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ON-SITE AIR BAG INVESTIGATION

CASE NUMBER - IN98-023
LOCATION - INDIANA
VEHICLE - 1995 MITSUBISHI ECLIPSE GS
CRASH DATE - October, 1998

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

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

Technical Report Documentation Page

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16. <i>Abstract</i> <p>This report covers an on-site investigation of an air bag deployment crash that involved a 1995 Mitsubishi Eclipse (case vehicle) and a 1996 Pontiac Grand Am (other vehicle). This crash is of special interest because the case vehicle's, restrained, front right passenger (8-year-old male) sustained a nonanatomic brain injury, including prolonged loss of consciousness and ventilator dependency, from his deploying front right air bag. The case vehicle was traveling west in a slight left-hand curve, in the westbound lane of a two-lane, undivided, state roadway. The Pontiac was also traveling west in the westbound lane of the same state roadway and was slowing to make a left-hand turn into a residential driveway. The crash occurred in the westbound lane of the roadway. The front of the case vehicle impacted the back of the Pontiac, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. All three of the case vehicle's occupants were restrained by their available, active, three-point, lap-and-shoulder, safety belt system. The case vehicle's driver (16-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 sustained, according to the Police Crash Report, a minor neck abrasion. The front right passenger was seated, leaning slightly to his left, with his seat track located in its middle position. He sustained, according to his medical records, severe injuries which included: a severe nonanatomic brain injury; a small, left, subdural hematoma; small, cerebral contusions; an abrasion to his right forehead; and a scalp contusion and laceration. His right forehead abrasion was caused by the deploying front right air bag, and his brain and scalp lesions were caused by the center console. The back right passenger (6-year-old male) was seated in a non-adjustable seat. He sustained, according to his medical records, minor injuries which included: contusions to his right hip bone and the soft tissue of his right hip, and a laceration to his upper mouth.</p>			
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This on-site investigation was brought to NHTSA's attention on October 19, 1998 by SCI Team #2 personnel. This crash involved a 1995 Mitsubishi Eclipse (case vehicle) and a 1996 Pontiac Grand Am (other vehicle). The crash occurred in October, 1998, at 7:59 p.m., in Indiana and was investigated by the applicable county police department. This crash is of special interest because the case vehicle's, restrained, front right passenger [8-year-old, White (non-Hispanic) male] sustained a nonanatomic brain injury, including prolonged loss of consciousness and ventilator dependency, from his deploying front right air bag. This contractor inspected the scene on 19 October, 1998 and vehicles on 19-20 October, 1998. This contractor had a conversation with the father of the case vehicle's front right and back right passengers on January 8, 1999, and interviewed the driver of the Pontiac on January 23, 1999. This report is based on the Police Crash Report, an interview with the Pontiac's driver, 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 in a slight left-hand curve, in the westbound lane of a two-lane, undivided, state roadway, and intended to continue its westerly travel path. The Pontiac was also traveling west in the westbound lane of the same state roadway and was slowing with the intention of making a left-hand turn into a residential driveway. The case vehicle's driver applied her brakes [depositing 3.6 meters (11.8 feet) of skid marks] in an attempt to avoid the crash. The crash occurred in the westbound lane of the roadway; see **CRASH DIAGRAM**.

The front of the case vehicle impacted the back of the Pontiac, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle rotated approximately 15 degrees counterclockwise while continuing forward a short distance. The case vehicle came to rest essentially in the westbound lane (i.e., its left front tire was on the center line) heading west. The Pontiac was pushed forward approximately 15.8 meters (51.8 feet) and came to rest straddling the westbound lane and the north (right) shoulder, heading west-northwest.

According to his family and his medical records, the case vehicle's front right passenger [unknown height and 29 kilograms (63 pounds)] was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. However, there was no evidence of belt pattern bruising and/or abrasions to the front right passenger's body, and the inspection of the front right passenger's "D"-ring and latch plate showed no evidence of loading. But, there was an ill-defined, diagonal crease across his seat belt webbing indicating at most a minor loading force.

