U.S. Department of Transportation
National Highway Traffic Safety Administration

TRAFFIC SAFETY FACTS
Research Note

NHTSA
www.nhtsa.gov

DOT HS 812 031

June 2014

The Effect of ESC on Passenger Vehicle Rollover Fatality Trends

Bob Sivinski

Summary

Electronic stability control (ESC) is highly effective at preventing certain types of crashes, including rollovers that result from loss of vehicle control. Although crash data does not show a significant decrease in the overall rate of rollover fatalities relative to all other traffic fatalities over the last several years, when analysis is restricted to newer vehicles and to the types of rollovers that ESC is designed to prevent, there is an obvious decline that is likely to be partially due to the effects of ESC. As ESC saturates the on-road fleet in the coming years, it is likely that rollovers resulting from loss of vehicle control will continue to decline. Other types of rollovers, such as those caused by an impact with another vehicle, are not likely to be affected by the spread of ESC in the population.

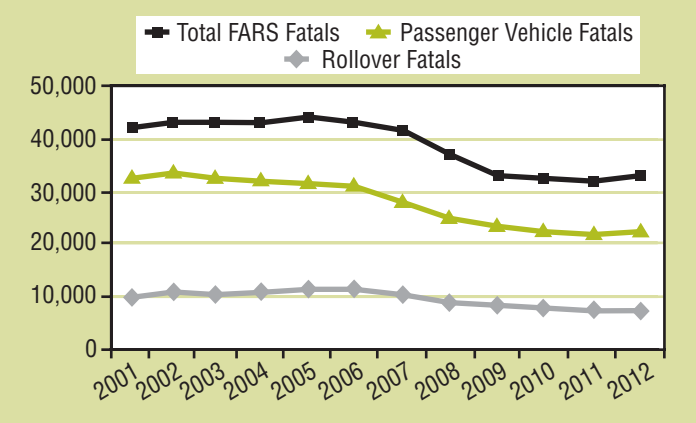
Introduction

While the overall number of rollover fatalities has decreased over the last several years along with total motor vehicle fatalities, the rate of rollover fatalities as a portion of total motor vehicle crash fatalities has remained at about one third of all passenger vehicle fatalities. This result is somewhat surprising given the estimated effectiveness of ESC in preventing rollovers. A NHTSA report[1] published in 2011 estimated that ESC is 56-percent effective at preventing fatal first event rollovers in passenger cars and 74-percent effective at preventing the same type of crash in light trucks and vans (LTVs). This Research Note investigates the crash data contained in the Fatality Analysis Reporting System (FARS) to help to explain the effect that ESC is having on rollover fatalities.

Rollover Fatalities: Historical Trends

The Fatality Analysis Reporting System (FARS), a census of fatal crashes compiled annually, can be used to investigate the rate of rollover fatalities over time. Figure 1 below shows the counts of passenger vehicle fatalities in the FARS data across the last 12 years, along with counts of fatalities of passenger vehicle occupants and passenger vehicle rollovers.

Figure 1
Number of Fatalities in FARS 2001–2012

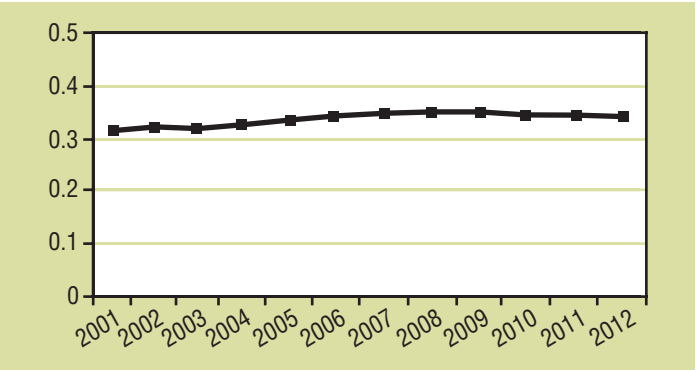


Although rollover fatalities have decreased over the last five years, the overall number of fatalities also decreased during this period. An important question for evaluating the effect of rollover prevention technology is the extent to which rollover fatalities have changed relative to total passenger vehicle fatalities. Figure 2 below shows the relative rate of rollover fatalities over the last 12 years. The relative rate of rollover fatalities is calculated as:

relative rate = # of PV rollover fatalities / # of total PV fatalities

[1] Sivinski, R. (2011). *Crash Prevention Effectiveness of Light-Vehicle Electronic Stability Control: An Update of the 2007 NHTSA Evaluation.* (Report No DOT HS 811 486). Washington, DC: National Highway Traffic Safety Administration

