

**Virginia Commonwealth University  
Transportation Safety Training Center  
Crash Investigation Team**

Report Number 190 - May 2003

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## **ABSTRACT**

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This report describes two separate traffic crashes, each involving teen-age drivers. Both crashes occurred because of driver error when the drivers, traveling in excess of the posted speed limits, lost control of their vehicles and over-corrected. Their vehicles then struck opposite traveling vehicles head on, one a school bus and the other a large sport utility vehicle. Both crashes occurred within two hours of each other on public school access roads during wet road conditions in rural counties and resulted in one fatality each.

These crashes illustrate the high-risk behavior typical of many teenage drivers, the importance of wearing safety belts, and the necessity of using proper techniques in off road recovery driving maneuvers. Also discussed are the safety benefits of school bus design, inattentive driving and problems associated with teen drivers transporting other teens.

**Virginia Commonwealth University**  
**Transportation Safety Training Center**  
**Crash Investigation Team**  
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**SYNOPSIS-Case Study Number One**

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**Day, Time, Season:** Tuesday, 3:29 p.m., autumn

**Road/weather:** Wet and mist

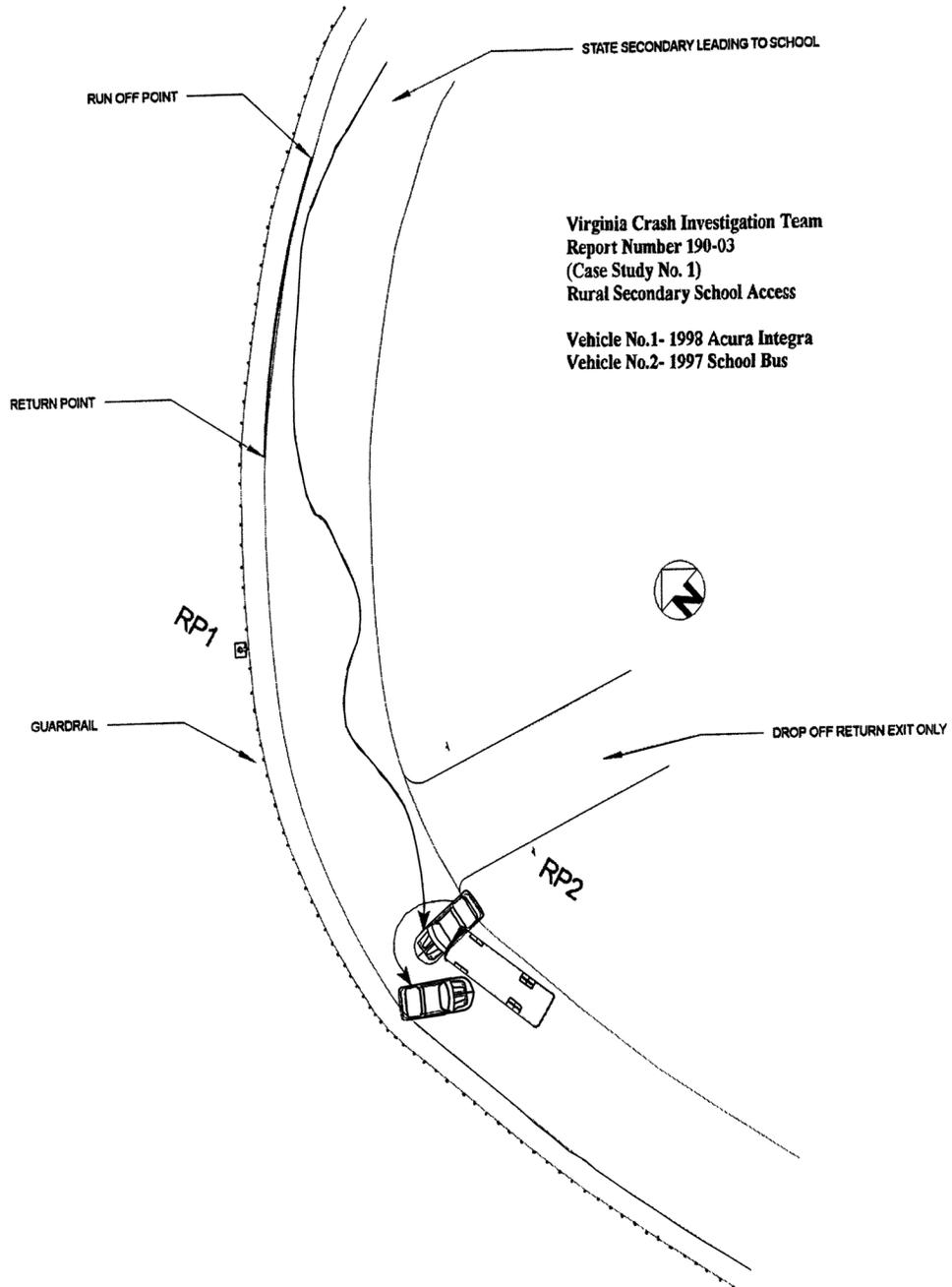
**Vehicles Involved:** 1998 Acura Integra  
1997 International School Bus

