



# 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 - NASS-2000-49-068A

LOCATION - TEXAS

VEHICLE - 1997 PLYMOUTH GRAND VOYAGER SE

CRASH DATE - April, 2000

Submitted:

October 30, 2000

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National Highway Traffic Safety Administration  
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## **DISCLAIMERS**

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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.

### **DIFFERENCES<sup>A</sup>:**

***There are differences between this SCI report and the NASS case data!***

This crash was located through a newspaper article. The NHTSA regional office contacted SCI and, as a result, this contractor was assigned to the case. SCI had completed their on-scene inspection prior to the case being selected in the NASS CDS. As a result, SCI was able to get to the vehicle before the vehicle had been altered. The case vehicle was under repair when the NASS inspection occurred. Likewise, SCI's inspection of the other vehicle occurred prior to the NASS inspection, but it is unknown what, if any, affect this had on the differences. Furthermore, it was determined that two separate investigations of this crash had been undertaken *only* after the case vehicle's driver questioned the NASS investigator as to why she was being interviewed a second time. As a result, the SCI interview contained considerably more information than the NASS interview. Finally, SCI talked with the applicable medical examiner and obtained some information found only in the SCI report.

Note: Letters were used to indicate endnotes.

**Technical Report Documentation Page**

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15. <i>Supplementary Notes</i> On-site air bag deployment investigation involving a 1997 Plymouth Grand Voyager SE, four-door minivan, with manual safety belts and dual front air bags, and a 1987 Dodge Dakota LE pickup truck					
16. <i>Abstract</i> This report covers an on-site investigation of an air bag deployment crash that involved a 1997 Plymouth Grand Voyager (case vehicle) and a 1987 Dodge Dakota (other vehicle). This crash is of special interest because the case vehicle's, unrestrained, out-of-position (i.e., "standing on driver's lap"), infant passenger (11-month-old female) sustained a critical injury from the case vehicle's deploying driver air bag, resulting in her death. The case vehicle was traveling east in the center eastbound through lane of a seven-lane, divided, city trafficway and was entering an intersection (i.e., both the east and westbound roadways had three through lanes while the eastbound roadway had one left-hand turn lane). The Dodge Dakota was traveling north in the outside through lane of a one-way, four-lane (i.e., three through lanes and one channelized right-hand turn lane), service road, which was adjacent to a divided, state toll road. The crash occurred in the four-leg intersection of the two trafficways. The front right half of the case vehicle impacted the left front of the Dodge Dakota, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle and the Dodge Dakota side slapped each other, right back to left back, respectively. The case vehicle was redirected to the east-northeast and impacted a raised median curb and sideswiping a traffic signal pole before coming to rest straddling the median and the inside lane of the westbound roadway heading east. The case vehicle's, unrestrained, "on-lap" passenger was standing, facing and leaning forward with her hands on the steering wheel. The driver's seat was position near its forward-most position. She sustained, according to her autopsy and medical records, a critical nonanatomic brain injury, a small subdural hemorrhage, cerebral edema, a posterior basilar skull fracture; contusions to her heart, lung, and thymus; a contusion to her frontal scalp; two parallel linear oblique abrasions to the left side of her head; and minor soft tissue injuries to her arms. The case vehicle's driver (33-year-old female; infant's mother) was seated, holding the infant against her chest with her right arm around her daughter's abdomen. The steering wheel was located between its middle and down-most positions. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to her interview, minor abrasions to her chin and neck, lacerations to her left distal arm, and a laceration to her upper right arm.					
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This on-site investigation was brought to NHTSA's attention on April 14, 2000 by the NHTSA's Regional office. This crash involved a 1997 Plymouth Grand Voyager SE (case vehicle) and a 1987 Dodge Dakota (other vehicle). The crash occurred in April, 2000, at 1:27 p.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the case vehicle's out-of-position (i.e., "standing on driver's lap"), infant passenger [11-month-old, White (non-Hispanic) female] sustained a critical injury from the case vehicle's deploying driver air bag, resulting in her death. This contractor inspected the scene and both vehicles on April 17, 2000. This contractor interviewed the driver for the case vehicle on August 17, 2000. This report is based on the Police Crash Report, interviews with the case vehicle's driver, witnesses, and the investigating police officer, vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

## SUMMARY

The case vehicle was traveling east in the center eastbound through lane of a seven-lane, divided, city trafficway and was entering a controlled, four-leg intersection while steering slightly to her left, intending to change into the inside eastbound lane (i.e., both the east and westbound roadways had three through lanes while the eastbound roadway had one left-hand turn lane). The Dodge Dakota was traveling north in the outside through lane of a one-way, four-lane (i.e., three through lanes and one channelized right-hand turn lane), service road, which was adjacent to a divided, state toll road and intended to continue traveling northward. The case vehicle's driver made no attempted avoidance maneuvers just prior to the crash. The crash occurred in the four-leg intersection of the two trafficways; see **CRASH DIAGRAM** below *{see End Note A. (1)}*.

The front right half of the case vehicle impacted the left front of the Dodge Dakota, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle rotated approximately 10 degrees counterclockwise while the Dodge Dakota rotated approximately 75 degrees clockwise and side slapped each other with the case vehicle's right back impacting the Dodge Dakota's left back. The case vehicle continued in a east-northeasterly direction before striking the curb of the raised median that separated the east and westbound roadways *{see End Note A. (3)}*. The case vehicle's left front tire was aired-out while driving onto the raised median. The case vehicle continued driving east-northeast, sideswiped a street light utility pole in the center of the median with its left side and traveled approximately 35.0 meters (115 feet) prior to coming to rest straddling the median and the inside lane of the westbound roadway heading east. The Dodge Dakota was redirected in an easterly direction coming to rest in the inside eastbound lane heading east.

The case vehicle's out-of-position, infant passenger [71 centimeters and 9 kilograms (28 inches, 20 pounds)] was standing on the lap of the case vehicle's driver, facing and leaning forward with her hands on the steering wheel (hands at unknown clock positions); thus, the infant passenger was neither secured in the available child safety seat nor any of the available, active, three-point, lap-and-shoulder, safety belt systems. The case vehicle's driver, however, was wearing her available, active, three-point, lap-and-shoulder, safety belt system, and she was holding the infant against her chest with her right arm around her daughter's abdomen. In

addition, the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed apparent evidence of loading (i.e., stretching and transfer to "D"-ring). Photographs taken by this contractor showed plastic residue on the "D"-ring from friction with the seat belt webbing.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the nonuse of the available safety belts and the child safety seat, the front left, "on-lap" infant passenger's pre-impact body position did not change just prior to impact. The case vehicle's primary impact with the Dodge Dakota enabled the infant and driver (i.e., mother) to move forward, with the infant's head falling forwards over the top of the steering wheel rim, and slightly to the right toward the 10 degree Direction of Principal Force as the case vehicle decelerated. The driver's safety belt usage prevented the mother from completely compressing the infant against the steering wheel and deploying air bag during the initial impact. Based on this contractor's inspection of the driver's air bag module, it was obvious that the air bag's path was momentarily blocked by the combination of the case vehicle's driver and infant, causing the air bag to distort the module's cover flaps as it expanded outwards.

The driver's air bag deployed during the initial impact, lifting the infant upwards and the mother backwards, with the mother striking the seat back. At this point the infant most likely came out of the grasp of the case vehicle's driver as the infant was lifted upwards. As a result the "on-lap" front left passenger struck the case vehicle's front left header and windshield. At maximum engagement the case vehicle was redirected slightly counterclockwise. The subsequent side slap impact caused both the mother and infant daughter to move to the right. After striking the front left header and windshield, the "on-lap" infant daughter most likely fell/rebounded downward and back into the driver's (i.e., mother's) grasp. The case vehicle's impact with the raised median curb caused the infant to move forwards and slightly upwards towards the steering wheel and deployed driver's air bag module. As the case vehicle continued traveling in an east-northeasterly direction, it sideswiped a metal light pole. This sideswiping impact had little or no effect on the occupant's movement. According to the case vehicle's driver, she was able to regain control of her vehicle and prevent it from traveling completely over the median into the westbound travel lanes. The case vehicle came to a stop straddling the raised median with the left tires on the inside through lane of the westbound roadway heading east. At final rest, according to the case vehicle's driver, the infant was still in her grasp. This assertion is supported by the crash's witnesses because, according to witnesses, she immediately exited the case vehicle cradling her infant child.

