TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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VERIDIAN REMOTE AIR BAG RELATED CHILD FATALITY INVESTIGATION SCI TECHNICAL SUMMARY REPORT

VERIDIAN CASE NO. CA00-051

SUBJECT VEHICLE - 1994 PLYMOUTH VOYAGER

LOCATION - STATE OF KENTUCKY

CRASH DATE - DECEMBER 1999

Contract No. DTNH22-94-D-07058

Prepared for:

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National Highway Traffic Safety Administration
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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. *Abstract* This remote investigation focused on a 1994 Plymouth Voyager equipped with frontal air bags for the driver and front right passenger positions that deployed as a result of a frontal collision with the right side of the power unit of a tractor, semi-trailer. The Voyager was occupied by a 31-year-old female driver and an 8-year-old male front right child passenger. The driver of the Voyager stated that both occupants were restrained by the manual 3-point lap and shoulder belts, however restraint usage could not be confirmed. The 8-year-old child may have been seated forward on the front right seat cushion and was displaced forward from pre-crash braking. At impact, both occupants initiated forward trajectories. The driver probably contacted the deployed driver's air bag and the police reported that she did not sustain injury. The out-of-position child was projected vertically into the windshield by the expansion of the air bag. It is possible that he may have altered the deployment of the air bag into the windshield. He sustained closed head injuries and multiple cervical spine fractures. He was transported by ambulance to a local hospital and transferred by helicopter to a regional children's hospital. He expired the day following the crash.			
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BACKGROUND

This remote investigation focused on a 1994 Plymouth Voyager **(Figure 1)** equipped with frontal air bags for the driver and front right passenger positions that deployed as a result of a frontal collision with the right side of the power unit of a tractor, semi-trailer. The Voyager was occupied by a 31-year-old female driver and an 8-year-old male front right child passenger. The driver of the Voyager stated that both occupants were restrained by the manual 3-point lap and shoulder belts, however restraint usage could not be confirmed. The 8-year-old child may have been seated forward on the front right seat cushion and was displaced forward from pre-crash braking. At impact, both occupants initiated forward trajectories. The driver probably contacted the deployed driver's air bag and the police reported that she did not sustain injury. The out-of-position child was projected vertically into the windshield by the expansion of the air bag. It is possible that he may have altered the deployment of the air bag into the windshield. He sustained closed head injuries and multiple cervical spine fractures. He was transported by ambulance to a local hospital and transferred by helicopter to a regional children's hospital. He expired the day following the crash.

Figure 1. 1994 Plymouth Voyager

This crash was identified through a search of the Fatality Analysis Reporting System (FARS) for child fatalities that occurred in vehicles equipped with air bags. The crash occurred in December 1999 and was assigned to the Veridian Special Crash Investigations Team on November 3, 2000 as a remote investigation effort. A police report, police photographs, EMS ambulance report and a coroner's report were obtained, which provided the basis for this narrative report.

SUMMARY

Crash Site

This crash occurred in the daytime hours at an off-set five-leg intersection of two undivided state highways and a local roadway. At the time of the crash, it was clear with no adverse conditions as the asphalt road surface was dry. The north and south legs consisted of a north/south two-lane state highway. The north west leg consisted of a two-lane east/west state highway. The south west leg was a single-lane westbound roadway. The east leg was a two-lane local roadway divided by a raised concrete median. Each leg of the intersection was bordered by painted white parking spaces and concrete curbs. The roadside environment consisted of commercial properties. Traffic control at the intersection consisted of painted left and right turn

arrows from the north/south roadway to and from the north west leg. Flashing red traffic signals were present for each leg except the one-way single lane roadway. The police scene schematic is attached as Figure 9 at the end of this report.

Pre-Crash

The 1994 Plymouth Voyager was southbound on the north leg of the intersection **(Figure 2)**. The driver stopped at the flashing red traffic signal and proceeded into the intersection. The driver of the Voyager stated that she was distracted and had turned her head to look for something in the vehicle. The tractor, semi-trailer was northbound on the south leg of the intersection **(Figure 3)**. The truck driver stopped at the flashing red traffic signal and initiated a left turn onto the one-way westbound roadway across the Voyager's path of travel. As the Voyager continued across the intersection, the driver realized the impending harmful event. According to the police report, she could not remember if she had applied the brakes or pressed the accelerator pedal, but it was likely that she applied the brakes. There did not appear to be any pre-impact skid marks within the Voyager's trajectory.