Figure 2
Relative Rate of Rollover Fatalities (FARS 2001–2012)



The rate of rollover fatalities relative to all fatalities appears fairly constant over time. The expected reduction in rollover fatality rates resulting from ESC is not apparent in this trend line.

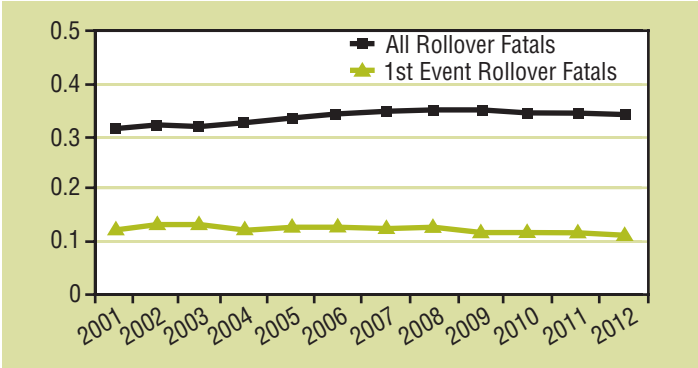
The Effect of ESC on Observed Crashes

The effect that a given technology will have on the crash population is a product of two primary factors: the effectiveness of the technology and the size of the population of crashes that the technology might affect. Given the high rate of effectiveness estimated for ESC, it is likely that the answer to identifying the real world effects of ESC lies in how we define the crash population that ESC might be expected to affect.

While the rate of fatalities occurring in passenger vehicle rollovers might be an intuitive place to look for the effect of ESC, there are a few reasons why this may be too broad of a category of crashes to reveal the effect. The first is that not all rollovers are likely to be affected by the presence of ESC. Many rollovers are initiated by a preceding collision with another vehicle or some fixed object. If these preceding collisions are unlikely to be affected by ESC presence on the rolling vehicle (e.g., struck in the side in an intersection by another vehicle) then ESC would not be expected to prevent these types of rollovers.

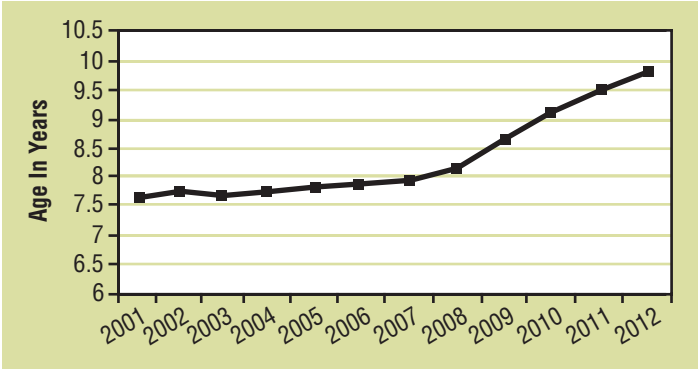
Previous effectiveness estimates of ESC have been calculated by restricting the population of interest to specific crash types that are likely to be affected by ESC, for example, first event or untripped rollovers. An example of such a rollover is a vehicle that rolls over due to the centrifugal force generated by taking a turn at excessive speed. In general, first event rollovers as defined by FARS[2] represent about one third of all rollover fatalities. Figure 3 below shows the rates of all rollover fatalities and first-event rollover fatalities as proportions of all passenger vehicle fatalities across time. Although the two trend lines appear similar, the rate of first-event rollovers is actually declining in a slow but statistically significant manner over time.

Figure 3
Relative Rate of Fatalities in Rollovers and First-Event Rollovers (FARS 2001–2012)



The second factor that may be obscuring the effect of ESC on rollover fatalities is that many of the vehicles currently on the road are not equipped with ESC. Although ESC has been available on vehicles for several years, it was not required until model year 2012. Figure 4 below shows the average age of the vehicles in the FARS data in which one or more fatalities occurred across the years 2001–2012.

