



Virginia Commonwealth University

**Virginia
Multi-disciplinary
Crash Investigation Team**

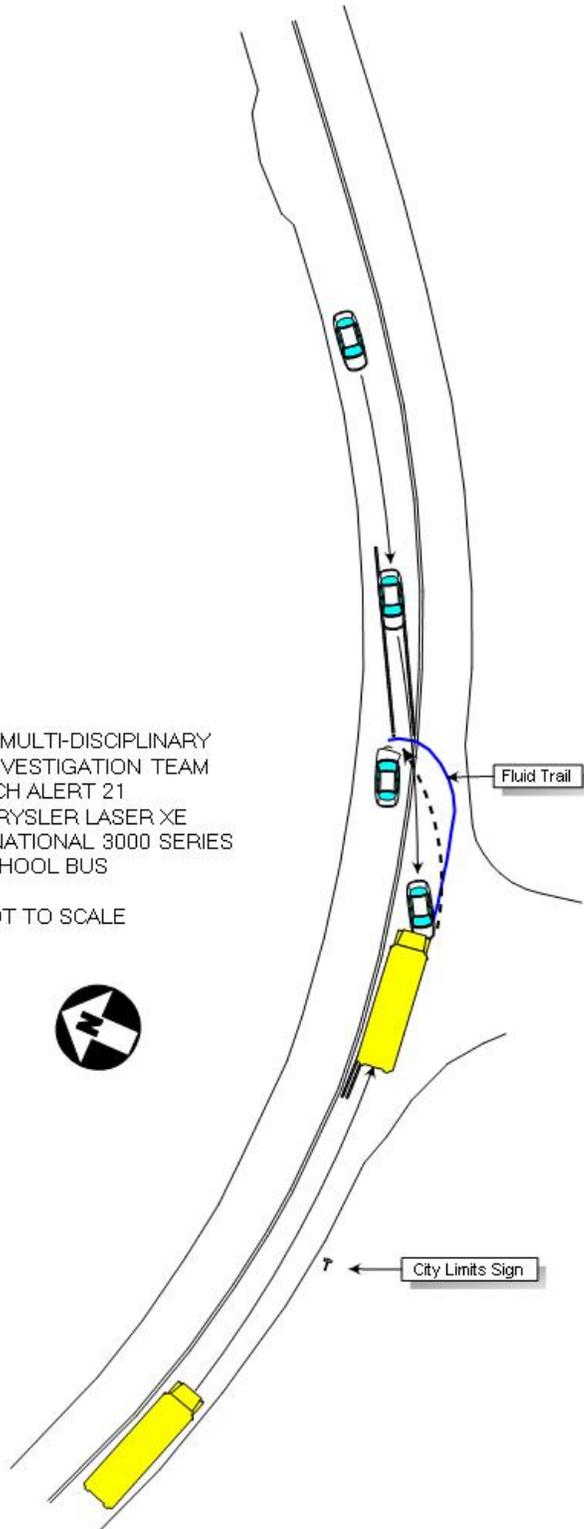
**Technical Alert: Number 21
Restraint Use In Double Fatality Head-On Collision**

Date: April, 2010

This Technical Alert describes a head on collision between a school bus and a passenger car that slid on an icy road into the opposing travel lane. The unbelted 45 year old male driver and the unbelted 11 year old female in the front seat died as a result of being thrown forward into the dash and windshield. The 8 year old female passenger in the rear seat was restrained by a lap belt and suffered minor injuries. As a result of compartmentalization for the passengers and belt use by the bus driver, no one on the school bus was seriously injured.

At 7:40 on a sunny, clear Monday morning in winter, a 45 year old man was driving his daughters to school. The two girls attended schools in different locations, and he was taking the oldest, an 11 year old sitting in the right front passenger seat, to her school first. He had only 20 minutes to travel approximately 7.5 miles further during the morning commute and may have been late in getting her to her first class on time. The 8 year old was seated behind the driver on the bench seat of the 1985 Chrysler Laser XE. She wore the lap belt that was installed on this older model vehicle, a front wheel drive, two-door hatchback (the corporate sister car to the Dodge Daytona). It is equipped with two front bucket style seats with a lap/shoulder combination restraint device and a bench style rear seat with a lap restraint. This model year was not equipped with any airbag systems or any additional, modern safety features.

