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SCI/NASS COMBINATION CASE REPORT

CASE NUMBER - NASS-2001-49-014K
LOCATION - Texas
VEHICLE - 1996 PLYMOUTH VOYAGER
CRASH DATE - February 2001

Submitted:

March 6, 2002

Revised:
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Contract Number: DTNH22-94-D-17058

Prepared for:

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National Highway Traffic Safety Administration
National Center for Statistics and Analysis
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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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15. *Supplementary Notes*
Combination SCI/NASS investigation involving a 1996 Plymouth Voyage minivan with integral child safety seats, and a 2000 Saturn station wagon

16. *Abstract*

This report covers a combination SCI/NASS investigation concerning a 1996 Plymouth Voyager minivan and a 2000 Saturn station wagon. This crash is of special interest because the case vehicle was equipped with integral child safety seats built into the second row bench seat. The case vehicle's second row left passenger (2-year-old female) was restrained in the integral child safety seat and sustained a fracture of the left femur. The case vehicle was traveling east in the center eastbound lane of a three-lane, one-way roadway that was part of a divided, six-lane trafficway, approaching a four-leg intersection and intending to continue east. The other vehicle had exited a parking lot on the north side of the divided roadway and was traveling south in the median cut intending to continue south across the eastbound lanes. The crash occurred within the intersection of the eastbound lanes and the north-south roadway. The front of the other vehicle impacted the left side of the case vehicle. The case vehicle rotated counterclockwise, rolled to the right three quarter-rolls and came to rest on its left side heading northwest, straddling the eastbound lanes of the divided roadway. The other vehicle traveled across the intersection and came to rest headed southeast at the southeast corner of the intersection. Both vehicles were towed due to disabling damage. The case vehicle's second row left passenger (2-year-old female) was seated in an integral child safety seat, restrained by the seat's five-point harness, and suffered a fracture of the left femur. The case vehicle's restrained driver (43-year-old female) sustained a concussion and minor soft tissue injuries. The restrained front right passenger (9-year-old male) did not sustain any injuries. The third row right passenger (13-year-old female) was not restrained and was completely ejected out the back right window. She suffered bilateral lung contusions from impacting the right side interior surface, and fractures of the nasal bones and alveolar ridge and subluxation of cervical vertebrae C5-C6 , from impacting the ground.

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BACKGROUND

NASS-2001-49-014K

This SCI/NASS combination investigation was brought to the NHTSA's attention in February 2001 by NASS/CDS sampling activities. This crash involved a 1996 Plymouth Voyager minivan (case vehicle, NASS vehicle #2) and a 2000 Saturn station wagon (other vehicle, NASS vehicle #1). The crash occurred in February 2001, at 4:32 p.m., in Texas, and was investigated by the applicable municipal police agency. This crash is of special interest because the case vehicle was equipped with integral child safety seats built into the second row bench seat. The case vehicle's second row left passenger (2-year-old female) was restrained in the integral child safety seat and sustained a fracture of the left femur. An electronic copy of the NASS case was forwarded to this contractor in December 2001. This report is based on the coded NASS case; scene and vehicle inspections and photographs; the scanned Police Crash Report, interview information and medical records; occupant kinematic principles; and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The case vehicle was traveling east in the center eastbound lane of a three-lane, one-way roadway that was part of a divided, six-lane trafficway, approaching a four-leg intersection and intending to continue east (**Figure 1**). The other vehicle had exited a parking lot on the north side of the divided roadway and was traveling south, intending to cross the divided roadway and continue southbound. The other vehicle had crossed the westbound lanes and was in the median cut intending to continue south across the eastbound lanes. The weather was clear, it was daylight, both roadways were of concrete construction, dry and without defects. The grass median was over 10 meters [30 feet] wide, with no longitudinal barrier. The speed limit for the case vehicle was 56 km.p.h. [35 m.p.h.], with the roadway straight and a negative slope to the east. The speed limit for the other vehicle was 48 km.p.h. [30 m.p.h.], with the roadway straight and level.

