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ON-SITE AIR BAG INVESTIGATION

CASE NUMBER - IN97-028
LOCATION - TEXAS
VEHICLE - 1997 TOYOTA CAMRY LE
CRASH DATE - August, 1997

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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 1997 Toyota Camry LE, four-door sedan, with manual safety belts and dual front air bags, and a 1994 Chrysler Concorde, four-door sedan

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 1997 Toyota Camry LE (case vehicle) and a 1994 Chrysler Concorde (other vehicle). This crash is of special interest because the case vehicle's unrestrained, front right passenger (6-year-old female) sustained a critical brain injury as a result of contacting her deploying front right air bag. The case vehicle was traveling west in the inside westbound through lane of a five-lane, divided, city trafficway [i.e., both the east and west roadways had two through lanes and one (opposing) left-hand, turn lane on both the west and east legs of the four-leg intersection]. The Chrysler had been traveling east in the left-hand turn lane of the eastbound roadway and was making a left turn attempting to travel north on an intersecting trafficway. The crash occurred in the inside through lane of the westbound roadway in the four-leg intersection of the two trafficways. The front of the case vehicle impacted the right side of Chrysler, 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, with her seat track located in its middle position, and was not using her available, active, three-point, lap-and-shoulder, safety belt system. She sustained, according to her medical records, a severe nonanatomic brain injury, bilateral subdural hematoma/hemorrhages, a brain contusion, a hyphema to her right eye, and abrasions to her forehead and right face as a result of contacting her deploying air bag. In addition, she sustained spiral fractures of her left tibia and fibula from contacting the right lower portion of the center instrument panel and right knee bolster. The case vehicle's driver (34-year-old female) was seated with her seat track located between its middle and forward-most positions, and the tilt steering wheel was located between its middle and up-most positions. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to her interview and her medical records, minor injuries which included: a laceration to her right upper arm; abrasions to her forehead and left inner forearm; and contusions to her forehead, arms–including left inner forearm, and right thumb.

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BACKGROUND

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This on-site investigation was brought to NHTSA's attention on September 2, 1997 by an investigator with the NTSB. This crash involved a 1997 Toyota Camry LE (case vehicle) and a 1994 Chrysler Concorde (other vehicle). The crash occurred in August, 1997, at 5:47 p.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the case vehicle's unrestrained, front right passenger [6-year-old, Black (non-Hispanic) female] sustained a critical brain injury as a result of contacting her deploying front right air bag. This contractor inspected the scene and vehicles on September 4, 1997. This contractor interviewed the case vehicle's driver on September 4, 1997. 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 in the inside westbound through lane of a five-lane, divided, city trafficway and intended to continue its westbound path of travel through an intersection [i.e., both the east and west roadways had two through lanes and one (opposing) left-hand, turn lane on both the west and east legs of the four-leg intersection]. The Chrysler had been traveling east in the left-hand turn lane of the eastbound roadway and was making a left turn attempting to travel north on an intersecting trafficway. The case vehicle's driver braked, attempting to avoid the crash. The crash occurred in the inside through lane of the westbound roadway in the four-leg intersection of the two trafficways; see **CRASH DIAGRAM** below.

The front of the case vehicle impacted the right side of Chrysler, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle continued in a west-northwesterly direction and rotated approximately 70 degrees clockwise before coming to rest in the intersection heading north, aligned with the inside southbound through lane of the intersecting trafficway. The Chrysler was pushed in a northwesterly direction and rotated approximately 65 degrees clockwise before coming to rest in the mouth of the intersecting southbound roadway straddling the lane line that separated the inside through lane from the left-hand turn lane.

The case vehicle's front right passenger [117 centimeters and 23.2 kilograms (46 inches, 51 pounds)] was not using her available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there was no indication of belt pattern bruising and/or abrasions to the front right passenger's body. In addition, the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the nonuse of any child safety seat or her available safety belts, the front right passenger moved rapidly (i.e., heavy braking) forward, with her head and torso angling forward, just prior to impact. The case vehicle's impact with the Chrysler enabled the front right passenger to continue further forward towards the **340** degree Direction of Principal Force and upwards in a sideways "V"-shaped pattern as the case vehicle decelerated. She contacted the right

side of the center instrument panel and right knee bolster with her left foot and lower legs. The front right passenger's forehead and face contacted the top portion of the air bag's fabric, and simultaneously, her chest contacted the front portion of the air bag as it expanded. She was subsequently lifted upwards by the deploying air bag, where she contacted the front right sun visor with the top of her head. At final rest the front right passenger ended up on the floorboard in the front right seating area of the case vehicle.

The front right occupant was transported by ambulance to the hospital. According to her medical records and the interview with the case vehicle's driver and family attorney, she sustained severe to critical brain injuries and was hospitalized for 14 days post-crash. The injuries sustained by the front right passenger included: a severe nonanatomic brain injury, bilateral subdural hematoma/hemorrhages, a brain contusion, a hyphema to her right eye, and abrasions to her forehead and right face as a result of contacting her deploying air bag. In addition, she sustained spiral fractures of her left tibia and fibula from contacting the right lower portion of the center instrument panel and right knee bolster.