VIRGINIA MULTI-DISCIPLINARY
CRASH INVESTIGATION TEAM
TECH ALERT 21
1985 CHRYSLER LASER XE
1992 INTERNATIONAL 3000 SERIES
SCHOOL BUS
NOT TO SCALE



The Chrysler operator's driving history revealed that he had a valid driver's license with a Class M endorsement, meaning he was authorized to drive motorcycles as well as passenger vehicles. He had renewed his license four months prior to the crash and had no convictions or accidents listed, resulting in the maximum safety point balance of +5. According to toxicology tests performed later, he was not under the influence of alcohol at the time of the crash.

The Chrysler travelled south on a two lane north-south secondary route located in a mixed residential/business area. It is asphalt and in good condition. The northbound lane is approximately 12 feet wide and the southbound lane is approximately 14 feet wide at the crash site. The grass shoulders are approximately 2 feet wide. The southbound lane curves approximately 6 degrees to the right and has a downgrade of approximately 4 percent at the location of the crash.

The road is controlled by pavement markings and signs. The lanes are separated by double solid yellow pavement markings, which are in fair condition. There are no edge line markings. The speed limit is 35 miles per hour (MPH). There is a horizontal alignment sign with a 25 MPH advisory speed plaque northbound in advance of the curve. Southbound, approaching the curve and prior to the crash site, there is a horizontal alignment sign; however, there is no advisory speed plaque. (The addition of the appropriate advisory speed plaque below this horizontal alignment sign is recommended.) There is one overhead light in the curve of the northbound lane.

The annual average daily traffic volume (AADT) is 5000 vehicles (Virginia Department of Transportation, 2008). There had been a light fog the previous night and moisture rising from a nearby creek had condensed and frozen into icy glaze patches on this section of roadway.

While the Chrysler was travelling south, a 1992 International 3000 Series school bus was headed north on the same road, approaching the curve. A 41 year old female, wearing her lap/shoulder belt, operated the school bus. Although the bus was capable of transporting up to 64 passengers, there were only 12 children—all middle school students—seated in the bench seats throughout the interior. This school bus was considered to have a “conventional layout”, since the engine compartment extended beyond the front of the occupant area.

The bus driver had been licensed to drive in the Commonwealth since 2005, after surrendering her license from another state. She had been issued a commercial driver's license (CDL) learner's permit in January 2009. In March, she was granted a Class B CDL with P and S endorsements, meaning that she was authorized to drive passenger and school buses. She had no restrictions to her license and was not physically impaired at the time of the crash. School authorities reported that the required post-crash toxicology tests showed she was not under the influence of drugs or alcohol. Her driving history revealed that she had no prior convictions or crashes, and her safety point balance was +3, the maximum she could have earned during the time she had been licensed in Virginia.

The school bus entered the curve from one end as the Chrysler was entering the opposite end, going downhill. The Chrysler driver applied his brakes and began to slip on the patch of ice, leaving two skid marks angling across the southbound travel lanes. These marks were light, given the roadway conditions. The skid mark from the right side of the Chrysler began approximately 3.8 feet east of the edge of the southbound travel lane. It measured approximately 45.3 feet in length, and ended approximately 8.4 feet east of the edge of the southbound travel lane. The skid mark from the left side of the Chrysler started approximately 17 feet south of the right side skid mark and approximately 4.2 feet west of the double solid yellow lines. The skid mark measured approximately 28.9 feet in length and was no longer discernable at the double solid yellow lines. The car at this point crossed the double solid yellow lines, into the travel path of the school bus. The driver of the school bus applied her brakes, leaving four skid marks (two dual tire marks) in the northbound travel lane, roughly parallel to the double solid yellow center lines. The skid marks from the left side rear dual tires of the bus started approximately 1.4 feet east of the center lines and measured approximately 37.9 feet in length. The right side dual tire skid marks were much shorter, at approximately 15.3 feet in length and were located approximately 9 feet east of the double solid yellow lines.