The case vehicle's driver braked (with lock-up), attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of his available safety belts, the front right passenger most likely moved slightly forward and upward (because the case vehicle dipped downward due to its pre-crash braking) just prior to impact. The case vehicle's impact with the Pontiac enabled the front right passenger to continue forward and slightly upward and only inconsequentially loading his safety belts, as the case vehicle decelerated. Because of the front right seat track's "middle" position, the deploying front right air bag struck the front right

passenger on his right forehead most likely before he was able to significantly load his safety belts and, as a result, his head and torso were redirected leftward, backward, and downward, out from underneath the torso portion of his safety belt, toward the case vehicle's center console. The left side of the front right passenger's head impacted the center console's storage area and the raised storage area cover. As the case vehicle rotated slightly counterclockwise and continued forward, the front right passenger's torso rebounded forward, reloading the lap portion of his safety belt system before rebounding backward into his seat back as the case vehicle came to rest. According to his medical records, the front right passenger was found sitting in his seat, but his exact posture is unknown. Based on the amount of blood found on and near the center console, the front right passenger's head was most likely leaning toward the console at final rest.

The front right occupant was transported by ambulance to the hospital. He sustained severe brain injuries and was hospitalized 3 days post-crash. The injuries sustained by the case vehicle's front right passenger included: a severe nonanatomic brain injury; a small, left, subdural hematoma; small, cerebral contusions; an abrasion to his right forehead; and a scalp contusion and laceration. His right forehead abrasion was caused by the deploying front right air bag, and his brain and scalp lesions were caused by the center console.

The 1995 Mitsubishi Eclipse GS was a front wheel drive, three-door hatchback (VIN: 4A3AK44Y8SE-----). Four-wheel, anti-lock brakes are an option for the case vehicle, but it is unknown if the case vehicle was so equipped. There was no "ABS" locale on the case vehicle's exterior, and the guardian of the driver (i.e., a minor) refused to cooperate in this research. The 1996 Pontiac Grand Am SE was a front wheel drive, two-door coupe (VIN: 1G2NE12T7TM-----). The case vehicle and the Pontiac were both towed due to disabling damage.

Based on the vehicle inspections, the CDCs were determined to be: **12-FDEW-3 (0)** for the case vehicle [maximum crush, which was located above the bumper, was 43 centimeters (16.9 inches)] and **06-BDEW-2 (180)** for the Pontiac [maximum crush was 15 centimeters (5.9 inches)]. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 21.2 km.p.h. (13.2 m.p.h.), -21.2 km.p.h. (-13.2 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The Police Crash Report narrative indicated that the case vehicle was going approximately 72-80 km.p.h. (45-50 m.p.h.) prior to the crash. The posted speed limit at this location is 64 km.p.h. (40 m.p.h.).

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 fabric 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 two tethers, each 8 centimeters (3.1 inches) wide. The driver's air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 11:30 and 12:30 o'clock positions. The deployed driver's air bag was elliptical with a height of approximately 52 centimeters (20.5 inches) and a width of approximately 60 centimeters (23.6 inches). There was a lipstick smear on the driver's air bag, located in the upper right quadrant near the center of the air bag.

The front right passenger's air bag was located in the middle of the instrument panel. An inspection of the front right air bag module's cover flaps and air bag fabric 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 front right passenger's air bag was designed without any tethers. The front right air bag had two vent ports, approximately 6 centimeters (2.4 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 66 centimeters (26.0 inches) and a width of approximately 44 centimeters (17.3 inches). There was no contact evidence readily apparent on the front right air bag.

An inspection of the case vehicle's interior revealed that there were scuff marks on: the rim and on one of the spokes of the steering wheel, to the left of the steering column on the left lower instrument panel, and on the glove box door. There was a bloodstain on the front header above the front right seating area and a soda splash mark on the roof. In addition, there was a large bloodstain on the center console storage area, including inside the center console's storage area cover. There were bloodstains on the forward side of the front right seat back. Finally, there were body oil smudges on the backside of the front right seat back.

