INDIANA UNIVERSITY

TRANSPORTATION RESEARCH CENTER

School of Public and Environmental Affairs
222West Second Street
Bloomington, Indiana 47403-1501
(812) 855-3908 Fax: (812) 855-3537

ON-SITE AIR BAG INVESTIGATION

CASE NUMBER - IN99-002
LOCATION - ILLINOIS
VEHICLE - 1999 PONTIAC GRAND AM SE
CRASH DATE - January, 1999

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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On-site air bag deployment investigation involving a 1999 Pontiac Grand Am SE, two-door coupe, with dual redesigned front air bags, and a 1998 Jeep Grand Cherokee Laredo, four-door sport utility

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 1999 Pontiac Grand Am SE (case vehicle) and 1998 Jeep Grand Cherokee Laredo (vehicle #2). This crash is of special interest because the case vehicle was equipped with redesigned air bags and case vehicle's front right passenger [4-year-old, Black (non-Hispanic) male] sustained a fatal cervical injury from his deploying front right air bag. The case vehicle was traveling south in the southbound lane of a two-lane, undivided, city street and entered a four-leg intersection, intending to turn left and travel east. Vehicle #2 was traveling west in the left-hand turn lane of a five-lane, divided, U.S. trafficway and was attempting to swerve around stopped westbound traffic and continue through the intersection (i.e., both east and westbound roadways had two through lanes and a left-hand turn lane). The crash occurred in the four-leg intersection of the two trafficways. The left front corner of the case vehicle was impacted by the front left of vehicle #2, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle's front right passenger was seated on the front edge of the seat towards the right side, and his seat track was located in its middle position. He was not wearing his available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to his autopsy, fatal injuries which included: an upper spinal cord laceration with atlanto-occipital dislocation and separation, cerebral edema, subarachnoid hemorrhage under his cerebrum and cerebellum, a contusion to his thymus, lacerations to his upper mouth and inner mucosa, abrasions to his left scalp and left posterior earlobe, a right subgaleal hemorrhage, abrasions to his whole face including the right forehead, bridge of nose, right cheek, and left corner of mouth, and a large abrasion to his anterior neck. The case vehicle's driver (44-year-old female) was seated with her seat track located in its forward-most position, and the tilt steering wheel was located between its middle and upmost positions. She was not wearing her available, active, three-point, lap-and-shoulder, safety belt system. She sustained, according to her interview and her medical records, minor injuries which included: blunt head and chest trauma and contusions to both knees and her right ankle.

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BACKGROUND

IN99-002

This on-site investigation was brought to NHTSA's attention on February 2, 1999 by NHTSA's Region IV office. This crash involved a 1999 Pontiac Grand Am SE (case vehicle) and a 1998 Jeep Grand Cherokee (vehicle #2). The crash occurred in January, 1999, at 6:20 p.m., in Illinois and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with redesigned air bags and case vehicle's front right passenger [4-year-old, Black (non-Hispanic) male] sustained a fatal cervical injury from his deploying front right air bag. This contractor inspected the scene and vehicles on 3-4 February, 1999. This contractor interviewed the driver for the case vehicle on February 19, 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, medical and autopsy records, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling south in the southbound lane of a two-lane, undivided, city street and hesitated (i.e., decelerated), possibly braking, into a controlled four-leg intersection, while waiting for a northbound vehicle to turn right and travel east. The case vehicle intended to turn left and travel east. Vehicle #2 was traveling west in the left-hand turn lane of a five-lane, divided, U.S. trafficway and was attempting to swerve around stopped westbound traffic and continue through the intersection (i.e., both east and westbound roadways had two through lanes and a left-hand turn lane). The driver of vehicle #2 (an off-duty corrections officer) was reportedly traveling at an unknown high rate of speed, attempting to catch up to another noncontact vehicle that was allegedly involved in a felony he witnessed. The case vehicle's driver began to turn left and accelerate just prior to the crash. Vehicle #2 was steering west-northwest toward the through lanes of the westbound roadway just prior to the crash. The crash occurred in the four-leg intersection of the two trafficways (see **CRASH DIAGRAM** below).

The left front of the case vehicle was impacted by the front left of vehicle #2, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle was pushed backwards, in a northwesterly direction, a short distance and rotated approximately 50 degrees clockwise before coming to rest in the intersection heading south-southwestward. Vehicle #2 continued westward a short distance post-impact while rotating approximately 20 degrees counterclockwise. Vehicle #2 also came to rest in the intersection, heading essentially westward.

The case vehicle's front right passenger [107 centimeters and 16 kilograms (42 inches, 35 pounds)] was not wearing his available, active, three-point, lap-and-shoulder, safety belt system. In addition, the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading or transfers of any kind.

The case vehicle's left turn and deceleration then acceleration just prior to the crash, when combined with the nonuse of his available safety belts, enabled the front right passenger's upper torso to move to the right and primarily forward just prior to impact. The case vehicle's impact with vehicle #2 resulted in the front right passenger's whole body moving further forward, to the left and slightly upward toward the 330 degree Direction of Principal Force. This movement placed the front right passenger nearly atop the right

instrument panel just prior to the time of deployment. This contractor believes that the case vehicle's air bags deployed late in the crash sequence (i.e., maximum engagement occurred when vehicle #2's front bumper impacted the case vehicle's front left wheel assembly). This delay allowed further forward movement by the front right passenger into and on top of the front right instrument panel.

