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ON-SITE AIR BAG INVESTIGATION

CASE NUMBER - IN01-016
LOCATION - TENNESSEE
VEHICLE - 1995 DODGE NEON
CRASH DATE - May, 2001

Submitted:

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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 be 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.

Technical Report Documentation Page

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16. <i>Abstract</i> This report covers an on-site investigation of an air bag deployment crash that involved a 1995 Dodge Neon (case vehicle) and a 1989 Plymouth Voyager LE (other vehicle). This crash is of special interest because the case vehicle's front right, child passenger (18-month-old male), who was restrained in a forward facing child safety seat (FFCSS) that was not secured by the available safety belt system, sustained a fatal head decapitation by the front right passenger air bag module's cover flap and air bag. The case vehicle was traveling east, negotiating a gentle right-hand curve, in the eastbound lane of a two-lane, undivided, U.S. highway. The Plymouth was also traveling east, ahead of the case vehicle, in the same eastbound lane of the two-lane, undivided, U.S. highway and had slowed to a stop because another eastbound, noncontact vehicle ahead of it was making a right turn into a private driveway. The crash occurred in the eastbound lane of the roadway. The front of the case vehicle impacted the back of the Plymouth, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle came to rest just past the impact point while the Plymouth moved forward, and the driver subsequently pulled off the roadway onto the south shoulder. The case vehicle's front right passenger was seated in a forward facing child safety seat and the front right seat track was located in its middle position. He was restrained in the child seat, but the child seat was not secured by the available, active, three-point, lap-and-shoulder, safety belt system. He sustained, according to the case vehicle's driver and the police investigation, a fatal decapitation injury, a large laceration to the back of his head, and abrasions to his chin and neck. This occupant's decapitation injury was caused by his contact with the front right passenger air bag module's cover flap and air bag. The driver (19-year-old female) was seated with her seat track located between its middle and forward-most positions, and the case vehicle was not equipped with a tilt steering wheel. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to her interview and the Police Crash Report, a minor contusion and laceration to her lower lip from her deploying air bag.			
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TABLE OF CONTENTS

IN01-016

Page No.

BACKGROUND 1

SUMMARY 1

CRASH CIRCUMSTANCES 5

CASE VEHICLE: 1995 DODGE NEON 6

 CASE VEHICLE DAMAGE 7

 AUTOMATIC RESTRAINT SYSTEM 9

 CHILD SAFETY SEAT 11

 CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS 12

 CASE VEHICLE FRONT RIGHT PASSENGER INJURIES 13

 CASE VEHICLE DRIVER KINEMATICS 14

 CASE VEHICLE DRIVER INJURIES 14

OTHER VEHICLE: 1989 PLYMOUTH VOYAGER LE 15

CRASH DIAGRAM 16

SELECTED PHOTOGRAPHS

 Figure 1: Westerly view from beyond final rest showing case vehicle’s and
 Plymouth easterly travel path in right-hand curve 5

 Figure 2: On-scene view looking east at case vehicle’s pre-crash skid marks
 and final rest position 5

 Figure 3: Case vehicle’s minor frontal damage from underride impact 6

 Figure 4: Damage to Plymouth’s back bumper 6

 Figure 5: On-scene view of case vehicle’s front right seating area 6

 Figure 6: Reference line view from left showing case vehicle’s frontal
 deformation 6

 Figure 7: Close-up of direct contact damage to case vehicle’s hood latch
 and radiator support 7

 Figure 8: Elevated vertical view from right showing damage to case vehi-
 cle’s headlight housing and hood latch 7

 Figure 9: Vertical view of case vehicle’s front right passenger seating area
 showing deployed air bag and contact evidence 8

SELECTED PHOTOGRAPHS (Continued)		<u>Page No.</u>
Figure 10:	Close-up of hair and blood evidence on case vehicle’s windshield glazing and front header	8
Figure 11:	Case vehicle’s front right greenhouse area showing contact evidence windshield’s glazing and header and front right sun visor	8
Figure 12:	Blood evidence on case vehicle’s back left and driver’s seats	8
Figure 13:	Close-up of blood from head contact on case vehicle’s seat backs and left rear side panel and window glazing	9
Figure 14:	On-scene close-up of case vehicle’s front right seat cushion where front right passenger’s head came to rest	9
Figure 15:	Case vehicle’s deployed driver air bag showing contact evidence . .	10
Figure 16:	Deformation to and contact evidence on cover flap of case vehicle’s front right air bag module	10
Figure 17:	Close-up of dark skin transfer on top surface of case vehicle’s deployed front right passenger air bag	10
Figure 18:	Frontal view of Fischer/Price convertible child safety seat used by case vehicle’s front right passenger	11
Figure 19:	Close-up of Fischer/Price child seat’s plastic shell used by case vehicle’s front right passenger	11
Figure 20:	Back view of Fischer/Price child safety seat showing blood evidence and seat’s damaged brace	12
Figure 21:	Close-up of brace displacement on Fischer/Price child safety seat used by case vehicle’s front right passenger	12
Figure 22:	Case vehicle’s front seating area showing child safety seat’s pre-impact position	12
Figure 23:	Case vehicle’s front right seating area showing approximation of child seat’s position at deployment	13

