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ON-SITE CHILD AIR BAG-RELATED FATALITY INVESTIGATION

CASE NUMBER - IN99-037
LOCATION - TEXAS
VEHICLE - 1994 PLYMOUTH VOYAGER SE
CRASH DATE - March, 1999

Submitted:

February 17, 2003

Contract Number: DTNH22-94-D-17058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
National Center for Statistics and Analysis
Washington, D.C. 20590-0003

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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

1. *Report No.* IN99-037	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* On-Site Child Air Bag-Related Fatality Investigation Vehicle - 1994 Plymouth Voyager SE Location - Texas		5. *Report Date:* February 17, 2003 6. *Performing Organization Code*	
7. *Author(s)* Special Crash Investigations Team #2		8. *Performing Organization Report No.* Task #s 0194 and 0276	
9. *Performing Organization Name and Address* Transportation Research Center Indiana University 222 West Second Street Bloomington, Indiana 47403-1501		10. *Work Unit No. (TRAIS)* 11. *Contract or Grant No.* DTNH22-94-D-17058	
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation (NRD-32) National Highway Traffic Safety Administration National Center for Statistics and Analysis Washington, D.C. 20590-0003		13. *Type of Report and Period Covered* Technical Report Crash Date: March, 1999 14. *Sponsoring Agency Code*	

15. *Supplementary Notes*
On-site air bag deployment investigation involving a 1994 Plymouth Voyager SE, three-door Minivan, with manual belts and dual front air bags, and a 1996 Honda Accord LX, four-door sedan

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash involved a 1994 Plymouth Voyager (case vehicle) and a 1996 Honda Accord LX (other vehicle). This crash is of special interest because one of the case vehicle's two, unrestrained, front right passengers (2-year-old female) sustained a fatal injury from the deploying front right air bag. The case vehicle was traveling northeast in the outside northeastbound lane of a five-lane, undivided, city roadway (i.e., there were two through lanes in both directions and one bidirectional center left-hand turn lane). The Honda was also traveling northeast in the outside northeastbound lane and came to a stop to allow a noncontact vehicle in front of her to turn right into a private driveway. The crash occurred in the outside northeastbound lane of the roadway. The front of the case vehicle impacted the back of the Honda, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The Honda was knocked forward, and both vehicle's came to final rest in the same lane. The case vehicle's front right bucket seat was occupied by the driver's two daughters. The passenger on the outside of the front right seat was seated but leaning forward. The passenger on the inside (4-year-old female) was also seated but was leaning slightly backwards and to her right with her right arm outstretched attempting to retrieve the stored front right seat belt. At the time of the vehicle inspection, the front right seat track was located in its rearmost position; however, the exact position of the seat track is unknown. The seat was most likely moved post-crash to allow for removal of one or both of the injured front right passengers. Neither front right passenger was using the available, active, three-point, lap-and-shoulder, safety belt system. The outside-seated front right passenger sustained, according to her autopsy, fatal decapitation-related injuries as a result of contacting the front right passenger air bag module's cover flap. The inside-seated front right passenger sustained, according to the interview with the case vehicle's driver (i.e., mother) lacerations underneath her left eye (cheek) and to her left chin and abrasions to the right side of her neck and around the right ear. In addition, she was treated for shock. The driver (34-year-old female) was seated with her seat track located between its middle and rearmost positions, and the tilt steering wheel was located in its upmost position. She was not using her available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to her interview, minor injuries which included: a fractured right index finger and contusions to her right hand (knuckles), right forearm, and knees, bilaterally.

17. *Key Words* Air Bag Deployment Motor Vehicle Traffic Crash Injury Severity		18. *Distribution Statement* General Public	
19 *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 17	22. *Price* $7,800

Form DOT 1700.7 (8-72) Reproduction of completed page authorized

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BACKGROUND IN99-037

This on-site investigation was brought to NHTSA's attention on March 26,1999 by a NHTSA regional office. This crash involved a 1994 Plymouth Voyager (case vehicle) and a 1996 Honda Accord LX (other vehicle). The crash occurred in March, 1999, at 9:26 a.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the one of the case vehicle's two, unrestrained, front right passengers [2-year-old, White (Hispanic) female] sustained a fatal injury from the deploying front right air bag. This contractor inspected the scene and vehicles on 29-30 March, 1999. This contractor obtained a partial interview from the case vehicle's driver in April 1999. This summary 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, the autopsy for the fatally injured passenger, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling northeast in the outside northeastbound lane of a five-lane, undivided, city roadway and intended to continue traveling northeastward (i.e., there were two through lanes in both directions and one bi-directional center left-hand turn lane). The Honda was also traveling northeast in the outside northeastbound lane of the same five-lane roadway and came to a stop to allow a noncontact northeastbound vehicle in front of her to turn right into a private driveway. The case vehicle's driver braked, depositing a 4.6 meter (15 foot) right front tire skid mark while attempting to avoid the crash. Because only the right front tire locked-up, the case vehicle went into an approximate 15 degree clockwise yaw just prior to impact. The crash occurred in the outside northeastbound lane of the roadway, just southwest of the private driveway; see **CRASH DIAGRAM** below.

The front of the case vehicle impacted the back of the Honda, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The Honda was knocked forward, and both vehicle's came to final rest in the outside northeastbound lane. The case vehicle came to rest heading in a east-northeasterly direction. The Honda came to rest heading in a northeasterly direction approximately 0.9 meters (3 feet) from a second noncontact vehicle which had entered the northeastbound lane from the driveway; see discussion on **CRASH DIAGRAM** below.

The case vehicle was a front wheel drive 1994 Plymouth Voyager, three-door minivan (VIN: 2P4GH45R4R4RR------). The case vehicle was not equipped with anti-lock brakes. Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **11-FDEW-1** (**340** degrees). 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: 20.5 km.p.h. (12.7 m.p.h.), -19.3 km.p.h. (-12.0 m.p.h.), and +7.0 km.p.h. (+4.3 m.p.h.). The case vehicle was towed due to damage.

