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

Report Number 206 – September, 2008

ABSTRACT

A minivan driven in excess of the speed limit approached traffic stopped for a red light at a signalized intersection. The impaired driver began to brake but his vehicle struck the rear end of a school bus that was stopped. The front of the minivan underrode the rear bumper of the bus, resulting in the death of the unbelted minivan driver. Several students on the bus suffered mild injuries, but none were serious. The bus sustained minor damage, mostly to the rear bumper.

This crash illustrates issues related to older or impaired drivers who have chronic and debilitating illnesses, as well as the need to educate the public with regard to the Medical Review process at the Department of Motor Vehicles, and to encourage law enforcement officers and physicians to report drivers with possible impairment. The crash also highlights problems with school bus bumper heights with respect to other vehicles on the highways, as well as the protective benefits of high back seats in school bus design, along with the importance of wearing safety belts when travelling in a vehicle equipped with airbags.

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SYNOPSIS

Day, Time, Season: Monday, 3:25 p.m., Spring

Road/Weather: Rural primary highway, sunny and dry

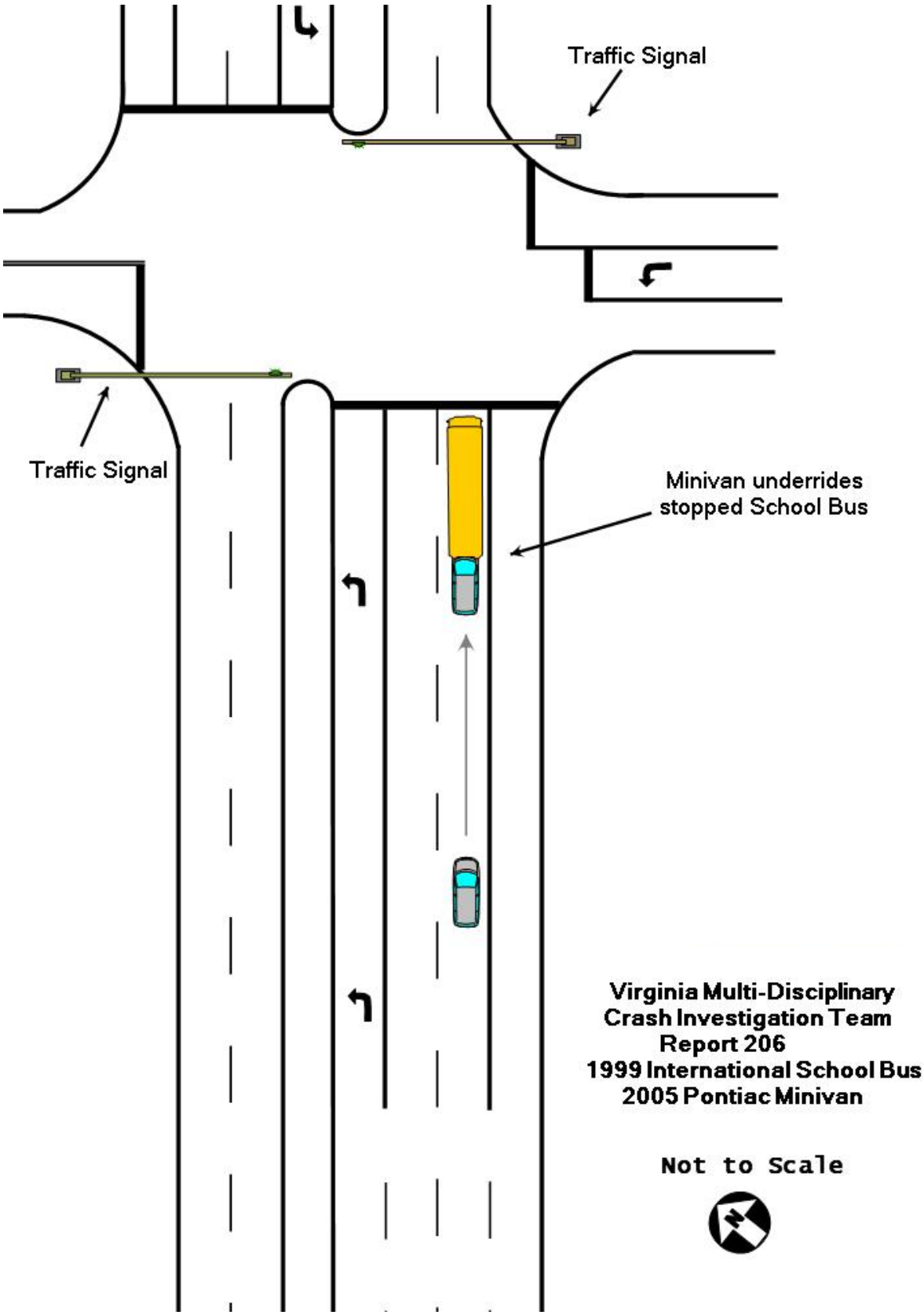
Vehicles Involved: 1999 International School Bus
2005 Pontiac Montana minivan