At impact the front right passenger's forehead was directly over the front right passenger air bag module's cover flap, momentarily blocking the air bag's deployment. The deploying cover flap lifted the front right passenger's head into the windshield causing a spider web fracture of the glazing. The deploying air bag caught the front right passenger under the neck and drove him back and to the right as the case vehicle rotated clockwise. At final rest the child passenger's torso was in an unknown position in his seat with his head near the space between the seat cushion and seat back (i.e., based on a bloodied area on the seat cushion).

The front right occupant was transported by ambulance to the hospital. He sustained fatal injuries and was pronounced dead 22 minutes post-crash. Based on the autopsy, the injuries sustained by the case vehicle's front right passenger included: a partial laceration of his upper cervical spinal cord with atlanto-occipital dislocation and 3.8 centimeters (1.5 inches) of separation, cerebral edema, subarachnoid hemorrhage on his inferior occipital lobes, subarachnoid hemorrhage on his cerebellum, a contusion to the left lobe of his thymus, a laceration to the upper frenulum of his mouth, a laceration on his lower inner mucosa, abrasions to his left scalp and left posterior earlobe, a subgaleal hemorrhage over his right frontal scalp, abrasions to his whole face including the right forehead, bridge of nose, right cheek, and left corner of mouth, and a large abrasion to his anterior neck.

The case vehicle was a front wheel drive 1999 Pontiac Grand Am SE, five-passenger, four-door sedan (VIN: 1G2NE52T4XM------). The case vehicle was equipped with anti-lock brakes. Vehicle #2 was a four wheel drive 1998 Jeep Grand Cherokee Laredo, five-passenger, four-door sport utility vehicle (VIN: 1J4GZ58S6WC------). The case vehicle and vehicle #2 were both towed due to damage. Based on the vehicle inspection, the CDCs were determined to be: **11-LYEW-2 (330)** and **10-LPEN-1** for the case vehicle [maximum crush was 23 centimeters (9.1 inches) at C_4 for the primary impact] and **12-FDEW-1 (10)** for vehicle #2 [maximum crush was 19 centimeters (7.5 inches) at C_1]. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity (i.e., initial) impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 20.7 km.p.h. (12.9 m.p.h.), -17.9 km.p.h. (-11.1 m.p.h.), and +10.4 km.p.h. (+6.5 m.p.h.). This contractor believes the longitudinal results are slightly low because the impact to the case vehicle involved the left front wheel assembly (i.e., stiffest part of vehicle) and the WinSMASH algorithm cannot be adjusted to account for the higher stiffness.

The case vehicle's initial contact with vehicle #2 involved the left front bumper corner, and direct damage to the frontal plane extended from the left front bumper corner inwards to the right, a measured distance of 45 centimeters (17.7 inches). Direct damage on the case vehicle's left side began at the left front bumper and extended rearward 136 centimeters (53.5 inches) just forward of the "A"-pillar. Visible direct damage starts again on the driver's door, 65 centimeters (25.6 inches) further rearward of where the original direct damage ended, and continues backward for a measured distance of 41 centimeters (16.1 inches). This separation of visible direct damage resulted from vehicle #2's front right bumper corner

contacting the left front door as the front of vehicle #2's bumper rotated counterclockwise off the case vehicle's left front wheel assembly. The wheelbase on the case vehicle's left side was shortened 11 centimeters (4.3 inches).

Concerning the case vehicle, an inspection of the driver 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 to the air bag or the cover flaps. The driver's air bag was designed without any tethers but had two vent ports, each port approximately 2 centimeters (0.8 inches) in diameter, located at the 11 and 1 o'clock positions. The driver's air bag was round with a diameter of 67 centimeters (26.4 inches). There was contact evidence (light make-up smear) not readily apparent on the driver's air bag in the upper right quadrant. An inspection of the front right passenger air bag module's cover flap and air bag revealed that the cover flap opened at the designated tear points, and there was significant contact evidence (e.g., skin and oil transfers) to the top and front portions of the front right passenger's air bag and contact (e.g., deformation with skin transfer) to the cover flap. The front right passenger's air bag had no vent ports but was designed with two tethers, each 2.75 centimeters (1.1 inches) wide located horizontally approximately **b** of the way down the front portion. The deployed front right passenger's air bag was rectangular with a height of approximately 74 centimeters (29.1 inches) and a width of approximately 51 centimeters (20 inches).

Immediately prior to the crash the case vehicle's front right passenger was seated in an upright posture with his buttocks on the front edge of the seat towards the right side, his feet touching the floor, his left hand on his side and his right arm on the door's arm rest. His seat track was located in its middle position, and the seat back was sightly reclined (measured at 64 degrees). The measured distance from the leading edge of the front right instrument panel to the middle of the front right passenger's seat back was 75 centimeters (29.5 inches). The excursion of the front right passenger's air bag was approximately 50 centimeters (19.7 inches).