The "on-lap" front left, infant passenger was transported by ambulance to the hospital. She sustained critical injuries and was pronounced dead 50 minutes post-crash. According to her autopsy and medical records, the injuries sustained by the case vehicle's "on-lap" infant passenger included: a critical nonanatomic brain injury, a small subdural hemorrhage, cerebral edema, a posterior basilar skull fracture; contusions to her heart, lung, and thymus; a contusion to her frontal scalp; two parallel linear oblique abrasions to the left side of her head; and minor soft tissue injuries to her arms.

The case vehicle was a front wheel drive 1997 Plymouth Grand Voyager SE, four-door minivan (VIN: 2P4GP44R6VR-----). The case vehicle was not equipped with anti-lock brakes.

The other vehicle was a rear wheel drive 1987 Dodge Dakota LE, 4x2, two-door pickup truck (VIN: 1B7GN14M1HS-----). The case vehicle and the Dodge Dakota were both towed due to damage. Based on the vehicle inspection, the primary CDCs were determined to be: **12-FZEW-2 (10)** for the case vehicle [maximum crush was 16 centimeters (6.3 inches) at C<sub>5</sub>-*{See End Note A. (9)}*] and **09-LFEW-3 (270)**-*{See End Note A. (8)}*, for the Dodge Dakota [maximum crush was 53 centimeters (20.9 inches) at C<sub>5</sub>-*{See End Note A. (10)}*]. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 15.5 km.p.h. (9.6 m.p.h.), -15.3 km.p.h. (-9.5 m.p.h.), and -2.7 km.p.h. (-1.7 m.p.h.)-*{See End Note A. (11)}*. No reconstruction program was used on this case vehicle's side slap and sideswipe impact because the impacts are out of scope of the NASS, CDS, WinSMASH algorithm requirements; however, this contractor's visually estimated Delta V for the side slap impact is minor [2-13 km.p.h. (1-8 m.p.h.)].

The case vehicle's initial contact with the Dodge Dakota involved the right half of the case vehicle's front. Direct damage extended from 12 centimeters (4.7 inches) left of center to the right bumper corner, a measured distance of 62 centimeters (24.4 inches). The side slap contact involved significant deformation to the right quarter panel. The direct damage width to the right quarter panel was 67 centimeters (26.4 inches) with the total length down the right side being 244 centimeters (96.1 inches). The case vehicle's third impact-*{See End Note A. (3)}*, was to the front left tire which aired out and split from impacting the raised median curb. The fourth and final impact was along the vehicle's left side (i.e., rearview mirror with minor scratches down side to just before the left rear taillight) from sideswiping the pole used to support the traffic signal and overhead streetlights. The direct damage for the left sideswipe involved only surface scratches and was measured at 342 centimeters (134.6 inches) in length.

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 fabric revealed that the cover flaps failed to open at the designated tear points [i.e., there was a 4 centimeter (1.6 inch) tear point that failed to open] most likely because the air bag's deployment path was blocked by one or both of the front left occupants. In addition, there was also a corner piece of the top cover flap that was torn off at some point because the deployment path was blocked. Furthermore, there appeared to be smudges on the driver air bag module's cover flaps. The driver's air bag was designed with two tethers, each 5 centimeters (2.0 inches) wide, sewn to the middle of the air bag at the 9 and 3 o'clock positions. The driver's air bag had no vent ports. The deployed driver's air bag was round with a diameter 66 centimeters (26.0 inches). There was no contact evidence readily apparent on the driver's air bag, except for a small red dot in the upper left quadrant. There were a large amount of black scuffs on the front and back of the air bag shell and an exceptional amount to the backside of the air bag's upper right quadrant. These black scuffs are a result of the friction between the underside of the cover flaps and the air bag's fabric, and they occurred when the air bags deployment path was being blocked.

The front right passenger's air bag was located in the middle of the instrument panel. An inspection of the front right air bag module's cover flaps and air bag fabric revealed that the cover flaps opened at the designated tear points and the plastic frame of the upper flap was cracked at the midway point causing it to hang down. There was no evidence of other damage during the



deployment to the air bag or the cover flaps. The front right passenger's air bag was designed without any tethers or vent ports. The deployed front right air bag was rectangular with a height of approximately 65 centimeters (25.6 inches) and a width of approximately 47 centimeters (18.5 inches)—{See End Note A. (16)}. There was no contact evidence readily apparent on the front right air bag. There was evidence of occupant contact on the case vehicle's interior surfaces. Contact evidence was found on the front header on the driver's side, to the left of the rearview mirror, and a grease smudge on the windshield to the left and below of the mark on the header. In addition, the rearview mirror was tilted, with its left side down, and the glove compartment door and right most air vent were dislodged—{See End Note A. (13)}.

As discussed above, immediately prior to the crash the case vehicle's out-of-position, front left infant passenger was standing on the driver's lap facing forward with her lower back against the driver's chest, her left foot on the seat between the driver's legs, her right foot on the seat to the right of the driver's right leg, and she was leaning forward with both hands on the case vehicle's steering wheel.

The case vehicle's driver [33-year-old, White (non-Hispanic) female; 155 centimeters and 58 kilograms (61 inches, 128 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot letting off the accelerator, her left hand on the steering wheel, and her right hand holding her standing infant child on her lap. Her seat track was located near its forward-most position, her seat back was upright, and the tilt steering wheel was located between its middle and down-most positions. The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The driver was transported by ambulance to the hospital. She sustained minor injuries but refused treatment. According to her interview, the injuries sustained by the case vehicle's driver included: abrasions to her chin and neck, lacerations to her left distal arm, and a laceration to her upper right arm.

### CRASH CIRCUMSTANCES



**Figure 1:** Case vehicle's eastward travel path in center through lane of eastbound roadway approaching underpass and four-leg intersection with service road on east side of underpass



**Figure 2:** Case vehicle's approach to four-leg intersection with service road, just prior to impact; Note: raised paved median and utility pole located therein

The case vehicle was traveling east in the center eastbound through lane (**Figure 1**) of a seven-lane, divided, city trafficway (i.e., both the east and westbound roadways had three through

lanes while the eastbound roadway had one left-hand turn lane) and was entering a controlled, four-leg intersection (**Figure 2** above) while steering slightly to her left, intending to change into the inside eastbound lane in order to turn left into a shopping center a couple hundred meters (approximately 650 feet) further east of the intersection. The Dodge Dakota was traveling north in the outside through lane (**Figure 3**) of a one-way, four-lane (i.e., three through lanes and one channelized right-hand turn lane), service road, which was adjacent to a divided, state toll



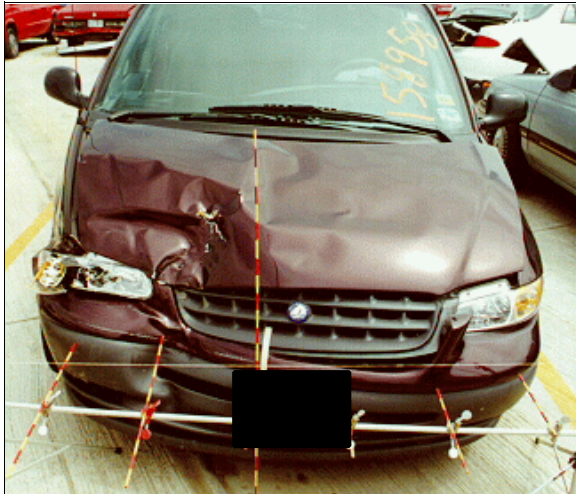
**Figure 3:** Other vehicle's rightward curving travel path in outside through lane of one-way service road, approaching four-leg intersection

road and intended to continue traveling northward. The case vehicle's driver was preoccupied by her infant (11-month-old) daughter who was standing on her lap and did not observe the light change or the oncoming northbound vehicle. As a result, the case vehicle's driver made no attempted avoidance maneuvers just prior to the crash. The crash occurred in the four-leg intersection of the two trafficways; see **CRASH DIAGRAM** below—{See End Note A. (1)}.