The 1997 Toyota Camry LE was a front wheel drive, four-door sedan (VIN: 4T1BG22K2VU------). The case vehicle was equipped with anti-lock brakes. The 1994 Chrysler Concorde was a front wheel drive, four-door sedan (VIN: 2C3HL56F9RH------). Both vehicles were towed from the scene due to damage. Based on the vehicle inspections, the CDCs are: **11-FZEW-1 (340)** for the case vehicle [maximum crush was 15 centimeters (5.9 inches) at C_6] and **01-RYEW-2 (30)** for the Chrysler [maximum crush was 29 centimeters (11.4 inches) at C_5]. 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: 18.9 km.p.h. (11.7 m.p.h.), -17.8 km.p.h. (-11.1 m.p.h.), and +6.5 km.p.h. (+4.0 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 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 6 centimeters (2.4 inches) in width. The driver's air bag had two vent ports, approximately 2.5 centimeters (1.0 inch) in diameter, located at the 11:30 and 12:30 o'clock positions. The deployed driver's air bag was round with a diameter of 70 centimeters (27.6 inches). There was contact evidence readily apparent (i.e., makeup and/or lipstick smears) just to the left and immediately above the center of the driver's air bag.

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 flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the bottom cover flap. However, there was a grease smudge near the bottom cover flap that most likely occurred during the air bag's removal (i.e., cutout) by the applicable rescue personnel. In addition, the top cover flap contacted the windshield fracturing it in an elongated spider web pattern. The front right passenger's air bag was designed with one tether, 45 centimeters (17.7 inches) in width, stretching almost across the entire front surface of the air bag. The front right air bag had no vent ports. The deployed front right air bag was rectangular

with a height of approximately 63 centimeters (24.8 inches) and a width of approximately 48 centimeters (18.9 inches). An inspection of the air bag revealed a large amount of contact evidence readily apparent [i.e., transfer marks (e.g., areas of skin and oil smears)] on the top surface and under side of the front right air bag.

The inspection of the case vehicle's interior revealed an area of what was most likely air bag exhaust gas residue on the upper portion of the left "A"-pillar and on the left sun visor. Further, there was a possible skin or cloth transfer on the right side of the steering column and a scuff on the right side of the center console. There were scuff marks on: the right side of the lower portion of the center instrument panel, the right knee bolster, the glove box door, and the right sun visor. The mirror on the back side of the right sun visor had been cracked from its compression against the front right header as a result of contact by the front right passenger. In addition, the windshield glazing, just to the left of the rearview mirror, had been cracked when the lower right corner of the rearview mirror was contacted by the front right passenger's air bag, knocking it backwards and to its left into the windshield. The front right passenger air bag's fabric had been compressed backwards and upwards by loading from the front right occupant. The rearview mirror was also broken out. Further, the lower portion of the right windshield's glazing was cracked by the front right air bag module's top cover flap. Finally, there was a scuff near the top of the right windshield's glazing that most likely came from the front right air bag's fabric.

Immediately prior to the crash the case vehicle's front right passenger was seated in an upright posture, with her back against the seat back, her feet dangling over the front edge of the seat's cushion, and both hands on her lap. According to the case vehicle's driver, her seat track was located in its middle position. The vehicle inspection showed that her seat track was located in its rearmost position, and the seat back was slightly reclined. The seat track was most likely moved backwards by emergency medical personal in order to remove the front right passenger from the floorboard.

Immediately prior to the crash the case vehicle's driver [Aunt of front right passenger; 34-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 on the brake, and both hands on the steering wheel. Her seat track was located between its middle and forward-most positions, the seat back was upright, and the tilt steering wheel was located between its middle and up-most positions. The case vehicle's driver [163 centimeters and 64 kilograms (64 inches, 140 pounds)] was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The driver was driven from the crash scene by a relative and went later to a hospital for treatment. She sustained minor injuries and was treated and released. According to her interview and medical records, the injuries sustained by the case vehicle's driver include: a laceration to her right upper arm; abrasions to her forehead and left inner forearm; and contusions to her forehead, arms–including left inner forearm, and right thumb.

The case vehicle was traveling west in the inside westbound through lane (**Figure 1**) of a five-lane, divided, city trafficway and intended to continue its westbound path of travel through an intersection [i.e., both the east and west roadways had two through lanes and one (opposing) left-hand, turn lane on both the west and east legs of the four-leg intersection]. The Chrysler had been traveling east in the left-hand turn lane of the eastbound roadway (**Figure 2**) and was making a left turn attempting to travel north on an intersecting trafficway. The case vehicle's driver braked, attempting to avoid the crash. The crash occurred in the inside through lane of the westbound roadway in the four-leg intersection of the two trafficways (**Figure 3**); see **CRASH DIAGRAM** below.

