Effectiveness of Rollover-Activated Side Curtain Airbags in Reducing Fatalities in Rollovers

Jeya Padmanaban[1], Matthew Fitzgerald[2]

Abstract This study uses U.S. field data to evaluate the effectiveness of rollover-activated side curtain airbags in reducing fatalities in rollover crashes. Rollover-activated side curtain airbags are designed to supplement seat belts in reducing risk of ejection and injury. Compared to traditional side-impact airbags, the rollover-activated side curtain airbags use more complex crash sensors and are designed to stay inflated longer to help secure occupants inside the vehicle in a rollover event. This technology, introduced in 2002, has since been widely used; about 30% of 2008 model year light vehicles on the road were equipped with rollover curtains as standard equipment. US fatal accident data from the Fatality Analysis Reporting System (FARS), the National Automotive Sampling System/General Estimates System (NASS/GES) databases, and state accident data files were examined for model years 2000-2009. A matched-pair comparison was made of the fatality rates of belted front outboard occupants involved in rollover crashes in vehicles equipped with and without rollover-activated side curtain airbags as standard equipment. Effectiveness was estimated for "all belted" and "belted, non-ejected" front outboard occupants. Results indicate rollover-activated side curtain airbags in single-vehicle accident rollovers are about 23% effective in reducing fatalities for all belted front outboard occupants, and about 20% effective in reducing fatalities for belted, non-ejected front outboard occupants. Crash severity factors, such as high travel speed, are also shown to contribute to injury severity.

Keywords airbags, belted, fatal, rollover, side-curtain

I. INTRODUCTION

In light of the final rule NHTSA established in FMVSS 226 on ejection mitigation, a comprehensive study of effectiveness involving vehicles with rollover-activated side curtain airbag deployment was undertaken for this study.

Rollover-activated side curtain airbags were first introduced in the automobile industry in 2002, on the 2002-1/2 model year Ford Explorer and the 2002 Mercury Mountaineer, with many manufacturers later including this feature in their vehicles. In 2011, the National Highway Traffic Safety Administration (NHTSA) published its Final Rule (Docket No. NHTSA-2011-0004) to add a new Federal Motor Vehicle Safety Standard (FMVSS), Number 226, "Ejection Mitigation", to parts 571 and 585. The rule requires that manufacturers include side-impact and rollover-initiated side curtain airbags—with the option to include laminated windows—and that these be installed in all vehicles by 2017 while allowing "advanced credits" to meet the phase-in schedule [1]. NHTSA's proposed phase-in schedule requires side-impact and rollover-initiated side curtain airbags in 20% of each manufacturer's vehicles by September 1, 2014; 40% by September 1, 2015; 75% by September 1, 2016; and "all vehicles (without use of advanced credits) manufactured on or after" September 1, 2017 [1].

Compared to side-impact-only curtains, curtain airbags designed for rollover activation use more sophisticated crash sensors and are designed to stay inflated longer because rollover events can last for several seconds. O'Brien-Mitchell et al. [2] have conducted laboratory tests to evaluate the ejection mitigation potential of rollover-activated curtains, demonstrating the risk for neck injuries—as assessed by the use of Injury Assessment Reference Values (IARVs)—as the number of contact locations increase during a rollover. Berg et al. [3] also conducted laboratory tests to evaluate the performance of advanced rollover sensing systems,

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demonstrating the protection rollover curtains offer is strongly correlated to when they are triggered during a rollover event. To date, very little literature exists examining the field performance of this technology in real-world crashes. This study examines the real-world effectiveness of rollover-activated side curtain airbags in reducing fatalities in rollovers.

II. METHODS

This study focused on “all belted” and “belted, non-ejected” front outboard occupants in single-vehicle accident (SVA) rollover crashes. A matched-pair analysis was performed by selecting models that existed three years prior to the introduction of rollover curtains as standard equipment and comparing these to the same platform with rollover curtains. The risk of fatality in rollover crashes was estimated using Fatality Analysis Reporting System (FARS) data combined with National Automotive Sampling System (NASS) General Estimates System (GES) data. Case reviews were also conducted, using the NASS Crashworthiness Data System (NASS/CDS), NHTSA’s Special Crash Investigation (SCI) files, and Florida’s detailed state police reports (including photos).

The term “rollover” as used in this study refers to vehicles that rolled at least one quarter turn and the term “ejected” includes both complete and partial occupant ejection.

Data Sources

VEHICLE IDENTIFICATION DATA

First, a thorough review was made of owner’s manuals, the New Car Assessment Program (NCAP) website, the Insurance Institute for Highway Safety (IIHS) website, and industry sources to identify vehicles equipped with different types of side airbags (including rollover-activated side curtains) for 2000-2009 model year vehicles. The sources were reviewed to identify whether rollover-activated side curtain airbags were installed as standard or optional equipment. A list of makes/models which existed prior to the introduction of rollover curtains in the same platform was compiled to conduct a matched-pair comparison of the fatality rates in rollover crashes in vehicles equipped with and without rollover-activated side curtain airbags as standard equipment. The list of vehicles used in the study is provided in the appendix.

FIELD PERFORMANCE DATA

FARS data and NASS/GES data for the years 1999-2010, and model years 2000-2009, were used to address the fatality risk in rollover crashes.

The FARS database is a census of all US traffic crashes that occur on public roads and result in death within 30 days of the crash. FARS data are compiled from police accident reports, vehicle registration files, driver licensing files, death certificates, medical examiner reports, state highway department data, and hospital/EMS records, and extensive quality control procedures are used by the state and federal FARS professionals to ensure accuracy and completeness of each piece of information entered into the database. Because more than 100 data elements associated with accident, vehicle, and occupant-related factors are coded for each fatal traffic crash, FARS data files are widely used by crash and vehicle safety investigators.

