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ON-SITE ADVANCED OCCUPANT PROTECTION SYSTEM INVESTIGATION

CASE NUMBER - IN-03-017
LOCATION - ALABAMA
VEHICLE - 2003 HONDA ACCORD EX
CRASH DATE - March 2003

Submitted:

January 30, 2007

Contract Number: DTNH22-01-C-07002

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

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

Technical Report Documentation Page

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16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 2003 Honda Accord EX (case vehicle) and a 1982 Plymouth Reliant (other vehicle). This crash is of special interest because the case vehicle was equipped with multiple Advance Occupant Protection System (**AOPS**) features, including front dual stage inflation air bags, front seat back-mounted side impact air bags, and side curtain air bags, and the case vehicle's driver (39-year-old, male) **and** front right passenger (7-year-old, female) both sustained moderate injuries, as a result of the crash. The trafficway on which the case vehicle was traveling was a four-lane, divided, U.S. Interstate trafficway, traversing in a north-northwesterly and south-southeasterly direction. Both the northern and southern roadways had two through lanes. The case vehicle was traveling north-northwestward in the outside through lane of the northern roadway. The Plymouth was stopped and abandoned, heading in a northerly direction, on the right (eastern) shoulder of the northern roadway. The case vehicle drifted off the roadway onto the right shoulder. The crash occurred on the eastern shoulder of the northern roadway. The front right half of the case vehicle impacted the back of the Plymouth, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle's seat back-mounted side air bags and side inflatable curtains did not deploy. The case vehicle's driver was seated, leaning somewhat forward with his head turned to the right toward the front right passenger. His seat track was located between its middle and rearmost positions, and the telescoping steering column was in its rearmost position. He was restrained by his available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to his interview and his medical records, a moderate laceration into his left elbow joint. In addition, the injuries he sustained included: a right forehead laceration; a large "road rash" type abrasion around his left elbow; and an abrasion and laceration to his right hand. The front right passenger was seated in a sunken posture, with her seat track located in its rearmost position and was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. She sustained, according to the driver's interview (i.e., father) and her medical records, a moderate nonanatomic brain injury (i.e., amnesic for crash event) and minor injuries that included: scratches on her face and abrasions and contusions to her right neck and transversely across her lower abdomen–including both hips.

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This investigation was brought to NHTSA's attention on April 25, 2003 by NASS GES sampling activities. This crash involved a 2003 Honda Accord EX (case vehicle) and a 1982 Plymouth Reliant (other vehicle). The crash occurred in March 2003, at 7:50 p.m., in Alabama and was investigated by the applicable state police department. This crash is of special interest because the case vehicle was equipped with multiple **A**dvance **O**ccupant **P**rotection **S**ystem (AOPS) features, including front dual stage inflation air bags, front seat back-mounted side impact air bags, and side curtain air bags, and the case vehicle's driver [39-year-old, White (non-Hispanic) male] **and** front right passenger [7-year-old, White (non-Hispanic) female] both sustained moderate injuries, as a result of the crash. This contractor inspected the case vehicle on May 6, 2003 and the scene on May 7, 2003. This contractor interviewed the driver for the case vehicle during July 2003. This report is based on the Police Crash Report, an interview with the case vehicle's driver, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

Crash Environment: The trafficway on which the case vehicle was traveling was a four-lane, divided, U.S. Interstate trafficway, traversing in a north-northwesterly and south-southeasterly direction. Both the northern and southern roadways had two through lanes. At the time of the crash the light condition was dark, but not illuminated by overhead street lamps at the area of impact, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was not determined, and the site of the crash was a combination of rural agricultural and undeveloped; see **CRASH DIAGRAM** at end.

Pre-Crash: The case vehicle was traveling north-northwestward in the outside through lane of the northern roadway and intended to proceed straight ahead. The Plymouth was stopped and abandoned, heading in a northerly direction, on the right (eastern) shoulder of the northern roadway. According to the case vehicle's driver, he was distracted by the front right passenger and drifted off the roadway onto the right shoulder. The case vehicle's driver made no avoidance maneuvers prior to the crash. The crash occurred on the eastern shoulder of the northern roadway.

Crash: The front right half of the case vehicle impacted the back (i.e., most likely left half) of the Plymouth, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. It is unknown whether more than one stage of the multi-stage air bags was activated. The case vehicle's seat back-mounted side air bags and side inflatable curtains did not deploy as a result of the case vehicle's frontal impact with the Plymouth.

Post-Crash: As a result of the crash the case vehicle rotated clockwise, back onto the roadway, where it overturned. Based on the vehicle damage, the case vehicle rolled leftward and landed on its right "A"-pillar and roof side rail. The case vehicle continued in a northerly direction while rolling over and rotating clockwise. The case vehicle rolled over at least six quarter turns before coming to rest, upside down, obliquely oriented across the outside lane of the northern roadway, heading in a westerly direction. According to the Police Crash Report, the Plymouth also rotated

approximately 180 degrees clockwise and overturned before coming to rest upside down on the eastern roadside, heading in a southerly direction.

Case Vehicle: The 2003 Honda Accord EX was a front wheel drive, two-door coupe (VIN: 1HGCM82643A------) and was equipped with **ADVANCED OCCUPANT PROTECTION SYSTEM** features. Four wheel, anti-lock brakes are standard on the case vehicle. The case vehicle was equipped with a Supplemental Restraint System (SRS) that featured multi-stage, frontal air bags at the driver and front right passenger positions and a passenger-side **O**ccupant **P**osition **D**etection **S**ystem (**OPDS**–i.e., occupant sensing for the front right passenger's position). In addition, the vehicle was equipped with front, seat back-mounted, side impact air bags and side-inflatable curtain air bags which extend from each of the roof side rails. Furthermore, the vehicle was equipped with LATCH system features and a traction control system. Both frontal air bags deployed as a result of the frontal impact with the Plymouth.

