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ON-SITE CHILD SAFETY SEAT INVESTIGATION

CASE NUMBER - IN01-023
LOCATION - ILLINOIS
VEHICLE - 1996 CHRYSLER CONCORDE LX
CRASH DATE - August, 2001

Submitted:

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Contract Number: DTNH22-94-D-17058

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

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

Technical Report Documentation Page

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On-site child safety seat investigation involving a 1996 Chrysler Concorde, four-door sedan, with manual safety belts and dual front air bags, a 1998 Pontiac Transport, and a 1998 Chevrolet Malibu LS

16. *Abstract*

This report covers an on-site child safety seat investigation that involved a 1996 Chrysler Concorde LX (case vehicle), a 1998 Pontiac Transport SE (1st other vehicle), and a 1998 Chevrolet Malibu LS (2nd other vehicle). This crash is of special interest because the case vehicle's back center passenger (17-month-old male) who was restrained in a convertible child safety seat, which was configured in the forward facing position, sustained only minor injuries during the crash. The case vehicle was traveling south in the inside southbound through lane of a five-lane, divided, U.S. highway and was approaching a four-leg intersection (i.e., both the north and southbound roadways had two through lanes and a left-hand, turn lane). The Pontiac had been traveling north in the northbound, left-hand, turn lane of the same U.S. trafficway and was turning left at the intersection. The Chevrolet was stopped at the four-leg intersection, heading east in the eastbound through lane of a three-lane, undivided, city street (there was one through lane in both the east and westbound directions and an opposing, left-hand, turn lane in each direction). The crash occurred in the inside, southbound through lane of the four-leg intersection. The front left half of the case vehicle impacted the front right of the Pontiac, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Next, the two vehicles side slapped–left quarter panel to right quarter panel. The case vehicle was redirected in a southwesterly direction and endswiped the stopped Chevrolet with its front right. The case vehicle continued in a southwesterly direction and impacted a curb and a traffic signal pole with its front left. The case vehicle rotated slightly counterclockwise and sideswiped a wooden utility pole with its right side prior to impacting and coming to rest against a wood pile. The case vehicle's back center child passenger was seated, asleep, in a forward facing child safety seat. His seat track was not adjustable. He was restrained in the child safety seat which was secured by his available, active, two-point, lap belt system. He sustained, according to the driver (mother), minor abrasions and contusions to his left shoulder. The case vehicle's driver (29-year-old female) was seated with her seat track located in its middle position, and the tilt steering wheel was located in its middle position. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to her interview and medical records, minor abrasions to her nose, chin, and bilateral forearms from her deploying driver air bag. Furthermore, she sustained seat belt abrasions and contusions to her left shoulder and both hips. In addition, she sustained: lacerations and abrasions to both knees, a laceration and contusion to her left shin, and contusions to her upper left arm and the dorsal surface of her left hand.

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TABLE OF CONTENTS IN01-023

Page No.

SELECTED PHOTOGRAPHS (Continued)

BACKGROUND

IN01-023

This on-site investigation was brought to NHTSA's attention on August 31, 2001 by an article in a newspaper. This crash involved a 1996 Chrysler Concorde LX (case vehicle), a 1998 Pontiac Transport SE (1st other vehicle), and a 1998 Chevrolet Malibu LS (2nd other vehicle). The crash occurred in August, 2001, at 11:43 a.m., in Illinois and was investigated by the applicable city police department. This crash is of special interest because the case vehicle's back center passenger [17-month-old, White (non-Hispanic) male] who was restrained in a convertible child safety seat, which was configured in the forward facing position, sustained only minor injuries during the crash. This contractor inspected the scene and vehicles on 10-11 September, 2001. This contractor interviewed the driver for the case vehicle on September 11, 2001. This report is based on the Police Crash Report, interviews with the case vehicle's driver and the investigating police officer, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling south in the inside southbound through lane of a five-lane, divided, U.S. highway and was approaching a four-leg intersection, intending to continue southward through the intersection (i.e., both the north and southbound roadways had two through lanes and a left-hand, turn lane). The Pontiac had been traveling north in the northbound, left-hand, turn lane of the same, five-lane, divided, U.S. trafficway and was turning left at the intersection, attempting to travel westward on the intersecting roadway. The Chevrolet was stopped at the four-leg intersection, waiting for the traffic signal light to change. The Chevrolet was heading east in the eastbound through lane of a three-lane, undivided, city street, and intended to continue eastward (there was one through lane in both the east and westbound directions and an opposing, left-hand, turn lane in each direction). The case vehicle's driver steered to the right and was attempting to brake, trying to avoid the crash. The crash occurred in the inside, southbound through lane of the four-leg intersection; see **CRASH DIAGRAM** at end.

The front left half of the case vehicle impacted the front right of the Pontiac, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Next, the two vehicles side slapped with the case vehicle's left quarter panel contacting the right quarter panel of the Pontiac. As a result of their converging trajectories and relative momentum, the case vehicle was redirected in a southwesterly direction and endswiped the stopped Chevrolet with its front right. The case vehicle continued in a southwesterly direction and impacted the curb as it went off the southwest corner of the intersection. Almost immediately, the case vehicle impacted a traffic signal light control pole with its front left, whereupon it rotated slightly counterclockwise before continuing in a southerly direction. Next, the case vehicle sideswiped a wooden utility pole with its right side prior to impacting and coming to rest against a wood pile, on the west side of the north-south trafficway, heading in a southerly direction. The Pontiac came to rest in the intersection heading in a south-southwesterly direction. The Chevrolet came to rest near its point of impact in the eastbound lane, still heading primarily in a easterly direction.