The NASS/GES database is a nationally representative weighted sample, selected from all police-reported traffic crashes. To be included, a crash must have had a police report completed for it and must have involved at least one vehicle traveling on a public roadway and have resulted in a death, injury, or property damage. This database is typically used by NHTSA to obtain national estimates of injuries and crashes.

CASE REVIEW DATA

Multiple databases were examined to obtain fatal rollover cases involving belted occupants for vehicles with standard and optional rollover curtains. (The data set was expanded to include optional rollover curtains in order to obtain the maximum number of cases for review.) NASS/CDS data and SCI data files for calendar years 2002-2010 were examined for detailed case data. State data reports from Florida were also searched for rollovers involving 2002-2009 model year case vehicles in calendar years 2002-2010.

The NASS/CDS database, which is maintained by NHTSA, is a nation-wide representative sample of tow-away crashes investigated in detail by NASS teams consisting of engineers, biomechanical experts, medical personnel, and statisticians. The NASS data files contain information on over 500 variables addressing crash/vehicle/occupant and injury factors associated with real-world crashes and hence, are widely used by

NHTSA and other highway safety researchers in the US to examine injury experience in rollovers. For the CDS database, NASS investigates about 5,000 crashes a year involving passenger cars and light trucks.

For the SCI database, information collected ranges from basic data maintained in routine police and insurance crash reports to comprehensive data from special reports by professional crash investigation teams. Hundreds of data elements relevant to the vehicle, occupants, injury mechanisms, roadway, and safety systems involved are collected for each of the over 200 crashes designated for study annually. SCI cases are intended to be an anecdotal data set useful for examining special crash circumstances or outcomes from an engineering perspective. The benefit of this program lies in its ability to locate unique real-world crashes anywhere in the country, and perform in depth clinical investigations in a timely manner. Historically, the primary focus of SCI investigations was airbag deployments in crashes involving serious and fatal injuries and/or advanced airbag designs.

Florida state data were also used for the detailed case studies. Police-reported accident data files maintained by the state highway department provide comprehensive information about occupants involved in crashes. Police officers, investigating the crash at the scene, complete a report that includes information about the crash, the vehicles, the persons involved, as well as driver-related factors for each accident that resulted in injury, fatality, or property damage. In addition, the state of Florida provides photographs, which enables positive identification of rollover curtain deployment.

FARS and NASS/GES Analysis

To calculate the effectiveness of rollover-activated curtain airbags, the first step was to determine the fatality rate for belted front outboard occupants in SVA rollover crashes. The number of fatalities was obtained from FARS data, and the number of occupants involved in rollover crashes was obtained from the NASS/GES data. The fatality rate was then calculated as follows:

Fatal rate per belted front outboard occupant = number of belted fatalities / number of belted front outboard occupants involved in SVA rollover crashes (1)

Once the fatal rate was determined, the effectiveness of rollover curtains in reducing fatalities could be calculated:

Effectiveness = 1 – (fatal rate per occupant for curtain equipped vehicles / fatal rate per occupant for non-curtain equipped vehicles) (2)

The analysis results are given in the following section, along with detailed case reviews.

III. RESULTS

Analysis of Rollover Curtain Airbag Effectiveness in Rollover Crashes

Vehicle registration data from R.L. Polk & Company were used to identify the percentage of vehicles equipped with rollover curtain airbags that were registered in the U.S. As seen in Figure 1, only about 1% of 2003 model year light vehicles on the road were equipped with rollover curtains as standard equipment, while for model year 2008, about 30% were equipped with rollover curtains as standard equipment.

FARS and NASS/GES data were used to identify the fatal rates of “all belted” and “belted, non-ejected” front outboard occupants (Figures 2 and 3) in vehicles with rollover curtain airbags as standard equipment, versus a matched set of vehicles *without*, and to calculate the effectiveness of rollover curtains in reducing fatalities.

As shown in Figure 2, the fatality rate per 1,000 occupants for belted front outboard occupants was about 12.8 for vehicles without rollover curtains and 9.9 for vehicles with rollover curtains as standard equipment. The effectiveness of rollover curtains in reducing belted occupant fatalities was found to be about 23% (95% confidence bounds: 3.5%-41.2%), calculated as:

$$(1 – (9.9 / 12.8)) * 100 = 22.6\% \qquad (3)$$

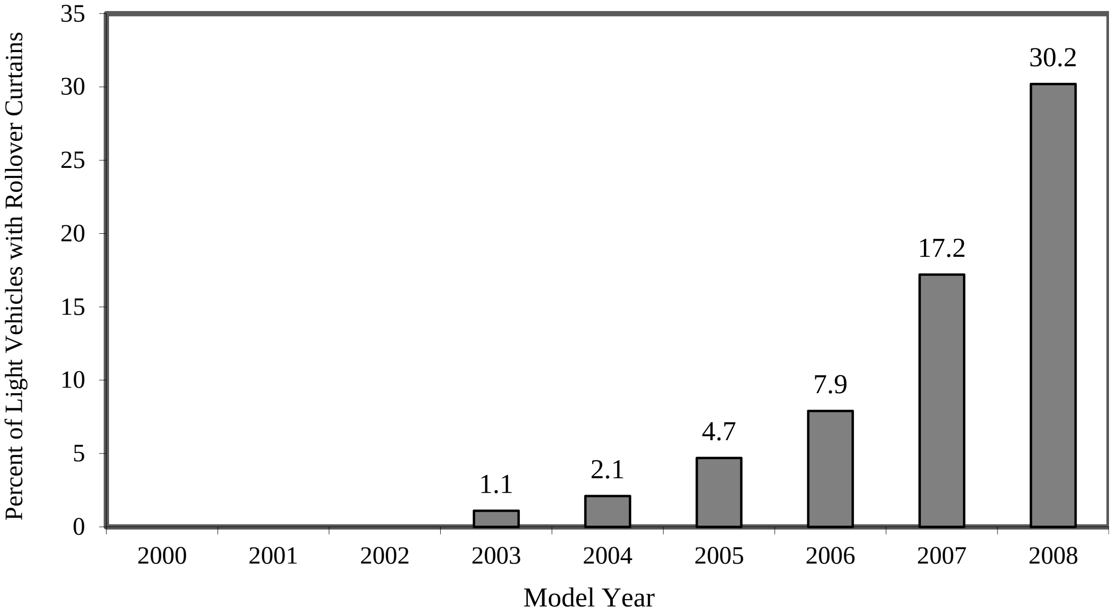

Fig. 1. Percent of Registered Light Vehicles with Rollover-Activated Side Curtain Airbags, by Vehicle Model Year

