

**Feasibility Analysis
of
Using Aftermarket
Backover Avoidance Technology
to
Reduce Backover Accidents**

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FEASIBILITY ANALYSIS

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Abstract

The feasibility of using aftermarket backover avoidance technology to reduce backover collisions is only dependent on whether or not a person owns a vehicle which does not have a functioning backup camera. If car owner does not have a backup camera, then installing one is important and there are models that are affordable for most any budget.

Drivers of larger vehicles, such as pickup trucks, SUVs, or minivans, take a substantial risk every time they back their vehicle due to the large size of the rear blindzone of these vehicles. Drivers of cars with smaller blindzones are still taking risks when backing, even if they do not have an excessively large blindzone. Sometimes, though, drivers of cars think they are taking less of a risk when they are actually not; many new styles of cars which place the back window slightly higher than the front window for a sleek design have rear blindzones which can be even worse than the blindzones of many pickup trucks.

Considering the fact that backing is usually for only a very short distance at a slow speed, the large number of injuries and deaths every year which involve backing vehicles shows that drivers need to be able to see where they are going. The government has acknowledged this need by requiring new vehicles to be manufactured with rearview cameras soon, but that will not help drivers of cars which do not already have cameras.

In the same way that drivers make sure their cars are safe by purchasing and installing new tires when the old ones get worn down, drivers also need to make their cars safe by purchasing and installing cameras so they no longer back blindly.

When choosing an aftermarket backover avoidance system to install keep these points in mind:

- ◆ Choose a rearview camera. Cameras instantly show any objects in the non-visible area directly behind a car, while rear pillar mirrors fail to provide adequate safety because the images are highly distorted and very small, and ultrasonic sensors fail to sense children a majority of the time.
- ◆ Determine if your vehicle already has a screen for the audio system which could accept an inexpensive and easy to install aftermarket license plate mounted camera.
- ◆ If you must purchase an additional screen for the video, you have several options: navigation units that pair with backup cameras, new stereo systems with screens that can accept camera input, or replacement windshield mounted rearview mirror with an embedded video screen.
- ◆ If you can afford a unit that is always in your vehicle and automatically turns on when the vehicle is shifted into reverse, your car will be safer no matter what member of your family is driving.

Introduction

Minimizing dangers for ourselves and our families is an important task, but we rarely give a second thought to the dangers of a vehicle sitting in a driveway. In reality, our cars are one of the most likely sources of substantial physical harm to ourselves and our loved ones.

Unfortunately, some risks are unknown until brought to light by tragedy. Backing up in a modern car or SUV is one of those hidden risks. The area behind a car that cannot be seen from inside the car is called the blindzone, and drivers are often completely unaware that it exists. When a backing driver strikes another vehicle or an object, it is called a backing collision, but when a driver strikes a person or pedestrian behind their vehicle, it is designated a backover. Although the number of child deaths caused by backovers has climbed since the late 1990s ("Lack of Visibility"), it took until the late 2000s for statistics to be compiled and a solution to be sought.

After analyzing numerous studies by the National Highway Traffic Safety Administration (NHTSA) and reports of investigations conducted by reputable news agencies and consumer organizations, the intent of this report is to make any reader who drives a car aware of the danger of blindzones and urge them to take action to lessen the danger.

In addition to highlighting the danger of blindzones, this report explains what causes blindzones, shows why backover fatalities of children have increased, and gives statistics of annual injuries and fatalities caused by backing vehicles. It goes on to give evaluations and costs of aftermarket backover avoidance technologies.

Finally, this report recommends that all vehicles without factory installed rearview cameras be equipped with aftermarket backover avoidance technology to allow a view of the otherwise invisible area behind the vehicle. The preferred system is a rearview video system that automatically activates when the vehicle is put into reverse.

Data Section

Understanding the Problem

Initial Investigation. In October 2003, Consumer Reports magazine published an article titled "Driving Blind" which discussed the problem of children being struck by backing vehicles. It was one of the first investigations into the cause of backovers involving children. Their research uncovered large areas behind vehicles which could not be seen by drivers (23). At the time, Consumer Reports referred to those areas as rear blind spots, but in order to avoid confusion with the much smaller areas to the side of cars, the non-visible areas behind vehicles are now called blindzones.