The case vehicle's driver [44-year-old, Black (non-Hispanic) female] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot pushing on the accelerator, and both hands on the steering wheel. Her seat track was located in its forward-most position, the seat back was upright, and the tilt steering wheel was located between its middle and upmost positions. The case vehicle's driver [160 centimeters and 70 kilograms (63 inches, 154 pounds)] was not wearing her available, active, three-point, lap-and-shoulder, safety belt system. The driver was transported by ambulance to the hospital. She sustained minor injuries and, according to her medical records, was treated and released. According to her medical records and interview, the injuries sustained by the case vehicle's driver included: blunt head and chest trauma and contusions to both knees and her right ankle.

The case vehicle was traveling south in the southbound lane of a two-lane, undivided, city street (**Figure 1**) and hesitated (i.e., decelerated), possibly braking, into a controlled four-leg intersection, while waiting for a northbound vehicle to turn right and travel east. The case vehicle intended to turn left and travel east. Vehicle #2 was traveling west in the left-hand turn lane of a five-lane, divided, U.S. trafficway (**Figure 2**) and was attempting to swerve around stopped westbound traffic and continue through the intersection (i.e., both east and westbound roadways had two through lanes and a left-hand turn lane). The driver of vehicle #2 (an off-duty corrections officer) was reportedly traveling at an unknown high rate of speed, attempting to catch up to another noncontact vehicle that was allegedly involved in a felony he witnessed. The case vehicle's driver began to turn left and accelerate just prior to the crash. Vehicle #2 was steering west-northwest toward the through lanes of the westbound roadway just prior to the crash. The crash occurred in the four-leg intersection of the two trafficways (see **CRASH DIAGRAM** below).

Figure 1: Case vehicle's southward travel path on city street approaching on-colors controlled, four-leg intersection (case photo #01)

Figure 2: Vehicle #2's westward travel path in transition from inside through lane into left-hand turn lane as driver intended to go around traffic stopped at controlled intersection in order to continue westward (case photo #06)

Both the city roadway and the U.S. highway were straight and level, and their pavements were bituminous. The case vehicle's (city) roadway was 9.1 meters (30 feet) wide, and the roadway was bordered on both the east and west sides by 10.2 centimeter (4 inch) high mountable curbs. The city roadway had no pavement markings present (i.e., the north and southbound lanes were not separated by any painted lane markings). Parking was allowed in both the north and southbound directions. The east and westbound roadways of the U.S. highway were separated by a curbed concrete median [15.2 centimeters (6 inches) high] which narrowed near the intersection. The two westbound through lanes had a width of approximately 3.4 meters (11 feet) and the westbound left-hand lane was 3.1 meters (10.2 feet) wide. The trafficway was bordered by mountable curbs. Pavement markings consisted of a solid white lane line that separated the through lanes from the left-hand turn lane and the two through lanes were divided by a dashed white line. No markings separated the outside through lane from the parking lane. In addition, the left-hand turn bay was marked by a white left-turn arrow. The estimated coefficient of friction was approximately 0.65 for both the city roadway and the U.S. highway. The intersection was controlled by vertically mounted, on-colors traffic control signals for the north and southbound traffic and vertically mounted, on-colors traffic control signals with separate left turn signals for the east and westbound traffic. There were regulatory signs indicating NO TRUCKS OVER 5 TONS could travel on the north and southbound city roadway. Other regulatory signs indicated NO PARKING on both trafficways

approximately 20 meters (66 feet) from the intersection; otherwise, there is legal parallel parking for both trafficways. The legal speed limit is 48 km.p.h. (30 m.p.h.) for the north and southbound city roadway and 56 km.p.h. (35 m.p.h.) for the east and westbound U.S. highway. At the time of the crash the light condition was dark, but illuminated by overhead street lamps at the area of impact and along the U.S. highway, the atmospheric condition was clear, and the road pavement was dry. Traffic density was moderate, and the site of the crash was primarily urban commercial.

The left front (**Figures 3** and **4**) of the case vehicle was impacted by the front left (**Figures 5** and **6**) of vehicle #2. This initial impact triggered the case vehicle's driver and front right supplemental restraints (air bags) to deploy. The case vehicle was pushed backwards, in a northwesterly direction, a short distance and rotated approximately 50 degrees clockwise before coming to rest in the intersection heading south-southwestward (**Figure 7** below). Vehicle #2 continued westward a short distance post-impact while rotating approximately 20 degrees counterclockwise. The front right corner of vehicle #2 contacted the case vehicle's driver door during the rotation (**Figures 8**, **9**, and **10** below). Vehicle #2 also came to rest in the intersection, heading essentially westward (**Figure 7** below).