Figure 1: Case vehicle's eastbound approach (in the middle lane); the other vehicle emerged from the median cut on the left

The crash occurred within the intersection of the eastbound lanes and the north-south roadway. The front of the other vehicle impacted the left side of the case vehicle. The case vehicle rotated counterclockwise, rolled to the right three quarter-rolls and came to rest approximately 32 meters [106 feet] east of the point of impact, on its left side heading northwest, straddling the eastbound lanes of the divided roadway (see **CRASH DIAGRAM**). The case vehicle's unrestrained third row right passenger (13-year-old female) was completed ejected out the right third side window. The other vehicle traveled across the intersection and came to rest headed southeast at the southeast corner of the intersection. Both vehicles were towed due to disabling damage.

The case vehicle was a front wheel drive, five-door, seven-passenger 1996 Plymouth Voyager base minivan (VIN: 2P4FP2530TR------), equipped with a 3.0 liter V-6 gasoline engine and an automatic transmission with a column-mounted selector lever. Four-wheel anti-lock brakes were an option for this model, but it is not known if the case vehicle was so equipped. The wheelbase was 288 centimeters [113.3 inches] and the odometer reading was 114,624 kilometers [71,226 miles]. The case vehicle was towed due to disabling damage.

CASE VEHICLE DAMAGE

The case vehicle sustained direct contact damage on the left side from the impact with the other vehicle (event 1). The case vehicle began rotating counterclockwise and rolled to the right three quarter-rolls (event 2), coming to rest on its left side and sustaining direct damage from contact with the ground on the right, top and left sides (**Figures 2 and 3**).

Figure 2: Front and right side of case vehicle

Figure 3: Front and left side of case vehicle

For event 1, direct damage extended from the left A-pillar along the driver's door and the left sliding side door to the left rear wheel well (**Figure 4**). The CDC for the first event was determined to be **12-LZEW-3 (350)**. Maximum crush was 19 centimeters [7.5 inches] at C4, near the center of the driver's door. The first event was judged to be the most severe and the WinSMASH reconstruction program was executed, based on the damage-only algorithm using the measured crush profiles from both vehicles. The Total, Longitudinal and Lateral DeltaVs for the case vehicle were, respectively: 11 km.p.h. [6.8 m.p.h.], -11 km.p.h. [-6.8 m.p.h.] and +2 km.p.h. [+1.2 m.p.h.].

Figure 4: Crush profile for event 1

For event 2, the heaviest damage was on the roof at the junction of the left A-pillar, windshield header and the left roof rail (**Figures 2 and 3**). The left A-pillar was crushed inward and downward, pulling the adjacent structures with it and causing the roof to buckle on the right. There was light scratching on the right and left sides, along the upper right A-pillar and the right roof rail, and on the mid-door area along the left side. There was also heavy abrading across the forward half of the roof, heavier on the left. The CDC for the rollover (second event) was determined to be **00-TZDO-3 (non-horizontal)**. The crash severity for the rollover was judged to be moderate.

The case vehicle sustained integrity loss due to glazing damage. The case vehicle's windshield was separated along the header and the left A-pillar, and had a vertical tear approximately at the center. The glazing was shattered (kernelized) in the second and third right side windows and the first and third left side windows. The two left doors were jammed shut while the two right doors and the back lift gate remained closed and operational.

Inspection of the interior revealed numerous areas of intrusion on the left side and the top. In the second row left seat area, intrusion by the left door panel (due to the impact with the other vehicle) was measured as 13 centimeters [5.1 inches]. Note, however, the left side door apparently had been forced opened and could not be closed completely, and the intrusion during the crash was probably somewhat greater. The left roof rail intruded 24 centimeters [9.4 inches] laterally into the second seat row as a result of the rollover. In the driver's seat position, the roof intruded 12 centimeters [4.7 inches] and the windshield header intruded 10 centimeters [3.9 inches] vertically, as a result of the rollover. Other components also intruded laterally or vertically, with lesser magnitude, into the left side seating areas in all three seat rows.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with driver and front right passenger air bags and no other automatic restraints. The driver's air bag was located in the steering wheel hub and the front right passenger's air bag was located in the middle of the instrument panel. The air bags did not deploy.