This on-site investigation was brought to NHTSA's attention on May 31, 2001 by an investigator with the National Transportation Safety Board. This crash involved a 1995 Dodge Neon (case vehicle) and a 1989 Plymouth Voyager LE (other vehicle). The crash occurred in May, 2001, at 1:45 p.m., in Tennessee and was investigated by the applicable police department. This crash is of special interest because the case vehicle's front right, child passenger [18-month-old, Black (non-Hispanic) male], who was restrained in a forward facing child safety seat (FFCSS) that was not secured by the available safety belt system, sustained a fatal head decapitation by the front right passenger air bag module's cover flap and air bag. This contractor inspected the scene and vehicles on 4-5 June, 2001. This contractor interviewed the driver for the case vehicle on July 3, 2001. This report is based on the Police Crash Report, interviews with the case vehicle's driver and the investigating police officer, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling east, negotiating a gentle right-hand curve, in the eastbound lane of a two-lane, undivided, U.S. highway and intended to continue eastward. The Plymouth was also traveling east, ahead of the case vehicle, in the same eastbound lane of the two-lane, undivided, U.S. highway and had slowed to a stop because another eastbound, noncontact vehicle ahead of it was making a right turn into a private driveway. The case vehicle's driver was momentarily distracted by her front right, child passenger and did not observe that the Plymouth ahead had come to a stop. Upon recognition of the stopped vehicle, the case vehicle's driver locked-up her brakes, depositing 16.5 meters (54.2 feet) of skid marks from both front tires, while attempting to avoid the crash. The crash occurred in the eastbound lane of the roadway; see **CRASH DIAGRAM** below.

The front of the case vehicle impacted the back of the Plymouth, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The damage on the case vehicle was primarily above the bumper resulting in an uneven damage (i.e., underride impact) pattern. The underride type damage resulted in the air bag deploying late during the duration of the impact. This late deployment occurred due to the prolonged change in time (Delta T) relative to the change in speed (magnitude of Delta V—i.e., ramp versus spike). The case vehicle came to rest just past the impact point while the Plymouth moved forward, and the driver subsequently pulled off the roadway onto the south shoulder.

The 1995 Dodge Neon was a front wheel drive, two-door coupe (VIN: 1B3ES42C2SD-----). The case vehicle was not equipped with anti-lock brakes. Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDEW-1 (0)**. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The preliminary Total, Longitudinal, and Lateral Delta Vs are, respectively: 14.0 km.p.h. (8.7 m.p.h.), -14.0 km.p.h. (-8.7 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). Because of the underride type impact configuration, these results should be considered suspect; although, they seem reasonable. The case vehicle was towed due to damage.

The case vehicle's initial contact with the Plymouth involved the entire front. Direct damage began 50 centimeters (19.7 inches) left of center (towards the driver's side) and extended rightward, a measured distance of 109 centimeters (42.9 inches). Because of the underride-type impact, the direct damage extended rearward on the hood approximately 10 centimeters (3.9 inches). Residual maximum crush was measured as 2 centimeters (0.8 inches) at C₁ and C₆ on the bumper and 7 centimeters (2.8 inches) uniformly above the bumper. The wheelbase on the case vehicle's left (driver's side) was shortened approximately 1 centimeter (0.4 inches) while the right side was extended 1 centimeter (0.4 inches). The case vehicle's grille was knocked out and the hood was folded slightly rearward. There was direct damage to the top of the front bumper fascia and to the hood, grille, radiator support, hood latch, and left turn signal assembly. None of the case vehicle's tires were damaged, deflated, or physically restricted. Both the right and left headlight and the right turn signal assemblies sustained induced damage as well as both the right and left portions of the front bumper. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior.

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps and the air bag fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flap. The driver's air bag was designed with four tethers, each 6 centimeters (2.4 inches) wide, and located at the 1, 5, 7, and 11 o'clock positions. The driver's air bag had one vent port, approximately 2 centimeters (0.8 inches) in diameter, located at the 12 o'clock position. The deployed driver's air bag was round with diameter 62 centimeters (24.4 inches). An inspection of the driver's air bag fabric revealed a 9 x 7 centimeter (3.5 x 2.8 inch) area of dark area of skin and oil transfer on the upper right portion of the circular center stitching. In addition, there were scattered blood splatters on the fabric with the majority of the spots aligned along a line between the center of the air bag and the 5 o'clock position.

The front right passenger's air bag was located in the top of the instrument panel. An inspection of the front right air bag module's cover flap and the air bag's fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag. However, the front right air bag module's cover flap was deformed from contact with the front right child passenger's chin and neck, and there appeared to be dried saliva residue and skin on the module's cover flap. The module's cover flap, in association with the air bag's fabric which followed, decapitated the front right child passenger's head. The front right passenger's air bag was designed with four tethers, each 7.5 centimeters (3.0 inches) wide. The front right air bag had one vent port, approximately 5 centimeters (2.0 inches) in diameter, located at the 12 o'clock position. The deployed front right air bag was rectangular with a height of approximately 57 centimeters (22.4 inches) and a width of approximately 47 centimeters (18.5 inches). An inspection of the front right air bag's front surface revealed a large area of blood with skin from the center of the air bag toward the 10:30 o'clock area and smaller areas of blood at the 7 o'clock area and toward the 12 o'clock area. Furthermore, there was a very large area [32 x 12 centimeters (12.6 x 4.7 inches)] of blood with skin on the air bag's left side surface. In addition, there was a large area of skin deposited [8 centimeters wide by over 20 centimeters long (3.1 x 7.9 inches)] on the top surface of the air bag, beginning just to the left and below the vent port and running forward and down onto the air bag's front surface.

