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

Special Report Number 23 – July, 2013

ABSTRACT

This Special Report focuses on rollover crashes in the Commonwealth. Rollovers generally occur when the vehicle is tripped. Tripping occurs when a vehicle slides sideways and its tires dig into soft earth or strike an object such as a curb. The resulting rollover is because the vehicle is slowed beneath its center of mass while the speed is relatively unchanged above the center of mass. There are also less common occasions when a top-heavy vehicle will rollover untripped as a result of a high speed avoidance maneuver.

The majority of rollover crashes in Virginia were the result of drivers running off of the road and overcorrecting, resulting in the loss of control and the tripping of the vehicle. This report will look at several case studies that demonstrate this maneuver and subsequent rollover fatal crash. The report also looks at the importance of occupant protection during a rollover crash and the unique scene evidence found at the crash site.

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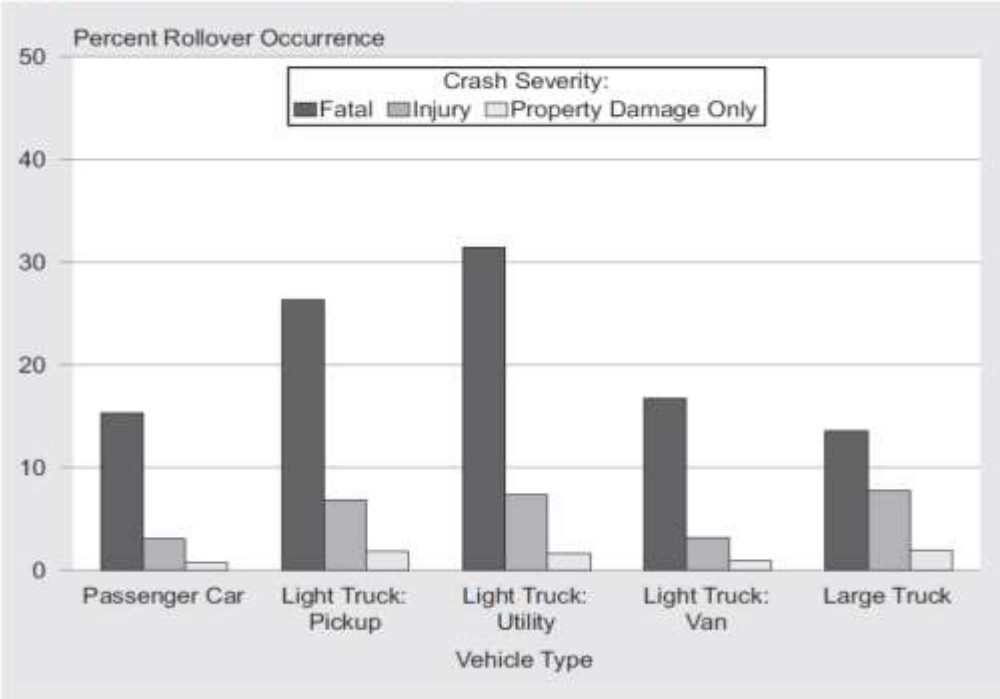
INTRODUCTION

A vehicle rolling over in a crash is a frequent event in the Commonwealth and across the nation, occurring in nearly one-third of all fatal crashes since 1994. According to data found in the Fatality Analysis Reporting System (FARS), rollovers accounted for 34.7 percent of all vehicle occupants killed in traffic crashes in the United States in 2011 and nearly 10 percent of all fatal crashes. In Virginia over the same time period, the same percentage (34.7) of vehicle occupant fatalities occurred in rollover crashes. Since 1994, in Virginia and Nationally, rollover crashes have accounted for over 30 percent of all occupant fatalities. This review of 2011 crash data reveals a significant loss of life due to rollover crashes.

Rollovers occur with nearly every vehicle classification type. As seen in the following chart, rollovers occur in more than 10 percent of the fatal crashes over every vehicle classification. The numbers are much lower for personal injury and property damage crashes.

Exhibit 19 - **Percent Rollover Occurrence by Vehicle Type and Crash Severity, 2011**



Source: FARS/GES 2011 Data Summary

Figure 1: FARS data

The Virginia Multi-disciplinary Crash Investigation Team (VMCIT) began to look at the issue of rollover crashes after a review of FARS data for 2011 revealed that an alarming number of vehicle occupants continued to be killed in rollover crashes. Because "rollover" is a vehicle maneuver (type of collision) classified by the Virginia Department of Motor Vehicles (DMV) as "Other," the number of crashes involving a vehicle rolling over is not an event that is easily captured by DMV. VMCIT members reviewed all fatal crash reports from 2012 and identified 200 rollover crashes that resulted in the death of one or more of the occupants. Of the 200 crashes, 148 were identified as single vehicle rollover crashes, which resulted in the death of 161 people (128 drivers and 33 passengers).