Summary: The school bus was stopped at an intersection and the minivan struck it in the rear.

Severity: One fatality (minivan driver), several bus passengers with mild injuries, extensive property damage

Probable Cause: Medically impaired driver

Significant Points: Driving while medically impaired; reporting and review of medically impaired drivers, school bus bumper heights and underride crash dynamics, seat design on school busses, post-crash safety and security issues, safety belt use with airbags


Traffic Signal
Traffic Signal
Minivan underrides
stopped School Bus
Virginia Multi-Disciplinary
Crash Investigation Team
Report 206
1999 International School Bus
2005 Pontiac Minivan
Not to Scale

CRASH DESCRIPTION

On a clear, dry afternoon in spring, a 1999 International school bus carrying 40 students was stopped for a red light at a signalized intersection. The students, who attended elementary, middle or high school in this rural county, were being transported home and all were seated on the bus. The driver, a 70 year old female who had been driving school busses in the county for 38 years, wore her lap/shoulder restraint. She had picked the children up from their schools and was just a few miles into her trip.

The bus was traveling east on a major four lane divided primary highway located in a rural area. Each lane is approximately 11 feet wide and the eastbound and westbound lanes are separated by a grass median approximately 27 feet wide at the crash site. There are single left and right turn lanes eastbound at the signalized intersection where the crash occurred. There is also a 2 foot gutter and 6 inch curb adjacent to the right turn lane. The pavement is asphalt and in good condition. The road is controlled by pavement markings, signs, and a traffic signal which are in good condition. The stop line is in poor condition. There is no overhead lighting. The speed limit is 55 mph.

Some distance behind the bus, a gold 2005 Pontiac Montana minivan was also travelling eastbound in the same lane. The unbelted driver, a 76 year old male with a history of physical and mental impairment, approached the intersection at a high rate of speed. He applied his brakes enough to slow his vehicle but left no visible tire marks on the roadway. The minivan was still traveling in excess of the 55 mph posted limit when it struck the rear of the school bus slightly offset to the right. During the collision, the radiator portion of the minivan impacted the rear bumper of the school bus. The minivan then underrode the school bus, shearing the engine compartment off the frame and pushing the contents backward toward the occupant compartment. The first and second stages of the airbags deployed for both the driver and the front passenger positions. The force of the impact caused the school bus to move upward and roll forward slightly. The vehicles disengaged and came to rest several feet apart, both still facing east in the right lane of the highway.

Photo #1: View facing east, direction both vehicles were travelling.

Immediately after the crash, several witnesses called and notified authorities, requesting emergency personnel. Children on the bus also began making calls. Another bus driver, who came upon the scene just after the impact, parked her bus in the right turn lane. She noticed that someone was checking on the driver of the minivan, so she boarded the struck bus to check the driver and students. None appeared to have serious injuries. She then returned to the minivan and assisted others in assessing the driver's condition. He was not responsive. Virginia State Police officers, emergency personnel from two counties and school personnel, including several school nurses, arrived and began managing the scene in their areas of responsibility. Children with no complaint of injury exited the bus and moved to a grassy area beside the highway, where they were supervised until they could be released and transported home. Three children were transported by ambulance to nearby hospitals for evaluation of possible head and neck injuries. Two had been sitting in the last row, nearest the point of impact, and the third had been seated mid-bus but complained of a sore neck. Other children were released to their parents or relatives

and some of these were taken to emergency rooms or their family physicians to be checked for possible injuries. None sustained anything more than minor injury. The remaining students were placed on another bus and driven home. The involved bus driver stayed at the scene for about an hour and a half. Her daughter then drove her to a local hospital where she was examined for injury.