The 1996 Chrysler Concorde LX was a front wheel drive, four-door sedan (VIN: 2C3HD56T9TH------). The case vehicle was equipped with four-wheel, anti-lock brakes. Based

on the vehicle inspection, for the case vehicle's seven impacts only four CDCs could be determined or estimated because of the overlapping damage. CDCs were determined to be: **09-LBEW-2 (270)** for the side slap (2nd event), **12-FLWN-3 (0)** for the curb impact (4th event), and **12-RDES-2 (10)** for the sideswipe of the utility pole (6th event). A CDC was estimated as: **12-FR99-9 (0)** for the end swipe to the Chevrolet (3rd event). The CDCs for the case vehicle's initial impact with the Pontiac (1st event), the impact with the traffic signal pole (5th event), and the impact with the wood pile (7th event) are unknown. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's initial impact (1st event) with the Pontiac in order to approximate the case vehicle's highest severity impact (i.e., deployment). The case vehicle was considered missing for this estimate because of the overlapping damage it sustained to its front. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 20.5 km.p.h. (12.7 m.p.h.), -20.5 km.p.h. (-12.7 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). These results appear reasonable. No reconstruction program was used on the side slap impact because the NASS, CDS, WinSMASH protocol requires that actual vehicular crush measurements be obtained; however, this contractor's visually estimated Delta V is between 5 km.p.h. (3 m.p.h.) and 11 km.p.h. (7 m.p.h.). No reconstruction program was used on the sideswipe impact since the collision type is considered out side the scope of the WinSMASH reconstruction program; however, this contractor's visually estimated Delta V is between 3 km.p.h. (2 m.p.h.) and 6 km.p.h. (4 m.p.h.). The case vehicle was towed due to damage.

The case vehicle's initial contact with the Pontiac involved its front left half. Direct damage appears to begin 1 centimeter (0.4 inches) to the left of center and extends to the right (towards the driver's side) a measured distance of 73 centimeters (28.7 inches) along the front bumper. The total residual maximum crush was approximately 37 centimeters (14.6 inches) at C_1. The case vehicle's side slap impact with the Pontiac involved the case vehicle's left quarter panel. The direct damage began 3 centimeters (1.2 inches) behind the left rear axle and extended rearwards a measured distance of 95 centimeters (37.4 inches). The maximum crush for the side slap was measured as 10 centimeters (3.9 inches). The direct damage and field L for the case vehicle's end swipe impact with the Chevrolet could not be determined. The direct damage location for the case vehicle's front left impact with the traffic signal pole was masked by its initial impact with the Pontiac. Direct and induced damage for the case vehicle's right sideswipe impact with the wooden utility pole began 29 centimeters (11.4 inches) forward of the right front axle and extended rearwards a measured distance of 231 centimeters (90.9 inches). Maximum crush for the sideswipe impact was measured as 14 centimeters (5.5 inches). As a result of the impacts, the wheelbase on the case vehicle's left side was shortened 6 centimeters (2.4 inches) while the right side remained unchanged. The case vehicle's front bumper, bumper fascia, grille, hood, radiator, left headlight assembly, right and left turn signal assemblies, and right and left fenders were directly damaged and crushed rearward. The case vehicle's right fender, right front door, right outside rear view mirror, right rear door, left quarter panel, and left back bumper were directly damaged and crushed inward. The case vehicle's left front tire was physically restricted, deflated, and dented from both the traffic signal and curb impacts. The case vehicle's right front tire was also deflated. The right headlight assembly, hood, and back bumper sustained induced damage. In addition, the left side of the windshield's glazing was cracked when the back left portion of the hood was pushed into it.

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 12 centimeters (4.7 inches) in width and located vertically between the 1 and 5 o'clock and 11 and 7 o'clock positions. The driver's air bag had no vent ports. The deployed driver's air bag was round with a diameter of 63 centimeters (24.8 inches). An inspection of the driver's air bag fabric revealed a diagonally oriented, 8 centimeter (3.1 inch) red lipstick smear within the center stitching area on the driver's air bag. In addition, there was a greasy type smear located toward the 3 o'clock position.

The front right passenger's air bag was located in the top of the instrument panel. An inspection of the front right air bag module's cover flap and the air bag's fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flap. The front right passenger's air bag was designed with one tether, 43 centimeters (16.9 inches) in width, located horizontally between the 4 and 8 o'clock positions. The front right air bag had no vent ports. The deployed front right air bag was rectangular with a height of approximately 63 centimeters (24.8 inches) and a width of approximately 53 centimeters (20.9 inches). An inspection of the front right passenger's air bag fabric revealed that there was no contact evidence readily apparent on the front right air bag's fabric.

Inspection of the case vehicle's interior revealed occupant contact evidence on the left "A"-pillar (i.e., scratches) and driver's knee bolster (i.e., scuffs), both left and right of the steering column. Finally, there was no evidence of intrusion to the case vehicle's interior, no evidence of compression to the energy absorbing shear capsules in the steering column, and no deformation to the steering wheel rim.

The convertible child safety seat used by the case vehicle's back center passenger was configured in the forward facing position at the time of the crash. The seat was manufactured by Evenflo on August 23, 2000 and was identified by Model name "Conquest". The seat was designed with a three-point harness connected to a pull-over shield which buckled between the child's legs. The seat also had an optional tether which was not used since the case vehicle was not equipped with a rear attachment point. There were three slots to thread the three-point harness through. The slot chosen is based on the child's height and weight which in turn determines the seat's configuration (i.e., rear facing versus forward facing). In this case, the harness belts were threaded through the bottom slot and should have been in the top slot because of the forward facing configuration. The harness placement most likely resulted in the child's shoulder injuries. The forward facing child seat showed numerous, small areas of stress to the plastic shell with very little wear and tear to the cloth cover or padding.

The 1998 Pontiac Transport was a front wheel drive, four-door, extended minivan (VIN: 1GMDX03E1WD------). Based on the vehicle inspection the CDCs for the Pontiac were determined to be: **02-FZEW-1 (50)** [residual maximum crush was 16 centimeters (6.3 inches)], and **03-RBEW-2 (90)**. The WinSMASH reconstruction program, missing vehicle algorithm was

used on the Pontiac's highest severity impact with the case vehicle (i.e., the case vehicle was considered missing for this estimate because of the overlapping damage it sustained to its front). The Total, Longitudinal, and Lateral Delta Vs are, respectively: 18.7 km.p.h. (11.6 m.p.h.), -12.0 km.p.h. (-7.5 m.p.h.), and -14.3 km.p.h. (-8.9 m.p.h.). These results appear reasonable. The Pontiac was towed due to damage.