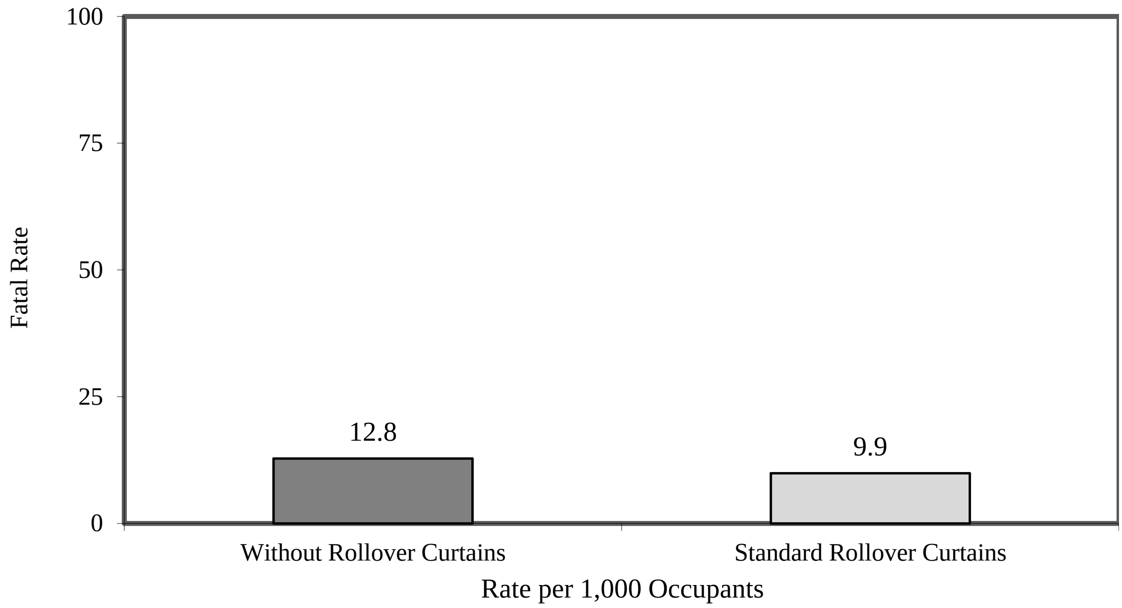

Fig. 2. Fatality Rates for Belted Front Outboard Occupants in Vehicles Equipped With and Without Rollover Curtains

As Figure 3 shows, the fatality rate per 1,000 occupants for belted, non-ejected front outboard occupants was again about 12.8 for vehicles without rollover curtains and 10.2 for vehicles with rollover curtains as standard equipment. The effectiveness of rollover curtains in reducing fatalities for belted, non-ejected front outboard occupants was found to be about 20% (95% confidence bounds: 6.0%-40.8%), calculated as:

$$(1 - (10.2 / 12.8)) * 100 = 20.3\% \quad (4)$$

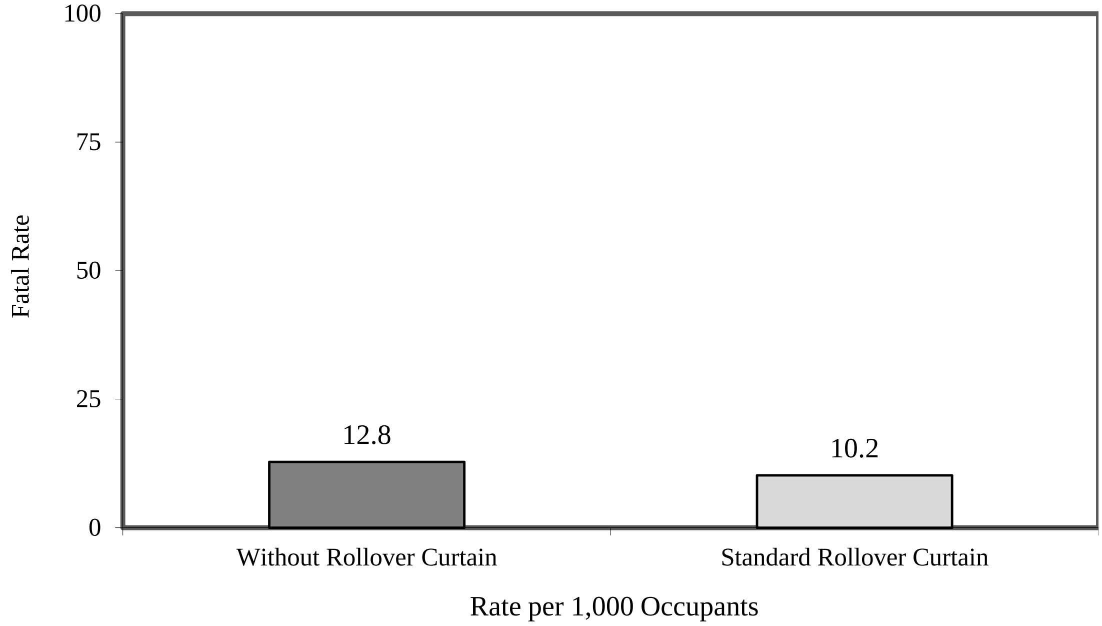

Fig. 3. Fatality Rates for Belted, Non-Ejected Front Outboard Occupants in Vehicles Equipped With and Without Rollover Curtains

The crash severity factors contributing to fatal rollover crashes could influence the effectiveness of rollover curtains in reducing fatalities. A comprehensive review of fatal cases with rollover curtain deployment was done to understand some of the factors influencing these fatality rates in rollovers.