Figure 4
Mean Age of Vehicles With a Fatality (FARS 2001–2012)



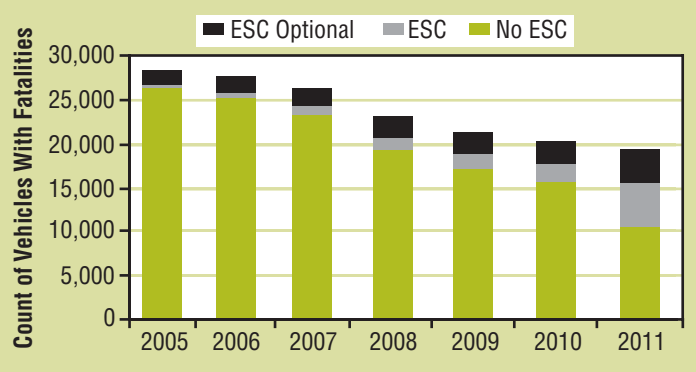
Over the last several years the mean age of the vehicles involved in fatal crashes has increased sharply, counteracting some extent of the effect of ESC saturation into the fleet. Because of the inflection point in the graph near 2007, any new technologies introduced around that time (such as ESC) will take longer than usual to saturate the population of vehicles involved in fatal crashes.

[2] National Highway Traffic Safety Administration. (2011). *Fatality Analysis Reporting System (FARS) Analytical Users' Manual 1975–2010.* (Report No. DOT HS 811 529). Washington, DC: Author. , Available at www-nrd.nhtsa.dot.gov/Pubs/811529.pdf

This increase in vehicle age could be due to several factors. For example, economic factors related to the recent recession may be influencing new vehicle purchases or improvements in vehicle quality could be increasing the effective life span of vehicles on the road. According to vehicle registration data from R.L. Polk the mean vehicle age in the overall population of passenger vehicles is not increasing as sharply as in the population of vehicles involved in fatal crashes.

Figure 5 below illustrates the effect that increasing vehicle age may be having on the number of vehicles in the FARS data that are equipped with ESC by showing the passenger vehicles in the FARS data from 2005–2011 (the years for which ESC status has been determined for the FARS cases) broken down by presence of ESC.

Figure 5
Presence of ESC in Passenger Vehicles Containing at Least One Fatality (FARS 2005–2011)

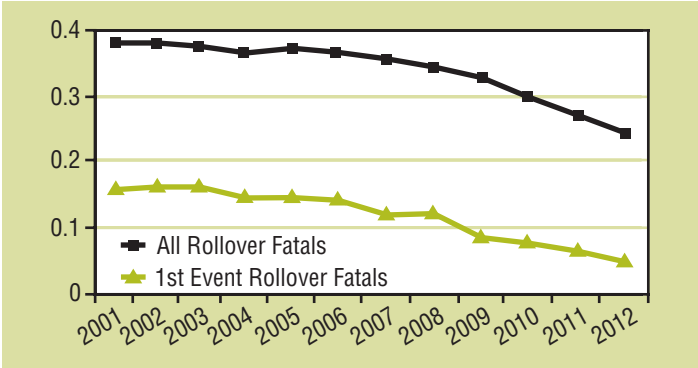


Although the proportion of vehicles equipped with ESC in the FARS data is increasing, it has been increasing at a modest rate and as late as 2010 represented a small portion of the vehicle population (5% with standard ESC, 7% with optional ESC). Part of the reason that ESC equipped vehicles are not common in the FARS data may be it is successfully preventing crashes, but the slow rate of fleet turnover illustrated by Figure 4 is likely to play a large role as well.

In light of these results, the effect of ESC on rollover trends was analyzed based only on the population of newer passenger vehicles. Figure 6 below shows the same trends as Figure 4, but restricted to newer vehicles that are no more than five years old[3] (for example, in the 2012 crash data eligible vehicles have model years 2008 and newer).

[3] Vehicle age is calculated as crash year minus model year, it's a sliding window that allows model year to change depending on the year of the crash.

