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ON-SITE CHILD AIR BAG-RELATED FATALITY INVESTIGATION

CASE NUMBER - IN99-080
LOCATION - MISSISSIPPI
VEHICLE - 1995 DODGE NEON
CRASH DATE - December, 1997

Submitted:

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Contract Number: DTNH22-94-D-17058

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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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On-site air bag deployment investigation involving a 1995 Dodge Neon, four-door sedan, with manual safety belts and dual front air bags, and a 1991 Pontiac Sunbird LE, four-door sedan

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 1995 Dodge Neon (case vehicle) and a 1991 Pontiac Sunbird (other vehicle). This crash is of special interest because the case vehicle's front right passenger (7-year-old female) sustained critical injuries from her deploying front right passenger air bag, resulting in her death. The case vehicle was traveling west-southwest in the westbound lane of a two-lane, undivided, county road. The Pontiac was in the process of exiting a right-hand curve on the same, two-lane, undivided, roadway when the Pontiac entered the westbound lane. The crash occurred in the westbound lane of the roadway. The front left of the case vehicle was impacted by the front left of the Pontiac, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy late during the duration of the impact. The front right passenger was seated with her seat track located between its middle and forward-most positions and was improperly restrained by her available, active, three-point, lap-and-shoulder, safety belt system (i.e., she did not have the shoulder portion over her shoulder). She sustained, according to her medical records, critical injuries, which included: a nonanatomic brain injury, severe cerebral edema, subarachnoid hemorrhage in both her cerebrum and cerebellum, an esophageal injury, pneumomediastinum, a blunt abdominal injury, a ***probable*** spinal cord injury, a left mandibular fracture, a partial avulsion of her left pinna (ear lobe), and abrasions and contusions to her neck, chin, upper chest, shoulders, and lower abdomen and right hip. This occupant's primary brain injuries were caused by her contact with the case vehicle's front right passenger air bag. The case vehicle's driver (31-year-old female) was seated with her seat track located between its middle and forward-most positions, and the tilt steering wheel was located in its middle position. She was not using her available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to her interview, minor injuries which included: contusions to both knees, scratches to her right shoulder, and a sore chest. Both of the back seat passengers (16-year-old male–back left, and 15-year-old female–back center) were seated in a non-adjustable bench seat and neither was using their available, active, safety belt systems. According to their medical records, the back left passenger sustained serious facial fractures, a pneumocephalus, and other soft tissue facial injuries while the back center passenger sustained minor soft tissue injuries. Both back occupants also sustained a moderate nonanatomic brain injury.

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BACKGROUND

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This on-site investigation was brought to NHTSA's attention on August 23, 1999 by a private consultant. This crash involved a 1995 Dodge Neon (case vehicle) and a 1991 Pontiac Sunbird (other vehicle). The crash occurred in December, 1997, at 6:54 p.m., in Mississippi and was investigated by the applicable county sheriff's department. This crash is of special interest because the case vehicle's front right passenger [7-year-old, White (non-Hispanic) female] sustained critical injuries from her deploying front right passenger air bag, resulting in her death. This contractor inspected the scene and vehicles on September 15, 1999. This contractor interviewed the driver of the case vehicle on October 18, 1999. 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, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling west-southwest in the westbound lane of a two-lane, undivided, county road and intended to continue traveling westward. The Pontiac was in the process of exiting a right-hand curve on the same, two-lane, undivided roadway when the Pontiac entered the westbound lane. The Pontiac's driver, who was intoxicated according to the Police Crash Report, had intended to continue traveling east-northeastward in the eastbound lane. The case vehicle's driver steered to the right and braked, attempting to avoid the crash. The crash occurred in the westbound lane of the roadway; see **CRASH DIAGRAM** below.

The front left of the case vehicle was impacted by the front left of the Pontiac, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy late during the duration of the impact. The case vehicle rotated approximately 90 degrees counterclockwise and came to rest straddling the middle of the roadway, heading in a southerly direction. The Pontiac rotated approximately 200 degrees counterclockwise and came to rest primarily in the westbound lane, heading in a southwesterly direction.

The 1995 Dodge Neon was a front wheel drive, four-door sedan (VIN: 1B3ES27C0SD------). Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FLAE-6 (350)**. The WinSMASH reconstruction program was not used on the case vehicle's highest severity impact because this crash involved a narrow corner impact and there was no common velocity achieved during the crash; however, this contractor's visually estimated Delta V is between 19 km.p.h. (12 m.p.h.) and 26 km.p.h. (16 m.p.h.). The case vehicle was towed due to damage.

The case vehicle's contact with the Pontiac involved its front left corner. Direct damage began 48 centimeters (18.9 inches) left of center and extended 20 centimeters (7.9 inches) to the front left bumper corner. This narrow corner engagement extended down the left side to the left "A"-pillar and driver's door. Direct contact was measured as 175 centimeters (68.9 inches). Residual maximum crush was measured as 32 centimeters (12.6 inches) at C_1. The case vehicle's left front wheel was torn away from the axle. The wheelbase on the case vehicle's left side was shortened an estimated 17 centimeters (6.7 inches) while the right side was extended approximately

4 centimeters (1.6 inches). The driver's window glazing was disintegrated from direct contact to the left "A"-pillar and driver's door. The case vehicle's front bumper, bumper fascia, grille, hood, and left headlight and turn signal assemblies, left fender, and left front door were directly damaged and crushed rearward. The case vehicle's left front tire was also deflated. Both the left front and rear doors sustained induced damage as well the fender. Remote buckling was also found on the left portion of the case vehicle's roof above the driver's seating area.

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 air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with four tethers, each approximately 6 centimeters (2.4 inches) in width. The driver's air bag had one vent port, approximately 2.5 centimeters (1.0 inches) in diameter, located at the 12 o'clock position. The deployed driver's air bag was round with a diameter of 59 centimeters (23.2 inches). An inspection of the driver's air bag fabric revealed contact evidence (i.e., skin and a faint lipstick mark) on the air bag's fabric.