INTEGRAL CHILD SAFETY SEATS

The case vehicle's second row bench seat was manufactured with two integral child safety seats (**Figure 5**). At the time of the crash, the left integral child safety seat (CSS) was open and in use (**Figure 6**) while the right integral CSS was folded away with no occupant in the second row right seat position.

Figure 5: Case vehicle's second row bench seat with two integral child safety seats folded open

The integral CSS is designed such that a portion of the bench seat's back cushion folds down and lays on the bench seat cushion,

revealing the CSS with its harness and shield. When the CSS is open, the lateral margins of the bench seat's back cushion create a recessed area in which the child is seated. The integral CSS is fitted with a five-point harness system with a T-Bar shield. There is only one set of slots for the harness straps, allowing for no harness height adjustment. The harness system is bucked by inserting the base of the T-Bar, which contains an integral buckle and release mechanism, into the base of the CSS, where the latch plate is located in a recessed slot. The label that is sewn into the CSS seat cushion indicates that the CSS is designed for use by children who weigh 9 - 23 kilograms [20 - 50 pounds] and who are no taller than 119 centimeters [47 inches].

CASE VEHICLE SECOND ROW LEFT PASSENGER

The case vehicle's second row left passenger (2-year-old female, white, Hispanic, 91 centimeters, 19 kilograms [36 inches, 42 pounds]) was restrained in an integral child safety seat with the CSS's five-point harness system (the vehicle's three-point, manual, lap-and-shoulder safety belt system was not in use). She was transported via ambulance and was hospitalized for 3 days at the initial facility and was discharged to a second facility. The reason for the transfer, the treatment received and the length of stay at the second facility are not known.

Prior to the left side impact with the other vehicle, the child was seated in the open integral CSS (**Figure 6**), restrained by the integral seat's five-point harness with the T-Bar in use. She was sitting upright, with her back against the integral CSS's seat back and her legs forward in front of her. The case vehicle driver braked immediately prior to the impact and the child moved slightly forward, but her movement was restricted by the harness. When the other vehicle struck the case vehicle's left side, the child moved further forward and slightly to the left, toward the 350 degree direction of force, loading the harness. The interior surface of the left sliding door intruded as a result of the impact (**Figure 7**), probably compressing the bench seat cushion and possibly contacting the child. As the case vehicle began to rotate counterclockwise, she moved slightly to the right but was probably held in place by the harness. As the case vehicle rolled over (i.e., rotated about the longitudinal axis) to the right, she moved first to the right, then upwards and then back to the left, but was held essentially in place by the harness, although her legs may have flailed and contacted the intruded door surface. The case vehicle rolled three quarter rolls onto its left side. Her posture at final rest is

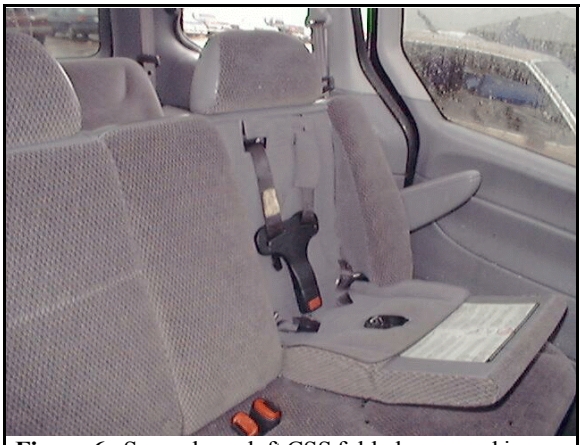


Figure 6: Second row left CSS folded open and in use at the time of the crash; right CSS closed

Figure 7: Second row left CSS cushion open on bench seat cushion, showing door panel intrusion

not known, but she was probably held in the recessed seating area by the CSS harness, leaning toward the intruded left side interior surface as the vehicle slid to final rest on its left side. The child suffered a fracture of the left femur in the area of the lesser trochanter, probably as a result of contacting the left side interior surface. No other injuries were reported for this occupant. Whether the fracture was caused by the impact with the other vehicle and the resulting intrusion, or from being thrown against the door during the rollover and/or slide to rest, is not known.