Figure 1: Case vehicle's westward travel path in inside through lane of westbound roadway (case photo #02)

Figure 2: Chrysler's eastward travel path in left-hand turn lane of eastbound roadway (case photo #05)

Figure 3: Chrysler's northeastward travel path during left-hand turn across westbound roadway just prior to impact (case photo #07)

The city trafficway was curved slightly to the left for westbound traffic and level at the area of impact. The pavement was bituminous, and the width of the case vehicle's inside westbound through lane was 3.7 meters (12.1 feet) and the Chrysler's eastbound left-hand turn lane was 3.2 meters (10.5 feet). The shoulders were improved (i.e., concrete), with a 0.5 meter wide (1.6 foot) shoulder adjacent to the barrier curb on the north side of the westbound roadway and a 0.5 meter wide (1.6 foot) shoulder adjacent to the barrier curb on the south side of the eastbound roadway. The roadways were divided by a mountable median that was only 1.5 meters (4.9 feet) wide at the area of impact. Pavement markings for both the east and westbound roadways consisted of a dashed white line to separate the two through lanes and a solid white line to separate the through lanes from their respective left-hand turn lanes. In addition, no edge lines were present. The estimated coefficient of friction for the trafficway was 0.75. On-colors, pre-timed, vertically and horizontally mounted traffic control signals with turn arrows were located on the opposite side of

the mouth of the intersection for each vehicle, respectively. No regulatory speed limit signs were posted near the crash site. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the road pavement was dry. Traffic density was moderate, and the site of the crash was primarily urban residential with some commercial buildings.

The front (**Figures 4**, **5**, and **6**) of the case vehicle impacted the right side (**Figures 7** and **8** below) of Chrysler, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle continued in a west-northwesterly direction and rotated approximately 70 degrees clockwise before coming to rest in the intersection heading north, aligned with the inside southbound through lane of the intersecting trafficway. The Chrysler was pushed in a northwesterly direction and rotated approximately 65 degrees clockwise before coming to rest in the mouth of the intersecting southbound roadway straddling the lane line that separated the inside through lane from the left-hand turn lane.

Figure 4: Case vehicle's frontal damage with contour gauge present; Note: direct damage extends along front from front right corner to yellow tape (case photo #16)

Figure 5: Case vehicle's damaged front viewed from right of front with contour gauge present; Note: yellow tape highlights end point of direct damage (case photo #09A)

Figure 6: Case vehicle's frontal damage viewed along reference line from right with contour gauge present (case photo #15)

CASE VEHICLE

The 1997 Toyota Camry LE was a front wheel drive, five passenger, four-door sedan (VIN: 4T1BG22K2VU------) equipped with power-assisted rack-and-pinion steering, a 2.2L, DOHC MPEFI, I-4 engine, and a four-speed automatic transmission. Braking was achieved by a power-assisted, front and rear disc, four-wheel, anti-lock system. The case vehicle's wheelbase was 267 centimeters (105.2 inches), and the odometer reading at inspection is unknown because the case vehicle was equipped with an electronic odometer. The Camry had an retractable electronic sun roof which was closed at the time of the crash.

Figure 7: Chrysler's damaged right side viewed from right of front (case photo #63)

Figure 8: Chrysler's right side damage viewed from front of right (case photo #62)

Inspection of the vehicle's interior revealed electronic window and door locks; adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat with adjustable head restraints for the back outboard seating positions; a 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. Only the passenger's knee bolster showed contact evidence (i.e., scuffing). 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 front seat air bags deployed as a result of the case vehicle's frontal impact with the Chrysler.

CASE VEHICLE DAMAGE

The case vehicle's contact with the Chrysler involved the right two-thirds of the Camry's front bumper. Direct damage began 40 centimeters (15.75 inches) left of center (**Figures 4** and **5** above) and extended across the bumper to the right bumper corner, a measured distance of 107 centimeters (42.1 inches). Maximum residual crush was measured as 15 centimeters (5.9 inches) at C_6; however, the residual crush was only 1 centimeter (0.4 inches) at C_1. The wheelbase on the case vehicle was not altered. The case vehicle's front bumper, bumper fascia, bumper reinforcement bar, grille, right headlight and turn signal assemblies, right fender, and hood were directly damaged and crushed rearward. The front bumper fascia, bumper reinforcement bar, and right fender were slightly shifted to the right due to the **340** degree Direction of Principal Force. The uneven damage pattern indicates an obtuse angle impact such as in this crash, consistent with the Chrysler's turning across the Camry's path of travel. The case vehicle's right front tire was physically restricted but not deflated. The right fender and hood sustained induced damage as well.

Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **11-FZEW-1 (340)**. 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: 18.9 km.p.h. (11.7 m.p.h.), -17.8 km.p.h. (-11.1 m.p.h.), and +6.5 km.p.h. (+4.0 m.p.h.). The case vehicle was towed from the scene due to damage.

