

Virginia Commonwealth University
Transportation Safety Training Center
Virginia Multi-disciplinary Crash Investigation Team

Report Number 203 – January, 2008

ABSTRACT

This report describes two single vehicle crashes that resulted in multiple fatalities. Both crashes occurred on interstate highways and involved Sport Utility Vehicles (SUV) in which the drivers overcorrected, causing the vehicles to overturn, ejecting multiple occupants. In the first crash, the driver lost control after swerving to avoid a deer. She overcorrected and the vehicle overturned. Seven of the nine occupants were ejected and four of those ejected were killed. In the second crash, the driver drifted out of the lane but remained on the pavement. She then swerved back into her lane and overcorrected twice, entered the median and overturned several times. Three of the five occupants were ejected and all five were killed.

These crashes illustrate the importance of maintaining control of a vehicle at all times and knowing how to recover when a vehicle swerves or runs off the road. The value of safety restraints and the importance of correctly restraining children in safety seats are discussed. Issues related to driving under the influence of drugs, long distance travel, as well as the instability of sport utility vehicles, especially those carrying numerous passengers, are addressed.

Virginia Commonwealth University
Transportation Safety Training Center
Virginia Multi-disciplinary Crash Investigation Team

Report Number 203 – January, 2008

SYNOPSIS: Case Study Number 1

<u>Day, Time, Season:</u>	Monday, 2:25 a.m., Spring
<u>Road/Weather:</u>	Interstate highway, clear and dry
<u>Vehicles Involved:</u>	2001 Chevrolet Suburban Sport Utility Vehicle (SUV)
<u>Summary:</u>	The driver swerved to the left to avoid a deer, overcorrected, and the SUV overturned, ejecting passengers.
<u>Severity:</u>	Four fatalities, five people injured, and extensive property damage
<u>Probable Cause:</u>	Attempting to avoid animal in roadway, passenger interference with vehicle operation, overcorrection
<u>Significant Points:</u>	Safety restraint use for children and adults, vehicle stability, overcorrection and recovery of control, avoidance of animals in roadway, long distance driving.

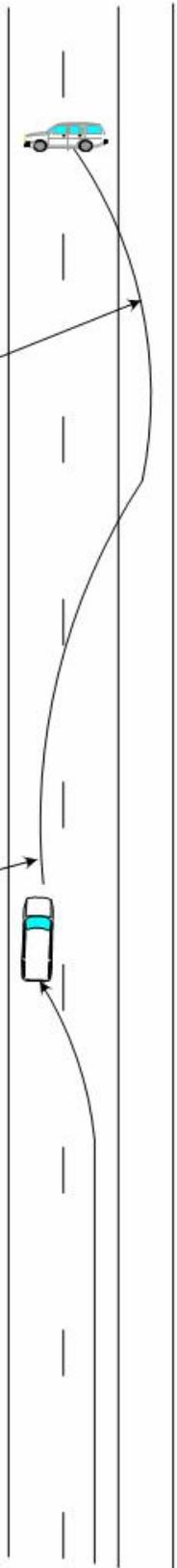
WIDE SCUFFS AND RIM GOUGES



FIRST VISIBLE SCUFF MARKS

VIRGINIA
MULTI-DISCIPLINARY
CRASH INVESTIGATION TEAM
REPORT NUMBER 203
Case Study Number 1
Rural Interstate Highway Safety corridor
2001 Chevrolet Suburban

(Not to scale)



CRASH DESCRIPTION

In the early morning hours of a clear, dry Monday holiday, a 2001 Chevrolet Suburban Sport Utility Vehicle (SUV) was traveling south on a four lane divided interstate highway. The 26 year old female driver was accompanied by eight members of her family. Her 31 year old brother sat in the right front passenger position. The second row bench seat was occupied by the driver's 51 year old father behind the driver, her brother's 11 year old son in the center position, and her husband's 28 year old cousin on the right. This 28 year old passenger and the driver were the only occupants in the SUV wearing safety restraints. In the rear bench seat, four people sat in a row. The driver's 50 year old mother sat in the center. To her left sat her 9 year old grandson and 6 year old granddaughter, children of the front seat passenger. To her right was the driver's 4 year old son. The family was returning home to a neighboring state after having visited the driver's aunt in another state to the north.

The road is a four lane divided north-south interstate with asphalt pavement which is in good condition. It is straight and on a slight downgrade. The lanes are separated by a grass median bordered with guardrail. The lanes are 12 feet wide with asphalt shoulders. Rumble strips adjacent to the shoulders are very worn but functional. The speed limit is 60 mph. The road is controlled by pavement markings and signs which are in good condition. The road also has raised snow plowable reflective pavement markers to help delineate the roadway at night and during inclement weather.

