

AIRBAGS

You are driving to work on a sunny morning.

The drive takes you through a busy intersection where there is rarely a

break in oncoming, left-turning traffic. Drivers wishing to turn left often end up accelerating dangerously to try to squeeze through small gaps between oncoming vehicles. As you approach the intersection heading straight, you see an oncoming car waiting to turn left. The left-turning car accelerates and attempts the turn just as you enter the intersection. You slam on the brakes but there is not enough time to stop and the front of your car hits the passenger side of the other vehicle. You feel your seatbelt tighten and hear a loud sound as the driver airbag opens. Both safety features do their job, and you are able to walk away from the crash with little more than a few bruises. You know that if you had hit the windshield or steering column, the outcome would have been much worse.

In the event of a crash, airbags offer added protection to the most vulnerable parts of the human body: the head, neck, and chest. Airbags work with the seatbelt to lessen and safely distribute the various forces that act on vehicle occupants when they are involved in a collision.

WHAT ARE AIRBAGS?

Airbags are passive safety features designed to mitigate or prevent injuries among drivers and passengers in the event of a crash. Airbags provide added protection to seatbelts. For example, in higher-speed crashes, a seatbelt alone may not prevent a driver's head from hitting the steering column. The deployment of a airbag protects the

head and upper body of the driver, and reduces some of the force exerted on the driver by the seatbelt.

Airbags are strong fabric bags that are folded and concealed behind various parts inside of the vehicle. Many vehicles in Canada have a driver airbag in the steering column and a front-passenger airbag in the dashboard. Newer vehicles may also have side-airbags located in the interior side panels, the roof, or the doors. When a crash occurs that is strong enough to trigger airbag deployment, a signal is sent from the airbag sensor to a small igniter to fill the airbag, which forces the bag out of its module. In the event that anyone in the vehicle is forced forward or to the side, they will come into contact with the airbag instead of the hard vehicle interior.

WHEN ARE AIRBAGS USEFUL?

Airbags are useful whenever you experience a sudden reduction in speed. The usefulness of airbags is evidenced by the number of lives saved. By 2013, it has been estimated that airbags have saved 39,886 lives since their inception (National Center for Statistics and Analysis 2015). Situations where airbags would benefit vehicle occupants include the following:

- A large animal runs into the road ahead of you and a collision is unavoidable.
- While turning left out of a parking lot, your vehicle is struck by another driver.
- You lose control of your vehicle in inclement weather and crash into a utility pole.
- A fatigued, oncoming driver falls asleep and drifts into your lane, causing a crash.

Airbags are most likely to deploy in frontal crashes, since the type of deceleration they are designed to detect most often occurs when a vehicle is hit head-on or nearly head-on. However, airbags may deploy in other crashes as long as the deceleration is fast enough in the right direction. For example, a side-collision would not generally cause airbags to deploy, but if the vehicle is struck hard enough and the vehicle is going fast enough to decelerate in a relatively straight line, the frontal airbag could still deploy.

HOW DO AIRBAGS WORK?

Airbag systems are composed of three basic parts: the bag itself, the inflator unit, and the crash sensor. The bag and inflator are contained together in the airbag module. Most often, the sensor is located in the passenger compartment of a vehicle and towards the front, so if a crash occurs it is quickly detected.

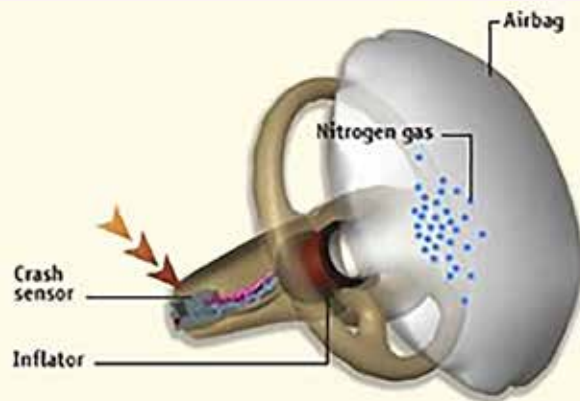
When the crash sensor detects rapid deceleration, it triggers the inflator to produce nitrogen gas that quickly inflates the bag, causing the bag to escape from its module. A commonly used type of sensor is the electromechanical ball-and-tube design. This type of sensor is made up of a tube with a mechanical switch at one end and a steel ball on the other held in place by a magnet. When a sufficiently forceful deceleration occurs, the ball is knocked loose from its place, rolls down the tube and hits the switch. Hitting the switch causes the electrical circuit that inflates the airbag to close. With the circuit closed, the inflator engages to deploy the airbag.