The case vehicle's initial contact with the Honda involved greater than two-thirds of the front surface, measured form the front left bumper corner. Direct damage began at the front left bumper corner and extended, a measured distance of 109 centimeters (42.9 inches), along the front

bumper to the right. Induced damage involved the entire front of the case vehicle, resulting in a Field "L" of 149 centimeters (58.7 inches). The most significant deformation was concentrated on the front left half of the vehicle. Maximum residual crush was measured as 18 centimeters (7.1 inches) at C_3. The case vehicle's wheelbase on both the left or right sides was not altered (i.e., shortened or extended). The case vehicle's front bumper, bumper fascia, grille, hood, radiator, and left headlight and turn signal assemblies were directly damaged and crushed rearward. The case vehicle's left front tire was partially, physically restricted from the front end damage, and none of the tires were deflated during the crash. Only the left fender sustained induced damage from the frontal impact.

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 to the air bag or the cover flaps. The driver's air bag was designed without any tethers. 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 round with diameter 63 centimeters (24.8 inches). There was contact evidence readily apparent (e.g., area of make-up and lipstick smears) on the fabric 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 flap and air bag revealed that the cover flap opened at the designated tear points and there was no evidence of damage during the deployment to the air bag; however, the cover flap was deformed and there appeared to be skin on the module's cover flap. The front right passenger's air bag was designed with two tethers, each 31 centimeters (12.2 inches) wide. The front right air bag had no vent ports. The deployed front right air bag was rectangular with a height of approximately 65 centimeters (25.6 inches) and a width of approximately 48 centimeters (18.9 inches). An inspection of the air bag's fabric revealed an area of oil/skin and blood transfer readily apparent on the front right air bag, extending from the top portion down the front continuing onto the bottom portion of the bag.

Inspection of the case vehicle's interior revealed that there was also evidence of occupant contact to the case vehicle's center instrument panel, glove box, right windshield, right windshield header and/or sun visor, and front right passenger seat back.

The Honda is a front wheel drive 1996 Honda Accord LX, four-door sedan (VIN: 1HGCD5633TA------). Based on the vehicle inspection the CDC for the Honda was **06-BDEW-2** (**180** degrees) [maximum crush was 37 centimeters (14.6 inches) at C_2]. The Honda was towed due to damage.

Immediately prior to the crash the case vehicle's front right bucket seat was occupied by the driver's two White, Hispanic daughters. The passenger located in the outside portion of the front right seat [95 centimeters and 15 kilograms (37.5 inches, 32 pounds)] was seated but leaning forward with her feet dangling over the front edge of the seat's cushion and both hands in her lap. The passenger located in the inside portion [4-year-old female; 109 centimeters and 17 kilograms (43 inches, 38 pounds)] was also seated but was leaning slightly backwards and to her right with

her feet hanging over edge of the seat cushion–most likely oriented toward the center console, and her arms outstretched toward the right. According to the case vehicle's driver, just prior to the crash the daughter seated on the inside portion of the seat was leaning back and to her right, behind her 2-year-old little sister, with her right arm outstretched attempting to retrieve the stored front right seat belt. As a result, the daughter on the outside was leaning forward and possibly scooted forward on the seat, making it easier for her sister to reach the seat belt.

At the time of the vehicle inspection, the front right seat track was located in its rearmost position, and the seat back was slightly reclined (i.e., 32 degrees rearward of vertically perpendicular to the floor). Because of the large amount of cargo packed in the van behind the front seats [e.g., 1.2 meter (4 foot) wooden table and boxes of hair curlers and other hairstyling supplies], it is more likely that the seat track was further forward allowing for more cargo space; however, the exact position of the seat track is unknown. According to the driver, she was not aware that the front right seat track was adjustable. The seat was most likely moved post-crash to allow for removal of one or both of the injured front right passengers.

The outside-seated front right passenger was not using the available, active, three-point, lap-and-shoulder, safety belt system. The case vehicle's inside-seated front right passenger was also not restrained by the available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there was no evidence of belt pattern bruising and/or abrasions on either the outside-seated or the inside-seated passenger's body. In addition, the inspection of the front right seating position'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, the resulting clockwise yaw, and the nonuse of the available safety belts, both front right passengers moved forward and slightly to the left just prior to impact. Since part of the inside-seated front right passenger's body was located behind the outside-seated front right passenger, the inside passenger's (4-year-old) weight helped push the outside passenger (2-year-old) forward where her knees impacted the glove box in the right instrument panel. The case vehicle's impact with the Honda enabled the case vehicle's outside-seated front right passenger to continue forward, slightly leftward, and upward toward the 340 degree Direction of Principal Force as the case vehicle decelerated. Furthermore, a portion of the inside passenger's body was compressing her outside sister against the instrument panel. As a result, the outside-seated front right passenger's head/neck was positioned directly atop the cover flap and deploying air bag near the moment of deployment.

At final rest the outside-seated front right passenger was found seated on the floor in the slide-out supplemental glove box with her torso turned slightly to the right, her back against the base of the seat cushion, her right leg folded under the left, and the left leg extended straight out in front of her. The outside-seated front right passenger's head was decapitated by the front right air bag module's cover flap and deploying air bag. Her head was lifted upward where it struck the windshield, front right header, sun visor, and front right seat back before coming to rest on the floor next to her inside-seated sister. The inside-seated front right passenger's lower legs broke the cup holder sticking out of the center instrument panel prior to rebounding and coming to rest on the floor between the two front seats.

The outside-seated front right occupant was transported directly to the morgue. She sustained fatal decapitation-related injuries as a result of contacting the front right passenger air bag module's cover flap and was pronounced dead at the scene.

The inside-seated front right passenger was transported by helicopter to a trauma hospital approximately 30 miles north as a precautionary measure. She sustained minor soft tissue injuries and was treated and released. Her injuries included: lacerations underneath her left eye (cheek) and to her left chin and abrasions to the right side of her neck and around the right ear. In addition, she was treated for shock.

The case vehicle's driver [34-year-old, White (non-Hispanic) female; 163 centimeters and 93 kilograms (64 inches, 205 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the brake, and both hands on the steering wheel. According to the case vehicle's driver the seat track was located between its middle and rearmost positions, the seat back was upright, and the tilt steering wheel was located in its upmost position. However, at the time of the vehicle inspection, her seat track was located in its rearmost position. The seat track had most likely been moved post-crash to allow for removal of the injured children from the floor.