The SUV swerved into the left lane, then back to the right. The left tires began scuffing in the middle of the left lane, leaving marks that continued through the right lane and onto the paved shoulder. The driver overcorrected again, swerving sharply back to the left and the vehicle began to rotate counter-clockwise. Once broadside, the right side tires and rims dug into the asphalt and the vehicle rolled with the right side leading. After rolling several times, it came to rest on its right side, straddling the traffic lanes. The SUV, facing east, was perpendicular to the roadway and blocked both travel lanes. All of the unrestrained passengers had been ejected.

Two tractor-trailer drivers came upon the crash and used their large vehicles to protect the victims from further injury by oncoming traffic. Witnesses stopped and called for emergency help. Several individuals began checking the passengers, determining the status of the victims. The driver's mother, father and brother died at the scene from the injuries suffered during the ejection. Local and State Police officers arrived within five minutes and fire and rescue

personnel arrived shortly thereafter. A local Medical Examiner was contacted and the local Virginia Department of Transportation (VDOT) office was called to assist local police with traffic control. The injured were transported to a nearby trauma center. The child originally in the right position of the rear bench seat died an hour and a half later at the hospital. The surviving occupants suffered varying severity of injuries. The crash scene was cleared and the road reopened approximately 3 hours and 20 minutes after the crash.



Photo# 1: View of highway in direction SUV was traveling.

REMARKS

This crash was one of two multiple fatality crashes that occurred six days apart on interstate highways in Virginia. Both were single vehicle rollover crashes involving out of state drivers transporting family members across the state in sport utility vehicles (SUVs). Failure to use safety restraints was a factor in ejection and/or death in some of the fatalities in each crash. In this first crash, all the fatalities were due to ejection-related injuries.

The nine occupants had spent a holiday weekend with family in a northern state several hours away and were returning home to a state further south. They had stopped for gas about 40 miles prior. The driver stated later that she saw a deer ahead in the road and swerved to avoid the animal. Her unbelted brother in the front passenger seat had been sleeping but awoke at the sudden movement. He reportedly reached over and jerked the steering wheel in an effort to assist the driver. The driver overcorrected again, causing the vehicle to begin rotating and then rollover.

The 26 year old driver held a valid license in a state to the south. That state's Department of Motor Services shared the driver's history, which showed that the license had been issued just over a year before the crash. The driver had been issued two citations two months later on the same date, and both were related to restraint use. The licensing state has a primary seat belt law which requires all motor vehicle occupants to wear safety restraints. The state's child safety restraint law requires children under 6 to be restrained in an appropriate child safety seat for their age, height and weight. This driver was convicted of a child or youth restraint violation, as well as a seat belt violation.

The benefits of wearing safety restraints were dramatically highlighted in this crash. Early in the investigation, it was reported that none of the occupants were restrained prior to the crash. However, further research revealed that two of the survivors were likely wearing their restraints. These were the only two occupants not ejected during the rollover: the driver and the right middle seat passenger. The driver was pulled from the SUV by a witness who stopped to help. She was conscious and did not suffer serious injuries. Additionally, when the Sensing and Diagnostic Module (SDM) on the SUV was downloaded, the belt status information contained in the crash data report showed that her belt status was "buckled". While it is possible that the driver could have had the belt buckled behind her or behind the seat, when this "buckled" reading is considered with the other evidence, the conclusion that she wore her lap/shoulder belt

is warranted. With regard to the middle seat passenger, the SDM does not retain seat belt status information. However, this 27 year old man verbally reported that he had been wearing his safety restraint. He remained in the vehicle as it flipped, suffering non-life threatening injuries. It is likely he was struck by some of the other occupants as they were tossed about and ejected through the window to his right.

The other seven occupants were ejected, including children ages 4, 6, 9 and 11 years. Even though the children were all required to be restrained, and the 4 year old should have been secured in a child safety seat, none were. The four year old boy suffered injuries to his lower back and the 6 year old girl had chest and pulmonary contusions. The 11 year old boy survived with head injuries but the 9 year old died from massive abdominal and extremity injuries, both from blunt and sharp forces. His father, the front seat passenger, died from blunt force head injuries. The children's grandparents both died as well, the grandfather from blunt force head injuries and skull fracture and the grandmother from blunt force injuries to the head and chest. Toxicology reports on the victims returned negative results for alcohol.