The inspection of the case vehicle's interior revealed a spider web impact to the right windshield's glazing, with embedded hair fibers from contact by the front right passenger's decapitated head. Hair fibers were also found on the front right header area and on the front right sun visor. Blood contact evidence was found on the left side of the back seat's seat back and on the driver's seat back. These bloody areas are believed to have been directly contacted by the front right passenger's head as it travel backward after rebounding on the right windshield's glazing. Furthermore, blood splatter was found on the roof, approximately over the driver's seat back, and on the left rear side panel and window's glazing. In addition, there was a large bloody area on the inward side of the front right seat and center console. This is the area where the front right passenger's head came to rest. According to the case vehicle's driver, the right front door glazing was disintegrated by rescue personnel who were attempting to get to the front right passenger. Finally, there was no evidence of intrusion to the case vehicle's interior, no evidence of compression to the energy absorbing sheer capsules in the steering column, and no deformation to the steering wheel rim.

The child safety seat used by the case vehicle's front right passenger was a convertible seat manufactured by Fischer-Price Products in 1984 and was identified by Model number 9100. The seat was equipped with a three-point harness with "T"-shield. The seat was designed with two different shoulder height levels (i.e., slots) that the harness webbing could be adjusted through (i.e., dependent on height and size of child). In addition, the seat was designed with a retractor for the three-point harness and "T"-shield. The child seat was designed with only one slot between the child's legs for buckling the "T"-shield/harness portion. A close inspection of the front right passenger's forward facing child safety seat showed visible evidence of stress to one of the metal reinforcement braces but nothing to the plastic shell of the seat itself.

The 1989 Plymouth Voyager LE was a front wheel drive, three-door minivan (VIN: 2P4FH5534KR-----). Based on the vehicle inspection, the CDC for the Plymouth was determined to be: **06-BDLW-1 (180)** [maximum crush was 1 centimeter (0.4 inches)]. The WinSMASH reconstruction program, damage only algorithm, was used on the Plymouth's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 10.0 km.p.h. (6.2 m.p.h.), +10.0 km.p.h. (+6.2 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The Plymouth was driven from the scene.

Immediately prior to the crash the case vehicle's front right passenger [79 centimeters and 14.5 kilograms (31 inches, 32 pounds)] was seated in a reclined posture with his back against the forward facing child safety seat's back and his feet dangling over the front edge of the seat's cushion. In addition, the exact location of his hands is unknown but just before the driver recognized the impending collision, the child had been touching the driver's (i.e., mother's) right hand. The front right seat track was located in its middle position, and the seat back was slightly reclined.

The case vehicle's front right passenger was restrained in a forward facing child safety seat, but the child seat was not secured by the available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the nonuse of the available safety belts to secure the forward facing child safety seat, the child safety seat with the restrained child occupant tipped forward just prior to impact. The case vehicle's impact with the Plymouth enabled the case vehicle's front right passenger and forward facing child safety seat to continue forward and slightly upward (i.e., pitch) toward the 0 degree Direction of Principal Force as the case vehicle decelerated. As a result and in conjunction with the seat track's location, the child's head was immediately in front of or atop the front right air bag module's cover flap at the instant of deployment. The deploying cover flap contacted the child's right lower cheek and chin, hyper extending the head backwards. As the cover flap continued to expand upwards, followed by the deploying air bag, the front right passenger's head was severed from his torso by the cover flap while his torso remained restrained in the forward facing child safety seat. The expanding cover flap and air bag propelled his head forward, with his scalp leading, into the windshield's glazing. Because of the short term resistance provided by the child seat and the occupant's torso, as the air bag continued to expand the air bag's fabric was directed upwards as the course of least resistance. As a consequence the child's head was lifted upwards, driving the back of his head upwards into the sun visor and front right portion of the windshield's header. The combination of the kinetic energy from the air bag's expansion and the elasticity of the windshield's glazing and front header, resulted in the front right passenger's head being redirected backward toward the back left interior of the vehicle. The front right passenger's head contacted the back left seat's seat back prior to rebounding forward where it contacted the inside upper right corner of the driver's seat back, prior to coming to rest near the inward portion of the front right seat's cushion on the center floor-mounted console. The deploying air bag knocked the free-floating forward facing child safety seat, along with the front right passenger's torso, backwards into the front right seat back. Based on witness statements, the unsecured forward facing child safety seat, along with the front right passenger's torso, were found lying on their left side atop the front right seat's cushion, facing forward.

The front right occupant was transported by ambulance to the county hospital's morgue after being pronounced dead at the scene. According to the case vehicle's driver and the police investigation, he sustained a fatal decapitation injury, a large laceration to the back of his head, and abrasions to his chin and neck. This occupant's decapitation injury was caused by his contact with the front right passenger air bag module's cover flap and air bag.