Figure 6
Relative Rate of Fatalities in Rollovers and First-Event Rollovers in Vehicles 5 Years Old or Less (FARS 2001–2012)

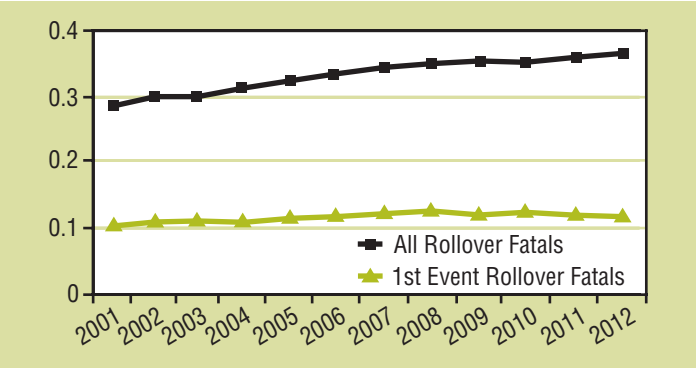


This figure shows that ESC is likely having a stronger effect on a certain subset of rollover fatalities. Rollover fatalities in newer passenger vehicles declined from 38.3 percent of all fatalities in 2001 to 24.6 percent in 2012, and first-event rollover fatalities in newer passenger vehicles (5 years old or less) have declined from 15.7 percent of all passenger vehicle fatalities in 2001 to 4.9 percent in 2012. While this subset is strictly defined, it still represents a significant number of potential annual fatalities. In terms of absolute count, all rollovers in newer (5 years old or less) passenger vehicles resulted in 1,527 deaths in 2001 but only 144 fatalities in 2012. This represents an impressive 91 percent reduction in this type of fatality over a 12-year span.

Although ESC is likely a contributor to this reduction, other vehicle changes such as improved static stability factors (defined as one half the vehicle track width divided by the height of the center of gravity above the road), side curtain air bags, and window curtains and glazing are also likely to have had an effect. It is difficult to parse these effects in the observed rate reduction.

Rollover and first-event rollover fatalities have increased over the same time frame in older vehicles, defined as more than five years old, as shown in Figure 7.

Figure 7
Relative Rate of Fatalities in Rollovers and First-Event Rollovers in Vehicles More Than 5 Years Old (FARS 2001–2012)



Although the increase appears modest, because older vehicles contain the bulk of the fatalities in the FARS data (75% over the included years) this increase has a large effect on the overall trends seen in Figures 1 and 2. It's beyond the scope of this report to speculate on the underlying causes of these observed increases, but it should be noted that these are relative rates subject to the number of other types of fatalities in the data.

Conclusions and Discussion

The rate of overall rollover fatalities has not declined in recent years, despite the effectiveness of ESC, perhaps because ESC is only effective within a subset of all rollover crashes and because many of the vehicles on the road are not equipped with ESC yet. However, ESC does appear to be highly effective at preventing certain types of rollovers, and it is reasonable to assume that in the future occurrences of these types of rollovers will continue to decline sharply. In this report, newer vehicles are used as a proxy for vehicles with ESC and first event rollovers are used as a proxy for rollovers caused by loss of vehicle control. These attributes are more thoroughly investigated and defined in the most recent NHTSA evaluation of ESC effectiveness (Sivinski, 2009).

The results presented in this report also suggest that much of the benefits from ESC have yet to manifest themselves due to the slow rate of fleet saturation for the technology. It is likely that as ESC saturates the fleet, its effect on rollover incidence will be more apparent in larger populations. These results also suggest that a large portion of rollover crashes, the non-first event rollovers, may be less affected by ESC.

A topic that warrants further investigation is the differences in crash kinematics and occupant injury outcomes between the types of rollovers that ESC is designed to prevent, which are likely to become increasingly less common, and the types of rollovers that ESC is not capable of preventing, which are likely to continue to occur at a similar rate.

Suggested APA Format Citation for This Document:

Sivinski, R. (2014, June). *The effect of ESC on passenger vehicle rollover fatality trends.* (Research Note. Report No. DOT HS 812 031). Washington, DC: National Highway Traffic Safety Administration.

U.S. Department of Transportation
National Highway Traffic Safety Administration

This research note and other general information on highway traffic safety may be accessed by Internet users at: www-nrd.nhtsa.dot.gov/CATS/index.aspx