Figure 3: Case vehicle viewed from front showing damage to left fender and some direct damage to front left bumper (vertical tape mark); Note: string line down left side (case photo #13)

Figure 4: Case vehicle's damaged left front from impact with vehicle #2; Note: direct contact to front bumper (case photo #17)

Figure 5: Vehicle #2's frontal damage; Note: bumper fascia torn away (case photo #48)

Figure 6: Reference line view of vehicle #2's frontal crush; Note: maximum crush at C_1 (case photo #49)

Figure 7: On-scene view looking east at final rest positions of case vehicle (foreground) and vehicle #2 (background); Note: point of impact is in the intersection, in the westbound roadway (for vehicle #2), and between the inside through lane and the left-hand turn lane (case photo #11)

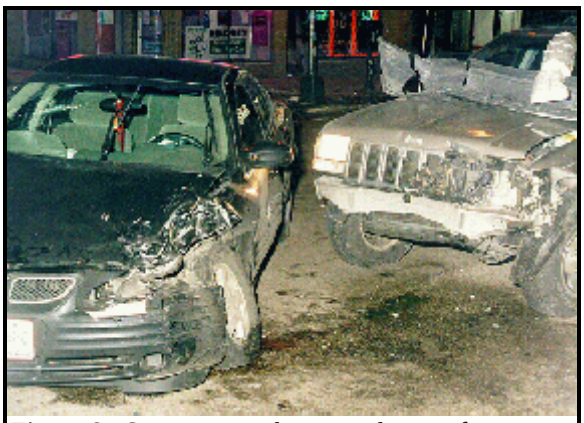

Figure 8: On-scene northeastward view of case vehicle (at left) and vehicle #2 (at right) at final rest; Note: initial contact involved vehicle #2's front left and the case vehicle's left front with a subsequent end slap between the front right half of vehicle #2 and the left front half of the case vehicle (case photo #12)

CASE VEHICLE

The case vehicle was a front wheel drive Pontiac Grand Am SE, five-passenger, four-door, sedan (VIN: 1G2NE52T4XM------) equipped with power-assisted, rack-and-pinion steering, four-speed automatic transmission, and a 2.4L L-4 DOHC SPFI engine. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The case vehicle's wheelbase was 272 centimeters (107.0 inches), and the odometer reading at inspection was 51,596 kilometers (32,060 miles).

Inspection of the vehicle's interior revealed electronic window and door locks; adjustable front bucket seats with adjustable head restraints; a nonadjustable back bench seat with integral head restraints for the back outboard seating positions; and 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 height 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 seat positions. Both front seat air bags deployed as a result of the case vehicle's left front impact with vehicle #2.

CASE VEHICLE DAMAGE

The case vehicle's initial contact with vehicle #2 involved the left front bumper corner, and direct damage to the frontal plane extended from the left front bumper corner inwards to the right (**Figure 3** above), a measured distance of 45 centimeters (17.7 inches). Direct damage on the case vehicle's left side began at the left front bumper and extended rearward 136

Figure 9: Case vehicle's left side damage extending from left front bumper to just past left "B"-pillar (case photo #18)

centimeters (53.5 inches), ending just forward of the "A"-pillar (**Figure 9** above). Visible direct damage starts again on the driver's door, 65 centimeters (25.6 inches) further rearward of where the original direct damage ended (**Figure 10**), and continues backward for a measured distance of 41 centimeters (16.1 inches). This separation of visible direct damage resulted from vehicle #2's front right bumper corner contacting the left front door as the front of vehicle #2's bumper rotated counterclockwise off the case vehicle's left front wheel assembly. The wheelbase on the case vehicle's left side was shortened 11 centimeters (4.3 inches) with the right side being lengthened 6 centimeters (2.4 inches) from the crash. The front left bumper fascia, left fender and front left headlight assembly were crushed rearward. The windshield had a spider web crack from the front right passenger's head. The left front tire was flattened and physically restricted from the left front impact damage (**Figures 4** and **8** above).

Figure 10: Close-up of damage to case vehicle's driver door from vehicle #2's front right bumper corner (case photo #22)

Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **11-LYEW-2 (330)** and **10-LPEN-1** [maximum crush was 23 centimeters (9.1 inches) at C_4 for the primary impact]. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity (i.e., initial) impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 20.7 km.p.h. (12.9 m.p.h.), -17.9 km.p.h. (-11.1 m.p.h.), and +10.4 km.p.h. (+6.5 m.p.h.). This contractor believes the longitudinal results are slightly low because the impact to the case vehicle involved the left front wheel (**Figure 4** above) assembly (i.e., stiffest part of vehicle), and the WinSMASH algorithm cannot be adjusted to account for the higher stiffness.