The 2001 Chevrolet K1500 Suburban, a 4 door SUV with 4 wheel drive, had one previous owner. It had been sold to a dealer at auction three weeks before the crash and purchased by the driver a week later. It was reported to have 139,459 miles on the odometer at the time of the auction. The vehicle carried temporary tags for the driver's state of residence and, although the registered state does not require yearly state inspections, it did not appear to have any defects prior to the crash. Post crash inspection of the vehicle did not show any obvious problems with the braking system. In fact, the brakes seemed to be in very good condition overall. Further examination revealed scratches and striated scrapes from at least three different angles, along both sides of the vehicle. The roof was crushed downward on the driver's side, nearly touching the driver's headrest. A portion of the roof also buckled upward slightly on the passenger side, and the glass in the sunroof was broken and missing. The vehicle rims on the right side were scarred, asphalt-embedded, and had several pieces broken off. The tires on the right side were also deflated with no obvious signs of cuts or puncture. All the damage evidence supports witness statements that the SUV rolled several times before coming to rest on its right side.

According to sources including the National Highway Traffic Safety Administration (NHTSA), the rollover resistance rating for this vehicle was considered "average", receiving 3 out of 5 stars, for 2001 standards. The Static Stability Factor (SSF), a measure of the vehicle's

vertical center of gravity and its track width, was the basis of the “star” rating in 2001. This vehicle’s SSF was listed as 1.14. In 2001, SUVs tested had SSF ratings ranging between 1.02 and 1.21, with the average being 1.11. Cars tested during the same time period had SSF ratings ranging from 1.30 to 1.50. Cars, which typically have a lower vertical center of gravity and a wider track width, have a lower propensity to roll. The higher the SSF rating, the more the vehicle resists rollover. Since this rating was based on the curb weight of an empty vehicle, adding passengers and cargo to the vehicle would both raise the center of gravity and move it rearward. Thus, the SSF factor would be reduced in proportion to the load the vehicle was carrying. One 2007 study from NHTSA showed that single vehicle, SUV-involved crashes had a rollover rate of 23 percent when carrying one or two passengers (including driver). The same study showed that when the number of passengers increased to between three and five, the percent of rollover crashes jumped to 33 percent and jumped again to 44 percent when the SUV was carrying six or more passengers. Since the SUV involved in this crash was carrying nine passengers with a combined weight of approximately 980 pounds, the vehicle’s center of gravity would have been raised, the SSF reduced, and it would have significantly raised the chance of rollover.

Other factors that increase the chance of rollover include speed traveled and age of vehicle. The speed the vehicle was traveling at the time of the crash could not be accurately calculated because yaw marks were no longer visible on the road when members of the VMCIT visited the crash site and no measurements had been documented. The vehicle age, however, is known: it was six years old. Due to differences in design and deterioration of certain parts including tires, shocks, etc., vehicles five years and older involved in single vehicle crashes rolled over at a higher percentage rate than did vehicles under five years. This is an area of continued focus for SUV manufacturers. With improvements in technology, including Electronic Stability Control features and new methods of testing vehicles, such as dynamic rollover testing, vehicles should continue to become more stable.

Age of driver and experience level are also key factors in rollover crashes. Although the driver’s experience prior to licensing in this state is not known, she held a valid operator’s license for just over one year. Also, since the SUV had only recently been purchased by a family member, the driver had limited (less than 2 weeks) time to become familiar with the vehicle.



Photo #2: Front view of the Chevrolet



Photo #3: Side view of the Chevrolet

Driver inexperience and/or a lack of familiarity with a vehicle generally increase the probability of crashing. The issues become even more critical when the vehicle has unusual handling characteristics, like this top-heavy SUV.

At some point during the crash, the change in velocity was enough to trigger the algorithm enable function in the SDM, and the event data recorder began to capture information. At five seconds prior to the algorithm enable, the SUV was reported to have a speed of 29 mph. The throttle was at 0 percent, indicating that gas was not being introduced to the engine, and the engine speed had begun to drop. At four seconds, the vehicle's forward speed had dropped to 3 mph, and varied slightly between 1 and 4 mph for the remaining three seconds. The crash data reported that the driver applied her brakes at the two second interval only.

Although the airbag had not been suppressed on the passenger side, neither passenger nor driver airbags deployed during the rollover sequence. This is not surprising and should not be considered a failure. Airbags in this vehicle were designed to protect occupants from crash forces during a frontal collision; it did not have side airbags. Although the change in forward velocity was sufficient to "awaken" the decision-making function of the system, most of the forces were from the sides as the vehicle rolled. The energy of the crash was spread out over a longer period of time than would have been the case in a collision with another vehicle or a fixed object. Consequently, the decision making function did not deploy the airbags.

