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

ON-SITE AIR BAG INVESTIGATION

CASE NUMBER - IN00-002
LOCATION - WEST VIRGINIA
VEHICLE - 1990 PLYMOUTH SUNDANCE
CRASH DATE - February, 2000

Submitted:

December 5, 2002

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

DISCLAIMERS

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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.* IN00-002	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* On-Site Air Bag Fatality Investigation Vehicle - 1990 Plymouth Sundance Location - West Virginia		5. *Report Date:* December 5, 2002 6. *Performing Organization Code*	
7. *Author(s)* Special Crash Investigations Team #2		8. *Performing Organization Report No.* Task #s 0223 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: February, 2000 14. *Sponsoring Agency Code*	

15. *Supplementary Notes*
On-site air bag deployment investigation involving a 1990 Plymouth Sundance, four-door sedan, with manual safety belts and driver's air bag, and a 1989 Chevrolet Camaro Sport Coupe

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 1990 Plymouth Sundance (case vehicle) and a 1989 Chevrolet Camaro Sport Coupe (other vehicle). This crash is of special interest because the case vehicle's driver (16-year-old female) sustained a cervical injury from her deploying driver air bag, resulting in her death. The case vehicle was making a left-hand turn from a commercial parking lot driveway and was attempting to enter the "northbound" lane of a two-lane, undivided, State roadway. The Chevrolet was negotiating a left-hand curve while traveling southwestward in the "southbound" lane of the same two-lane, undivided, State roadway. The crash occurred within the driveway junction, just inside the "northbound" lane of the roadway. The front of the case vehicle was impacted by the front right corner of the Chevrolet, causing the case vehicle's driver supplemental restraint (air bag) to deploy. The case vehicle rotated approximately 5 degrees clockwise before coming to rest, heading east, straddling the roadway's double solid yellow center lines. The Chevrolet continued southward after impact and its front traveled off the eastern edge of the roadway into a drainage ditch. The Chevrolet came to rest heading southward. The case vehicle's driver was seated with her seat track located near its forward-most position, and the tilt steering wheel was located between its middle and upmost positions. She was not using her available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to the non-invasive post mortem examination, unknown injuries which included: an atlanto-occipital fracture (with almost certain high cervical spinal cord injury); abrasions to her inferior chin, anterior neck, and left chest; and contusions within the chin abrasion and to her left chest. In the opinion of the medical examiner, the driver sustained a "traumatic hyperextension … and … died as the result of cervical fracture due to air bag deployment …." The front right passenger (14-year-old male) was seated with his seat track located between its middle and forward-most positions and was not using his available, active, three-point, lap-and-shoulder, safety belt system. He sustained, according to his medical records, a blunt head trauma from contacting the right side of the windshield's glazing. The back center passenger (14-year-old male) was seated but his seat track was not adjustable, and he was not using his available, active, two-point, lap safety belt system. He sustained, according to his medical records, a blunt head trauma and a right head contusion from contacting the head restraint on the top of the driver's seat back.

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* 13	22. *Price* $8,500

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

TABLE OF CONTENTS IN00-002

Page No.

SELECTED PHOTOGRAPHS (Continued)

This on-site investigation was brought to NHTSA's attention on April 6, 2000 by the Fatality Analysis Reporting System (FARS). This crash involved a 1990 Plymouth Sundance (case vehicle) and a 1989 Chevrolet Camaro Sport Coupe (other vehicle). The crash occurred in February, 2000, at 12:24 p.m., in West Virginia and was investigated by the applicable state police department. This crash is of special interest because the case vehicle's driver [16-year-old, White (non-Hispanic) female] sustained a cervical injury from her deploying driver air bag, resulting in her death. This contractor inspected the scene and vehicles on April 26, 2000. This contractor was unable to interview the case vehicle's front right or back seat passengers. The attorney for the family of the case vehicle's driver provided medical records for these two occupants. This summary is based on the Police Crash Report, interviews with the investigating police officer, a conversation with the driver's parents, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was making a left-hand turn from a commercial parking lot driveway and was traveling in a northerly direction, attempting to enter the "northbound" lane of a two-lane, undivided, State roadway and travel north-northeastward. The Chevrolet was negotiating a left-hand curve while traveling southwestward in the "southbound" lane of the same two-lane, undivided, State roadway and intended to continue traveling southward. The case vehicle's driver made no avoidance maneuvers prior to the crash. The driver of the Chevrolet steered to his left and braked, depositing several (i.e., unknown) meters of skid marks in his attempt to avoid the crash. The crash occurred within the driveway junction, just inside the "northbound" lane of the roadway; see **CRASH DIAGRAM** below.