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 flaps and air bag 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 front right passenger's air bag was designed with four tethers, each approximately 7.5 centimeters (3.0 inches) in width. 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 50 centimeters (19.7 inches) and a width of approximately 46 centimeters (18.1 inches). An inspection of the front right passenger's air bag fabric revealed contact evidence, although not readily apparent (e.g., an area of discoloration was present--most likely dried blood, but no visible skin transfers), on the air bag's fabric along the left edge at the top and bottom corners.

Inspection of the case vehicle's interior revealed scuffs and indentation to the driver's knee bolster and on the right side of the steering column. Furthermore there was evidence, possibly mucous spray, on the front right sun visor, and there was also evidence of occupant contact on the interior surfaces of the case vehicle's center instrument panel, glove box, and both front seat backs. There was a moderate amount of intrusion to the front left toe pan and sill area with less intrusion to the left "A"-pillar, left instrument panel, and left front door panel.

The 1991 Pontiac Sunbird is a front wheel drive, four-door sedan (VIN: 1G2JB54KXM7------). Based on the available photograph, the CDC for the Pontiac was estimated as: **12-FLEW-2**. The Pontiac was towed due to damage.

According to the case vehicle's driver, immediately prior to the crash the front right passenger [daughter; 91 centimeters and 20 kilograms (36 inches, 43 pounds)] was sitting upright, facing forward, with both feet out in front of her and was properly restrained (i.e., using both the lap and shoulder belts). In addition, the exact position of her hands is unknown. Her seat track was located between its middle and forward-most positions, and the seat back was upright. Based

on our inspection and her injury pattern, this contractor believes it is more likely that either or some combination of the following two scenarios occurred.

Under the first scenario, immediately prior to the crash the case vehicle's front right passenger was seated in an upright posture, partially turned to the left with the left side of her back against the seat back, both feet hanging over the front edge of the seat's cushion, and talking or listening to her sister and her sister's boyfriend who were in the back seat. In this scenario, the torso portion of her three-point restraint was not engaged against her right shoulder. In the second scenario, the front right passenger's short stature [91 centimeters (36 inches)] in combination with the case vehicle's **350** degree Direction of Principal Force may have allowed her to slip out from under the torso portion of her safety belt in response to the collision forces.

In this contractor's opinion, the case vehicle's front right passenger was not completely restrained by her available, active, three-point, lap-and-shoulder, safety belt system (i.e., the shoulder portion of her restraint was not securely located over her shoulder just prior to impact). There was, however, evidence of lap belt pattern contusions and abrasions to the front right passenger's right lower quadrant and hip, as well as contusions distributed across her lower abdomen. In addition, the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed some trace evidence of loading on the "D"-ring; however, there was no evidence (i.e., loading or blood) on the safety belt's webbing.

The case vehicle's driver steered to the right and braked attempting to avoid the crash. As a result of these attempted avoidance maneuvers and the front right passenger's use of the lap belt portion of her available safety belts, she most likely moved slightly forward and to her left just prior to impact. The case vehicle's impact with the Pontiac enabled the front right passenger to continue forward and slightly leftward toward the **350** degree Direction of Principal Force as the case vehicle decelerated. As previously mentioned, the initial narrow end engagement and subsequent wheel interaction (i.e., similar to a sideswiping impact that starts on the side but results in pocketing) 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 (i.e., ramp versus spike)] relative to the change in speed (Delta V). This delay allowed the partially belted front right passenger (in effect, lap belted only) to move closer to the front right air bag module and contact both knees on the glove box door. As the front right air bag deployed and the case vehicle reached maximum engagement, the case vehicle rotated counterclockwise to final rest. As a result, the front right passenger's upper torso moved backwards, upwards, and to her right toward the right front door and/or right side of her seat back. Her movements were restricted by her lap belt usage. As the case vehicle came to rest, the front right passenger most likely rebounded leftward toward the center instrument panel. According to the case vehicle's driver, at final rest the front right passenger was slumped forward in her seat, leaning slightly to the left (towards driver).

The front right occupant was transported by ambulance to the hospital where she was stabilized and subsequently airlifted to a children's trauma center. She sustained critical injuries and was pronounced dead 6 hours and 42 minutes post-crash. The injuries sustained by the case vehicle's front right passenger included: a nonanatomic brain injury, severe cerebral edema, subarachnoid hemorrhage in both her cerebrum and cerebellum, an esophageal injury,

pneumomediastinum–both anteriorly and posteriorly, a blunt abdominal injury, a ***probable*** spinal cord injury, a left mandibular fracture, a partial avulsion of her left pinna (ear lobe), abrasions and contusions to her anterior neck and chin, abrasions and contusions to her left and right upper chest and shoulders, and abrasions and contusions to her lower abdomen and right hip. This occupant's primary brain injuries were caused by her contact with the case vehicle's front right passenger air bag.

The case vehicle's driver [31-year-old, White (non-Hispanic) female; 150 centimeters and 48 kilograms (59 inches, 105 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the brake, and both hands on the steering wheel at the 11 and 1 o'clock positions. Her seat track was located between its middle and forward-most positions, the seat back was upright, the tilt steering wheel was located in its middle position.

The case vehicle's driver was not using her available, active, three-point, lap-and-shoulder, safety belt system. The driver was transported to the hospital by her husband who picked her up at the crash scene. She sustained minor injuries but did not seek treatment. The self-reported injuries sustained by the case vehicle's driver included: contusions to both knees, scratches to her right shoulder, and a sore chest.

The case vehicle's back left passenger [16-year-old, White (non-Hispanic) male; 170 centimeters and 61 kilograms (67 inches, 135 pounds)] was seated in an upright posture with his back against the seat back and his feet on the floor. In addition, the exact position of his hands are unknown. His seat track and seat back were not adjustable.