**Summary:** The Acura ran partially off the right side of the road, over corrected, came back onto the roadway and struck the front of a stopped school bus broadside.

**Severity:** 1 fatality, 11 injuries and extensive property damage.

**Probable Cause:** The 16-year-old driver, in a rush to arrive at his destination, was exceeding the posted speed limit and was distracted by interaction with his two teen passengers.

**Significant Points:** Driver distraction; speed too fast for road and weather conditions; lack of safety belt use; younger inexperienced driver; violation of teen driving laws; driver over-correction and safety aspects of larger school buses.



## CRASH DESCRIPTION

On a Tuesday afternoon at 3:29 p.m., a 1998 Acura two-door Integra was eastbound on a two-lane secondary road. The unbelted 16-year-old, driving the Acura, was accompanied by a belted 15-year-old male in the right front and an unbelted 15-year-old female in the rear. The three friends had just left their high school less than two miles away and were en route to a middle school to drop off the male passenger who was trying out for the basketball team. The male passenger was supposed to be at practice by 3:30 p.m. After turning off the primary highway and onto the middle school's access road, which is posted at 25 mph, the Acura driver accelerated on the wet pavement. This section of the road is constructed on a long curve and upgrade. After traveling about 150 feet into the moderately sharp left curve, the car's right tires ran off the pavement about 1-½ feet and onto the wet grassy shoulder. The Acura traveled 57 feet along the roadway with its two right tires on the shoulder. The driver, aware that he had traveled off the road and was heading toward a guardrail, steered hard to his left which caused the car to abruptly regain the pavement. The car then crossed into the opposite lane and headed toward the opposite shoulder. The driver counter-steered again, this time to his right. This action caused the car to rotate clockwise on the wet surface, still in the opposite lane. These abrupt over-steering actions caused the car to travel out-of-control as it slid toward a westbound school bus. The distance from where the car regained the pavement to the point that it encountered the bus was about 100 feet.

The full size 1997 International school bus had just picked up its normal afternoon load of students from the middle school, located 1000 feet away, and was en route to deliver the students home. The bus was driven by its normally assigned driver, a belted 49-year-old female, and carried 43 children seated throughout. Since public school buses are not equipped with safety belts, none of these children were belted. As she rounded the highway curve and traveled downhill, the bus driver saw the approaching Acura "fishtailing" on the roadway. She screamed at the children to "hold on" in anticipation of a collision as she "stomped" on the brake pedal. This braking action caused the bus to skid on the pavement. The school bus had been completely stopped in its proper lane of travel for about two seconds when the Acura slammed into it. The car's

left driver door area made initial contact with the front bumper and grill on the bus. The car's momentum and collision with the bus caused the left rear side behind the driver's door to collapse inward onto the 15-year-old female. The car spun off the bus in a counter-clockwise rotation, causing its left front corner to strike the left front side of the bus. The Acura then came to rest facing the bus while diagonally blocking the eastbound lane. The two vehicles were only a few feet apart, the unmoved school bus still facing west and the Acura facing northwest.



***Photo #1- View looking east in the direction the Acura was originally traveling. Photo was taken about 150 feet prior to where the car ran-off-the-road on the right and 250 feet before the point of impact. Note the excellent road conditions for this school access facility posted for 25 mph. The weather was mist and the pavement was wet at the time of the crash.***

The three Acura occupants remained inside the car at final rest. The belted front passenger was able to unbuckle his safety belt and exit under his own power through the right door. The unbelted driver, although shaken up, exited the vehicle under his own power, also through the same door. The unbelted female was found lying inside the car, against the damaged left side, and was not able to exit the vehicle. She sustained multiple serious injuries, which later proved fatal.