Vehicle Exterior: Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **12-FZEW-3** (**0** degrees) for the impact with the Plymouth, and **00-TDDO-03** for the rollover event. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact (i.e., the deployment impact with the Plymouth). The Total, Longitudinal, and Lateral Delta Vs are, respectively: 31.0 km.p.h. (19.3 m.p.h.), -31.0 km.p.h. (-19.3 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). Based on the interview with the case vehicle's driver, the case vehicle was going approximately 105 to 113 km.p.h. (65 to 70 m.p.h.) prior to the crash. According to the Police Crash Report, the speed limit was 113 km.p.h. (70 m.p.h.). The case vehicle was towed due to damage.

Exterior Damage: The case vehicle's contact with the Plymouth involved the front with the damage distributed on approximately the right half. Direct damage began at the front right bumper corner and extended inward along the bumper. It was not possible to determine the direct damage length because the front bumper fascia was separated from the vehicle and not available during our inspection. Crush was measured on the actual bumper, and the residual maximum crush was measured as 44 centimeters (17.3 inches) at C_5. The wheelbase on the case vehicle's left side was extended 4 centimeters (1.6 inches) while the right side was shortened 14 centimeters (5.5 inches). The case vehicle's front bumper, bumper fascia, grille, hood, radiator, right fender, and right headlight and turn signal assemblies were directly damaged and crushed rearward. During the rollover event, the case vehicle's hood; right and left fenders; right and left quarter panels; right front door; right and left "A"-pillars, "B"-pillars, and "C"-pillars; right and left roof side rails, and roof all were directly damaged and crushed either downward and/or inward. The left headlight and turn signal assemblies sustained induced damage as well as both the right and left fenders, hood, and roof. All four side glazings and the backlite were disintegrated. The roof glazing was missing, and the windshield was cracked and holed, yet remained in place.

The vehicle manufacturer's recommended tire size was: P205/60R16, and the case vehicle tires were the recommended size. The case vehicle's tire data are shown in the table below. In addition, the case vehicle's right front tire was rotated inward, physically restricted, and deflated.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	214	31	221	32	7	9	None	No	No
RF	0	0	221	32	7	9	None	Yes	Yes
LR	200	29	207	30	6	8	None	No	No
RR	207	30	207	30	6	8	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior revealed no obvious occupant contact evidence except for copious amounts of blood splattered throughout the roof and sun visors. There were numerous vertical intrusions to the case vehicle's front seating area including: the left and right "A"-pillars and roof side rails, the windshield, the windshield's header (and sun visors), and roof. There was also vertical intrusion from the roof into the back left and right seating positions. The greatest intrusion involved the windshield and the roof into the driver [17 centimeters (6.7 inches)] and front right passenger [23 centimeters (9.1 inches)] seating positions. The heavy intrusion damage may have masked the existence of occupant contact evidence. In addition, there was no evidence of compression to the energy absorbing shear capsules in the base of the steering column. Finally, the left upper portion of the steering wheel rim was visually bent toward the left instrument panel, as a result of the driver loading the air bag, momentarily blocking the air bag's forward expansion, and causing the air bag to expand against and bend the steering wheel rim.

Supplemental Restraints: 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 the air bag's fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two tethers, each approximately 7 centimeters (2.8 inches) in width. The driver's air bag had two vent ports, approximately 5 centimeters (2.0 inches) in diameter, located near the center but oriented toward the 11 and 1 o'clock positions. The deployed driver's air bag was round with a diameter of 58 centimeters (22.8 inches). An inspection of the driver's air bag fabric revealed numerous blood spots and splatters throughout the front surface and random blood splatters on the back surface of the air bag's fabric. It is unlikely that these were caused by direct contact to the air bag itself.

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 the air bag's fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The front right passenger's air bag was designed without any tethers. The front right air bag had two vent ports, approximately 5 centimeters (2.0 inches) in diameter, located at the 9 and 3 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 68 centimeters (26.8 inches) and a width of approximately 46 centimeters (18.1 inches). An inspection of the front right passenger's air bag fabric revealed large blood stains on the front right half of the air bag's front surface. Based on

the driver's interview and the injuries he reported for his daughter (i.e., front right passenger), it is unlikely that the front right passenger's initial contact with the air bag caused this heavy bleeding. Instead, the copious blood evidence found on the air bag's front surface most likely resulted from the driver's lesions while he was in the process of extricating his daughter from the vehicle.

Other Vehicle: The 1982 Plymouth Reliant was a front wheel drive, four-door station wagon (VIN: 1P3BP49D9CF------). Anti-lock brakes and supplemental restraint systems (air bags) were not available for this model.

Exterior Damage: With no available vehicle photographs, the CDCs for the Plymouth are not estimable. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the Plymouth's impact with the case vehicle. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 44.0 km.p.h. (27.3 m.p.h.), +44.0 km.p.h. (+27.3 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The Plymouth was towed due to damage.

Case Vehicle's Driver: Prior to the crash, the case vehicle's driver [39-year-old, White (non-Hispanic) male; 183 centimeters and 98 kilograms (72 inches and 215 pounds)] was seated leaning somewhat forward with his lower back against the seat back, his head turned to the right toward the front right passenger, his left foot on the floor, his right foot on the accelerator, and his hands on the steering wheel. Immediately prior to the crash, the driver saw the impending impact and moved further forward and to his right, bracing for the crash with his left hand on the steering wheel while attempting to cover the face (protect) of the front right passenger with his right hand/arm. His seat track was located between its middle and rearmost positions, seat back was slightly reclined, the tilt steering wheel was located in its middle position, and the telescoping steering column was in its rearmost position.