SECOND ROW LEFT PASSENGER INJURIES

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Fracture in the area of the lesser trochanter, left femur	851818.3 serious	Left side interior surface	Possible	Post-ER Med. Records

CASE VEHICLE DRIVER

The case vehicle's driver (43-year-old female, white, Hispanic, 142 centimeters, 55 kilograms [56 inches, 121 pounds]) was restrained by the available, manual, three-point, lap-and-shoulder safety belt system. She was transported via ambulance and was hospitalized for four days.

Figure 8: Driver's seat area

Prior to the impact with the other vehicle, the driver was seated in a van-type box-mounted bucket seat, in an upright posture with her back against the seat back, both hands on the steering wheel, her left foot on the floor and her right foot on the foot controls. Immediately prior to the left side impact, the driver braked, causing her to move slightly forward. Upon impact, she moved further forward and slightly upward and to the left, toward the 350 degree direction of force, loading the safety belt webbing. As the case vehicle began to rotate counterclockwise, she moved slightly to the right. As the case vehicle rolled over (i.e., rotated about the longitudinal axis) to the right, she moved first to the right, then upwards and then back to the left. Her head probably struck the left roof rail and she sustained a laceration on her scalp and a non-anatomic brain injury resulting in loss of consciousness. Her posture at final rest is not known, but she was probably laying against the left side interior surface as the vehicle lay on its left side following the rollover.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Non-anatomic brain injury, brief loss of consciousness	160414.2 moderate	Left roof side rail	Probable	Emergency Room
2.	Small laceration, top of head	190602.1 minor	Left roof side rail	Probable	Emergency Room
3.	External bruising and swelling, NFS	990400.1 minor	Unknown	Unknown	Emergency Room
4.	Small laceration, unknown finger, right hand	790602.1 minor	Unknown	Unknown	Emergency Room

CASE VEHICLE FRONT RIGHT PASSENGER

The case vehicle front right passenger (9-year-old male, white, Hispanic, 122 centimeters, 31 kilograms [48 inches, 68 pounds]) was restrained by the available, manual, lap-and-shoulder safety belt system. He was transported via ambulance to a hospital, where he was found not to have any injuries and released.

Figure 9: Front right seat area

Prior to the impact with the other vehicle, the front right passenger was seated in a van-type box-mounted bucket seat, in an upright posture with his back against the seat back, his hands in an unknown position and his legs hanging down in front of the seat. Immediately prior to the left side impact, the driver braked, causing him to move slightly forward. Upon impact, he moved further forward and slightly upward and to the left, toward the 350 degree direction of force, loading the safety belt webbing. As the case vehicle began to rotate counterclockwise, he moved slightly to the right. As the case vehicle rolled over (i.e., rotated about the longitudinal axis) to the right, he moved first to the right, then upwards and then back to the left, but was held essentially in place by the safety belt. His posture at final rest is not known, but he was probably hanging to the left, held by the safety belt. He did not sustain any injuries.

The case vehicle third row right passenger (13-year-old female, white, Hispanic, 147 centimeters, 39 kilograms [58 inches, 86 pounds]) was not using the available, manual, lap-and-shoulder safety belt system and was completely ejected through the third right side window opening. She was transported via ambulance and was hospitalized for four days.