The exact posture of the case vehicle's front right passenger, immediately prior to the crash, is unknown. However, based on the available evidence, the case vehicle's front right passenger was most likely seated in an upright posture with his back against the seat back, leaning slightly to his left, and both feet hanging over the front edge of the seat's cushion, angled downward. The exact position of his hands is unknown. Based on the vehicle inspection, his seat track was located in its middle position, and the seat back was upright.

The exact posture of the case vehicle's driver [babysitter; 16-year-old, White (unknown if Hispanic) female] is unknown. However, based on the available physical evidence, she was most likely 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 at least one hand on the steering wheel (i.e., the exact position of her hands is unknown). Her seat track was located between its middle and forward-most positions, the seat back was upright, and the tilt steering wheel was located in its middle position. The case vehicle's driver (of unknown height and weight) was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The driver was transported by ambulance to the hospital. She sustained, according to the Police Crash Report, a minor neck abrasion and was treated and released.

The exact posture of the case vehicle's back right passenger [i.e., brother of front right passenger; 6-year-old, White (non-Hispanic) male] is unknown; however, he was most likely seated in an upright posture with his back against the seat back and both feet dangling down over the front edge of the seat's cushion, angled downward. The exact position of his hands is unknown. His seat track and seat back were not adjustable. The case vehicle's back right passenger (of unknown height and weight) was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. The back right passenger was transported by ambulance to the hospital. He sustained minor injuries and was treated and released. According to his medical records, the injuries he sustained included: contusions to his right hip bone and the soft tissue of

his right hip, and a laceration to his upper mouth. His contusions were caused by his loading the lap portion of his safety belt system and the laceration was caused by his face striking the backside of the front right seat back.

CRASH CIRCUMSTANCES

The case vehicle was traveling west in a slight left-hand curve (**Figure 1**), in the westbound lane of a two-lane, undivided, state roadway, and intended to continue its westerly travel path. The Pontiac was also traveling west in the westbound lane of the same state roadway and was slowing with the intention of making a left-hand turn into a residential driveway (**Figure 2**). The case vehicle's driver applied her brakes [depositing 3.6 meters (11.8 feet) of skid marks] in an attempt to avoid the crash. The crash occurred in the westbound lane of the roadway; see **CRASH DIAGRAM**.

The State roadway was level [actual grade was 0.8 percent negative to the west (i.e., the direction of travel for both vehicles)] and was curved slightly leftward for westbound traffic. The westbound lane measured 3.4 meters (11.2 feet) and the eastbound lane measured 3.8 meters (12.5 feet). Ambient conditions were dark, clear skies, and dry pavement. The pavement was bituminous but traveled and worn, and the coefficient of friction was estimated as 0.70. Traffic density was heavy, and the site of the crash was essentially rural residential. Pavement markings consisted of a double solid yellow centerline for east and westbound traffic, and solid white edge lines marked both the north and side edges of the roadway. Shoulders were improved (i.e., bituminous) and measured, at the point of impact, 3.9 meters (12.8 feet) on the north and 2.9 meters (9.5 feet) on the south. The Police Crash Report narrative indicated that the case vehicle was going approximately 72-80 km.p.h. (45-50 m.p.h.) prior to the crash. The posted speed limit at this location is 64 km.p.h. (40 m.p.h.).



Figure 1: Case vehicle's westward travel path in westbound lane of slight left-hand curve, approaching Pontiac which was stopped (arrow) waiting to make a left-hand turn (case photo #01)



Figure 2: Case vehicle's and Pontiac's westward travel path in westbound lane showing approximate (arrow) point of impact (case photo #04)



Figure 3: Underride damage to case vehicle's front with contour gauge showing above bumper damage (case photo #10)

The front of the case vehicle (**Figure 3** above and **Figure 4**) impacted the back of the Pontiac (**Figure 5**), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle rotated approximately 15 degrees counterclockwise while continuing forward a short distance. The case vehicle came to rest essentially in the westbound lane (i.e., its left front tire was on the center line) heading west. The Pontiac was pushed forward approximately 15.8 meters (51.8 feet) and came to rest straddling the westbound lane and the north (right) shoulder, heading west-northwest.