The case vehicle's driver was restrained by his available, active, three-point, lap-and-shoulder, safety belt system; the belt system was equipped with a retractor-mounted pretensioner, housed within the "B"-pillar. There was no mention by the driver of belt pattern bruising and/or abrasions to the driver's torso, but the inspection of the driver's seat belt webbing, "D"-ring, and latch plate revealed that the pretensioner had actuated and the belt webbing was bunched up and showed friction burns on the webbing at the "D"-ring.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of his available safety belts, his pre-impact body position did not change just prior to impact. The case vehicle's primary impact with the Plymouth enabled the case vehicle's driver to continue forward and slightly upward toward the case vehicle's **0** degree Direction of Principal Force as the case vehicle decelerated. As a result, the driver loaded his safety belts and contacted the deploying driver air bag. The driver may have been redirected backward by the deploying air bag. As a result of the frontal impact, the case vehicle rotated clockwise. The driver most likely moved backward and to his right as the vehicle rotated underneath him. As the case vehicle moved forward with its left side leading, it began to roll over about the longitudinal plane. The vehicle rolled six quarter turns and rotated approximately 270 degrees clockwise. The case vehicle most likely rolled about its lateral axis somewhere during the

rollover sequence. While it is unclear which interior components the driver contacted, the driver reported medical information indicates that the driver's left arm contacted the roadway, producing a significant abrasion which bled quite heavily on the interior of the vehicle. During the rollover sequence the driver moved forward, backward, right, left, up, and down. The driver does not remember his exact posture at final rest; however, he indicated that he was able to exit the case vehicle without assistance.

The driver was transported by ambulance to the hospital. According to his interview and medical records, he sustained a moderate laceration into his left elbow joint and was hospitalized for three days because of the required surgical repair. In addition, the injuries he sustained included: a small cut on the forehead above the right eye; a large "road rash" type abrasion around his left elbow; and an abrasion and laceration to the top of his right hand between the thumb and forefinger. The driver's left elbow injuries were caused by his contact with the roadway and his right hand lesions was likely caused by broken glazing from the windshield.

Case Vehicle's Front Right Passenger: According to the case vehicle's driver, the front right child passenger [i.e., daughter; 7-year-old, White (non-Hispanic) female; 112 centimeters and 27 kilograms (44 inches, 60 pounds)] was seated in a somewhat sunken posture, with her back against the seat back, as she was sleeping and turned slightly to her left. Her feet were dangling off the front edge of the seat cushion, angled downward, with her hands in her lap; although, the exact position of her hands is unknown. According to the case vehicle's driver, her seat track was located in its rearmost position, and the seat back was slightly reclined. During this contractor's vehicle inspection, the front right seat track was located between its middle and rearmost positions.

The case vehicle's front right child passenger was restrained by her available, active, three-point, lap-and-shoulder, safety belt system; the belt system was equipped with a retractor-mounted pretensioner, housed within the "B"-pillar. According to the driver's interview, the front right passenger sustained bruising across her lower abdomen, consistent with lap belt usage. The inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate revealed that the pretensioner had actuated but did not showed any evidence of loading. Given the age and stature of this child [7-years-old; 112 centimeters (44 inches)], it is unlikely that the torso portion of the safety belt system was snugly fitted against this occupant's right shoulder to begin with and, as a result, she most likely did not load the torso portion of her safety belt.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of the front right passenger's available safety belts, her pre-impact body position did not change just prior to impact. The case vehicle's primary impact with the Plymouth enabled the case vehicle's front right passenger to continue forward and slightly upward toward the case vehicle's **0** degree Direction of Principal Force as the case vehicle decelerated. As a result, the front right passenger loaded the lap portion of her safety belt and contacted the deploying front right passenger air bag. The front right passenger was redirected backward by the deploying air bag. As a result of the frontal impact, the case vehicle rotated clockwise. The front right passenger most likely moved backward and to her right as the vehicle rotated underneath her. As the case vehicle moved forward with its left side leading, it began to roll over about the longitudinal plane. The vehicle rolled six quarter turns and rotated approximately 270

degrees clockwise. The case vehicle most likely rolled about its lateral axis somewhere during the rollover sequence. While it is unclear which interior components the front right passenger contacted, the driver reported medical information indicates that the front right passenger had contusions across her lower abdomen and her face was struck by shards of flying glass, producing dicing type lacerations to her facial area. It's unclear at this time how significant these facial lacerations were, but it is likely that she bled onto the interior of the vehicle. During the rollover sequence the front right passenger moved forward, backward, right, left, up, and down. The driver does not remember his daughter's exact posture at final rest; however, he indicated that she was able to exit the case vehicle with some assistance.

The right front passenger was transported by ambulance to the hospital. According to the driver's interview (i.e., father) and her medical records, she sustained a moderate nonanatomic brain injury (i.e., amnesic for crash event) as well as minor injuries and was hospitalized for two days as a precaution. The injuries sustained included: random scratches on her face and abrasions and contusions to her right neck and transversely across her lower abdomen–including both hips.

Plymouth's Occupants: According to the Police Crash Report, the Plymouth was abandoned and had no occupants at the time of the crash.

CRASH CIRCUMSTANCES

Figure 1: Arrow indicates estimated area of impact between case vehicle and Plymouth on eastern shoulder of northern roadway (case photo #03)

Crash Environment: The trafficway on which the case vehicle was traveling was a four-lane, divided, U.S. Interstate trafficway, traversing in a north-northwesterly and south-southeasterly direction (**Figure 1**). Both the northern and southern roadways had two through lanes. The interstate highway was straight and level (i.e., actual slope was less than 2.0%, positive to the north-northwest) near the area of impact. The pavement was bituminous but traveled, and the width of the travel lanes was most likely 3.7 meters (12 feet). The shoulders were improved (i.e., bituminous). The eastern side of the northern road had an unmeasured "lane width" size paved shoulder, and the western side had a much narrower paved shoulder, prior to the unprotected grassy median. The roadway was not bordered by curbs. Pavement markings for the roadway consisted of a solid yellow edge line on the western side and a solid white edge line on eastern side. In addition, the through lanes were divided by a dashed white line. The estimated coefficient of friction for the case vehicle was 0.60. There were no visible traffic controls in the immediate area of the crash. The statutory speed limit was 113 km.p.h. (70 m.p.h.). No regulatory speed limit sign was posted near the crash site. At the time of the crash the light condition was dark, but not illuminated by overhead street lamps at the area of impact, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was not determined, and the site of the crash was a combination of rural agricultural and undeveloped; see **CRASH DIAGRAM** at end.