The 1998 Chevrolet Malibu LS was a front wheel drive, four-door sedan (VIN: 1G1NE52MXW6------). With no available vehicle photographs, the CDC for the Chevrolet is unknown. The Chevrolet was driven from the scene.

Immediately prior to the crash the case vehicle's back center child passenger [64 centimeters and 11 kilograms (25 inches, 25 pounds)] was seated, asleep, in a forward facing child safety seat. He was sitting essentially in an upright posture with his back against the seat back of the child safety seat, his feet dangling over the front edge of the child seat's cushion, and both hands were on the shield in front of him. The exact position of his head is unknown (i.e., tilted forward versus laying toward the left or right). His seat track and seat back were not adjustable.

The case vehicle's back center passenger was restrained in a child safety seat which was secured by his available, active, two-point, lap belt system. The lap belt had a manual retractor with a locking teeth plate. Furthermore, there was evidence of belt pattern bruising and abrasions to his left shoulder, and the inspection of his seat belt webbing and latch plate showed evidence of loading.

The case vehicle's driver steered to the right and was in the process of attempting to brake, trying to avoid the crash. As a result of these attempted avoidance maneuvers and the combined use of his child safety seat and the two-point, lap belt, the back center passenger most likely moved slightly forward and to his left immediately prior to the initial impact. The case vehicle's primary impact with the Pontiac enabled the case vehicle's back center, child safety seated passenger to continue forward and slightly leftward toward the case vehicle's **350** degree Direction of Principal Force as the case vehicle decelerated. As a result, the child loaded against the child safety seat's harness and shield. This loading of the child safety seat's harness belt most likely contused and abraded his shoulder. When the case vehicle reached maximum engagement, the case vehicle was redirected in a southwesterly direction prior to side slapping the Pontiac. As a result of the redirection and the subsequent side slap impact, the child moved further leftward against the side of the child seat. As the case vehicle continued in its southwesterly direction, the child remained leaning to his left. The case vehicle's frontal impacts with the Chevrolet, the curb, and the traffic signal control pole, which immediately followed the curb impact, resulted in him moving slightly forward and upward against the child seat's restraints as the case vehicle further decelerated. The impact with the traffic control signal pole also resulted in the case vehicle rotating slightly counterclockwise. This rotation sent the child back to his right and then forward as the vehicle continued to decelerate. The case vehicle's sideswipe impact with the wooden utility pole most likely had little effect upon the child. As the case vehicle continued further forward into the wood pile, the child most likely moved back forward and upward against his seat's harness as the case vehicle came to a stop. According to the case vehicle's driver (i.e., mother), at final rest the child remained seated in his child safety seat. The child seat was twisted/turned slightly

leftward. Based on the statement of the case vehicle's driver that the child was turned/twisted leftward at final rest, this investigator would assume that the seat belt securing the child safety seat to the vehicle was not cinched down tight enough prior to the crash.

The case vehicle's back center occupant was transported by ambulance to the hospital for precautionary measures. He sustained minor injuries and was treated and released. According to the driver (mother), the case vehicle's back center passenger sustained abrasions and contusions to his left shoulder.

The case vehicle's driver [29-year-old, White (non-Hispanic) female; 165 centimeters and 59 kilograms (65 inches, 130 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot reaching for the brake, and both hands on the steering wheel. Her seat track was located in its middle position, the seat back was upright, and the tilt steering wheel was located in its middle position.

The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there was evidence of belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed trace evidence of loading.

The driver was transported by ambulance to the hospital. She sustained minor injuries and was treated and released. According to the case vehicle's driver and her medical records, she sustained abrasions to her nose, chin, and bilateral forearms from her deploying driver air bag. Furthermore, she sustained seat belt abrasions and contusions to her left shoulder and both hips. In addition, she sustained: lacerations and abrasions to both knees, a laceration and contusion to her left shin, and contusions to her upper left arm and the dorsal surface of her left hand.

CRASH CIRCUMSTANCES

Figure 1: Case vehicle's southward travel path in inside through lane of southbound roadway (case photo #01)

Figure 2: Pontiac's northward travel path in left-hand turn lane and likely converging trajectory (case photo #11)

The case vehicle was traveling south in the inside southbound through lane of a five-lane, divided, U.S. highway (**Figure 1**) and was approaching a four-leg intersection, intending to continue southward through the intersection (i.e., both the north and southbound roadways had two through lanes and a left-hand, turn lane). The Pontiac had been traveling north in the northbound, left-hand, turn lane of the same, five-lane, divided, U.S. trafficway and was turning

left at the intersection (**Figure 2** above), attempting to travel westward on the intersecting roadway. The Chevrolet was stopped at the four-leg intersection, waiting for the traffic signal light to change. The Chevrolet was heading east in the eastbound through lane of a three-lane, undivided, city street, and intended to continue eastward (there was one through lane in both the east and westbound directions and an opposing, left-hand, turn lane in each direction). The case vehicle's driver steered to the right and was attempting to brake, trying to avoid the crash. The crash occurred in the inside, southbound through lane of the four-leg intersection; see **CRASH DIAGRAM** at end.

The southbound roadway of the U.S. highway was curved slightly/gradually to the right for southbound traffic and level at the area of impact. The pavement was bituminous, but traveled, and the width of the inside southbound lane was 3.8 meters (12.5 feet). The west side of the southbound road had a 3.3 meter (10.8 foot) wide gravel shoulder and the east side did not have a shoulder prior to the 9.0 meter (29.5 feet) wide unprotected grassy median that separated the north and southbound roadways of the trafficway. Pavement markings for the southbound roadway consisted of a solid yellow edge line on the east side and a solid white edge line on west side. In addition, the through lanes were divided by a dashed white line and the left-hand turn lane was separated from the through lanes by a solid white lane line. The estimated coefficient of friction was 0.70. Traffic controls consisted of three on-colors, pre-timed, vertical mounted traffic control signals that were located along with a pedestrian signal on the southwest quadrant of the intersection. In addition, a vertically mounted signal was also located on the northwest quadrant. The statutory speed limit was 89 km.p.h. (55 m.p.h.), and no regulatory speed limit sign was posted near the crash site.