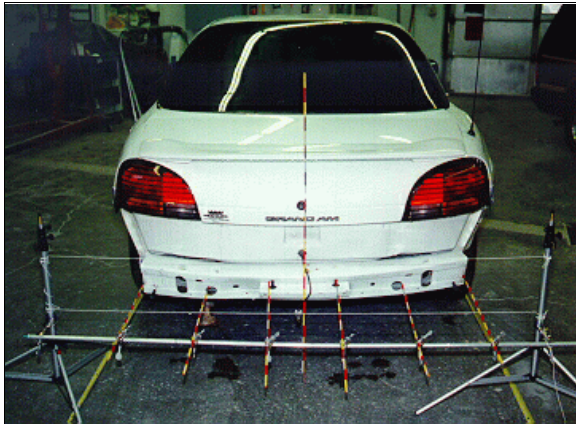


Figure 5: Pontiac's damaged back with contour gauge present; Note: bumper and reinforcement bar were knocked off (case photo #66)



Figure 4: Case vehicle's front underride damage viewed from right along front reference line (case photo #22)



Figure 6: Case vehicle's front right seating area showing deployed front right passenger air bag and center console with floor-mounted, transmission selector lever (case photo #31)

CASE VEHICLE

The 1995 Mitsubishi Eclipse GS was a front wheel drive, , four-passenger, three-door hatchback (VIN: 4A3AK44Y8SE-----) equipped with a 2.0L, DOHC-SFI, I-4 engine and a four-speed automatic transmission. Four-wheel, anti-lock brakes are an option for the case vehicle, but it is unknown if the case vehicle was so equipped. There was no "ABS" locale on the case vehicle's exterior, and the guardian of the driver (minor) refused to cooperate in this research. The case vehicle's wheelbase was 251 centimeters (98.8 inches), and the odometer reading at inspection was 60,070 kilometers (37,326 miles).

The interior of the case vehicle had front bucket seats with folding backs and adjustable head restraints (**Figure 6**). The back seat was a bench seat without head restraints. The case vehicle's front seat was equipped with manual, three-point, lap-and-shoulder, safety belt systems in the outboard seating positions. The case vehicle was equipped with manually operated height adjusters

for the “D”-rings on the front belt systems. The back seat also had manual, three-point, lap-and-shoulder, safety belt systems in the outboard seating positions. The case vehicle was equipped with knee bolsters for the driver and front right passenger. The driver’s knee bolster showed contact evidence (deformation with scuffing). Additional automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of frontal air bags for the driver and front right passenger positions (**Figures 7 and 8**).



Figure 7: Case vehicle’s front seating area showing deployed driver air bag, center instrument panel, and automatic transmission selector lever (case photo #28)



Figure 8: Case vehicle’s steering wheel showing driver air bag module’s top and bottom cover flaps and refolded air bag (case photo #32)

CASE VEHICLE DAMAGE

The upper half of the case vehicle’s front bumper impacted the lower half of the Pontiac’s back bumper. This vertical mismatch of bumpers resulted in a classic underride of the Pontiac. Direct damage to the case vehicle extended across the entire frontal surface and included: rearward displacement of the front bumper and fascia, a cracked plastic grille, a shattered front left fog light, a front right fog light that was knocked askew, front headlamp assemblies that were pushed rearward and upward, cracked and splintered glass covers to the front headlamp assemblies, a shattered front left turn light lens, indentation to the forward edge of the left fender, white paint transfers on the forward edge of the right fender, **and** rearward displacement of the forward edge of the hood with buckling approximately a third of the way to its rear edge. Induced damage included: buckling of the left fender at its rear seam, rearward displacement of the left front door such that the door latch became inoperable, and a slight displacement of the right fender rearward, reducing the space between the fender’s rear seam and the forward seam of the right front door. In addition, there was no evidence of intrusion to the case vehicle. The case vehicle was towed due to disabling damage.