All the students remained seated inside the bus after the collision. None were thrown onto the floor or contacted the interior sides of the bus. The bus driver unbuckled her safety belt and helped direct the students off the bus. School personnel and other motorists who had seen and/or heard the collision assisted her. The investigating Trooper responded to the scene within minutes after the crash. The scene was marked, the vehicles examined and statements were gathered with the assistance of other troopers and deputies. Photographs and other physical documentation were gathered during their investigation.

Due to the seriousness of the collision and the involvement of a loaded school bus, at least eight rescue squads in the area were called to attend the victims. Three different hospitals in the area were also used due to the high number of expected injuries. The seriously injured female car occupant was transported via rescue vehicle to the closest hospital located about 15 miles away. She died of chest injuries about 1-½ hours after the crash. Both male occupants in the Acura were treated for minor injuries at the same hospital and released the same day. Eight students from the school bus and the bus driver were transported to other hospitals, where they were treated and released. These students' injuries consisted of "bumps, bruises, and some back and neck pain". None stayed overnight in the hospital. Two students missed classes the next day, due to anxiety and stress rather than to physical injuries. The bus driver was traumatized by the collision and at the time of this writing, (six months after the crash) had not returned to driving. She is presently receiving counseling.

## REMARKS

The 16-year-old Acura driver received his driver's license less than five months prior to the crash. His DMV record revealed he had no restrictions and he had accumulated no point balance in his short driving history. He advised the investigating Trooper, both at the scene and at the hospital, that he "did not remember what happened." He said he was taking his friend to the middle school. He remembered turning off the main road "but that's about it." He admitted to not wearing his safety belt. The 15-year-old male passenger told the Trooper that the Acura driver was taking him to basketball tryouts. According to this passenger, the driver "jerked" the car back onto the road after initially running off the pavement. The car was over-corrected again but the Acura "just kept going" until it collided with the school bus. He said he was wearing his safety belt but was unsure about the driver and female passenger's belt use. He described the impact as "really hard." This passenger also said that just before the car ran off the road, the driver was engaged in a conversation with them. The 15-year-old female in the back seat was leaning forward between the two front seats. He was unsure how fast the car was going.

The school bus driver saw the Acura run off the road and swerve a couple of times, then slide toward her bus. Although she could not estimate the car's exact speed she advised that, "it was traveling at a good clip." The bus was stopped and she had her foot on the brake pedal at impact, resulting in minor injuries to her right foot and ankle in the collision.

A motorist who had just picked up her son from the middle school and was traveling behind the school bus also saw the car "fishtailing" on the wet road. Although she did not give an exact speed for the Acura she said, "he sure looked like he was going fast."

All the students on the school bus were able to exit through the right front service door and rear emergency door without mishap. The eight students who were taken to hospitals for observation were seated in the first rows directly behind the driver. This area was nearest the collision point and experienced the higher energy loads. The structural integrity of the school bus was not compromised, including its interior. None of the seat

frames loosened from the floor. The backs of the seats heavily, padded cushions remained intact. The center aisle, roof and vertical walls did not deform. The sliding windows, emergency exists and service door were not distorted and all worked normally after the collision. The driver's seat and three-point safety belt system were not compromised and functioned well in the collision.



***Photo #2- Left rear side view of the 1998 Acura Integra showing the nearly 26 inches of collapse and 7 feet wide damage area.***

Due to the road surface being wet, no tire marks from the Acura were detected; therefore, no precise speed estimate can be calculated from roadway evidence. (The school bus, however, due to its heavy size and weight, left short, faint, white “squeegee” marks from its rear dual wheels). Based on the amount of damage sustained to both vehicles, inflicted entirely from the car's momentum, “crush” can be used to calculate a likely speed of the car at impact. This accident reconstruction method utilizes the approximate weights of the vehicles, the amount of intrusion on both vehicles, and the equivalent barrier “stiffness coefficients” for similar vehicles that were crash tested at

research sites. The Acura incurred nearly 26 inches of static crush or penetration to its left side. The left rear wheel and axle was also broken. The length of the damage was just under seven feet, matching the frontal width of the school bus. The bus sustained seven inches of crush damage to its heavy, rigid bumper. Its grille was also pushed backwards near the radiator. Upon disengagement, the car spun around the front of the bus about 25 feet, striking the bus a second time causing additional damage to both vehicles. Based on both vehicles' damage patterns combined with the post-impact travel distance of the car, the Team calculated that the Acura was traveling at least 45 mph at the time of impact. However, the car slid some distance on the wet pavement prior to impact, which, if known and combined with the calculated speed, would raise the initial speed. Due to the lack of physical evidence on the road, this distance is unknown. It is likely, however, that this young driver was exceeding the posted 25 mph limit for this road by at least 20 mph.