The case vehicle's back left passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. The back left passenger was transported by ambulance to the hospital. He sustained serious injuries and was hospitalized for 5 days post-crash. According to the interview with the case vehicle's driver and his medical records, the injuries sustained by the back left passenger included: multiple facial fractures involving the frontal sinus, the anterior cranial fossa, the left maxillary sinus, the left and right orbits, the left nasal bone, and two teeth. In addition, he sustained a pneumocephalus, a moderate nonanatomic brain injury, bilateral periorbital contusions, a left subconjunctival hemorrhage, and a laceration over his right eyebrow.

The case vehicle's back center passenger [15-year-old, White (non-Hispanic) female; 152 centimeters and approximately 73 kilograms (60 inches, 160 pounds)] was seated in an upright posture with her back partially against the seat back and both feet on the floor. Once again, the exact positions of her hands are unknown.

Her seat track and seat back were not adjustable. The case vehicle's back center passenger was not using her available, active, two-point, lap belt. The back center passenger was transported by ambulance to the hospital. She sustained a moderate injury and was treated and released. According to the case vehicle's driver and her medical records, the injuries sustained by the back center passenger included: a nonanatomic brain injury (i.e., amnesia to event), a cervical strain, and lacerations to her forehead and below her left knee.

The case vehicle was traveling west-southwest in the westbound lane of a two-lane, undivided, county road and intended to continue traveling westward (**Figure 1**). The Pontiac was in the process of exiting a right-hand curve on the same, two-lane, undivided roadway when the Pontiac entered the westbound lane (**Figure 2**). The Pontiac's driver, who was intoxicated according to the Police Crash Report, had intended to continue traveling east-northeastward in the eastbound lane. The case vehicle's driver steered to the right and braked, attempting to avoid the crash. The crash occurred in the westbound lane of the roadway; see **CRASH DIAGRAM** below.

Figure 1: Case vehicle's westerly travel path in left-hand curve; Note: arrow marks approximate point of impact (case photo #02)

Figure 2: Sunbird's easterly travel path in right-hand curve; Note: arrow marks approximate point of impact (case photo #06)

The county roadway was curved slightly to the left for westward traffic and level (i.e., actual slope was less than 1.0%, negative to the west) at the area of impact. The pavement was bituminous, and the width of the roadway was 5.5 meter (18.2 feet). The shoulders were not improved (i.e., vegetation). No pavement markings or edge lines were present. The estimated coefficient of friction was 0.80. There were no visible traffic controls. The statutory speed limit was 72 km.p.h. (45 m.p.h.) and no regulatory speed limit sign was posted near the crash site. At the time of the crash the light condition was dark, the atmospheric condition was clear, and the road pavement was dry. There was no other traffic present, and the site of the crash was rural undeveloped.

Figure 3: Case vehicle's very narrow front left corner damage; Note: yellow tape marks rightward extend of direct damage (case photo #09)

Figure 4: Case vehicle's narrow front left damage pattern viewed from left of front; Note: direct damage extends to left "A"-pillar and driver's door (case photo #13)

The front left (**Figures 3** and **4** above) of the case vehicle was impacted by the front left (**Figure 5**) of the Pontiac. As the Pontiac traveled down the case vehicle's left side, it snagged the case vehicle's left front wheel assembly, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy late during the duration of the impact. The case vehicle rotated approximately 90 degrees counterclockwise and came to rest straddling the middle of the roadway, heading in a southerly direction. The Pontiac rotated approximately 200 degrees counterclockwise and came to rest primarily in the westbound lane, heading in a southwesterly direction.

Figure 5: On-scene view of Pontiac Sunbird's front left damage from impact with case vehicle (case photo #43)

CASE VEHICLE

The 1995 Dodge Neon was a front wheel drive, five-passenger, four-door sedan (VIN: 1B3ES27C0SD------) 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's wheelbase was 264 centimeters (104.0 inches), and the odometer reading at inspection as 82,408 kilometers (51,206 miles).

Inspection of the vehicle's interior revealed adjustable front bucket seats with integral head restraints; a non-adjustable back bench seat without head restraints; 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 equipped with manually operated, upper anchorage adjusters for the "D"-rings. Both the driver and front right passenger had their upper anchorage adjusters located in the down-most positions. The vehicle was equipped with knee bolsters for both the driver and front right passenger. The driver's knee bolster was scuffed and 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 very narrow frontal impact with the Pontiac.

CASE VEHICLE DAMAGE

The case vehicle's contact with the Pontiac involved its front left corner (**Figures 3** and **4** above). Direct damage began 48 centimeters (18.9 inches) left of center and extended 20 centimeters (7.9 inches) to the front left bumper corner (**Figure 6**). This narrow corner engagement extended down the left side to the left

Figure 6: Case vehicle's very narrow front left corner damage viewed down left side (case photo #12)

"A"-pillar and driver's door (**Figure 7**). Direct contact was measured as 175 centimeters (68.9 inches). Residual maximum crush was measured as 32 centimeters (12.6 inches) at C_1. The case vehicle's left front wheel was torn away from the axle. The wheelbase on the case vehicle's left side was shortened an estimated 17 centimeters (6.7 inches) while the right side was extended approximately 4 centimeters (1.6 inches). The driver's window glazing was disintegrated from direct contact to the left "A"-pillar and driver's door. The case vehicle's front bumper, bumper fascia, grille, hood, and left headlight and turn signal assemblies, left fender, and left front door were directly damaged and crushed rearward. The case vehicle's left front tire was also deflated. Both the left front and rear doors sustained induced damage as well the fender. Remote buckling was also found on the left portion of the case vehicle's roof above the driver's seating area.