Review of Fatal Cases with Rollover Curtain Deployment

A review of fatal accident reports and photographs for vehicles with rollover curtains was made to identify factors associated with rollover crashes in which, despite the presence of rollover curtain airbags, a belted front outboard occupant sustained fatal injury. A secondary purpose of the detailed review was to confirm the deployment of the rollover curtain airbags. In every case reviewed, the rollover curtain airbags deployed.

NASS/CDS CASE REVIEW— BELTED, FATAL OCCUPANTS

For the years 2002-2010, the NASS/CDS files contained three rollover cases in which belted front outboard occupants were fatally injured in vehicles with rollover-activated curtain deployment.

Case # 2007-12-189

The subject vehicle (2004 Lincoln Aviator) was struck on its right side in a 55 mph intersection by another vehicle (2005 Chevrolet Suburban), causing significant damage to the Aviator's passenger side. Both vehicles then side slapped, which caused the subject vehicle to lose control, depart the road, and roll three quarter turns over a distance of 45 ft.

The right front belted 90-year old female sustained a fatal injury. The passenger's age and her proximity to the side impact might be important contributing factors to the fatal injury. The belted 60-year old female driver sustained minor injury.

Fig. 4. 2004 Lincoln Aviator

Fig. 5. Deployed Passenger-Side Rollover Airbags

Case # 2008-45-137

This single-vehicle rollover accident involved a 2005 Toyota 4Runner that departed the road to the right, travelled down an embankment, and contacted a street sign, followed by a tree, with its front. The vehicle then began to rotate and rolled over, left-side leading. During the rollover, the 4Runner contacted another tree with its roof and a steel guardrail with its undercarriage before coming to final rest approximately 79 feet from the initial roll point.

The 60-year old belted female driver sustained fatal injuries at the scene. The frontal impacts prior to the rollover, the tree impact to the roof during the rollover, and the roll distance are likely significant factors in this case.

Fig. 6. 2005 Toyota 4Runner

Fig. 7. Deployed Driver-Side Rollover Airbags

Case # 2007-45-182

The subject vehicle (2005 Acura MDX) departed a rural road, struck a guardrail with its front, and then began to roll to the left one quarter turn, where the vehicle's left side and roof struck a tree. The tree impact caused the vehicle to then roll to the right two quarter turns.

The fatal belted male driver sustained an AIS 3 head attributed to the roof by investigators. The impact with the guardrail prior to rollover and the interrupted roll with the tree, which reversed the direction of roll rotation, were likely significant factors in this fatality.

Fig. 8. 2005 Acura MDX

Fig. 9. Deployed Driver-Side Rollover Airbags

SCI CASE REVIEW — BELTED, FATAL OCCUPANTS

SCI files for the years 2002-2010 contained three rollover cases in which belted front outboard occupants were fatally injured in vehicles with rollover-activated curtain deployment.

Case # CA10006

This single-vehicle rollover involved a 2003 Lincoln Navigator that departed the right road edge and rolled a minimum of eight quarter turns over a distance of 221 ft. The posted speed limit of the roadway was 75 mph. Police reported the vehicle traveling at approximately 80 mph.

The 62-year old belted female driver was partially ejected through the glazing opening. Her head was captured between the ground and the left side rail, evidenced by body fluid on the outboard side of the curtain airbag. Body fluid was also present on the inboard side of the window glazing, which post-crash was found folded over against the outer door panel. Crash severity factors such as high speed, number of rolls, and long roll distance were significant factors in this case.

Fig. 10. 2003 Lincoln Navigator

Fig. 11. Deployed Driver-Side Rollover Airbags

Case # CA05050

The subject vehicle (2004 Infiniti QX56) was involved in a severe run-off-road collision where it departed the road and yawed down a slight embankment. The vehicle then severely impacted a large diameter tree with its front left corner and subsequently rolled two quarter turns onto its roof. The impact location of the tree was such that it crushed the occupant compartment at the area of the left A-pillar and continued down the left side plane to the left D-pillar area.

The 18-year old belted female driver of the subject vehicle sustained massive head trauma. Per the SCI investigator: “[D]ue to the intrusion of the left A-pillar and left roof area, the driver contacted the roof at the junction of the A-pillar with her head.” Additionally, “the EDR recorded an 11-degree roll angle with a total roll rate of 130 degrees per second to the left, which triggered the deployment of the left and right canopy airbags" while the vehicle yawed down the embankment. Per the SCI report, this airbag deployment would have occurred prior to both the severe tree impact and the subsequent roll. Compounding factors such as the multiple events and the severe fixed object impact were likely significant components in this fatal case.

Fig. 12. 2004 Infiniti QX56

Fig. 13. Deployed Driver-Side Rollover Airbags

Case # CA06029

The subject vehicle (2005 Ford Escape) was involved in a run-off-road frontal impact with a concrete median barrier before rolling over ten quarter turns before coming to final rest on its roof. The vehicle was traveling on a 65 mph divided interstate roadway.