The front of the case vehicle was impacted by the front right corner of the Chevrolet, causing the case vehicle's driver supplemental restraint (air bag) to deploy. The case vehicle rotated approximately 5 degrees clockwise before coming to rest, heading east, with its front axle straddling the roadway's double solid yellow center lines. The Chevrolet continued southward after impact and its front traveled off the eastern edge of the roadway into a drainage ditch. The Chevrolet came to rest heading southward, primarily in the "northbound" lane, with the Chevrolet's front straddling the "east" edge line of the roadway.

The 1990 Plymouth Sundance was a front wheel drive, two-door coupe (VIN: 1P3XP44K7LN------). 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: **10-FDEW-1 (310)**. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 11.8 km.p.h. (7.3 m.p.h.), -7.6 km.p.h. (-4.7 m.p.h.), and +9.1 km.p.h. (+5.7 m.p.h.). In this contractor's opinion, these results should be considered suspect (i.e., low), but not totally out of range. The case vehicle was towed due to damage.

The case vehicle's contact with the Chevrolet involved almost the entire width of its front. Direct damage began 45 centimeters (17.7 inches) left of center (i.e., towards the driver's side)

and extended to the right bumper corner, a measured distance of 116 centimeters (45.7 inches). The field L extended from bumper corner to bumper corner a measured distance of 138 centimeters (54.3 inches). Residual maximum crush was 9 centimeters (3.5 inches) at C_6. There is no evidence that the case vehicle's wheelbase was altered from the crash. The case vehicle's front bumper fascia, grille, and right headlight and turn signal assemblies were directly damaged and crushed rearward. None of the case vehicle's tires were damaged, deflated, or physically restricted. Both the right and left fenders sustained induced damage. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior.

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points and there was no evidence of damage during the deployment to the air bag. Furthermore, there appeared to be cloth transfers on the driver air bag module's top cover flap. Unfortunately the driver's air bag fabric was cut out prior to this contractor's inspection. But, based on the inspection of the interior of the driver air bag module, it was designed without any tethers. Based on the on-scene police photos, the driver's air bag had two vent ports but, their diameter and clock positions are unknown. The design (i.e., circle versus ellipse) and measurements of the deployed driver's air bag are also unknown. Based on the on-scene photographs, there was a significant amount of blood on the driver's air bag fabric. The case vehicle was not equipped with a front right passenger air bag module.

Inspection of the case vehicle's interior revealed that right windshield's glazing sustained a spider web-type contact from the front right passenger, and there was no other evidence of occupant contact on the interior surfaces of the case vehicle. Finally, the energy absorbing steering column's shear capsules were completely separated with over 4 centimeters (1.6 inches) of separation on both sides.

The 1989 Chevrolet Camaro sport coupe was a rear wheel drive, two-door liftback (VIN: 1G1FP21E8KL------). Based on the available photographs, the CDC for the Chevrolet was estimated as: **01-FREE-3 (20)**. Maximum crush for the impact with the case vehicle is estimated as 12 centimeters (4.7 inches). The Chevrolet was towed due to damage.

Immediately prior to the crash the case vehicle's driver was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the accelerator, and presumably both her hands on the steering wheel. Because of the driver's left turn maneuver, the driver was most likely leaning slightly leftward into her turn. Based on the on-scene photographs, her seat track was located near its forward-most position, and the tilt steering wheel was located between its middle and upmost positions.