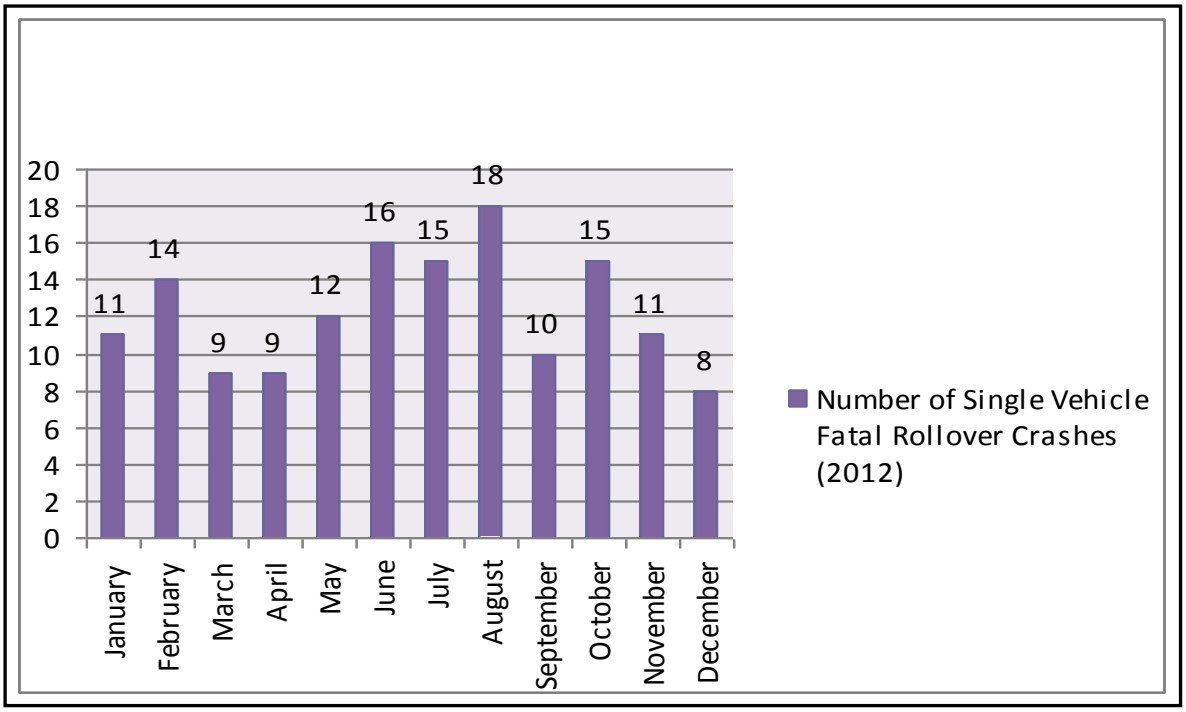


Figure 2: Single Vehicle Rollover Crashes in Virginia.

CAUSATION

Human

Ran Off Road-Right	83
Ran Off Road-Left	56
TOTAL	**139**

Of the 148 single vehicle rollover crashes reviewed, the most frequently listed vehicle maneuver was "Ran off Road." VMCIT members looked at the drivers' actions to further understand why the drivers had run off of the roadway. The most common driver's action reported was "Fail to Maintain Control" (72%). This category is similar to "unknown" in that it is a very general category and is often used in place of a more thorough investigation. It is often not possible to ascertain why the driver failed to maintain control.

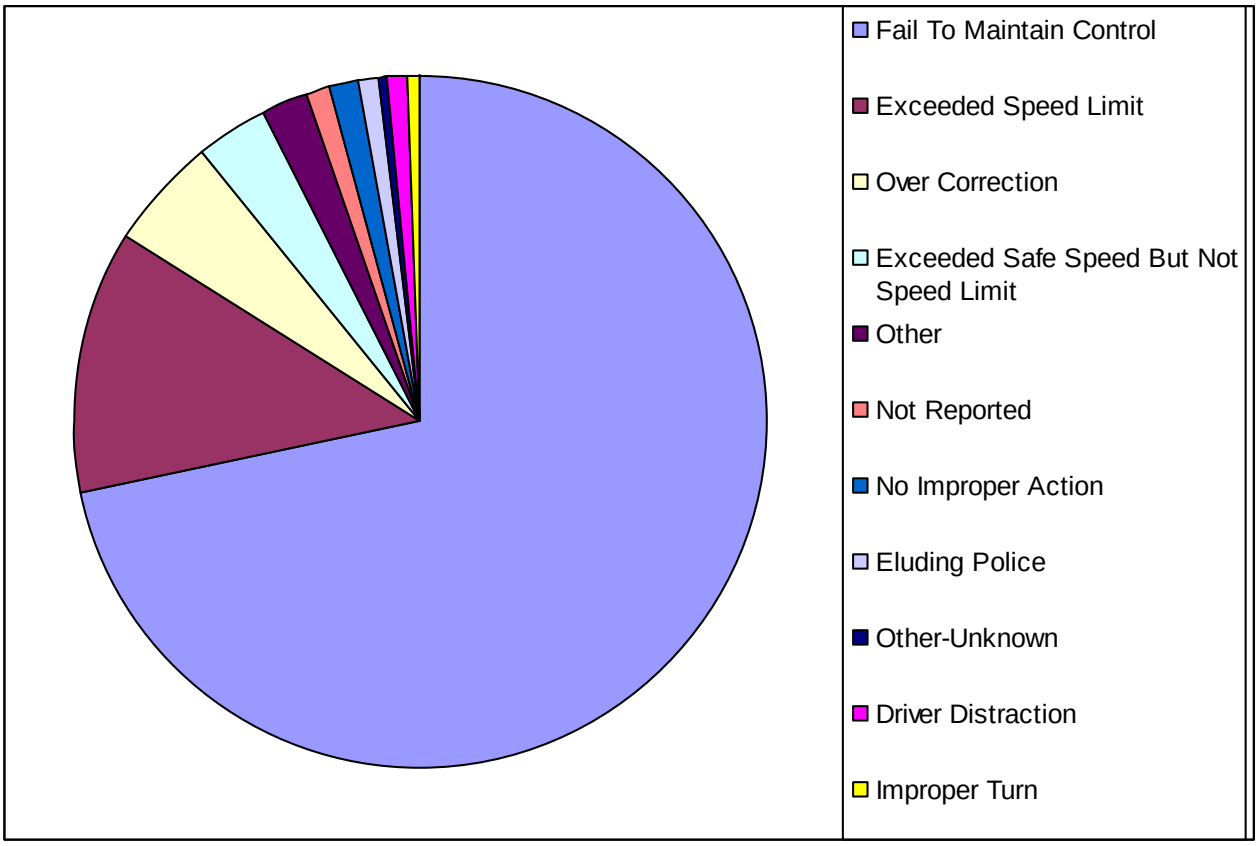


Figure 3: Driver's action in rollover fatal crashes.

Driver distraction is another human causal element that the VMCIT members analyzed. The number of reports that listed "N/A" or "No Driver Distraction" as the driver distraction was alarming. Of the 148 crashes the team examined, 119 of the reports listed the driver distraction as "N/A" or "No Driver Distraction."