The 31-year old belted male driver sustained massive head injuries and expired at the scene. Although the driver's sunroof was closed prior to the sequence of events, the investigator reports that the sunroof disintegrated as the roof contacted the ground during the rollover. This allowed the driver's head to be partially ejected through the sunroof opening and consequently contact the road surface. The left door glazing was also reported as disintegrated, allowing the partial ejection of the driver's left hand and arm, which also contacted the road surface. Factors such as speed, number of quarter turns, and ejection portals are likely significant in this fatal case.

Fig. 14. 2005 Ford Escape

Fig. 15. Deployed Driver-Side Rollover Airbags

FLORIDA STATE (POLICE ACCIDENT REPORT) CASE REVIEW — BELTED, FATAL OCCUPANTS

For the years 2002-2010, Florida's state data files contained three rollover cases in which belted front outboard occupants were fatally injured in vehicles with rollover-activated curtain deployment.

Case # 77065990

This single-vehicle rollover involved a 2007 Volvo XC90 that departed the roadway to the right, struck a utility pole, shrubs, and a fence before rolling over an unknown number of times. It ultimately impacted the side of a building, which brought it to final rest.

The belted 46-year old male driver expired due to injuries sustained in this crash. The police report stated an estimated travel speed of 70 mph on a 55 mph roadway prior to the multiple collisions, subsequent roll, and final impact with the building. Factors such as high speed, multiple pre-rollover collisions, and the arrested rollover were significant contributing factors in this case.

Fig. 16. 2007 Volvo XC90

Fig. 17. Deployed Driver-Side Rollover Airbags

Case # 76765691

The subject vehicle (2007 Cadillac Escalade) was traveling at approximately 45 mph on a 35 mph state road when the driver failed to negotiate a left curve and departed the roadway on the right side. The driver then impacted one of two 3-foot tall steel poles on either side of the adjacent driveway with his right front tire. This caused the vehicle to yaw and subsequently roll over two quarter turns, during which the vehicle struck two parked cars. The vehicle came to final rest on its roof upon impacting the second steel driveway pole with the rear part of its roof.

The 61-year old male driver was unresponsive when medical personnel arrived and never regained consciousness. The police report coded that the driver had been drinking. Contributing factors of this accident include fixed object impacts, an arrested roll, alcohol and exceeding the stated speed limit.

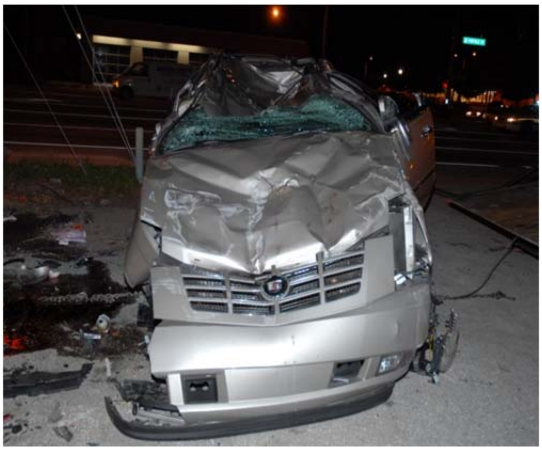

Fig. 18. 2007 Cadillac Escalade

Fig. 19. Deployed Driver-Side Rollover Airbags

Case # 77175626

This rollover involved a 2006 Mercedes CLS that departed a 55 mph roadway at a high rate of speed (estimated at approximately 100 mph). The vehicle rolled an unknown number of times, striking a barbed wire fence, a tree, and another barbed wire fence before coming to final rest in an adjacent field.

The 49-year old male driver sustained fatal injuries at the scene. Factors such as high speed and multiple fixed object impacts were present in this case.

Fig. 20. 2006 Mercedes CLS

Fig. 21. Deployed Driver-Side Rollover Airbags

IV. Discussion

While no hard and fast conclusions regarding the ways in which rollover-activated side curtain airbags work best or are least effective may yet be drawn from the existing crash data, the case reviews do show that crash severity (due to speed, force of impact, or number of rolls and events) likely plays a significant role. Several other issues that are indicated by the studies deserve more research. First, *when* a roll-activated curtain deploys can be critical. The first case discussed (a Lincoln Aviator) had a side impact followed by a rollover, and it was not clear when the curtains deployed. In SCI Case # CA05050 (an Infiniti QX56), the side curtains were known to be activated prior to the rollover or side impact. In addition, there are some crashes involving occupants in the front outboard positions where one suffers a fatality and the other does not in the same crash. It would be useful to review the accident circumstances and sequence of events leading to rollovers in these cases.

The principal value of these detailed reviews is that they show what has actually happened in a complex crash event such as a rollover. Reviews such as this one provide a ready reference for tracking real-world performance. Further research, especially as more vehicles are equipped with this safety feature and more data become available, could greatly enhance our knowledge on rollover safety.

A final note: Since the research reported here was completed, several new studies of vehicle performance with various mandated safety features have been published. The Insurance Institute for Highway Safety (IIHS) reports [4] that, due to Electronic Stability Control (ESC) systems, drivers in SUVs are now less likely to die in a rollover than are drivers in passenger cars—a complete turnaround from IIHS's position of just a few years ago. Since ESC systems were introduced nearly concurrently with rollover-activated side airbags, the influences of these two safety features on crash and injury severity would be interesting to separate and track. But the problem is still one of data. As the recent NHTSA *Rollover Data Special Study* noted of its own research into rollover cases involving vehicles equipped with ESC and/or side curtain airbags (with or without rollover sensing): "… only sixty-two percent of the rollover-involved vehicles were equipped with ESC" [5]. The number of vehicles with the new safety features is growing, and the crash data will very soon allow for more sophisticated analysis; in the meanwhile, studies such as this one can help researchers to frame the questions that need to be asked as safety regulators mandate increasingly sophisticated measures meant to keep motorists safe.

