ABSTRACT

A Nissan Sentra was exiting an interstate highway during misty conditions. The vehicle was traveling too fast for conditions and began to slide off the curving ramp. The vehicle rotated and skidded off the left side of the road, striking several trees. The right front door struck one tree directly, causing significant intrusion into the occupant space and killing one passenger, an infant in a rear-facing child safety seat. The 30 year old driver suffered serious injuries and a child restrained in a high back booster in the rear seat had non life-threatening injuries. The vehicle was destroyed.

This crash reinforces the fact that children are safest when restrained in the rear seat of a vehicle and demonstrates the potential for tragic consequences when failing to comply with state laws on placement of infant passengers. The crash also demonstrates the value of restraining an older child in a booster seat. In addition, this report identifies the value of photographing and documenting evidence at the scene, as well as corroborating physical evidence in the vehicle with injury patterns on victims to determine their placement in the vehicle.
SYNOPSIS

Day, Time, Season: Wednesday, 7:45 p.m., winter

Road/Weather: Wet, misty

Vehicles Involved: 1986 Nissan Sentra 2 door sedan

Summary: Sedan ran off the road to the left and struck trees

Severity: One fatality, one serious injury, one non life-threatening injury, and extensive property damage

Probable Cause: Driver was traveling too fast for conditions. Improper location of infant and driver’s lack of belt use contributed to severity of outcome.

Significant Points: Exceeding safe speeds during inclement weather, placement of child safety seats, investigation and determination of restraint use during crashes, speed estimates in lateral collisions.
CRASH DESCRIPTION

On a misty Wednesday evening in winter, a 30 year old male was driving south on an interstate highway in a 1986 Nissan Sentra two door sedan. He was accompanied by two children: his six year old son seated directly behind him on the rear bench seat and his four month old son, seated in the front passenger bucket seat. The six year old was restrained in a high back booster seat with a lap belt, the only type of belt restraint available in the vehicle’s back seat. The infant was restrained in a 5 point harness in a rear-facing infant seat. The driver was not restrained.

The road is a major north-south interstate route located in a rural area. The southbound road consists of three 12 foot lanes and a 12 foot wide deceleration lane that is approximately 950 feet long, prior to an exit ramp to westbound lanes of the primary road. The pavement on the ramp is concrete and is 16 feet wide with a 30 inch asphalt shoulder on the left and a 6 foot asphalt shoulder on the right. The ramp, which is bordered by trees on both sides, curves to the right at approximately 6 degrees and is approximately 1018 feet long. The concrete pavement is in good condition. The road is controlled by pavement markings and signs which are in good condition. There is no overhead lighting. The ramp has an advisory speed limit of 45 miles per hour (MPH).

The driver merged right onto the exit ramp leading to the west bound lanes of a primary highway. As the vehicle exited the interstate and approached the curve, it began sliding on the wet roadway. The Nissan also began to rotate counter-clockwise as it approached the edge of the pavement. At some point, the driver began to brake. The car entered a grassy area adjacent to the road and began furrowing the ground as it slid approximately 40 feet toward a drop-off lined with trees. It went over the embankment and the right side struck several trees, with the majority of the damage to the passenger side door. One of the trees intruded into the passenger compartment 36 inches.

As the tree intruded into the vehicle, it pushed the door and window into the left side of the infant’s seat. Shattering glass caused “dicing” injuries, most obviously to his left hand, although the baby also had scratches on the left side of his head and some cuts to his right hand. The child’s body was impacted by the side of the child safety seat and the intruding door, causing multiple skull fractures, as well as fractures to his spine (causing transection of the upper
spinal cord) and ribs. The child safety seat was pushed towards the driver’s side of the vehicle. As the Nissan’s frame wrapped around the tree, the driver’s compartment was deformed. After being struck by the infant seat, the unbelted driver struck the steering wheel and then was pinned in his seat. He reportedly suffered injuries to his ribs, pelvis and legs. The six year old restrained in a booster seat behind the driver remained in his occupant space; his injuries were not life-threatening.