The northbound roadway of the U.S. highway was also curved slightly/gradually to the left for northbound traffic and level at the area of impact. The pavement was bituminous, but traveled, and the width of the left-hand northbound turn lane was 3.0 meters (9.8 feet). The west side of the northbound road did not have a shoulder prior to the 9.0 meter (29.5 foot) wide unprotected grassy median that separated the north and southbound roadways of the trafficway and the east side had a grassy shoulder which was 14.0 meters (45.9 feet) wide and separated the northbound traffic lanes from a frontage road. Pavement markings for the roadway consisted of a solid yellow edge line on the west side and a solid white edge line on east side. In addition, the through lanes were divided by a dashed white line and the left-hand turn lane was separated from the through lanes by solid a white lane line. The estimated coefficient of friction was 0.70. Traffic controls consisted of three on-colors, pre-timed, vertical mounted traffic control signals were located on the northeast quadrant of the intersection. In addition, a vertically mounted signal was also located on the southeast quadrant. The statutory speed limit was 89 km.p.h. (55 m.p.h.), and no regulatory speed limit sign was posted near the crash site.

The Chevrolet’s city roadway was straight and level in the approach area. The pavement was bituminous, but traveled, and the width of the eastbound through lane was 3.6 meters (11.8 feet). The roadway was bordered by bicycle lanes and barrier curbs on both the north and south sides. Pavement markings consisted of a double solid yellow centerline for both east and westbound traffic, and the left-hand turn lane was separated from the eastbound lane by a solid white line. In addition, solid white lane/edge lines were used to separate the travel lanes from the

bicycle lanes. The estimated coefficient of friction was 0.70. Traffic controls consisted of two on-colors, pre-timed, vertical mounted traffic control signals that were located on the southeast quadrant of the intersection. In addition, a vertically mounted signal was also located on the southwest quadrant. The statutory speed limit was 56 km.p.h. (35 m.p.h.), and no regulatory speed limit sign was posted near the crash site.

At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the road pavement was dry. Traffic density was moderate, and the site of the crash was urban commercial.

Figure 3: Elevated view from left of front of case vehicle's frontal deformation with contour gauge present showing damage from impact with Pontiac and traffic signal pole (case photo #18)

Figure 4: Pontiac's front right deformation viewed from right of front with contour gauge present showing impact from case vehicle; Note: side slap damage to right rear (case photo #73)

Figure 5: Case vehicle damaged left quarter panel from side slap impact with Pontiac; Note: yellow tape marks direct contact width (case photo #25)

Figure 6: Case vehicle's redirected travel path toward Chevrolet which was stopped in eastbound through lane of intersecting roadway **and** toward southwest corner of four-leg intersection as a result of impacts with Pontiac (case photo #03)

The front left half of the case vehicle (**Figure 3**) impacted the front right of the Pontiac (**Figure 4**), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Next, the two vehicles side slapped with the case vehicle's left quarter panel (**Figure 5**) contacting the right quarter panel of the Pontiac (**Figure 4**). As a result of their converging trajectories and relative momentum, the case vehicle was redirected in a southwesterly direction and endswiped the stopped Chevrolet with

its front right (**Figure 6** above). The case vehicle continued in a southwesterly direction and impacted the curb as it went off the southwest corner of the intersection. Almost immediately, the case vehicle impacted a traffic signal light control pole with its front left (**Figure 7**), whereupon it rotated slightly counterclockwise before continuing in a southerly direction. Next, the case vehicle sideswiped a wooden utility pole with its right side (**Figure 8**) prior to impacting and coming to rest against a wood pile, on the west side of the north-south trafficway, heading in a southerly direction (**Figure 9**). The Pontiac came to rest in the intersection heading in a south-southwesterly direction. The Chevrolet came to rest near its point of impact in the eastbound lane, still heading primarily in a easterly direction.

Figure 7: Case vehicle's southwesterly travel path and subsequent impacts with curb, traffic signal pole, wooden utility pole, and wood pile–in background (case photo #04)

Figure 8: Case vehicle's right side damage (i.e., between yellow tape) from sideswipe with wooden utility pole (case photo #32)

Figure 9: Case vehicle's southwesterly travel path into impact with wood pile; Note: side swiping damage on wooden utility pole and scattered remnants of wood pile (case photo #07)

CASE VEHICLE

The 1996 Chrysler Concorde LX was a front wheel drive, five-passenger, four-door sedan (VIN: 2C3HD56T9TH------) equipped with a 3.3L, V-6 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The case vehicle's wheelbase was 287 centimeters (113.0 inches), and the odometer reading at inspection was 113,732 kilometers (70,670 miles).

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat without head restraints for the back seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the front and back outboard positions; and a two-point, lap belt system at the back center position. The front seat belt systems were equipped with manually operated, upper anchorage adjusters for the "D"-rings. Both the driver and front right passenger positions had their upper anchorage adjusters located in the upmost positions. The vehicle was equipped with knee bolsters for both the driver and front right passenger. The driver's knee bolster was scuff both left and right of the steering column. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a

frontal air bag for the driver and front right passenger seating positions. Both frontal air bags deployed as a result of the case vehicle's front left corner impact with the Pontiac.