Consumer Reports found the sizes of blindzones varied widely between vehicles, as shown in Figure 1 below, and were considerably worse for shorter drivers such as women and teens than for average men. In order for the 5' 1" driver of a Chevy Avalanche to see the top of a 28" traffic cone, Consumer Reports had to move the cone 50' out from the back of the truck. This

meant anything 28" or shorter in the first 50' behind the rear of the vehicle was completely invisible to the driver ("Driving Blind" 23).

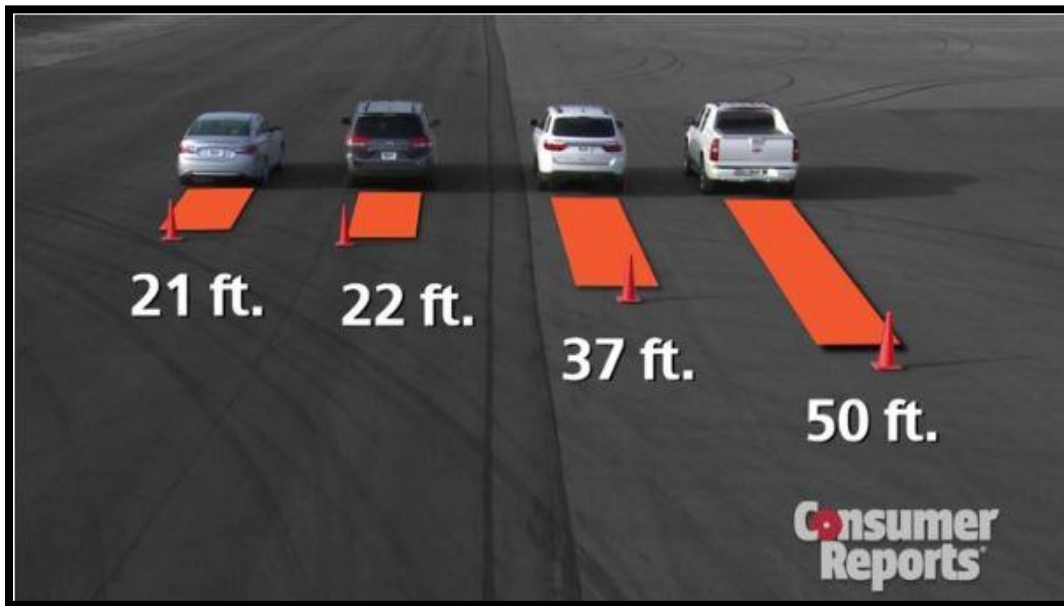


Figure 1 - Blindzone Distances for Various Vehicles. Source: Consumer Reports. "The Danger of Blind Zones". Apr. 2014.

Because a driver cannot avoid hitting something which they cannot see, blindzones are one of the most likely causes of backover injuries and deaths.

Blindzone Explanation. When a driver turns around and looks out the vehicle rear window, their vision of what is behind them is obstructed by the bottom of the rear window and/or the end of the car trunk or truck bed. The shorter the driver is, the farther their view is obstructed. Therefore, women and teen drivers cannot see objects behind them for a longer distance than men drivers.

Figure 2 below is a demonstration of this concept. In the front seat area, the blue oval represents the approximate placement of a man's eyes, and the pink oval represents a shorter woman or teen's eyes. The solid blue area behind the vehicle represents the non-visible area of an object of a certain size for an average height male driver. The much longer pink solid area shows a shorter driver's non-visible area for the same size object.

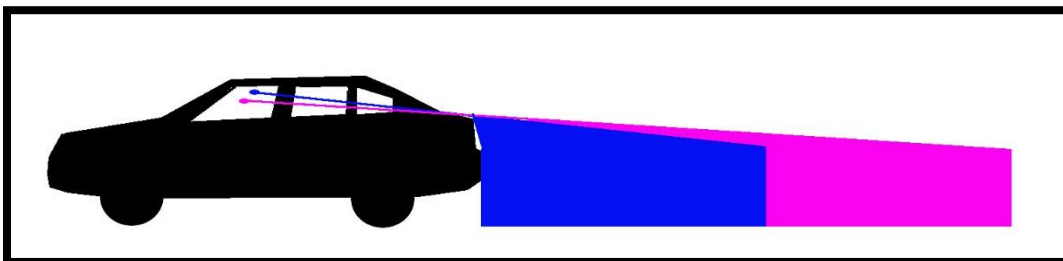


Figure 2 - Length of blindzones behind car in relation to eye-height of driver.