Figure 7: Case vehicle's very narrow frontal impact showing deformation down left side; Note: yellow tape indicates length of direct contact (case photo #10)

Inspection of the case vehicle's interior revealed a cracked windshield and a disintegrated driver's door window glazing from the direct contact to the left "A"-pillar and the driver's door. The rearview mirror was also askew from contact with the deploying front right passenger air bag. There was evidence, possibly mucous spray, on both the driver and the front right (**Figure 8**) sun visors. Furthermore, there were scuffs and indentation to the driver's knee bolster and on the right side of the steering column (**Figure 9** below). There was also evidence of occupant contact on the interior surfaces of the case vehicle's center instrument panel, glove box door (**Figures 9** and **10** below), and both front seat backs (**Figures 11** and **12** below). There was greater than 15 centimeters (5.9 inches) of intrusion to the left "A"-pillar and left front door panel areas with less than 15 centimeters (5.9 inches) of intrusion to the front left toe pan, left instrument panel, driver's seat back, and front right passenger's seat back. The energy absorbing steering column showed no evidence of compression; although, because of the amount of intrusion, it was slightly tilted to the right.

Figure 8: Case vehicle's front right passenger seating area showing deployed front right passenger air bag, tow yard damage to right windshield's glazing and either mucous spray or bag exhaust residue on front right sun visor (case photo #26)

Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FLAE-6 (350)**. The WinSMASH reconstruction program was not used on the case vehicle's highest severity impact because this crash involved a narrow corner impact and there was no common velocity achieved during the crash; however, this contractor's visually estimated Delta V is between 19 km.p.h. (12 m.p.h.) and 26 km.p.h. (16 m.p.h.). The case vehicle was towed due to damage.

Figure 9: Case vehicle's instrument panel and glove box door showing deployed front right passenger's air bag and contact evidence around steering column, on center instrument panel and right glove box door (case photo #30)

Figure 10: Close-up of cloth transfers to bottom of case vehicle's glove box door; Note: deformation to right side of center instrument panel (case photo #31)

Figure 11: Case vehicle's front seating area showing deployed driver and front right passenger air bags; Note: both front seat backs deformed by passenger impacts from rear (case photo #32)

Figure 12: Case vehicle's back seating area; Note: deformed front seat backs from contact by back seat passengers (case photo #32a)

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 air bags deployed as a result of the very narrow frontal impact with the Pontiac. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of a single asymmetrical cover flap made of thick vinyl with overall dimensions of 19 centimeters (7.5 inches) at the top horizontal seam, 21 centimeters (8.3 inches) at the bottom horizontal seam, and 15 centimeters (5.9 inches)

vertically. An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The cover flap, however, was pushed through the steering wheel rim during the deployment, most likely from loading to the air bag's fabric by the driver which caused the air bag to expand towards the left instrument panel. The driver's air bag was designed with four tethers, each approximately 6 centimeters (2.4 inches) in width. The driver's air bag had one vent port, approximately 2.5 centimeters (1.0 inches) in diameter, located at the 12 o'clock position. The deployed driver's air bag was round with a diameter of 59 centimeters (23.2 inches). An inspection of the driver's air bag fabric revealed two areas of skin–a smaller area to the center of the air bag and a larger area in the lower right quadrant. It should be noted that the top of the steering wheel had been rotated to the 5 o'clock position at time of inspection. The small area measured 4 x 2 centimeters (1.6 x 0.8 inches) and the larger area measured 9 x 4 centimeters (3.5 x 1.6 inches). There was also a faint red lipstick mark on the air bag's fabric (**Figure 13**).

Figure 13: Vertical view of case vehicle's driver seating area and deployed air bag showing contact evidence near center of air bag; Note: intrusion to "A"-pillar and air bag exhaust residue on sun visor (case photo #23)

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 plastic type frame. The flap's dimensions were 34 centimeters (13.4 inches) at the lower horizontal seam and 15.5 centimeters (6.1 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 flaps and air bag 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 front right passenger's air bag was designed with four tethers, each approximately 7.5 centimeters (3.0 inches) in width. The top set of tethers were sewn to the interior face of the air bag at a point that was 5 centimeters (2.0 inches) below the top edge and 10 centimeters (3.9 inches) in from either side. The second set of tethers were sewn at a point that was 13 centimeters (5.1 inches) above the bottom edge and 10 centimeters (3.9 inches) in from either side. 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 50 centimeters (19.7 inches) and a width of approximately 46 centimeters (18.1 inches). An inspection of the front right passenger's air bag fabric revealed two areas of dark

discoloration–most likely dried blood, on the air bag's fabric along the left edge at the top and bottom corners (**Figure 14** and **Figure 15**). No visible skin transfers were found. The upper area was 8 x 5 centimeter (3.1 x 2.0 inches) and located on the left side surface at upper front corner. The second area was on lower left corner of the front surface and measured approximately 10 x 3 centimeters (3.9 x 1.2 inches). In addition, there was an very small area of unknown substance to the front lower right corner.

Figure 14: Case vehicle's deployed front right air bag; Note: highlighted discolored areas (case photo #36)

Figure 15: Close-up of case vehicle's deployed front right passenger air bag showing bloody discoloration along left side surface (case photo #38)

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

According to the case vehicle's driver, immediately prior to the crash the front right passenger [daughter, 7-year-old, White (non-Hispanic) female; 91 centimeters and 20 kilograms (36 inches, 43 pounds)] was sitting upright, facing forward, with both feet out in front of her and was properly restrained (i.e., using both the lap and shoulder belts). In addition, the exact position of her hands is unknown. Her seat track was located between its middle and forward-most positions, and the seat back was upright. Based on our inspection and her injury pattern, this contractor believes it is more likely that either or some combination of the following two scenarios occurred.

Under the first scenario, immediately prior to the crash the case vehicle's front right passenger was seated in an upright posture, partially turned to the left with the left side of her back against the seat back, both feet hanging over the front edge of the seat's cushion, and talking or listening to her sister and her sister's boyfriend who were in the back seat. In this scenario, the torso portion of her three-point restraint was not engaged against her right shoulder. In the second scenario, the front right passenger's short stature [91 centimeters (36 inches)] in combination with the case vehicle's **350** degree Direction of Principal Force may have allowed her to slip out from under the torso portion of her safety belt in response to the collision forces.