Pre-Crash: The case vehicle was traveling north-northwestward in the outside through lane of the northern roadway and intended to proceed straight ahead (**Figure 1** above). The Plymouth was stopped and abandoned, heading in a northerly direction, on the right (eastern) shoulder of the northern roadway (**Figure 1** above). According to the case vehicle's driver, he was distracted by the front right passenger and drifted off the roadway onto the right shoulder. The case vehicle's driver made no avoidance maneuvers prior to the crash. The crash occurred on the eastern shoulder of the northern roadway.

Figure 2: Case vehicle's frontal damage viewed at bumper level with contour gauge present; Note: damage primarily to right half (case photo #06)

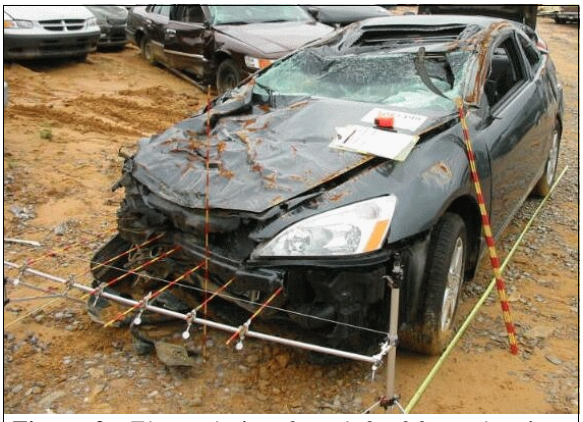


Figure 3: Elevated view from left of front showing case vehicle's frontal damage from impact with Plymouth and subsequent rollover damage; Note: greater vertical crush to right "A"-pillar and damage to left fender, "A"-pillar, and roof side rail (case photo #08)

Crash: The front right half (**Figure 2**) of the case vehicle impacted the back (i.e., most likely left half) of the Plymouth, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. It is unknown whether more than one stage of the multi-stage air bags was activated. The case vehicle's seat back-mounted side air bags and side inflatable curtains did not deploy as a result of the case vehicle's frontal impact with the Plymouth.

Figure 4: Elevated view from left of back showing rollover damage to case vehicle's left quarter panel and roof side rail (case photo #20)

Post-Crash: As a result of the crash the case vehicle rotated clockwise, back onto the roadway, where it overturned. Based on the vehicle damage, the case vehicle rolled leftward and landed on its right "A"-pillar and roof side rail (**Figure 3**). The case vehicle continued in a northerly direction while rolling over and rotating clockwise. The case vehicle rolled over at least six quarter turns (**Figure 4** and **Figures 5** and **6** below) before coming to rest, upside down, obliquely oriented across the outside lane of the northern roadway, heading in a westerly direction. According to the Police Crash Report, the Plymouth also rotated approximately 180 degrees clockwise and overturned before coming to rest upside down on the eastern roadside, heading in a southerly direction. According to the medical records for the case vehicle's driver, he had a positive test for cannabinoids and cocaine; however, no quantifiable results were reported.

The 2003 Honda Accord EX was a front wheel drive, five-passenger, two-door coupe (VIN: 1HGCM82643A------) equipped with a 3.0L, V-6 engine and a five-speed automatic transmission. Braking was achieved by a power-assisted, ventilated front and solid rear disc, four-wheel, anti-lock system with electronic brake distribution system (**EBD**) and traction control system (**TCS**). The case vehicle's wheelbase was 267 centimeters (105.1 inches), and the odometer reading at inspection is unknown because the case vehicle was equipped with an electronic odometer. The case vehicle was equipped with **ADVANCED OCCUPANT PROTECTION SYSTEM** features including a Supplemental Restraint System (SRS) that featured multi-stage, frontal air bags at the driver and front right passenger positions and a passenger-side **O**ccupant **P**osition **D**etection **S**ystem (**OPDS**–i.e., occupant sensing for the front right passenger's position). The occupant sensing system automatically switches the right front-passenger front air bag on or off based on the passenger's weight and the type of pressure on the seat. In addition, the vehicle was equipped with front, seat back-mounted, side impact air bags and side-inflatable curtain air bags which extend from each of the roof side rails (**Figure 7**). Furthermore, the case vehicle was equipped with LATCH system features.

Inspection of the case vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat with folding backs and adjustable head restraints for the back outboard seating positions; and continuous loop, three-point, lap-and-shoulder, safety belt systems at all five front and back positions. The front seat belt systems were not equipped with manually operated, upper anchorage adjusters for the "D"-rings. The vehicle was equipped with knee bolsters for both the driver and front right passenger, neither of which showed evidence of occupant contact or deformation. Automatic restraint was provided by

Figure 5: Rollover damage to case vehicle's right quarter panel, front door, roof side rail, and "A"-pillar; Note: backlite and right side glazing disintegrated (case photo #21)

Figure 6: Elevated view from right of front of showing extensive rollover damage to case vehicle's top and right side (case photo #22)

Figure 7: Case vehicle's exposed, non-deployed, left side-inflatable curtain air bag; Note: air bag exposed during rollover event as a result of damage to left "A"-pillar and roof side rail (case photo #37)

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 frontal impact with the Plymouth. The case vehicle's seat back-mounted side air bags and side inflatable curtains (**Figure 7** above) did not deploy as a result of the case vehicle's frontal impact with the Plymouth.