Effect of Vehicle Height and Length on Blindzone Size. The vehicle length and height also have an effect on the size of the blindzone created. A representation of the difference between a car and truck is given in Figure 3 below. It shows the same blindzone diagram for a car as in Figure 2, but compares it with the theoretical blindzones of a longer, higher pickup truck based on the eye level of an average height driver and shorter driver.

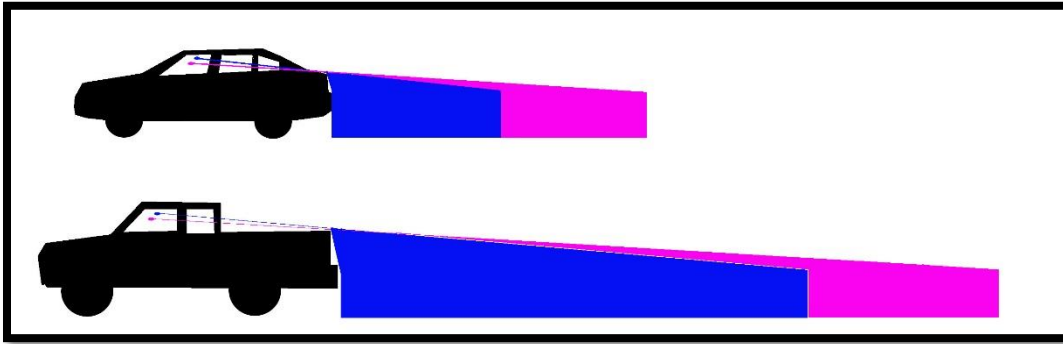


Figure 3 - Blindzones of a car compared to those of a longer and taller pickup.

Number of Child Fatalities and Blindzone Size. According to Kids and Cars backover facts, during the four-year period of 1996-2000, there were 88 child backover fatalities. In contrast, during the 2006-2010 four-year period, there were 448 children killed in backovers, an increase of over 500% (“Lack of Visibility”).

Consumer Reports studied the problem and concluded that part of the growing problem of child backovers is an increase in the popularity of pickups and SUVs, which have much larger blindzones due to their height and length (“Danger of Blindzones”). In addition, the popular trend of cars designed with low front-ends, high back windows, and sloping lines has increased the size of blindzones on cars. One such car, a 2007 Chrysler 300C, was studied by NHTSA after the driver backed over her 18-month-old child. The NHTSA visibility study found that no part of an object of the child’s size could be seen by the driver in the first 34 feet behind the car (NHTSA, *Fatalities* 27). In effect, automobile manufacturers have created a deadly design trend.

Injury and Fatality Statistics

The National Highway Traffic Safety Administration conducted several studies to determine the number of injuries caused each year by backing vehicles.

An Underestimated Problem. Estimating the number of fatalities was difficult for many reasons. For example, a death certificate might not make any mention of the involvement of a vehicle if a victim was knocked down by a car and later died of brain injuries at a hospital. In addition, injuries that are not life threatening may not have been reported by police or treated in an emergency room. The NHTSA stated in their report to congress, “the current sources of data on traffic crashes very likely underestimate the true extent of the backover crash problem” (NHTSA, *Vehicle* 9).

Injuries and Fatalities Related to Backing Vehicles. The 2008 NHTSA report *Fatalities and Injuries in Motor Vehicle Backing Crashes* estimates backover fatalities alone total 292 per year, and other types of backing crashes add an additional 171 deaths. A breakdown of the estimates by type of crash and type of injury is shown in the NHTSA Table below.