While the bus driver was applying her brakes, the vehicles collided with the right front corner of the Chrysler leading into the front center of the bus. The car underrode the front bumper of the bus, pushing the Chrysler bumper and engine compartment

downward onto the roadway, creating numerous scratches and gouge marks. The Chrysler continued underriding the bus, the car's hood crumpling upward and rearward. The entire front of the Chrysler engaged the school bus and sustained severe contact damage. The car's engine compartment was pushed rearward toward the passenger compartment area, but did not intrude onto the occupant space. The school bus sustained contact damage to the front bumper, which was pushed rearward and slightly under the bus. The right front spring hanger was broken and dislodged from its original position by the collision.

After reaching maximum engagement, the Chrysler was pushed rearward and began to rotate as it separated from the school bus. This separation left a fluid trail in the northbound lane that extended approximately 32 feet north of the area of impact and curving into the southbound lane. The Chrysler came to final rest facing north in the southbound lane with the front end of the vehicle approximately 48.9 feet north of the area of impact and the left tires approximately 5 feet east of the right edge of the southbound lane. The school bus came to final rest under its own power in the northbound travel lane, 4.7 feet east of the double solid yellow lines. The front of the school bus stopped approximately 14 feet north of the area of impact, with the mid-section of the bus stationary over the point of impact.

Damage to both vehicles was focused to their fronts, with the Chrysler sustaining the most severe damage. The overall length of a standard 1985 Chrysler XE is 14.6 feet. Post crash, the left side of this vehicle measured 13.9 feet in length and the right side measured 12.1 feet in length. The school bus received much less severe damage. The overall length of a standard 1992 International 3000 Series school bus is 35 feet. Post crash, the left side of the bus measured 34.9 feet and the right side measured 34.4 feet in length. The majority of the damage to the school bus was focused to the center of the bumper and grill and the undercarriage.

Of the three Chrysler occupants, only the child seated on the bench seat behind the driver was restrained. This 8 year old wore the lap belt that was installed standard in this older model car. When the car collided with the front end of the bus, this child initially continued travelling forward (with respect to her position in the car). However, her belt kept her in her seat and limited the extent of her movement. Her head and arms

struck the back of the front seat and she suffered only minor injuries: a black eye, some bumps and bruises. Both the driver and the 11 year old front seat passenger also continued their forward movement upon the initial impact. However, with nothing to hold them in place, they continued the motion while the car abruptly stopped and reversed direction. This vehicle was not equipped with airbags. The driver struck the steering wheel and dash area, then proceeded to strike the windshield with his head. He died at the scene from blunt force trauma to his head and chest. The middle school child also struck the dash and then the windshield, the latter with enough force to push her entire head through the shattering glass, inches from the right “A” pillar. As the vehicles disengaged, she was thrown back into the vehicle, causing additional neck injuries, and landed with her body in the floor and her head positioned in the console area of the front seat. This child was still alive when emergency crews arrived, but she died after being transported to a nearby medical center. Her cause of death was listed as blunt force trauma to head, chest, abdomen and extremities.

The Code of Virginia requires children under the age of 8 years to be restrained in a child restraint and that all children under the age of 16 “shall wear the appropriate safety belt system at all times while the motor vehicle is in motion on any public highway.” (Code of Virginia §46.2-1095). Research conducted on nationwide samples shows a negative correlation between safety restraint use and the age of child passengers—the older a child is, the less likely he or she will be properly restrained in a vehicle (Decina, Lococo & Block, 2005). Consistent with the decreased restraint use, child traffic fatalities nationwide tend to increase with age (National Highway Traffic Safety Administration, 2008). In Virginia, observational studies have reported that belt use in children between 8 and 12 years old—“tweens”—has ranged between 35% (Will, Dunaway, Lorek, Kokorelis & Sabo, 2010) and 66% (Kokorelis, Lazenka, Sabo, Lorek, & Will, 2008). These rates are much lower than the 82.27% belt use reported for all Virginia vehicle occupants (Porter, Martinez, Dozier & Braitman, 2009). Will et al. (2008) also report that belt use for this age group varies substantially across demographic groups.