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

The driver sought treatment later at a hospital. She sustained minor injuries and was treated and released. The self-reported injuries sustained by the case vehicle's driver included: a fractured right index finger and contusions to her right hand (knuckles), right forearm, and knees, bilaterally.

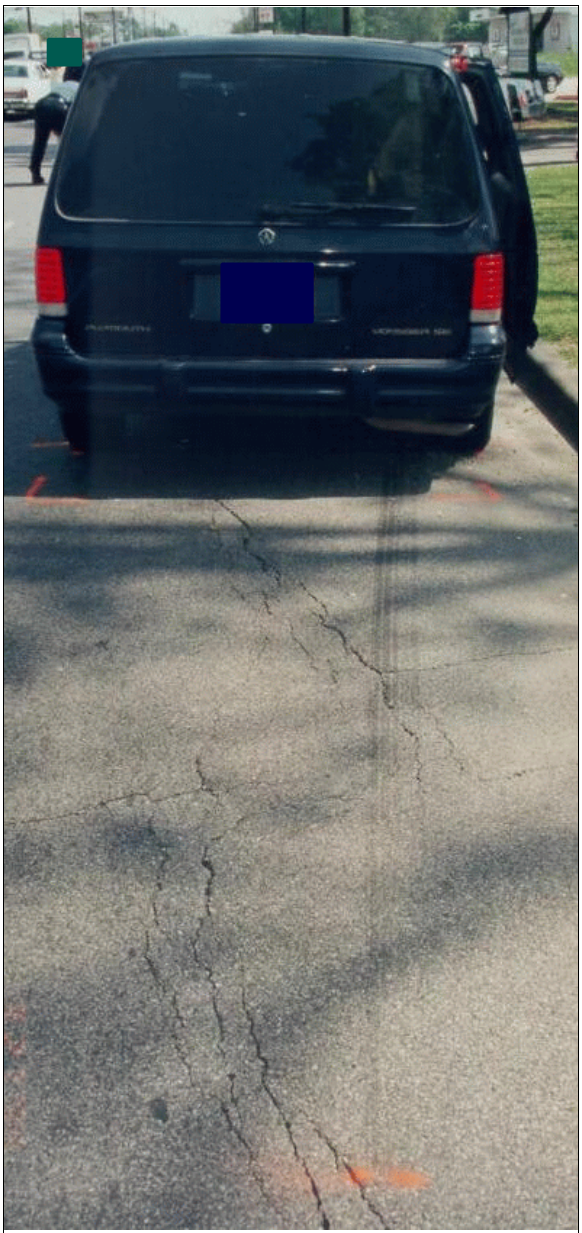

Figure 1: On-scene eastward view showing case vehicle's pre-crash trajectory and final rest position; Note: rightward yawing skid mark (case photo #63)

The case vehicle was traveling northeast in the outside northeastbound lane of a five-lane, undivided, city roadway and intended to continue traveling northeastward (i.e., there were two through lanes in both directions and one bi-directional center left-hand turn lane). The Honda was also traveling northeast in the outside northeastbound lane of the same five-lane roadway and came to a stop to allow a noncontact northeastbound vehicle in front of her to turn right into a private driveway. The case vehicle's driver braked, depositing a 4.6 meter (15 foot) right front tire skid mark while attempting to avoid the crash (**Figure 1** above). Because only the right front tire locked-up, the case vehicle went into an approximate 15 degree clockwise yaw just prior to impact. The crash occurred in the outside northeastbound lane of the roadway (**Figure 2**), just southwest of the private driveway; see **CRASH DIAGRAM** below.

Figure 2: Approximate point of impact (arrow) in outside northeastbound lane between case vehicle and Honda (case photo #02)

The city roadway was straight and level (i.e., actual slope was 0.03%, positive to the east) near the area of impact. The pavement was bituminous, but traveled, and the width of the outside eastbound travel lane for both vehicles was 3.3 meters (10.8 feet). The shoulders were improved (i.e., concrete) with a short concrete shoulder adjacent to and bordered by 10.2 centimeter (4 inches) high barrier curbs on both the north and south sides of the road. The east and westbound lanes were separated by an unknown width bidirectional turn lane which was bordered on each side by a single solid yellow line on the outside and a single broken yellow line on the inside. The two east and westbound lanes were divided by a dashed white line; in addition, no edge lines were present. The estimated coefficient of friction was 0.75. Regulatory **NO PARKING ANY TIME** signs (Manual on Uniform Traffic Control Devices, R7-1) were located on both the north and south sides of the road in the immediate area of the crash. The posted speed limit was 64 km.p.h. (40 m.p.h.). At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the road pavement was dry. The traffic density is unknown, and the site of the crash was urban commercial. In addition, there were a driveway within a short distance of the crash site.

The front of the case vehicle (**Figure 3**) impacted the back of the Honda (**Figure 4** below), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The Honda was knocked forward, and both vehicle's came to final rest in the outside northeastbound lane. The case vehicle came to rest heading in a east-northeasterly direction. The Honda came to rest heading in a northeasterly direction approximately 0.9 meters (3 feet) from

Figure 3: Case vehicle's frontal damage viewed from left of center; Note: damage from impact with back of Honda (case photo #11)

a second noncontact vehicle which had entered the northeastbound lane from the driveway; see discussion on **CRASH DIAGRAM** below.

Figure 4: Deformation to back of Honda from impact with case vehicle; Note: impact offset toward right side and location (arrow) of tailpipe–see **Figure 5** below (case photo #58)

CASE VEHICLE

The 1994 Plymouth Voyager SE was a front wheel drive, seven-passenger, three-door minivan (VIN: 2P4GH45R4RR------) equipped with a 3.3L, V-6 engine and a four-speed automatic transmission. Four-wheel, anti-lock brakes are an option for this model, but the case vehicle was not so equipped. The case vehicle's wheelbase was 285 centimeters (112.3 inches), and the odometer reading at inspection was 161,766 kilometers (100,517 miles).