Figure 2. Southbound approach for the Voyager

Figure 3. Northbound approach for the truck

Crash

As the Plymouth Voyager traveled through the intersection, the front right area impacted the right leading drive axle of the power unit of the tractor, semi-trailer. Impact resulted in moderate damage to the Voyager and minimal damage to the tractor. The Voyager was redirected rearward in a slight clockwise (CW) rotation as the truck continued forward. The resultant direction of force was in the 11 o'clock sector for the Voyager. The barrier routine of the WinSMASH program calculated a barrier equivalent speed of 22.1 km/h (13.7 mph) based on an estimated crush profile of the Voyager. The longitudinal and latitudinal components were -19.1 km/h (-11.9 mph) and 11.0 km/h (6.9 mph), respectively. A gouge mark and a tire mark within the trajectory of the right front wheel of the Voyager were noted at the point of impact in the police photographs **(Figure 4)**.

Figure 4. Westbound view of the point of impact with the gouge mark and tire mark visible

Post-Crash

It was not known how the driver of the Voyager exited the vehicle. The police reported that she did not sustain injury. The 8-year-old male child passenger was found in the vehicle in the front right position by the first responding police officer. It was not known how he was removed from the vehicle, although rescue personnel found him lying on the roadway next to the vehicle. He was treated at the scene by rescue

personnel and transported by ambulance to a local hospital. Upon arrival at the hospital he went into cardiac arrest and was resuscitated. He was transferred by helicopter to a regional children's hospital where he expired the following day. The Plymouth Voyager was towed from the scene. The tractor, semi-trailer was not damaged and was driven from the scene.

***VEHICLE DATA* - 1994 Plymouth Voyager**

The 1994 Plymouth Voyager was identified by the Vehicle Identification Number (VIN): 2P4GH2536RR (production sequence omitted). The Plymouth minivan was equipped with front wheel drive, automatic transmission, and a 3.0 liter V-6 engine. At the time of the police vehicle inspection, the odometer read 163,606 km (101,244 miles). The seating was configured with front bucket seats with integrated head restraints. Both the driver's and the front right passenger's seat track positions appeared to be near the full-forward positions. The second and third rows were configured with a two-person bench seat and three-person bench seat, respectively. Each bench seat was equipped with a folding back. The front seating positions were equipped with manual 3-point lap and shoulder belt systems with adjustable D-rings. Each outboard bench seat position was also equipped with manual 3-point lap and shoulder belts. The center position in the third row was equipped with a lap belt.

VEHICLE DAMAGE

Exterior Damage - *1994 Plymouth Voyager*

The 1994 Plymouth Voyager sustained moderate damage as a result of the impact with the truck **(Figure 5)**. The front plastic bumper fascia was completely separated from the vehicle, and was fractured laterally in the center and fractured vertically approximately 46 cm (18") to the right of the centerline on the top aspect. Multiple abrasions were also noted on the right corner of the front bumper fascia. The bumper beam was fractured approximately 46 cm (18") to the right of the centerline, and the portion to the right of the fracture was completely separated. The lower radiator support was crushed rearward behind the bumper beam approximately 10 cm (4") on the front left and center aspects. The upper radiator support and radiator core were both crushed rearward. The maximum crush was estimated to be 25 cm (10") and located at C5, approximately 46 cm (18") to the right of the centerline **(Figure 6)**. The hood was displaced to the right approximately 30 cm (12"), and buckled at the designated fold points. The right front fender was crushed rearward against the right front wheel and was displaced to the right. It appeared that the right front wheel was restricted in the police photographs. The right headlamp assembly was fractured and displaced. The Collision Deformation Classification (CDC) for this impact was 11-

Figure 5. Lateral view of frontal damage

Figure 6. Frontal damage showing maximum crush

FREW-2. Six crush measurements were estimated at the level of the lower radiator support and were as follows: C1 = 5 cm (2"), C2 = 10 cm (4"), C3 = 15 cm (6"), C4 = 20 cm (8"), C5 = 25 cm (10"), C6 = 20 cm (8").

The police vehicle inspection indicated that the post-crash overall length was shortened by 46 cm (18"), and the wheelbase was shortened by 18 cm (7").