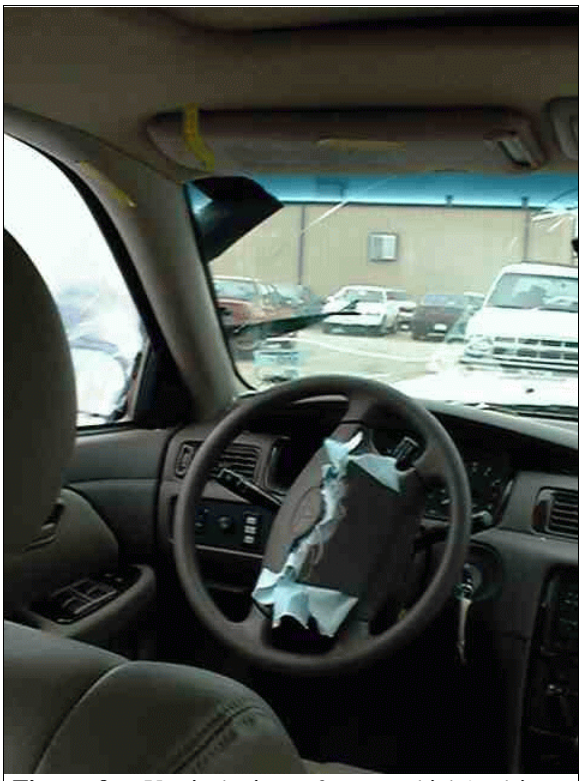


Figure 9: Vertical view of case vehicle's driver seating area showing deployed driver air bag module's cover flaps, remainder of cutout driver's air bag, and probable air bag exhaust gas residue on left "A"-pillar and on left sun visor (case photo #21)

Figure 10: Vertical view of case vehicle's front right seating area showing contacts to instrument panel area (i.e., yellow tape) and sun visor by front right passenger; Note: windshield glazing was cracked by front right module's top cover flap (case photo #32)

The Inspection of the case vehicle's interior revealed an area of what was most likely air bag exhaust gas residue on the upper portion of the left "A"-pillar and on the left sun visor (**Figure 9**). The driver's door glazing was disintegrated during the Camry's air bag deployment sequence. The energy absorbing steering column showed no evidence of compression. Further, there was a possible skin or cloth transfer on the right side of the steering column and a scuff on the right side of the center console. There were scuff marks on (**Figure 10**): the right side of the lower portion of the center instrument panel, the right knee bolster, the glove box door (**Figure 11** below), and the right sun visor (**Figure 12** below). The mirror on the back side of the right sun visor had been cracked from its compression against the front right header as a result of contacted by the front right passenger. In addition, the windshield glazing, just to the left of the rearview mirror, had been cracked when the lower right corner of the rearview mirror was contacted by the front right passenger's air bag, knocking it backwards and to its left into the windshield. The front right passenger air bag's fabric had been compressed backwards and upwards by loading from the front right occupant. The rearview mirror was also broken out. Further, the lower portion of the right windshield's glazing was cracked by the front right air bag module's top cover flap. Finally,

there was a scuff near the top of the right windshield's glazing that most likely came from the front right air bag's fabric.

Figure 11: Close-up of contact evidence on case vehicle's center instrument panel and front right knee bolster and glove box door (case photo #34)

Figure 12: Close-up of case vehicle's right sun visor showing contact evidence from front right passenger's head (case photo #36)

AUTOMATIC RESTRAINT SYSTEM

Figure 13: Close-up of case vehicle's steering wheel showing deployed driver air bag module's cover flaps and remainder of cutout driver's air bag (case photo #23)

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 frontal impact with the Chrysler. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of slightly asymmetrical "H"-configuration cover flaps made of thick vinyl with overall dimensions of 16 centimeters (6.3 inches) at the horizontal seam and, along the side seams, 6 centimeters (2.4 inches) vertically for the upper flap and 8 centimeters (3.1 inches) vertically for the lower flap. 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**). The driver's air bag was designed with two tethers, each 6 centimeters (2.4 inches) in width, sewn internally at the 3 and 9 o'clock positions. A 16 centimeter (6.3 inches) diameter tether reinforcement was sewn to the center face of the air bag with two rows of stitching. The driver's air bag had two vent ports, approximately 2.5 centimeters (1.0 inch) in diameter, located at the 11:30 and 12:30 o'clock positions. The deployed driver's air bag was round with a diameter of 70 centimeters (27.6 inches). There was contact evidence readily apparent (i.e., makeup and/or lipstick smears) just to the left and immediately above the center tether reinforcement of the driver's air bag (**Figure 14** below). The contact evidence started 15 centimeters (5.9 inches) down from the top edge and 27 centimeters (10.6 inches) in from the right edge.

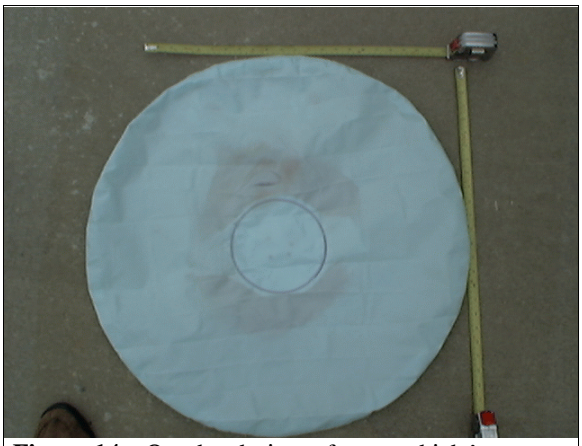


Figure 14: Overhead view of case vehicle's cutout driver air bag showing sewn center tether and contact evidence (case photo #38)