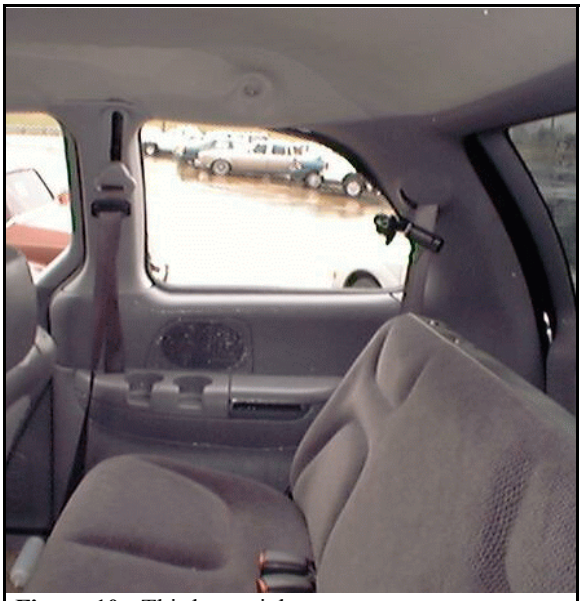


Figure 10: Third row right seat area

Prior to the impact with the other vehicle, the third row right passenger was seated in the right portion of the three-position bench seat, in an upright posture with her back against the seat back, her hands in an unknown position, her knees bent and her feet on the floor. Immediately prior to the left side impact, the driver braked, causing her to move slightly forward. Upon impact, she moved further forward and slightly upward and to the left, toward the 350 degree direction of force. As the case vehicle began to rotate counterclockwise, she moved back to the right. As the case vehicle rolled over (i.e., rotated about the longitudinal axis) to the right, she was thrown against the right side interior surface and window sill, causing a contusion of her lungs. The window glazing shattered as a result of the rollover contact and she essentially fell out through the window opening as the vehicle continued to roll, leaving her on the ground. Her face and head contacted the ground, causing a non-anatomic brain injury resulting in unconsciousness, a displaced nasoseptal fracture, and a fracture of the alveolar ridge with loosened teeth. The contact by her face and head on the ground caused hyperextension of her cervical spine, resulting in subluxation of the 5th and 6th cervical vertebrae. She also sustained lacerations, abrasions and contusions from contact with the ground.

CASE VEHICLE THIRD ROW RIGHT PASSENGER INJURIES

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Lung contusions, bilateral, upper lobes	441410.4 severe	Right side window sill	Probable	Post-ER Med. Records
2.	Displaced nasoseptal fracture	251004.2 moderate	Ground	Probable	Post-ER Med. Records
3.	Fracture, alveolar ridge, with loose teeth	250200.2 moderate	Ground	Probable	Post-ER Med. Records
4.	Non-anatomic brain injury, approx. 10 minute loss of consciousness	160414.2 moderate	Ground	Probable	Post-ER Med. Records

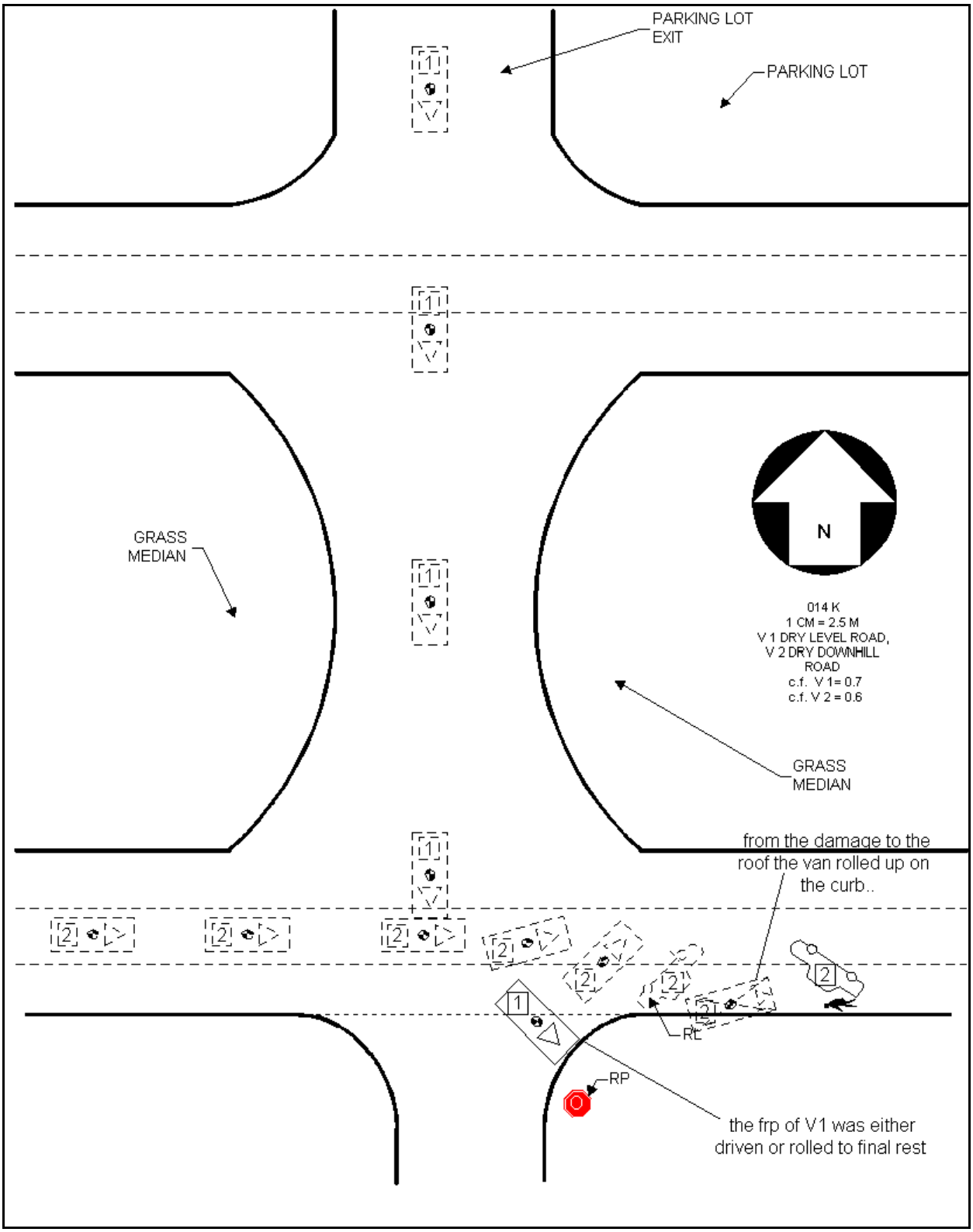
Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
5.	Subluxation, C5-C6	650204.2 moderate	Ground	Probable	Post-ER Med. Records
6.	Superficial lacerations left scalp	190602.1 minor	Ground	Probable	Post-ER Med. Records
7.	Superficial lacerations right scalp	190602.1 minor	Ground	Probable	Post-ER Med. Records
8.	Abrasions, right scalp	190402.1 minor	Ground	Probable	Emergency Room
9.	Contusion, right hand	790402.1 minor	Ground	Probable	Interview