The case vehicle's driver [19-year-old, Black (non-Hispanic) female; 157 centimeters and 81 kilograms (62 inches, 178 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the clutch, her right foot on the brake, her left hand on the steering wheel, and her right on the transmission selector lever. Her seat track was located between its middle and forward-most positions, and the seat back was slightly reclined. The case vehicle was not equipped with a tilt steering wheel.

The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, the inspection of the case vehicle driver's seat belt webbing, "D"-ring, and latch plate showed minor evidence of loading and blood splatter on the webbing.

The driver was transported by ambulance to the hospital but signed a document refusing treatment. She sustained minor injuries and was released. According to her interview and the Police Crash Report, she sustained a contusion and a laceration to her lower lip from her deploying air bag.

CRASH CIRCUMSTANCES



Figure 1: Westerly view, looking back from beyond point of impact, showing case vehicle's and Plymouth's pre-crash travel path in "gentle" right-hand curve; Note: driveway, where noncontact vehicle turned, in lower left-hand corner of photo (case photo #01)



Figure 2: On-scene view looking east at case vehicle's pre-impact skid marks leading to final rest; Note: other vehicle at final rest on shoulder further eastward (case photo #48)

The case vehicle was traveling east, negotiating a gentle right-hand curve, in the eastbound lane of a two-lane, undivided, U.S. highway and intended to continue eastward (**Figure 1**). The Plymouth was also traveling east, ahead of the case vehicle, in the same eastbound lane of the two-lane, undivided, U.S. highway and had slowed to a stop because another eastbound, noncontact vehicle ahead of it was making a right turn into a private driveway. The case vehicle's driver was momentarily distracted by her front right, child passenger and did not observe that the Plymouth ahead had come to a stop. Upon recognition of the stopped vehicle, the case vehicle's driver locked-up her brakes, depositing 16.5 meters (54.2 feet) of skid marks from both front tires, while attempting to avoid the crash (**Figure 2**). The crash occurred in the eastbound lane of the roadway; see **CRASH DIAGRAM** below.

The U.S. highway was curved slightly to the right for eastbound traffic and level at the area of impact. The pavement was bituminous, and the width of the roadway was 7.1 meters (23.2 feet). The shoulders were improved (i.e., bituminous), with a 0.2 meter (0.5 foot) wide paved shoulder adjacent to the grassy roadside on both the north and south sides of the roadway. Pavement markings consisted of a single broken yellow centerline for both east and westbound traffic, augmented by a single solid yellow "no passing" line for eastbound traffic. In addition, solid white edge lines were present. The estimated coefficient of friction was 0.75. There were no visible traffic controls in the immediate area of the crash. The statutory speed limit was 89 km.p.h. (55 m.p.h.). No regulatory speed limit sign was posted near the crash site. At the time of the crash the light condition was daylight, the atmospheric condition was overcast, and the road pavement was dry. Traffic density was light, and the site of the crash was primarily rural undeveloped with some residential and commercial near the site of the crash. Specifically, there

was a driveway that played a key role in this crash within a short distance of the crash site.



Figure 4: Contact (taped) on Plymouth's bumper showing minimal deformation (case photo #41)

The front (**Figure 3**) of the case vehicle impacted the back (**Figure 4**) of the Plymouth, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy (**Figure 5**). The damage on the case vehicle was primarily above the bumper resulting in an uneven damage (i.e., underride impact) pattern (**Figure 6**). The underride type damage resulted in the air bag deploying late during the duration of the impact. This late deployment occurred due to the prolonged change in time (Delta T) relative to the change in speed (magnitude of Delta V-i.e., ramp versus spike). The case vehicle came to rest just past the impact point while the Plymouth moved forward, and the driver subsequently pulled off the roadway onto the south shoulder (**Figure 2** above).

CASE VEHICLE

The 1995 Dodge Neon was a front wheel drive, five-passenger, two-door coupe (VIN: 1FAFP13P9WW-----) equipped with a 2.0L, I-4 engine and a five-speed manual transmission. Braking was achieved by a power-assisted, front disc and rear drum, system. The case vehicle was not equipped with anti-lock brakes. The case vehicle's wheelbase was 264 centimeters (104.0 inches), and the odometer reading at inspection was 192,014 kilometers (119,312 miles).



Figure 3 Case vehicle's minor frontal damage from underride impact; Note: tape indicates area of direct contact (case photo #05)



Figure 5: On-scene view of case vehicle's front right seating area showing excessive blood on seat and deployed passenger air bag; Note: front right seat track was moved backward by rescue personnel (case photo #49)



Figure 6: Reference line view from left showing case vehicle's front deformation; Note: damage primarily above bumper (case photo #09)

Inspection of the vehicle's interior revealed adjustable front bucket seats with folding backs and adjustable head restraints; a non-adjustable back bench seat with separate back cushions integral head restraints for the back outboard seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the front and back outboard positions; and a two-point, lap belt system at the back center position. The front seat belt systems were not equipped with manually operated, upper anchorage adjusters for the "D"-rings. The vehicle was equipped with knee bolsters for both the driver and front right passenger, neither of which were deformed. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. Both frontal air bags deployed as a result of the case vehicle's frontal impact with the Plymouth minivan.