CASE VEHICLE DAMAGE

Figure 10: Case vehicle's overlapping frontal damage from four frontal impacts–Pontiac, Chevrolet, traffic signal pole, and wood pile (case photo #17)

Figure 11: Reference line view from left showing case vehicle's damage from Pontiac and traffic signal pole (case photo #21)

The case vehicle's initial contact with the Pontiac involved its front left half. Direct damage appears to begin 1 centimeter (0.4 inches) to the left of center and extends to the right (towards the driver's side) a measured distance of 73 centimeters (28.7 inches) along the front bumper (**Figure 10**). The total residual maximum crush was approximately 37 centimeters (14.6 inches) at C_1 (**Figure 11**). The case vehicle's side slap impact with the Pontiac involved the case vehicle's left quarter panel (**Figure 5** above). The direct damage began 3 centimeters (1.2 inches) behind the left rear axle and extended rearwards a measured distance of 95 centimeters (37.4 inches). The maximum crush for the side slap was measured as 10 centimeters (3.9 inches). The direct damage and field L for the case vehicle's end swipe impact with the Chevrolet could not be determined. The direct damage location for the case vehicle's front left impact with the traffic signal pole was masked by its initial impact with the Pontiac (**Figure 11**). Direct and induced damage for the case vehicle's right sideswipe impact with the wooden utility pole (**Figure 6** above) began 29 centimeters (11.4 inches) forward of the right front axle and extended rearwards a measured distance of 231 centimeters (90.9 inches). Maximum crush for the sideswipe impact was measured as 14 centimeters (5.5 inches). As a result of the impacts, the wheelbase on the case vehicle's left side was shortened 6 centimeters (2.4 inches) while the right side remained unchanged. The case vehicle's front bumper, bumper fascia, grille, hood, radiator, left headlight assembly, right and left turn signal assemblies, and right and left fenders were directly damaged and crushed rearward. The case vehicle's right fender, right front door, right

Figure 12: Stress fracture to case vehicle's windshield caused by back left tip of hood (case photo #24)

outside rear view mirror, right rear door, left quarter panel, and left back bumper were directly damaged and crushed inward. The case vehicle's left front tire was physically restricted, deflated, and dented from both the traffic signal and curb impacts. The case vehicle's right front tire was also deflated. The right headlight assembly, hood, and back bumper sustained induced damage. In addition, the left side of the windshield's glazing was cracked when the back left portion of the hood was pushed into it (**Figure 12** above).

Figure 13: Case vehicle's left "A"-pillar and windshield's glazing showing scratches on "A"-pillar from rings on driver's left hand and stress fracture of windshield's glazing (case photo #38)

Inspection of the case vehicle's interior revealed occupant contact evidence on the left "A"-pillar (i.e., scratches–**Figure 13**) and driver's knee bolster (i.e., scuffs), both left (**Figure 14**) and right of the steering column. Finally, there was no evidence of intrusion to the case vehicle's interior, no evidence of compression to the energy absorbing shear capsules in the steering column, and no deformation to the steering wheel rim.

Figure 14: Close-up of scuff mark on left side of case vehicle's driver knee bolster from contact by driver's left knee (case photo #37)

Based on the vehicle inspection, for the case vehicle's seven impacts only four CDCs could be determined or estimated because of the overlapping damage. CDCs were determined to be: **09-LBEW-2 (270)** for the side slap (2nd event), **12-FLWN-3 (0)** for the curb impact (4th event), and **12-RDES-2 (10)** for the sideswipe of the utility pole (6th event). A CDC was estimated as: **12-FR99-9 (0)** for the end swipe to the Chevrolet (3rd event). The CDCs for the case vehicle's initial impact with the Pontiac (1st event), the impact with the traffic signal pole (5th event), and the impact with the wood pile (7th event) are unknown. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's initial impact (1st event) with the Pontiac in order to approximate the case vehicle's highest severity impact (i.e., deployment). The case vehicle was considered missing for this estimate because of the overlapping damage it sustained to its front. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 20.5 km.p.h. (12.7 m.p.h.), -20.5 km.p.h. (-12.7 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). These results appear reasonable. No reconstruction program was used on the side slap impact because the NASS, CDS, WinSMASH protocol requires that actual vehicular crush measurements be obtained; however, this contractor's visually estimated Delta V is between 5 km.p.h. (3 m.p.h.) and 11 km.p.h. (7 m.p.h.). No reconstruction program was used on the sideswipe impact since the collision type is considered out side the scope of the WinSMASH reconstruction program; however, this contractor's visually estimated Delta V is between 3 km.p.h. (2 m.p.h.) and 6 km.p.h. (4 m.p.h.). The case vehicle was towed due to damage.

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. Both frontal air bags deployed as a result of the front left corner impact with the Pontiac. The case vehicle's driver air bag was located in the steering wheel hub (**Figure 15**). The module cover consisted of asymmetrical, essentially "H"-configuration, cover flaps made of thick vinyl with overall dimensions of 16 centimeters (6.3 inches) at the top and bottom horizontal seams and 8 centimeters (3.1 inches) vertically for the upper flap and 6 centimeters (2.4 inches) vertically for the lower flap. 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 12 centimeters (4.7 inches) in width and located vertically between the 1 and 5 o'clock and 11 and 7 o'clock positions. The driver's air bag had no vent ports. The deployed driver's air bag was round with a diameter of 63 centimeters (24.8 inches). An inspection of the driver's air bag fabric revealed a diagonally oriented, 8 centimeter (3.1 inch) red lipstick smear within the center stitching area on the driver's air bag (**Figure 16**). In addition, there was a greasy type smear located toward the 3 o'clock position.