Fatalities and Injuries in All Backovers and Other Backing Crashes				
<i>Injury Severity</i>	<i>Backovers</i>		<i>Other Backing Crashes</i>	
	Estimated Total	Sample Count	Estimated Total	Sample Count
<i>Fatalities</i>	292	716	171	894
<i>Incapacitating Injury</i>	3,000	131	3,000	173
<i>Nonincapacitating Injury</i>	7,000	372	5,000	441
<i>Possible Injury</i>	7,000	179	20,000	750
<i>Injured Severity Unknown</i>	1,000	23	2,000	25
<i>Total Injuries</i>	18,000	705	30,000	1,389

Source: FARS 2002-2006, NASS-GES 2002-2006, NiTS 2007
 Note: Estimates may not add up to totals due to independent rounding.

Table 1- Fatalities and Injuries in All Backovers and Other Backing Crashes. Source: National Highway Traffic Safety Administration. *Fatalities and Injuries in Motor Vehicle Backing Crashes*. Nov. 2008.

When backovers and other backing crashes are combined, the table shows that nearly 500 deaths annually involve a backing vehicle. In addition, there are an estimated 48,000 injuries every year, of which 6,000 are listed as incapacitating (11).

Considering the slow speeds, short distances, and incredibly brief time spans that comprise most vehicle backing activities, these totals seem excessively high.

Victim Age Breakdown. Children under five years of age and persons over the age of 70 comprise over 69% of backover fatalities. This is a disproportionately high percentage since they make up less than 16% of the population. Even worse, children in the age range of 1 to 4 years old make up nearly 40% of backover fatalities, and the drivers are usually their parent or a relative (Federal Motor Vehicle 19186).

Government Involvement

History of Recent Regulation. In the early 2000s, several consumer advocacy groups started campaigns to bring public awareness to the lack of rear visibility and pressure lawmakers to enact rear visibility standards. In early 2008, President Bush signed into law a mandate that the issue of rear visibility be researched and a rear visibility standard be enacted and implemented by 2011. In response, the NHTSA conducted several extensive studies and presented overwhelming proof that a lack of rear visibility causes unnecessary deaths. They also tested the effectiveness of several technologies available to automakers and

recommended rearview cameras be installed on all new cars. In March 2014, the recommendation was adopted as a federal regulation (Paltrow).

Government Tests. The NHTSA, under the Department of Transportation (DOT) conducted extensive testing of available technology before making their recommendation. First, the NHTSA tested each technology's ability to detect objects within the blindzone areas. Test drivers, who were not aware of the purpose of the study, were then used to determine how well each technology enabled a driver to detect and avoid hitting objects placed in their backing path after they entered the vehicle.

Mirrors. One of the methods which automakers originally tried implementing to address the lack of adequate visibility was convex mirrors installed in the rear pillars to help see out the back window. This technology is inexpensive, and the NHTSA studied it in hopes that it would prove to be an economical solution.

Unfortunately, mirrors provide only spotty coverage of the area behind vehicles. In addition, because of their convex shape, images in the mirrors are often distorted beyond recognition (Mazzae 10). For these two reasons, mirrors are not an acceptable backover avoidance technology.

Ultrasonic Sensors. Another technology the NHTSA tested was ultrasonic sensors. They are a fairly popular factory installed parking aid and held promise because their audible beep could get a driver's attention. Ultrasonic sensors are expensive and also require complex installations.

Ultrasonic Sensor have a very limited sensing range, which leaves a blind area between their extent and the distance at which objects can be seen out of the back window. The worst issue, though, is that ultrasonic sensors regularly fail to pick up children and moving objects at all (Mazzae 17). This makes ultrasonic sensors unacceptable as a backover avoidance technology as well.

Rearview Cameras. The third technology tested by NHTSA was rearview cameras. In early testing, cameras were estimated to be the most expensive solution. By the time the final regulation was made four years later, though, prices had come down considerably (Paltrow).

Tests show that video systems immediately display objects which come into the backing path. Nearly half the test drivers avoided striking objects secretly placed behind them. The only drawbacks were that drivers had to actually look at the screen and that the video could be somewhat difficult to discern in low light or rain. (Mazzae 21).