CASE VEHICLE DAMAGE

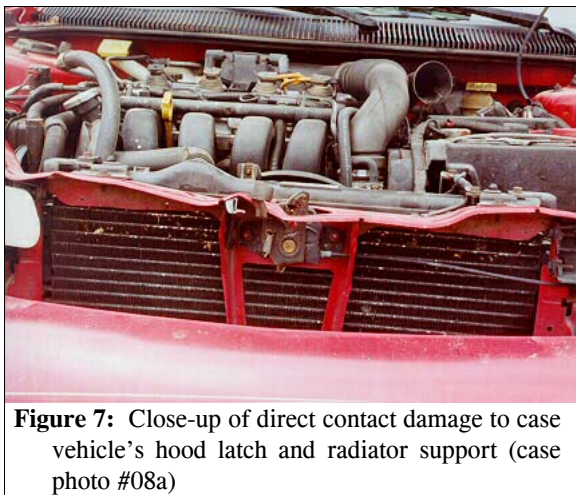


Figure 7: Close-up of direct contact damage to case vehicle's hood latch and radiator support (case photo #08a)

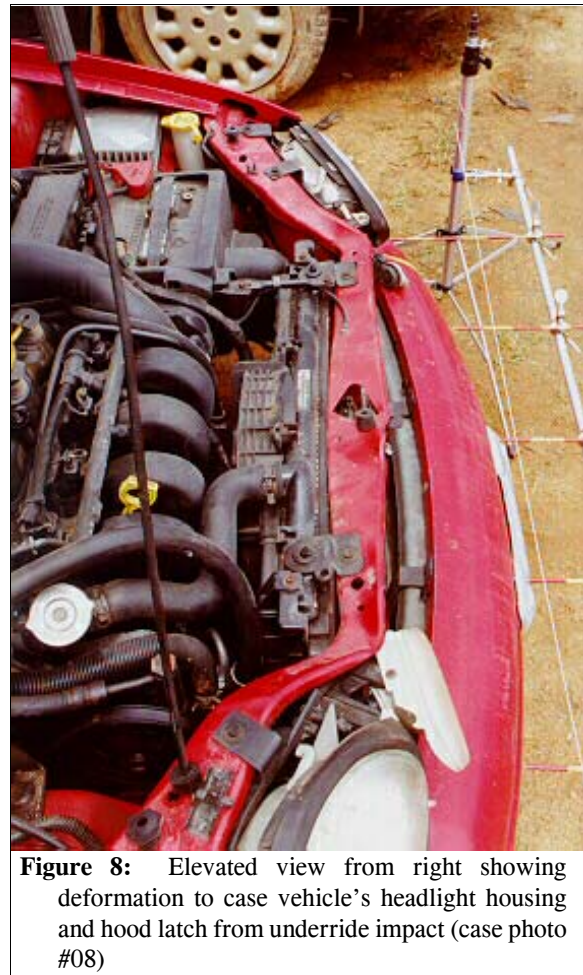


Figure 8: Elevated view from right showing deformation to case vehicle's headlight housing and hood latch from underride impact (case photo #08)

The case vehicle's initial contact with the Plymouth involved the entire front (**Figure 3** above). Direct damage began 50 centimeters (19.7 inches) left of center (towards the driver's side) and extended rightward, a measured distance of 109 centimeters (42.9 inches). Because of the underride-type impact, the direct damage extended rearward on the hood approximately 10 centimeters (3.9 inches—**Figure 3** above). Residual maximum crush was measured as 2 centimeters (0.8 inches) at C_1 and C_6 on the bumper and 7 centimeters (2.8 inches) uniformly above the bumper. The wheelbase on the case vehicle's left (driver's side) was shortened approximately 1 centimeter (0.4 inches) while the right side was extended 1 centimeter (0.4 inches). The case vehicle's grille was knocked out and the hood was folded slightly rearward. There was direct damage to the top of the front bumper fascia and to the hood, grille, radiator support, hood latch, and left turn signal assembly (**Figures 7** and **8**). None of the case vehicle's tires were damaged, deflated, or physically restricted. Both the right and left headlight and the

right turn signal assemblies sustained induced damage as well as both the right and left portions of the front bumper. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior.



Figure 9: Vertical view of case vehicle's front right passenger seating area showing bloody air bag and contacts to windshield's glazing and windshield's header (case photo #31)



Figure 10: Close-up of hair and blood evidence on case vehicle's windshield glazing and front header from front right passenger (case photo #26)

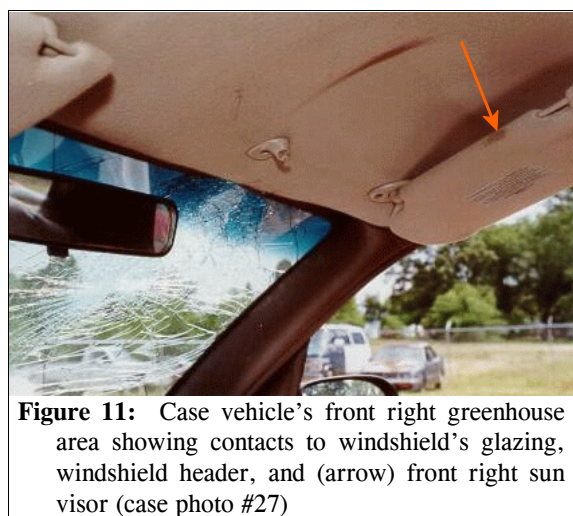


Figure 11: Case vehicle's front right greenhouse area showing contacts to windshield's glazing, windshield header, and (arrow) front right sun visor (case photo #27)