V. Conclusions

Field data (FARS and NASS/GES) on rollover crashes involving vehicles that have rollover-activated side curtain airbags as standard equipment show that:

- Rollovers are complex events and crash severity factors, such as high travel speed, are important factors contributing to injury severity and fatality.
- Rollover-activated side curtain airbags are about 23% effective in reducing fatalities for all belted front outboard occupants in SVA rollovers.
- Rollover-activated side curtain airbags are about 20% effective in reducing fatalities for belted, non-ejected front outboard occupants in SVA rollovers.

In-depth reviews of NASS/CDS, SCI, and police reports and photos for individual rollover cases involving vehicles in which a belted front outboard occupant sustained a fatality, despite the fact that the rollover-activated side curtain airbags deployed, support the statistical analysis findings that rollovers are complex events and that crash severity is an important factor in injury outcome.

VI. References

[1] National Highway Traffic Safety Administration, Ejection Mitigation; Phase-In Reporting Requirements, *Federal Motor Vehicle Safety Standards,* Final Rule, Docket No. NHTSA-2011-0004, pp. 1-310, March 1, 2011.

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[4] Insurance Institute for Highway Safety, "Dying in a Crash", *Status Report*, Vol. 46, No. 5, June 9, 2011.

[5] National Highway Traffic Safety Administration, Rollover Data Special Study, Final Report, DOT HS 811 435, p. iv, January 2011.

VII. Appendix

VEHICLE SELECTION

Make	Model/Trim	Doors	Body Style	Min. Model Year Std.*	Max. Model Year Std.*
ACURA	MDX	4	UTILITY	2004	2009
ACURA	MDX TOURING	4	UTILITY	2004	2006
AUDI	A3 2.0	4	Wagon	2008	2009
AUDI	A3 3.2 QUATTRO S-LINE	4	Wagon	2008	2009
AUDI	A3 PREMIUM	4	Wagon	2008	2008
AUDI	A4 2.0 AVANT QUATTRO	4	Wagon	2008	2008
AUDI	A4 2.0 AVANT QUATTRO S-LINE	4	Wagon	2008	2008
AUDI	A4 2.0 QUATTRO	4	SEDAN	2008	2009
AUDI	A4 2.0 TURBO	4	SEDAN	2008	2008
AUDI	A4 2.0T QUATTRO S-LINE	4	SEDAN	2008	2008
AUDI	A4 2.0T S-LINE	4	SEDAN	2008	2008
AUDI	A4 3.2	4	SEDAN	2008	2008
AUDI	A4 3.2 AVANT QUATTRO	4	Wagon	2008	2008

Make	Model/Trim	Doors	Body Style	Min. Model Year Std.*	Max. Model Year Std.*
AUDI	A4 3.2 QUATTRO	4	SEDAN	2008	2009
AUDI	A6 3.0 QUATTRO	4	SEDAN	2009	2009
AUDI	A6 3.2	4	SEDAN	2008	2008
AUDI	A6 3.2 AVANT QUATTRO	4	Wagon	2008	2008
AUDI	A6 3.2 QUATTRO	4	SEDAN	2008	2008
AUDI	A6 4.2 QUATTRO S-LINE	4	SEDAN	2008	2008
AUDI	A8 4.2 QUATTRO	4	SEDAN	2008	2009
AUDI	A8 L 4.2 QUATTRO	4	SEDAN	2008	2009
AUDI	A8 L W12 QUATTRO	4	SEDAN	2008	2009
AUDI	RS4 QUATTRO	4	SEDAN	2008	2008
AUDI	S4 AVANT QUATTRO	4	Wagon	2008	2008
AUDI	S6 QUATTRO	4	SEDAN	2008	2008
AUDI	S8 QUATTRO	4	SEDAN	2008	2009
BMW	X3 3.0SI	4	UTILITY	2008	2009
BMW	X5 3.0I	4	UTILITY	2008	2009
BMW	X5 4.8I	4	UTILITY	2008	2008
CADILLAC	ESCALADE	4	UTILITY	2007	2009
CADILLAC	ESCALADE ESV	4	UTILITY	2007	2009
CADILLAC	ESCALADE EXT	4	UTILITY	2007	2009
CADILLAC	SRX	4	UTILITY	2006	2009
CHEVROLET/GEO	AVALANCHE C1500	4	PICKUP - CREW CAB	2008	2008
CHEVROLET/GEO	AVALANCHE K1500	4	PICKUP - CREW CAB	2008	2008
CHEVROLET/GEO	EQUINOX LS	4	UTILITY	2009	2009
CHEVROLET/GEO	EQUINOX LT	4	UTILITY	2009	2009
CHEVROLET/GEO	EQUINOX LTZ	4	UTILITY	2009	2009
CHEVROLET/GEO	EQUINOX SPORT	4	UTILITY	2009	2009
CHEVROLET/GEO	SUBURBAN C1500	4	UTILITY	2008	2008
CHEVROLET/GEO	SUBURBAN C2500	4	UTILITY	2008	2008
CHEVROLET/GEO	SUBURBAN K1500	4	UTILITY	2008	2008
CHEVROLET/GEO	SUBURBAN K2500	4	UTILITY	2008	2008
CHEVROLET/GEO	TAHOE C1500	4	UTILITY	2008	2008
CHEVROLET/GEO	TAHOE K1500	4	UTILITY	2008	2008
CHEVROLET/GEO	TRAILBLAZER	4	UTILITY	2008	2008
CHEVROLET/GEO	TRAILBLAZER SS	4	UTILITY	2008	2009
CHRYSLER	TOWN AND COUNTRY LIMITED	V	Van	2008	2009
CHRYSLER	TOWN AND COUNTRY LX/LXI	V	Van	2008	2009
CHRYSLER	TOWN AND COUNTRY TOURING	V	Van	2008	2009
DODGE	DURANGO LTD	4	UTILITY	2007	2009
DODGE	DURANGO SLT	4	UTILITY	2007	2009
DODGE	DURANGO SXT	4	UTILITY	2007	2008
DODGE	GRAND CARAVAN SE/SPORT	V	Van	2008	2009
DODGE	GRAND CARAVAN SXT	V	Van	2009	2009
DODGE	RAM 1500	2	PICKUP - REGULAR CAB	2009	2009
DODGE	RAM 1500 MEGA	4	PICKUP - CREW CAB	2008	2008
DODGE	RAM 1500 QUAD	4	PICKUP - CREW CAB	2009	2009