In this contractor's opinion, the case vehicle's front right passenger was not completely restrained by her available, active, three-point, lap-and-shoulder, safety belt system (i.e., the shoulder portion of her restraint was not securely located over her shoulder just prior to impact). There was, however, evidence of lap belt pattern contusions and abrasions to the front right passenger's right lower quadrant and hip, as well as contusions distributed across her lower abdomen. In addition, the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed some trace evidence of loading on the "D"-ring (**Figure 16**); however, there was no evidence (i.e., loading or blood) on the safety belt's webbing (**Figure 17**).

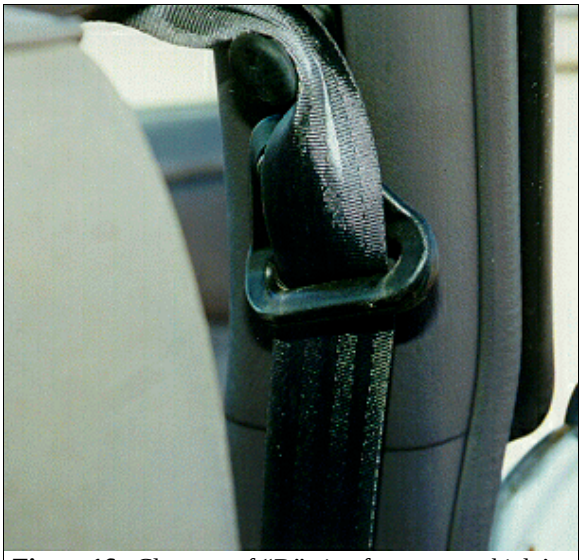

Figure 16: Close-up of "D"-ring from case vehicle's front right safety belt showing trace evidence of loading (case photo #41)

Figure 17: Vertical view of case vehicle's front right seat belt showing no apparent evidence (i.e., blood or loading) on webbing (case photo #40)

The case vehicle's driver steered to the right and braked attempting to avoid the crash. As a result of these attempted avoidance maneuvers and the front right passenger's use of the lap belt portion of her available safety belts, she most likely moved slightly forward and to her left just prior to impact. The case vehicle's impact with the Pontiac enabled the front right passenger to continue forward and slightly leftward toward the **350** degree Direction of Principal Force as the case vehicle decelerated. As previously mentioned, the initial narrow end engagement and subsequent wheel interaction (i.e., similar to a sideswiping impact that starts on the side but results in pocketing) 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 (i.e., ramp versus spike)] relative to the change in speed (Delta V). This delay allowed the partially belted front right passenger (in effect, lap belted only) to move closer to the front right air bag module and contact both knees on the glove box door (**Figures 9** and **10** above). As the front right air bag deployed and the case vehicle reached maximum engagement, the case vehicle rotated counterclockwise to final rest. As a result, the front right passenger's upper torso moved backwards, upwards, and to her right toward the right front door and/or right side of her seat back. Her movements were restricted by her lap belt usage. As the case vehicle came to rest. the front right passenger most

likely rebounded leftward toward the center instrument panel. According to the case vehicle's driver, at final rest the front right passenger was slumped forward in her seat, leaning slightly to the left (towards driver).

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right occupant was transported by ambulance to the hospital where she was stabilized and subsequently airlifted to a children's trauma center. She sustained critical injuries and was pronounced dead 6 hours and 42 minutes post-crash. The injuries sustained by the case vehicle's front right passenger included: a nonanatomic brain injury, severe cerebral edema, subarachnoid hemorrhage in both her cerebrum and cerebellum, an esophageal injury, pneumomediastinum–both anteriorly and posteriorly, a blunt abdominal injury, a ***probable*** spinal cord injury, a left mandibular fracture, a partial avulsion of her left pinna (ear lobe), abrasions and contusions to her anterior neck and chin, abrasions and contusions to her left and right upper chest and shoulders, and abrasions and contusions to her lower abdomen and right hip. This occupant's primary brain injuries were caused by her contact with the case vehicle's front right passenger air bag.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury, unconscious, GCS = 3, pupils fixed and dilated, flaccid, unresponsive to painful stimuli with severe anoxic[1], ischemic brain injury and hypovolemic shock	160824.5 critical	Air bag, front right passenger's	Certain	Hospitalization records
2	Edema, severe, cerebral with Loss of gray/white differential and third ventricle not seen	140666.5 critical	Air bag, front right passenger's	Certain	Hospitalization records

[1] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
anoxic (a-nok′sik): pertaining to or characterized by anoxia.
anoxia (a-nok′se-a): a total lack of oxygen; often used interchangeably with ***hypoxia*** to mean a reduced supply of oxygen to the tissues.
ischemia (is-ke′me-a): deficiency of blood in a part, usually due to functional constriction or actual obstruction of a blood vessel
shock (shok): 1. a sudden disturbance of mental equilibrium. 2. a condition of profound hemodynamic and metabolic disturbance characterized by failure of the circulatory system to maintain adequate perfusion of vital organs. It may result from inadequate blood volume (hypovolemic shock); inadequate cardiac function (cardiogenic shock); or inadequate vasomotor tone (neurogenic shock, septic shock).

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
3	Hemorrhage, subarachnoid, in interhemispheric fissure around circle of Willis[2]	140684.3 serious	Air bag, front right passenger's	Probable	Hospitalization records
4	Hemorrhage, subarachnoid, in cerebellum	140466.3 serious	Air bag, front right passenger's	Probable	Hospitalization records
5	Injury, esophageal with air leak into neck tissues	440899.2 moderate	Air bag, front right passenger's	Probable	Hospitalization records
6	Pneumomediastinum both anteriorly and posteriorly (Hamman's sign[3])	442204.3 serious	Air bag, front right passenger's	Probable	Hospitalization records
7	Injury, blunt abdominal with abdomen distended and rigid {tense}; probable intra-abdominal injury; possible bowel (hallow viscus[4]) injury; possible microscopic liver injury	515099.7 unknown	Lap portion of safety belt system	Probable	Hospitalization records
	Injury, **probable**[5], spinal cord; possible {most likely} hyperextension injury to neck	Not Coded	Air bag, front right passenger's	Not applicable	Hospitalization records
8	Fracture, linear, left mandible {submandibular}	250602.1 minor	Air bag, front right passenger's	Probable	Hospitalization records
9	Avulsion, partial, left pinna (ear lobe)	290802.1 minor	Center instrument panel and below	Possible	Hospitalization records

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[2] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

anastomosis (a-nas″to-mo″sis): 1. a connection between two vessels. 2. an opening created by surgical, traumatic, or pathological means between two normally separate spaces or organs.

circle of Willis: circulus arteriosus cerebri.

circulus (sir″ku-les): a circle or circuit, used in anatomical nomenclature to designate such an arrangement, usually of arteries or veins.

c. arterio″sus ce″rebri: the important polygonal anastomosis formed by the internal carotid, the anterior and posterior cerebral arteries, the anterior communicating artery, and the posterior communicating arteries; called also *c. arteriosus [Willisi]*, ***circle of Willis***.