Figure 15: Case vehicle's deployed driver air bag showing small red transfer in center of air bag's stitching and contact (i.e., tape) to knee bolster (case photo #45)

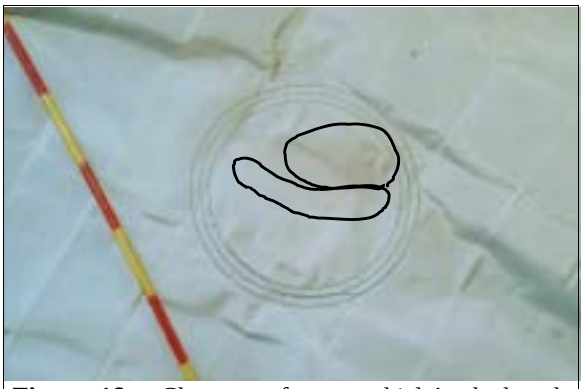


Figure 16: Close-up of case vehicle's deployed driver air bag showing (highlighted) lipstick transfer and oily smudge on center stitching (case photo #47)

The front right passenger's air bag was located in the top of the instrument panel. There was a single, essentially rectangular, modular cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were 35 centimeters (13.8 inches) at the lower horizontal seam and 16 centimeters (6.3 inches) along both vertical seams. The profile of the case vehicle's instrument panel resulted in a 5 centimeter (2.0 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. An inspection of the front right air bag module's cover flap and the air bag's fabric revealed that the cover flap opened at the designated tear points, and there was

Figure 17: Case vehicle's deployed front air bags; Note: absence of contact evidence to windshield's glazing and sun visors (case photo #44)

no evidence of damage during the deployment to the air bag or the cover flap. The front right passenger's air bag was designed with one tether, 43 centimeters (16.9 inches) in width, located horizontally between the 4 and 8 o'clock positions (**Figure 17** above). The front right air bag had no vent ports. The deployed front right air bag was rectangular with a height of approximately 63 centimeters (24.8 inches) and a width of approximately 53 centimeters (20.9 inches). An inspection of the front right passenger's air bag fabric revealed that there was no contact evidence readily apparent on the front right air bag's fabric.

Figure 18: Overhead view of convertible child safety seat used by back center passenger, with top half of cover pulled down, showing (highlighted) a small area of stress; Note: shield, buckle, and three upper harness slots (case photo #57)

CHILD SAFETY SEAT

Figure 19: Close-up of child safety seat used by case vehicle's back center passenger showing small stress area to upper left corner of plastic shell (case photo #58)

Figure 20: Elevated view of bottom and left side of convertible child safety seat used by case vehicle's back center passenger showing stressed areas (tape) on left side; Note: right side had identical stressed areas (case photo #60)

The convertible child safety seat used by the case vehicle's back center passenger was configured in the forward facing position at the time of the crash. The seat was manufactured by Evenflo on August 23, 2000 and was identified by Model name "Conquest". The seat was designed with a three-point harness connected to a pull-over shield which buckled between the child's legs (**Figure 18**). The seat also had an optional

tether which was not used since the case vehicle was not equipped with a rear attachment point. There were three slots to thread the three-point harness through. The slot chosen is based on the child's height and weight which in turn determines the seat's configuration (i.e., rear facing versus forward facing). In this case, the harness belts were threaded through the bottom slot and should have been in the top slot because of the forward facing configuration. The harness placement most likely resulted in the child's shoulder injuries. The forward facing child seat showed numerous, small areas of stress to the plastic shell (**Figures 18**, **19** and **20** above) with very little wear and tear to the cloth cover or padding.

CASE VEHICLE BACK CENTER PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's back center child passenger [17-month-old, White (non-Hispanic) male; 64 centimeters and 11 kilograms (25 inches, 25 pounds)] was seated, asleep, in a forward facing child safety seat. He was sitting essentially in an upright posture with his back against the seat back of the child safety seat, his feet dangling over the front edge of the child seat's cushion, and both hands were on the shield in front of him. The exact position of his head is unknown (i.e., tilted forward versus laying toward the left or right). His seat track and seat back were not adjustable.

Figure 21: Case vehicle's back seat showing loading evidence (yellow taped area) to center lap belt (case photo #51)

The case vehicle's back center passenger was restrained in a child safety seat which was secured by his available, active, two-point, lap belt system. The lap belt had a manual retractor with a locking teeth plate. Furthermore, there was evidence of belt pattern bruising and abrasions to his left shoulder, and the inspection of his seat belt webbing and latch plate showed evidence of loading (**Figures 21** and **22**).

Figure 22: Close-up of case vehicle's back center lap belt showing loading evidence (case photo #54)

The case vehicle's driver steered to the right and was in the process of attempting to brake, trying to avoid the crash. As a result of these attempted avoidance maneuvers and the combined use of his child safety seat and the two-point, lap belt, the back center passenger most likely moved slightly forward and to his left immediately prior to the initial impact. The case vehicle's primary impact with the Pontiac enabled the case vehicle's back center, child safety seated passenger to continue forward and slightly leftward toward the case vehicle's **350** degree Direction of Principal Force as the case vehicle decelerated. As a result, the child loaded against the child safety seat's harness and shield. This loading of the child safety seat's harness belt most likely contused and abraded his shoulder. When the case vehicle reached maximum engagement, the

case vehicle was redirected in a southwesterly direction prior to side slapping the Pontiac. As a result of the redirection and the subsequent side slap impact, the child moved further leftward against the side of the child seat. As the case vehicle continued in its southwesterly direction, the child remained leaning to his left. The case vehicle's frontal impacts with the Chevrolet, the curb, and the traffic signal control pole, which immediately followed the curb impact, resulted in him moving slightly forward and upward against the child seat's restraints as the case vehicle further decelerated. The impact with the traffic control signal pole also resulted in the case vehicle rotating slightly counterclockwise. This rotation sent the child back to his right and then forward as the vehicle continued to decelerate. The case vehicle's sideswipe impact with the wooden utility pole most likely had little effect upon the child. As the case vehicle continued further forward into the wood pile, the child most likely moved back forward and upward against his seat's harness as the case vehicle came to a stop. According to the case vehicle's driver (i.e., mother), at final rest the child remained seated in his child safety seat. The child seat was twisted/turned slightly leftward. Based on the statement of the case vehicle's driver that the child was turned/twisted leftward at final rest, this investigator would assume that the seat belt securing the child safety seat to the vehicle was not cinched down tight enough prior to the crash.