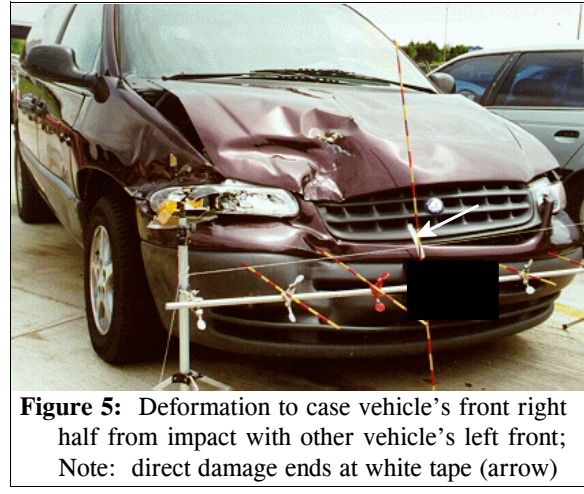
The eastbound city roadway was straight and level at the area of impact. The pavement was concrete, and the width of the center eastbound through lane was 3.5 meter (11.5 feet). The eastbound roadway was bordered by 10.2 centimeter (4 inch) high barrier curb on the south side and a raised median curb to the north. Pavement markings at the mouth of the intersection (i.e., west leg for the eastbound roadway) consisted of single, solid white, lane lines separating the three eastbound through lanes and the eastbound left-hand turn lane. In addition, no white or yellow edge lines were present. The estimated coefficient of friction was 0.75. Traffic controls consisted of two vertically mounted and one horizontally mounted on-colors, pre-timed, traffic control signals. One vertically mounted signal was located on the traffic island on the southwest quadrant of the intersection. The second vertically mounted signal was located in the median that separates the east and westbound roadways, and the horizontal signal hanging was appended from the traffic signal pole located on the traffic island and was hanging over the eastbound through lanes. The legal speed limit was 56 km.p.h. (35 m.p.h.).

The northbound one way service roadway which was adjacent to an elevated state toll road was curved slightly to the right for northbound traffic and was level near the area of impact. The pavement was concrete, and the width of the outside northbound lane was 3.7 meters (12.1 feet). The shoulders were improved (i.e., concrete), with a short shoulder adjacent to a curb on the south side of the roadway. The roadway was bordered by 10.2 centimeter (4 inch) high barrier curbs on both the east and west sides. Pavement markings, at the mouth of the intersection (i.e., south leg of intersection), consisted of single, solid white, lane lines separating the northbound lanes. Once again, no white or yellow edge lines were present. The estimated coefficient of friction was 0.70. The intersection was controlled by two on-colors, pre-timed, vertical mounted traffic control signals. One was mounted in median that separated the east and westbound lanes and the other was appended to this traffic signal pole and located over the northbound travel lanes. The legal speed limit was 64 km.p.h. (40 m.p.h.).

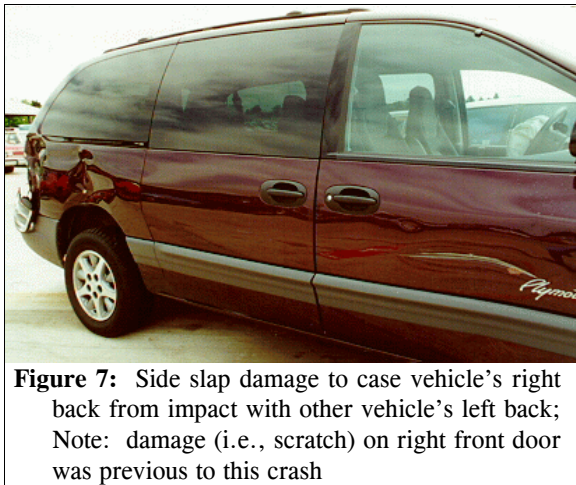
At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the road pavement was dry. Traffic density was moderate to heavy, and the site of the crash was urban commercial.



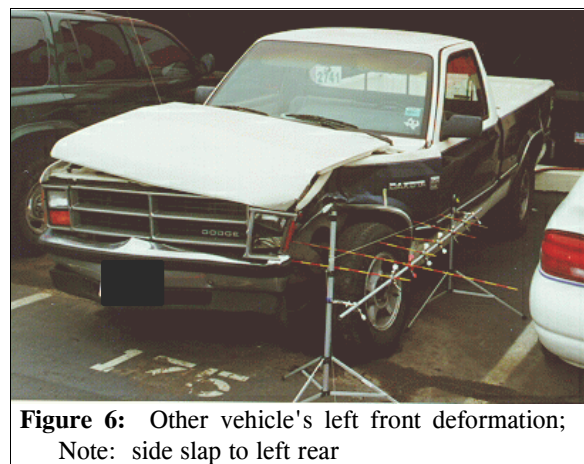
**Figure 4:** Standing view of case vehicle's damaged front right half; Note: direct damage extends from front right bumper corner to white tape



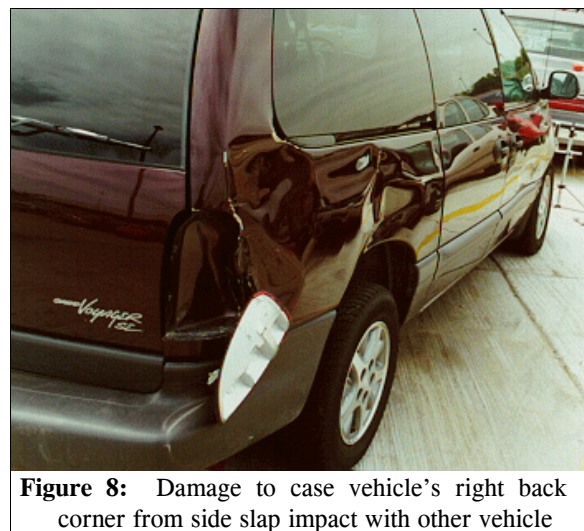
**Figure 5:** Deformation to case vehicle's front right half from impact with other vehicle's left front; Note: direct damage ends at white tape (arrow)



**Figure 7:** Side slap damage to case vehicle's right back from impact with other vehicle's left back; Note: damage (i.e., scratch) on right front door was previous to this crash



**Figure 6:** Other vehicle's left front deformation; Note: side slap to left rear



**Figure 8:** Damage to case vehicle's right back corner from side slap impact with other vehicle

The front right half of the case vehicle (**Figures 4 and 5**) impacted the left front of the Dodge Dakota at the left front tire (**Figure 6**), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle rotated approximately 10 degrees counterclockwise while the Dodge Dakota rotated approximately 75 degrees clockwise and side slapped each other with the case vehicle's right back (**Figures 7 and 8**) impacting the Dodge Dakota's left back (**Figure 9** below). The case vehicle continued in a east-

northeasterly direction before striking the curb—*{See End Note A. (3)}*, of the raised median that separated the east and westbound roadways (Figure 10). The case vehicle's left front tire was aired-out while driving onto the raised median (Figure 11). The case vehicle continued driving east-northeast, sideswiped a street light utility pole in the center of the median with its left side (Figure 12), and traveled approximately 35.0 meters (115 feet) prior to coming to rest straddling the median and the inside lane of the westbound roadway heading east (Figure 13 below). The Dodge Dakota was redirected in an easterly direction coming to rest in the inside eastbound lane heading east.