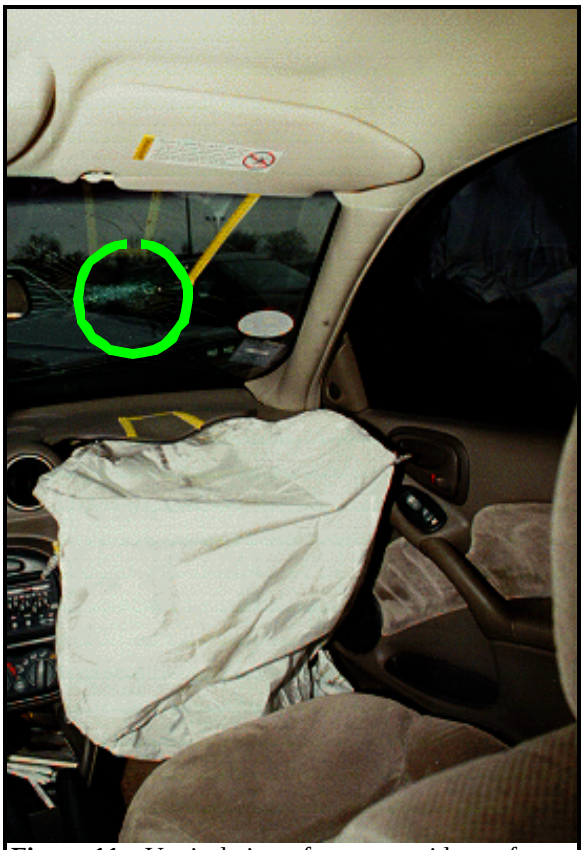

Figure 11: Vertical view of contact evidence from front right passenger to case vehicle's front right air bag module's cover flap as well as top and front portions of air bag; Note: contact and skin spray to windshield (case photo #34)

An examination of the case vehicle's interior revealed a cracked windshield from the front right passenger contacting it with his head (**Figure 11**). The energy absorbing steering column showed no evidence of compression. The driver's window glazing, at the top towards the front, had an oil smudge and several strands of hair hanging down from the frame near the roof, almost certainly from contact by the case vehicle's driver. There was an area of puddled blood on the front right passenger's seat cushion near the

space between the seat cushion and seat back (**Figure 12**) and smeared blood on the right front door panel along the door handle area from the front right passenger. There was no intrusion noted within the interior.

Figure 12: Case vehicle's front right seat showing blood stain deposited by front right passenger at final rest position (case photo #43)

AUTOMATIC RESTRAINT SYSTEM

As previously mentioned, the 1999 Pontiac Grand Am SE was equipped with a SRS that consisted of frontal air bags at both the driver and front right passenger seating positions. The SRS deployed as a result of the case vehicle's left front impact with the front of vehicle #2. However, the initial narrow end engagement (i.e., there was direct contact along the front left bumper) 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) relative to the change in speed (magnitude of Delta V--i.e., ramp versus spike).

Figure 13: Case vehicle's steering wheel showing "I"-configuration driver air bag module's cover flaps and no evidence of contact (case photo #32)

Figure 14: Case vehicle's driver seating area showing no contacts to left "A"-pillar, roof, or sun visor and no obvious evidence of contact to deployed air bag (case photo #30)

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he case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of symmetrical "I"-configuration cover flaps made of thick vinyl with overall dimensions of 8 centimeters (3.1 inches) at the left and right horizontal seams and 13.5 centimeters (5.3 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 (**Figure 13** above). The driver's air bag was designed without any tethers. The driver's air bag had two vent ports, approximately 2 centimeters (0.8 inches) in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was round with a diameter of 67 centimeters (26.4 inches). There was a 22 x 16 centimeter (8.7 x 6.3 inch) area of contact evidence (i.e., a light pink make-up smear) that was not readily apparent on the driver's air bag in the upper right quadrant (**Figure 14** above).

The front right passenger's air bag was located in the top of the instrument panel. There was a single, asymmetrical, modular cover flap. The cover flap was made of a thick vinyl over a thick metal type frame. The flap's dimensions were: 28 centimeters (11.0) at the forward horizontal seam, 34 centimeters (13.4 inches) at the rear (i.e., toward the windshield) horizontal seam, and 13 centimeters (5.1 inches) along both vertical seams. The profile of the case vehicle's instrument panel/dash resulted in a 7 centimeter (2.8 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. An inspection of the front right passenger air bag module's cover flap and air bag revealed that the cover flap opened at the designated tear points, and there was significant intra-modular contact evidence (e.g., black streaks) to the top and front portions of the front right passenger's air bag and a large contact (e.g., scuff and deformation/indentation with skin transfer) to the cover flap from the front right passenger's chin (**Figure 15**). The indentation/skin transfer was 8 centimeters (3.1 inches) wide and 8 centimeters (3.1 inches) deep and was located 9 centimeters (3.5 inches) from the left edge of the cover flap and 11 centimeters (4.3 inches) in from the right edge. The front right passenger's air bag was designed with two tethers, each 2.75 centimeters (1.1 inch) wide. Both tethers were sewn to the interior face of the air bag and were located approximately 10 centimeters (3.9 inches) inwards from the edges and was 47 centimeters (18.5 inches) down from the top edge. The front right passenger's air bag had no vent ports. The deployed front right passenger's air bag was rectangular with a height of approximately 74 centimeters (29.1 inches) and a width of approximately 51 centimeters (20.1 inches). There was contact evidence readily apparent [e.g., a blue and red streak (cloth transfer) and skin and oil transfers] on the front right passenger's air bag. Examination revealed a large transfer of skin to the top and front portions of the air bag (**Figure 16**). The skin transfer started approximately 27 centimeters (10.6 inches) down from the exhaust module of the air bag and extended downwards onto the front portion a total of 65 centimeters (25.6 inches). The skin transfer was