The 16-year-old driver was also in violation of the Commonwealth's recently passed law concerning the transportation of juveniles. Virginia and national studies have shown that crash risks for teens increase remarkably when teenage drivers transport other teens. The 2001 General Assembly passed legislation limiting the number of young passengers in such instances. In this case, the driver was issued a provisional driver's license. Since he was not yet seventeen years old, he violated the provision that prohibited him from operating a motor vehicle with more than one passenger under eighteen years of age. As this case illustrates, the interaction of the driver with his two 15-year-old passengers contributed to his unsafe driving behavior.

Furthermore, this driver was not wearing his safety belt. He likewise did not require that the rear passenger wear her safety belt, as was his responsibility under state law. Due to the circumstances associated with this collision, the Team is of the opinion that had the female passenger been wearing a safety belt and positioned in the right rear (and not leaning forward into the center front of the car), she would have survived this collision.

The 16-year-old driver was charged with reckless driving by the Commonwealth. At trial, he pled guilty to the charge and the court took the plea under advisement. He was ordered to perform 100 hours of community service and his driving record may indicate

only that he was involved in a crash resulting in a fatality, an injury, and/or property damage.



*Photo #3- View of the 1997 International full size school bus from its front and right side. The entire front was damaged with the left front corner sustaining over 7 inches of collapse from being struck by the Acura. The belted bus driver and the unbelted students sustained only minor physical injuries.*

**Virginia Commonwealth University  
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Report Number 190 - May 2003

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**SYNOPSIS-Case Study Number Two**

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**Day, Time, Season:** Tuesday, 5:30 p.m., autumn

**Road/weather:** Wet and mist

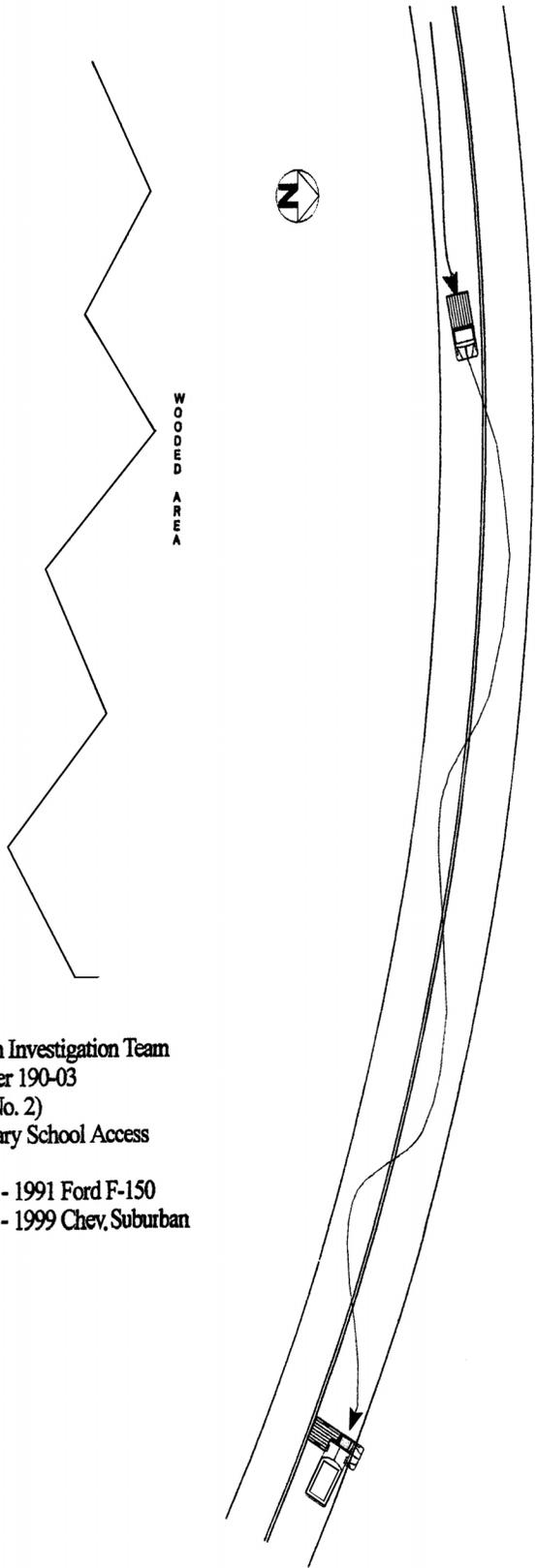
**Vehicles Involved:** 1991 Ford F-150 pickup truck  
1999 Chevrolet Suburban 1500