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's contact with the Plymouth involved the front with the damage distributed on approximately the right half (**Figure 2** above). Direct damage began at the front right bumper corner and extended inward along the bumper (**Figure 8**). It was not possible to determine the direct damage length because the front bumper fascia was separated from the vehicle and not available during our inspection. Crush was measured on the actual bumper (**Figure 2** above), and the residual maximum crush was measured as 44 centimeters (17.3 inches) at C_5. The table below shows the case vehicle's crush profile.

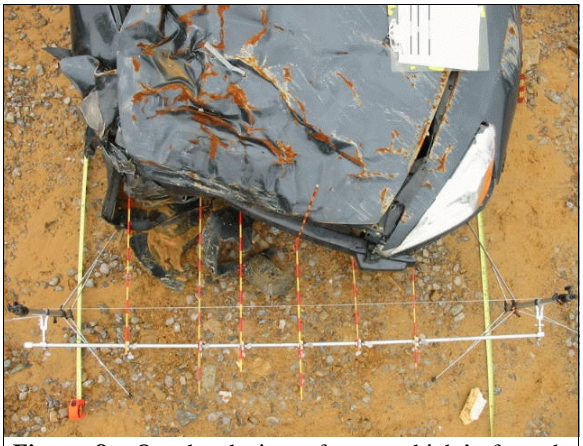


Figure 8: Overhead view of case vehicle's frontal crush from impact with back of Plymouth; Note: contour gauge at bumper level and hood damage from subsequent rollover impact (case photo #18)

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	Unk	44	109	0	14	24	34	44	22	0	18
in		0.0	17.3	42.9	0.0	5.5	9.4	13.4	17.3	8.7	0.0	7.1

The wheelbase on the case vehicle's left side was extended 4 centimeters (1.6 inches) while the right side was shortened 14 centimeters (5.5 inches). The case vehicle's front bumper, bumper fascia, grille, hood, radiator, right fender, and right headlight and turn signal assemblies were directly damaged and crushed rearward. During the rollover event, the case vehicle's hood; right and left fenders; right and left quarter panels; right front door; right and left "A"-pillars, "B"-pillars, and "C"-pillars; right and left roof side rails, and roof all were directly damaged and crushed either downward and/or inward. The left headlight and turn signal assemblies sustained induced damage as well as both the right and left fenders, hood, and roof. All four side glazings and the backlite were disintegrated. The roof glazing was missing, and the windshield was cracked and holed, yet remained in place.

The vehicle manufacturer's recommended tire size was: P205/60R16, and the case vehicle tires were the recommended size. The case vehicle's tire data are shown in the table below. In addition, the case vehicle's right front tire was rotated inward, physically restricted, and deflated.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	214	31	221	32	7	9	None	No	No
RF	0	0	221	32	7	9	None	Yes	Yes
LR	200	29	207	30	6	8	None	No	No
RR	207	30	207	30	6	8	None	No	No

Figure 9: Vertical view of case vehicle's center instrument panel area showing no obvious contact evidence to right side driver's knee bolster or center instrument panel (case photo #42)

Figure 10: Case vehicle's blood splattered front right sun visor viewed from right; Note: sun visor and roof/windshield header have been collapsed downward against front right headrest (case photo #46)

Interior Damage: Inspection of the case vehicle's interior revealed no obvious occupant contact evidence (**Figure 9**) except for copious amounts of blood splattered throughout the roof and sun visors (**Figure 10** and **Figures 11** and **12** below). There were numerous vertical intrusions to the case vehicle's front seating area including: the left and right "A"-pillars and roof side rails (**Figure 7** above, **Figure 10**, and **Figure 12** below), the windshield, the windshield's header (and sun visors–**Figure 10**), and roof (**Figure 12** below). There was also vertical intrusion from the roof into the back left and right seating positions. The greatest intrusion involved the windshield and the roof into the driver [17 centimeters (6.7 inches)] and front right passenger [23 centimeters

(9.1 inches)] seating positions. The heavy intrusion damage may have masked the existence of occupant contact evidence. In addition, there was no evidence of compression to the energy absorbing shear capsules in the base of the steering column. Finally, the left upper portion of the steering wheel rim was visually bent toward the left instrument panel (**Figure 13**), as a result of the driver loading the air bag, momentarily blocking the air bag's forward expansion, and causing the air bag to expand against and bend the steering wheel rim.

Figure 11: Case vehicle's driver seating area viewed from left at seat level; Note: blood splatter to driver's sun visor and roof and exposed, non-deployed, left side-inflatable curtain air bag (case photo #27)

Figure 12: Case vehicle's blood splattered roof over front right seating position (case photo #47)

Figure 13: Case vehicle's deformed steering wheel viewed from left; Note: front right sun visor/roof in contact with top of head rest (case photo #25)

Damage Classification: Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **12-FZEW-3** (**0** degrees) for the impact with the Plymouth, and **00-TDDO-03** for the rollover event. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact (i.e., the deployment impact with the Plymouth). The Total, Longitudinal, and Lateral Delta Vs are, respectively: 31.0 km.p.h. (19.3 m.p.h.), -31.0 km.p.h. (-19.3 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). Based on the interview with the case vehicle's driver, the case vehicle was going approximately 105 to 113 km.p.h. (65 to 70 m.p.h.) prior to the crash. According to the Police Crash Report, the speed limit was 113 km.p.h. (70 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 dual stage frontal air bags at the driver and front right passenger positions. In addition, the vehicle was equipped with front, seat back-mounted, side impact air bags and side-inflatable curtain air bags which extend from each of the roof side rails. Both frontal air bags deployed as a result of