The front right passenger's air bag was located in the top of the instrument panel. There were two, essentially rectangular, modular cover flaps with hinges forward (i.e., towards the passenger) and rearward (i.e., toward the windshield). The cover flaps were made of a thick vinyl without any metal frame backing. The upper flap's dimensions were 22 centimeters (8.7 inches) along the horizontal seam and 5 centimeters (2.0 inches) along both vertical seams. The lower flap's dimensions were 22 centimeters (8.7 inches) along the horizontal seam and 9 centimeters (3.5 inches) along both vertical seams. The profile of the case vehicle's instrument panel resulted in a 15 centimeter (5.9 inch) setback of the leading edge of the bottom 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 flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the bottom cover flap. However, there was a grease smudge near the bottom cover flap that most likely occurred during the air bag's removal (i.e., cut out) by the applicable rescue personnel. Because of the absence of cover flap-type injuries to the front right passenger, direct contact to the bottom cover flap was discounted. In addition, the top cover flap contacted the windshield fracturing it in an elongated spider web pattern (**Figure 10** above). The front right passenger's air bag was designed with one tether, 45 centimeters (17.7 inches) in width, stretching almost across the entire front surface of the air bag (**Figure 15**). The tether was sewn to the face of the passenger air bag at a point that was approximately 44 centimeters (17.3 inches) below the top horizontal edge of the bag and approximately 19 centimeters (7.5 inches) above the bottom horizontal edge. The front right air bag had no vent ports. The deployed front right air bag was rectangular with a height of approximately 63 centimeters (24.8 inches) and a width of approximately 48 centimeters (18.9 inches).

Figure 15: Overhead view of front surface of case vehicle's cutout, front right passenger air bag showing, no visible contact evidence, dimensions, and tether straps (case photo #43)

Examination of the front right passenger's air bag revealed a large amount of transfer marks (e.g., areas of skin) to the top surface and a small amount to the under side of the air bag (**Figure 16** below). The transfers on the under side most likely came from the front right passenger's legs (**Figure 17** below). The transfer evidence on the top of the front right passenger's air bag consisted of three heavy streaks of what appeared to be dark skin transfers. There was also an unknown fluid stain on the left side of the air bag, towards the top. The skin transfers to the

bottom portion were approximately 13 centimeters (5.1 inches) wide and 11 centimeters (4.3 inches) long, starting at the left edge. The other transfer was 8 centimeters (3.1 inches) wide and 16 centimeters (6.3 inches) long, starting 13 centimeters (5.1 inches) inward from the right edge.

Figure 16: Overhead view of case vehicle's cutout and folded over, front right passenger air bag showing skin evidence on top and underside surfaces (case photo #47)

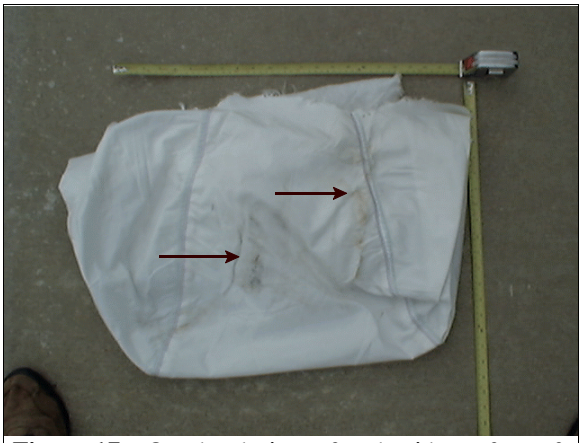


Figure 17: Overhead view of underside surface of case vehicle's cutout, front right passenger air bag showing skin transfers (case photo #44)

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's front right passenger [6-year-old, Black (non-Hispanic) female] was seated in an upright posture, with her back against the seat back, her feet sticking out over the front edge of the seat's cushion, and both hands on her lap. According to the case vehicle's driver, her seat track was located in its middle position. The vehicle inspection showed that her seat track was located in its rearmost position, and the seat back was slightly reclined. The seat track was most likely moved backwards by emergency medical personal in order to remove the front right passenger from the floorboard.

The case vehicle's front right passenger [117 centimeters and 23.2 kilograms (46 inches, 51 pounds)] was not using her available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there was no indication of belt pattern bruising and/or abrasions to the front right passenger's body. In addition, the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading. The front right safety belt's adjustable upper anchorage was located in its down-most position (**Figure 18**).