The case vehicle's driver [160 centimeters and 46 kilograms (63 inches, 102 pounds)] was not wearing her available, active, three-point, lap-and-shoulder, safety belt system. In addition, there was no evidence of belt pattern bruising and/or abrasions to the driver's body noted on the non-invasive post-mortem examination, 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 made no known pre-crash avoidance maneuvers. As a result and independent of the nonuse of her available safety belts, her pre-impact body position did not change just prior to impact. The case vehicle's impact with the Chevrolet enabled the case vehicle's driver to move forward and to the left towards the case vehicle's **310** degree Direction of Principal Force as the case vehicle decelerated. Because of the driver's short stature and close proximity to the steering wheel, the driver loaded the left side of the steering wheel, possibly depositing the suspected cloth transfer on the air bag module's top cover flap. Because of the large oblique-angled nature of the impact, the case vehicle's driver air bag module most likely did not immediately deploy. This delayed deployment allowed the driver to rebound backward slightly from the steering wheel and column so that when the air bag module did deploy she was still very close to the module. As discussed above, the driver's loading of the steering column resulted in the column's shear capsules completely separating on both sides. The deploying air bag forced the driver rearward and slightly to the right as the case vehicle rotated slightly clockwise. At final rest the driver was slumped forward and leaning slightly to the right.

The driver was transported by ambulance to the hospital. She sustained unknown (AIS=7) injuries and was pronounced dead an unknown time post-crash. According to the non-invasive post mortem examination, the injuries sustained by the case vehicle's driver included: an atlanto-occipital fracture (with almost certain high cervical spinal cord injury); abrasions to her inferior chin, anterior neck, and left chest; and contusions within the chin abrasion and to her left chest. In the opinion of the medical examiner, the driver sustained a "traumatic hyperextension due to air bag deployment with impact to the inferior chin …." and "died as the result of cervical fracture due to air bag deployment …."

The case vehicle's front right passenger [14-year-old, White (non-Hispanic) male; unknown height and 86 kilograms (190 pounds)] was seated in an upright posture with his back against the seat back and both feet on the floor. In addition, the exact position of his hands is unknown. His seat track was located between its middle and forward-most positions, and the seat back was upright.

According to his medical records, the case vehicle's front right passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. He sustained at most minor injuries and refused medical transport but was treated by ambulance personnel and released. Subsequently, his parents took him to a hospital, complaining of a headache, and he was examined and released. According to his medical records, he sustained a blunt head trauma from contacting the right side of the windshield's glazing, but no definite soft tissue injury was identified.

The case vehicle's back center passenger [14-year-old, White (non-Hispanic) male; unknown height and 76 kilograms (167 pounds)] was presumably seated in an upright posture with his back against the seat back, both feet on the floor, and both hands on the front seat backs. His seat track and seat back were not adjustable.

According to his medical records, the case vehicle's back center passenger was not using his available, active, two-point, lap safety belt system. The back center passenger sustained minor injuries and refused medical transported to the hospital but was treated at the scene by ambulance

personnel. Subsequently, his parents also took him to a hospital, complaining of a severe headache, and he was examined and released. According to his medical records, he sustained a blunt head trauma and a right head contusion from contacting the head restraint on the top of the driver's seat back.

CRASH CIRCUMSTANCES

The case vehicle was making a left-hand turn from a commercial parking lot driveway and was traveling in a northerly direction (**Figure 1**), attempting to enter the "northbound" lane of a two-lane, undivided, State roadway and travel north-northeastward. The Chevrolet was negotiating a left-hand curve while traveling southwestward in the "southbound" lane of the same two-lane, undivided, State roadway (**Figure 2**) and intended to continue traveling southward. The case vehicle's driver made no avoidance maneuvers prior to the crash. The driver of the Chevrolet steered to his left and braked, depositing several (i.e., unknown) meters of skid marks in his attempt to avoid the crash. The crash occurred within the driveway junction, just inside the "northbound" lane of the roadway; see **CRASH DIAGRAM** below.