This section of interstate road was designated a Highway Safety Corridor (HSC) on January 13, 2004. Some of the criteria used to determine this designation include speeding and heavy truck traffic. The purpose of such a designation is to reduce the number of crashes by reducing speeds and gaining improved compliance with the posted speed limits. These areas are sometimes targeted for selective enforcement programs like "Land, Speed and Air" and fines are higher than for the same violations on other sections of interstate highways. VDOT analyzes the impact of these safety corridor designations on crash experience. According to a memorandum dated July 24, 2007 from VDOT to the Department of State Police (VSP), the following are some observations from the crash data:

- From 2000 to 2003, prior to the HSC, total crashes in the area later designated HSC increased 54 percent or about 15 percent each year.
- After the HSC designation went into effect, there were slightly more total crashes in 2004, but those totals were significantly lower in 2005 and 2006, and were similar to 2001 and 2002 levels.

- Similarly, the number of severe (injury and/or fatality) crashes had been increasing prior to implementation of the HSC. These numbers decreased to 2000 and 2001 levels after the HSC went into effect.

Although the statistical summaries are based on a limited set of data and may be subject to variability based on other factors, the trends of increasing total and severe crashes appear to have been slowed, if not halted. The memorandum stated: “While these findings are somewhat encouraging, appropriate driver behavior issues should continue to be the HSC program focus to improve the corridor safety further. Review of the spot speeds in the corridor indicates that on average many continue to travel above the posted limit. We still need to focus our press release toward Driver Behavior issues such as:

- Aggressive driving (speeding, abrupt lane changes, weaving, following too close)
- Impaired driving (distracted, drowsy, drunk)
- Occupant Protection (seat belts, child safety seats, and booster seats)

The VSP citation summary numbers we received for 2006 bear witness to the driver behavior issues so the message on the crash numbers can be framed with the need for improvement.”

This tragic crash will become a statistic in the 2007 HSC crash summary. While the speed of the vehicle could not be conclusively determined, the lack of occupant protection was definitely a factor in the severity of the outcome.

SYNOPSIS: Case Study Number 2

<u>Day, Time, Season:</u>	Saturday, 3:40 p.m., Spring
<u>Road/Weather:</u>	Interstate highway, clear and dry
<u>Vehicles Involved:</u>	2001 Ford Explorer Sport Trac Sport Utility Vehicle (SUV)
<u>Summary:</u>	The SUV ran off the road to the left, was overcorrected to the right and then to the left. It crossed the median and overturned several times.
<u>Severity:</u>	Five fatalities and extensive property damage
<u>Probable Cause:</u>	High speed, overcorrection
<u>Significant Points:</u>	Safety restraint use for children and adults, vehicle stability, overcorrection and recovery of control, long distance driving, driver distraction and driving under the influence of drugs.