Figure 18: Case vehicle's unused front right passenger safety belt system; Note: adjustable upper anchorage located in down-most position (case photo #37)

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted

avoidance maneuver and the nonuse of any child safety seat or her available safety belts, the front right passenger moved rapidly (i.e., heavy braking) forward, with her head and torso angling forward, just prior to impact. The case vehicle's impact with the Chrysler enabled the front right passenger to continue further forward towards the **340** degree Direction of Principal Force and upwards in a sideways "V"-shaped pattern as the case vehicle decelerated. She contacted the right side of the center instrument panel and right knee bolster with her left foot and lower legs (**Figure 11** above). Her head was most likely close to the front right air bag module at the moment of deployment with her face and neck just beyond the excursion of the leading edge of the air bag module's bottom cover flap. The front right passenger's forehead and face (i.e., primarily the right side) contacted the top portion of the air bag's fabric, and simultaneously, her chest contacted the front portion of the air bag as it expanded. The passenger's forward movement did not impede the deploying air bag, but her loading of the air bag redirected the air bag's fabric in an upward direction where it contacted the windshield and rearview mirror. She was subsequently lifted upwards by the deploying air bag, where she contacted the front right sun visor with the top of her head (i.e., skin and hair deposits–**Figure 12** above). At final rest the front right passenger ended up on the floorboard in the front right seating area of the case vehicle.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right occupant was transported by ambulance to the hospital. According to her medical records and the interview with the case vehicle's driver and family attorney, she sustained severe to critical brain injuries and was hospitalized for 14 days post-crash. The injuries sustained by the front right passenger included: a severe nonanatomic brain injury, bilateral subdural hematoma/hemorrhages, a brain contusion, a hyphema to her right eye, and abrasions to her forehead and right face as a result of contacting her deploying air bag. In addition, she sustained spiral fractures of her left tibia and fibula from contacting the right lower portion of the center instrument panel and right knee bolster.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury with loss of consciousness and neurological deficit (i.e., unequal pupils); GCS=9 decreasing to 6	160804.4 severe	Air bag, front right passenger's	Probable	Hospitalization records
2	Hematoma/hemorrhage, subdural, bilaterally[1]: tiny (3 mm) right frontal hematoma; small, interhemispheric, hemorrhage over left occipital pole	140654.5 critical	Sun visor, front right[1]	Probable	Hospitalization records

[1] It is entirely possible that the right frontal subdural hematoma resulted from contact with the front right passenger's air bag; however, it could also have resulted from the front right sun visor. On the other hand, the subdural hemorrhage over the left occipital pole most likely came from the contact with the front right sun visor. Because these lesions are aggregated in the AIS, the contact mechanism was assigned to the front right sun visor as the "best fit".

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
3	Contusion left temporal lobe	140606.3 serious	Sun visor, front right	Probable	Hospitalization records
4	Fracture, spiral, left distal tibia, not involving epiphysis	853420.2 moderate	Center instrument panel and below[2]	Probable	Hospitalization records
5	Fracture, spiral, left proximal fibula, not involving epiphysis	851606.2 moderate	Knee bolster, front right[2]	Probable	Hospitalization records
6	Abrasions, multiple, forehead with swelling[3] (i.e., right greater than left)	290202.1 minor	Air bag, front right passenger's	Certain	Hospitalization records
7	Abrasions, multiple, right face around right eye	290202.1 minor			
8	Contusion (i.e., hyphema) right cornea	240604.1 minor	Air bag, front right passenger's	Certain	Hospitalization records

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [Aunt of front right passenger; 34-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 on the brake, and both hands on the steering wheel. Her seat track was located between its middle and forward-most positions, the seat back was upright, and the tilt steering wheel was located between its middle and up-most positions. The case vehicle's driver [163 centimeters and 64 kilograms (64 inches, 140 pounds)] was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed evidence of loading (**Figure 19**) on the upper torso portion of the belt webbing. The upper anchorage for the driver's shoulder belt was adjusted between its middle and down-most positions.

Figure 19: Close-up of loading evidence on case vehicle's driver safety belt (case photo #25)

[2] In this contractor's opinion, the left foot most likely snagged on and smudged the right side of the center instrument panel as she was moving forward in response to the Direction of Principal Force. When her face contacted the front right passenger's air bag, she was lifted upwards. As a result, the proximal portion of her left leg impact the right knee bolster. Because of the snagging a twisting force was created causing the spinal fractures. Therefore, the distal fracture was assigned to the center instrument panel and the proximal fracture was assigned to the knee bolster.

[3] The swelling most likely resulted from the contact with the sun visor whereas the abrasions came from the front right passenger air bag.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of her available safety belts, she moved (i.e., heavy braking) forward, with her head and torso angling forward, just prior to impact. The case vehicle's impact with the Chrysler enabled the driver to continue further forward and leftward toward the **340** degree Direction of Principal Force as the Camry decelerated. The driver's face impacted the deploying driver's air bag depositing make-up transfers on the air bag's fabric (**Figure 14** above). At final rest the driver remained in her seat, essentially in her pre-crash posture. The steering wheel rim was not deformed, and there was neither evidence of contact on the steering wheel nor was there compression of the energy absorbing steering column.