Inspection of the vehicle's interior revealed that the front seating area had adjustable front bucket seats with adjustable head restraints. The second seating row had two non-adjustable bucket seats with integral head restraints. The back row had a non-adjustable back bench seat with folding backs but without head restraints. Continuous loop, three-point, lap-and-shoulder, safety belt systems were provided at the front, second, and back outboard seating 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 positioned in their down-most position. The vehicle was equipped with knee bolsters for both the driver and front right passenger, neither of which were deformed. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. Both frontal air bags deployed as a result of the case vehicle's frontal impact with the Honda.

CASE VEHICLE DAMAGE

The case vehicle's initial contact with the Honda involved greater than two-thirds of the front surface, measured form the front left bumper corner. Direct damage began at the front left bumper corner and extended, a measured distance of 109 centimeters (42.9 inches), along the front bumper to the right. Induced damage involved the entire front of the case vehicle, resulting in a Field "L" of 149 centimeters (58.7 inches). The most significant deformation was concentrated on the front left half of the vehicle (**Figure 5** and **Figure 6** below). Maximum residual crush was measured as 18 centimeters (7.1 inches) at C_3. The case

Figure 5: Case vehicle's frontal damage; Note: direct damage extends from front left corner rightward to yellow tape and slight imprint (arrow) from Honda's tailpipe (case photo #07)

vehicle front bumper had an impression of the Honda's tailpipe towards the center indicating the crash was offset (**Figures 4** and **5** above). The case vehicle's wheelbase on both the left or right sides was not altered (i.e., shortened or extended). The case vehicle's front bumper, bumper fascia, grille, hood, radiator, and left headlight and turn signal assemblies were directly damaged and crushed rearward. The case vehicle's left front tire was partially, physically restricted from the front end damage, and none of the tires were deflated during the crash. Only the left fender sustained induced damage from the frontal impact.

Figure 6: Case vehicle's frontal damage viewed from right of center (case photo #13)

Figure 7: Case vehicle's front right seating area showing blood evidence on front right seat cushion, scuffs to glove box door, and blown out air vent in right instrument panel (case photo #32)

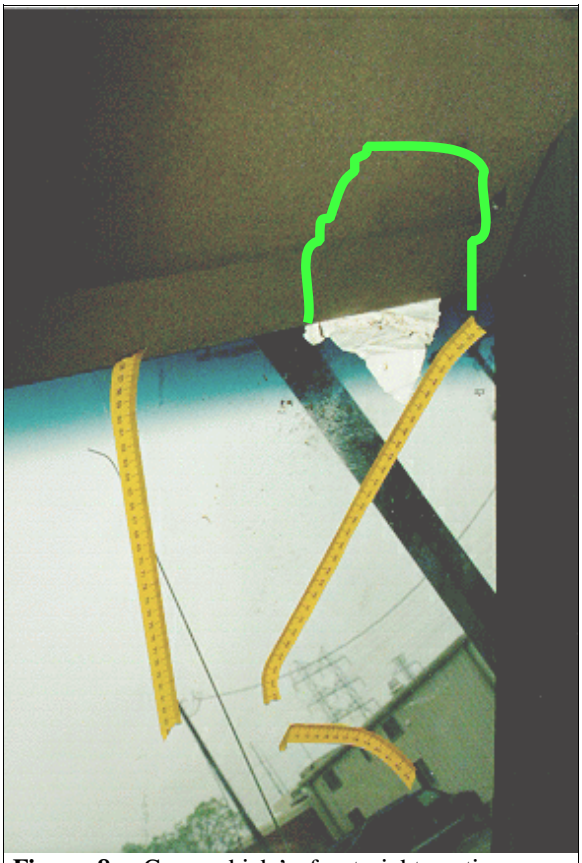

Figure 8: Case vehicle's front right seating area showing skin and body fluid transfers to windshield, front header, and sun visor from decapitated head; Note: paper from air bag has been jammed between front header and windshield (case photo #36)

Inspection of the case vehicle's interior revealed that there was also evidence of occupant contact to the case vehicle's center instrument panel, glove box, right windshield, right windshield header and/or sun visor, and front right passenger seat back. Specifically, the cup holder in the center instrument panel was broken off and the center instrument panel was scuffed from contact by the lower extremities of the inside-seated front right passenger. The glove box door on the right instrument panel had both a distinct and barely visible scuff from the outside-seated front right passenger's knees. The air vent on the far right corner of the instrument panel had most likely been blown out during the air bag's deployment (**Figure 7**). There was tape residue ("L"-shaped) on the windshield near the base on

the front right passenger side. In addition, as seen in previous SCI crashes involving Minivans, there was a brush abrasion from the air bag to the door handle on the right front passenger's door.

The windshield on the right side towards the header was contacted by the decapitated head of the outside-seated front right passenger. Furthermore, the right header and/or sun visor was also contacted by the decapitated head. The windshield header on the passenger side had a piece of paper from the air bag jammed between the header and windshield. This paper (**Figure 8** above) was most likely driven upwards to this location by the front right passenger's head (**Figure 8** above). There was also an area of puddled blood on the front right seat cushion and a blood splatter to the front right seat back from the decapitated head of the outside-seated front right passenger (**Figure 9**). In addition, there were blood splatters scattered throughout the entire front seat area. The left windshield had a spider web crack towards the left "A"-pillar which most likely resulted from contact by a piece of cargo from within the case vehicle; however, it is possible that the driver's left hand contacted the windshield, but there were no lesions reported to this extremity. The rearview mirror was knocked off most likely from contact by the front right air bag as the air bag expanded upwards because of the loading from the two front right occupants. Finally, the energy absorbing steering column showed no visible evidence of compression, and there was no visible evidence of intrusion.