[3] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

Hamman's sign: a precordial crunching, clicking, or knocking sound, synchronous with each heart beat, heard on auscultation in such conditions as acute mediastinitis, pneumomediastinum, and pneumothorax.

mediastinum (me"de-as"ti″nam): The mass of tissues and organs separating the two pleural sacs, between the sternum anteriorly and the vertebral column posteriorly *{i.e., the bodies of the 12 thoracic vertebrae}* and from the thoracic inlet superiorly to the diaphragm inferiorly. It contains the heart and its pericardium, the bases of the great vessels *{e.g., aorta, aortic arch, vena cava, pulmonary arteries and veins}*, the trachea and bronchi, esophagus, thymus, lymph nodes, thoracic duct, phrenic and vagus nerves, and other structures and tissues.

[4] The following term is defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

viscus (vis″kes) any large interior organ in any one of the three great cavities of the body, especially in the abdomen. In addition, see the section entitled: **VISCUS INJURIES** below.

[5] According to the Discharge Summary, the family of this occupant refused to allow a postmortem examination.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
10	Abrasions anterior neck and underneath chin	390202.1 minor	Air bag, front right passenger's	Certain	Hospitalization records
11	Contusions anterior neck and submental area (underneath chin)	390402.1 minor		Certain	
12	Abrasions left and right upper chest	490202.1 minor	Air bag, front right passenger's	Probable	Hospitalization records
13	Contusion, large, right upper chest	490402.1 minor	Air bag, front right passenger's	Probable	Hospitalization records
14	Abrasion right lower quadrant	590202.1 minor	Lap portion of safety belt system	Certain	Hospitalization records
15	Contusions distributed across lower abdomen	590402.1 minor	Lap portion of safety belt system	Certain	Hospitalization records
16	Contusions right and left shoulders and right upper arm	790402.1 minor	Air bag, front right passenger's	Probable	Hospitalization records
17	Abrasion right upper arm	790202.1 minor	Air bag, front right passenger's	Probable	Hospitalization records
18	Contusion, large, right hip at iliac crest or lower right abdomen	890402.1 minor	Lap portion of safety belt system	Probable	Hospitalization records

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [31-year-old, White (non-Hispanic) female; 150 centimeters and 48 kilograms (59 inches, 105 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the brake, and both hands on the steering wheel at the 11 and 1 o'clock positions. Her seat track was located between its middle and forward-most positions, the seat back was upright, the tilt steering wheel was located in its middle position.

The case vehicle's driver was not using her available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there was no evidence of belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The case vehicle's driver steered to the right and braked attempting to avoid the crash. As a result of these attempted avoidance maneuvers and her nonuse of her available safety belts, she most likely moved slightly forward and to her left just prior to impact. The case vehicle's impact with the Pontiac enabled the driver to continue forward and slightly leftward toward the **350** degree Direction of Principal Force as the case vehicle decelerated. As previously mentioned, the initial narrow end engagement and subsequent wheel interaction (i.e., similar to a sideswiping impact that starts on the side but results in pocketing) 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 (i.e., ramp versus spike)] relative to the change in speed (Delta V). This delay allowed the driver to move closer to her air bag module and contact her left knee on the knee bolster and her right knee on the steering column (**Figure 9** above). As her air bag deployed and the case vehicle reached maximum engagement, it rotated counterclockwise to final rest. As a result, the driver moved backwards, upwards, and to her right toward the right side of her seat back. As the case vehicle came to rest, the driver most likely rebounded leftward toward the intruded left instrument panel. According to the case vehicle's driver, at final rest she was still in her seat and close to her original seating position.

CASE VEHICLE DRIVER INJURIES

The driver was transported to the hospital by her husband who picked her up at the crash scene. She sustained minor injuries but did not seek treatment. The self-reported injuries sustained by the case vehicle's driver included: contusions to both knees, scratches to her right shoulder, and a sore chest.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Lacerations {scratches} right shoulder	790600.1 minor	Noncontact injury: flying glass, left front glazing	Probable	Interviewee (same person)
2	Contusion {black and blue} left knee	890402.1 minor	Knee bolster, driver's, left of steering column	Certain	Interviewee (same person)
3	Contusions {black and blue} right knee	890402.1 minor	Steering column, right side	Certain	Interviewee (same person)

CASE VEHICLE BACK LEFT PASSENGER KINEMATICS

The case vehicle's back left passenger [16-year-old, White (non-Hispanic) male; 170 centimeters and 61 kilograms (67 inches, 135 pounds)] was seated in an upright posture with his back against the seat back and his feet on the floor. In addition, the exact position of his hands are unknown. His seat track and seat back were not adjustable.

The case vehicle's back left passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there was no evidence of belt pattern bruising and/or abrasions to the back left passenger's body, and the inspection of the back left passenger's seat belt webbing and latch plate showed no evidence of loading.