CASE VEHICLE DRIVER INJURIES

The case vehicle's driver was driven from the crash scene by a relative and went later to a hospital for treatment. She sustained minor injuries and was treated and released. According to her interview and medical records, the injuries sustained by the case vehicle's driver include: a laceration to her right upper arm; abrasions to her forehead and left inner forearm; and contusions to her forehead, arms–including left inner forearm, and right thumb.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Abrasion forehead, not further specified	290202.1 minor	Air bag, driver's	Certain	Interviewee (same person)
2	Contusion {bruise} forehead, not further specified	290402.1 minor	Air bag, driver's	Probable	Interviewee (same person)
3	Laceration {cut} right upper arm	790600.1 minor	Air bag, driver's	Probable	Emergency room records
4	Abrasion, minor, left inner forearm	790202.1 minor	Air bag, driver's	Certain	Emergency room records
5	Contusion {bruise}, large, inside left forearm	790402.1 minor	Air bag, driver's	Probable	Emergency room records
6	Contusions {bruises} to arms, location(s) not further specified	790402.1 minor	Air bag, driver's	Possible	Emergency room records
7	Contusion right thumb	790402.1 minor	Steering wheel rim	Probable	Emergency room records

OTHER VEHICLE

The 1994 Chrysler Concorde was a front wheel drive, five-passenger, four-door sedan (VIN: 2C3HL56F9RH------) equipped with a 3.5L, SOHC SMPS, V-6 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, four-wheel, anti-lock system. The 1997 Chrysler Camry's wheelbase was 287 centimeters (113.0 inches), and the odometer reading at inspection {was 127,687 kilometers (79,341 miles).

Inspection of the vehicle's interior revealed electronic window and door locks; adjustable front bucket seats with center arm rest and adjustable head restraints; a non-adjustable back bench seat without head restraints for the back outboard seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the front and back outboard positions; and a two-point, lap belt system at the back center position. The front seat belt systems were equipped with manually operated height adjusters for the "D"-rings, both of which were located in their down-most position. The vehicle was equipped with knee bolsters for both the driver and front right passenger. 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. Neither front seat air bag deployed (**Figure 20** and **Figure 21**) as a result of the Chrysler's right side impact with the case vehicle.

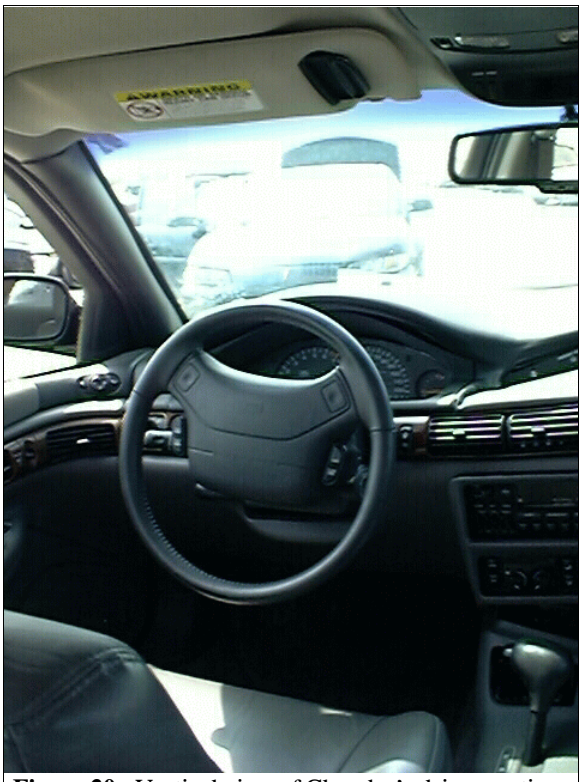


Figure 20: Vertical view of Chrysler's driver seating area showing non-deployed driver's air bag; Note: steering wheel is inverted (case photo #67)