Figure 9: Damage to other vehicle's left back from side slap impact (i.e., 2<sup>nd</sup> event) with case vehicle; Note: direct damage begins at white tape



Figure 10: Case vehicle's path of travel into median after initial and side slap impacts with other vehicle; Note: case vehicle impacted the curb and then sideswiped the utility pole

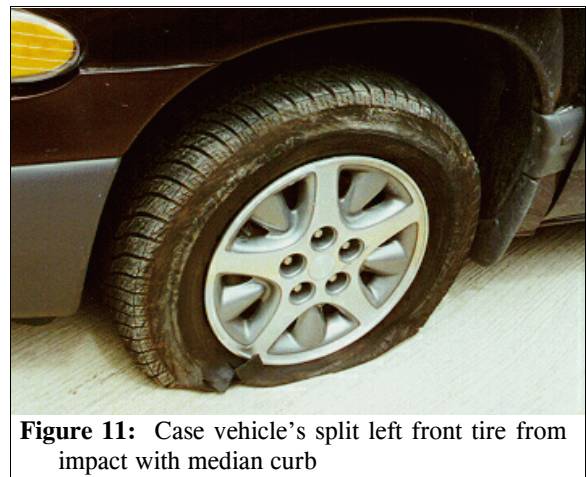


Figure 11: Case vehicle's split left front tire from impact with median curb

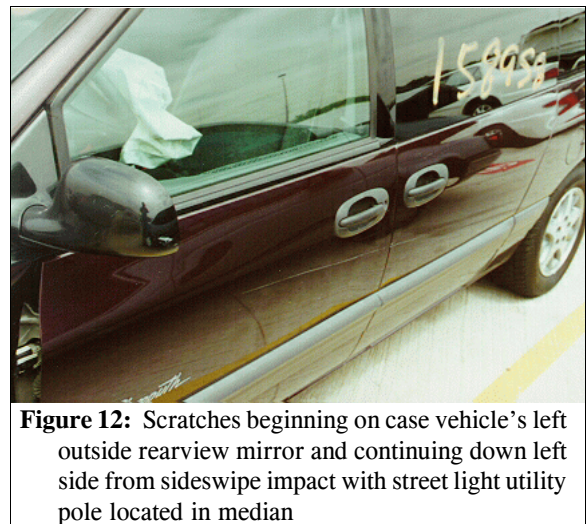


Figure 12: Scratches beginning on case vehicle's left outside rearview mirror and continuing down left side from sideswipe impact with street light utility pole located in median

### CASE VEHICLE

The case vehicle was a front wheel drive 1997 Plymouth Grand Voyager SE, seven-passenger, four-door minivan (VIN: 2P4GP44R6VR-----) equipped with power-assisted rack-and-pinion steering, a 3.3L, OHV, SMPI, V-6 engine, and a four-speed automatic transmission. The case vehicle was not equipped with anti-lock brakes. Braking was achieved by a hydraulic, power-assisted, front disc and rear drum, four-wheel anti-lock system. The case vehicle's wheelbase was 303 centimeters (119.3 inches), and the odometer reading—*{See End Note A. (12)}*, at inspection was 70,409 kilometers (43,750 miles).

Inspection of the vehicle's interior revealed electronic window and door locks and adjustable front bucket seats with integral head restraints. The second seating area had been equipped with bucket seats that had an adjustable head restraint and folding backs; however, the second seating area's right bucket seat had been removed so that a combination TV/VCR could be placed directly behind the front right seat. The non-adjustable back bench seat had a folding back with adjustable head restraints in the outboard seating positions. There were continuous loop, three-point, lap-and-shoulder, safety belt systems at the front, second, and back outboard positions; and a two-point, lap belt system at the back center position. The front seat belt systems were equipped with manually operated height adjusters for the "D"-rings. The vehicle was equipped with rigid plastic knee bolsters for both the driver and front right passenger, neither of which were deformed. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. Both front seat air bags deployed as a result of the case vehicle's frontal impact with the Dodge Dakota.



**Figure 13:** On-scene view looking west at case vehicle's final rest position atop median; Note: orange cone is located in inside westbound through lane of divided trafficway

#### CASE VEHICLE DAMAGE

The case vehicle's initial contact with the Dodge Dakota involved the right half of the case vehicle's front. Direct damage began 12 centimeters (4.7 inches) left of center (**Figures 4 and 5** above) and extended to the right bumper corner, a measured distance of 62 centimeters (24.4 inches). The case vehicle's front bumper, bumper fascia, grille, hood, right headlight and turn signal assemblies, and right fender were directly damaged and crushed rearward. There was induced damage to the right windshield (i.e., cracked from impact forces; **Figure 14**) and to the left headlight and turn signal assemblies. Remote buckling was also found on the left fender (**Figures 11 and 12** above). The wheelbase on the case vehicle's right side was shortened 1 centimeter (0.4 inches) while the left side was not shortened. Maximum crush—*{See End Note A. (9)}*, was measured as 16 centimeters (6.3 inches) at C<sub>5</sub> (**Figure 15** below). The side slap contact was



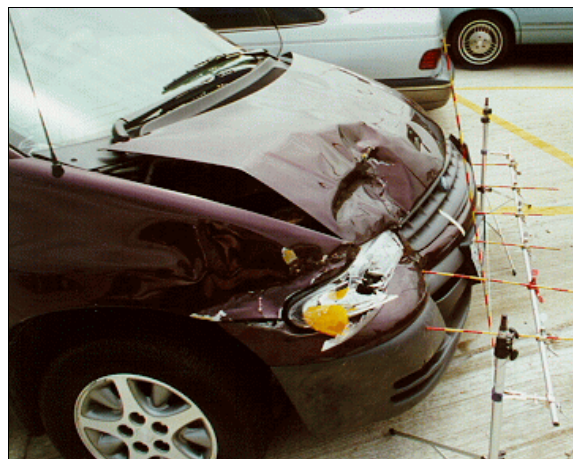
**Figure 14:** Hairline cracks to case vehicle's right windshield from impact with other vehicle's left front; Note: arrows highlight cracks

### Case Vehicle Damage (Continued)

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located along the right side starting with light scratching to the sliding door then significant deformation again to the right quarter panel (Figures 7 and 8 above). The direct damage started 148 centimeters (58.3 inches) rearward of the right front axle and extended down the right side a measured distance of 244 centimeters (96.1 inches). The direct damage width to the right quarter panel was 67 centimeters (26.4 inches). The case vehicle's third impact—{See End Note A. (3)}, was to the left front tire which was aired out and split from impacting the raised median curb (Figure 11 above). The fourth and final impact was along the vehicle's left side from sideswiping the pole used to support the traffic signal and overhead streetlights [i.e., contact to the rearview mirror (Figure 12 above) with minor scratches down the left side to just before the left rear taillight]. The direct damage (excluding the rearview mirror) for the left sideswipe involved only surface scratches and was measured at 342 centimeters (134.6 inches) in length. There was a 32 centimeter (12.6 inch) separation from the mirror to the start of the scratch to the left side.

Based on the vehicle inspection, the primary CDC for the case vehicle was determined to be: **12-FZEW-2 (10)**. The case vehicle's other CDCs were determined to be: **03-RZEW-02 (90)**—for the side slap impact {See End Note A. (5)}, **12-FLWN-03 (360)**—for the impact to the left front tire {See End Note A. (6)}, and **12-LZMS-01 (360)**—for the sideswiping impact to the traffic signal pole {See End Note A. (7)}. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 15.5 km.p.h. (9.6 m.p.h.), -15.3 km.p.h. (-9.5 m.p.h.), and -2.7 km.p.h. (-1.7 m.p.h.)—{See End Note A. (11)}. No reconstruction program was used on this case vehicle's side slap and sideswipe impacts because the impacts are out of scope of the NASS, CDS, WinSMASH algorithm requirements; however, this contractor's visually estimated Delta V for the side slap impact is minor [2-13 km.p.h. (1-8 m.p.h.)]. The case vehicle was towed due to damage.