FIRST VISIBLE SCUFF CROSSES EDGE LINE

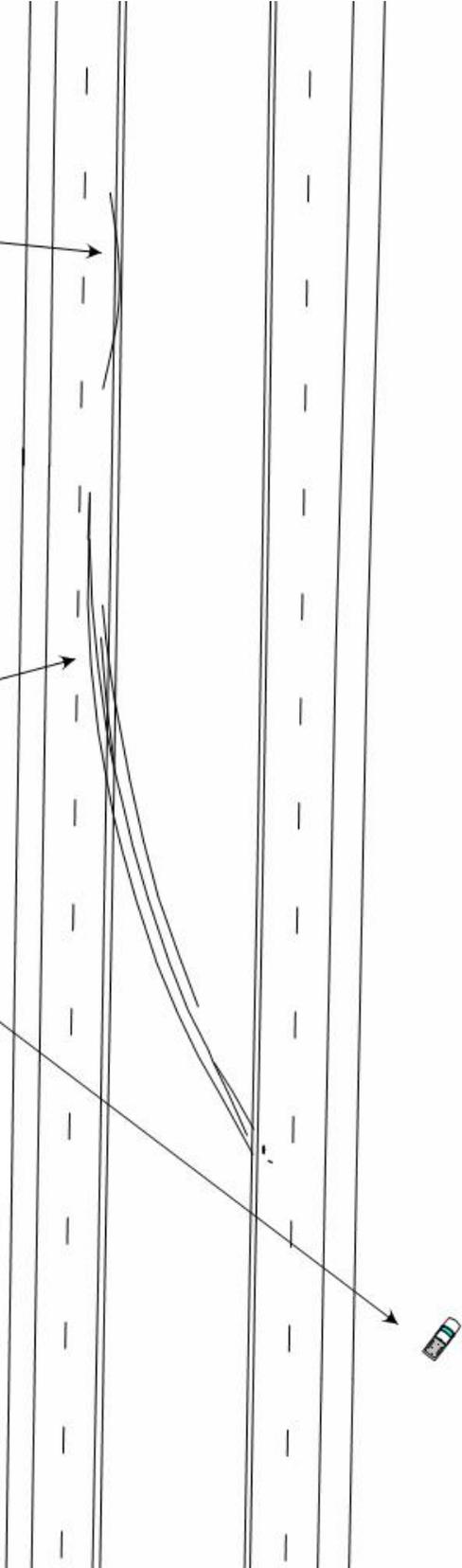


FORD BEGINS ROTATION

FORD AT FINAL REST

VIRGINIA
MULTI-DISCIPLINARY
CRASH INVESTIGATION TEAM
REPORT NUMBER 203
Case Study Number 2
Rural Interstate Highway
2001 Ford Explorer "Sport Trac"

(Not to scale)



CRASH DESCRIPTION

On a clear, dry Saturday afternoon in late spring, a 2001 Ford Explorer Sport Trac Sport Utility Vehicle (SUV) was traveling northbound on a rural interstate highway. The 22 year old female driver was accompanied by four other female members of her extended family. Her 57 year old mother sat in the right front seat and both women wore their lap/shoulder restraints. The driver's 28 year old sister-in-law sat on the left side of the rear bench seat, beside her 6 year old daughter in the center position. Neither wore restraints. The driver's 18 month old daughter sat on the right side of the bench, in a forward facing child safety seat with a tray shield. The women were following a vehicle carrying other members of the family and the group was traveling from an adjacent state. They were on their way to visit relatives in another part of Virginia, about 90 miles from the crash site.

This road is a four lane divided north-south interstate highway with asphalt pavement which is in good condition. The road is straight and is on a slight downgrade. A grass median 55 feet wide separates northbound from southbound traffic. The lanes are 12 feet wide with asphalt shoulders. There were no rumble strips in the area of the crash site. The road is controlled by pavement markings, which are in fair condition. The posted speed limit is 65 mph, controlled by signs which are in good condition. The road has raised, snow plowable reflective pavement markers to help delineate the road at night and during inclement weather.

As the SUV traveled in the left lane, the left tires crossed over the yellow edge line on the left side but did not leave the pavement. The driver then steered to the right, leaving scuff marks from the left side tires that crossed the yellow line and into the left edge of the lane. The vehicle then moved toward the right edge of the left lane, changed direction, and swerved left just before crossing into the right lane (see diagram). The vehicle began to rotate counter-clockwise, the right side tires now scuffing the pavement in the left lane near the dashed center line. It then slid off the left edge of the pavement, nearly broadside. As the vehicle entered the grass median, the tires furrowed in the dirt. The subsequent build up of grass and dirt caused the vehicle to trip. The SUV began rolling and tumbling as it traversed the grass median, leaving vehicle parts along its path. It continued to roll, entering and crossing the southbound lanes, where it left circular rim gouges and other scrapes and marks in the pavement. The two unbelted rear seat occupants were ejected onto the pavement. The SUV traveled approximately 285 feet from the time it made the second departure from the left lane until it stopped.



Photo #4: View looking northbound, direction Ford was traveling, in the area where the SUV ran off the road

The vehicle came to rest in an upright position on the southbound shoulder, facing southwest. The front seat passenger, although belted, was partially ejected and was still tethered to the vehicle. She was found in a semi-kneeling position outside the right front door with one arm caught in the belt. The toddler in the rear seat was also partially ejected. The chest strap on her car seat had become entangled around her neck and she was found with her upper body inside the vehicle while her feet and lower body extended through the passenger side window opening. The driver remained in the vehicle.

Witnesses immediately stopped to render aid and called for emergency help. Rescue and fire units arrived within minutes, followed by State Police troopers. Both the driver and front seat passenger were deceased, as was the adult passenger who had been ejected from the rear seat. The 18 month old child in the child seat suffered fatal injuries and also died at the scene. The ejected 6 year old passenger was transported to a nearby trauma center, but she died just over three hours later. The family members who had been ahead of the SUV prior to the crash realized that the Ford was no longer behind them and retraced part of their route. They stopped at the scene of the crash and the driver's brother identified all of the victims. A Medical

Examiner authorized removal of the bodies to the District Office. Traffic was re-routed around this section of the interstate by VDOT workers and local police, while State Police, rescue and emergency personnel worked to investigate and clear the scene. The roadway was re-opened approximately 3 hours after the crash occurred.

REMARKS

This was the second multiple fatality single vehicle crash involving an SUV that occurred in the Commonwealth within a week. When the VMCIT began investigating, the similarities were apparent.