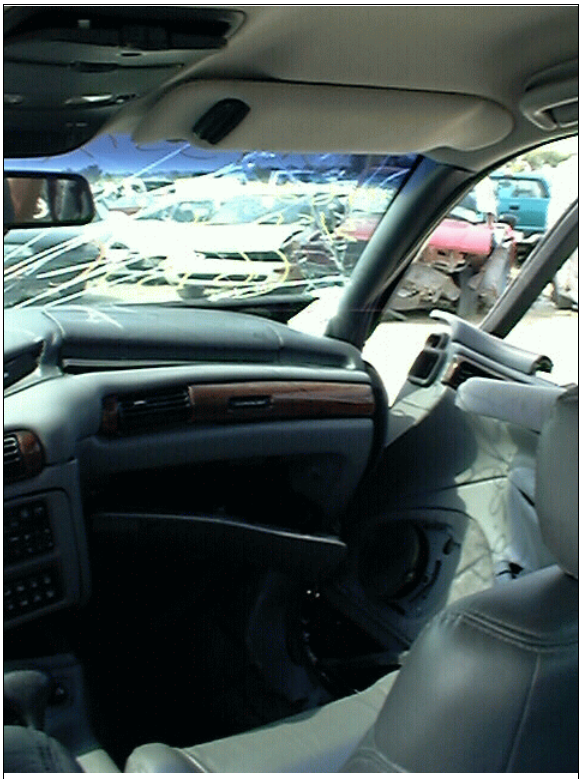
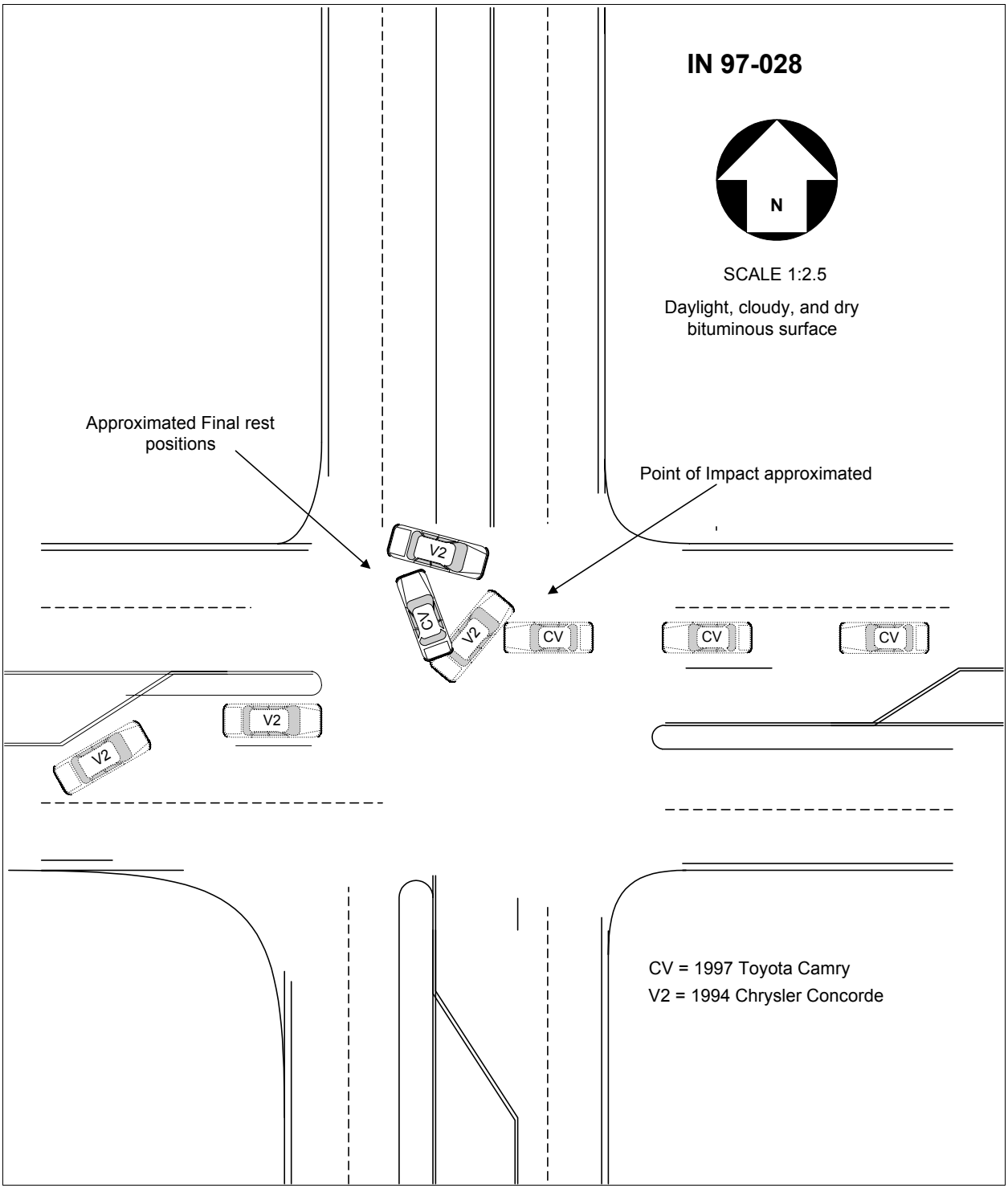


Figure 21: Vertical view of Chrysler's front right passenger seating area showing deformed front right instrument panel and non-deployed front right passenger's air bag (case photo #69)

The Chrysler's contact with the case vehicle involved the right side between the axles. Direct damage began 86 centimeters (33.9 inches) forward of the right rear axle and extended forward, a measured distance of 196 centimeters (77.2 inches), to just rearward of the right front axle (**Figures 7** and **8** above). Maximum crush was measured as 29 centimeters (11.4 inches) at C_5. The Chrysler's right fender, right front and rear doors, and right quarter panel were directly damaged and crushed inward. The right front door glazing was disintegrated from the side impact. There was moderate lateral intrusion [15-24 centimeters (6-9 inches)] to the right door panel, sill, and side panel forward of the right front door's "A"-pillar (**Figure 8** above). There

was also minor lateral intrusion to the right front dash board and right B-pillar (**Figure 21** above). The Chrysler's right front was physically restricted and deflated as a result of the crash.

Based on the vehicle inspection, the CDC for The Chrysler was determined to be: **01-RYEW-2 (30)**. The WinSMASH reconstruction program, damage only algorithm, was used on the Chrysler's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 16.1 km.p.h. (10.0 m.p.h.), -14.0 km.p.h. (-8.7 m.p.h.), and -8.1 km.p.h. (-5.0 m.p.h.). The Chrysler was towed from the scene due to damage.


IN 97-028
N
SCALE 1:2.5
Daylight, cloudy, and dry bituminous surface
Approximated Final rest positions
Point of Impact approximated
V2
V2
V2
CV
CV
CV
V2
V2
CV = 1997 Toyota Camry
V2 = 1994 Chrysler Concorde