The FR 300M (Crash Report Manual) states:

Shade the bubble adjacent to one of the options that best describes the driver's distraction. A driver distraction should be identified for drivers whose distraction contributed to the crash even though driver distraction may not have been selected within **"Driver's Action."** If there was more than one distraction, choose the one that contributed most to crash causation.

Explain **"other"** in the crash description.

Figure 4: FR300P

Of the 72 fatal crashes that listed "N/A" as the driver distraction, 66 resulted in the death of the driver. In the 47 crashes that listed "No Driver Distraction," 39 drivers died. Investigation and/or interviews may have accounted for some of these answers, but it is likely that "N/A" or "No Driver Distraction" was selected because it was unknown whether or not the driver was distracted before the crash. Seventeen of the remaining crashes listed "Unknown" as the type of distraction. Only 12 of the 148 crashes reviewed actually listed a driver distraction as a causal factor in the crash. Because most of the drivers died, investigators have few tools available to determine driver distractions. Therefore, actual distractions are most likely being grossly under-reported. However, "N/A" and "No Driver Distraction" are seemingly inappropriate answers. If the investigators simply cannot determine whether or not the driver was distracted, then "Other" should be selected, and it should be stated in the narrative that driver distraction was unknown.

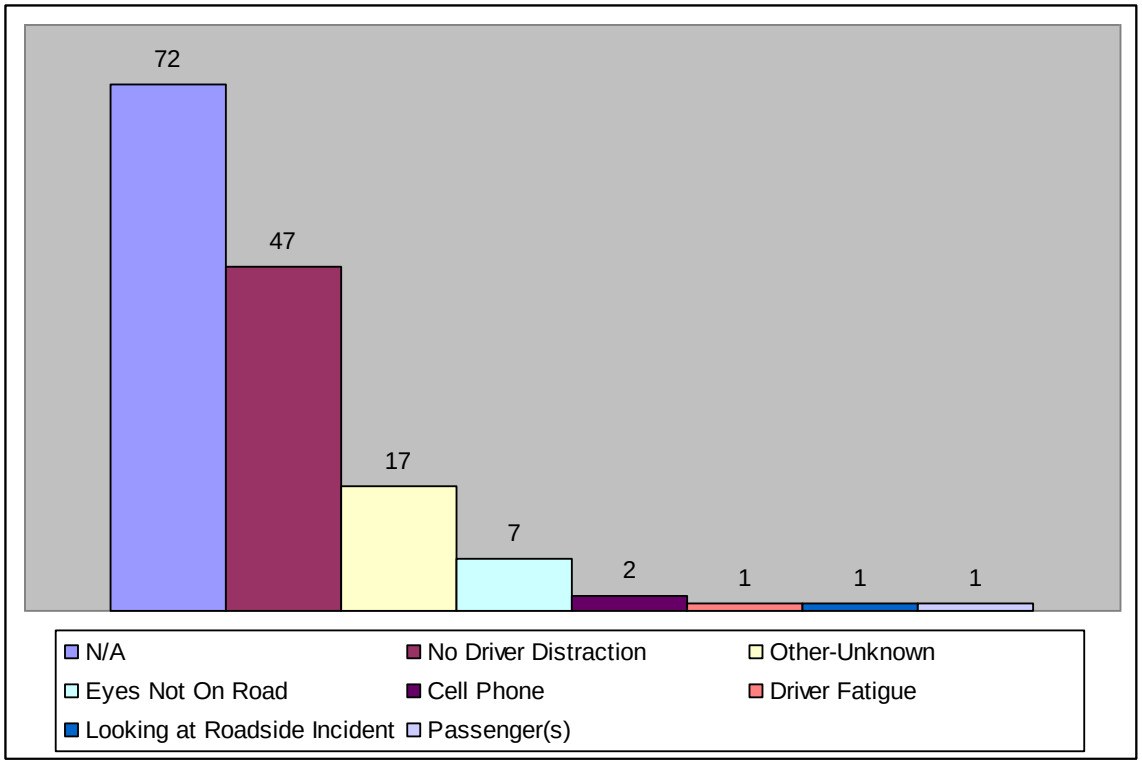


Figure 5: Driver distraction.

Alcohol usage is another human causal factor examined. Analysis of the crash data revealed that "Unknown" was most often chosen under the "Drinking" section of the FR300P. Since alcohol could have been a contributing factor in these crashes, it is important for the investigating officers to submit a revised report so that more accurate data can be recorded. As it stands, there could be missing alcohol data in 48 percent of the rollover crashes studied by VMCIT.

Figure 6: FR300P

Had not Been Drinking	37
Drinking	40
Unknown	**72**
***N/A**	**1**

*Unknown Driver

VMCIT requested additional data from DMV in regards to the use of alcohol by the driver prior to the crash. DMV receives revised reports along with additional sources, such as the Office of the Chief Medical Examiner (OCME) toxicology reports, which shed additional light as to the use of alcohol. The additional data revealed that the majority of the involved drivers (72) had consumed some amount of alcohol prior to being involved in a fatal rollover crash.