Photo #1: View looking southwest, the direction the Nissan was traveling. The arrow points to a small cross which denotes the area of the sedan’s final rest.

Other drivers who came upon the crash called for emergency help. The investigating trooper and fire and emergency medical personnel arrived shortly thereafter. They closed the ramp and the appropriate Virginia Department of Transportation (VDOT) contractor was called to assist with traffic management. Members of the State Police Divisional Reconstruction Team were dispatched to assist in the investigation. Emergency crews worked to extricate the driver, and then he was airlifted to a trauma center about 15 miles from the crash site. His 6 year old
son was transported via ambulance to the same hospital. The infant had died in the initial collision, so dispatchers contacted the Office of the Chief Medical Examiner (OCME). A Medical Examiner advised those on scene to remove the body and transport it to the OCME for examination. The investigating trooper went to the hospital and notified the driver’s wife of her son’s death. He then returned to the scene. The car was towed and investigators completed their evidence collection, opening the ramp to traffic approximately four hours after the crash occurred.
REMARKS

Virginia Multi-disciplinary Crash Investigation Team (VMCIT) members learned of this crash through media coverage the next day. After hearing conflicting information regarding the seating location and restraint use for the children, the Team decided to pursue a deeper investigation.

The 1986 Nissan Sentra had two prior owners and was purchased by the last owner about 17 months prior to the crash. The driver, however, did not own the vehicle. The CARFAX report showed that it had an odometer reading of 237,286 miles. At the time of the crash, it had 242,472 miles on the odometer, meaning that it appears to have been driven about 5186 miles since the purchase in another part of the state. This mileage change is lower than is typical. Despite the vehicle being 23 years old and having high overall mileage, it was in relatively good condition when inspected by members of the VMCIT. The vehicle had a recent and valid Virginia State Inspection sticker. The tires appeared to be new with excellent tread and the brakes showed no adverse wear. Because of the age of the vehicle, it was not equipped with anti-lock brakes. Anti-lock brakes may have been useful in this type of crash, allowing the driver to have some steering even with the brakes fully depressed.

Contact damage to the vehicle was focused primarily on the passenger’s side, including the door area, the passenger’s side roof, and front fender area. Damage intrusion into the vehicle at the deepest point was measured at approximately 36 inches. Induced damage was present throughout the remainder of the vehicle. The collision deformed the entire vehicle around the trees contacted. The interior of the vehicle reflects the severity of this impact. Both the driver’s and passenger’s seats were dislodged from their original positions and pushed toward the left side of the vehicle. The roof was pushed downward and inward from the passenger’s side of the vehicle towards the driver’s side. The rear seat passenger compartment showed less intrusion on the right side of the vehicle and the left side showed little to no damage or intrusion.

The speed of the vehicle exiting the interstate was believed to play a major role in this crash. Determining the speed of a vehicle in a motor vehicle crash can be challenging and should be conducted with rigorous attention to detail. In this crash, there were several factors limiting the ability to make a speed determination with great accuracy. The first of these factors was the lack of skid marks, yaw marks, or other tire marks in the roadway. The weather conditions at that time (wet roadway, misty cold weather) caused less friction between the tires
and the roadway. Less friction results in less heat build-up and the tires do not mark the roadway. The first indication of tire markings was when the vehicle left the roadway and the tires began furrowing in the grassy shoulder.

Obtaining an accurate coefficient of friction or drag factor is another important factor in speed calculations. Due to the traffic conditions, roadway geometrics and changing, wet weather at this location, replicating conditions to conduct skid tests using an accelerometer or “known speed” approach was difficult and potentially dangerous. Instead of conducting site tests, a range of drag factors for the grass shoulder was developed using test data from an outside source. That testing was conducted over several types of grass surface to include long damp grass and mowed grass, both with and without ABS activated. The range for drag factor was .355 to .497. (Frost and Kwasnsoki, 2002) When the drag factor information was applied in a standard slide over a known distance formula, a speed loss of between 20 and 24 MPH over the grass surface was calculated.