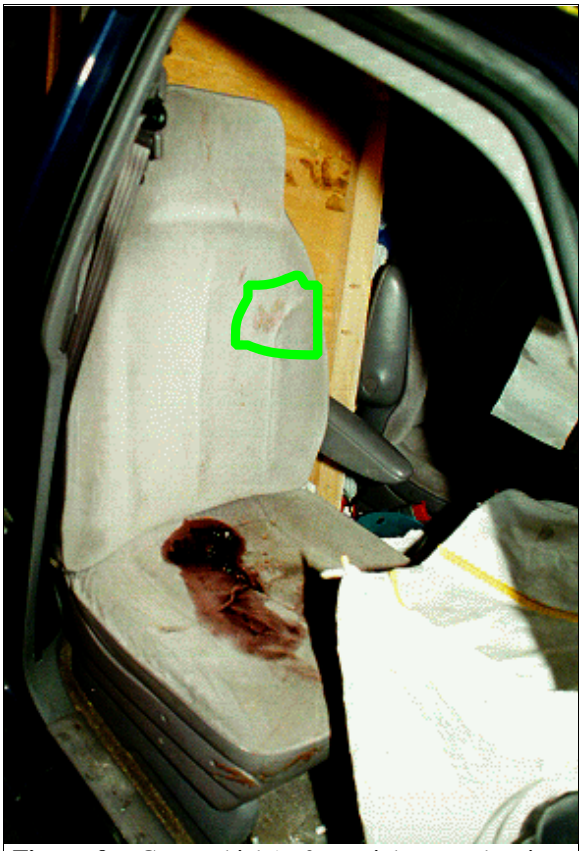

Figure 9: Case vehicle's front right seat showing pooled blood on seat cushion and head contact (i.e., outlined) to seat back (case photo #31)

Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **11-FDEW-1** (**340** degrees). 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: 20.5 km.p.h. (12.7 m.p.h.), -19.3 km.p.h. (-12.0 m.p.h.), and +7.0 km.p.h. (+4.3 m.p.h.). The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. Both air bags deployed as a result of the frontal impact with the Honda. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of asymmetrical "H"-configuration cover flaps made of thick vinyl with overall dimensions of 17 centimeters (6.7 inches) at the middle horizontal seam

and 6 centimeters (2.4 inches) vertically for the upper flap and 7 centimeters (2.8 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 to the air bag or the cover flaps; however, the air bags deployment did result in a 2 centimeter (0.8 inch) tearing at the module's four corners. The driver's air bag was designed without any tethers. 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 round with a diameter 63 centimeters (24.8 inches). An inspection of the driver's air bag revealed a lipstick imprint and make-up smear, measuring 13 x 11 centimeters (5.1 x 4.3 inches), on the lower right quadrant of the front surface (**Figure 10**).

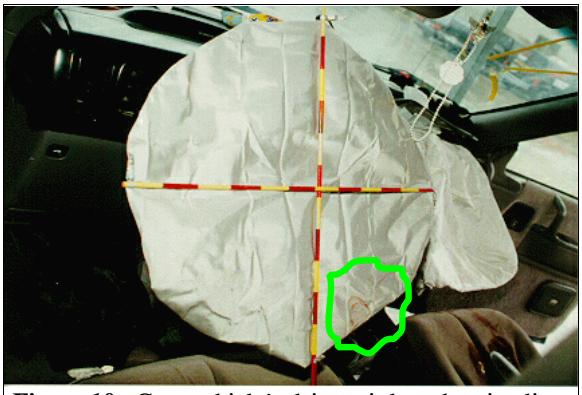

Figure 10: Case vehicle's driver air bag showing lipstick and make-up smear (i.e., circled) on lower right quadrant (case photo #39)

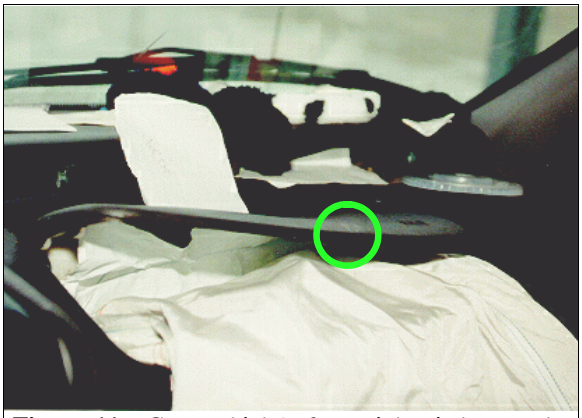

Figure 11 Case vehicle's front right air bag module's cover flap showing misalignment resulting from contact with front right passenger and skin transfer in circled area (case photo #48)

The front right passenger's air bag was located in the top of the instrument panel. There was a single, essentially rectangular, modular cover flap. The cover flap was made of a thick vinyl over a thin metal frame. The flap's dimensions were 32 centimeters (12.6 inches) at the lower horizontal seam and 14 centimeters (5.5 inches) along both vertical seams. The profile of the case vehicle's instrument panel resulted in a 3 centimeter (1.2 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. An inspection of the front right air bag module's cover flap and air bag revealed that the cover flap opened at the designated tear points and there was no evidence of damage during the deployment to the air bag; however, the cover flap was deformed (**Figure 11**) and there appeared to be skin on the top and leading edge of the module's cover flap. The skin transfer was at the middle of the leading edge with the skin flakes directly behind on the top of the flap. The front right passenger's air bag was designed with two internal tethers, each 31 centimeters (12.2 inches) wide. Both tethers were sewn to the interior face of the air bag, 30 centimeters (11.8 inches) apart with the lower tether starting at a point that was 11 centimeters (4.3 inches) above the bottom edge. The front right air bag had no vent ports. The deployed front right air bag was rectangular with a height of approximately 65 centimeters (25.6 inches) and a width of approximately 48 centimeters (18.9 inches). An inspection of the air bag's fabric revealed an extensive transfer of skin to the top, front, and bottom surfaces of the air bag (**Figure 12** below). The skin transfer started approximately 26 centimeters (10.2 inches) down from the inflator tube and extended downwards onto the front surface and continued down the entire length of the front

surface. The skin transfer also continued onto the bottom surface an additional 26 centimeters (10.2 inches). The composition of the skin transfer on the top surface was very heavy then became lighter for the next 24 centimeters (9.4 inches) prior to the resumption of the heavy skin transfer and its continuation down the remainder of the front and bottom surfaces. The top of the skin transfer was 10 centimeters (3.9 inches) wide and started 18 centimeters (7.1 inches) in from the left edge. The lower half of the skin transfer was 13 centimeters (5.1 inches) wide and started 8 centimeters (3.1 inches) from the left edge.