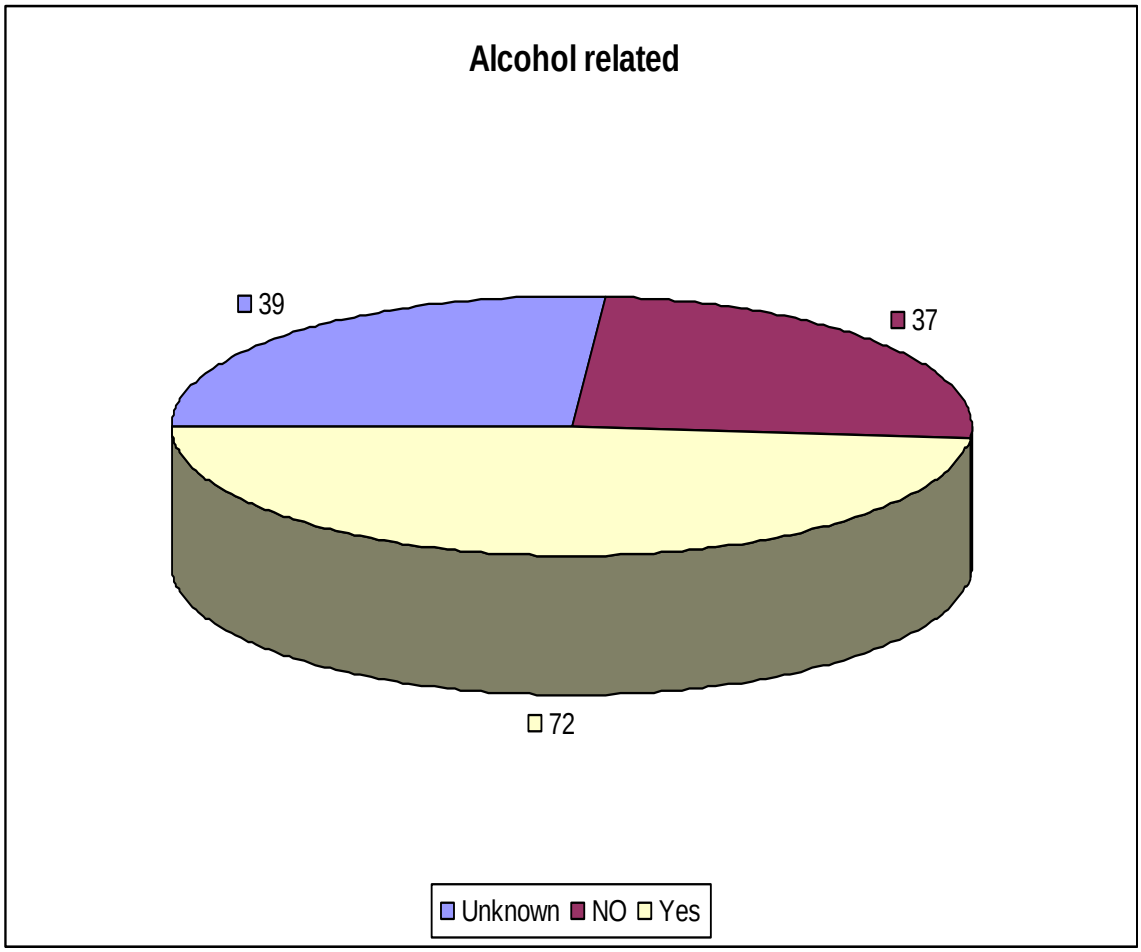


Figure 7: Updated alcohol related crash data.

Vehicle

Only two crashes reported "No Improper Action," listing a tire puncture/blowout (vehicle causal factor) as a factor in the crash. The vehicle did not play a significant causal role in rollover fatalities.

Environment

Weather or other environmental factors do not appear to be causative factors in the rollover crashes analyzed. 87 percent of the fatal rollover crashes occurred during clear weather conditions.

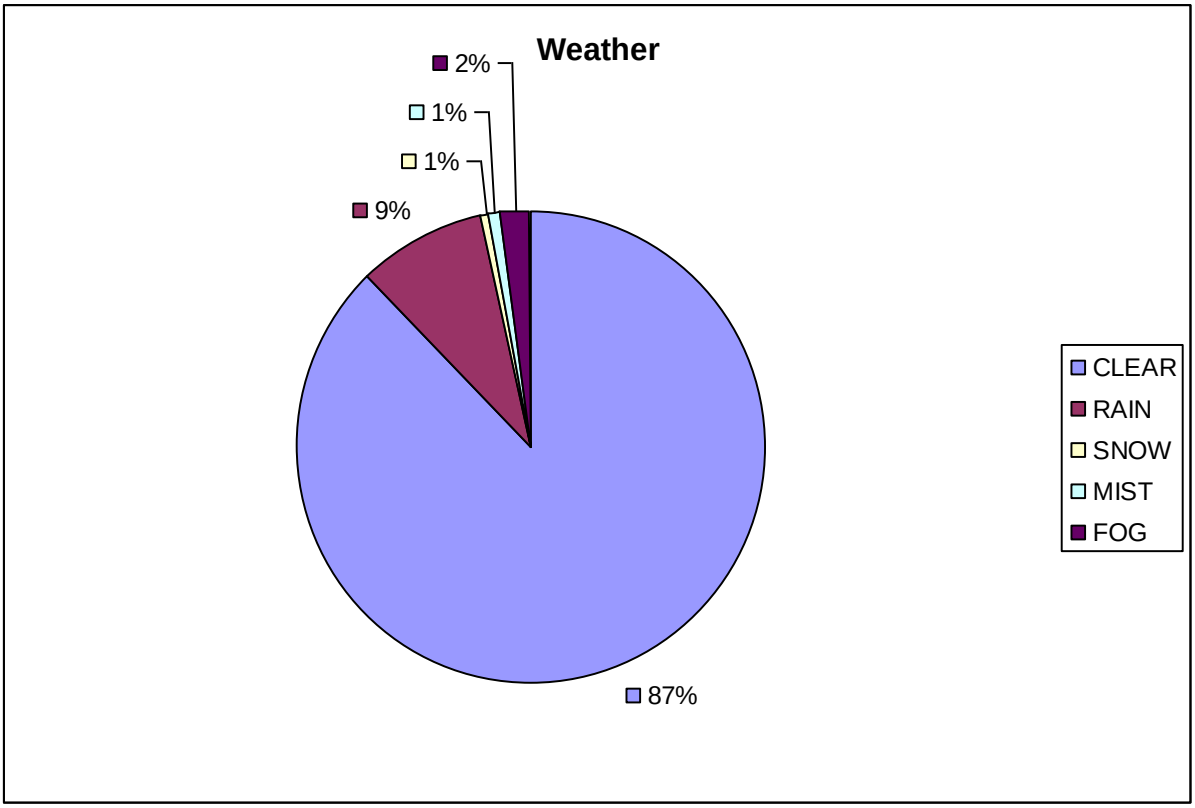


Figure 8: Environmental factors.