Although his airbag deployed, the minivan driver suffered blunt force injuries to his chest, including laceration of the aorta and heart, and fractures of the ribs, sternum and thoracic spine. He died at the scene. State Police contacted the local medical examiner, who authorized that the body be transported to the District Office of the Chief Medical Examiner for autopsy and toxicology tests. The investigating trooper notified the driver's wife of his death. Once those involved had been transported or released and the vehicles were towed, all lanes of travel were re-opened. The scene was cleared just over six hours after the crash occurred.

REMARKS

Members of the Virginia Multi-disciplinary Crash Investigation Team (VMCIT) learned of this crash through evening news broadcasts, within hours after it occurred. State Police contacts provided more insight into the particulars of the case and the VMCIT decided to pursue an in-depth study.

One area of focus was the minivan driver. His vehicle left no skid marks on the asphalt and one witness reported that he may have been slumped over the wheel prior to impact with the bus. Based on information obtained during an interview with his wife, it became apparent that this driver had been in poor health. A Korean War veteran, the 76 year old was a diabetic who, due to his deteriorating health, had been retired since 1962. He required insulin shots to control his diabetes but was not medically compliant with his treatment regimen. As a consequence, he suffered vascular complications and required additional medications to help control cholesterol and blood pressure levels. He had suffered two "silent" (symptomless) heart attacks during a one week span about a decade ago, with resulting heart damage. He had symptoms of continued cardiovascular problems, including swelling on one side of his face and body. The Medical Examiner told his wife that his heart was enlarged at the time of his death. These problems affected his kidneys: this individual was experiencing renal failure as well.

Perhaps most significantly, this driver suffered neurological complications from the diabetes and cardiovascular problems. He'd had 2 mild strokes (with damage apparent at autopsy). As a result of the brain damage, his gait was uneven and he lost control of some facial muscles around his mouth, which was evident when he smiled. He had ongoing transient ischemic attacks (TIAs, also called "mini-strokes"). These attacks, although short in duration, mimic the effects of a stroke and are due to a temporary interruption of blood flow to an area of the brain. The symptoms include sudden weakness, numbness or paralysis in the extremities, often localized to one side of the body, problems with speech and or vision, and dizziness or loss of coordination. In an episode consistent with a TIA, the driver reported to his wife that he had become blind for about 10 minutes the previous week and had fallen. (Otherwise, his vision was reported to be good. He only needed reading glasses, no corrective lenses for driving or distance vision.)

Further evidence of the damage he incurred from the strokes and TIAs, however, came in the form of cognitive and behavioral changes. This driver was diagnosed with vascular

dementia, which manifested in occasional blackouts and episodes of confusion when he became lost while driving in his community. During the previous year, he exhibited suspiciousness and paranoia and had become verbally abusive on occasion. His wife stated that he had been detained by police on at least two occasions. The first time, she picked him up and took him home. During the second occasion, she had wanted him to be evaluated in a psychiatric facility, but local police put him in a cab and sent him home after she refused to pick him up.

Six months prior to this fatal crash, the minivan driver was involved in a non-reportable crash in which he rear ended another moving vehicle. According to the officer who investigated the incident, the driver struck another moving vehicle several times in the rear before other motorists were able to force him off the road and detain him. He was incoherent when the officer arrived on scene. When being treated by emergency workers at the crash scene, his blood sugar levels were found to be very low. A neurological and psychological evaluation was performed after he had been transported to a local hospital. At least two physicians (a neurologist and his primary care doctor) verbally informed him that he should not be driving, but there is no evidence that they ever notified the Virginia Department of Motor Vehicles (DMV) that he was medically unfit to drive. He was charged with reckless driving, but an FR-300 accident report was not filed with the DMV because the property damage was minimal and no one was injured as a result of the crash. His wife reported that, due to his medical impairment, the reckless driving charge was dropped before she had the chance to present the medical report in court (and reveal that he should have his license suspended for medical reasons). The officer who charged him indicated that he had interviewed the driver 30 minutes after the crash, at the hospital, and that he was completely lucid (his low blood sugar had been elevated) and that he had no memory of the incident. Judging that the crash was the result of a temporary medical condition and believing that the driver would probably not have been convicted, he decided not to pursue the reckless driving charge. Court records show that the case was nolle prosequi. His driving history does not contain any record of violations or convictions and he had a driver point balance of +5.