Figure 1: Case vehicle's northerly travel path from parking lot driveway as driver attempted to turn left onto state roadway; Note: parked car at left obstructs view (case photo #01)

Figure 2: Chevrolet's south-southeastward travel path in left-hand curve approaching impact location (arrow) with case vehicle which pulled from driveway junction; Note: parked car obstructs view (case photo #05)

The parking lot driveway was straight and level at the area of impact. There was a 4.8 meter (15.7 foot) wide paved, bituminous, section prior with the remainder packed gravel, and the width of the driveway was 23 meters (75.5 feet). The State highway curved to the left for "southbound" traffic and level at the area of impact. The pavement was bituminous, and the width of both the northerly and southerly travel lanes was 3.1 meters (10.2 feet). There were improved (i.e., bituminous) shoulders along the State highway. On the western side of the roadway, the shoulder blended with and became part of the driveway. On the eastern side the shoulder was approximately 1 meter (3.3 feet) wide. Pavement markings consisted of a double solid yellow centerline for both north and southbound traffic. In addition, solid white edge lines were present. The estimated coefficient of friction was 0.70. There were no visible traffic controls located in the immediate area of the crash. The posted speed limit was 56 km.p.h. (35 m.p.h.). At the time of the crash the light condition was daylight, the atmospheric condition was overcast, and the road pavement was dry. Traffic density on the roadway at the time of the crash was light to moderate, and the site of the crash was rural with some commercial and residential structures in the immediate area.

Figure 3: Case vehicle's front oblique damage; Note: yellow tape marks width (leftmost) of direct damage from Chevrolet (case photo #08)

Figure 4: Case vehicle's frontal damage, viewed from right of front with contour gauge present, showing minimal deformation from oblique type impact with Chevrolet (case photo #16)

Figure 5: Attorney provided photo of Chevrolet's front right corner damage viewed from front at eye level (case photo #35)

Figure 6: Attorney provided photo of Chevrolet's front right corner damage, viewed down right side from impact with case vehicle (case photo #42)

The front (**Figures 3** and **4**) of the case vehicle was impacted by the front right corner (**Figures 5** and **6**) of the Chevrolet, causing the case vehicle's driver supplemental restraint (air bag) to deploy. The case vehicle rotated approximately 5 degrees clockwise before coming to rest, heading east, with its front axle straddling the roadway's double solid yellow center lines (**Figure 7**). The Chevrolet continued southward after impact and its front traveled off the eastern edge of the roadway into a drainage ditch. The Chevrolet came to rest heading southward, primarily in the "northbound" lane, with the Chevrolet's front straddling the "east" edge line of the roadway (**Figure 8** below).

Figure 7: On-scene view looking north-northeast-ward showing case vehicle's final rest position straddling double yellow center lines and Chevrolet's evasive skid marks leading into case vehicle's front (case photo #46)

The 1990 Plymouth Sundance was a front wheel drive, five-passenger, two-door coupe (VIN: 1P3XP44K7LN------) equipped with a 2.5L, I-4 engine and a three-speed automatic transmission. The case vehicle was not equipped with anti-lock brakes. Braking was achieved by a power-assisted, front disc and rear drum system. The case vehicle's wheelbase was 246 centimeters (97.0 inches), and the odometer reading at inspection was 153,772 kilometers (95,549 miles).

Figure 8: On-scene view looking north-northeast-ward in the northbound lane at Chevrolet's final rest position straddling east edge line of roadway; Note: case vehicle's front straddling center lines (case photo #45)

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat without any head restraints for the 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 not equipped with manually operated, upper anchorage adjusters for the "D"-rings. The vehicle was equipped with knee bolsters for the driver's seating position only and the knee bolster showed no evidence of deformation. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver position only. The driver's air bag deployed as a result of the case vehicle's front oblique-angled impact with the Chevrolet.

CASE VEHICLE DAMAGE

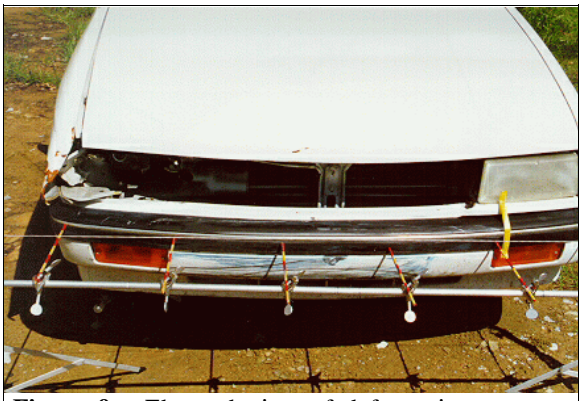


Figure 9: Elevated view of deformation to case vehicle's front with contour gauge present; Note: yellow tape indicates width (i.e., leftmost) of direct damage (case photo #09)

