

On scene Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS04018
1996 Dodge Grand Caravan
California
May, 2004

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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 crash-worthiness performance of the involved vehicle(s) or their safety systems.

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16. Abstract This on-scene investigation focused on the performance of the front right passenger air bag in a 1996 Dodge Grand Caravan and its interaction with a 9-year-old male seated in the front right seating position. This four vehicle, chain reaction crash occurred in northern California in May, 2004 at 1420 hours. The crash occurred in the eastbound lanes of a four-lane divided interstate roadway. The case vehicle is a 1996 Dodge Grand Caravan van driven by a 34-year-old female. The Caravan was equipped with dual front air bags. The front right seat was occupied by a restrained 9-year-old male The second row left seat was occupied by a restrained 7-year-old male. The third row left seat was occupied by a 10-year-old male. The Caravan was traveling eastbound in the second lane from the right. In front of the Caravan was a 1996 Lexus GS 300 driven by an 18-year-old male. In front of the Lexus was a 1997 Chrysler Town and Country driven by a 67-year-old male. In front of the Town and Country was a 1998 Pontiac Sunfire driven by a 26-year-old male. The case vehicle was traveling at a driver reported speed of 56 km/h (35 mph). The Lexus in front of the Caravan slowed or stopped. The driver of the Caravan braked, but was unable to stop in time. The front of the Caravan struck the rear of the Lexus. The Lexus was then pushed into the rear of the Town and Country. The Town and Country was pushed into the rear of the Sunfire. The 9-year-old occupant of the Caravan sustained a concussive head injury with loss of consciousness, a small left subdural hematoma, and a right ethmoid sinus fracture.				
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Dynamic Science, Inc.
Crash Investigation
Case Number: DS04018

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BACKGROUND:

Description: This on-scene investigation focused on the performance of the front right passenger air bag in a 1996 Dodge Grand Caravan and its interaction with a 9-year-old male seated in the front right seating position. This was a four-vehicle chain reaction type crash with this vehicle being involved in the first impact. At impact, the front right passenger bag deployed and came into contact with the front right occupant's face. He sustained a concussive head injury with loss of consciousness, a small left subdural hematoma, and a right ethmoid sinus fracture. He was transported by air ambulance to an area children's trauma center where he arrived with a Glasgow Coma Scale (GCS) score of 5 and was hospitalized for a total of 62 days.

This Passenger Air Bag Serious Injury Case was initiated in response to an electronic mail notification by a private citizen (driver of the case vehicle). NHTSA was notified on July 21, 2004. A follow up call to the citizen was made by NHTSA personnel on July 28, 2004. DSI was assigned the case on July 29, 2004. . Field work was completed on August 16, 2004.

Investigation Type:	On scene
Crash Location:	California
Crash Date:	May, 2004
Notification Date:	July 29, 2004
Field Work Completed:	August 16, 2004

SUMMARY**Crash Site**

This four vehicle, chain reaction crash occurred in northern California in May, 2004 at 1420 hours. The crash occurred in the eastbound lanes of a four-lane divided interstate roadway. The roadway consists of two eastbound and two westbound travel lanes separated by a 18 m (58 ft) median. Parallel to the westbound travel lanes is a concrete barrier. The weather was clear and dry. The asphalt roadway was straight and level. Traffic was heavy at the time of the crash. The speed limit is 105 km/h (65 mph).



Figure 1. Path of travel (east)

Pre-Crash

The case vehicle is a 1996 Dodge Grand Caravan LE (VIN: 1B4GP54L8TBxxxxxx) 7-passenger van driven by a 34-year-old female (168 cm/66 in, 57 kg/125 lbs). The Caravan was equipped with dual front air bags. The front right seat was occupied by a restrained¹ 9-year-old male (152 cm/60 in, 39 kg/85 lbs). This occupant has a history of a 40 percent hearing loss bilaterally that is believed to be congenital. He wears hearing aids in noisy situations. He is taking Adderall² for Attention Deficit Disorder with Hyperactivity (ADHD). At the time of the crash he was a special education student in the second grade. The second row left seat was occupied by a restrained 7-year-old male. The third row left seat was occupied by a 10-year-old male. The Caravan was traveling eastbound in the second lane from the right.

In front of the Caravan was a 1996 Lexus GS 300 driven by an 18-year-old male. In front of the Lexus was a 1997 Chrysler Town and Country driven by a 67-year-old male. In front of the Town and Country was a 1998 Pontiac Sunfire driven by a 26-year-old male.

The case vehicle was traveling at a driver reported speed of 56 km/h (35 mph). The Lexus in front of the Caravan slowed or stopped.

Crash

The driver of the Caravan braked, but was unable to stop in time. The front of the Caravan (12FDEW1) struck the rear of the Lexus. The total velocity change for the Caravan as calculated by the missing vehicle algorithm of the WinSmash program was 30.1 km/h (18.8



Figure 2. Front left, Dodge Caravan



Figure 3. Front right, Dodge Caravan

¹Restraint usage was determined by blood splatter location which indicated that the seat belt was in the proper position prior to the crash. Age darkened stains on the belt were tested and were identified as blood using a presumptive blood test.

²Adderall contains the stimulants amphetamine and dextroamphetamine and is used to improve attention span, increase ability to follow directions, and to decrease distractibility and impulsivity.

mph)³. The longitudinal and lateral delta V components were -30.1 km/h (-18.8 mph) and 0 km/h (0 mph), respectively. Both front air bags in the Caravan deployed at this time. The results appear high.

The Lexus was then pushed into the rear of the Town and Country. The Town and Country was pushed into the rear of the Sunfire.