The Pontiac driver's wife had been trying to find ways to keep him from driving. She had hoped his physicians, the police or the courts would take action to have his license revoked, but she was not aware that she could have reported his medical impairment to the DMV herself. She had also tried to deny him access to a vehicle, including selling a previous one so that he would not be able to drive while she was at work. Unfortunately, her husband purchased the

Montana a few months prior to the fatal crash, without the involvement or approval of his wife. The agent from the dealership had come to his home to pick him up so he could take possession of the vehicle.

The fact that others missed many opportunities to identify this individual as medically impaired when driving was a concern that arose from this investigation. As indicated, various individuals involved with the driver made decisions that resulted in his continuing to drive. Most of these decisions were passive in nature—despite knowing that he had some mental and physical problems, they did not take action.

After the driver's earlier crash, the officer did not pursue prosecution of the reckless driving charges, which meant the DMV had no knowledge of a driving problem from a legal/administrative standpoint. The officer also declined to report him to the DMV for a medical evaluation. Law enforcement officers can be identified to the reported driver, and consequently may receive complaints later from that person. However, this officer did not mention that issue when he spoke of his decision. Instead, he indicated that he preferred not to refer older individuals with suspected medical issues unless they appeared to have some sort of dementia or symptoms of Alzheimer's disease at the time of the offense. His reason for this "rule of thumb" was his belief that 90 to 95% of these older drivers would not get their licenses back if they were referred. The ironic aspect in this case was that the driver *did* have some cognitive impairment but, as is often the case with dementia and early stages of Alzheimer's, the symptoms weren't present all the time. One moment an individual is lucid and seems quite normal, and then he becomes incoherent, irrational, or even belligerent. While the officer was acting upon his personal observations and the information available to him at the time, he did not have access to the full context of this individual's background. In trying to be empathetic to the driver's plight if his license was suspended, he made a judgment call that should more appropriately been made by medical reviewers who would take the driver's entire background into consideration.

This individual's physicians also declined to refer him for a medical review. When physicians or relatives make such a report, the DMV may not release information about who made the report or the reasons they cite. Physicians may indicate that they are unsure about a person's ability to drive and recommend that the driver's knowledge and/or road skills be evaluated, or they may recommend a complete driver evaluation. In some cases, a medical professional may submit an initial impaired driver report recommending that the person no

longer drive. Without these reports, the DMV has no way of knowing that there is a problem until the driver violates a law or becomes involved in a crash, as in this case. The treating physician's reasons for not reporting this at-risk driver are not known.

When the DMV is notified that a driver has had a seizure or a blackout, their established policy is to suspend that driver's license for at least six months to ensure that enough time has passed to show that the condition is under control, usually through treatment and medication. As part of the medical review process, the DMV may require a driver to submit information from a physician or nurse practitioner, or from and ophthalmologist or optometrist if the impairment is vision-related. The DMV may also require that the driver be evaluated by a driver rehabilitation specialist, and/or that they pass the driver's license knowledge exam and/or road skills test. After considering all the information, the DMV reviewers will then make a decision about the license status, and may choose to suspend or restrict driving privileges. The DMV may also require further evaluation and the submission of periodic medical and/or vision assessments, especially in the case of drivers with chronic illness. According to DMV records for the most recent fiscal year, a total of 6,815 drivers were reported as medically impaired, most frequently by medical professionals and law enforcement officers. Less than 3% were reported by relatives. Of those reported, 1,180 (17.3%) were in their 70's and 1,782 (26.1%) were 80 years or older. The suspension rates for medical impairment were about the same for each of the age groups compared to the total rate: 48.2% of those in their seventies were suspended, 50.2% of those 80 or older were suspended while the suspension rate for all ages combined was 49.4%.