Figure 15: Close-up of contact evidence on case vehicle front right air bag module's cover flap and skin transfer to top of air bag (case photo #36)

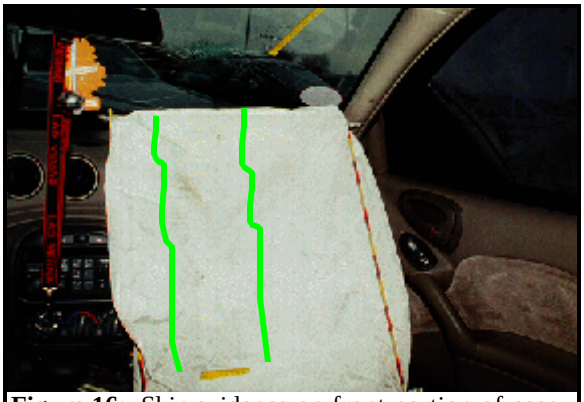


Figure 16: Skin evidence on front portion of case vehicle's front right passenger air bag (case photo #38)

approximately 15 centimeters (5.9 inches) wide and started 11 centimeters (4.3 inches) in from the left edge.

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's front right passenger [4-year-old, Black (non-Hispanic) male] was seated in an upright posture with his buttocks on the front edge of the seat towards the right side, his feet touching the floor, his left hand on his side, and his right arm on the door's arm rest. His seat track was located in its middle position, and the seat back was sightly reclined (measured at 64 degrees). The measured distance from the leading edge of the front right instrument panel to the middle of the front right passenger's seat back was 75 centimeters (29.5 inches). The front right passenger air bag's excursion was approximately 50 centimeters (19.7 inches).

The case vehicle's front right passenger [107 centimeters and 16 kilograms (42 inches, 35 pounds)] was not wearing his available, active, three-point, lap-and-shoulder, safety belt system. In addition, the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading or transfers of any kind.

The case vehicle's left turn and deceleration then acceleration just prior to the crash, when combined with the nonuse of his available safety belts, enabled the front right passenger's upper torso to move to the right and primarily forward just prior to impact. The case vehicle's impact with vehicle #2 resulted in the front right passenger's whole body moving further forward, to the left, and slightly upward toward the 330 degree Direction of Principal Force. This movement placed the front right passenger nearly atop the right instrument panel just prior to the time of deployment. This contractor believes that the case vehicle's air bags deployed late in the crash sequence because the maximum engagement occurred when vehicle #2's front bumper impacted the case vehicle's front left wheel assembly. This delay allowed further forward movement by the front right passenger into and on top of the front right instrument panel.

At impact the front right passenger's forehead was directly over the front right passenger air bag module's cover flap, momentarily blocking the air bag's deployment. The deploying cover flap lifted the front right passenger's head into the windshield causing a spider web fracture of the glazing. The deploying air bag caught the front right passenger under the neck and drove him back and to the right as the case vehicle rotated clockwise. At final rest the child passenger's torso was in an unknown position in his seat with his head near the space between the seat cushion and seat back (i.e., based on a bloodied area on the seat cushion).

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right occupant was transported by ambulance to the hospital. He sustained fatal injuries and was pronounced dead 22 minutes post-crash. Based on the autopsy, the injuries sustained by the case vehicle's front right passenger included: a partial laceration of his upper cervical spinal cord with atlanto-occipital dislocation and 3.8 centimeters (1.5 inches) of separation, cerebral edema, subarachnoid hemorrhage on his inferior occipital lobes, subarachnoid hemorrhage on his cerebellum, a contusion to the

left lobe of his thymus, a laceration to the upper frenulum of his mouth, a laceration on his lower inner mucosa, abrasions to his left scalp and left posterior earlobe, a subgaleal hemorrhage over his right frontal scalp, abrasions to his whole face including the right forehead, bridge of nose, right cheek, and left corner of mouth, and a large abrasion to his anterior neck.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Laceration, partial, upper cervical spinal cord with an atlanto-occipital dislocation {separation}	640274.6 untreatable	Front right module's cover flap	Probable	Autopsy
2	Edema, cerebral, not further specified [Aspect = Unknown]	140668.3 serious	Front right module's cover flap	Probable	Autopsy
3	Hemorrhage, subarachnoid, on inferior occipital lobes [Aspect = Unknown]	140684.3 serious	Front right module's cover flap	Probable	Autopsy
4	Hemorrhage, subarachnoid, on cerebellum	140466.3 serious	Front right module's cover flap	Probable	Autopsy
5	Contusion, 3.0 x 1.0 cm (1.2 x 0.4 in), left lobe of thymus	Not listed	Air bag, front right passenger's	Possible	Autopsy
6	Laceration, 0.8 cm (0.3 in), on upper frenulum[1] of mouth	243099.1 minor	Windshield	Certain	Autopsy
7	Laceration, 2.5 cm (1.0 in), on lower inner mucosa in front of teeth	243204.1 minor	Windshield	Certain	Autopsy
8 9	Abrasion, 3.8 x 1.8 cm (1.5 x 0.7 in), over left scalp and left posterior earlobe	190202.1 290202.1 minor	Right front roof rail	Possible	Autopsy
10	Hemorrhage, subgaleal, 5.0 x 3.0 cm (2.0 x 1.2 in), over right frontal scalp	190402.1 minor	Windshield	Probable	Autopsy
11	Abrasions whole face including right forehead, bridge of nose, right cheek, and left corner of mouth	290202.1 minor	Front right module's cover flap	Probable	Autopsy