Photo #2: Side view of the Nissan, showing impact damage to the door and roof.
The ability to accurately calculate speed loss from crush damage is limited in this case due the fact that more than one tree was impacted. The first tree struck was actually uprooted and carried forward with the vehicle as it made contact with other trees. The amount of energy expended during that process is indeterminate. With this knowledge, making calculations using stationary impact equations could lead to inaccurate conclusions. Accident investigators and reconstructionists should be cautious assigning speeds to crashes in which data cannot be adequately measured, and they should note any such limitations, as well as stating any assumptions they used in their calculations, when presenting their findings. It is appropriate and necessary to refrain from making a determination when the evidence is not sufficient to support the calculations. While the vehicle in this crash is likely to have been at least traveling too fast for the road conditions (based on the extreme amount of vehicle rotation and intrusion), the VMCIT was not able to determine an accurate speed estimate prior to crash.

Contact information for the 30 year old driver was not made available to the VMCIT, so members were unable to interview him. He had a valid Virginia driver’s license that listed his address as the same the address for the owner of the Nissan, a city almost 200 miles away from the crash site. However, the address he reported to the investigating officer for the FR300P (Police Crash Report form) was in the same geographic area as the crash. His experience driving the Nissan and his familiarity with the roadway are unknown. His driving history showed no previous crashes, but he had been convicted of speeding 15-19 miles above the speed limit about 3 years earlier in a neighboring county. He did not have any restrictions on his license and his driver point balance was +1. Although no toxicology tests were conducted, he was not deemed to have been impaired in any way prior to the crash. He was not charged with any offenses as a result of this crash.

Restraint use was an issue in this crash. A high priority in the safety field is to encourage people to always use restraints when riding in vehicles. With children under the age of eight, this means using child safety seats. The next priority is to have children correctly restrained in child safety seats, which is a more complex task. The correct seat type and size must be used, based on the child’s height, weight and age. Then the seat must be installed correctly in the vehicle. Finally, the child must be restrained in the seat correctly. This may include ensuring that the harness straps are adjusted to the correct length and sufficiently snug, and that all the harness straps are buckled or otherwise fastened, and that the chest clip, if present, is correctly positioned and secured. In recent years, the VMCIT has investigated several other crashes in
which failure to restrain children and improper use of child restraints have resulted in more serious injury and death (see VMCIT Special Report No. 20: Child Safety Restraint Study, 2006; VMCIT Report Number 203: Two Single Vehicle Crashes –Multiple Fatalities, 2008; Tech Alert No. 16: Infant Seat/Airbag and Cell Phone, 2007).

The four month old infant killed in this crash was restrained within a rear-facing infant seat. This device, which could be used with or without a base, was installed without the base in the front bucket seat of the Nissan, using the vehicle’s lap/shoulder belt. The Code of Virginia requires that rear-facing infant seats be installed in the rear seats of a vehicle. The only exception the Code allows is in the case of vehicles that have no rear seat and then only after any airbag systems had been deactivated. The Nissan, a 1986 model, did not have an airbag system, but the car did have a rear bench seat, which was the required location and would have been safer for the baby.

Initial reports indicated that the child was in a rear-facing seat that had been incorrectly installed forward-facing in the front passenger seat. Because the seat had been pushed toward the driver’s occupant space, investigators thought it may not have been properly installed. However, members of the VMCIT were able to meet with the Medical Examiner assigned to the case, view photographs and discuss injury patterns to the infant. He had “dicing” injuries mainly to his left hand and scratches on the left side of his face. “Dicing” injuries are small cuts caused by glass as it shatters and they are usually seen on exposed areas of the body closest to the point of impact. If the baby had been forward-facing, these injuries would have been most prevalent on the right side of his body. They were, however, consistent with the child being in the rear-facing position in the front seat. Later in the investigation, VMCIT members obtained photographs of the crash scene, including the vehicle before the child’s body was removed. Through these pictures, the positioning of the infant seat, the lack of seat base, the routing of the seat belt path and the child’s position post-crash were confirmed.