**Figure 15:** Reference line view from right of case vehicle's frontal damage with contour gauge present showing crush profile



**Figure 16:** Vertical view of case vehicle's driver seating area showing contacts to front left header and windshield from impact by "out-of-position" (i.e., standing on driver's lap) front left infant passenger

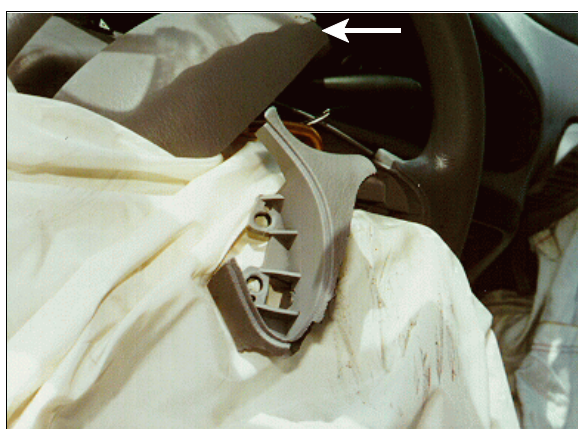
An examination of the case vehicle’s interior revealed evidence of occupant contact on the interior surfaces. Contact evidence was found on the front header on the driver’s side to the left of the rearview mirror (i.e., scuff with hair) from contact by the head of the “on-lap” infant passenger, and there was a grease smudge on the windshield to the left and below of the mark on the header (Figure 16 above and Figure 17). In addition, the rearview mirror was tilted, with its left side down, but most likely not from direct contact, and the glove compartment door and right most air vent were dislodged (i.e., blown outwards from deployment of the front right passenger air bag)–{See End Note A. (13)}.

#### AUTOMATIC RESTRAINT SYSTEM

As previously mentioned, the case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. Both air bags deployed as a result of the frontal impact with the Dodge Dakota. The case vehicle’s driver air bag was located in the steering wheel hub.



**Figure 17:** Close-up of contact evidence on case vehicle’s front left header and windshield (i.e., smudging) from impact by “on-lap” infant, front left passenger



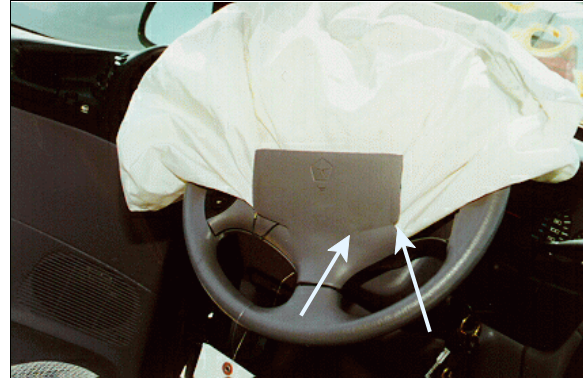
**Figure 18:** Close-up of case vehicle’s driver air bag module showing top cover flap with corner torn off and piece torn out from inside of module



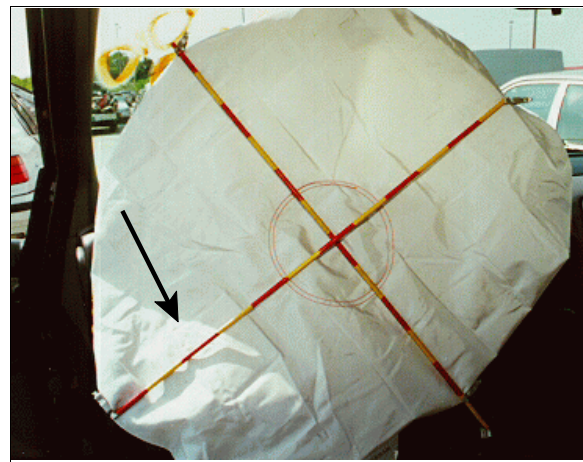
**Figure 19:** Close-up of right side of case vehicle driver air bag module’s top cover flap showing that part of corner that has been torn away

The module cover consisted of two asymmetrically shaped cover flaps made of thick vinyl–{See End Note A. (14)}. The top flap was half moon-shaped with overall dimensions of 17.5 centimeters (6.9 inches) at the horizontal seam and 3.5 centimeters (1.4 inches) vertically at its apex (Figures 18 and 19). The bottom cover flap was shaped like a windshield ice scraper with

overall dimensions of 18 centimeters (7.1 inches) at the top horizontal seam, 8 centimeters (3.1 inches) at the left and right vertical seams, and 6 centimeters (2.4 inches) along the oblique left and right seams (**Figure 20**). An inspection of the air bag module's cover flaps and air bag fabric revealed that the cover flaps failed to open at the designated tear points [i.e., there was a 4 centimeter (1.6 inch) tear point that failed to open], most likely because the air bag's deployment path was blocked by one or both of the front left occupants (**Figure 20**). In addition, there was also a corner piece of the top cover flap that was torn off at some point because the deployment path was blocked (**Figures 18 and 19** above). Furthermore, there appeared to be smudges on the driver air bag module's cover flaps. The driver's air bag was designed with two tethers, each 5 centimeters (2.0 inches) wide, sewn to the middle of the air bag at the 9 and 3 o'clock positions. The driver's air bag had no vent ports. The deployed driver's air bag was round with a diameter 66 centimeters (26.0 inches). There was no contact evidence readily apparent on the driver's air bag, except for a small red dot in the upper left quadrant (**Figure 21**). There were a large amount of black scuffs on the front and back of the air bag shell and an exceptional amount to the backside of the air bag's upper right quadrant. These black scuffs are a result of the friction between the underside of the cover flaps and the air bag's fabric, and they occurred when the air bags deployment path was being blocked.



**Figure 20:** Case vehicle's deployed driver air bag and air bag module's irregular-shaped bottom cover flap showing seam in cover flap that did not tear during deployment



**Figure 21:** Case vehicle's deployed driver air bag showing small red mark (e.g., lipstick, nail polish) indicative of occupant contact

The front right passenger's air bag was located in the middle of the instrument panel (**Figure 22** below). There were two, asymmetrical, rectangular, modular cover flaps—{See End Note A. (15)}. The cover flaps were made of a thick vinyl over a sheet metal frame/liner which acted as the hinge point for the deploying flaps. The flap's dimensions were: 29 centimeters (11.4 inches) at both the forward and rear (i.e., toward the windshield) horizontal seams, 8 centimeters (3.1 inches) along the top flap's right and left vertical seam, and 5 centimeters (2.0 inches) along the both flap's right and left vertical seam. The profile of the case vehicle's instrument panel resulted in a 0 centimeter (0.0 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 flaps and air bag fabric revealed that the cover flaps opened at the designated tear points and the plastic frame of the upper flap was cracked at the midway point causing it to hang down. There was no evidence of other damage during the deployment to the air bag or the cover flaps. The front right



passenger's air bag was designed without any tethers or vent ports. The deployed front right air bag was rectangular—*{See End Note A. (16)}*, with a height of approximately 65 centimeters (25.6 inches) and a width of approximately 47 centimeters (18.5 inches). There was no contact evidence readily apparent on the front right air bag (**Figure 23**).



**Figure 23:** Case vehicle's deployed front right passenger air bag showing no evidence of occupant contact



**Figure 22:** Vertical view of case vehicle's front right seating position showing front right passenger air bag module's top cover flap and deployed air bag

### CASE VEHICLE "ON-LAP" FRONT LEFT PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's out-of-position, front left infant passenger [11-month-old, White (non-Hispanic) female; 71 centimeters and 9 kilograms (28 inches, 20 pounds)] was standing on the driver's lap facing forward with her lower back against the driver's chest, her left foot on the seat between the driver's legs, her right foot on the seat to the right of the driver's right leg, and she was leaning forward with both hands on the case vehicle's steering wheel (hands at unknown clock positions).