**Summary:** The pickup, while rounding a curve on a downgrade, traveled out of its lane and was over-corrected by its driver, causing the Ford to slide broadside into the front of a stopped Suburban in the opposite lane.

**Severity:** One fatality, one injury.

**Probable Cause:** The 17-year-old driver was exceeding the posted speed limit, was traveling at a speed too fast for weather conditions and, as a result, lost control of his vehicle on the wet road.

**Significant Points:** Speed too fast for roadway/weather conditions; driver lost control of the vehicle and over-corrected; younger, inexperienced driver; driver partially sliding out of safety belt: proper safety belt use and Event Data Recorders (“black boxes”) in selected vehicles.



Virginia Crash Investigation Team  
Report Number 190-03  
(Case Study No. 2)  
Rural Secondary School Access

Vehicle No. 1 - 1991 Ford F-150  
Vehicle No. 2 - 1999 Chev. Suburban

## CRASH DESCRIPTION

On a Tuesday afternoon at 5:30 pm, a 1991 Ford F-150 full size pickup truck was traveling east on a two lane secondary road. This school access facility is located in a rural county, and is in excellent condition. No other buildings, homes or businesses are located along this six-mile long road. The 17-year-old driver was familiar with his vehicle and the area, and he was wearing the vehicle's combination lap and shoulder safety belt. The driver, alone in his pickup, had just completed high school football practice, and was en route home. He had traveled less than one mile from his school and entered a sharp 5-degree curve to the right. At this point, the asphalt-paved road is constructed on a steep 10% downgrade. While in the curve, the pickup traveled wide and crossed the double yellow centerlines. The driver then steered back to the right, causing the vehicle to regain the eastbound lane at a sharp angle. Aware that the pickup would soon run off the road, the driver over-corrected again, causing the pickup to travel to his left and cross the center lines again into the opposite lane. While this was occurring, the truck began to slide broadside on the wet pavement, on a direct collision course with a westbound vehicle.

The vehicle traveling in the opposite direction was a 1999 Chevrolet Suburban, a large size sport utility vehicle (SUV), driven by its 44-year-old female owner. The lone driver was wearing her lap and shoulder safety belt. She was driving to the high school to pick up her son who played on the same football team as the Ford driver. Since the roadway at this point allowed for over 2000 feet of sight-distance, the SUV driver was able to see the out-of-control pickup's approach. As a result, she braked hard in an unsuccessful attempt to avoid the impending collision. The roadway was constructed with only narrow grassy shoulders, bordered by steep wooded embankments, which prevented her from steering off the roadway. From an initial speed of "about 20-25 mph" on this highway posted for 35mph, the SUV had decelerated almost to a stop when the pickup's right side slammed into the front of the Suburban. The vehicles were nearly perpendicular at this time.

At impact, the pickup immediately stopped the forward movement of the Suburban and both vehicles began to collapse into and against each other. The pickup's

right side crushed inward while its fenders deformed around the front of the suburban. At the point of maximum engagement, both vehicles were stuck together and began to slide eastward on the wet pavement due to the pickup's post-crash momentum. At final rest, both vehicles remained in the westbound lane with the pickup positioned broadside against the front of the Suburban and about 30 feet from the point of impact. The pickup incurred 40 inches of collapse to its right side in the door area. The frame bent, causing the front of the bed to separate from the left side of the cab nearly 24 inches. The truck's frame was warped in a classic "U" design. The Suburban's front was crushed rearward about 29 inches with the left front compressed by 33 inches. The wheelbase was reduced by 6 inches on the right side and 15 inches on the driver's side.