The Code also addresses seating position of child passengers, but only if they are infants in rear facing child safety seats. These tiny children are required to be placed in a

rear seat, if available, to avoid exposure to a deploying airbag in the event of a crash (§46.2-1095). The National Highway Traffic Safety Administration (NHTSA) and other proponents of highway safety recommend that all children ride in the back seats for as long as possible, wherever possible, because it is generally the safest location for a motor vehicle occupant. They stress, however, that it is very important for children under age 13 to stay in the back seats, to avoid exposing their developing bodies to deploying airbags and to provide greater protection from crash forces in frontal collisions. Despite these recommendations, “tweens” show a decided preference for sitting in the front seat of a vehicle. One study noted that 73% of “tweens” were observed riding in the front seat, closer to the driver, when they were the only other vehicle occupant (Durbin, Chen, Elliott & Winston, 2006).

Focus group research has revealed that these children in transition from early childhood to teenager perceive riding in the back seat as something for “little kids” or babies (Will, Dunaway, Sabo, Kokorelis & Lorek, 2008). Their reasons for not wearing belts range from forgetting to buckle up, especially when not reminded, to having some fears that belts are likely to cause injury during a crash (Will, et al., 2008). Even though children are susceptible to peer influences at this age, parental influences are still very strong (Jennings, Mercer & Mitchell, 2006). Since these youngsters are just starting to develop their own safety habits, it is critical that parents actively educate and encourage them to act in self-preserving ways. This includes stressing that the rear seats are the safest place for all youngsters, not just the little ones, and that everyone in the vehicle should wear safety restraints, for their own sake as well as for that of the other occupants. The Code of Virginia (§46.2-1094) requires that drivers and any front seat passengers be restrained while the vehicle is in motion (a secondary seat belt law). Parents, caregivers, and other adults should act as good role models by consistently practicing what they are teaching and by complying with the law—they too should always buckle up before starting a trip. Children learn as much from observing how adults act as they do from listening to what adults say, and consistent restraint use will keep everyone safer. Any loss that could have been prevented by using safety restraints simply adds to the anguish suffered by those who care about the victims of a crash.

Occupants on the bus were also affected by the force of the collision. The belted driver remained in her seat and did not strike any other interior components of the bus. Although she did not express any discomfort while still in the presence of the students on the bus, she reported feeling stiff and sore later. She went to a medical facility so that routine toxicological tests could be conducted, where she was also checked for injury and released. The 12 children on the bus were seated when the crash occurred. Compartmentalization designed into the occupant space performed as expected. As the children slid forward while the bus was abruptly stopping, their knees, then chests and heads struck the padded backs of the seats in front of them. These seat backs deformed, flexing to absorb more of the energy being transferred during the collision. Four of the students reported bumps and bruises but did not want to go to the medical center. The other eight reported no injuries. These real-life crash results are consistent with crashworthiness testing of buses, and validate the finding that school buses are one of the safest forms of transportation in the United States. According to a NHTSA report to Congress, students in the U.S. are “nearly eight times safer riding in a school bus than riding with their parents and guardians in cars.” (Hinch, McCray, Prasad, Sullivan, Wilke, Hott & Elias, 2002). Their research indicates that adding lap belts to buses may actually increase neck injuries and that the addition of lap/shoulder restraints may result in unintended injuries if the restraints do not fit properly or if they are misused.

As soon as her vehicle stopped moving, the bus driver immediately called the transportation office on her two-way radio to report the crash. She remained on the bus with her charges. Staff at the school system notified police and emergency agencies, as well as the principal and school system officials. An off-duty paramedic either witnessed the crash or came upon it immediately afterward. He checked the driver and front seat passenger in the Chrysler, then removed the back seat passenger from the car. He placed the 8 year old on the school bus, in the front seat, where the driver could watch her and keep her safe. Returning to the Chrysler, he stayed with the front seat passenger until emergency crews arrived. He left without leaving his name with investigators.