the frontal impact with the Plymouth. It is unknown whether more than one stage of the multi-stage air bags was activated. The vehicle's seat back-mounted side air bags and side inflatable curtains did not deploy as a result of the case vehicle's frontal impact with the Plymouth. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of asymmetrical, essentially, "H"-configuration cover flaps made of medium, pliable vinyl. The top cover flap was essentially rectangular with the exception of a Honda logo which protruded from the lower horizontal seam (**Figure 14**). Overall dimensions were 14 centimeters (5.5 inches) at the top horizontal seam and 7.5 centimeters (3.0 inches) vertically. The bottom cover flap was hexagonal, in an inverted pyramidal shape, with overall dimensions of 13.5 centimeters (5.3 inches) at the top horizontal seam and 7 centimeters (2.8 inches) at the bottom horizontal seam, and 6.5 centimeters (2.6 inches) vertically. An inspection of the air bag module's cover flaps and the air bag's fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two tethers, each approximately 7 centimeters (2.8 inches) in width. The driver's air bag had two vent ports, approximately 5 centimeters (2.0 inches) in diameter, located near the center but oriented toward the 11 and 1 o'clock positions. The deployed driver's air bag was round with a diameter of 58 centimeters (22.8 inches). The distance between the mid-center of the driver's seat back, as positioned at the time of the vehicle inspection, and the front surface of the air bag's fabric at full excursion was 32 centimeters (12.6 inches). An inspection of the driver's air bag fabric revealed numerous blood spots and splatters throughout the front surface (**Figure 15**) and random blood splatters on the back surface of the air bag's fabric. It is unlikely that these were caused by direct contact to the air bag itself.

Figure 14: Configuration of cover flaps on case vehicle's driver air bag module and no obvious contact evidence to driver's knee bolster (case photo #26)

Figure 15: Case vehicle's deployed driver air bag showing blood spots and splatter on all four quadrants of air bag's fabric (case photo #29)

The front right passenger's air bag was located in the top of the instrument panel (**Figure 16** below). There were two symmetrical, "H"-configuration, modular cover flaps made of a medium, pliable vinyl with overall dimensions of 24 centimeters (9.4 inches) at both the top and bottom horizontal seams and 5 centimeters (2.0 inches) along both vertical seams. The profile of the case vehicle's instrument panel resulted in a 13 centimeter (5.1 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. An inspection of the front right air bag module's cover flaps and the air bag's fabric revealed that the cover flaps opened at

the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The front right passenger's air bag was designed without any tethers. The front right air bag had two vent ports, approximately 5 centimeters (2.0 inches) in diameter, located at the 9 and 3 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 68 centimeters (26.8 inches) and a width of approximately 46 centimeters (18.1 inches). The distance between the mid-center of the front right seat back, as positioned at the time of the vehicle inspection, and the front surface of the air bag's fabric at full excursion was 17 centimeters (6.7 inches). An inspection of the front right passenger's air bag fabric revealed large blood stains on the front right half of the air bag's front surface (**Figure 17**). Based on the driver's interview and the injuries he reported for his daughter (i.e., front right passenger), it is unlikely that the front right passenger's initial contact with the air bag caused this heavy bleeding. Instead, the copious blood evidence found on the air bag's front surface most likely resulted from the driver's lesions while he was in the process of extricating his daughter from the vehicle.

Figure 16: Case vehicle's top-mounted front right passenger air bag showing lower cover flap and no obvious contact evidence to front right knee bolster or glove box (case photo #45)

Figure 17: Case vehicle's deployed front right passenger air bag showing copious amounts of blood evidence, primarily on right half (case photo #48)

CASE VEHICLE DRIVER KINEMATICS

Prior to the crash, the case vehicle's driver [39-year-old, White (non-Hispanic) male; 183 centimeters and 98 kilograms (72 inches and 215 pounds)] was seated leaning somewhat forward with his lower back against the seat back, his head turned to the right toward the front right passenger, his left foot on the floor, his right foot on the accelerator, and his hands on the steering wheel. Immediately prior to the crash, the driver saw the impending impact and moved further forward and to his right, bracing for the crash with his left hand on the steering wheel while attempting to cover the face (protect) of the front right passenger with his right hand/arm. His seat track was located between its middle and rearmost positions, seat back was slightly reclined, the tilt steering wheel was located in its middle position, and the telescoping steering column was in its rearmost position.

The case vehicle's driver was restrained by his available, active, three-point, lap-and-shoulder, safety belt system; the belt system was equipped with a retractor-mounted pretensioner, housed within the "B"-pillar. There was no mention by the driver of belt pattern bruising and/or abrasions to the driver's torso, but the inspection of the driver's seat belt webbing, "D"-ring, and latch plate revealed that the pretensioner had actuated and the belt webbing was bunched up and showed friction burns on the webbing at the "D"-ring (**Figure 18**).

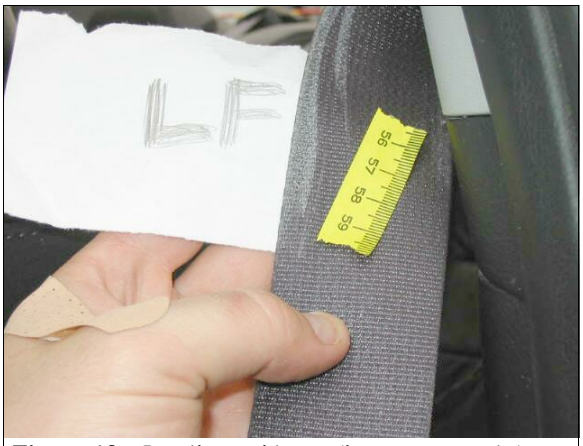


Figure 18: Loading evidence (i.e., wear marks) on webbing of case vehicle's driver safety belt near "D"-ring (case photo #33)