***Photo #4- View looking east in the direction the Ford pickup was originally traveling. Photo was taken about 400 feet before impact point. Note the highway grade and curve on this secondary road posted for 35 mph, which serves as a high school access road. The weather was mist and the pavement was wet at the time of the crash.***

After impact, both drivers remained inside their vehicles and both were conscious. The pickup driver's torso slid out of his three-point safety belt system during the crash. He was lying to his right and partially on the right front bench seat, which had been

shoved up against him. Within minutes after the crash, he exited the vehicle through the driver's side under his own power, about the same time that other motorists arrived. These motorists and the Suburban's driver called authorities on their cell phones. The SUV driver was initially trapped in her vehicle by the crushed interior and the presence of the Ford against her vehicle. She eventually exited her vehicle with assistance from motorists through the right front door. The investigating Trooper and rescue personnel arrived within minutes after the crash. The pickup driver was complaining of chest pains, but otherwise appeared normal. The SUV driver received chest and abdominal bruising from the seatbelt and deployment of the airbag. She also sustained a more serious injury to her right foot and ankle.

The SUV driver advised the Trooper that she was driving only about 20-25 mph due to the poor weather conditions. She saw the pickup's approach. Then, suddenly it was sideways in her lane, directly in front of her. She had no place to go and knew that the two vehicles were going to collide. She "slammed" on her brakes. At the scene, the pickup driver told the Trooper that he could not remember what had happened and was unsure as to how fast he was going. He realized the extent of damage on both his pickup and the SUV while being loaded into the ambulance. He was over-heard asking the attendant whether or not he was going to be all right.

The trooper took photographs at the scene and had the vehicles removed. The site was cleared about 1-1/2 hours after the crash. When the trooper arrived at the hospital to follow up with his investigation, he was informed that the driver had just died from a ruptured aorta. He was told the driver was talking normally while in the emergency room and, while being examined, he lost consciousness. One of the last inquiries the young driver made before he died was "I'm not going to die, am I?"

## REMARKS

The state medical examiners office listed chest injuries as the cause of death for the pickup driver. The ruptured aorta he sustained in this collision was a deceleration injury due to the sudden stop after high speed. He had no other significant injuries to his body.

The Crash Investigation Team examined the pickup driver's safety belt several days after the crash and it displayed obvious signs of being worn at the time of the crash. The belt remained locked within its inertia reel system, in a fully extended position. (As a comparison, the passenger side belt webbing remained reeled back in its normal, unworn position alongside the right B-post). The driver side webbing was brittle at the point where it was threaded through the dual slots on the sliding latch plate. Striation marks were also observed on the metal latch plate where the polyester webbing rubbed against it. Because the severe impact forces exerted on the driver and his safety belt were directed laterally (as opposed to a forward direction), the driver's upper body slid underneath the shoulder strap at impact. This action caused the driver to be thrown partially to his right, directly toward the impact with the striking Suburban. His lap belt, however, remained locked and properly restrained his lower body. While the actions of the belt system were not defective, they do illustrate a design problem associated with three-point restraint systems when a severe broadside collision of this magnitude occurs. However, due to the high-energy loads associated with this collision, it is questionable if the young driver would have survived this impact even if he had not slipped out of the shoulder harness. Although speculative, another driver who was not as large (6 feet, 232 lbs) or as physically fit as this 17-year-old probably would have died instantly in the collision.

The 44-year-old driver of the SUV survived the collision with contusions to her upper body. However, she incurred multiple serious fractures to her right foot, ankle and heel. These impact injuries were sustained when she had her foot positioned on the brake pedal at the time of collision. The impact forces were so great that the floorboard collapsed and was pushed back against her feet and lower legs. Due to the seriousness of

her foot injuries, at the time of this writing, she has not been able to return to her normal working duties.

Based on the collapse damages sustained to both vehicles, a minimum speed for the striking pickup can be estimated. The total combined static crush from both vehicles was measured at 69 inches (40 inches on the pickup and 29 inches on the SUV). If the suburban was indeed stopped just prior to impact, all of the crush damages were produced by the pickup's speed. Based on the best evidence available by using several different vehicle damage/crush equations, the likely speed of the pickup at impact was calculated at 56 mph. The investigating Trooper estimated that the pickup was initially traveling 65 mph before impact.