Inside the inflation device is a small, solid propellant that is not very different from the

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types of propellants used in rocket boosters. The propellant used in most airbags is a combination of sodium azide (NaN_3) and potassium nitrate (KNO_3). When these two chemical compounds react, they burn extremely rapidly and produce the nitrogen gas that fills the bag.



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Airbags must deploy at a very high rate of speed in order to effectively prevent vehicle occupants from hitting the hard interior of the vehicle. In fact, when an airbag deploys it bursts from its module at up to 322km/h. The whole process of airbag inflation from the moment a crash is detected to the moment the bag completely inflates lasts approximately one-twenty-fifth of a second. Seconds after the bag is fully inflated, the gas inside the bag slowly starts to leak from small holes. This allows people inside the vehicle to have room to move after a crash. In addition, after the airbag deploys people around it are likely to notice that a powdery substance has been released. This substance – either talcum powder or cornstarch – is harmless and used to keep airbags soft and lubricated while they are stored in the module.

ARE AIRBAGS EFFECTIVE?

Airbags have been studied for several decades by road safety organizations, so there are significant data to demonstrate their effectiveness. However, as with many subjects that receive decades of scrutiny, not all conclusions reached concerning the effectiveness of airbags are similar. This may be due in part to the various factors that affect whether the deployment of an airbag is helpful, neutral, or detrimental to the overall safety of persons in a vehicle. These factors include the position of people inside the vehicle, the type of crash, and whether they were wearing a seatbelt or not.

When paired with a properly worn seatbelt, airbags reduce the risk of sustaining fatal injuries in the event of a crash (Evans 2006; Høye 2010). Conservative estimates suggest that airbags reduce risk of fatality by 9% among belted passengers (Evans 2006; IIHS 2003). A meta-analysis conducted in 2010 concluded that among belted drivers, airbags reduce fatalities in frontal collisions by approximately 22% (Høye 2010). The benefits of airbags increase as the direction of the crash approaches 12 o'clock. In other words, airbags offer more protection in a head-on collision.

Side airbags were introduced in the mid-1990s and have been proven very effective at reducing fatalities that result from side-impact collisions. The Insurance Institute for Highway Safety (IIHS) in the United States estimates that side airbags which protect the chest, abdomen, and head reduce deaths among passenger cars struck on the driver's side by 45% (IIHS 2003). Side airbags that protect the chest and abdomen but not the head reduce fatalities by about 10% among drivers in driver-side crashes (IIHS 2003).

CAN AIRBAGS CAUSE INJURIES?

Airbags must strike a careful balance between deploying fast enough to prevent vehicle occupants from colliding with the inside of the vehicle and deploying so fast that they cause injury. In order to protect vehicle occupants, airbags must inflate so quickly that under certain conditions the force of this inflation can itself cause injuries to vehicle occupants. As such, drivers and front-seat passengers must take care to ensure that they are not positioned in a way that could put them at risk of injury should the airbag deploy.

A driver's position in relation to the airbag is arguably the most important factor in whether or not he or she sustains an injury from the deployment of the airbag. Transport Canada notes that the only similarity among the eight people in 2001 who sustained fatal injuries caused by airbags was that they were too close to the airbag when it deployed (Transport Canada 2011). Since the airbag leaves the module with such force and at such a high rate of speed, the most serious injuries caused by airbags are sustained by drivers sitting very close to or in direct contact with the steering column. Transport Canada recommends that drivers sit at least 25cm away from the steering column. Front-seat passengers who are sitting close to the dashboard or who have some part of their body in contact with the dashboard (e.g., legs or feet resting on the dash) may sustain similar injuries if the passenger airbag deploys.

To further protect themselves from the speed at which the airbag is deployed, it is also important that vehicle occupants wear their seatbelts properly.



Unbelted occupants are more likely to shift forward in the event of a crash, bringing them into closer contact with the airbag module.

There are also recommendations regarding who should be sitting across from an airbag in the front passenger seat. It is recommended by Transport Canada that children under the age of 12 sit in the backseat. In theory, children of this age are safe in the front as long as they are belted properly, do not lean forward, and are positioned far away from the passenger airbag. However, since these conditions are more difficult to maintain with children, the safest place for them is in the back seat. In addition, rear-facing infant carriers should never be placed in the front seat. If the airbag deploys, it will push the infant carrier forward and may cause the infant to be pushed against the seat or other hard surface on the seat. Infants should also not face forward in the front seat, since their heads and necks cannot tolerate crash forces (Transport Canada 2011).