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of his available safety belts, his pre-impact body position did not change just prior to impact. The case vehicle's primary impact with the Plymouth enabled the case vehicle's driver to continue forward and slightly upward toward the case vehicle's **0** degree Direction of Principal Force as the case vehicle decelerated. As a result, the driver loaded his safety belts and contacted the deploying driver air bag. The driver may have been redirected backward by the deploying air bag. As a result of the frontal impact, the case vehicle rotated clockwise. The driver most likely moved backward and to his right as the vehicle rotated underneath him. As the case vehicle moved forward with its left side leading, it began to roll over about the longitudinal plane. The vehicle rolled six quarter turns and rotated approximately 270 degrees clockwise. The case vehicle most likely rolled about its lateral axis somewhere during the rollover sequence. While it is unclear which interior components the driver contacted, the driver reported medical information indicates that the driver's left arm contacted the roadway, producing a significant abrasion which bled quite heavily on the interior of the vehicle. During the rollover sequence the driver moved forward, backward, right, left, up, and down. The driver does not remember his exact posture at final rest; however, he indicated that he was able to exit the case vehicle without assistance. According to the driver's medical records, he had a positive test for cannabinoids and cocaine; however, no quantifiable results were reported.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital. According to his interview and medical records, he sustained a moderate laceration into his left elbow joint and was hospitalized for three days because of the required surgical repair. In addition, the injuries he sustained included: a small cut on the forehead above the right eye; a large "road rash" type abrasion around his left elbow; and an abrasion and laceration to the top of his right hand between the thumb and forefinger. The driver's left elbow injuries were caused by his contact with the roadway and his right hand lesions was likely caused by broken glazing from the windshield.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Laceration {cut}, 2.5 cm (1 in) near hairline of right forehead	minor 290602.1,7	Noncontact injury: flying glass, left front glazing	Probable	Interviewee (same person)
2	Abrasion {road rash}, large, below and above left elbow	minor 790202.1,2	Ground (i.e., road surface)	Certain	Emergency room records
3	Lacerations x 2, open, complex, left elbow into joint, requiring surgical repair	moderate 750640.2,2	Ground (i.e., road surface)	Certain	Hospitalization records
4	Abrasion right hand, not further specified	minor 790202.1,1	Front left windshield's glazing	Probable	Hospitalization records
5	Laceration, 7.6 cm (3 in)[1], between thumb and forefinger, top surface of right hand	minor 790602.1,1	Front left windshield's glazing	Probable	Emergency room records

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

According to the case vehicle's driver, the front right child passenger [i.e., daughter; 7-year-old, White (non-Hispanic) female; 112 centimeters and 27 kilograms (44 inches, 60 pounds)] was seated in a somewhat sunken posture, with her back against the seat back, as she was sleeping and turned slightly to her left. Her feet were dangling off the front edge of the seat cushion, angled downward, with her hands in her lap; although, the exact position of her hands is unknown. According to the case vehicle's driver, her seat track was located in its rearmost position, and the seat back was slightly reclined. During this contractor's vehicle inspection, the front right seat track was located between its middle and rearmost positions.

The case vehicle's front right child passenger was restrained by her available, active, three-point, lap-and-shoulder, safety belt system; the belt system was equipped with a retractor-mounted pretensioner, housed within the "B"-pillar. According to the driver's interview, the front right passenger sustained bruising across her lower abdomen, consistent with lap belt usage. The inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate revealed that the pretensioner had actuated but did not showed any evidence of loading. Given the age and stature of this child [7-years-old; 112 centimeters (44 inches)], it is unlikely that the torso portion of the safety belt system was snugly fitted against this occupant's right shoulder to begin with and, as a result, she most likely did not load the torso portion of her safety belt.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of the front right passenger's available safety belts, her pre-impact body position did not change just prior to impact. The case vehicle's primary impact with the Plymouth

[1] Interviewee-reported wound dimensions are shown. Medical records indicate the lesion was between 3 and 5 cm (1.2 to 2 in).

enabled the case vehicle's front right passenger to continue forward and slightly upward toward the case vehicle's **0** degree Direction of Principal Force as the case vehicle decelerated. As a result, the front right passenger loaded the lap portion of her safety belt and contacted the deploying front right passenger air bag. The front right passenger was redirected backward by the deploying air bag. As a result of the frontal impact, the case vehicle rotated clockwise. The front right passenger most likely moved backward and to her right as the vehicle rotated underneath her. As the case vehicle moved forward with its left side leading, it began to roll over about the longitudinal plane. The vehicle rolled six quarter turns and rotated approximately 270 degrees clockwise. The case vehicle most likely rolled about its lateral axis somewhere during the rollover sequence. While it is unclear which interior components the front right passenger contacted, the driver reported medical information indicates that the front right passenger had contusions across her lower abdomen and her face was struck by shards of flying glass, producing dicing type lacerations to her facial area. It's unclear at this time how significant these facial lacerations were, but it is likely that she bled onto the interior of the vehicle. During the rollover sequence the front right passenger moved forward, backward, right, left, up, and down. The driver does not remember his daughter's exact posture at final rest; however, he indicated that she was able to exit the case vehicle with some assistance.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The right front passenger was transported by ambulance to the hospital. According to the driver's interview (i.e., father) and her medical records, she sustained a moderate nonanatomic brain injury (i.e., amnesic for crash event) as well as minor injuries and was hospitalized for two days as a precaution. The injuries sustained included: random scratches on her face and abrasions and contusions to her right neck and transversely across her lower abdomen–including both hips.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Amnesia for crash event	moderate 160410.2,0	Unknown contact mechanism	Unknown	Hospitalization records
2	Abrasions {scratches} on face from broken glazing	minor 290202.1,9	Noncontact injury: flying glass, unknown source	Probable	Interviewee (driver)
3	Abrasion and/or friction burn right anterolateral neck	minor 390202.1,1	Torso portion of safety belt system	Probable	Hospitalization records
4	Contusion {bruise}, significant over right neck	minor 390402.1,1	Torso portion of safety belt system	Probable	Emergency room records
5	Abrasion across lower abdomen, most significant on right abdomen/flank, right lower quadrant, right iliac crest areas	minor 590202.1,8	Lap portion of safety belt system	Certain	Hospitalization records