According to family members, the occupants of the two vehicle caravan had left their home city in a nearby state approximately two hours earlier. They had stopped at a rest area just across the border about 40 minutes before the crash, to buy drinks. The male members of the family rode ahead in one vehicle and the five females followed in the Ford Sport Trac. At some point, the lead vehicle lost sight of the Ford.

About two miles from the crash site, a witness driving a tractor-trailer reported that the Ford passed him at a high rate of speed. He indicated that he was exceeding the 65 mph limit by 5 to 10 mph and that the SUV “was flyin” and appeared to be traveling “at least 85” mph. He also stated that it looked like the driver “was turned around doing something with the child in the back seat.” He recalled seeing the vehicle leave the road, still at a high speed. Other witnesses reported seeing the vehicle in the air and seeing dirt and smoke, but did not see the earlier crash sequence.

The 22 year old driver was operating her mother’s vehicle and the amount of experience she had driving this vehicle is unknown. She possessed an identification card from the Division of Motor Vehicles in a state south of Virginia, which had been issued seven months prior to the crash. However, the driver did not possess a valid driver’s license in any Eastern state. She did not have a previous driving record in her home state or in Virginia, so it is unknown how much driving experience she may have had. This is one of several fatal crashes involving an unlicensed operator driving with the permission of the vehicle owner to come to the attention of the VMCIT this year.

A toxicology report revealed that the driver had Chlordiazepoxide in her blood. Commonly marketed under the name Librium, this drug is prescribed to relieve anxiety and produce a calming effect. At .08 mg/L, the amount of drug in this driver’s blood was not above a therapeutic level; however, side effects may occur in some individuals at these lower concentrations. Dizziness and drowsiness are possible, as well as blurred vision and decreased muscle coordination. Since there were no survivors and no witnesses to report on the driver’s behaviors before the crash, her level of impairment, if any, is unknown.

According to a CARFAX report, the 2001 Ford Explorer Sport Trac had only two owners, and had belonged to the second owner, the front seat passenger, for over three years. This vehicle had a sport utility body with pickup-type open bed instead of a closed in cargo area. Consequently, it was designed to carry only five people in the occupant area. About six months prior to this crash, it had been involved in a collision with another vehicle, with mild to moderate damage reported to the right front area. Two months later, it passed a safety inspection and the registration was renewed. During the course of this rollover crash, it was damaged beyond repair.

A post-crash inspection of the vehicle showed striations and scratches on both sides of the vehicle. The middle of the roof was buckled upward, with a large amount of the damage to the hood in the same pattern. The rim on the front passenger side of the vehicle showed slight scarring around the bead, and the tire was deflated. The passenger rear tire and rim had been broken off as a result of the crash. The windshield was broken and pulled away from the roof in the center portion of the vehicle, and all of the other glass was broken and missing.



Photo #5: Front view of the Ford Sport Trac

Mirrors on both sides of the vehicle were missing and found with large quantities of glass in the debris trail leading toward final rest. Angle of departure from the roadway, evidence left in the median and roadway, as well as the patterns of damage on the vehicle, are consistent with a rollover crash.

The conditions of this crash are similar to those in Case Study Number 1, including the SSF rating being reduced as a result of adding weight in the form of passengers. The SSF rating for this vehicle, listed as 1.06, gives the vehicle a 2 “star” rating and indicates that it has a risk of rollover between 30 and 40 percent.



Photo #6: Side view of the Ford Sport Trac

Other factors that increased the rollover risk included the age of the vehicle, the speed of the vehicle before the crash, and the driver’s level of experience. First, since it was more than 5 years old, the parts on the SUV involved in turning maneuvers, such as ball joints, springs, shocks, etc., were likely to have deteriorated over time, even though they may not have been defective. Additionally, the SUV did not have design improvements which lower its susceptibility to rollover. Second, calculations based on the scuffmark measurements taken at

the scene show that this vehicle was traveling between 69 and 79 mph. Higher speeds make sudden turning maneuvers more dangerous. Finally, based upon the driver's age and lack of driving record, it is likely she was inexperienced. When combined with the fact that she was under the influence of a drug that may have affected her judgment and motor control, her ability to handle the vehicle while facing unexpected and challenging situations may have been diminished. All of these factors contributed to the potential for this rollover crash.