Make	Model/Trim	Doors	Body Style	Min. Model Year Std.*	Max. Model Year Std.*
DODGE	RAM 1500 QUAD ST	4	PICKUP - CREW CAB	2008	2008
DODGE	RAM 1500 QUAD ST/SLT	4	PICKUP - CREW CAB	2008	2008
DODGE	RAM 1500 ST	2	PICKUP - REGULAR CAB	2008	2008
DODGE	RAM 1500 ST/SLT	2	PICKUP - REGULAR CAB	2008	2008
DODGE	RAM 2500	2	PICKUP - REGULAR CAB	2009	2009
DODGE	RAM 2500 MEGA	4	PICKUP - CREW CAB	2008	2009
DODGE	RAM 2500 QUAD ST/SLT	4	PICKUP - CREW CAB	2008	2009
DODGE	RAM 2500 ST/SLT	2	PICKUP - REGULAR CAB	2008	2008
DODGE	RAM 3500	2	CHASSIS - REGULAR CAB	2009	2009
DODGE	RAM 3500	2	PICKUP - REGULAR CAB	2009	2009
DODGE	RAM 3500 MEGA	4	PICKUP - REGULAR CAB	2008	2009
DODGE	RAM 3500 QUAD ST/SLT	4	CHASSIS - CREW CAB	2008	2008
DODGE	RAM 3500 QUAD ST/SLT	4	PICKUP - CREW CAB	2008	2008
DODGE	RAM 3500 ST/SLT	2	CHASSIS - CREW CAB	2008	2008
DODGE	RAM 3500 ST/SLT	2	PICKUP - REGULAR CAB	2008	2008
FORD	500 LIMITED	4	SEDAN	2007	2007
FORD	500 LIMITED AWD	4	SEDAN	2007	2007
FORD	500 SEL	4	SEDAN	2007	2007
FORD	500 SEL AWD	4	SEDAN	2007	2007
FORD	ESCAPE HYBRID	4	UTILITY	2009	2009
FORD	ESCAPE LIMITED	4	UTILITY	2008	2009
FORD	ESCAPE XLS	4	UTILITY	2008	2009
FORD	ESCAPE XLT 2.3L	4	UTILITY	2008	2009
FORD	EXPEDITION EDDIE BAUER	4	UTILITY	2007	2009
FORD	EXPEDITION LIMITED	4	UTILITY	2007	2009
FORD	EXPEDITION XLT	4	UTILITY	2007	2009
FORD	EXPLORER EDDIE BAUER	4	UTILITY	2008	2009
FORD	EXPLORER LIMITED	4	UTILITY	2008	2009
FORD	EXPLORER XLT	4	UTILITY	2008	2009
FORD	EXPLORER SPORT TRAC	4	UTILITY PICKUP	2008	2009
FORD	F-150	2	PICKUP - REGULAR CAB	2009	2009
FORD	F-150 SUPER CAB	4	PICKUP - EXTENDED CAB	2009	2009
FORD	F150 SUPERCREW	4	PICKUP - CREW CAB	2009	2009
FORD	FREESTYLE LIMITED		VAN - PASSENGER	2007	2007
FORD	FREESTYLE SEL		VAN - PASSENGER	2007	2007
FORD	TAURUS SEL	4	SEDAN	2008	2008
GMC	K1500 SIERRA DENALI	4	PICKUP - CREW CAB	2007	2008
GMC	SIERRA K1500 DENALI	4	PICKUP - EXTENDED CAB	2007	2008
GMC	ENVOY	4	UTILITY	2008	2008
GMC	JIMMY/YUKON/DENALI	4	UTILITY	2008	2009
GMC	YUKON XL C1500	4	UTILITY	2007	2009
GMC	YUKON XL C2500	4	UTILITY	2007	2009
GMC	YUKON XL K2500	4	UTILITY	2007	2009
HONDA	CR-V EX	4	UTILITY	2005	2009
HONDA	CR-V LX	4	UTILITY	2005	2009
HONDA	ELEMENT EX	4	UTILITY	2007	2009
HONDA	ELEMENT LX	4	UTILITY	2007	2009

