions will save thousands of lives annually when they are in most vehicles on the road.
After years of unavailability, air cushions are available again in the United States. (They were offered for sale in some General Motors cars during the mid 1970s.) The prospect is improving for wider availability. Mercedes-Benz offers driver air cushions in selected models. And one American automaker, Ford Motor Company, is equipping fleet cars with driver-side air cushion systems.

The Supreme Court, finding the air cushion “an effective and cost-beneficial lifesaving technology,” instructed the U.S. Department of Transportation in 1983 to require automatic restraints—air cushions or automatic seat belts—in all new cars or provide sound justification for not doing so. The Department now has ruled that some 1987 model cars—and all 1990 models—must have automatic restraints unless seat belt use laws are passed in a substantial number of states.

This special publication looks at air cushion safety systems—how they work, how they have performed in tests and more than 10 years of real-world driving, and how they compare with other kinds of occupant restraints.
How They Work

The components of an air cushion and the mechanics of its operation are simple. In a frontal or front-angle crash with an impact equivalent to hitting a wall at 12 mph or more (the speed above which almost all injuries occur), crash sensors trigger an inflator. Nitrogen gas then fills the fabric pillows to cushion the front-seat occupants.

The violence of virtually all crashes is over in 1/8th of a second or less. Peak inflation of an air cushion occurs in less than 1/25th of a second—faster than the blink of an eye. Even as the cushion is inflating, some of its air is being released through the fabric to further the cushioning effect.

The air cushion system works during the "second" collision. In a frontal crash, the crashing vehicle is stopped abruptly by another vehicle or a fixed object. But the unrestrained occupants continue moving forward at the same speed that the vehicle was traveling just before the crash began. The "second" or "human" collision—the one in which people are injured or killed—occurs when the moving occupants slam into the abruptly stopped or nearly stopped vehicle's hard interior surfaces, or are ejected.
and hit an equally unforgiving outside surface.

The air cushion diffuses the potentially harmful forces of the human collision by serving as a pillow between the occupants and the vehicle’s interior.

Common sense tells us that, given a choice, we would rather have our faces and bodies hit something soft, gently contoured, and energy-absorbing—like an air cushion—than sharp, protruding, edged, or hard structures like those across the front of a car’s interior.

The concept of an air-filled buffer to protect people in crashes was outlined as early as 1941, and patents for air cushions began to be issued in the 1950s. Extensive tests during the 1960s and 1970s—including controlled crashes and extensive on-the-road use—brought air cushions to an advanced “second generation,” ready for full scale application. Now, even simpler and far less expensive generations of air cushions are being planned and developed for the cars of the future.

**Air Cushions Save Lives . . .**

The engineering skills of the U.S. automobile industry and its suppliers have made the air cushion system by far the most effective and thoroughly tested safety technology ever developed. If all cars on the road today were
equipped with air cushions, thousands of additional lives could be saved—9,000 every year according to a U.S. Department of Transportation study—and more than 50,000 major injuries could be avoided.

The most extensive, real-world demonstration that air cushions are lifesavers began in the mid 1970s when Ford, General Motors, and Volvo sold or leased more than 12,000 cushion-equipped cars. As of July 1983, these cars had traveled about one billion miles. There had been 267 frontal and front-angle crashes severe enough to deploy the cushions. The Insurance Institute for Highway Safety analyzed injury data from most of these crashes, finding that the air cushion-protected occupants experienced substantial reductions in injury severity, compared to unrestrained occupants.

More recent information involves thousands of air cushion-equipped Mercedes-Benz cars on the roads in Europe. The company reports that dozens of these cars have been in crashes severe enough for the cushions to deploy. No deaths and only eight minor injuries occurred during the first year of availability.

This real-world performance of air cushions follows thousands of pre-production tests (see page 9) by automakers, insurers, air cushion suppliers, and independent research organizations. After years of such tests, General Motors in 1981 described air cushions as having a "highly acceptable" level of reliability. More recently, a German aerospace company said "there is technically no practical alternative to the air bag system."

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**Air cushions protect children.**

Detailed investigations of real-world crashes indicate that children have been protected by air cushions. In fact, the cushions protect virtually all occupants in the front seat because they extend wall to wall—steering wheel to passenger door.

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**... Crash Survivors Tell How**

"We just hit head on.... And the impact speed was about 24 miles an hour. I did not have any safety belts on at the time. I felt [myself] going into the air bag—it felt like going into a soft feather pillow or something like this. The other car was totaled out and the people did have injuries from it, but I
"I knew I was headed head on for a collision with the biggest city transport bus that was available.... The bus was going about 20-25 miles an hour, and I estimated that I was traveling about the same speed when we collided head on. I had a car with air bags, but I was not wearing my belt.