Interior Damage - ***1994 Plymouth Voyager***

Interior damage to the 1994 Plymouth Voyager appeared to be moderate and was attributed to occupant contact. The windshield glazing was fractured in a spider-web fashion directly above the front right passenger's air bag module **(Figure 7)**. The rearview mirror was separated from the windshield. The cargo drawer under the front right passenger's seat was displaced forward from impact forces. There did not appear to be any occupant contact to the instrument panel area.

Figure 7. Interior view showing windshield damage

AIR BAG SYSTEM - 1994 Plymouth Voyager

The 1994 Plymouth Voyager was equipped with frontal air bags for the driver and front right passenger positions that deployed as a result of the impact with the truck **(Figure 8)**. The driver's air bag was housed in the center of the steering wheel with H-configuration module cover flaps.

Figure 8. Frontal air bag system in the Voyager

The front right passenger's air bag deployed from a top mounted module located in the right upper-instrument panel with a single cover flap design hinged at the forward aspect. The cover flap was rectangular in shape. Blood was identified on the front left aspect of the air bag in the police photographs.

OCCUPANT DEMOGRAPHICS - 1994 Plymouth Voyager

Driver

Age/Sex:	31-year-old female
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Appeared to be near full forward in police photographs
Manual Restraint Use:	Probably unrestrained
Usage Source:	Police report
Eyewear:	Unknown
Type of Medical Treatment:	Not injured and did not receive any medical treatment

Driver Kinematics

The 31-year-old female driver of the Plymouth Voyager may have been out-of-position prior to the crash from looking around the interior of the vehicle for an unspecified object. The seat track was presumed to have been adjusted to near the full forward position, based on the police photographs. The police report does not indicate restraint usage, but it is likely that the driver was unrestrained. She probably assumed an upright posture prior to the impact when she realized the impending crash, and probably attempted to brace. At impact, the frontal air bag system deployed and she initiated a forward trajectory. She probably contacted the deployed driver's air bag which offered protection from the frontal crash forces. She did not sustain injury, and did not receive medical treatment.

Front Right Child Passenger

Age/Sex:	8-year-old male
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Appeared to be near full forward in police photographs
Manual Restraint Use:	Unrestrained
Usage Source:	Injury data
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a local hospital and transferred by helicopter to a regional children's medical center where he expired the day following the crash.

Front Right Child Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Possible Injury Mechanisms
Closed head injury, NFS	Unknown (115999.7,0)	Windshield glazing, indirect - front right passenger's air bag
Multiple cervical spine fractures, NFS	Moderate (650216.2,6)	Indirect - front right passenger's air bag

Injury source: Coroner's report

Front Right Child Passenger Kinematics

The 8-year-old male child was presumed to have been seated in an upright posture in the front right position. The seat track appeared to be near the full forward position in the police photographs. It was unknown if he was seated with his back against the seat back or if he was forward to allow his lower legs to clear the edge of the seat cushion. The length of the seat cushion and short femur length of an average child this age probably necessitated a more comfortable forward position in the seat with the upper body more upright. He was not restrained by the available 3-point manual lap and shoulder belt. Probable pre-crash braking caused the child to initiate a forward trajectory into the path of the front right passenger's air

bag. Due to the lack of detailed injury data, an accurate reconstruction of the child's kinematics could not be made. There were no soft tissue injuries identified in any of the official reports. The child's head injuries could have been related to direct contact with the windshield, although there were no hair or tissue transfers noted in the fractured glazing. Alternatively, not knowing the child's height or weight, the child may have altered the deployment of the air bag into the windshield.

The child passenger was placed out-of-position forward over the deployment path of the air bag due to pre-crash braking. At impact, the frontal air bag system deployed. The expansion of the air bag accelerated the child's forehead into the windshield, as evidenced by the spider-web type fracture in the glazing. The child may have received the closed head injury from the windshield strike as a result of the vertical air bag expansion. The spider-web fracture in the glazing appears consistent with a head strike, even though there was no hair or tissue transfers identified in the fractured windshield. It was not known what type of clothing the child was wearing, or if he may have been wearing a hat, which may have mitigated any transfers. As the air bag continued to expand against the child, his head was deflected rearward which hyper-extended the neck resulting in numerous cervical spine fractures. He probably rebounded rearward into the seat back and came to rest in the seat.