Make	Model/Trim	Doors	Body Style	Min. Model Year Std.*	Max. Model Year Std.*
HONDA	ODYSSEY EX	V	Van	2005	2009
HONDA	ODYSSEY EXL	V	Van	2005	2009
HONDA	ODYSSEY LX	V	Van	2005	2009
HONDA	PILOT EX	4	UTILITY	2006	2009
HONDA	PILOT EXL	4	UTILITY	2007	2009
HONDA	PILOT LX	4	UTILITY	2006	2009
HUMMER	H2 SUT	4	UTILITY	2008	2009
HUMMER	H3 SUV	4	UTILITY	2008	2009
INFINITI	FX35	4	UTILITY	2005	2009
INFINITI	FX45	4	UTILITY	2005	2008
ISUZU	ASCENDER S/LS/LTD	4	UTILITY	2008	2008
JEEP	GRAND CHEROKEE LAREDO	4	UTILITY	2007	2009
JEEP	GRAND CHEROKEE LIMITED	4	UTILITY	2007	2009
JEEP	GRAND CHEROKEE OVERLAND	4	UTILITY	2007	2009
JEEP	GRAND CHEROKEE SRT-8	4	UTILITY	2007	2009
JEEP	LIBERTY LIMITED	4	UTILITY	2008	2009
JEEP	LIBERTY SPORT	4	UTILITY	2008	2009
LEXUS	GX 470	4	UTILITY	2004	2009
LEXUS	LX470	4	UTILITY	2003	2007
LEXUS	RX330	4	UTILITY	2005	2006
LINCOLN	NAVIGATOR	4	UTILITY	2003	2009
MAYBACH	57	4	SEDAN	2005	2008
MAZDA	TRIBUTE I	4	UTILITY	2008	2009
MAZDA	TRIBUTE S	4	UTILITY	2008	2009
MERCEDES BENZ	CL500	2	COUPE	2003	2006
MERCEDES BENZ	CL55 AMG	2	COUPE	2003	2006
MERCEDES BENZ	CL600	2	COUPE	2003	2009
MERCEDES BENZ	E320	4	SEDAN	2003	2005
MERCEDES BENZ	E320	4	Wagon	2003	2005
MERCEDES BENZ	E55	4	SEDAN	2003	2006
MERCEDES BENZ	GL320	4	UTILITY	2008	2008
MERCEDES BENZ	GL450	4	UTILITY	2008	2009
MERCEDES BENZ	ML320	4	UTILITY	2007	2008
MERCEDES BENZ	ML350	4	UTILITY	2006	2009
MERCEDES BENZ	ML500	4	UTILITY	2006	2007
MERCEDES BENZ	S430	4	SEDAN	2003	2006
MERCEDES BENZ	S500	4	SEDAN	2003	2009
MERCEDES BENZ	S55 AMG	4	SEDAN	2003	2006
MERCEDES BENZ	S600	4	SEDAN	2003	2009
MERCURY	MARINER	4	UTILITY	2008	2009
MERCURY	MARINER PREMIER	4	UTILITY	2008	2009
MERCURY	MONTEGO LUXURY	4	SEDAN	2007	2007
MERCURY	MONTEGO PREMIER	4	SEDAN	2007	2007
MERCURY	MONTEREY	4	VAN - MINI	2006	2006
MERCURY	MOUNTAINEER LUXURY	4	UTILITY	2008	2009
MERCURY	MOUNTAINEER PREMIER	4	UTILITY	2008	2009

Make	Model/Trim	Doors	Body Style	Min. Model Year Std.*	Max. Model Year Std.*
MITSUBISHI	ENDEAVOR LS	4	UTILITY	2007	2008
MITSUBISHI	OUTLANDER LS	4	UTILITY	2007	2008
MITSUBISHI	OUTLANDER XLS	4	UTILITY	2007	2009
NISSAN/DATSUN	MURANO SL/SE	4	UTILITY	2005	2007
NISSAN/DATSUN	PATHFINDER LE/SE	4	UTILITY	2008	2008
NISSAN/DATSUN	PATHFINDER XE/SE/LE	4	UTILITY	2007	2007
NISSAN/DATSUN	XTERRA SE/OFF ROAD	4	UTILITY	2009	2009
SUBARU	B9 TRIBECA	4	UTILITY	2007	2007
SUBARU	FORESTER 2.5 X	4	UTILITY	2009	2009
SUBARU	FORESTER 2.5 X LL BEAN	4	UTILITY	2009	2009
SUBARU	FORESTER 2.5 X PREMIUM	4	UTILITY	2009	2009
SUBARU	FORESTER 2.5 XT	4	UTILITY	2009	2009
SUBARU	FORESTER 2.5 XT LIMITED	4	UTILITY	2009	2009
SUBARU	FORESTER 2.5XS	4	UTILITY	2009	2009
SUZUKI	XL7	4	UTILITY	2007	2008
SUZUKI	XL7/PLUS/TOURING/LTD	4	UTILITY	2007	2009
TOYOTA	4RUNNER LTD	4	UTILITY	2008	2009
TOYOTA	4RUNNER SR5	4	UTILITY	2008	2009
TOYOTA	FJ CRUISER	4	UTILITY	2009	2009
TOYOTA	HIGHLANDER	4	UTILITY	2007	2009
TOYOTA	HIGHLANDER HYBRID	4	UTILITY	2007	2007
TOYOTA	HIGHLANDER/LIMITED	4	UTILITY	2007	2007
TOYOTA	LAND CRUISER	4	UTILITY	2008	2009
TOYOTA	RAV4	4	UTILITY	2007	2009
TOYOTA	RAV4 LIMITED	4	UTILITY	2007	2009
TOYOTA	RAV4 SPORT	4	UTILITY	2007	2009
TOYOTA	SEQUOIA LIMITED	4	UTILITY	2008	2009
TOYOTA	SEQUOIA SR5	4	UTILITY	2008	2009
TOYOTA	TACOMA ACCESS CAB	4	PICKUP - EXTENDED CAB	2009	2009
TOYOTA	TACOMA DCAB LONG BED	4	PICKUP - EXTENDED CAB	2009	2009
TOYOTA	TACOMA DOUBLE CAB	4	PICKUP - CREW CAB	2009	2009
TOYOTA	TACOMA DOUBLE CAB PRERUNNER	4	PICKUP - CREW CAB	2009	2009
TOYOTA	TACOMA RCAB PRERUNNER	2	PICKUP - REGULAR CAB	2009	2009
TOYOTA	TACOMA X-RUNNER	4	PICKUP - EXTENDED CAB	2009	2009
TOYOTA	TUNDRA DOUBLE CAB LIMITED	4	PICKUP - CREW CAB	2007	2009
TOYOTA	TUNDRA REGULAR CAB	2	PICKUP - REGULAR CAB	2007	2009

* Min./Max. Model Year Std. refers to the earliest and latest model years that vehicles of that model were available with rollover-activated side-curtain airbags as standard equipment.