Based on the vehicle inspection, the CDC was determined to be: **12-FDEW-3 (0)** for the case vehicle [maximum crush, which was located above the bumper, was 43 centimeters (16.9 inches)]. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle’s highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 21.2 km.p.h. (13.2 m.p.h.), -21.2 km.p.h. (-13.2 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.).

An inspection of the case vehicle's interior revealed that there were scuff marks on: the rim and on one of the spokes of the steering wheel, to the left of the steering column on the left lower instrument panel, and on the glove box door. There was a bloodstain on the front header above the front right seating area and a soda splash mark on the roof. In addition, there was a large bloodstain on the center console storage area, including inside the center console's storage area cover (Figures 9, 10, 11 and 12). There were bloodstains on the forward side of the front right seat back. Finally, there were body oil smudges on the backside of the front right seat back.

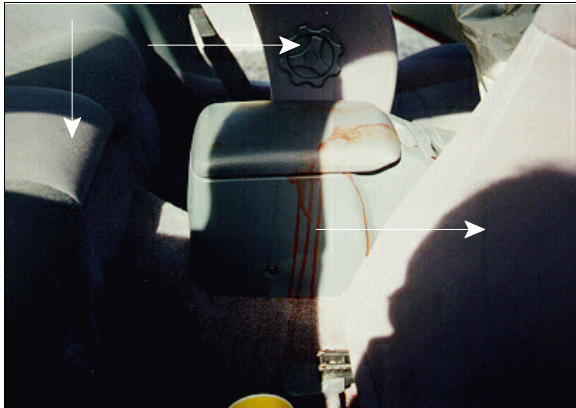


Figure 9: Case vehicle's bloodstained console storage area cover; Note: arrows indicate (left-to-right) back bench seat and driver and front right passenger bucket seats (case photo #42)



Figure 10: Overhead view of case vehicle's bloodstained console storage area cover; Note: driver's seat is further forward than front right passenger's seat (case photo #43)



Figure 11: Inside surface of case vehicle's console storage area cover showing bloodstains, indicating that cover was raised at time of crash (case photo #44)



Figure 12: Bloodstains on inside of case vehicle's console storage area; Note: console storage area is viewed from driver's seat (case photo #45)

AUTOMATIC RESTRAINT SYSTEM

As previously mentioned, the case vehicle was equipped with a SRS that consisted of frontal air bags at the driver and front right passenger seat positions. The SRS deployed as a result of the case vehicle's frontal impact with the rear of the Pontiac. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of "H"-configuration cover flaps made of thick vinyl with both the top and bottom cover laps being 17 centimeters (6.7 inches) wide

and 6 centimeters (2.4 inches) high. An inspection of the air bag module's cover flaps and air bag fabric 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 two tethers, each 8 centimeters (3.1 inches) wide. The driver's air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 11:30 and 12:30 o'clock positions. The deployed driver's air bag was elliptical with a height of approximately 52 centimeters (20.5 inches) and a width of approximately 60 centimeters (23.6 inches). There was a lipstick smear on the driver's air bag, located in the upper right quadrant near the center of the air bag (**Figure 13**). The smear was located 10 centimeters (3.9 inches) above a line laterally through the middle of the air bag and 9 centimeters (3.5 inches) to the right of a line vertically through the center of the air bag.



Figure 13: Case vehicle's deployed driver air bag showing probable occupant contact evidence in upper right quadrant (case photo #39)

The front right passenger's air bag was located in the middle of the instrument panel. There was a single, rectangular, modular cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were: 53 centimeters (20.9) at the horizontal seam and 23 centimeters (9.1 inches) along the vertical seam. The profile of the case vehicle's instrument panel/dash resulted in a 2 centimeter (0.8 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 fabric 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 front right passenger's air bag was designed without any tethers. The front right air bag had two vent ports, approximately 6 centimeters (2.4 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 66 centimeters (26.0 inches) and a width of approximately 44 centimeters (17.3 inches). There was no contact evidence readily apparent on the front right air bag (**Figure 14**). The distance from the forward surface of the front right seat back to the approximate maximum excursion point of the front right air bag was measured as 34 centimeters (13.4 inches).