—Russ Parrish
Crashed September 1973
Winston County, Alabama

The gas that inflates air cushions is harmless.
Nitrogen, which comprises 78 percent of the air we breathe, is the gas that inflates the cushions. The solid chemical, sodium azide, generates the nitrogen in the process of burning rapidly. Not in normal driving, nor in crashes, nor in disposal does the sodium azide present a safety hazard. In fact, there is no contact between the occupants and the sodium azide. There is only contact with the nitrogen generated by the sodium azide.

"I recall very well within seconds after the crash seeing what had happened. The air bag filled in front of the steering wheel and it was lying on my lap. I could see I was alive. I could see that I had no broken bones. To my surprise I did not have a headache. I did not have a whiplash injury. I was able to walk.

"The air bag had certainly done something that I had never realized was possible with any piece of safety equipment."

—Arnold Arms, M.D.
Crashed October 1975
Kansas City, Kansas
"This car came right into me just head on, and there was absolutely nothing I could do to avoid the collision. The speed of impact was approximately 35 to 38 miles an hour, and I would only imagine that the oncoming car was going about the same speed, so it had to be about a 60 to 70 mile an hour collision.

"The air bags immediately were deployed. I recall absolutely nothing about the impact, of course. My windshield shattered and within a few seconds after that I was immediately sitting upright looking around to see what really had taken place. And I was perfectly all right. Nothing happened to me. I was fully mobile and able to go back to work within an hour after the crash.

"I'm totally sold on the system, no question in my mind about it. I feel that if the air bag were made standard on the automobile, it just would relieve many families of heartbreak and traumatic experiences."

—Kenneth Gnaster
Crashed February 1974
Schiller Park, Illinois

Air cushions do not inflate inadvertently.

Air cushions do not inflate when cars go over violent bumps or potholes in the road or when bumpers hit other bumpers or posts at low speeds. Nor do air cushions inflate when automobiles brake suddenly, as in a panic stop. The cushions are designed to inflate only in frontal impacts equivalent to hitting a solid wall at 12 mph or higher speed. (Most collisions with fender and other property damage occur at lower speeds, but most injuries occur in crashes at higher speeds. Air cushions are designed to protect occupants in the higher-speed crashes.)

In any case, control of the car would not be lost in the highly unlikely event of an inadvertent air cushion deployment. General Motors inflated air cushions without warning as test subjects drove on straightaways and turns at speeds up to 45 mph. GM reported that "without exception, the subject retained control of the automobile."
The Cost

As early as 1976, the U.S. Secretary of Transportation said automatic restraints could be provided to new car buyers “at a reasonable cost.” The latest estimates of air cushion costs prove this point. Full front-seat cushion systems would cost $320 (1983 dollars), the U.S. Department of Transportation estimates.

In contrast, the cost of not providing automatic restraints such as air cushions is staggering. Virtually every economic analysis has concluded that the benefits of these restraints would far outweigh their costs. A Yale professor has said the net economic benefit to society of automatic restraints—including air cushions—would be $2.4 billion per year.

Air cushions are even more essential in small cars than in larger vehicles.
Small cars crash more often than large ones, and the occupants of small cars die and are severely injured in crashes—including frontal crashes—more often than are occupants of large cars. The lifesaving potential of air cushions thus is especially important in small cars.

The U.S. Department of Transportation’s Research Safety Vehicle program has demonstrated that many practical safety technologies—including air cushions—could be incorporated into the design and production of attractive, fuel-efficient, and reasonably priced small cars. In addition, several manufacturers of small cars currently are developing air cushions for future sale in their vehicles.

Replacing air cushions after a crash is a routine job—if it needs to be done at all.
After a crash severe enough to deploy air cushions, most cars are non-repairable. For cars that can be repaired, the cushions also should be repaired or replaced—just like brakes, lights, and other safety-related components. The cost of air cushion replacement would be covered by insurance.
The Insurance Institute for Highway Safety crash tested 1975 Volvos and Oldsmobiles—some with air cushions, others without. These photos, taken at parallel moments during the tests, show how air cushions provide a buffer between people and potential harm in a crash.
Air Cushions And Seat Belts: HOW THEY COMPARE

Three kinds of restraint systems—manual seat belts, automatic seat belts, and air cushions—substantially reduce the likelihood of crash injuries when they are used. The key to saving lives and reducing injuries is increasing restraint use and manufacturing vehicles that maintain their structural integrity in crashes.

Manual seat belts provide crash protection vastly superior to no restraint at all. The principal drawback is the fatal one of nonuse by the vast majority of occupants. Studies show that belt use rates are highest for daytime expressway driving, but even then use is fewer than 2 out of 10 drivers and lower among passengers. At night and for young drivers and others who are more likely to be in crashes, belt use rates are lower still. On the average, 85-90 percent of all drivers—that's up to 9 out of 10—are unrestrained.

The indisputable record of many years' attempts by both government and private organizations, including insurers, to increase voluntary belt use through campaigns of persuasion, often costing millions of dollars, has been one of repeated, dismal failure.