***Photo #5- Right side view of 1991 full size Ford F-150 pickup truck, weighing nearly 3800lbs. Contact damage measured 40 inches deep and 72 inches wide. The truck's frame was severely bent causing the pickup to distort in a classic U-shape pattern while the Suburban was embedded into the Ford's side. The Ford's interior was reduced in size by over one half its normal width.***

The 1999 Chevrolet Suburban was equipped with an Event Data Recorder, called a Sensing Diagnostic Module or SDM (i.e. "black box") located under the driver's seat. It

was examined and downloaded by the Team using the Crash Data Retrieval System's toolbox. The information recorded on this model vehicle captured post crash data only. The data confirms much of what the physical evidence on the vehicle revealed. For instance, the SIR (Supplemental Inflatable Restraint) warning lamp on the instrument panel indicated that the airbag system checked out properly prior to the crash and that the airbag performed as designed upon impact, as indicated by its deployment. The SDM data indicated that the passenger side airbag had not been deactivated; this was confirmed by the deployment of this airbag. The driver's belt switch circuit status indicated that the driver's safety belt was buckled at the time of impact. This was validated by the driver's lack of head and chest injuries, (which she would have sustained had she not been belted), as well as by the lack of damage to the SUV's steering wheel, dashboard and windshield. The driver likewise reported she was wearing her lap and shoulder belt at the time of the collision. The SDM also records vehicle forward velocity change for the first 300 milliseconds after the deployment of the air bag. At 150 milliseconds the recorded velocity change peaked at -36.64 mph. Based on the amount of damage sustained to the Suburban and considering that it was pushed backwards on a wet downgrade pavement, this strongly suggests that the highest velocity change is in line with the calculated impact speed occurring at collision. The recorded time between vehicle impact to airbag deployment was recorded at 12.5 milliseconds.

The presence of Event Data Recorders (EDR) in vehicles will prove a vital tool in future investigations and reconstructions of traffic crashes, especially on the vehicle models that record pre-crash data. The information may be useful for possible litigation, insurance and highway safety matters when supported by physical evidence. The Crash Investigation Team now routinely employs this relatively new technical tool in all of its investigations involving late model General Motors and Ford Motors vehicles equipped with EDRs. Additionally, The Department of State Police, other law enforcement agencies, and risk management professionals across the Commonwealth are now ordering downloading toolboxes and will begin using them in the very near future. The Insurance Institute for Highway Safety also uses them during laboratory testing of selected vehicles. It is recommended that others involved in crash reconstruction, highway safety, vehicle crash research and related fields employ such devices. (The Crash Team is presently

conducting a special study of EDR equipped vehicles involved in crashes, in an attempt to corroborate the recorded data with the supportive physical evidence. This report is scheduled to be complete by the fall of 2003. See CIT Technical Alert Numbers 9 and 12 and Full Report Number 188 for past investigations referencing EDRs).



***Photo #6- Right front view of the 1999 Chevrolet Suburban 1500 weighing 4700lbs. The SUV's front end was pushed rearward into the engine and occupant compartments nearly 30 inches. The left and right side wheel base lengths were reduced 33 inches and 24 inches respectively. The driver's side floor area at the foot controls was collapsed inward about 6 inches from its normal measurement.***

## RECOMMENDATIONS

1. Younger drivers must continue to be taught and advised by parents and teachers to drive in a safe, responsible manner. Emphasis in drivers' education should be given to the skills associated with assessing the roadway environment (conditions), and making driving adjustments accordingly.
2. Procedures of safe off-road recovery should be emphasized to all drivers, especially young drivers. Generally, the worst corrective maneuver that a driver can take when he finds himself partially off-road is to "jerk" the steering wheel back toward the road.
3. Young drivers must heed the current laws such as the law regarding the transportation of other teen passengers. They also must understand the purpose of these laws.
4. All drivers should realize that distractions, contributing to crashes, occur both inside and outside their vehicle. All drivers must at all times keep their full attention on the driving task.
5. Law enforcement should aggressively enforce Virginia's motor vehicle codes regardless as to whether they are "primary" or "secondary".
6. The importance of proper belt use for auto occupants should be emphasized.
7. The data captured in Event Data Recorder equipped vehicles should be regularly used by law enforcement and highway safety research personnel.
8. Since these two crashes occurred on or near school property, school administrators are urged to take a more pro-active stance on highway safety for their students, especially on school access roads.
9. The National Highway Traffic Safety Administration should consider testing side impact collisions with respect to the three point safety belt systems to evaluate the restraint effectiveness of the torso strap.