The case vehicle's contact with the Chevrolet involved almost the entire width of its front (**Figure 9**). Direct damage began 45 centimeters (17.7 inches) left of center (i.e., towards the driver's side) and extended to the right bumper corner, a measured distance of 116 centimeters (45.7 inches). The field L extended from bumper corner to bumper corner a measured distance of 138 centimeters (54.3 inches). Residual maximum crush was 9 centimeters (3.5 inches) at C_6. There is no evidence that the case vehicle's wheelbase was altered from the crash. The case vehicle's front bumper fascia, grille, and right headlight and turn signal assemblies were directly damaged and crushed rearward. None of the case vehicle's tires were damaged, deflated, or physically restricted. Both the right and left fenders sustained induced damage. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior.

Figure 10: Vertical view of case vehicle's front right passenger seating area showing head contact to right windshield (case photo #24)

Figure 11: Case vehicle's driver seating area showing steering wheel, instrument panel, and greenhouse area with no apparent evidence of occupant contact; Note: air bag was cut out and driver's seat was removed by family (case photo #23)

Inspection of the case vehicle's interior revealed that right windshield's glazing sustained a spider web-type contact from the front right passenger (**Figure 10**), and there was no other evidence of occupant contact on the interior surfaces of the case vehicle (**Figures 10** and **11**). Finally, the energy absorbing steering column's shear capsules were completely separated with over 4 centimeters (1.6 inches) of separation on both sides (**Figure 12**).

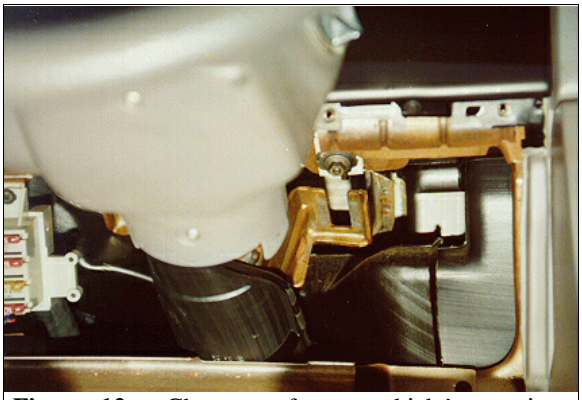


Figure 12: Close-up of case vehicle's steering column shear capsules showing their complete separation (case photo #26)

Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **10-FDEW-1 (310)**. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 11.8 km.p.h. (7.3 m.p.h.), -7.6 km.p.h. (-4.7 m.p.h.), and +9.1 km.p.h. (+5.7 m.p.h.). In this contractor's opinion, these results should be considered suspect (i.e., low), but not totally out of range. The case vehicle was towed due to damage.

Figure 13: Close-up of suspected cloth transfer on case vehicle driver air bag module's top cover flap (case photo #28)

Figure 14: Close-up of interior of case vehicle's driver air bag module after air bag was cut out by family (case photo #29)

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained a frontal air bag at the driver (only) seating position. The driver's air bag deployed as a result of the front oblique-angled impact with the Chevrolet. 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 20 centimeters (7.9 inches) at the horizontal seam and 8 centimeters (3.1 inches) vertically for the upper flap and 9 centimeters (3.5 inches) vertically for the lower flap. An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points and there was no evidence of damage during the deployment to the air bag. Furthermore, there appeared to be cloth transfers on the driver air bag module's top cover flap (**Figure 13**). Unfortunately the driver's air bag fabric was cut out prior to this contractor's inspection. But, based on the inspection of the interior of the driver air bag module (**Figure 14**), it was designed without any tethers. Based on the on-scene police photos (**Figure 15**), the driver's air bag had two vent ports but, their diameter and clock positions are unknown. The design (i.e., circle versus ellipse) and measurements of the deployed driver's air bag are also unknown. Based on the on-scene photographs, there was a significant amount of blood on the driver's air bag fabric (**Figures 16** and **17** below). The case vehicle was not equipped with a front right passenger air bag module.