Figure 12: Vertical view of case vehicle's front right passenger air bag showing skin and body fluid transfers down entire front of air bag (case photo #44)

CASE VEHICLE "OUTSIDE-SEATED" FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's front right bucket seat was occupied by the driver's two daughters. The passenger located in the outside portion of the front right seat [2-year-old, White (Hispanic) female; 95 centimeters and 15 kilograms (37.5 inches, 32 pounds)] was seated but leaning forward with her feet dangling over the front edge of the seat's cushion and both hands in her lap. According to the case vehicle's driver, just prior to the crash the daughter seated on the inside portion of the seat was leaning back and to her right, behind her 2-year-old little sister, with her right arm outstretched attempting to retrieve the stored front right seat belt. As a result, the daughter on the outside was leaning forward and possibly scooted forward on the seat, making it easier for her sister to reach the seat belt.

At the time of the vehicle inspection, the front right seat track was located in its rearmost position, and the seat back was slightly reclined (i.e., 32 degrees rearward of vertically perpendicular to the floor). Because of the large amount of cargo packed in the van behind the front seats [e.g., 1.2 meter (4 foot) wooden table and boxes of hair curlers and other hairstyling supplies], it is more likely that the seat track was further forward allowing for more cargo space (**Figure 13**); however, the exact position of the seat track is unknown. According to the driver, she was not aware that the front right seat track was adjustable and had no idea of its location. The seat was most likely moved post-crash to allow for removal of one or both of the injured front right passengers.

Figure 13: Case vehicle's second seating area viewed from sliding door showing excess cargo loaded behind front seats; Note: child safety seat stuffed between second left seat's seat back and table (case photo #53)

The outside-seated front right passenger was not using the available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there was no evidence of belt pattern bruising and/or abrasions on the outside-seated passenger's body. In addition, the inspection of the front right seating position'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, the resulting clockwise yaw, and the nonuse of the available safety belts, the outside-seated front right passengers moved forward and slightly to the left just prior to impact. Since part of the inside-seated front right passenger's body was located behind the outside-seated front right passenger, the inside passenger's (4-year-old) weight helped push the outside passenger (2-year-old) forward where her knees impacted the glove box in the right instrument panel. The case vehicle's impact with the Honda enabled the case vehicle's outside-seated front right passenger to continue forward, slightly leftward, and upward toward the 340 degree Direction of Principal Force as the case vehicle decelerated. Furthermore, a portion of the inside passenger's body was compressing her outside sister against the instrument panel. As a result, the outside-seated front right passenger's head/neck was positioned directly atop the cover flap and deploying air bag near the moment of deployment (**Figures 11** and **12** above).

At final rest the outside-seated front right passenger was found seated on the floor in the slide-out supplemental glove box with her torso turned slightly to the right, her back against the base of the seat cushion, her right leg folded under the left, and the left leg extended straight out in front of her (**Figure 14**). The outside-seated front right passenger's head was decapitated by the front right air bag module's cover flap and deploying air bag. Her head was lifted upward where it struck the windshield, front right header, sun visor (**Figure 8** above), and front right seat back (**Figure 9** above) before coming to rest on the floor next to her inside-seated sister.

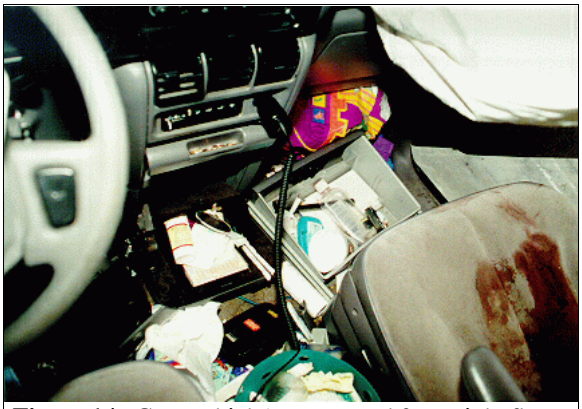

Figure 14: Case vehicle's center and front right floor board area showing final rest positions of both front right passengers; Note: case passenger was found seated in rolled out glove box with back against seat cushion (case photo #26)

CASE VEHICLE "OUTSIDE-SEATED" FRONT RIGHT PASSENGER INJURIES

The outside-seated front right occupant was transported from the scene directly to the morgue. She sustained fatal decapitation-related injuries as a result of contacting the front right passenger air bag module's cover flap (**Figure 11** above) and was pronounced dead at the scene. In addition to her decapitation, she sustained contusions to the outmost layer of her vena cava and to her lungs, bilaterally, and abrasions to her whole neck and right upper arm, both proximally and distally.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Decapitation[1] at upper neck and posterior aspect of head	311000.6 untreatable	Front right module's cover flap	Certain	Autopsy
2	Contusions bilateral lungs involving anterior right and left upper lobes and anterior right middle lobe	441410.4 severe	Air bag, front right passenger's	Probable	Autopsy
3	Contusion to adventitia[2] of inferior vena cava at level just superior to liver	421899.3 serious	Air bag, front right passenger's	Probable	Autopsy
4	Abrasions anterior, posterior, right, and left upper neck [Aspect = Whole]	390202.1 minor	Air bag, front right passenger's	Certain	Autopsy
5	Abrasion proximal lateral right upper arm	790202.1 minor	Air bag, front right passenger's	Possible	Autopsy
6	Contusion distal lateral right upper arm	790402.1 minor	Air bag, front right passenger's	Possible	Autopsy

CASE VEHICLE "INSIDE-SEATED" FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's front right bucket seat was occupied by the driver's two daughters. The passenger located in the inside portion [4-year-old, White (Hispanic) female; 109 centimeters and 17 kilograms (43 inches, 38 pounds)] was also seated but was leaning slightly backwards and to her right with her feet hanging over edge of the seat cushion–most likely oriented toward the center console, and her arms outstretched toward the right. According to the case vehicle's driver, just prior to the crash the daughter seated on the inside portion of the seat was leaning back and to her right, behind her 2-year-old little sister, with her right arm outstretched attempting to retrieve the stored front right seat belt. As a result, the daughter on the outside was leaning forward and possibly scooted forward on the seat, making it easier for her sister to reach the seat belt.