In addition to the improper seat location, the Graco Snug Ride seat itself was a concern. The Graco seat label specifies that it is designed for children up to 26 inches long and 20 pounds. This infant was 23 inches long and 18 pounds, so it would appear that the seat was still a good fit for him. However, when he was diapered and dressed, the baby’s head extended about two inches above the seat back, meaning that his sitting height was longer than the 17.5 inches from seat bight (where bottom of the seat meets the lowest part of the seat back) to top. While it is acceptable for the back of a forward-facing seat to be as low as the top of the child’s ears, the
back of rear-facing infant seats should always be taller than the top of the child’s head. In the rear-facing position, during a frontal collision, a child will continue to move forward as the harness and seat belts stretch and the seat may tip slightly. Having a higher seat back provides support and additional protection to the infant’s head. If it is too low, that protection is gone and the top of the seat may actually act as an injury mechanism. In addition to the fit issue, the seat was older. The bottom of the seat was stamped with the message “DO NOT use this car seat after DECEMBER 2007”. The harness straps were frayed, showing signs of wear. Although they had been appropriately moved to the top position on the seat back, the shoulder straps were folded, providing less surface area for dispersing energy forces during an impact. The harness restrained the child fully within the seat, however, and bruise patterns consistent with the belt path were indicative of the severe forces exerted on the baby’s body.

The infant suffered skull fractures and transection of the spine during impact. These injuries were not the result of any failure of the child safety seat. They were directly related to his location inside the vehicle. As the Nissan slid into the trees, they pushed the door into the child’s occupant space. The deforming door struck the side of the seat, transferring much of the energy load to the child, causing instantaneous death. Any person seated in that position would likely have died as a result of this crash.

Initial reports, including the FR-300P report filed in this case, indicated that the six year old boy in the rear seat was restrained with a lap/shoulder belt, which would have been in violation of Code of Virginia requirements. However, some individuals at the scene reported seeing a high back booster in the rear seat behind the driver’s seat after the crash. A vehicle examination revealed that only lap belts were available in the rear seating positions, which is consistent with manufacturing requirements for this older sedan, and it is likely the boy was wearing it while sitting in the booster. The booster seat raises the child up in the seat, keeping the lap belt low on his pelvic area and making it less likely that it would ride up onto his abdomen. Because no shoulder strap was available, this child would have had free upper body movement during the crash, causing his body to be jerked to the right during impact. However, because he was seated behind the driver, he had more unobstructed space to flail and recover during the crash sequence. If he had not worn any belt, he would have been thrown to the right side of the vehicle and bounced around the interior, if not ejected. His lower level of injury (reported as non-life threatening and mild to moderate) is consistent with his being retrained.
When members of the VMCIT examined the crash site and surrounding area, they found no evidence of roadway defects. This exit ramp is located on a heavily traveled interstate bypass. According to the Virginia Department of Transportation 2007 booklet *AVERAGE DAILY TRAFFIC VOLUMES with VEHICLE CLASSIFICATION DATA on INTERSTATE, ARTERIAL AND PRIMARY ROUTES*, the annual average daily traffic volume on this section of interstate highway is 17,000 vehicles per day.

In the most recent data available for three years prior to this fatal crash, five other crashes have been reported on or near the ramp. All five involved vehicles running off the road and striking fixed objects. This included one crash (reported as a rear end collision on the FR-300) in which a car ran off the road and struck a tractor and trailer that was parked on the right shoulder. The remaining four struck trees: two ran off the road to the right (one was coded as a head on collision on the FR-300), while the other two ran off the road to the left, similar to the dynamics of this crash. None of these crashes were alcohol related, although two of the at-fault drivers had either a medical condition or were under the influence of medication that contributed to the crash. Speed was indicated as a factor in all five crashes, mainly exceeding the maximum safe speed rather than the posted speed limit. Three of these crashes resulted in injuries to a total of seven people (five of whom were restrained); two resulted in property damage only.