CASE STUDY NUMBER 1

Type of Crash: Single Vehicle Rollover

Day, Time, Season: Sunday, 1452 Hours

Road/Weather: Secondary roadway, dry and clear

Vehicle Involved: 2001 Honda Civic

Occupants: Driver (minor injury)
Two passengers (Serious and minor injury)

SUMMARY:

This crash occurred when a young driver, 18 years old, was distracted while reaching for a cell phone. The vehicle drifted to the right, at which time the driver looked back to the roadway and found she was rapidly approaching a mailbox.

The roadway is a two lane east-west secondary route in a rural area. The road is asphalt and was in good condition when examined by members of the VMCIT. Each lane is approximately 9 feet wide and there are no shoulders. The roadway is straight and level and the pavement markings are in good condition. A ditch runs parallel to both the eastbound and westbound lanes. The average daily traffic is 1800 vehicles for this section of the road (VDOT, 2010). The Speed limit is 45 MPH.

Photo # 1: ***Crash site looking west (travel direction of the Honda).***

The driver ran off the roadway to the right, steered left, overcorrected back to the right, and lost control of the vehicle. The Honda began to rotate clockwise and yaw across the roadway, and then continued off of the roadway where the vehicle went into a ditch. As the Honda Civic entered the ditch sideways, it ramped upward as the vehicle struck a driveway to a residence. The vehicle was vaulted airborne and began to rotate. It first contacted the ground with the front end, and then continued to rotate over. The rear of the Honda struck the ground, breaking out the rear glass, creating an ejection portal for the unrestrained passenger in the backseat. The vehicle then came to rest on the passenger side.

Photo # 2: Honda at final rest.

A post-crash examination of the vehicle and crash site was done by members of the VMCIT along with the investigating officers. The yaw marks in the roadway were still visible however, not dark enough to obtain proper measurements for speed calculations.

VMCIT members obtained post crash measurements of the vehicle to compare with manufacturer vehicle specifications.

2001 Honda	Overall Length	Overall Width	Wheel Base
Vehicle Specifications	14.57 Feet	5.58 Feet	8.6 Feet
Post Crash Measurements	13.75 Feet (Left) 14.00 Feet (Right)	4.58 Feet (Front) 4.75 Feet (Rear)	9.0 Feet (Left) 8.41 Feet (Right)

Table 1: Comparison of Honda Data

The vehicle exam noted one item of particular interest. The back seat passenger compartment sustained little damage. This was noteworthy because the rear passenger, who was thrown from the vehicle and injured, may have escaped injury if she had worn the seatbelt that was available.

Photo # 3: ***Back seat of Honda.***

The vehicle showed several contact points with the ground as it tumbled to rest.

Photo # 4: ***Damaged right front of the involved vehicle with grass and dirt lodged into the damage and rim.***

Photo # 5: ***Rear of Honda.***

The ground contact points were also still visible at the crash site upon examination of the scene.

Photo # 6: ***Crash site showing ditch that vaulted the vehicle.***

As the vehicle was airborne and rotating, the first contact with the ground was with the front right corner of the Honda. This was evident by the damage to the vehicle and the vehicle debris left on the ground. As the vehicle continued to tumble, the rear window was broken out and deposited on the ground.

A careful scene examination and vehicle examination can assist the investigating officer in tracking the vehicle's trajectory during the rollover. Parts broken off of the vehicle during the rollover can be used to determine the vehicle's orientation; however, parts of the vehicle can be thrown during the rollover or moved prior to the investigator's arrival. The investigator should properly document all evidence for a careful analysis to determine the vehicle's trajectory.

Photo # 7: ***Honda at final rest and parts of vehicle broken off during the tumbling.***

Photo # 8: Honda post crash.

Photo #7 above is an example of utilizing the parts left by the vehicle hitting the ground to determine the vehicle's trajectory. At the bottom of the picture (1), a part from the front left of the vehicle was located, indicating that the vehicle had begun to roll, end-over. The next ground disturbance (2) is where the rear glass was found. The rear of the vehicle also had damage and grass/dirt lodged in the body of the vehicle to indicate ground contact.

VIRGINIA MULTI-DISCIPLINARY CRASH INVESTIGATION TEAM SPECIAL REPORT 23

2001 Honda Civic

CASE STUDY NUMBER 2

Type of Crash: Single Vehicle Rollover

Day, Time, Season: Saturday, 0158 Hours

Road/Weather: Secondary roadway, dry and clear

Vehicle Involved: 1997 Toyota 4Runner

Occupants: Driver (Fatal)
Two passengers (minor injury)

The driver in this crash was traveling east on a two lane secondary road. The driver was reportedly distracted by the passengers who both were seated in the front of the 4Runner. The back of the vehicle had four newer tires that the owner had planned to install soon. The asphalt was in good condition, however the lane markings were in poor condition when examined by members of the VMCIT. Each lane is approximately 10 feet wide and there is no shoulder. The roadway has a slight curve. The speed limit is 25 MPH.

Photo # 9: ***Daylight photo of the crash site, looking east.***

The 24 year old male ran off of the right edge of the road and overcorrected. The vehicle began to yaw across the roadway crossing the double solid line. As the vehicle rotated counterclockwise, it tripped and rolled. The vehicle rolled onto the right side (passenger side) and then onto the roof as it slid across the roadway and off of the edge of the road. The Toyota came to rest wheels up, against a tree and utility pole. As the vehicle was tripping and/or rolling, the unrestrained driver was ejected from the vehicle and came to rest near the vehicle's final rest location. The driver was pronounced dead on scene as a result of his injuries.

Photo # 10: ***Toyota 4Runner at final rest.***

Interviews with the investigating officer and photographic evidence taken the night of the crash showed yaw marks on the roadway. A post crash examination of the vehicle and the crash site was done by members of the VMCIT. The crash site was visited five days after the crash, and the yaw marks were faded. As a result of the condition of the yaw, VMCIT members were unable to obtain measurements to calculate a speed.