As a result of inaction by various individuals across multiple settings, the driver was killed and a busload of children was put at risk. With the advancement of medical science, drivers who are older or who have what were once debilitating illnesses are able to live active and independent lives. However, not all of these individuals are able to operate a motor vehicle safely, especially if their health begins to deteriorate, yet they may not be cognizant of their own impairment. The loss of driving privileges may be difficult for such individuals, psychologically and from a lifestyle perspective, but this must be contrasted with the bigger picture. Impaired drivers are at risk for harming—or killing—innocent others. Those consequences cannot be tolerated.

The minivan driver had a habit of using the vehicle to go out during the day, but the frequency of his driving is unknown. No one knew the reason for his travel, or his route, on the day of the crash. There were no receipts to indicate that he had purchased anything. Although at

least one eyewitness thought he may have been slumped over the wheel of the Montana just prior to the crash, information downloaded from the Airbag Control Module (ACM) showed that he was responsive enough to begin braking about 6 seconds before the impact triggered the ACM's decision-making mechanisms (algorithm enable). His brake switch circuit status remained on for the last 6 of the 8 seconds of the pre-crash recorded data. Lack of evidence on the roadway indicates that the brakes of the Pontiac never locked the wheels. Speed data recorded in the ACM is consistent with a vehicle slowing at a moderate pace. The brakes themselves seemed to be in good condition during the post crash inspection.

According to a Carfax History Report, the 2005 Pontiac minivan had three previous owners and was purchased by the victim in March of 2008. It was reported to have 45,499 miles at time of purchase. The minivan had a current Virginia registration and current state inspection sticker expiring 12/08. Other than the crash damage, the vehicle appeared to be in good condition during post crash inspection at a local tow yard. The front of the Pontiac above the bumper was crushed backward toward the occupant compartment as a result of the impact.

Photo #2: Front view of minivan showing underride damage.

The damage was angled with the deepest penetration on the driver's side of the van. Contact damage caused the roof of the vehicle to buckle inward and the doors to wrinkle. The engine, as a result of the crash, broke free of its mounts, as designed, and was pushed down and under the vehicle. The windshield was badly broken but still in place. The plastic bumper cover was torn free of the metal bumper, but the bumper itself, which connected directly to the frame, was mostly undamaged.

Members of VMCIT downloaded the ACM and inspected the interior of the vehicle. The distance between the driver's seat and steering wheel was measured at 4 inches, although pushing on the seat revealed that it moved freely on its track without lifting the locking latch. According to the ACM download, the seat was positioned on the front third of the track at the time of the crash, closer to the steering wheel.

Initially, the driver was reported to have been wearing his lap/shoulder belt. This information was inconsistent with evidence from both the vehicle and the victim. The ACM download showed that the driver's seatbelt was unbuckled and the pretensioners did not fire. A seatbelt pretensioner is a device, in this case a pyrotechnic mechanism (see photo #4), that removes slack from a safety belt when activated by a vehicle's crash sensing system. A closer inspection of the driver's seat belt revealed that it had been cut in two places, with a 4 foot section removed in the middle. Usually a cut seatbelt is consistent with an occupant wearing the seatbelt and emergency personnel cutting it to allow removal. In this case, however, the door and "B" pillar were removed by the "Jaws of Life" to assist in extrication. The "B" pillar was cut near the base of the door, just above the seatbelt retractor. When the middle portion of the cut seatbelt was looped through the "D" ring and the cut ends brought down to the retractor and anchor point, the cut portions lined up perfectly with the cut made by the "Jaws of Life". The seat belt latch plate was still attached to the middle cut portion as well. Emergency personnel will usually leave the latch plate in the buckle after cutting the belt when removing an occupant. Inspection of the pyrotechnic seatbelt pretensioner showed that it did not fire during the crash, which is also consistent with the ACM report. With this model vehicle, the pretensioner, if working properly, will not fire unless the latch plate is inserted into the buckle.

Autopsy results were also consistent with no restraint use. The driver's ribs and sternum were fractured, his aorta and heart were lacerated, and he had a spinal fracture with crushing injury to his spinal cord. During the crash sequence, this unbelted driver moved forward and was

Photo #3: Minivan driver's seat belt. Note that belt was cut but latch plate was not in buckle.