As in the previous case, the lack of safety restraint use contributed to the high number of fatalities. The family was traveling from a state that has a primary seat belt law. Although the two front seat passengers wore lap/shoulder belts, the intrusive damage to their area of the vehicle and the severe rotational forces resulted in their fatal injuries. For the two ejected rear seat passengers, this crash was potentially survivable. The left seat passenger was seated in an area where there was less intrusion or crushing into the occupant space. However, contact with interior vehicle components, other objects and/or occupants could have been expected during the violent rollover. Her fatal head injuries were most likely sustained during ejection and contact with the pavement. The six year old was required by Virginia law to be restrained and, although changes to the Virginia child safety restraint law had not yet gone into effect, she would have been most appropriately restrained in a booster type seat, wearing a lap/shoulder belt. Her home state requires children under the age of 8 years to be restrained in a child safety seat appropriate to their age, height and weight. The SUV did not carry a child safety seat for this child: she sat in the center of the rear seat, unrestrained, next to her mother. Just like her mother, she suffered fatal head injuries, as well as injuries to her extremities, when she was ejected during the rollover.

The toddler, at 18 months, was restrained in the correct type of forward-facing child seat for her age and size, which appeared to have been correctly installed in the vehicle. The shoulder straps on the harness of the tray-type convertible seat were threaded at the highest levels, consistent with proper use of the harness. The retainer clip that connects the two shoulder straps to keep them positioned correctly over the body, and helps prevent one or both straps from sliding off a child's shoulder, was not fastened when the VMCIT examined the seat. The right shoulder strap showed evidence of stretching and was stained. A witness who was the first to assist this child at the scene reported that the strap was wrapped around the child's neck, anchoring her in the vehicle. The glass had been broken out of the passenger side window and the child's lower back rested on the window frame, with her feet extending through the opening.

This individual located the buckled retainer clip and unfastened it so that he could free the child from the strap. He reported that the crotch strap on the car seat was not buckled. The child was not breathing when he removed her from the vehicle and attempts at CPR were unsuccessful.

In the autopsy report, the Medical Examiner noted that a “ligature-type abrasion that is upward sloping is present on the neck.” In addition, the child’s trachea and upper cervical spine were completely transected. These fatal blunt force injuries caused the toddler’s death. This is the second fatality involving this type of injury mechanism noted by the VMCIT in the past two years. In *Special Report Number 20: Child Safety Restraint Study*, the first case study describes a toddler dying under similar circumstances. The retainer clip at the chest level of her tray-type convertible seat was missing and, during the course of the crash sequence, she moved out of her seat and her neck was entangled in the shoulder harness.



Photo #7: Convertible child safety seat. Note stretching of right shoulder strap.

In this second case, the unfastened crotch strap allowed the tray part of the seat to move up and down freely during the rollovers, making her ejection possible. This little girl was probably ejected from the seat in a dynamic similar to the earlier case, where her right shoulder caught on the right strap as her left shoulder slipped out of the left strap. As the vehicle rotated around her, the strap became wrapped around her neck, tightening as the car flipped, and inflicting the fatal neck trauma. Both toddlers died from hanging type injuries because they had not been correctly buckled into their child safety seats, and it appears that both could have survived if they had been correctly restrained with the five point harness systems.

During a two month period in late spring and summer this year, six fatal crashes occurred in the Commonwealth in which four or more individuals, all in the same vehicle, died. Two were four fatality crashes, including the first case study in this report. One was the five fatality crash that is this second case study. Another was a six fatality crash. Four of these six crashes involved victims who were Hispanic and/or emigrated from a South American nation, and three of these involved the deaths of multiple family members. These last three crashes also involved drivers who were traveling long distances, between states, often to visit extended family. While these are only a few cases and may simply reflect a chance variation, they draw attention to the fact that cultural differences may influence different travel patterns and driving behaviors. An emphasis on maintaining close knit extended family ties, for example, may lead to larger family groups traveling more frequently in single vehicles over long distances. The increased mileage exposure alone may be a factor in a higher risk for crashes.

Seat belt use in Mexico and in Central and South America is lower than in the United States. However, that trend does not appear to transfer to those of Hispanic background living in the U.S. Recent research (Briggs, Schlundt, Levine, Goldzweig, Stinson & Warren, 2006) compared seat belt use for non-Hispanic whites to belt use by Hispanics, dividing the latter group into sub-groups based on national origin. The study found that seat belt use among fatal crash victims in the Hispanic subgroups was at least as high if not higher than belt use in the non-Hispanic white group. The primary author pointed out, “A greater adherence to seat belt laws among undocumented Central/South American and Mexican American motorists compared with Whites could reflect greater concerns about being stopped by law enforcement officers. This is consistent with our finding that, among both Hispanic sub-groups, the [prevalence] of seat belt

use was much higher in states with primary enforcement seat belt laws than in states with secondary enforcement laws.” (Hispanic Business News, 2007)

RECOMMENDATIONS

1. State and local agencies should continue taking measures to increase the use of safety belts for all occupants of motor vehicles.
 - a. The Department of Motor Vehicles (DMV), the Department of Health (DOH), and agencies focused on public safety should continue to stress the life-saving and injury reducing capabilities of seat belts and actively promote safety belt use through media campaigns, training, and individual counseling.
 - b. The Department of State Police (VSP), local law enforcement agencies and the DMV should continue to develop, implement and assess enforcement programs designed to increase safety belt use (including programs like “Click it or Ticket” mobilizations).