Figure 14: Case vehicle's deployed front right passenger air bag; Note: no visible contact evidence was found on this air bag (case photo #49)

The exact posture of the case vehicle's front right passenger [8-year-old, White (non-Hispanic) male; unknown height and 29 kilograms (63 pounds)], immediately prior to the crash, is unknown. However, based on the available evidence, the case vehicle's front right passenger was most likely seated in an upright posture with his back against the seat back, leaning slightly to his left, and both feet hanging over the front edge of the seat's cushion, angled downward. The exact position of his hands is unknown. Based on the vehicle inspection, his seat track was located in its middle position, and the seat back was upright.

According to his family and his medical records, the case vehicle's front right passenger was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. However, there was no evidence of belt pattern bruising and/or abrasions to the front right passenger's body, and the inspection of the front right passenger's "D"-ring and latch plate showed no evidence of loading. But, there was an ill-defined, diagonal crease across his seat belt webbing indicating at most a minor loading force.

The case vehicle's driver braked (with lock-up), attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of his available safety belts, the front right passenger most likely moved slightly forward and upward (because the case vehicle dipped downward due to its pre-crash braking) just prior to impact. The case vehicle's impact with the Pontiac enabled the front right passenger to continue forward and slightly upward and only inconsequentially loading his safety belts, as the case vehicle decelerated. Because of the front right seat track's "middle" position, the deploying front right air bag struck the front right passenger on his right forehead most likely before he was able to significantly load his safety belts and, as a result, his head and torso were redirected leftward, backward, and downward, out from underneath the torso portion of his safety belt, toward the case vehicle's center console. The left side of the front right passenger's head impacted the center console's storage area and the raised storage area cover. As the case vehicle rotated slightly counterclockwise and continued forward, the front right passenger's torso rebounded forward, reloading the lap portion of his safety belt system before rebounding backward into his seat back as the case vehicle came to rest. According to his medical records, the front right passenger was found sitting in his seat, but his exact posture is unknown. Based on the amount of blood found on and near the center console, the front right passenger's head was most likely leaning toward the console at final rest.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right occupant was transported by ambulance to the hospital. He sustained severe brain injuries and was hospitalized 3 days post-crash. The injuries sustained by the case vehicle's front right passenger included: a severe nonanatomic brain injury; a small, left, subdural hematoma; small, cerebral contusions; an abrasion to his right forehead; and a scalp contusion and laceration. His right forehead abrasion was caused by the deploying front right air bag, and his brain and scalp lesions were caused by the center console.

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 = 7-8, with appropriate movements but only to painful stimuli	160820.4 severe	Center console	Probable	Hospitalization records
2	Hematoma, subdural, small [5 mm (0.2 in) thick], over left frontal-parietal area	140652.4 severe	Center console	Probable	Hospitalization records
3	Contusions ¹ , small [5 mm (0.2 in) in diameter] over right upper frontal lobe and right temporal-parietal lobe	140614.3 serious	Center console	Certain	Hospitalization records
4	Abrasion, small right forehead	290202.1 minor	Air bag, front right passenger's	Certain	Hospitalization records
5	Contusion {subgaleal hematoma}, prominent, high left posterior	190402.1 minor	Center console	Certain	Hospitalization records
6	Laceration, 2 cm (0.8 in) left occipital scalp	190602.1 minor	Center console	Certain	Hospitalization records

CASE VEHICLE DRIVER KINEMATICS

The exact posture of the case vehicle's driver [babysitter; 16-year-old, White (unknown if Hispanic) female] is unknown. However, based on the available physical evidence, she was most likely 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 at least one hand on the steering wheel (i.e., the exact position of her hands is unknown). Her seat track was located between its middle and forward-most positions, the seat back was upright, and the tilt steering wheel was located in its middle position. The case vehicle's driver (of unknown height and weight) was restrained by her available, active, three-point, lap-and-shoulder, safety belt system.