Photo #4: Pretensioner on driver's seatbelt buckle. The cartridge parallel to the seat base contains chemicals to fuel the pyrotechnic device. If the pretensioner had fired, the accordion pleats would be tightly compacted instead of expanded.

struck by the deploying airbag (if the airbag had not deployed, he would have struck the steering wheel). If he had been belted, bruising in the pelvic area would have been likely, with lacerations of the liver or other lower abdominal organs possible. All evidence suggests that the driver was not wearing his seatbelt.

According to the ACM, the speed of the vehicle 5 seconds prior to impact was 88 mph. Over the next 4 seconds the driver activated his brakes and slowed his vehicle to 55 mph just before striking the rear of the school bus. With the lack of physical evidence on the roadway, the speed would normally be difficult to corroborate; however, the needle on the speedometer was pinned against the plastic covering due to damage at impact. The needle was locked slightly above the 55 mph dial reading. Although such information alone does not provide conclusive evidence, when considered along with the ACM download, it validates the van's recorded speed at impact.

Photo #5: Minivan speedometer with needle fixed between 55 and 60 mph.

Damage to the school bus was limited to the bumper and the sheet metal just above bumper. The lower glass on the emergency exit door was also broken and missing as a result of the crash. Some minor scratches were also noted on the frame under the bus.

The bottom of the school bus bumper was measured by members of VMCIT at 25½ inches above the ground. Height measurements were also taken from the ground to the bottom and top of the 6 inch bumper on the minivan. The measurements were 12 ½ inches to the bottom and 17 ½ inches to the top of the nearly untouched bumper. The difference between the top of the minivan bumper and the bottom of the school bus bumper was 8 inches. During the investigation, VMCIT members measured the bumpers of several other school busses manufactured between 1999 and 2007. All of the bumpers measured on the busses had heights above the ground between 25 and 27 inches. This is where a potential problem exists.

Photo #6: Rear view of school bus. Note area of impact and underride on right.

Federal Motor Vehicle Safety Standards 223 and 224 list standards for trailers in excess of 10,000 pounds, requiring them to have underride protection. These standards require

protection in the form of a drop down bumper to extend not more than 22 inches above the ground. The primary objective of a rear impact guard is to prevent an especially hazardous crash configuration known as "underride with passenger compartment intrusion (PCI)" that can occur when the front of a passenger vehicle contacts the rear of a truck trailer. The rigid structures in the front end of a small passenger car, such as the engine block, are often less than 30 inches above the ground, whereas the bed of the truck trailer is usually more than 45 inches off the ground. The passenger vehicle can underride the trailer, and the bed of the trailer will almost immediately intrude into the occupant compartment above and behind the hood, at great risk to occupants.

Photo #7: Right rear corner of bus. Note depth of intrusion damage to underside.

These standards were adopted for trailers in 1998 but do not apply to straight trucks or busses. Several reasons have been stated for excluding these vehicles, including cost, hydraulic lifts on some vehicles making mounting difficult, and the fact that these vehicles only account for around 20 deaths a year nationwide (Sauer, 2001). Although it could be expensive to retrofit

all straight trucks on the roadway, estimates show that it would only cost about $375 to install the underride protection on new vehicles (Vaudel, Tumuhairwe & Berwick, 2007). The fatality numbers for underride crashes change annually but average around 700 nationwide (National Center for Statistics & Analysis (NCSA), 2005 & 2006), with an average of 25% resulting from straight truck collisions (NCSA, 2008). The adoption of drop down, underride protection for all vehicles over 10,000 pounds could significantly reduce death and injury in rear end crashes that might involve underride. With the mandatory implementation of underride protection by the Federal Government in 1998, the number of deaths from these types of crashes decreased nearly 30% over the next year. Straight truck configured vehicles and busses make up 72% of all commercial trucks in the United States (NCSA, 2005 & 2006).