Figure 15: On-scene view of case vehicle's deployed driver air bag showing at least one vent port (case photo #49)

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the accelerator, and presumably both her hands on the steering wheel. Because of the driver's left turn maneuver, the

driver was most likely leaning slightly leftward into her turn. Based on the on-scene photographs, her seat track was located near its forward-most position (**Figure 16**), and the tilt steering wheel was located between its middle and upmost positions.

Figure 16: On-scene view showing case vehicle's deployed, blood stained, air bag and front seat positions prior to removal of air bag by family; Note: driver's seat was located at its forward-most position (case photo #47)

Figure 17: Closer-up on-scene view of case vehicle's blood stained, driver air bag (case photo #48)

The case vehicle's driver [160 centimeters and 46 kilograms (63 inches, 102 pounds)] was not using her available, active, three-point, lap-and-shoulder, safety belt system. In addition, there was no evidence of belt pattern bruising and/or abrasions to the driver's body noted on the non-invasive post-mortem examination, 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 made no known pre-crash avoidance maneuvers. As a result and independent of the nonuse of her available safety belts, her pre-impact body position did not change just prior to impact. The case vehicle's impact with the Chevrolet enabled the case vehicle's driver to move forward and to the left towards the case vehicle's **310** degree Direction of Principal Force as the case vehicle decelerated. Because of the driver's short stature and close proximity to the steering wheel, the driver loaded the left side of the steering wheel, possibly depositing the suspected cloth transfer on the air bag module's top cover flap (**Figure 13** above). Because of the large oblique-angled nature of the impact, the case vehicle's driver air bag module most likely did not immediately deploy. This delayed deployment allowed the driver to rebound backward slightly from the steering wheel and column so that when the air bag module did deploy she was still very close to the module. As discussed above, the driver's loading of the steering column resulted in the column's shear capsules completely separating on both sides (**Figure 12** above). The deploying air bag forced the driver rearward and slightly to the right as the case vehicle rotated slightly clockwise. At final rest the driver was slumped forward and leaning slightly to the right.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital. She sustained unknown (AIS=7) injuries and was pronounced dead an unknown time post-crash. According to the non-invasive post mortem examination, the injuries sustained by the case vehicle's driver included: an atlanto-occipital fracture (with almost certain high cervical spinal cord injury); abrasions to her inferior

chin, anterior neck, and left chest; and contusions within the chin abrasion and to her left chest. In the opinion of the medical examiner, the driver sustained a "traumatic hyperextension due to air bag deployment with impact to the inferior chin …." and "died as the result of cervical fracture due to air bag deployment …."

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Traumatic cervical spine injury, not further specified	615999.7 unknown	Air bag, driver's	Certain	Post-mortem examination
2	Fracture atlas {atlanto-occipital} due to traumatic hyperextension from impact to inferior chin	650216.2 moderate	Air bag, driver's	Certain	Post-mortem examination
3	Abrasion, 14.0 cm (5.5 in), curvilinear, inferior chin, parallel to mandible	290202.1 minor	Air bag, driver's	Certain	Post-mortem examination
4	Contusion, 3.8 cm (1.5 in) within inferior chin abrasion	290402.1 minor	Air bag, driver's	Certain	Post-mortem examination
5	Abrasions, 14.0 (5.5 in) proximal anterior neck–horizontally	390202.1 minor	Air bag, driver's	Certain	Post-mortem examination
6	Abrasions, 10.2 x 7.6 cm (4 x 3 in) left lateral thorax just above left costal margin	490202.1 minor	Air bag, driver's	Certain	Post-mortem examination
7	Contusions, 10.2 x 7.6 cm (4 x 3 in) left lateral thorax just above left costal margin	490402.1 minor	Air bag, driver's	Certain	Post-mortem examination

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The case vehicle's front right passenger [14-year-old, White (non-Hispanic) male; unknown height and 86 kilograms (190 pounds)] was seated in an upright posture with his back against the seat back and both feet on the floor. In addition, the exact position of his hands is unknown. His seat track was located between its middle and forward-most positions, and the seat back was upright.