The inspection of the case vehicle's interior revealed a spider web impact to the right windshield's glazing (**Figure 9**), with embedded hair fibers from contact by the front right passenger's decapitated head. Hair fibers were also found on the front right header area (**Figure 10**) and on the front right sun visor (**Figure 11**). Blood contact evidence was found on the left side of the back seat's seat back and on the driver's seat back (**Figure 12**). These bloody areas are believed to have been directly contacted by the front right passenger's head as it travel backward after rebounding on the right windshield's glazing. Furthermore, blood splatter was found on the roof, approximately over the driver's seat back, and

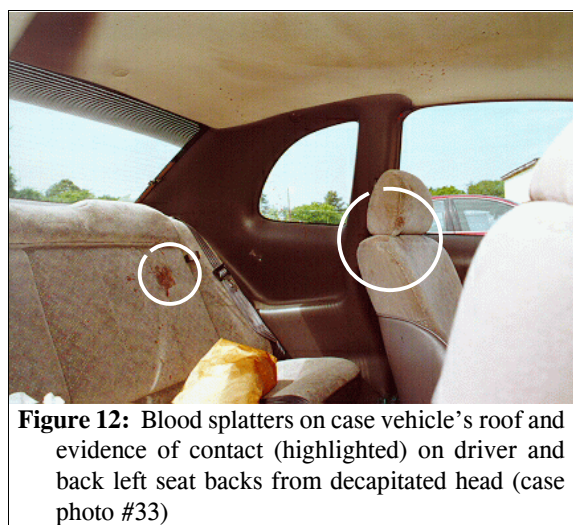


Figure 12: Blood splatters on case vehicle's roof and evidence of contact (highlighted) on driver and back left seat backs from decapitated head (case photo #33)

on the left rear side panel and window's glazing (**Figure 13**). In addition, there was a large bloody area on the inward side of the front right seat and center console. This is the area where the front right passenger's head came to rest (**Figure 14**). According to the case vehicle's driver, the right front door glazing was disintegrated by rescue personnel who were attempting to get to the front right passenger. Finally, there was no evidence of intrusion to the case vehicle's interior, no evidence of compression to the energy absorbing sheer capsules in the steering column, and no deformation to the steering wheel rim.



Figure 13: Close-up of blood from head contact on case vehicle's seat backs and blood splatters on left rear side panel and window glazing (case photo #34)



Figure 14: On-scene close-up of case vehicle's front right seat showing bloody area where front right passenger's head came to final rest on manual gear shifter; Note: torso and extremities remained in car seat on seat cushion (case photo #23)

The 1995 Dodge Neon was a front wheel drive, two-door coupe (VIN: 1B3ES42C2SD-----). The case vehicle was not equipped with anti-lock brakes. Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDEW-1 (0)**. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The preliminary Total, Longitudinal, and Lateral Delta Vs are, respectively: 14.0 km.p.h. (8.7 m.p.h.), -14.0 km.p.h. (-8.7 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). Because of the underride type impact configuration, these results should be considered suspect; although, they seem reasonable. The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. Both frontal air bags deployed as a result of the frontal impact with the Plymouth. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of a single trapezoidal cover flap made of thick vinyl with overall dimensions of 21 centimeters (8.3 inches) at the top horizontal seam, 19 centimeters (7.5 inches) at the bottom horizontal seam, and 13 centimeters (5.1 inches) vertically. An inspection of the air bag module's cover flaps and the air bag fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flap. The driver's air bag was designed with four tethers, each 6 centimeters (2.4 inches) wide, and located at the 1, 5, 7, and 11 o'clock positions. The driver's air bag had one vent port, approximately 2 centimeters (0.8 inches) in diameter, located at the 12 o'clock position. The deployed driver's air bag was round with diameter 62 centimeters (24.4

inches). An inspection of the driver's air bag fabric revealed a 9 x 7 centimeter (3.5 x 2.8 inch) area of dark area of skin and oil transfer on the upper right portion of the circular center stitching (Figure 15). In addition, there were scattered blood splatters on the fabric with the majority of the spots aligned along a line between the center of the air bag and the 5 o'clock position.

The front right passenger's air bag was located in the top of the instrument panel. There was a single, essentially rectangular, modular cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were 33 centimeters (13.0 inches) at the lower horizontal seam and 15 centimeters (5.9 inches) along both vertical seams. The profile of the case vehicle's instrument panel resulted in a 3 centimeter (1.2 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. An inspection of the front right air bag module's cover flap and the air bag's fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag. However, the front right air bag module's cover flap was deformed from contact with the front right child passenger's chin and neck, and there appeared to be dried saliva residue and skin on the module's cover flap (Figure 16). The module's cover flap, in association with the air bag's fabric which followed, decapitated the front right child passenger's head. The front right passenger's air bag was designed with four tethers, each 7.5 centimeters (3.0 inches) wide. The front right air bag had one vent port, approximately 5 centimeters (2.0 inches) in diameter, located at the 12 o'clock position. The deployed front right air bag was rectangular with a height of approximately 57 centimeters (22.4 inches) and a width of approximately 47 centimeters (18.5 inches). An inspection of the front right air bag's front surface revealed a large area of blood with skin from the center of the air bag toward the 10:30 o'clock area (Figure 9 above) and smaller areas of blood at the 7 o'clock area and toward the 12 o'clock area. Furthermore, there was a very large area [32 x 12 centimeters (12.6 x 4.7 inches)] of blood with skin on the air bag's left side surface (Figure 15 and Figure 9 above). In addition, there was a large area of skin deposited