There are approximately 600,000 school busses on the road each day across our country. These busses carry over 24 million students daily and travel nearly 4 billion miles annually (National Association of State Directors of Pupil Transportation, 2000). In fatal school bus crashes, an occupant of the other vehicle is the victim 61% of the time. Statistics (NCSA, 2008) show that nearly 30% of all injury crashes involving school busses were rear end crashes. In this case, we know that the driver of the minivan was not restrained and contributed to his own death. However, information from the airbag control module shows a slight delay in airbag deployment. This delay is attributed to underride crash factors. The differences between the bumper heights of the two vehicles allowed the minivan to underride the bus and not make contact until the mid-point of the Pontiac's hood. Because the hood is designed to crumple and absorb energy, the airbag control module doesn't recognize the severity of the crash until components in the engine compartment collide with the bus' rear bumper, thus causing a delay in airbag deployment. Had the Pontiac's bumper struck a solid object, such as another bumper, the airbag control module would have recognized the severity of the crash much sooner and deployed the airbag more quickly.

Earlier deployment of the airbag allows it to fill with air completely before the occupant strikes it. This early deployment is especially important if the driver is sitting close to the steering wheel and/or unbelted, as in this crash. Tests also show that when an airbag is fully inflated before the occupant strikes it, the greater the chance the occupant will remain centered in the vehicle and avoid hitting the windshield.

The 70 year old school bus driver had 38 years experience driving school busses for this rural county. Like the minivan driver, she was an insulin dependent diabetic. However, she was

careful to follow her doctor's recommendations for treating the illness and its complications. Although she had some kidney dysfunction and high blood pressure, these were being managed and she visited a physician every three months for checkups. None of her medications affected her ability to drive. However, because she had a commercial driver's license with endorsements for driving passenger and school busses, the DMV required a medical review of her case once she began using insulin to manage her diabetes. Her license was briefly suspended about a year before the crash while she dealt with the administrative details of getting the correct medical paperwork to the DMV. She currently holds a valid commercial driver's license with a medical waiver, restricting her to school and/or school activity busses. However, she must wear corrective lenses and is required to provide medical review information to the DMV on an annual basis. Her driving history shows no convictions and she has a driver point balance of +5. A post-crash drug screen taken the following day showed that she was not under the influence of any potentially impairing drugs, and there is no evidence that her ability to drive was impaired in any way.

With her extensive experience in the county, this woman was well-acquainted with the roads she drove. She had been operating the same bus for about six years and was familiar with it as well. She described the events prior to the crash as part of a "normal" day. She had picked up children at each of the three schools in the county, starting with the elementary school, then the high school and middle school. The students were seated with the younger children closer to the front and the older ones claiming the rear seats. Forty students were aboard the bus that day and she recalled that they were talking with each other but remained in their seats.

She followed her usual route from the schools, heading east, and stopped at the intersection when the light turned red. Her bus was the first vehicle in the lane and she recalled that the signal had just changed from red to green, but that she still had her foot on the brake. She felt the bus shake, stating that it seemed to "drop down" at impact, but she did not realize what had happened until students began screaming that someone had run into the back. With the safety and welfare of her charges as her primary concern, she first inquired about any injuries. When no one seemed to have been seriously harmed, she called the School Board to notify them of the crash. After putting the bus in neutral and activating the emergency brake, she got up to check the students more closely and to see what had happened at the rear. By that time, the other bus driver and another adult had come on board to assess the situation as well. Students generally stayed in their seats, although the ones in the rear had initially moved forward away

from the area of the impact. Several students started to walk back to look at the vehicle behind the bus, but generally they were well-behaved and compliant with instructions. Many children were upset and fearful and called family members with cell phones they carried with their school gear. Within minutes, school nurses, emergency crew members, police and other teachers arrived.

This bus had a video camera that was in operation at the time of the crash, documenting events prior to, during and after the crash. The effects of the impact on the students was immediately apparent, as well as their immediate reactions. Clearly, one sitting in the last seat struck the back of his head against the back wall and, although he immediately got up and moved toward the front, he was obviously in some discomfort. Another appeared to be rubbing his neck. The video footage also revealed the effectiveness of the seat design, especially for the younger, smaller children, who experienced lower levels of the energy forces due to the high seat backs and cushioning. The driver's actions, as well as those of the students and the adults who later boarded the bus, were easily observed and the tape will be invaluable to the school administration in evaluating the overall response to this emergency situation.