According to his medical records, the case vehicle's front right passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there was no evidence of belt pattern bruising and/or abrasions to the front right passenger's body, and the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the nonuse of his available safety belts, the front right passenger's pre-impact body

position did not change just prior to impact. The case vehicle's impact with the Chevrolet enabled the case vehicle's the front right passenger to move forward and to the left towards the case vehicle's **310** degree Direction of Principal Force as the case vehicle decelerated. As a result, the front right passenger moved forward over the instrument panel and dash and struck his head on the windshield glazing (**Figure 10** above). He rebounded off the windshield falling back to his left as the case vehicle rotated slightly clockwise underneath him. At final rest he remained in the front seat leaning to the left over the center floor-mounted emergency brake.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

He sustained at most minor injuries and refused medical transport but was treated by ambulance personnel and released. Subsequently, his parents took him to a hospital, complaining of a headache, and he was examined and released. According to his medical records, he sustained a blunt head trauma from contacting the right side of the windshield's glazing, but no definite soft tissue injury was identified.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Blunt head trauma {minor head injury with headache} without loss of consciousness	115099.7 unknown	Front right windshield's glazing	Certain	Emergency room records

CASE VEHICLE BACK CENTER PASSENGER KINEMATICS

The case vehicle's back center passenger [14-year-old, White (non-Hispanic) male; unknown height and 76 kilograms (167 pounds)] was presumably seated in an upright posture with his back against the seat back, both feet on the floor, and both hands on the front seat backs. His seat track and seat back were not adjustable.

According to his medical records, the case vehicle's back center passenger was not using his available, active, two-point, lap safety belt system. Furthermore, there was no evidence of belt pattern bruising and/or abrasions to the back center passenger's body, and the inspection of the passenger's seat belt webbing and latch plate showed no evidence of usage during this crash.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the nonuse of his available safety belts, the back center passenger's pre-impact body position did not change just prior to impact. The case vehicle's impact with the Chevrolet enabled the case vehicle's the back center passenger to move forward and to the left towards the case vehicle's **310** degree Direction of Principal Force as the case vehicle decelerated. As a result, the back center passenger impacted the head restraint on top of the driver's seat back. He rebounded off the seat back to his left as the case vehicle rotated slightly clockwise underneath him. At final rest he remained in the back center seat leaning to the left over the back left seat.

The back center passenger sustained minor injuries and refused medical transported to the hospital but was treated at the scene by ambulance personnel. Subsequently, his parents also took him to a hospital, complaining of a severe headache, and he was examined and released. According to his medical records, he sustained a blunt head trauma and a right head contusion from contacting the head restraint on the top of the driver's seat back.