Figure 15: Case vehicle's deployed driver air bag with contact evidence highlighted (case photo #20)



Figure 16: Deformation and contact evidence on cover flap of case vehicle's front right air bag module (case photo #32)

the air bag. However, the front right air bag module's cover flap was deformed from contact with the front right child passenger's chin and neck, and there appeared to be dried saliva residue and skin on the module's cover flap (Figure 16). The module's cover flap, in association with the air bag's fabric which followed, decapitated the front right child passenger's head. The front right passenger's air bag was designed with four tethers, each 7.5 centimeters (3.0 inches) wide. The front right air bag had one vent port, approximately 5 centimeters (2.0 inches) in diameter, located at the 12 o'clock position. The deployed front right air bag was rectangular with a height of approximately 57 centimeters (22.4 inches) and a width of approximately 47 centimeters (18.5 inches). An inspection of the front right air bag's front surface revealed a large area of blood with skin from the center of the air bag toward the 10:30 o'clock area (Figure 9 above) and smaller areas of blood at the 7 o'clock area and toward the 12 o'clock area. Furthermore, there was a very large area [32 x 12 centimeters (12.6 x 4.7 inches)] of blood with skin on the air bag's left side surface (Figure 15 and Figure 9 above). In addition, there was a large area of skin deposited



Figure 17: Close-up of dark skin transfer on top surface of case vehicle's front right passenger air bag (case photo #30)

[8 centimeters wide by over 20 centimeters long (3.1 x 7.9 inches)] on the top surface of the air bag, beginning just to the left and below the vent port and running forward and down onto the air bag's front surface (**Figure 17** above).

CHILD SAFETY SEAT



Figure 18: Frontal view of bloodied Fischer/Price model 9100 convertible child safety seat used by case vehicle's front right passenger (case photo #37)



Figure 19: Fischer/Price model 9100 child safety seat used by case vehicle's front right passenger with bloodied cover pulled away showing no visible stress to plastic shell (case photo #37a)

The child safety seat used by the case vehicle's front right passenger was a convertible seat manufactured by Fischer-Price Products in 1984 and was identified by Model number 9100. The seat was equipped with a three-point harness with "T"-shield (**Figure 18**). The seat was designed with two different shoulder height levels (i.e., slots) that the harness webbing could be adjusted through (i.e., dependent on height and size of child—**Figure 19**). In addition, the seat was designed with a retractor for the three-point harness and "T"-shield. The child seat was designed with only one slot between the child's legs for buckling the "T"-shield/harness portion (**Figure 19**). A close inspection of the front right passenger's forward facing child safety seat showed visible evidence of stress to one of the metal reinforcement braces (**Figures 20 and 21** below) but nothing to the plastic shell of the seat itself.

Immediately prior to the crash the case vehicle's front right passenger [18-month-old, Black (non-Hispanic) male; 79 centimeters and 14.5 kilograms (31 inches, 32 pounds)] was seated in a reclined posture with his back against the forward facing child safety seat's back and his feet dangling over the front edge of the seat's cushion. In addition, the exact location of his hands is unknown but just before the driver recognized the impending collision, the child had been touching the driver's (i.e., mother's) right hand. The front right seat track was located in its middle position, and the seat back was slightly reclined.

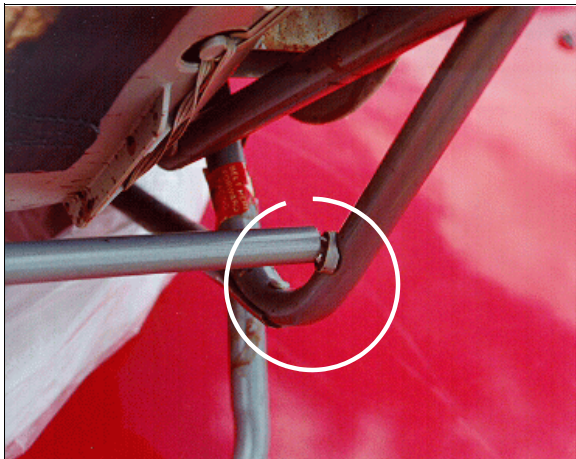


Figure 21: Close-up of metal brace displacement on Fischer/Price child safety seat used by case vehicle's front right passenger (case photo #35a)

The case vehicle's front right passenger was restrained in a forward facing child safety seat, but the child seat was not secured by the available, active, three-point, lap-and-shoulder, safety belt system (**Figure 22**). Furthermore, the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the nonuse of the available safety belts to secure the forward facing child safety seat, the child safety seat with the restrained child occupant tipped forward just prior to impact. The case vehicle's impact with the Plymouth enabled the case vehicle's front right passenger and forward facing child safety seat to continue forward and slightly upward (i.e., pitch) toward the 0 degree Direction of Principal Force as the case vehicle decelerated. As a result and