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

frenulum (frenu-lam) pl. ***frenula (frenu-la)***: a small bridle; a general term for a small fold of integument or mucous membrane that checks, curbs, or limits the movement of an organ or part

f. of inferior lip, f. labii inferioris: the fold of mucous membrane on the inside of the middle of the lower lip, connecting the lip with the gums.

f. of superior lip, f. labii superioris: the fold of mucous membrane on the inside of the middle of the upper lip, connecting the lip with the gums.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
12	Abrasions neck: **right** [7.6 x 3.8 cm (3.0 x 1.5 in)], **anterior**, [10.2 x 12.7 cm (4.0 x 5.0 in)], and **left** [12.7 x 15.2 cm (5.0 x 6.0 in)] {Aspect = Anterior}	390202.1 minor	Air bag, front right passenger's	Certain	Autopsy

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [44-year-old, Black (non-Hispanic) female] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot pushing on the accelerator, and both hands on the steering wheel. The left turn maneuver resulted in her upper torso leaning slightly to the left. Her seat track was located in its forward-most position, the seat back was upright, and the tilt steering wheel was located between its middle and upmost positions. The case vehicle's driver [160 centimeters and 70 kilograms (63 inches, 154 pounds)] was not wearing her available, active, three-point, lap-and-shoulder, safety belt system.

The case vehicle's left turn and deceleration then acceleration just prior to the crash, when combined with the nonuse of her available safety belts, enabled the driver's upper torso to move slightly to the right just prior to impact. The case vehicle's impact with vehicle #2 resulted in the driver's whole body moving further forward, to the left, and slightly upward toward the 330 degree Direction of Principal Force. The deploying driver's air bag contacted the driver's face and upper torso and accelerated her movement towards the 330 degree Direction of Principal Force. Because the driver's seat track was in its full forward position, both of her knees contacted the knee bolster. The driver's head/forehead subsequently contacted the left door glazing, frame, sill, side roof rail, and/or left "A"-pillar. The driver rebounded off the left door area back to her right. At final rest the driver remained in her seat near her original seating position.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital. She sustained minor injuries and, according to her medical records, was treated and released. According to her medical records and interview, the injuries sustained by the case vehicle's driver included: blunt head and chest trauma and contusions to both knees and her right ankle.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Trauma, blunt head[2], with swelling to forehead	115099.7 unknown	Left side window glazing and/or window frame, window sill, left "A"-pillar, or left front roof side rail	Probable	Emergency room records
2	Trauma, blunt to chest–tenderness over left upper chest with pain radiating down left side	415099.7 unknown	Air bag, driver's	Probable	Emergency room records
3	Contusion[3] {trauma, blunt} to right knee	890402.1 minor	Left instrument panel or below	Probable	Emergency room records
4	Contusion to left knee	890402.1 minor	Left instrument panel and below	Probable	Interviewee (same person)
5	Contusion[3] {trauma, blunt} to right ankle with swelling	890402.1 minor	Foot controls	Possible	Emergency room records

VEHICLE #2

Vehicle #2 was a four wheel drive 1998 Jeep Grand Cherokee Laredo, five-passenger, four-door sport utility vehicle (VIN: 1J4GZ58S6WC------) equipped with a four-speed automatic transmission and a 4.0L, OHV SMPI, V-6 engine. Braking was achieved using a dual hydraulic, self adjusting, front disc and rear drum, four-wheel, anti-lock system. Vehicle #2's wheelbase was 269 centimeters (105.9 inches), and the vehicle's odometer reading at impact is unknown because the vehicle was equipped with an electronic odometer.

Inspection of the vehicle's interior revealed electronic window and door locks; adjustable front bucket seats; an adjustable 60/40 back bench seat; and 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. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a driver air bag and a front right passenger air bag. Both front seat air bags deployed as a result of vehicle #2's frontal impact with the case vehicle (**Figures 17** and **18** below).

Vehicle #2's frontal impact with the case vehicle tore away the front bumper fascia, pushed the bumper reinforcement beam inward and knocked out the front left headlight assembly (**Figures 5** and **6** above). The entire grille and left front fender sustained induced damage. The field "L" and direct damage

[2] The driver indicated to the physician that she hit her head; otherwise, there is no evidence in her medical records to support this lesion. During her interview, the driver indicated that her forehead was swollen