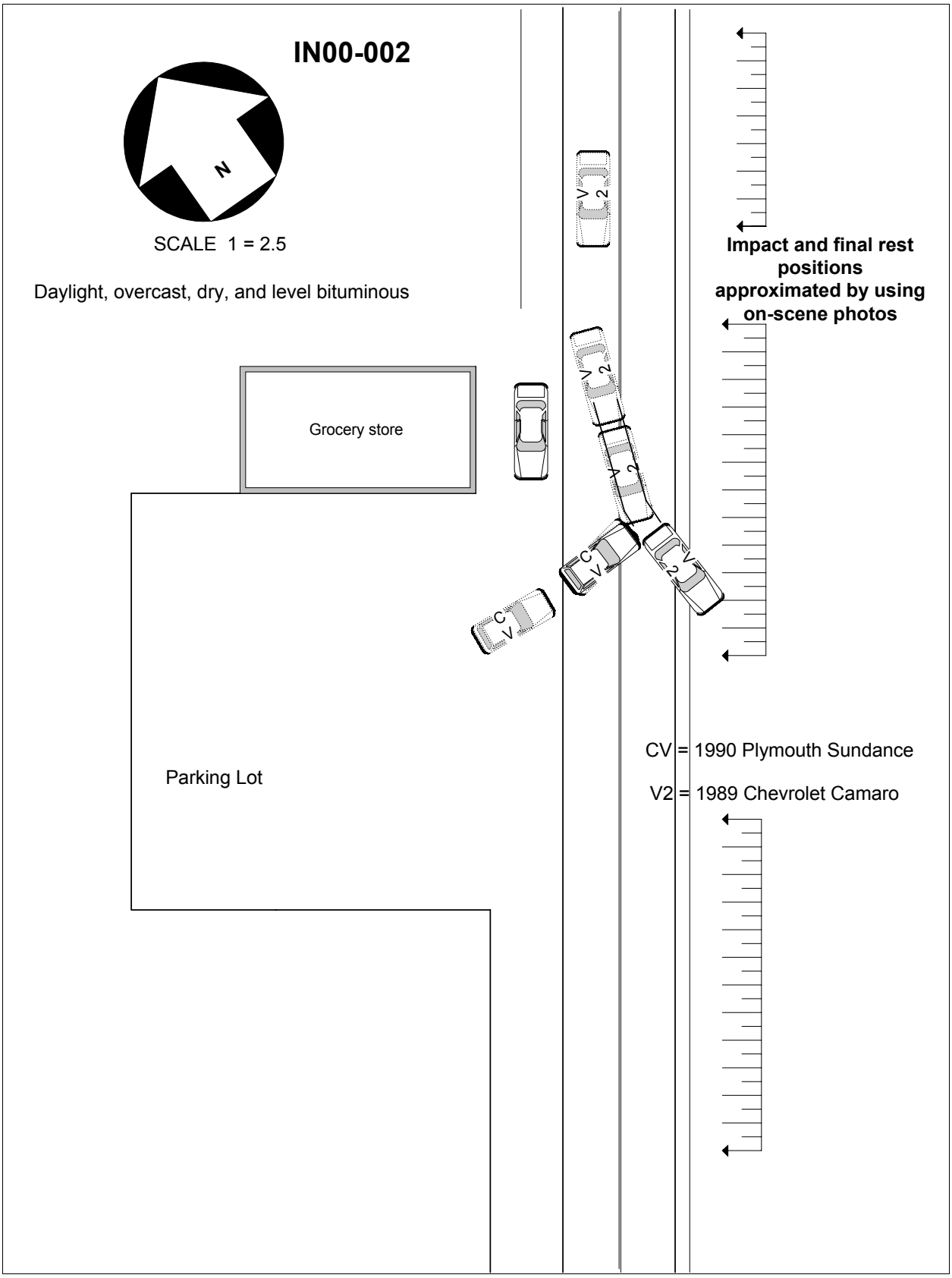
Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion right frontal area	190402.1 minor	Head restraint, driver's	Probable	Emergency room records
2	Blunt head trauma {head injury with headache} with momentary (i.e., seconds) loss of consciousness	115099.7 unknown	Head restraint, driver's	Probable	Emergency room records

OTHER VEHICLE

Based on the VIN and manufacturer's specifications, the 1989 Chevrolet Camaro sport coupe was a rear wheel drive, four-passenger, two-door liftback (VIN: 1G1FP21E8KL------) equipped with a 5.0L, V-8 engine, and a manual transmission was standard. The Chevrolet's wheelbase was 257 centimeters (101.0 inches), and the odometer reading is unknown because the Chevrolet was not inspected.

Figure 18: Attorney provided close-up photo of Chevrolet's front right corner damage from oblique-angled impact with case vehicle's front (case photo #43)

The damage to the Chevrolet from the impact with the case vehicle involved the front right bumper corner with damage extending down the right side to the front right wheel area (**Figures 5**, **6**, and **8** above and **Figure 18**). Maximum crush for the impact with the case vehicle is estimated as 12 centimeters (4.7 inches). Based on the available photographs, the CDC for the Chevrolet was estimated as: **01-FREE-3 (20)**. The WinSMASH reconstruction program, was not be used on the Chevrolet because there were no crush measurements; however, this contractor's visually estimated Delta V is between 8 km.p.h. (5 m.p.h.) and 14.5 km.p.h. (9 m.p.h.). The Chevrolet was towed due to damage.


IN00-002
N
SCALE 1 = 2.5
Daylight, overcast, dry, and level bituminous
Grocery store
Parking Lot
Impact and final rest positions approximated by using on-scene photos
CV = 1990 Plymouth Sundance
V2 = 1989 Chevrolet Camaro