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[1] The decapitation included the following injuries: (1) lacerations (amputation) of the brainstem–at the medulla oblongata, cerebellum, larynx, epiglottis, and proximal trachea and esophagus with organs remaining attached to head; (2) hemorrhage along brainstem and pons; (3) basilar skull fractures involving the petrous portions of the left and right temporal bone, along the lambdoid sutures (diastatic), at the junction between the posterior and middle cranial fossa, and to the posterior-inferior occipital bone with fragments attached to the body; (4) palpable fractures of maxilla and mandible; and (5) numerous abrasions, contusions, and lacerations to face.

[2] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
adventitia (ad"ven-tish/e-a): outermost; denoting the layer of loose connective tissue forming the outermost coating of an organ. See ***tunica adventitia***.
tunica (too/ni-ka) adventitia: the outer coat of various tubular structures, made up of connective tissue and elastic fibers.

At the time of the vehicle inspection, the front right seat track was located in its rearmost position, and the seat back was slightly reclined (i.e., 32 degrees rearward of vertically perpendicular to the floor). Once again because of the large amount of cargo packed in the van behind the front seats [e.g., 1.2 meter (4 foot) wooden table and boxes of hair curlers and other hairstyling supplies], it is more likely that the seat track was further forward allowing for more cargo space (**Figure 13** above); however, the exact position of the seat track is unknown. According to the driver, she was not aware that the front right seat track was adjustable and had no idea of its location. The seat was most likely moved post-crash to allow for removal of one or both of the injured front right passengers.

The inside-seated front right passenger was not using the available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there was no evidence of belt pattern bruising and/or abrasions on the inside-seated passenger's body. In addition, the inspection of the front right seating position'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, the resulting clockwise yaw, and the nonuse of the available safety belts, the inside-seated front right passengers moved forward against her sister and to the left just prior to impact. Since part of the inside-seated passenger's body was located behind the outside-seated passenger, the inside passenger's (4-year-old) weight helped push the outside passenger (sister; 2-year-old) forward. The case vehicle's impact with the Honda enabled the case vehicle's inside-seated front right passenger to continue forward, slightly leftward, and upward toward the 340 degree Direction of Principal Force as the case vehicle decelerated. Furthermore, a portion of the inside passenger's body was compressing her outside sister against the instrument panel. As a result, the inside-seated front right passenger's face/neck was turned slight to the right at the approximate moment of deployment. The left side of the inside-seated passenger's face was most likely struck by the deploying air bag. Because this occupant was seated offset to the left of the air bag's center, as the air bag continued to expand the bag's fabric most likely contracted the right side of this passenger's face and she was redirected to her left by the continuing expansion of the air bag's fabric.

At final rest the exact posture of the inside-seated front right passenger is unknown. However, based on the available information, the inside-seated front right passenger's lower legs broke the cup holder sticking out of the center instrument panel prior to her rebounding and coming to rest on the floor between the two front seats next to her inside-seated sister.

CASE VEHICLE "INSIDE-SEATED" FRONT RIGHT PASSENGER INJURIES

The inside-seated front right passenger was transported by helicopter to a trauma hospital approximately 30 miles north as a precautionary measure. She sustained minor soft tissue injuries and was treated and released. Her injuries included: lacerations underneath her left eye (cheek) and to her left chin and abrasions to the right side of her neck and around the right ear. In addition, she was treated for shock.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Laceration under left eye, not further specified	290600.1 minor	Air bag, front right passenger's	Probable	Interviewee (driver)
2	Laceration left side of chin, not further specified	290600.1minor	Air bag, front right passenger's	Probable	Interviewee (driver)
3	Abrasion around right ear	290202.1 minor	Air bag, front right passenger's	Possible	Interviewee (driver)
4	Abrasion right side of neck	390202.1 minor	Air bag, front right passenger's	Possible	Interviewee (driver)

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [34-year-old, White (non-Hispanic) female; 163 centimeters and 93 kilograms (64 inches, 205 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the brake, and both hands on the steering wheel (unknown positioning). According to the case vehicle's driver the seat track was located between its middle and rearmost positions, the seat back was upright, and the tilt steering wheel was located in its upmost position. However, at the time of the vehicle inspection, her seat track was located in its rearmost position. The seat track had most likely been moved post-crash to allow for removal of the injured children from the floor.

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

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver, the resulting clockwise yaw, and the nonuse of her available safety belts, the driver moved forward and slightly to the left just prior to impact. The case vehicle's impact with the Honda enabled the case vehicle's driver to continue forward, slightly leftward, and upward toward the 340 degree Direction of Principal Force as the case vehicle decelerated. The driver's face (**Figure 10** above), neck, and chest loaded the deploying air bag while her knees continued forward impacting the left knee bolster. Based on the available evidence, the driver's right hand most likely came off of the steering wheel rim and struck the left instrument panel fracturing her right index finger and contusing her knuckles on her right hand. The exact posture of the driver at final rest is unknown but she most likely rebounded backwards toward her seat back as the case vehicle came to rest. The driver has no recollection of her final rest position which is quite understandable given the lesions sustained by her 2-year-old daughter.

The driver sought treatment later at a hospital. She sustained minor injuries and was treated and released. The self-reported injuries sustained by the case vehicle's driver included: a fractured right index finger and contusions to her right hand (knuckles), right forearm, and knees, bilaterally.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture right index finger, not further specified	752404.1 minor	Left instrument panel and below	Probable	Interviewee (same person)
2	Contusion {bruised} knuckles on right hand, not further specified	790402.1 minor	Left instrument panel and below	Probable	Interviewee (same person)
3	Contusion {bruise} and sprain[3] right forearm, not further specified	790402.1 minor	Air bag, driver's	Possible	Interviewee (same person)
4	Contusions {bruises} to knees, bilaterally, not further specified	890402.1 minor	Knee bolster, driver's	Probable	Interviewee (same person)

OTHER VEHICLE

The 1996 Honda Accord LX was a front wheel drive, five-passenger, four-door sedan (VIN: 1HGCD5633TA------) equipped with a 2.2L, I-4 engine and a four-speed automatic transmission. Four-wheel, anti-lock brakes are an option for this model, but the Honda was not so equipped. The case vehicle's wheelbase was 272 centimeters (106.9 inches), and the odometer reading at inspection was 81,216 kilometers (50,465 miles).