The county school board had a crisis management plan that administrators immediately implemented. In addition to ensuring that any injured students were attended, they had to maintain the safety of all the students until they could be released to family members. At first, fire personnel wanted to evacuate the bus but were told that they couldn't, because there was no one to supervise the students. After paramedics had determined that several students required medical attention, they began treating them, while those that were not hurt were allowed to exit the bus through the front door. These children were guided across the right turn lane, which was blocked by the other bus, and kept as a group on the grassy slope beside the road. About a dozen administrators, teachers and school nurses supervised them and began collecting information. Each student was identified by name and grade level and evaluated by a paramedic. Staff at the schools began calling parents. When an authorized adult came to pick them up, each student's departure was documented. Those who were not picked up were taken home aboard the second bus. The students who remained on the bus were transported by ambulance to a nearby hospital. One had a possible mild concussion when he struck the back of his head against the back wall of the bus and the other reported whiplash type pain. They were treated and kept overnight for observation before being released.

The bus driver did not leave her vehicle until all but the two injured students had exited. She stayed with her students, on the grassy area, until all had been sent home with family members or on another bus. Then, because she experienced some shoulder pain, she agreed to have her daughter drive her to a local hospital for examination. She was treated and given a prescription for pain medication. She missed the next two days of work, but returned to office work on Thursday and resumed driving the following Monday.

Finally, with regard to highway issues, the VMCIT assessed the approach to the intersection and crash site. Although some of the markings are in poor condition, they did not contribute to this crash. The speed limit at the signalized intersection is 55 mph. Prior to the 55 mph zone, the speed limit is 60 mph. The 5 mph speed reduction is such a small change that it may seem insignificant and motorists may be less likely to slow down. However, this issue was probably not a factor in the crash, since other data indicated that the deceased driver was travelling well in excess of the speed limit before approaching this zone and that he did brake to slow down.

The VMCIT concluded that the primary cause of this tragic crash arose from the driver's impairments. Secondarily, the design of the bus and the minivan, in conjunction with the driver's failure to wear his safety belt, played a role in the crash severity.

RECOMMENDATIONS

1. When treating individuals who are impaired to the extent that they should not be driving, physicians should:
    a. take steps to ensure that the patient understands that he should not be driving, for his/her own safety and the safety of others,
    b. notify the Department of Motor Vehicles (DMV) of the need for a medical review of this individual's case, which may result in the suspension or revocation of the patient's driving privileges, and
    c. take steps to ensure that family members understand that the patient is a risk to himself/herself and others if they persist in driving, if divulging such information is possible and permissible under the law.

2. State and local law enforcement officers, upon observing a driver who is or has been operating a vehicle while medically impaired, should report the driver to the DMV for medical review. While the officer may wish to give a driver the benefit of the doubt, believing that their impairment is temporary and/or minor, some conditions cannot be assessed accurately without full knowledge and consideration of the driver's medical background. This is the purpose of the medical review process.

3. The DMV should continue to stress the importance of identifying and reporting impaired or medically unfit drivers for medical review.
    a. Public campaigns could target caregivers and family members, focusing on the well being of the at-risk driver as well as others he or she may harm, and making the reporting process as easy and accessible as possible.
    b. Specifically targeted efforts should be focused on physicians, social workers, and other health care personnel.
    c. Quick and simple tools for identification of drivers who may be medically impaired should be included in continuing education and training for local and state law enforcement officers.

4. The United States Department of Transportation should consider adopting Federal Motor Vehicle Safety Standard 223 and 224 for straight trucks and busses. If effects are consistent with the implementation of these standards in 1998, injuries and fatalities resulting from underride crashes could be reduced significantly.

5. The Virginia Department of Transportation (VDOT) should conduct a speed study on this section of roadway to determine if a lower reduced speed is warranted, since the current reduction from 60 to 55 mph may not be significant enough to slow drivers.

6. VDOT should improve markings and signage on this roadway:
    a. The eastbound lane has a "55 MPH" speed limit sign on the right shoulder behind the guardrail. An additional "55 MPH" sign should be erected in the grass median opposite the one on the right shoulder. The sign should be same size as the one on the right shoulder.
    b. The stop line should be remarked.
    c. Since the pavement markings on the entrance and exit of the shopping center to the primary road are in poor condition, VDOT should contact the owners of the shopping center and encourage them to install new pavement markings.

REFERENCES

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