The yaw was visible as it crossed the double solid line, as were several scrapes and gouges. Tinted glass was found off of the roadway near a small grove of trees. A distance of approximately 74 feet from the trip point to the vehicle's final rest was measured by VMCIT. Based on this distance, a speed of 33 MPH was calculated.

VMCIT members obtained post crash measurements of the vehicle to compare with manufacturer vehicle specifications.

1997 Toyota	**Overall Length**	**Overall Width**	**Wheel Base**
Vehicle Specifications	14.9 Feet	5.68 Feet	8.79 Feet
Post Crash Measurements	14.33 Feet (Left) 14.05 Feet (Right)	5.5 Feet (Front) 5.16 Feet (Rear)	8.8 Feet (Left) 8.75 Feet (Right)

Table 2: Comparison of Toyota Data

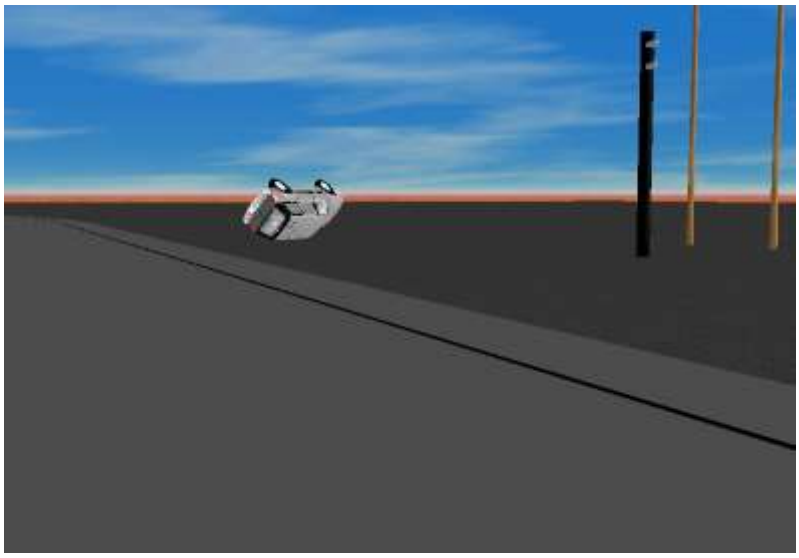
The damage to the Toyota was severe, with the roof collapsing downward. However, the passenger compartment remained largely undamaged and there was adequate survivable space in the interior. Also noted during the inspection of the vehicle was the presence of the four tires inside the cargo area of the vehicle. Several marks on the headliner of the vehicle were observed, that may have been produced during the crash as the vehicle rolled.

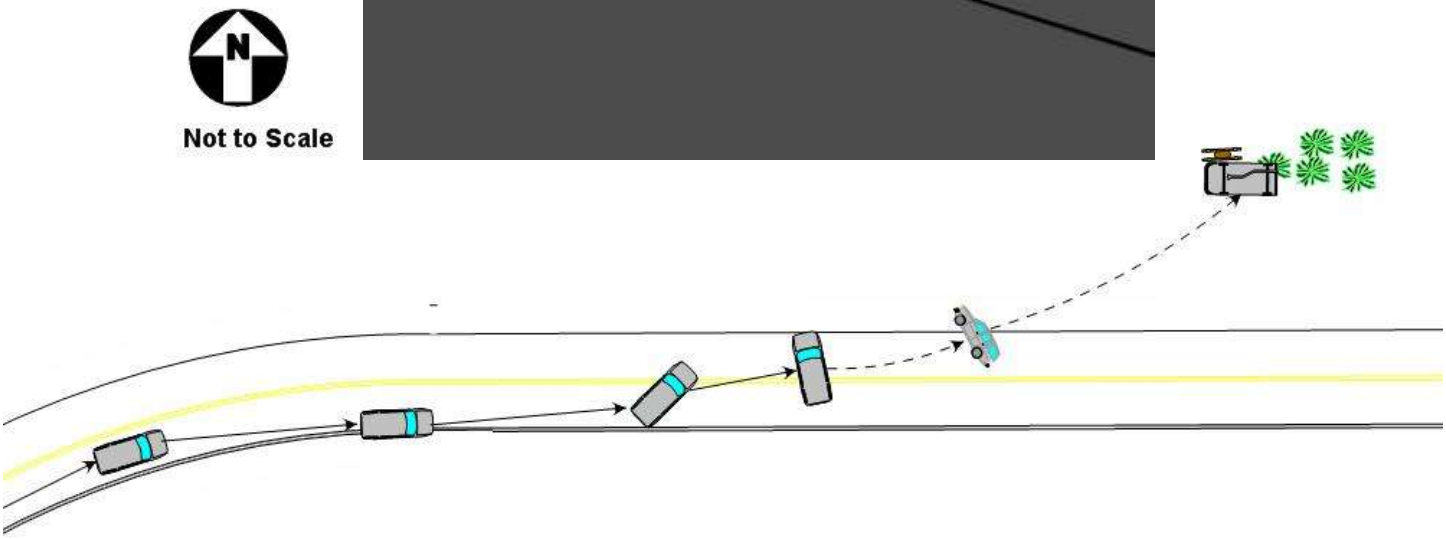
Photo # 11: ***Right side of the Toyota.***

Photo # 12: ***Left side of the Toyota.***

Again, the survivable space in the passenger compartment should be noted.

Photo # 13: ***Driver compartment of involved Toyota.***





VIRGINIA MULTI-DISCIPLINARY CRASH INVESTIGATION TEAM SPECIAL REPORT 23

1997 Toyota 4Runner

CASE STUDY NUMBER 3

Type of Crash: Single Vehicle Rollover

Day, Time, Season: Saturday, 2216 Hours

Road/Weather: Secondary roadway, dry and clear

Vehicle Involved: 2001 Ford F250

Occupants: Driver (Serious injury)
One passenger (Minor injury)

SUMMARY:

This crash occurred when a 21 year old male intoxicated driver was exceeding the speed limit and ran off of the roadway to the right. The roadway is a two lane east-west secondary route in a rural area. The road is asphalt and was in good condition when examined by members of the VMCIT. Each lane is approximately 9.5 feet wide and there are no shoulders. The roadway is straight and level and the pavement markings are in good condition. The average daily traffic is 1200 vehicles for this section of the road (VDOT, 2010). The Speed limit is 45 MPH.