CASE VEHICLE BACK CENTER PASSENGER INJURIES

The case vehicle's back center occupant was transported by ambulance to the hospital for precautionary measures. He sustained minor injuries and was treated and released. According to the driver (mother), the case vehicle's back center passenger sustained abrasions and contusions to his left shoulder.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Abrasion left shoulder {lateral neck[1]}	790202.1 minor	Child safety seat harness	Certain	Interviewee (driver)
2	Contusion left shoulder {lateral neck[2]}	790402.1 minor	Child safety seat harness	Certain	Interviewee (driver)

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [29-year-old, White (non-Hispanic) female; 165 centimeters and 59 kilograms (65 inches, 130 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot reaching for the brake, and both hands on the steering wheel. Her seat track was located in its middle position, the seat back was upright, and the tilt steering wheel was located in its middle position.

[1] These two lesions are supported, but not confirmed, by this occupant's medical records. This patient's emergency room records cited a 2 centimeter (0.8 inch) linear erythematous area to the left lateral neck, near the clavicle.

The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there was evidence of belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed trace evidence of loading.

The case vehicle's driver steered to the right and was in the process of attempting to brake, trying to avoid the crash. As a result of these attempted avoidance maneuvers and the use of her safety belts, the driver most likely moved slightly forward and to her left immediately prior to the initial impact. The case vehicle's primary impact with the Pontiac enabled the case vehicle's driver to continue forward and slightly leftward toward the case vehicle's **350** degree Direction of Principal Force as the case vehicle decelerated. As a result, she loaded her safety belts and contacted the deploying driver air bag. This loading of her safety belts contused and abraded her shoulder and hips. The deploying air bag contacted the driver's face knocking her back into her seat back. When the case vehicle reached maximum engagement, the case vehicle was redirected in a southwesterly direction prior to side slapping the Pontiac. As a result of the redirection and the subsequent side slap impact, the driver moved further leftward against her window sill and the interior surface of her door. As the case vehicle continued in its southwesterly direction, the driver remained leaning to her left. The case vehicle's frontal impacts with the Chevrolet, the curb, and the traffic signal control pole, which immediately followed the curb impact, resulted in her moving slightly forward and upward against her safety belts as the case vehicle further decelerated. The impact with the traffic control signal pole also resulted in the case vehicle rotating slightly counterclockwise. This rotation sent the driver back to her right and then forward as the vehicle continued to decelerate. The case vehicle's sideswipe impact with the wooden utility pole most likely had little effect upon the driver. As the case vehicle continued further forward into the wood pile, the driver most likely moved back forward and upward against her safety belts as the case vehicle came to a stop. According to the case vehicle's driver, at final rest she remained seated in her seat near her original seat position.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital. She sustained minor injuries and was treated and released. According to the case vehicle's driver and her medical records, she sustained abrasions to her nose, chin, and bilateral forearms from her deploying driver air bag. Furthermore, she sustained seat belt abrasions and contusions to her left shoulder and both hips. In addition, she sustained: lacerations and abrasions to both knees, a laceration and contusion to her left shin, and contusions to her upper left arm and the dorsal surface of her left hand.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Abrasion left side of nose	290202.1 minor	Air bag, driver's	Certain	Emergency room records
2	Abrasion chin, not further specified	290202.1 minor	Air bag, driver's	Certain	Emergency room records

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
3	Abrasions over hips, bilaterally, including anterior iliac crests near lateral inguinal areas	590202.1 minor	Lap portion of safety belt system	Certain	Emergency room records
4	Contusions over lower abdomen {seat belt-related}	590402.1 minor	Lap portion of safety belt system	Certain	Emergency room records
5	Contusion {ecchymosis} to left clavicle	790402.1 minor	Torso portion of safety belt system	Certain	Emergency room records
6	Abrasion to left shoulder {seat belt-related}	790202.1 minor	Torso portion of safety belt system	Certain	Interviewee (same person)
7	Abrasions forearms, not further specified	790202.1 minor	Air bag, driver's	Probable	Emergency room records
8	Contusion upper left arm, not further specified	790402.1 minor	Left side window sill	Probable	Interviewee (same person)
9	Contusion with swelling dorsal surface of left hand	790402.1 minor	Left "A"-pillar	Certain	Emergency room records
10	Abrasions, small (i.e., almond size), bilateral inferior patellas	890202.1 minor	Knee bolster, driver's, left and right of steering column	Certain	Emergency room records
11	Lacerations[2] to both knees, not further specified	890600.1 minor	Knee bolster, driver's, left and right of steering column	Certain	Interviewee (same person)
12	Contusion left shin, not further specified	890402.1 minor	Left instrument panel and below	Probable	Interviewee (same person)
13	Laceration left shin, not further specified	890600.1 minor	Left instrument panel and below	Probable	Interviewee (same person)

1ST OTHER VEHICLE

The 1998 Pontiac Transport SE was a front wheel drive, seven-passenger, four-door, extended minivan (VIN: 1GMDX03E1WD------) equipped with a 3.4L, V-6 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The 1st other vehicle's wheelbase was 305 centimeters (120.0 inches), and the odometer reading is unknown because the vehicle's interior was not inspected.

The Pontiac's initial contact with the case vehicle involved its front right corner. Direct damage began 17 centimeters (6.7 inches) right of center and extended, a measured distance of 57 centimeters (22.4 inches), along the front bumper to the front right bumper corner (**Figure 23**

[2] According to the interview with the case vehicle's driver, she reported both abrasions and lacerations to her knees, bilaterally.

below). Residual maximum crush was measured as 16 centimeters (6.3 inches) at C_6. The Pontiac's side slap impact involved the back right (**Figure 24**). Direct damage began14 centimeters (5.5 inches) rearward of the right rear axle and extended, a measured distance of 60 centimeters (23.6 inches), along the right side to the right back bumper. The wheelbase on the Pontiac's left side was shortened 3 centimeters (1.2 inches) while the right side was extended 2 centimeters (0.8 inches).