Figure 20: Back view of Fischer/Price model 9100 used by case vehicle's front right passenger showing blood splatters and highlighted area of brace displacement (case photo #35)



Figure 22: Case vehicle's front seating area showing deployed air bags and unsecured forward facing child safety seat in its pre-impact position (case photo #22)

in conjunction with the seat track's location, the child's head was immediately in front of or atop the front right air bag module's cover flap at the instant of deployment (**Figure 23**). The deploying cover flap contacted the child's right lower cheek and chin, hyper extending the head backwards. As the cover flap continued to expand upwards, followed by the deploying air bag, the front right passenger's head was severed from his torso by the cover flap while his torso remained restrained in the forward facing child safety seat. The expanding cover flap and air bag propelled his head forward, with his scalp leading, into the windshield's glazing (**Figure 10** above). Because of the short term resistance provided by the child seat and the occupant's torso, as the air bag continued to expand the air bag's fabric was directed upwards as the course of least resistance. As a consequence the child's head was lifted upwards, driving the back of his head upwards into the sun visor and front right portion of the windshield's header (**Figure 11** above). The combination of the kinetic energy from the air bag's expansion and the elasticity of the windshield's glazing and front header, resulted in the front right passenger's head being redirected backward toward the back left interior of the vehicle. The front right passenger's head contacted the back left seat's seat back prior to rebounding forward where it contacted the inside upper right corner of the driver's seat back (**Figure 12** above), prior to coming to rest near the inward portion of the front right seat's cushion on the center floor-mounted console (**Figure 14** above). The deploying air bag knocked the free-floating forward facing child safety seat, along with the front right passenger's torso, backwards into the front right seat back. Based on witness statements, the unsecured forward facing child safety seat, along with the front right passenger's torso, were found lying on their left side atop the front right seat's cushion, facing forward.



Figure 23: Case vehicle's front right seating area showing approximation of position of unsecured forward facing child safety seat at deployment (case photo #36)

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right occupant was transported by ambulance to the county hospital's morgue after being pronounced dead at the scene. According to the case vehicle's driver and the police investigation, he sustained a fatal decapitation injury, a large laceration to the back of his head, and abrasions to his chin and neck. This occupant's decapitation injury was caused by his contact with the front right passenger air bag module's cover flap and air bag.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Decapitation	311000.6 untreatable	Front right module's cover flap	Certain	Interviewee (driver)

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
2	Laceration {cut}, large to back of head	190600.1 minor	Front right windshield's glazing	Probable	Interviewee (driver)
3	Abrasions and friction burns to lower jaw	290202.1 minor	Front right module's cover flap	Certain	Other: Police Crash Report
4	Abrasions and friction burns to neck, not further specified	390202.1 minor	Front right module's cover flap	Certain	Other: Police Crash Report

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [19-year-old, Black (non-Hispanic) female; 157 centimeters and 81 kilograms (62 inches, 178 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the clutch, her right foot on the brake, her left hand on the steering wheel, and her right on the transmission selector lever. Her seat track was located between its middle and forward-most positions, and the seat back was slightly reclined. The case vehicle was not equipped with a tilt steering wheel.

The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, the inspection of the case vehicle driver's seat belt webbing, "D"-ring, and latch plate showed minor evidence of loading and blood splatter on the webbing.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of her available safety belts, she most likely moved slightly forward just prior to impact. The case vehicle's impact with the Plymouth enabled the case vehicle's driver to continue forward and slightly upward toward the 0 degree Direction of Principal Force as the case vehicle decelerated. As a result, she loaded her safety belts and contacted the deploying driver air bag. The deploying air bag reversed the driver's forward momentum and caused her to move backwards into her seat back. The driver's exact posture at final rest is unknown, but she was most likely seated near her pre-crash position.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital but signed a document refusing treatment. She sustained minor injuries and was released. According to her interview and the Police Crash Report, she sustained a contusion and a laceration to her lower lip from her deploying air bag.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion lower lip	290402.1 minor	Air bag, driver's	Certain	Interviewee (same person)
2	Laceration {cut} lip, not further specified	290602.1 minor	Air bag, driver's	Certain	Other: Police Crash Report

OTHER VEHICLE

The 1989 Plymouth Voyager LE was a front wheel drive, five-passenger, three-door minivan (VIN: 2P4FH553RKR-----) equipped with a 3.0L, V-6 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum system. The Plymouth was not equipped with anti-lock brakes. The Plymouth's wheelbase was 284 centimeters (112.0 inches), and the odometer reading at inspection is unknown because the Plymouth's interior was not inspected.

The Plymouth's contact with the case vehicle involved the entire back bumper. Direct damage began 37.5 centimeters (14.8 inches) right (toward the passenger side) of center and extended, a measured distance of 113 centimeters (44.5 inches), along the back bumper toward the back left bumper corner. Residual maximum crush was measured as only 1 centimeters (0.4 inches) at C₁ through C₃.

Based on the vehicle inspection, the CDC for the Plymouth was determined to be: **06-BDLW-1 (180)**. The WinSMASH reconstruction program, damage only algorithm, was used on the Plymouth's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 10.0 km.p.h. (6.2 m.p.h.), +10.0 km.p.h. (+6.2 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The Plymouth was driven from the scene.