The case vehicle's driver braked (with lock-up), attempting to avoid the crash. As a result of her attempted avoidance maneuver and the use of her available safety belts, the driver most likely moved slightly forward and upward (because the case vehicle dipped downward due to its pre-crash braking) just prior to impact. The case vehicle's impact with the Pontiac enabled the

¹ In this contractor's opinion, these contusions are most likely contrecoup in nature and occurred when this occupant's left posterior head impacted the inside portion of the center console's lid, which was open and raised upward at the time of the crash. The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

contrecoup (kon"tra-koo'): injury resulting from a blow on another site, such as a fracture of the skull caused by a blow on the opposite side. See also *contrecoup contusion*.

contusion (ken"too'zhen): a bruise; an injury of a part without a break in the skin.

contrecoup c.: a contusion resulting from a blow on one side of the head with damage to the cerebral hemisphere on the opposite side by transmitted force.

driver to continue forward and slightly upward, loading her safety belts, as the case vehicle decelerated. Based on the available evidence, the deploying driver air bag struck her in the face and neck area (i.e., according to the police reported injuries) and redirected her head and torso backward toward the left side of her seat back as the case vehicle rotated slightly counterclockwise and continued forward. The case vehicle's driver most likely rebounded forward, reloading her safety belt system before rebounding backward into her seat back as the case vehicle came to rest. Because there was no interview with the case vehicle's driver, her exact posture at final rest is unknown.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital. She sustained, according to the Police Crash Report, a minor neck abrasion and was treated and released.

CASE VEHICLE BACK RIGHT PASSENGER KINEMATICS

The exact posture of the case vehicle's back right passenger [i.e., brother of front right passenger; 6-year-old, White (non-Hispanic) male] is unknown; however, he was most likely seated in an upright posture with his back against the seat back and both feet dangling down over the front edge of the seat's cushion, angled downward; however, the exact position of his hands is unknown. His seat track and seat back were not adjustable. The case vehicle's back right passenger (of unknown height and weight) was restrained by his available, active, three-point, lap-and-shoulder, safety belt system.

The case vehicle's driver braked (with lock-up), attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of his available safety belts, the back right passenger most likely moved slightly forward and upward (because the case vehicle dipped downward due to its pre-crash braking) just prior to impact. The case vehicle's impact with the Pontiac enabled the back right passenger to continue forward and slightly upward, loading the lap portion of his safety belt system, as the case vehicle decelerated. Although it is unknown exactly what position (i.e., on the child's body) the torso portion of the continuous loop, three-point, safety belt was in, based on the child's age and the distance from the front portion of the back seat's seat back to the back side of the front right seat's seat back (**Figure 15**), this contractor concluded, based on the physical evidence found during the case vehicle's inspection, that the torso portion of the safety belt was most likely behind the back right passenger's back just prior to the crash. As the back right passenger rotated over the lap portion of his safety belt, his face continued forward, striking the back side of the front right seat's seat back. As the case vehicle rotated slightly counterclockwise and continued forward,

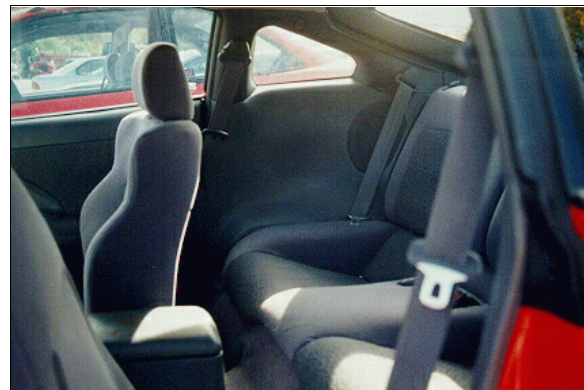


Figure 15: Case vehicle's back right seating area viewed from driver's door; Note: proximity of console storage area to front right seat, front bucket seats, and three-point safety belts in outboard seating positions (case photo #53)

the back right passenger’s torso rotated slightly leftward before rebounding backward into his seat back as the case vehicle came to rest. At final rest the exact posture of the back right passenger is unknown, but he was most likely still seated in the back right seat.