Even with these drawbacks, test drivers avoided hitting objects placed in their blindzone far more often than with any other technology. This improvement was despite the fact that test drivers were often driving an unfamiliar vehicle in tests. Had more drivers been familiar with the reverse camera systems being tested, the results would have undoubtedly improved. The Federal Motor Vehicle Safety Standards Rear Visibility Final Rule states that backup cameras

which meet the mandated requirements are “not only the most effective system at addressing the backover crash risk but also the most cost-effective” (19179).

Ongoing Dangers

The recent government regulation has not solved the problem of backovers. Even though all new vehicles manufactured in 2018 and later are now required to have cameras, most previous-year vehicles in operation do not have adequate rear visibility. The Federal Motor Vehicle Safety Standards Rear Visibility Final Rule estimates that it will take until the year 2054 before there are no longer any vehicles without factory installed rearview cameras on the road (19180). Drivers of vehicles without backup cameras are still in danger of hitting objects or people which they have no way of seeing, and therefore need to install an aftermarket system.

Aftermarket Solutions

Availability and Styles. There are backup camera systems that can be added to any vehicle. A search of Amazon.com revealed a wide assortment of aftermarket backup cameras and monitors available. Garmin makes wireless backup cameras that pair to most of their recent navigation units for video display. Audiovox makes inexpensive backup cameras that can be connected to most modern in-dash stereo system screens that accept RCA inputs. Cameras that are supplied power from the reverse lights have the added advantage of automatically turning on whenever the vehicle is shifted into reverse. Some name brand systems offer backing guides and automatically dim the video at night. There are also numerous inexpensive off-brand cameras, displays, and even entire systems.

Another possible solution for displaying video is a windshield-mounted rearview mirror with an embedded video display when reversing. These have been available for several years as aftermarket additions, but earlier this year, Cadillac received approval from the NHTSA to use this style of display to meet rear visibility standards (Nelson). The consumer acceptance of this solution is likely to rise as new car manufacturers implement this technology in vehicles which have no in-dash monitor.

Cost and Benefits. Cars that already have a compatible video screen can be outfitted with a camera-only solution for as little as \$30. Many aftermarket systems can be installed in a few hours by handy car owners for a total cost of under \$100. More reputable brands will cost somewhat more, and a name brand system installed professionally could run around \$700 from a local car audio and accessory shop. On the average, a rearview camera system can probably be installed for less than the cost of a set of tires, but even the more expensive options are far less costly than the damage likely to be done in a backing collision. In addition, the investment could save a life.

Conclusion

Summary and Interpretation of Findings

The National Highway Traffic Safety Administration testing proves that modern vehicles have a dangerous lack of rear visibility. In addition, their data reveals that the rate of injuries and fatalities caused by backing vehicles is linked to the size of the non-visible area behind the vehicle, and that SUVs, minivans, and pickup trucks cause more injuries and deaths than cars with smaller blindzones.

Finally, their test results of various backover avoidance technologies showed about half the test drivers avoided striking an unknown object in their backing path when operating a vehicle with a rearview camera. This improvement was despite the fact that the rearview video system may have been completely unfamiliar to the test drivers. Drivers who are familiar with their rearview video system and have a backing process which includes the video would logically be even less likely to back into an object.

These NHTSA tests verified that vehicle backup camera systems provide needed rear visibility that would undoubtedly save lives and reduce injuries and damage caused by backing vehicles. Unfortunately, the recent regulation requiring backup cameras on all vehicles manufactured after 2018 will not ensure rear visibility in the entire passenger vehicle fleet until around 2054.

In spite of this delay, driver's do not need to buy a new car or wait until 2054 in order to see where they are going when they back up. Any vehicle can be outfitted with an aftermarket backup camera. In addition, there are backup cameras available for most any budget. Quality and features may vary, but the most important feature is simply a view of the area behind the vehicle.

Recommendations

- If you own a vehicle without a backup camera, install one as soon as possible.
- If you have friends or family members without a backup camera on their car, you should make them aware of the dangerous blindzone behind their vehicle and recommend installation of an aftermarket camera.
- Make your children and loved ones aware that backing drivers cannot usually see behind the vehicle and stress the importance of staying clear of any vehicle with reverse lights on.

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