Fire, rescue and police personnel arrived on the scene within ten minutes of the first reports of the crash. Paramedics assessed the victims in the car and began working to stabilize and move the front seat passenger. Others went onto the bus to check the

children and the driver. Once the child from the Chrysler was identified, she was removed and transported to the local medical center for evaluation and treatment. Her mother was located and went to the hospital to check on both her daughters, learning that only one had survived. The Chrysler driver's parents were also notified of the deaths.

School officials took additional action upon learning of the crash. Other bus drivers in the area were quickly notified of a problem and asked to pick up the remainder of the students (about 21 in all) waiting to be transported to the school. These stops were identified based on the bus driver's normal route. The Assistant Superintendent and Director of Transportation for the school system, as well as the middle school Principal, all went to the scene. A second bus was dispatched to collect and transport the children from the crashed bus to their school. School officials asked that the body of the Chrysler driver not be extricated until the children had been moved from the area, and they kept the children on the first bus until the second had arrived. The buses and school personnel were situated so that the students' view—and their visibility as well—was shielded as they changed vehicles. This kept them from seeing the wreckage of the Chrysler and from being photographed by members of the press. All students' parents were notified as well.

Local police closed the road in both directions and managed traffic at the scene. They also called Virginia State Police (VSP) to assist their investigators in the reconstruction of the crash. Members of the Divisional Reconstruction Team responded and began photographing and gathering physical evidence. After the children had been moved, employees from a funeral home extricated the body from the Chrysler and transported it to their facility. There, the local Medical Examiner performed a "view" type examination and took samples of blood for toxicological analysis. Once wreckers had moved the bus and car, city personnel swept the area of debris and treated the road to prevent additional problems with the icy spot. State Police and local law enforcement investigators completed their evidence collection and the road was reopened just under seven hours after the crash occurred.

The local school system had a protocol for assessing the roads during inclement weather, which they implemented the day of this crash. This protocol included multiple school system employees riding roads throughout the county and checking surface

temperatures and road conditions. Others monitored the weather and kept in contact with the Virginia Department of Transportation and the VSP, if necessary. School officials conferred at about 5:00 a.m. and, based on information about conditions at that time, they decided not to delay school openings. Local police told members of the Virginia Multi-disciplinary Crash Investigation Team that one other spot—one very close to this crash site—had reports of icy conditions that were hazardous for driving. A single vehicle crash had occurred there just moments prior to this fatal crash and another crash also occurred nearby that morning. The only other crash reported in the same time frame was on another side of the city. The weather was cold, but it was dry and clear. It appears that the icy conditions in this confined area were mainly due to the freezing of the vapor rising from the creek, an isolated roadway issue.

This effects of this crash reverberated within the local community. School officials worked to provide psychological support to those immediately affected: members of the deceased child's family (including her surviving sister), the bus driver, and children who had been on the bus, as well as those who had known the child who died. Additionally, they and the local police provided relevant information to the media, although school administration members expressed concern that the media sensationalized the crash, causing the family additional grief. While the Chrysler driver had no reason to suspect the icy conditions and while neither he nor the bus driver had much opportunity to avert the collision, the tragedy of this crash is that the severity could have been much lower. The Chrysler driver would probably have suffered serious injuries but may have survived the collision if he had been restrained. Furthermore, his 11 year old daughter is very likely to have received only minor to moderate injuries if she had been wearing her lap/shoulder belt, and especially if she had been restrained in the rear seat with her sister. This crash reinforces the need to protect child passengers—no matter what their age—by requiring that they use age-appropriate restraints and ride in the rear seats as much as possible.

Video clips of sled tests showing occupant kinematics related to compartmentalization and restraint use can be found at the following links:

[Side by Side Comparison of Lap Belted and Unbelted Occupants](#)

[Typical Compartmentalization Test](#)

[Typical Lap Belt Test](#)

[Typical Lap/Shoulder Belt System Test](#)

All clips are from the National Highway Traffic Safety Administration.

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