The case vehicle's "on-lap" infant passenger was neither secured in the available child safety seat (**Figure 24**) nor any of the available, active, three-point, lap-and-shoulder, safety belt systems. The case vehicle's driver, however, was wearing



**Figure 24:** On-scene view of case vehicle's second seating area with unsecured child safety seat leaning forward against front right seat back

her available, active, three-point, lap-and-shoulder, safety belt system, and she was holding the infant against her chest with her right arm around her daughter’s abdomen.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the nonuse of the available safety belts and the child safety seat, the front left, “on-lap” infant passenger’s pre-impact body position did not change just prior to impact. The case vehicle's primary impact with the Dodge Dakota enabled the infant and driver (i.e., mother) to move forward, with the infant’s head falling forwards over the top of the steering wheel rim, and slightly to the right toward the 10 degree Direction of Principal Force as the case vehicle decelerated. The driver’s safety belt usage prevented the mother from completely compressing the infant against the steering wheel and deploying air bag during the initial impact. Based on this contractor’s inspection of the driver’s air bag module, it was obvious that the air bag’s path was momentarily blocked by the combination of the case vehicle’s driver and infant, causing the air bag to distort the module’s cover flaps as it expanded outwards (**Figures 18 and 20** above).

The driver’s air bag deployed during the initial impact, lifting the infant upwards and to the right and the mother backwards. At this point the infant most likely came out of the grasp of the case vehicle’s driver as the infant was lifted upwards. As a result the “on-lap” front left passenger struck the case vehicle’s front left header and windshield (**Figures 16 and 17** above). At maximum engagement the case vehicle was redirected slightly counterclockwise. The subsequent side slap impact caused the infant daughter to move to the right. After striking the front left header and windshield, the “on-lap” infant daughter most likely fell/rebounded downward and back into the driver’s (i.e., mother’s) grasp. The case vehicle’s impact with the raised median curb caused the infant to move forwards and slightly upwards towards the steering wheel and deployed driver’s air bag module. As the case vehicle continued traveling in an east-northeasterly direction, it sideswiped a metal light pole. This sideswiping impact had little or no effect on the occupant’s movement. According to the case vehicle’s driver, she was able to regain control of her vehicle and prevent it from traveling completely over the median into the westbound travel lanes. The case vehicle came to a stop straddling the raised median with the left tires on the inside through lane of the westbound roadway heading east. At final rest, according to the case vehicle’s driver, the infant was: on the driver’s lap with the infant’s right side against her mother’s chest; both of the infant’s legs were hanging off to the right between the two front bucket seats; and the infant’s upper torso was slumped over the driver’s right forearm. This assertion is supported by the crash’s witnesses because, according to witnesses, she immediately exited the case vehicle cradling her infant child and carried her around to the back of the case vehicle and started to perform CPR (i.e., cardiopulmonary resuscitation).

#### **CASE VEHICLE “ON-LAP” FRONT LEFT PASSENGER INJURIES**

The “on-lap” front left, infant passenger was transported by ambulance to the hospital. She sustained critical injuries and was pronounced dead 50 minutes post-crash. According to her autopsy and medical records, the injuries sustained by the case vehicle's “on-lap” infant passenger included: a critical nonanatomic brain injury, a small subdural hemorrhage, cerebral edema, a posterior basilar skull fracture; contusions to her heart, lung, and thymus; a contusion to her

frontal scalp; two parallel linear oblique abrasions to the left side of her head; and minor soft tissue injuries to her arms.

Note: Numbers indicate footnotes while letters were used to indicate endnotes.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury with loss of consciousness, GCS=3, unresponsive to painful stimuli, and flaccid	160824.5 critical	Header, front left	Probable	Emergency room records
2	Hemorrhage, subdural, 20 ml, location not specified	140652.4 <sup>B</sup> severe	Header, front left	Probable	Autopsy
3	Edema, marked, cerebral, location not specified	140660.3 <sup>C</sup> serious	Header, front left	Probable	Autopsy
4	Contusions right atrium (heart) and proximal posterior myocardium of left ventricle	441002.1 <sup>D</sup> minor	Steering wheel hub/spokes and rim <sup>E</sup>	Possible <sup>1,F</sup>	Autopsy
5	Contusions, bilateral, scattered, lungs with left hemothorax, 5 ml	441410.4 severe	Steering wheel hub/spokes and rim <sup>D</sup>	Possible <sup>1,E</sup>	Autopsy
6	Contusion thymus	Not Coded	Steering wheel hub/spokes and rim	Possible <sup>1,E</sup>	Autopsy
7	Fracture, linear, basilar in posterior fossa	150200.3 <sup>G</sup> serious	Header, front left	Probable	Autopsy
8	Abrasion x 2, parallel, linear, obliquely oriented, left parietal scalp, 1.9 cm (0.75 in)	190202.1 minor	Header, front left <sup>H</sup>	Probable	Autopsy
9	Contusion, faint, 3.8 cm (1.5 in) right frontal scalp at hairline with hemorrhage, subscalpular, in right frontal scalp	190402.1 minor	Windshield, upper left	Possible <sup>2,I</sup>	Autopsy
10	Abrasions bilateral antecubital fossa and left forearm x 3	790202.1 minor	Air bag, driver's	Probable	Autopsy
11	Contusion 3.2 cm (1.25 in) left arm, location not specified	790402.1 minor	Steering wheel rim <sup>J</sup>	Possible <sup>I</sup>	Autopsy

<sup>1</sup> According to this contractor's conversation with the medical examiner, he indicated that he suspected that the contusions to this patient's heart, lungs, and thymus were a result of the resuscitation efforts and not crash-related; however, he also indicated that he couldn't be sure, and the actual autopsy makes no mention regarding this issue.

<sup>2</sup> According to the interview with the case vehicle's driver (i.e., mother), she indicated that her daughter had a previous bruise to the right side of her head. The autopsy made no mention that this injury was possibly old.

The case vehicle's driver [33-year-old, White (non-Hispanic) female; 155 centimeters and 58 kilograms (61 inches, 128 pounds)–{See End Note A. (17)}] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot letting off the accelerator, her left hand on the steering wheel, and her right hand holding her standing infant child on her lap. The driver's seat track was located near its forward-most position, her seat back was upright, and the tilt steering wheel was located between its middle and down-most positions.

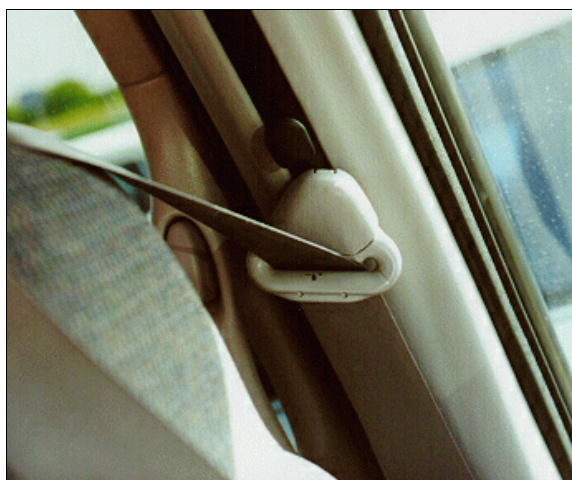
The case vehicle's, short statured driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The upper anchorage for the driver's shoulder belt was adjusted to its down-most position (**Figure 25**). The inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed apparent evidence of loading (i.e., stretching and transfer to "D"-ring). In addition, photographs taken by the this contractor showed plastic residue on the "D"-ring from friction with the seat belt webbing (**Figure 26**).

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of her available safety belts, the driver's pre-impact body position did not change just prior to impact. The case vehicle's primary impact with the Dodge Dakota enabled the driver (i.e., infant's mother) to move forward, toward the infant's back, loading her safety belts and slightly to the right toward the 10 degree Direction of Principal Force as the case vehicle decelerated. The driver's safety belt usage prevented the mother from completely compressing the infant against the steering wheel and deploying air bag during the initial impact. Based on this contractor's inspection of the driver's air bag module, it was obvious that the air bag's path was momentarily blocked by the combination of the case vehicle's driver and infant, causing the air bag to distort the module's cover flaps as it expanded outwards (**Figures 18 and 20** above).