Photo # 14: ***Daylight photo of crash site, yaw marks still visible.***

The driver overcorrected, losing control of the Ford F250. The vehicle began to yaw across the roadway rotating counter clockwise. As the truck left the roadway with the passenger side leading, it stuck a utility pole with its front right. The vehicle then became airborne, landing and rolling over in a yard where the unrestrained driver was ejected.

Photo # 15: ***The Ford at final rest.***

Members of the VMCIT examined the scene and vehicle post crash. The roadway and the yard where the crash sequence took place still showed evidence of the crash. Yaw marks were noted and measured on the road. Speed calculations based on the marks indicate that the vehicle was traveling approximately 88 MPH prior to leaving the roadway.

In the yard where the vehicle rolled, evidence of the vehicle ground contacts were visible along with several areas of glass concentration that had been deposited by the vehicle while rolling. Several areas of both clear and tinted glass were found on the ground. The Ford came to rest against a large tree and the driver was found some distance past the tree.

VMCIT members obtained post crash measurements of the vehicle to compare with manufacturer vehicle specifications.

2000 Ford F-250	Overall Length	Overall Width	Wheel Base
Vehicle Specifications	20.11 Feet	6.66 Feet	13.02 Feet
Post Crash Measurements	19.75 Feet (Left) 19.41Feet (Right)	5.83 Feet (Front) 6.25 Feet (Rear)	13 Feet (Left) 13.41 Feet (Right)

Table3: Comparison of Ford Data

Photo # 16: ***Photo post crash of the involved Ford.***

The Ford was severely damaged in the crash. The truck's roof was obviously pushed further down as the vehicle was removed from the crash site. Looking at the photographs taken at the scene (see photo # 15) the roof was not as damaged as seen in the photo above. In this case it is difficult to determine the actual post crash condition of the occupant space.

VIRGINIA MULTI-DISCIPLINARY CRASH INVESTIGATION TEAM SPECIAL REPORT 23

2001 Ford F250

EVIDENCE

During the investigation of a rollover crash, it is important to mark, measure, and photograph all evidence from the crash. The investigator should look for events preceding the vehicle tripping. This may include yaw marks or tire impressions in the soft soil off of the edge of the roadway. The next mark the officer should attempt to locate is the trip point. The trip point may be caused by an object that the vehicle struck, such as a curb, tree or embankment. Other tripping mechanisms found are from the vehicle's tire sliding sideways and the rim gouges into the road or ground tripping the vehicle.

Photo # 17: ***Tire marks leading up to the trip. Where the vehicle begins to roll.***

Photo #18: ***Damage to vehicle that stuck the wall in Photo #19 then rolled over.***

Photo # 19: ***Wall stuck by the vehicle, scrape marks and paint found on the wall.***

Other evidence may be left on the pavement to indicate the vehicle's position while rolling. This may be scratches, gouges or paint from the vehicle deposited on the road surface. Also, the vehicle may gather evidence from the roadway. One very useful mark is that of the vehicle's rim. As the vehicle is rolling, it may contact the road on one side and leave a rim gouge that is very helpful in placing the vehicle during the investigation. Seen below is one such mark.

Photo #20: ***Round rim mark.***

Another item that the investigating officer should note is the deposits of glass left by the vehicle as it rolls. This again may be useful in the crash reconstruction. Tinted glass and/or clear glass may be found that could assist the investigator in the determination of the vehicle's rotation during the crash sequence.

Photo # 21: ***Clear and tinted glass deposited on the ground during the crash.***

Photo # 22: ***Involved vehicle from the photos referenced above. Note both tinted window and the adjacent driver side window (clear glass) have been broken out.***

Photo # 23: ***Larger distance between the broken out tinted and clear glass.***

A vehicle examination that is performed and documented properly can be related back to the scene evidence. The glass in photo # 21 is from the left side of the vehicle. As seen in the photograph above, both the tinted rear glass and the clear front glass have both been broken out.

Also, during the vehicle examination, the investigator should note and photograph the scratching on the vehicle. The presence of scratches in multiple directions <u>may</u> indicate that the vehicle came in contact with the ground more than once. The scratches may also show the direction the vehicle was moving, as seen below.

Photo # 24: ***Scratches and pushing of vehicle trim in direction of travel.***

It may be difficult to determine what part of the vehicle contacted the road to create the scratches/gouge. This is why a careful and thorough vehicle examination should be done.

Photo # 25: ***Yellow paint of vehicle from the lane markings.***

Photo # 26: ***Close up of Photo #25.***

Other physical evidence to note should be that of an ejected occupant. Often times, the investigator may find such evidence around the ejection portal. This evidence may include hair, blood or fabric. There was no such evidence in this case.

CONCULSIONS

Rollovers are violent crashes that add a unique dynamic to the occupants of the involved vehicle. In a “typical” crash the occupant does not experience the same forces that are found in a rollover crash. If not properly restrained, the occupant may be thrown about and be injured by coming in contact with the interior of the vehicle. As seen in the case studies, an unrestrained occupant may also be ejected from the vehicle. Another hazard during a rollover is from unsecured objects in the vehicle that may be tossed about, striking the occupants.

Safety systems are in place to help reduce injury in a crash. Two systems in particular are air bags and seatbelts. Many vehicles now offer side curtain air bags in addition to the front air bags. Of these two systems, the driver or passenger has the personal responsibility of using a seatbelt and the driver has a responsibility to insure that all passengers buckle up.

Looking at the number of ejected occupants and the seeing the survivable passenger compartment, it is likely that many lives could and would have been saved by the simple use of the seatbelt. NHTSA data indicates that an occupant is 2.3 times more likely to be killed when ejected, as opposed to an occupant who remains inside a vehicle.