Figure 23: Pontiac's front right damage viewed from right of front from impact with case vehicle; Note: left shifted front bumper and yellow tape marks width of direct contact (case photo #74)

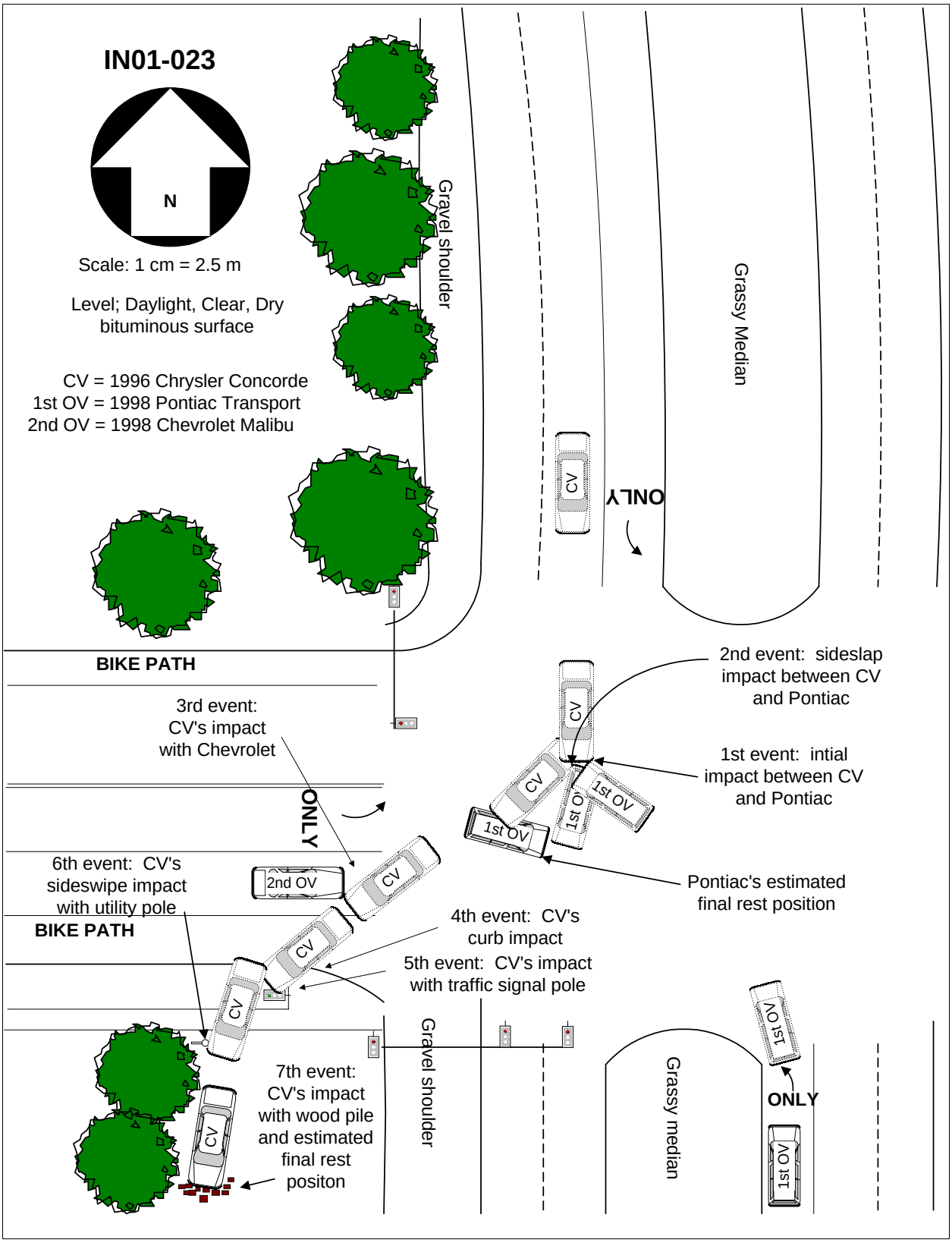
Based on the vehicle inspection the CDCs for the Pontiac were determined to be: **02-FZEW-1 (50)** and **03-RBEW-2 (90)**. The WinSMASH reconstruction program, missing vehicle algorithm was used on the Pontiac's highest severity impact with the case vehicle (i.e., the case vehicle was considered missing for this estimate because of the overlapping damage it sustained to its front). The Total, Longitudinal, and Lateral Delta Vs are, respectively: 18.7 km.p.h. (11.6 m.p.h.), -12.0 km.p.h. (-7.5 m.p.h.), and -14.3 km.p.h. (-8.9 m.p.h.). These results appear reasonable. The Pontiac was towed due to damage.

Figure 24: Pontiac's right back damage viewed from right of back, resulting from side slap impact with case vehicle's left back (case photo #70)

2ND OTHER VEHICLE

The 1998 Chevrolet Malibu LS was a front wheel drive, five-passenger, four-door sedan (VIN: 1G1NE52MXW6------) equipped with a 3.1L, V-6 engine and a four-speed automatic transmission. Four wheel anti-lock brakes are standard for this model. The case vehicle's wheelbase was 272 centimeters (107.0 inches), and the odometer reading is unknown because the vehicle was not inspected.

With no available vehicle photographs, the CDC for the Chevrolet is unknown. The Chevrolet was driven from the scene.


IN01-023
N
Scale: 1 cm = 2.5 m
Level; Daylight, Clear, Dry
bituminous surface
CV = 1996 Chrysler Concorde
1st OV = 1998 Pontiac Transport
2nd OV = 1998 Chevrolet Malibu
Gravel shoulder
Grassy Median
CV
ONLY
BIKE PATH
3rd event:
CV's impact
with Chevrolet
ONLY
2nd event: sideslap
impact between CV
and Pontiac
1st event: intial
impact between CV
and Pontiac
1st OV
Pontiac's estimated
final rest position
6th event: CV's
sideswipe impact
with utility pole
BIKE PATH
2nd OV
4th event: CV's
curb impact
5th event: CV's impact
with traffic signal pole
7th event:
CV's impact
with wood pile
and estimated
final rest
positon
Gravel shoulder
Grassy median
ONLY