2. Child safety seat use continues to factor into child passenger deaths in the Commonwealth, as highlighted in *Special Report Number 20: Child Safety Restraint Study, Report Number 198: Aggressive Drivers in Merging Lanes—Triple Fatality, Report Number 200: Five Fatality Alcohol-Related Collision* and *Technical Alert 16: Infant Seat/Airbag and Cell Phone*. DOH, DMV, VSP, and local agencies should continue to focus on education and enforcement in this area. These groups presently work with other state and local agencies to inform and educate those who transport children about appropriate child safety restraint use.
 - a. Beyond stressing the importance of using restraints, these groups should continue to emphasize correct selection and installation of seats, including proper use of internal harnesses and vehicle lap and shoulder belts.
 - b. Methods for creating greater awareness and improving understanding as well as compliance across all populations should be explored, including working with pediatricians, child advocacy groups, and local communities. Recent research conducted at Virginia Tech and the Eastern Virginia Medical School may provide valuable insight into effective message design and presentation. Such research reveals that non-graphic threat appeals may be effective in gaining child booster seat use compliance (Will & Geller, 2004; Will, 2005).

3. As mentioned in *Report Number 201: Fatal Motorcycle Crash: Alcohol & Speed*, DMV, VSP and local law enforcement agencies should study the issue of drivers without valid licenses operating vehicles on Virginia roads to determine (a) if this is a significant problem, especially with regard to safety, and (b) how to identify and reduce the numbers of such drivers.

4. Members of the General Assembly, the judiciary, DMV and VSP should seek ways to address the issue of unlicensed or suspended individuals, or unsupervised individuals with learner's permits, driving on the roads of the Commonwealth.
 - a. Consider legislation to place some fault on drivers who knowingly drive while unlicensed or suspended, when involved in vehicle crashes, even if they were not at fault in the crash.
 - b. Recommend insurance companies, (1) penalize the owner of a vehicle with higher rates or (2) decrease or deny claim payments for vehicle repairs, when a vehicle is involved in a crash where the driver is not licensed or a driver with only a learner's permit is not properly supervised, as required by law. This could include situations in which a vehicle owner knowingly allows such an individual to drive their vehicle.
 - c. Stress to state and local law enforcement officers, as well as the judiciary, the importance of strictly enforcing laws relating to licensing.

5. DMV, DOH, VSP and public media campaigns should continue to stress the importance of driving sober, making efforts to highlight the potential risks of driving under the influence of prescription medications. One way to help make the point that drivers need to take warning labels on medications seriously could be to include messages that compare the potentially debilitating side effects of certain legal drugs with effects similar to those due to consuming alcohol and/or illegal drugs. In addition, continuing to enforce laws against driving under the influence of alcohol or drugs will help improve compliance.

6. Education and public awareness of vehicle rollover should be a focus of DMV, VSP and local law enforcement agencies, as well as DOH.
 - a. Public service campaigns should inform consumers of the change in handling characteristics of SUVs and high center of gravity vehicles when additional passengers are on board. Also the parents of young drivers should be educated on the dangers of allowing an inexperienced driver to operate vehicles unsupervised, especially when they are not familiar with the vehicle.
 - b. Driver's education courses should include information on handling characteristics of different types of vehicles and how additional weight affects those characteristics. These courses should also continue to stress the importance of becoming familiar with each vehicle driven, so drivers are better prepared for emergencies as they arise. Run-off-the-road recovery skills should be emphasized as well.
 - c. The VSP and local law enforcement agencies should continue to enforce aggressive and unsafe driving violations that increase the likelihood of rollover crashes.

7. DMV, VDOT, VSP and public media campaigns should continue to stress the importance of maintaining vigilance while driving, especially during long distance driving. It only takes a moment of inattention for a crash to occur. This message may be important for different cultural audiences, especially when long distance travel to maintain extended family ties is commonplace. Electronic message boards that are not in use during highway alerts might be one tool to keep drivers alert on the road.

8. Research on highway design has shown that rumble strips are effective at reducing run-off-the-road crashes, alerting drivers of their deviation from the travel portion of a highway. VDOT should install rumble strips on the section of road (Case 1) where they are absent.

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