The 8-year-old was found in the front right seat by the first responding officer. It was not known how he exited the vehicle, although rescue personnel reported finding the child on the roadway next to the vehicle. The child was treated at the scene by rescue personnel and transported by ambulance to a local hospital. According to the EMS report, the child went into cardiac arrest upon arrival at the hospital. He was resuscitated and transferred by helicopter to a regional children's hospital where he expired the following day.

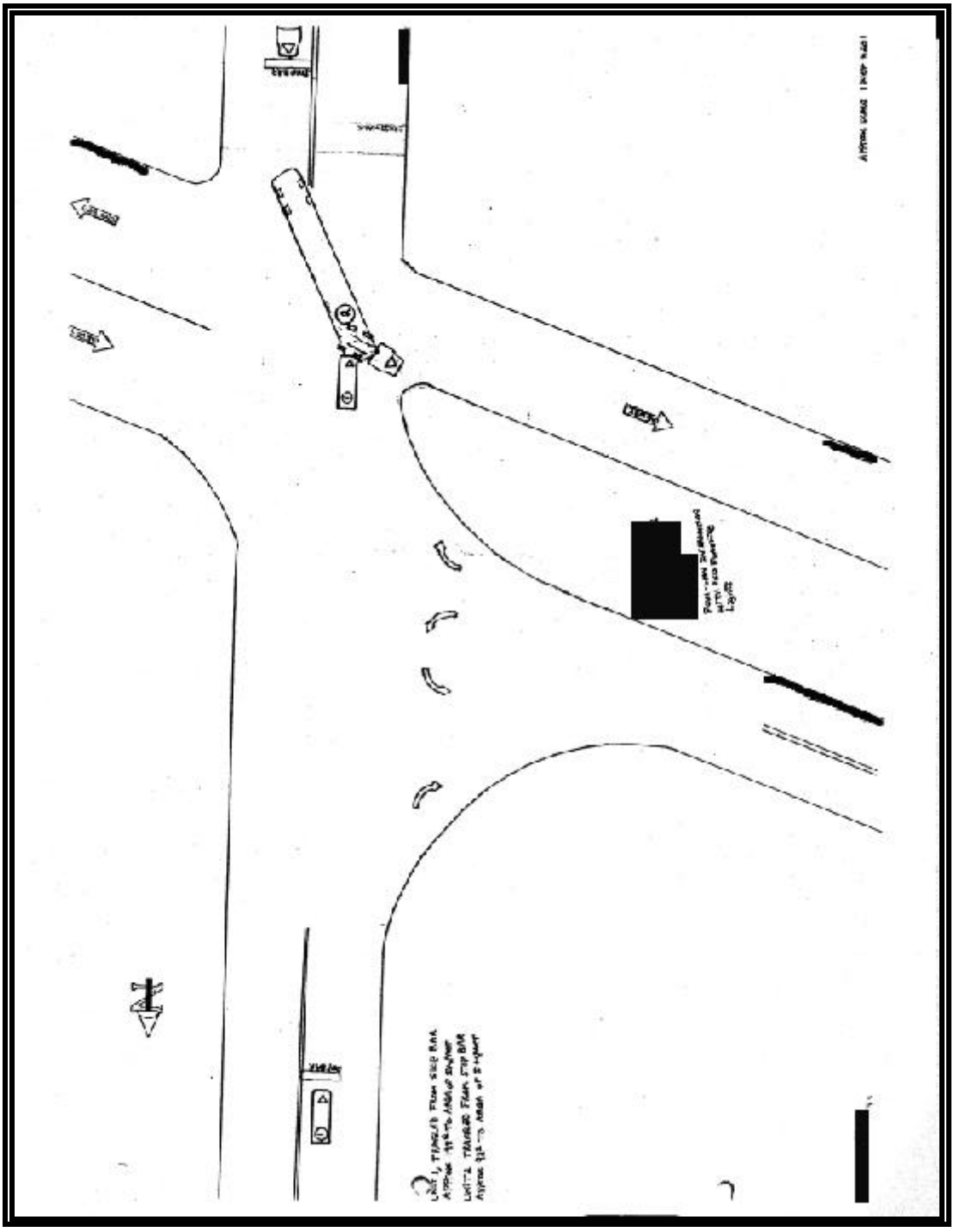

Figure 9. Police schematic