Exit and entrance ramps on highways are known for having a higher propensity for crashes (McCartt, Northrup & Retting, 2004), partly because they are transition areas from high speed to lower speed roadways and involve curving paths. The tightness of the curve may vary throughout the length of the ramp. Unfamiliar or inattentive drivers who do not follow posted advisory speeds may suddenly find that they are traveling too fast for conditions, causing the vehicle to leave the travel portion of the roadway. As part of its continuing roadway improvement process, VDOT personnel review fatal crash reports to determine if they can take any measures to enhance safety. About four months later, after reviewing the data on this crash, VDOT installed delineators along the left side of the roadway, to help provide visual cues to drivers about the curvature as they transition from the interstate to the primary roadway. Such guidance is especially helpful in dark conditions and inclement weather where there is little other reflective marking, apart from the pavement edge lines.
As noted earlier, members of the VCMCIT discovered errors during the in-depth investigation of this case. The mistakes were not only in early reporting for this case, but in two of the five FR-300 reports of other crashes at the same location. Good investigation skills and accurate reporting of crash information is critical to improving safety at the local, state and national levels. Errors in such basic issues as differentiating run-off the road/fixed object crashes from collisions between two moving vehicles can have significant impact on safety efforts, especially if they are pervasive within a records management system. They may result in problems as basic as identifying high risk locations, as well as large scale analysis of changing trends nationwide. Inaccurate data may affect law enforcement, roadway improvement, and public education efforts. In order to be optimally effective, it is imperative that the data entering any system be consistently coded and as accurate as possible. Valid data is the only way to make valid assessments which may then be used to develop effective safety measures. The ultimate purpose is to reduce crashes and save lives.
In summary, this crash was the result of a driver traveling at speeds too fast for conditions, losing control of his vehicle and striking trees after running off the road. The severity of the consequences was increased due to the improper location of the restrained infant in the front seat and the driver’s lack of seat belt use. While weather and road conditions played a role in the crash, the roadway itself was not defective. However, the positive guidance (delineators) added later to this ramp may assist other drivers in better assessing and adapting to the curvature, hopefully preventing other tragedies.
RECOMMENDATIONS

1. Child safety seat use continues to factor into child passenger deaths in the Commonwealth, as highlighted in Special Report Number 20: Child Safety Restraint Study, Report Number 198: Aggressive Drivers in Merging Lanes—Triple Fatality, Report Number 200: Five Fatality Alcohol-Related Collision and Technical Alert 16: Infant Seat/Airbag and Cell Phone. The Department of Motor Vehicles (DMV), the Department of State Police (VSP), and other state and local agencies should continue to focus on education and enforcement in this area.
   a. Beyond stressing the importance of using restraints in general, these groups should continue to emphasize correct selection and installation of seats, including making sure the individual child fits properly in the seat, that seats are not outdated, and that rear-facing seats are always placed in rear seats, when available.
   b. Law enforcement agencies should work to ensure that their officers are knowledgeable about the different types of child safety seats and their installation and use, both from a public safety and a law enforcement standpoint. Because so many officers observe children being transported in motor vehicles and investigate crashes, it is important that they be able to identify when appropriate restraints are correctly used and when they are not.

2. While patrolling, law enforcement officers should maintain vigilance with regard to unrestrained children being transported in violation of the Code of Virginia (§46.2-1095 and §46.2-1100). Heightened enforcement of child safety seat laws will increase the likelihood that those transporting children will properly restrain them, resulting ultimately in fewer injuries and innocent lives lost.

3. DMV, VSP, driver’s education teachers and public media campaigns should continue to stress the importance of paying attention to posted advisory speeds and to driving conditions and for drivers to adjust their speeds during inclement weather.
4. VSP, DMV, VDOT and local law enforcement agencies should continue to improve training in crash investigation and reporting, stressing the critical importance of accuracy. While law enforcement personnel bring an essential and unique perspective to their investigations, the fact that the data are used for additional purposes cannot be discounted. In addition to investigator training, supervisors should continue to carefully review these reports for consistency and accuracy. Where possible, other users of the reports should attempt to assess their internal reliability by cross referencing coded information with crash diagrams and descriptions.
REFERENCES


Virginia Department of Transportation (2007) AVERAGE DAILY TRAFFIC VOLUMES with VEHICLE CLASSIFICATION DATA on INTERSTATE, ARTERIAL AND PRIMARY ROUTES.


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