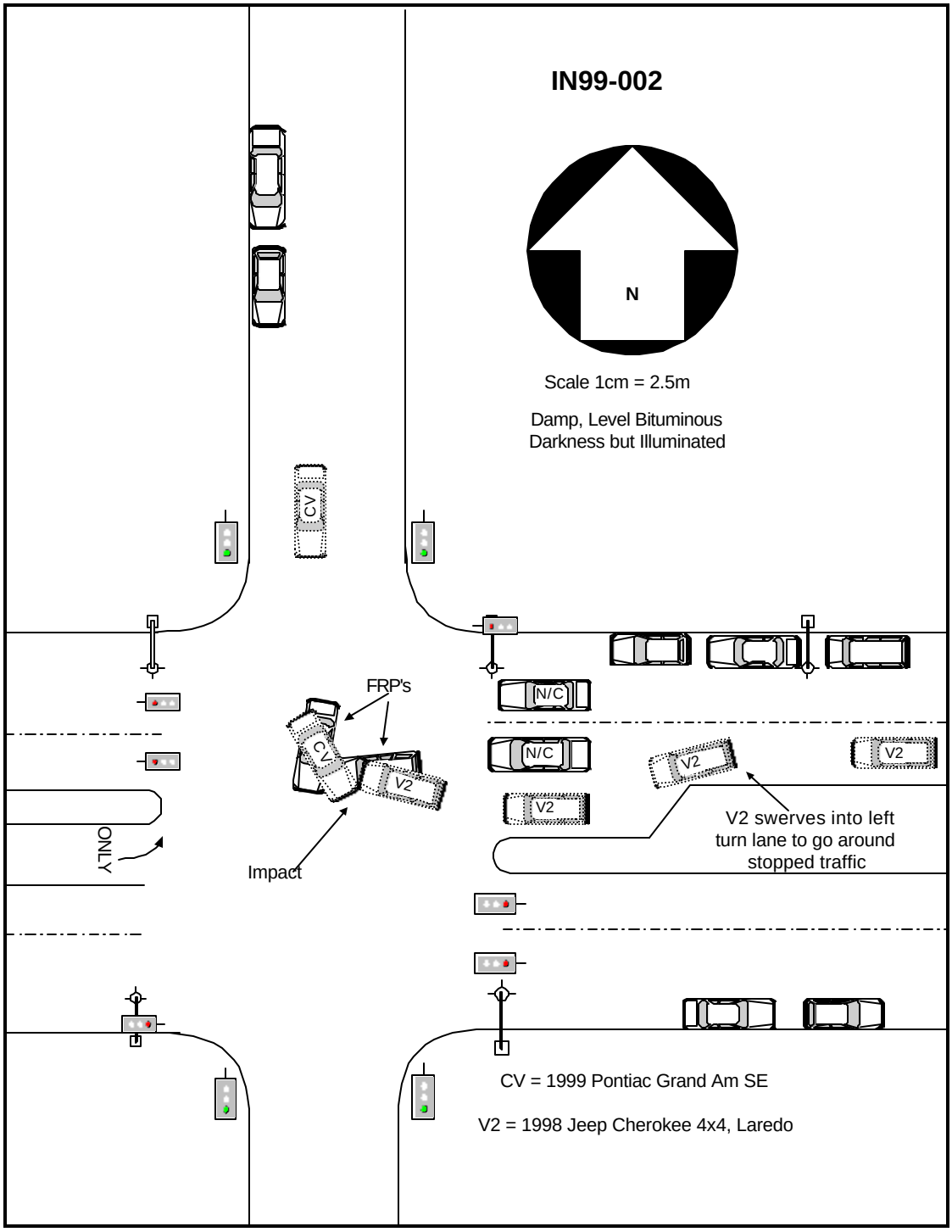
[3] Based on NASS injury coding conventions, numbers 11 and 12, the lesion "contusion" is most likely applicable.

extended from bumper corner to bumper corner. The direct damage width measured a distance of 135 centimeters (53.2 inches) and the undeformed end width (field "L") was 158 centimeters (62.2 inches). The maximum crush was measured at 19 centimeters (7.5 inches) at C_1. The wheelbase on the left side was shortened 1 centimeter (0.4 inches).

Figure 17: Vehicle #2's driver seating area showing no evidence of contact to greenhouse area or deployed driver air bag (case photo #57)

Figure 18: Vehicle #2's front right seating area showing no evidence of occupant contact to greenhouse area or deployed front right passenger air bag (case photo #59)

Based on the vehicle inspection, the CDC for vehicle #2 was determined to be: **12-FDEW-1 (10)**. The WinSMASH reconstruction program, damage only algorithm, was used on vehicle #2's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 17.2 km.p.h. (10.7 m.p.h.), -17.0 km.p.h. (-10.6 m.p.h.), and -3.0 km.p.h. (-1.9 m.p.h.). This contractor believes the longitudinal results are slightly low because the impact to the case vehicle involved the left front wheel assembly (i.e., stiffest part of vehicle) and the WinSMASH algorithm cannot be adjusted to account for the higher stiffness.


IN99-002
N
Scale 1cm = 2.5m
Damp, Level Bituminous
Darkness but Illuminated
CV
FRP's
N/C
N/C
V2
V2
V2
V2
V2
ONLY
Impact
V2 swerves into left
turn lane to go around
stopped traffic
CV = 1999 Pontiac Grand Am SE
V2 = 1998 Jeep Cherokee 4x4, Laredo