Image courtesy of Toyota Canada

Injuries caused by airbags are usually minor compared to the types of injuries they prevent. However, serious injuries by airbags are possible if vehicle occupants are not properly positioned in their seats. The proper use of the seatbelt and correct seat placement is necessary in order for airbags to deliver maximum safety benefits.

DO AIRBAGS HAVE ANY LIMITATIONS?

Yes. Similar to other safety features, realizing the full safety benefits of airbags depends largely on whether drivers understand the design and functional limitations of airbags and use them properly, and continue to drive safely and attentively. It has already been mentioned that one limitation of airbag effectiveness is the dependency on the proper positioning of vehicle occupants. However, other factors must be taken into consideration when investigating the limits of airbags.

Airbags are not pillows. Colliding with an airbag is preferable to colliding with a steering column, but neither is comfortable. The speed at which a vehicle strikes an object is a major determinant in the overall force of the crash. The force of the crash is directly related to the severity of the crash. Crashes that are forceful enough can twist and compress the steering column so badly that the airbag cannot deploy (Pipkorn 2004). At speeds above 65km/h, the integrity of modern passenger vehicles is not guaranteed, and twisting, intrusion, and crumpling may affect the performance of the airbag (Pipkorn 2004). As such, drivers are urged not to speed excessively or to rely on airbags to compensate for unsafe increases in speed.

In addition, airbags do not offer the same level of protection in all types of crashes. Vehicles without side airbags are still vulnerable to side-collisions, while all vehicles are vulnerable to being hit from behind. Driver behaviours that increase the odds of involvement in a collision are detrimental to road safety since these behaviours increase the likelihood of being involved in a crash for which airbags were not designed. Distraction, impairment, poor driving conditions and fatigue all increase crash risk. Airbags cannot prevent these crashes from happening or

protect vehicle occupants in all the crashes that could occur as a result of these factors. The same factors can also increase reaction time, which may lead drivers to brake less quickly. Drivers who brake too late will be unable to lower their speed as much as they could have before a collision. At higher speeds, crashes are more forceful and airbags are pushed to the limit.

It cannot be overstated that the only way to receive the maximum safety benefits of airbags is to drive safely and attentively and to drive within speed limits.

CAN I TURN THE AIRBAGS OFF?

With the installation of an on/off switch, driver and passenger airbags can be turned off. These switches are available from Transport Canada (www.tc.gc.ca), and operate with a special key. In most cases, switches are installed by the dealer or other vehicle service technician. When either the driver or passenger airbag is turned off, a light will appear on the front console indicating the deactivation.

While most drivers would not benefit from turning the airbag off, there are certain drivers and passengers who are safer with the airbags turned off. Groups who are definitely safer with the airbags off include:

- rear-facing infants carriers, and;
- drivers with unusual medical conditions and who have been informed by their medical practitioner of the specific risks airbags pose for them.

Groups who may be safer with the airbags off include:

- children under twelve years old, and;



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- drivers who are physically incapable of sitting 25cm away from the steering wheel.

Many medical conditions do not interfere with the safety benefits of airbags. For example, drivers or passengers who are pregnant, wear pacemakers, or have asthma should keep the airbags on as long as they have not been told otherwise by a physician and can maintain a proper position in the seat. For a more detailed description of the circumstances under which airbags should and should not be deactivated, visit Transport Canada's website at www.tc.gc.ca.

HOW MANY VEHICLES HAVE AIRBAGS?

Widespread commercialization of airbags began in the late 1980s and early 1990s when they received uptake from several major manufacturers. In the United States, where frontal airbags have been mandatory on all but the heaviest vehicles since 1999, the IIHS estimates that by 2016 airbags will be available in 95% of registered vehicles (IIHS 2012).

Airbags are not mandatory in new vehicles in Canada. However, Transport Canada sets performance standards for airbags that are installed on vehicles.

HOW MUCH DO AIRBAGS COST?

When installed in the factory, airbags cost approximately \$280 for a driver-only system and \$410 for a dual system (driver and front-passenger airbags). There are additional costs attached to rebuilding an airbag after it has deployed. These costs range depending on where the repairs take place and whether replacement parts are also necessary.

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