The case vehicle's driver steered to the right and braked attempting to avoid the crash. As a result of these attempted avoidance maneuvers and the back left passenger's nonuse of his

available safety belts, he most likely moved slightly forward and to his left just prior to impact. The case vehicle's impact with the Pontiac enabled the back left passenger to continue forward and slightly leftward toward the **350** degree Direction of Principal Force as the case vehicle decelerated. As a result he most likely loaded struck the top of the driver's seat back (i.e., with integral head restraint), just above the bridge of the nose area, causing his extensive facial and underlying structure injuries. As the case vehicle reached maximum engagement, it rotated counterclockwise to final rest. As a result, the back left passenger moved to his right toward the right rear door and/or the left side of the front right passenger's seat back. As the case vehicle came to rest, the back left passenger most likely rebounded leftward toward the center of the back seat. At final rest he was still in the back seat most likely towards the center seat. The case vehicle's driver was unsure of his exact position in the back seat.

CASE VEHICLE BACK LEFT PASSENGER INJURIES

The back left passenger was transported by ambulance to the hospital. He sustained serious injuries and was hospitalized 5 days post-crash. According to the interview with the case vehicle's driver and his medical records, the injuries sustained by the back left passenger included: multiple facial fractures involving the frontal sinus, the anterior cranial fossa, the left maxillary sinus, the left and right orbits, the left nasal bone, and two teeth. In addition, he sustained a pneumocephalus, a moderate nonanatomic brain injury, bilateral periorbital contusions, a left subconjunctival hemorrhage, and a laceration over his right eyebrow.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture, basilar, anterior cranial fossa (i.e., right orbital roof and cribriform plate of ethmoid bone) with cerebral spinal fluid rhinorrhea	150204.3 serious	Seat back, driver's	Possible	Hospitalization records
2	Pneumocephalus–air {leak} in anterior cranial fossa	140682.3 serious	Seat back, driver's	Possible	Hospitalization records
3	Fracture, comminuted, frontal sinus involving both anterior and posterior tables	150404.3 serious	Seat back, driver's	Possible	Hospitalization records
4	Nonanatomic brain injury with loss of consciousness and amnesia for crash event	160410.2 moderate	Seat back, driver's	Possible	Hospitalization records
5	Fracture left maxillary sinus, anterior medial wall	250800.2 moderate	Seat back, driver's	Possible	Emergency room records
6	Fracture left nasal bone	251000.1 minor	Seat back, driver's	Possible	Hospitalization records

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
7	Fracture medial wall left orbit	251202.2 moderate	Seat back, driver's	Possible	Emergency room records
8	Fracture medial wall right orbit	251202.2 moderate			
9	Fracture {broken} teeth	251404.1 minor	Seat back, driver's	Possible	Emergency room records
10	Contusion, periorbital, with	297402.1	Seat back, driver's	Possible	Hospitalization records
11	edema bilateral eyes	297402.1 minor			
12	Injury, subconjunctival hemorrhage	240416.1 minor	Seat back, driver's	Possible	Hospitalization records
13	Laceration, 7 cm (2.8 in) forehead over right eyebrow	290602.1 minor	Seat back, driver's	Possible	Hospitalization records

CASE VEHICLE BACK CENTER PASSENGER KINEMATICS

The case vehicle's back center passenger [15-year-old, White (non-Hispanic) female; 152 centimeters and approximately 73 kilograms (60 inches, 160 pounds)] was seated in an upright posture with her back partially against the seat back and both feet on the floor. Once again, the exact positions of her hands are unknown.

Her seat track and seat back were not adjustable. The case vehicle's back center passenger was not using her available, active, two-point, lap belt. Furthermore, there was no evidence of belt pattern bruising and/or abrasions to the back center passenger's body, and the inspection of the back center passenger's seat belt webbing and latch plate showed no evidence of loading.

The case vehicle's driver steered to the right and braked attempting to avoid the crash. As a result of these attempted avoidance maneuvers and the back center passenger's nonuse of her available safety belts, she most likely moved slightly forward and to her left just prior to impact. The case vehicle's impact with the Pontiac enabled the back center passenger to continue forward and slightly leftward toward the **350** degree Direction of Principal Force as the case vehicle decelerated. As a result her torso most likely move forward through the space between the front seat backs and contacted the center instrument panel with her forehead. In this contractor's opinion, this occupant's feet snagged on the underneath side of one or both of the front seat backs, limiting her forward motion. As the case vehicle reached maximum engagement, it rotated counterclockwise to final rest. As a result, the back center passenger's moved to her right toward the right front passenger and/or the right side of the front right passenger's seat back. As the case vehicle came to rest, the back center passenger most likely rebounded leftward toward the center console. According to the case vehicle's driver, her exact position at final rest was unknown.

Her seat track and seat back were not adjustable. The case vehicle's back center passenger was not using her available, active, two-point, lap belt. The back center passenger was transported by ambulance to the hospital. She sustained a moderate injury and was treated and released. According to the case vehicle's driver and her medical records, the injuries sustained by the back center passenger included: a nonanatomic brain injury (i.e., amnesia to event), a cervical strain, and lacerations to her forehead and below her left knee.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury, GCS = 15, amnesic to event	160410.2 moderate	Center instrument panel and below	Possible	Emergency room records
2	Acute cervical strain	640278.1 minor	Center instrument panel and below	Possible	Private physician
3	Laceration, 4 cm (1.6 in), left forehead	190602.1 minor	Center instrument panel and below	Possible	Emergency room records
4	Laceration, 7.6 cm (3 in), left shin–near left knee	890602.1 minor	Seat back, driver's	Probable	Emergency room records