Below are examples where the use of a seatbelt may have made a difference in the crash. Note the survivable space. Each of these pictures represent an unrestrained person who was killed in crash after either being ejected from the vehicle or thrown about the passenger compartment in a violent way.

Once again, note the survivable space in the passenger compartment. It cannot be said for certain whether or not the occupants would have sustained serious injuries, but the chance of surviving the crash would have been better. Not all crashes are survivable, but the actions of the vehicle occupants before the crash may prevent deaths. That action could be the simple use of the seatbelt or greater attention to the task of driving.

Alcohol plays a role in many crashes, and from the data examined it is a major factor in severe rollover crashes. The driver is less likely to be able to maintain control of his/her vehicle when judgment, coordination, and vision are impaired. US Department of Transportation data indicates that nearly half of all rollover crashes involve alcohol.

Looking at the data and the case studies included in this report, it is obvious there are many reasons that a driver loses control and rolls the vehicle. In most cases, the driver was involved in a routine driving maneuver. Some of the crashes are caused by impairment or excessive speed, but the remaining causal factors are related to inattentiveness or distraction. The number of vehicle or environmental causes of rollover crashes is minimal.

RECOMMENDATIONS

1. The Virginia General Assembly should strengthen the present safety restraint statute by the enacting a primary restraint use law for all vehicle occupants, front and rear seated positions. A study conducted by the Centers for Disease Control found that seatbelt usage in primary enforcement states is nine (9) percent higher than in states with secondary laws.

   This is reiterated recommendation that was most recently suggested in Special Report 21. http://www.vcu.edu/cppweb/tstc/crashinvestigation/crash-report.html

2. The Commonwealth of Virginia should follow the recent recommendations by the National Transportation Safety Board report. Specifically, the report makes recommendations to the states in the following safety issue areas:

   To the 50 states, the Commonwealth of Puerto Rico, and the District of Columbia:

   a. Establish a per se blood alcohol concentration (BAC) limit of 0.05 or lower for all drivers who are not already required to adhere to lower BAC limits. (H-13-5)

   b. Include in your impaired driving prevention plan or highway safety plan provisions for conducting high-visibility enforcement of impaired driving laws using passive alcohol-sensing technology during law enforcement contacts, such as routine traffic stops, saturation patrols, sobriety checkpoints, and accident scene responses. (H-13-6)

   c. Include in your impaired driving prevention plan or highway safety plan elements to target repeat offenders and reduce driving while intoxicated (DWI) recidivism; such elements should include measures to improve compliance with alcohol ignition interlock requirements; the plan should also provide a mechanism for regularly assessing the success of these efforts. (H-13-7) [*This recommendation supersedes Safety Recommendation H-00-26*.]

   d. Take the following steps to move toward zero deaths from impaired driving: (1) set specific and measurable targets for reducing impaired driving fatalities and injuries, (2) list these targets in your impaired driving prevention plan or highway safety plan, and (3) provide a mechanism for regularly assessing the success of implemented

countermeasures and determining whether the targets have been met. (H-13-8)
http://www.ntsb.gov/doclib/reports/2013/SR1301.pdf

3. The Department of Motor Vehicles (DMV) should consider the following revision/improvement to the FR300P:

    a. When "Other" is checked in a field, a blank line is should be auto populated for an explanation. The information then typed in the field would automatically display at the bottom of the narrative.

4. Other recommendations for DMV are for "Crash Facts" to include all data and allow a user to search the fields better. Currently, rollover crash data is not available without an exhaustive review of all reports.

5. Local and State Police should better review reports for spelling and typographical errors in the narrative of the FR300P. Although not discussed in this report, the addition of a spell check feature for the narrative would enhance the quality of crash reporting in the Commonwealth.

6. All police agencies in the Commonwealth should have policy dictating that an investigating officer follow up with the OCME for evidence of alcohol usage when a driver is killed in a crash. This information should be passed to DMV for accurate reporting purposes. Too many investigators are simply choosing "Unknown" on the FR300 and, as a result, causation in nearly half of these single vehicle rollover crashes may not be truly reflected.

7. State and local police departments, in cooperation with the DMV, should continue to seek funding for seatbelt and DUI enforcement.

8. The Department of Motor Vehicles, Virginia Department of Transportation, Virginia State Police, county and local police and other groups that focus on highway safety should continue to educate drivers on the dangers of drinking while driving and encourage the use of seatbelts. Also educate drivers of the dangers of distraction while driving.

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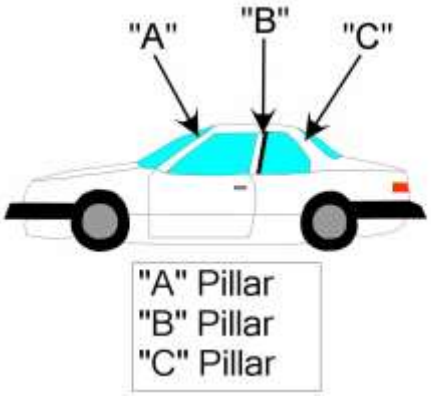
GLOSSARY

ADT	Average Daily Traffic
AE	Algorithm Enable
AASHTO	American Association State Highway and Transportation Officials
ASAP	Alcohol Safety Action Program
BAC	Blood Alcohol Concentration
CDL	Commercial Drivers License
CDR	Bosch Crash Data Retrieval System
DOH	Department of Health
DOT	Department of Transportation
DMV	Department of Motor Vehicles
DUI	Driving Under the Influence
EDR	Event Data Recorder
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
HOV	High Occupancy Vehicle
LED	Light Emitting Diode
ME	Medical Examiner
MPH	Miles Per Hour
MUCTD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
OCME	Office of the Chief Medical Examiner
SAE	Society of Automotive Engineers
SUV	Sport Utility Vehicle
TRB	Transportation Research Board
USDOT	United States Department of Transportation
VCU	Virginia Commonwealth University
VSP	Virginia State Police
VDOT	Virginia Department of Transportation
VMCIT	Virginia Multi-disciplinary Crash Investigation Team
VWAPM	Virginia Work Area Protection Manual