OTHER VEHICLE

The other vehicle was a front wheel drive, four-door, five-passenger 2000 Saturn LW2 station wagon (VIN: 1G8JW82R1YY------), equipped with a 3.0 liter V-6 gasoline engine and an automatic transmission with a console-mounted selector lever. Anti-lock brakes were an option for this model, but it is not known if this vehicle was so equipped. The wheelbase was 271 centimeters [106.5 inches] and the odometer reading was estimated by the driver as 11,265 kilometers [7,000 miles]. The Saturn was towed from the scene due to disabling damage.

Figure 11: Other vehicle's front damage, body parts removed for repair

The Saturn sustained direct contact damage across the entire front plane, with maximum crush 15 centimeters [5.9 inches] at the front right corner. The vehicle was under repair at the time of inspection, with the hood, grille, bumper cover and the two front fenders removed and not available. The bumper was pushed leftward and rearward, with bending of the radiator support bracket and the fender support brackets on both sides, heavier on the left. The post-crash wheelbase was shortened by 7 centimeters [2.8 inches] on both sides. The CDC was determined to be **03-FDEW-1 (80)**. The WinSMASH reconstruction program, damage-only algorithm based on the measured crush profiles of both vehicles, was used. The Total, Longitudinal and Lateral Delta Vs for the Saturn were, respectively: 13 km.p.h. [8.1 m.p.h.], -2 km.p.h.[1.2 m.p.h.] and -13 km.p.h.[-8.1 m.p.h.]. The Saturn was equipped with driver and front right passenger air bags that did not deploy. The Saturn's restrained driver (62-year-old female) did not sustain any injuries. There was no other occupant in the other vehicle.


PARKING LOT
EXIT
PARKING LOT
GRASS
MEDIAN
N
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1 CM = 2.5 M
V 1 DRY LEVEL ROAD,
V 2 DRY DOWNHILL
ROAD
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c.f. V 2 = 0.6
GRASS
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roof the van rolled up on
the curb..
RE
RP
the frp of V1 was either
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