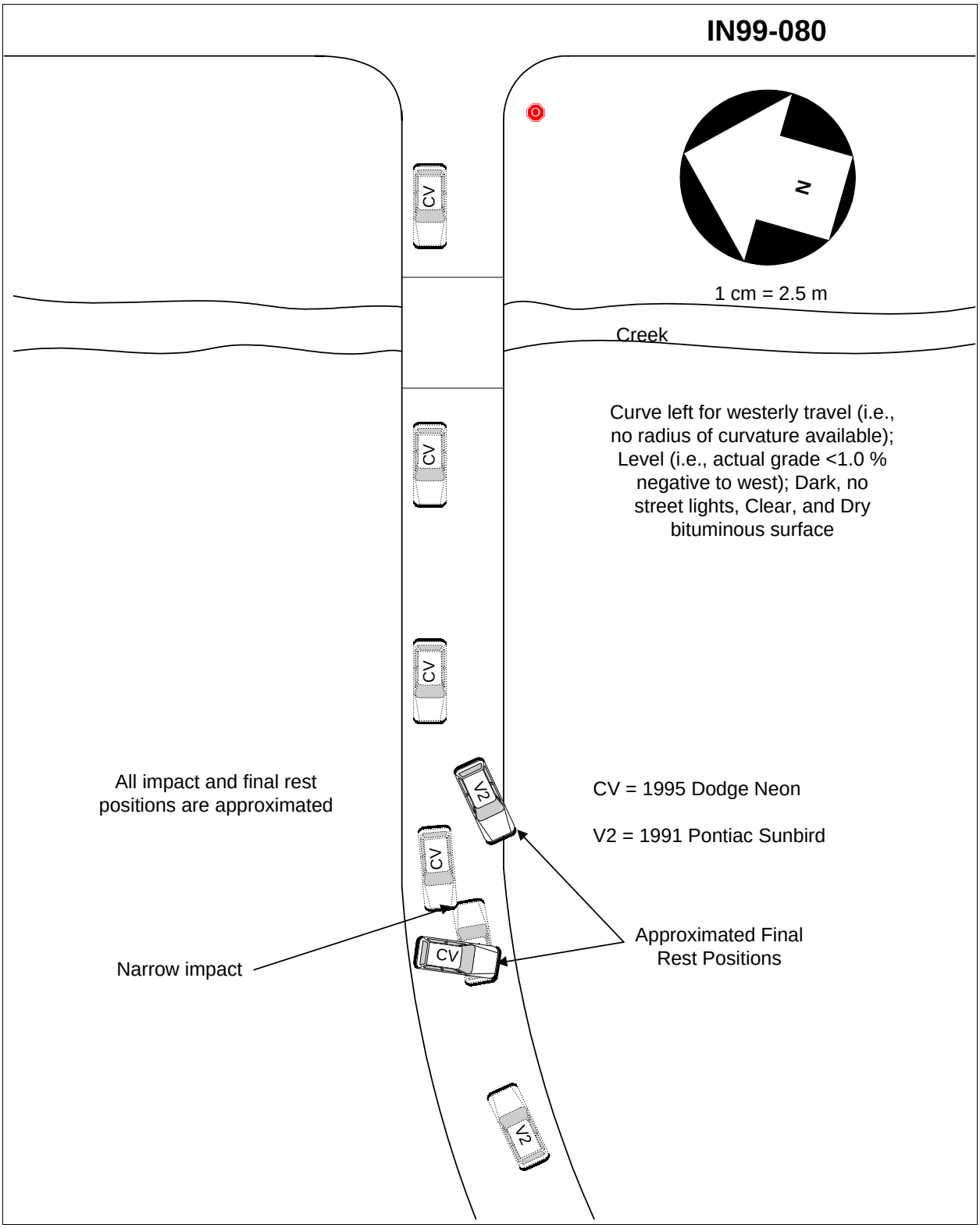
OTHER VEHICLE

Based on the VIN and manufacturer's specifications, the 1991 Pontiac Sunbird LE is a front wheel drive, five-passenger, four-door sedan (VIN: 1G2JB54KXM7------) equipped with a 2.0L, L-4 engine and a five-speed manual transmission. Braking was achieved by a power-assisted, front disc and rear drum system. The case vehicle's wheelbase was 257 centimeters (101.3 inches), and the odometer reading is unknown because the Pontiac was not inspected. Furthermore, the vehicle was equipped with an air bag for the driver's seat position only and manual, three-point, lap-and-shoulder, safety belt systems for the front and back outboard seating positions. The back center seat had a manual, two-point, lap belt. The interior was equipped with bucket seats for the driver and front right passenger, and the back bench seat was non-adjustable.

Base on the available photograph, the CDC for the Pontiac was estimated as: **12-FLEW-2** (**Figure 5** above). The Pontiac was towed due to damage.

The following material is taken from the book: THE MANAGEMENT OF TRAUMA, 4th Edition, by Zuidema, Rutherford, and Ballinger, W.B. Saunders Co., Philadelphia, 1985; Chapter Fourteen: Abdominal Injuries, by Anderson and Ballinger, ***Nonpenetrating Trauma***, page 454.

> Although blunt abdominal trauma constitutes only 0.1 percent of all hospital admissions and 1 percent of all trauma admissions, it is associated with a 20 to 30 percent mortality rate, much of which is attributable to associated injuries of the head and chest, and fractures of the extremities....
>
> Mechanism of blunt visceral injury include crushing, shearing, and bursting forces. The first is the crushing of an organ against the posterior abdominal wall, especially the anterior ridge in the midline produced by the vertebral bodies. Second, a sharp shearing force may suddenly be applied to both solid and hollow organs, resulting in tears with perforation or hemorrhage or both. Finally, an intra-abdominal hollow viscus can be burst open by a sudden increase in its intraluminal pressure.
>
> A sudden application of pressure is more apt to rupture solid than **hollow viscera**, thus accounting for the greater incidence of solid organ injury. The more elastic tissues of the young tolerate trauma better than the less resilient tissues of the aged. A strong, firmly muscled abdominal wall constitutes a better barrier than the flaccid, relaxed abdomen of the old or intoxicated.


IN99-080
N
1 cm = 2.5 m
Creek
Curve left for westerly travel (i.e., no radius of curvature available); Level (i.e., actual grade <1.0 % negative to west); Dark, no street lights, Clear, and Dry bituminous surface
CV
CV
CV
V2
CV
CV
V2
All impact and final rest positions are approximated
CV = 1995 Dodge Neon
V2 = 1991 Pontiac Sunbird
Approximated Final Rest Positions
Narrow impact