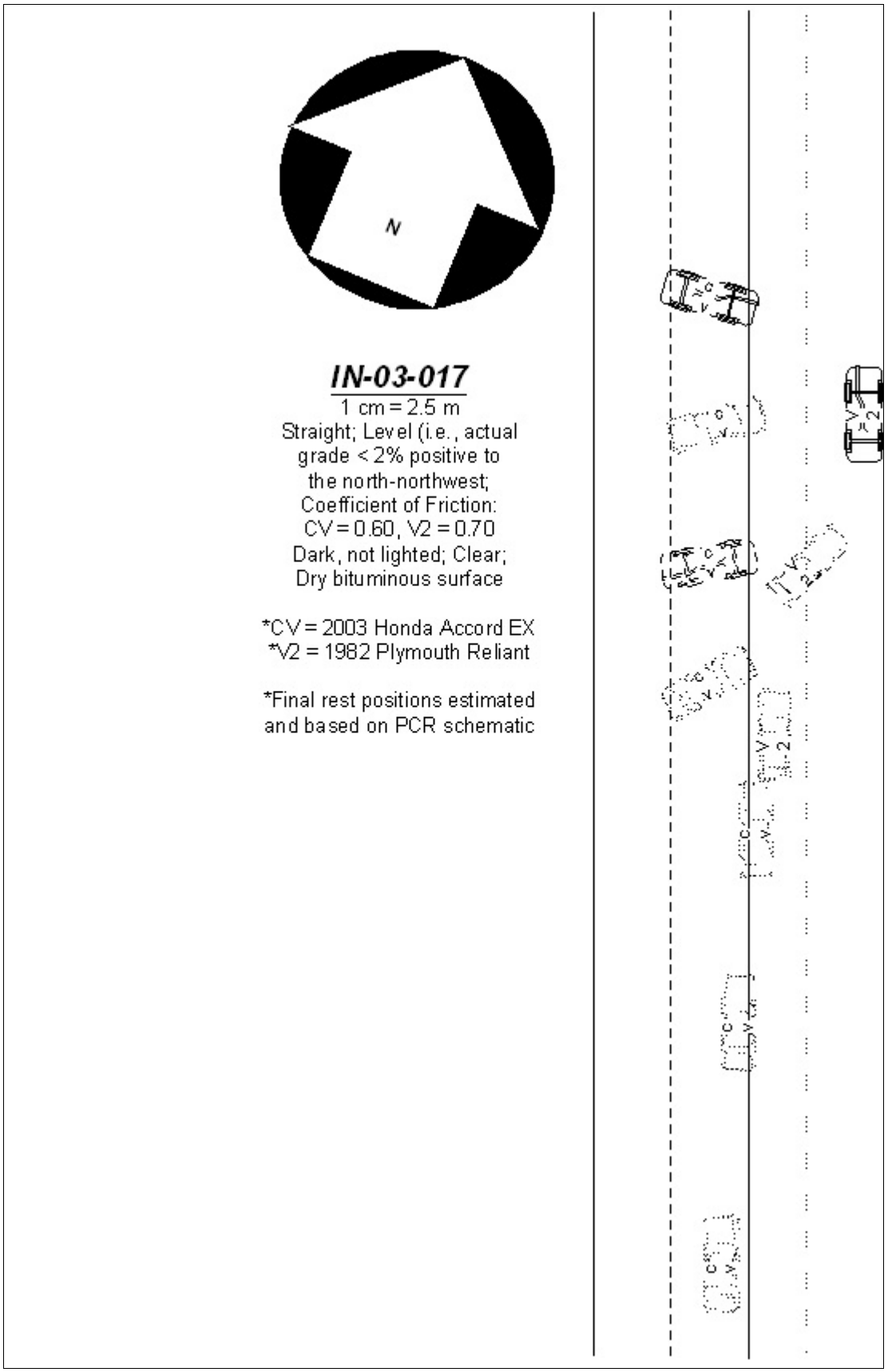
Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
6	Contusion {bruising}, significant across mid-abdomen and both hips, more severe at left hip	minor 590402.1,8	Lap portion of safety belt system	Certain	Emergency room records

OTHER VEHICLE

Based on the VIN and manufacturer's specifications, the 1982 Plymouth Reliant was a front wheel drive, six-passenger, four-door station wagon (VIN: 1P3BP49D9CF------) equipped with a 2.6L, L-4 engine and an unknown speed manual transmission. Anti-lock brakes were not available for this model. Braking was achieved by a power-assisted, front disc and rear drum system. The Plymouth's wheelbase was 253 centimeters (99.8 inches), and the odometer reading is unknown because the Plymouth's interior was not inspected. Furthermore, the standard equipment for this vehicle included manual, three-point, lap-and-shoulder, safety belt systems for the front outboard seating positions. The front center and all three back seating positions had a manual, two-point, lap belt. The interior was equipped with front and back bench seats.

Exterior Damage: With no available vehicle photographs, the CDCs for the Plymouth are not estimable. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the Plymouth's impact with the case vehicle. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 44.0 km.p.h. (27.3 m.p.h.), +44.0 km.p.h. (+27.3 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The Plymouth was towed due to damage.

Plymouth's Occupants: According to the Police Crash Report, the Plymouth was abandoned and had no occupants at the time of the crash.


N
IN-03-017
1 cm = 2.5 m
Straight; Level (i.e., actual grade < 2% positive to the north-northwest;
Coefficient of Friction:
CV = 0.60, V2 = 0.70
Dark, not lighted; Clear;
Dry bituminous surface
*CV = 2003 Honda Accord EX
*V2 = 1982 Plymouth Reliant
*Final rest positions estimated and based on PCR schematic