CASE VEHICLE BACK RIGHT PASSENGER INJURIES

The back right passenger was transported by ambulance to the hospital. He sustained minor injuries and was treated and released. According to his medical records, the injuries sustained by the case vehicle's back right passenger included: contusions to his right hip bone and the soft tissue of his right hip, and a laceration to his upper mouth. His contusions were caused by his loading the lap portion of his safety belt system and the laceration was caused by his face striking the backside of the front right seat back.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion, bone, right anterior iliac crest	850602.1 minor	Lap portion of 3-point safety belt	Certain	Emergency room records
2	Contusion {ecchymosis} right pelvis	890402.1 minor	Lap portion of 3-point safety belt	Certain	Emergency room records
3	Laceration, superficial, upper gum {gingiva}	243204.1 minor	Front right seat back	Probable	Emergency room records

OTHER VEHICLE

The 1996 Pontiac Grand Am SE was a front wheel drive, five-passenger, two-door coupe (VIN: 1G2NE12T7TM-----) equipped with a 2.4L, MFI, L-4 engine and a four-speed automatic transmission with a console-mounted shift lever. Four-wheel, anti-lock brakes are standard for this model. The Pontiac’s wheelbase was 263 centimeters (103.4 inches), and the odometer reading at inspection was 53,681 kilometers (33,356 miles). The Pontiac was equipped with both driver and front right passenger supplemental restraint systems (air bags) which did not deploy as a result of its rear impact. The Pontiac was towed due to disabling damage.

The lower half of the back bumper of the Pontiac was impacted by the top half of the case vehicle’s front bumper. This vertical mismatch of the bumpers resulted in a classic underride of the Pontiac. The low contact to the Pontiac's back bumper, combined with the 180 Direction of Principal Force, torqued the back bumper off its



Figure 16: Pontiac's damaged back viewed from left of back; Note: induced damage to left quarter panel (case photo #64)

mounts. The back bumper corners were cracked. The bumper backing bracket was torqued downward. Both the right and left quarter panels were displaced forward and buckled, both rearward and forward of the rear axle (**Figure 16** above and **Figure 17**). The back panel above the bumper and below the trunk lid shows back-to-front contact damage.

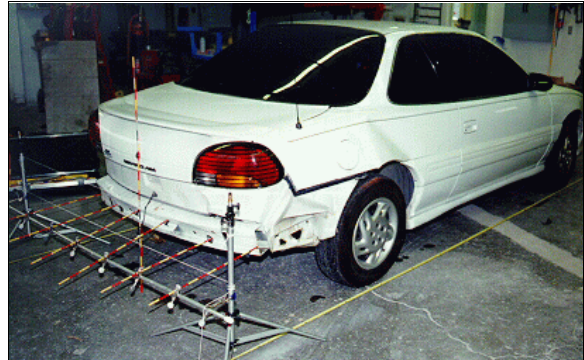


Figure 17: Pontiac's damaged back viewed from right of back; Note: induced damage to right quarter panel (case photo #68)

Based on the vehicle inspection, the CDC was determined to be: **06-BDEW-2 (180)** for the Pontiac [maximum crush was 15 centimeters (5.9 inches)]. The WinSMASH reconstruction program, damage only algorithm, was used on the Pontiac's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 22.2 km.p.h. (13.8 m.p.h.), +22.2 km.p.h. (+13.8 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.).

The Pontiac's driver [23-year-old, White (non-Hispanic) female; 163 centimeters and 91 kilograms (64 inches, 200 pounds)] was not using her available, active, three-point, lap-and-shoulder, safety belt system. The Pontiac's driver air bag was located in the steering wheel hub and did not deploy.

The Pontiac's driver sustained self-reported lacerations to each side of the bridge of her nose from her glasses. In this contractor's opinion, her face most likely contacted the steering wheel hub after she rebounded forward from her seat back. In addition, she complained of soreness to her right neck, center of her chest, right upper arm, and upper back. She was transported by ambulance from the scene to a local medical facility where she was treated and released.