The driver's air bag deployed during the initial impact. The driver impacted the deploying air bag with the left side of her chin and neck causing abrasions and was knocked backwards into her seat back. The driver's manual, three-point lap and shoulder belt locked up during the impact,



**Figure 25:** Case vehicle's front seating area showing deployed driver and front right passenger air bags, front bucket seats, and driver's adjustable upper seat belt anchorage, positioned in its down most position



**Figure 26:** Close-up of plastic transfer to case vehicle's driver "D"-ring from friction with safety belt webbing

preventing her from contacting the knee bolster. An inspection of the driver's air bag showed only a small unknown red spot to the left side (**Figure 21** above) but no visible skin evidence. At maximum engagement the case vehicle was redirected slightly counterclockwise. The subsequent side slap impact caused the mother to move to the right; however, her use of her available restraints minimized her movement. The case vehicle's impact with the raised median curb caused the driver to move forwards and slightly upwards again, towards the steering wheel and deployed driver's air bag module, and reload her safety belts. As the case vehicle continued traveling in an east-northeasterly direction, it sideswiped a metal light pole. This sideswiping impact had little or no effect on her movement. According to the case vehicle's driver, she was able to regain control of her vehicle and prevent it from traveling completely over the median into the westbound travel lanes. The case vehicle came to a stop straddling the raised median with the left tires on the inside through lane of the westbound roadway heading east. At final rest, according to the case vehicle's driver, she remained in her seat near her original seat position and immediately exited the case vehicle cradling her infant child.

### CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital. She sustained minor injuries but refused treatment. According to her interview, the injuries sustained by the case vehicle's driver included: abrasions to her chin and neck, lacerations to her left distal arm, and a laceration to her upper right arm.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Abrasion {rug burn} chin, not further specified	290202.1 minor	Air bag, driver's	Probable	Interviewee (same person)
2	Abrasion {rug burn} neck, not further specified	390202.1 minor	Air bag, driver's	Probable	Interviewee (same person)
3	Lacerations {scratches} left distal arm	790600.1 minor	Air bag, driver's and jewelry	Certain	Interviewee (same person)
4	Laceration {puncture} upper right arm (i.e., through blouse)	790600.1 minor	Unknown contact mechanism	Unknown	Interviewee (same person)

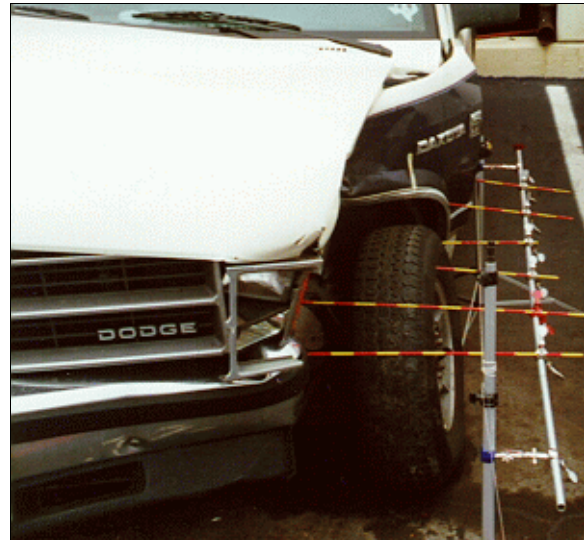
### OTHER VEHICLE

The other vehicle was a rear wheel drive 1987 Dodge Dakota LE, 4x2, three-passenger, two-door pickup truck (VIN: 1B7GN14M1HS-----) equipped with a 3.9L, 2Bbl. engine and a four-speed automatic transmission. Anti-lock brakes are not available for this model. Braking was achieved by a power-assisted, front disc and rear drum system. The case vehicle's wheelbase was 250 centimeters (98.4 inches), and the odometer reading at inspection was 213,974 kilometers (132,957 miles).

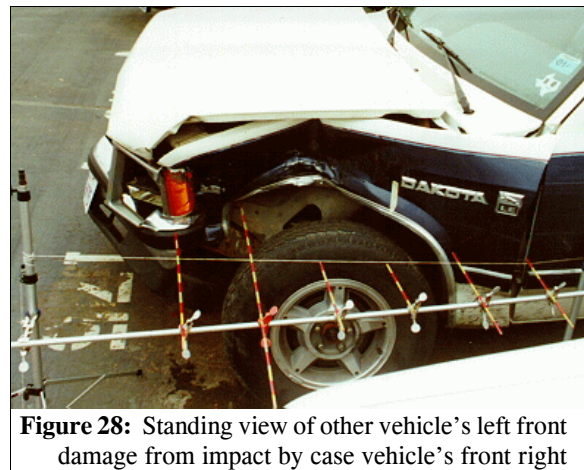
*Other Vehicle (Continued)*

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Based on the vehicle inspection, the primary CDC for the Dodge Dakota (Figures 27 and 28) was determined to be: **09-LFEW-3 (270)**—{See End Note A. (8)}. Maximum crush was 53 centimeters (20.9 inches) at C<sub>5</sub>—{See End Note A. (10)}. For the side slap impact, the CDC was determined to be: **09-LBEW-02 (270)**. Maximum crush was 55 centimeters (21.7 inches). The WinSMASH reconstruction program, damage only algorithm, was used on the Dodge Dakota's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 20.3 km.p.h. (12.6 m.p.h.), 0.0 km.p.h. (0.0 m.p.h.), and +20.3 km.p.h. (+12.6 m.p.h.)—{See End Note A. (11)}. No reconstruction program was used on the Dodge Dakota's side slap impact because the impact is out of scope of the NASS, CDS, WinSMASH algorithm requirements; however, this contractor's visually estimated Delta V for the side slap impact is minor [2-13 km.p.h. (1-8 m.p.h.)]. The Dodge Dakota was towed due to damage.



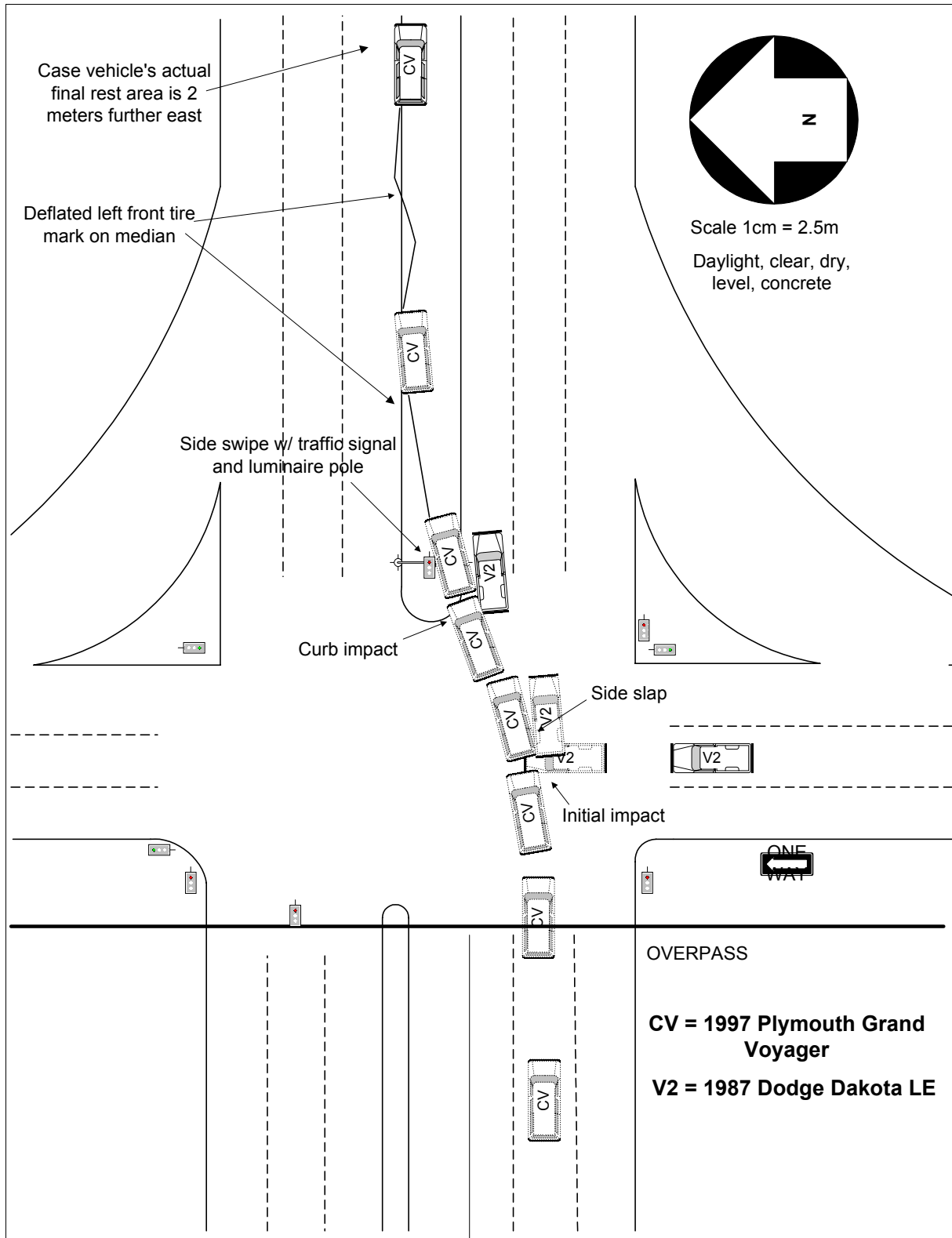
**Figure 27:** Reference line view from front of damage to other vehicle's left front with contour gauge present showing crush profile