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat with separate back cushions and integral head restraints for the back outboard seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the front and back outboard positions; and a two-point, lap belt system at the back center position. The front seat belt systems were equipped with manually operated height adjusters for the "D"-rings and both of which were positioned in the upmost 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 frontal air bag deployed as a result of the case vehicle's impact with the back of the Honda.

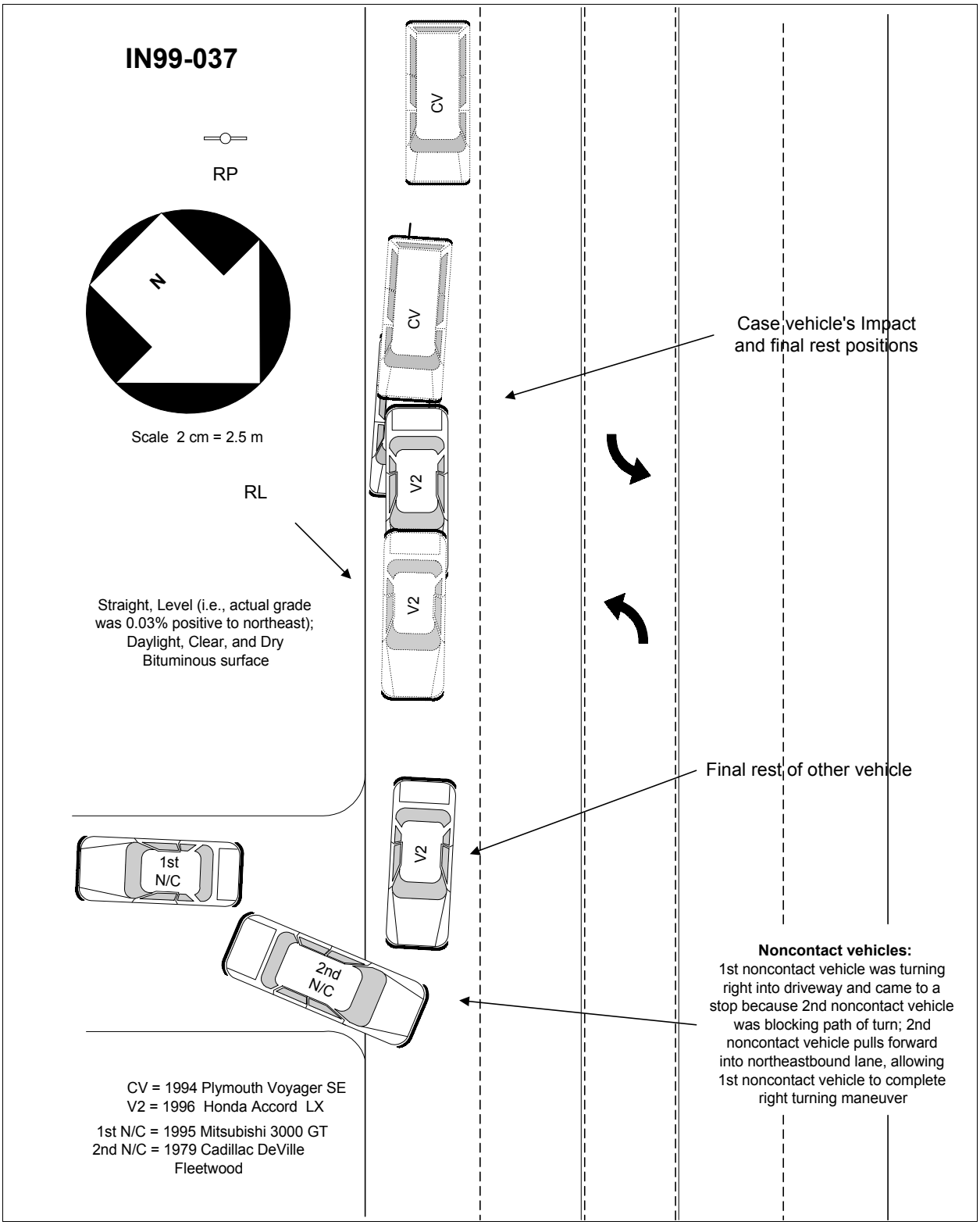
The back impact to the Honda caused the back bumper and trunk lid to be crushed inward (**Figure 4** above and **Figure 15** below). Direct damage started at the back right bumper corner and extended, a measured distance of 117 centimeters (46.1 inches), leftward along the back bumper. Maximum crush was measured at 37 centimeters (14.6 inches) at C_2. The total field L

[3] This lesion is discounted since there was no mention of any injury to the driver's wrist or elbow.

was measured at 132 centimeters (52.0 inches). The right quarter panel sustained induced damage and the back right tail light was broken out. The wheelbase on the right side was shortened by 3 centimeters (1.2 inches) while the left side was shortened by only 1 centimeter (0.4 inches).

Based on the vehicle inspection the CDC for the Honda was **06-BDEW-2** (**180** degrees) The WinSMASH reconstruction program, damage only algorithm, was used on the Honda's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 26.7 km.p.h. (16.6 m.p.h.), +26.7 km.p.h. (+16.6 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The Honda was towed due to damage.

Figure 15: Honda's damaged back showing offset nature of crush profile; direct damage extends leftward from back right corner to yellow tape (case photo #56)


IN99-037
RP
N
Scale 2 cm = 2.5 m
RL
Straight, Level (i.e., actual grade was 0.03% positive to northeast); Daylight, Clear, and Dry Bituminous surface
CV
CV
V2
V2
V2
1st N/C
2nd N/C
Case vehicle's Impact and final rest positions
Final rest of other vehicle
Noncontact vehicles:
1st noncontact vehicle was turning right into driveway and came to a stop because 2nd noncontact vehicle was blocking path of turn; 2nd noncontact vehicle pulls forward into northeastbound lane, allowing 1st noncontact vehicle to complete right turning maneuver
CV = 1994 Plymouth Voyager SE
V2 = 1996 Honda Accord LX
1st N/C = 1995 Mitsubishi 3000 GT
2nd N/C = 1979 Cadillac DeVille Fleetwood