*The Volkswagen Rabbit's automatic seat belt system is attached to the car door and wraps itself around the vehicle occupant when the door closes. No reaching or buckling is required.*
Air cushions are reliable for years; they require no maintenance.

Air cushions have no moving parts. There is nothing about them to wear out. Their key parts are hermetically sealed against climatic degradation. Consequently, they work for the life of the car.

Of the 228 cars in which air cushions had deployed as of July 1979, about 40 had traveled more than 40,000 miles. The highest mileage vehicle with a deployment had traveled almost 115,000 miles at the time of the crash. In every case, the air cushions worked as designed.

An alternative to the manual belt system is the automatic seat belt, which positions itself around an occupant as the car door closes. No buckling action by the occupant is required. The automatic feature gives this belt a potential for higher use rates, compared to those for manual belts. For example, the use rate in Volkswagen Rabbits with automatic belts is about 80 percent, compared to 35 percent in cars of the same type equipped with conventional manual lap/shoulder belts.

Air cushions have a use rate of virtually 100 percent. They do not require occupants to reach for and buckle shoulder harnesses, or to buckle manual lap belts, or to do anything at all. They work automatically, only when needed, like fuses and sprinkler systems. And, unlike both manual and automatic belts, air cushions are so unobtrusive and convenient that there is no incentive to disconnect them. So air cushions are always ready to protect people in frontal crashes.

Even if the use rates of shoulder belts and air cushions were nearly equal, the cushions would offer some advantages. No kind of belt protects occupants' necks, heads, and faces from the flying glass and debris generated in crashes. The air cushion does.
BELT USE LAWS: Air Cushion Complement

Seat belt use laws in more than 30 countries throughout the world have resulted in widely varying use rate increases, depending on public accep-

tance and enforcement. New York and New Jersey are the first states in this country to pass such laws.

Air cushions protect occupants with or without seat belts.

Air cushions are designed to protect front-seat occupants without belts in frontal crashes at least up to 30 mph into the wall. More than 90 percent of the occupants in crashes of air cushion-equipped cars were not using their lap belts. Yet the reduction in average injury severity in serious frontal crashes was about 64 percent for these occupants, compared to unrestrained occupants.

An air cushion system plus a lap belt provides the best possible occupant crash protection, with the lap belt protecting the occupant principally in rollover and ejection crashes.

In Canada, use rates of about 50 percent prevail under belt use laws. With intense enforcement, rates of 80 percent have been achieved. But there is a catch: Deaths and injuries have not declined accordingly, because the laws have succeeded in getting mainly drivers who are at low risk of crashing to use belts while others continue to drive without restraints. The same is true in Great Britain and Australia: Death and injury reductions under seat belt laws have not been as great as anticipated.

These findings are important because the U.S. Department of Transportation has ruled that all new 1990 model cars must have automatic restraints unless state legislatures covering two-thirds of the national population enact and enforce belt use laws by 1989.

The point is that belt use laws work to some extent—if they are enforced. Such laws complement and are compatible with air cushions as means of saving lives in cars. We need both.
Drivers, Car Buyers Favor Air Cushions

Probably because they are so unobtrusive, air cushions have an impressive marketplace potential. After several years of successful air cushion marketing in Europe, for example, Mercedes-Benz now is offering these restraints on some of its cars for sale in the United States.

In addition, more than a dozen public opinion polls have focused on motor vehicle safety, especially occupant crash protection, and their results show enthusiasm for air cushions. For example:

- General Motors' studies in 1971 and 1979 found that when given a choice between automatic belts or air cushions, GM customers said they preferred the cushions, 56 to 44 percent. The 1971 study concluded that the air cushion was preferred "because it afforded equal protection, but was judged far superior in all areas of style and convenience."

- By a vote of 46 to 37 percent, a public sample interviewed by Gallup in 1977 endorsed air cushions in all new cars. Young adults 18 to 29 years old voted 65 to 27 percent in favor of air cushions. Women of all ages endorsed air cushions by the substantial margin of 51 to 27 percent.

- In 1980, The New York Times commissioned Market Opinion Research of Detroit to poll drivers and automobile dealers about vehicle safety. This question was asked: "Would you favor or oppose requiring car manufacturers to equip all new cars with air safety bags?" Nearly half said they wanted air cushions to be required. Drivers younger than 35, who have high injury and death rates on the highways, were overwhelmingly in favor of air cushions, 63 percent to 21 percent.

- A 1983 poll for the Insurance Institute for Highway Safety indicated 90 percent of car buyers believe that automatic crash protection should be required on new cars as standard or optional equipment. Only four percent of the respondents said the availability of automatic restraints should be left up to motor vehicle manufacturers.

About Air Cushions is published by the Insurance Institute for Highway Safety (IIHS). For further information, including films, contact IIHS at Watergate 600, Washington, DC 20037.