**Figure 28:** Standing view of other vehicle's left front damage from impact by case vehicle's front right

**CRASH DIAGRAM**

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{See End Note A. (1)}

- A. (1) NASS scene diagram is a different drawing from the SCI diagram, but there are no substantive differences
- (2) SCI photographs were taken before the case vehicle was repaired. NASS photographs were taken after some repair work had begun. The SCI report includes some of the police photographs; NASS does not acquire police photographs, but some of the police photographs SCI sent to the zone center are included.
- (3) The SCI scenario includes four events while NASS has only three (i.e., SCI includes case vehicle’s wheel impact as event #3; this is absent in NASS)
- (4) NASS photographs include vehicle ID items (i.e., license plates and VINs); no such items are included in the SCI.
- (5) Case vehicle’s second CDC: NASS 03-RBAW-2 versus SCI 03-RZEW-2
- (6) For Case vehicle, SCI includes wheel impact CDC, NASS does not include this event.
- (7) SCI includes complete CDC for Case vehicle swiping-type impact with pole, NASS has incomplete CDC.
- (8) NASS coding for Other vehicle’s first CDC includes +60 right shift increment, this is not included in the SCI report.
- (9) SCI reports that the maximum crush for case vehicle’s Event #1 was 16 cm; NASS codes 26 cm, and the entire crush profiles are different between the two reports.
- (10) SCI reports that the maximum crush for the other vehicle’s Event #1 was 53 cm; NASS codes 62 cm, and the entire crush profiles are different between the two reports.
- (11) SCI WinSMASH results differ from NASS WinSMASH results (event #1):

WinSMASH Results	Case Vehicle		Other Vehicle	
	SCI	NASS	SCI	NASS
Total Delta V	15.5 km.p.h.	21 km.p.h.	20.3 km.p.h.	22 km.p.h.
Longitudinal Delta V	-15.3 km.p.h.	-21 km.p.h.	0 km.p.h.	-4 km.p.h.
Lateral Delta V	-2.7 km.p.h.	-4 km.p.h.	+20.3 km.p.h.	+22 km.p.h.
Energy	19550 joules	43566 joules	47245 joules	56650 joules
Barrier Equivalent Speed	16.5 km.p.h.	25 km.p.h.	19.7 km.p.h.	20 km.p.h.



- (12) SCI includes case vehicle's odometer reading, NASS is coded "unknown"
- (13) SCI mentions occupant contact points not included in NASS, and NASS includes occupant contact points not mentioned in SCI.
- (14) SCI reported measurements of the case vehicle driver air bag module's cover flaps are slightly different from NASS.
- (15) SCI reported measurements of the case vehicle front right passenger air bag module's cover flap are slightly different from NASS.
- (16) SCI reported dimensions for the case vehicle's front right passenger air bag are slightly different from NASS.
- (17) SCI reported weight for the case vehicle's driver differs slightly from NASS.

## DIFFERENCES BETWEEN NASS CDS AND SCI INJURY CODING

- B. The NASS CDS case used the injury code 140656.5: **cerebrum, hematoma/hemorrhage, subdural, large**. To be “large” for a child # 10-years-old, the volume requirement is >25 cc (25 ml). Only 20 ml was reported.
- C. The NASS CDS case used the injury code 140662.3: **cerebrum, brain swelling/edema, mild**. The edema was described in the medical records as “marked”. Because “marked” is not listed in the synonym listing, this contractor used the NFS (Not Further Specified) code.
- D. The NASS CDS case used the injury code 441004.1: **heart, contusion, minor**. This contractor used the NFS (Not Further Specified) code because the actual medical records made no mention of the severity of the myocardial contusions.
- E. The NASS CDS case used the Injury Source code: Air bag, driver’s. This contractor chose its Injury Source (contact mechanism) based on the following reasoning. The driver's seat is near its forward-most position. The child's left leg is between the mother's (i.e., driver's) two legs. The child's right leg is outside (i.e., to the right) her mother's right leg. This places the child offset to the right of the center of the steering wheel prior to the crash. The driver has her left hand on the steering wheel and her right hand around the child's waist. The child's butt is against the mother's chest, but the child's torso is leaning forward and her hands are somewhere on the steering wheel, most likely on the right side. When the impact occurs the child and mother move toward the 10 degree Direction of Principal Force. The child moves even further away (i.e., toward the right) from the center of the steering wheel. The impact pulse is most likely elongated because the case vehicle drives through the left front of the other vehicle spinning the other vehicle out of the case vehicle's way. The child's head is over (i.e., forward) of the steering wheel rim. This explains why the child has absolutely no facial or anterior neck lesions from the air bag. The mother provides the vast majority of the loading and subsequent resistance to the air bag's deployment that compresses the deploying air bag causing the cover flap to tear inappropriately. Given that the child's head was over the rim we felt that it was most likely that the child contacted the rim and/or a spoke with his upper torso before the air bag's fabric could reach her. Keep in mind that the driver was changing lanes from the center through lane to the inside through lane just prior to the impact so that a right spoke could have been rotated upward to where the child was. Once the air bag expanded, it abraded the child's arm pits and left forearm and lifted her out of her mother's arms and into the right side of the front left header where the fatal lesions occurred. Since the injury mechanism choices for the steering wheel are: hub and spokes; rim; OR hub, rim and spokes, we felt that we had to code the total combination, BUT we do not think that the hub was in anyway involved.
- F. The NASS CDS case used the Source Confidence code: Probable. The doctor who performed the autopsy told us that he suspected that the heart and lung lesions were from CPR and not from the crash (footnote); however, his opinion didn't make it into the actual autopsy. For that reason we felt that the lesions to the heart, thymus, lungs reported in the autopsy must be coded, BUT given all the ambiguity about what caused them we choose POSSIBLE as the highest certainty that should be assigned.
- G. The NASS CDS case used the injury code 150202.3: **Base (basilar) fracture, without CSF leak**. This contractor used the NFS (Not Further Specified) code because there is no information presented in the medical records pertaining to whether or not there was CSF (cerebrospinal fluid) leakage.
- H. The NASS CDS case used the Injury Source code: Air bag, driver’s.
- I. The NASS CDS case used the Source Confidence code: Probable. This contractor believes that Possible is a better fit because of the lesion may have pre-dated the crash (see footnote).
- J. The NASS CDS case used the Injury Source code: Air bag, driver’s, and a Source Confidence code: Probable.