Post-Crash

The 9-year-old occupant of the Caravan sustained a concussive head injury with loss of consciousness, a small left subdural hematoma, and a right ethmoid sinus fracture. He was transported by air ambulance to an area children's trauma center where he arrived with a Glasgow Coma Scale (GCS) score of 5 and was hospitalized for a total of 62 days. A time line of transport and treatment is shown below.

<i>Event</i>	<i>Time</i>
Crash	1420
Trauma surgeon called	1540
Arrived at emergency department	1550
Trauma surgeon arrived	1543
Admitted to intensive care unit (ICU)	0 days post crash
Discharged from ICU, admitted to rehabilitation ward	17 days post crash
Discharged from rehabilitation ward	62 days post crash

After his release he required the use of a wheelchair and was undergoing physical and speech therapy.

The Dodge Caravan (case vehicle) and the Chrysler Town and Country were towed from the scene. The Lexus GS300 and the Pontiac Sunfire were driven from the scene.

³Calculated using stiffness values derived from NCAP test 2335

VEHICLE DATA -1996 Dodge Grand Caravan LE 7-passenger van

The Grand Caravan was identified by the Vehicle Identification Number (VIN): 1B4GP54L8TBxxxxxx. The vehicle's odometer could not be read since there was no power to the instrument panel. The Caravan was equipped with a 3.8 liter V6 engine, an automatic transmission, front wheel drive, tilt steering wheel, optional driver side sliding door, AM/FM cassette stereo, air conditioning and power windows and locks. A defect has been reported concerning the air bag clockspring⁴.

The 1996 Dodge Grand Caravan was equipped with Big O Eurotour P215/65R16 tires on the front and Uniroyal Tiger Paw P215/65R16 tires on the rear. The specific tire data is as follows:

Tire	Tread	Pressure	Recommended pressure
LF	7 mm (9/32 in)	159 kPa (23 psi)	241 kPa (35 psi)
LR	8 mm (10/32 in)	193 kPa (28 psi)	241 kPa (35 psi)
RF	10 mm (13/32 in)	200 kPa (29 psi)	241 kPa (35 psi)
RR	9 mm (11/32 in)	207 kPa (30 psi)	241 kPa (35 psi)

The front row and second row seating positions in the 1996 Dodge Grand Caravan were configured with dual leather covered bucket seats. The seats were equipped with adjustable head restraints that were not damaged. The third row was configured as a leather covered bench seat with a folding back. The third row seat is removable for additional cargo storage. The two outboard seating positions were equipped with adjustable head restraints that were not damaged.

⁴Investigation: Preliminary Evaluation 00-032. Problem Description: Alleged that the vehicle's air bag readiness indicator lamp illuminated to indicate potential air bag system failure. Opened: 08/08/2000. Closed: 02/21/2001.

VEHICLE DAMAGE

Exterior Damage - 1996 Dodge Grand Caravan

Damage Description:	Minor front end damage. Fascia off.	
CDC:	12FDEW1	
Delta V:	Total	30.3 km/h (18.8 mph)
	Longitudinal	-30.3 km/h (-18.8 mph)
	Latitudinal	0 km/h (0 mph)
	Energy	26,073 joules (19,230 ft-lbs)

The case vehicle sustained 180.0 cm (70.9 in) of direct contact to the front bumper fascia from the initial impact. The residual crush measured along the bumper was as follows: C1=7.4 cm (2.9 in), C2=13.0 cm (5.1 in), C3=15.0 cm (5.9 in), C4=15.0 cm (5.9 in), C5=12.0 cm (4.7 in), C6=7.0 cm (2.8 in). The maximum crush was at C4. The principle direction of force was within the 12 o'clock sector and was an estimated 0 degrees. The damaged components included the bumper fascia and reinforcement bar.



Figure 4. Front bumper fascia



Figure 5. Front bumper measurements

Interior Damage - 1996 Dodge Grand Caravan

Interior damage included the normal damage associated with air bag deployments. There was also contact damage to the bottom center console drawer.

MANUAL RESTRAINT SYSTEMS - 1996 Dodge Grand Caravan

The interior of the Dodge Caravan consisted of a seven passenger, three row seating configuration with bucket seats for the first and second rows and a bench seat that seats three for the third. The front seats were equipped with 3-point lap and shoulder belts with emergency locking retractors, cinching latch plates, and adjustable D rings that were positioned in the full down positions. The second row bucket seats were equipped with 3-point lap and shoulder belts with emergency locking retractors, cinching latch plates, and adjustable D rings that were positioned in the full down positions. The third row bench seat was equipped with lap and shoulder belts at the two outboard seating positions and a lap belt in the middle position. The lap and shoulder belts were configured with emergency locking retractors and cinching latch plates. The rear center seating position was equipped with a 2-point manual lap belt system with a locking latch plate.



Figure 6. Driver's seat position

FRONTAL AIR BAG SYSTEM - 1996 Dodge Grand Caravan

The Dodge Grand Caravan was equipped with dual front air bags that deployed at impact with the Lexus. The driver's air bag module was mounted in the center of the steering wheel and had an H configuration. The top cover measured 2.5 cm (0.9 in) high by 17.5 cm (6.9 in) wide. The bottom cover measured 7.5 cm (2.9 in) high by 17.5 cm (6.9 in) wide. The air bag was circular in shape and measured 64.0 cm (25.2 in) in its deflated state. There was a single tether. The bag was internally vented. There was a single scuff roughly in the center of the face of the air bag. There was no damage to the module cover or the air bag itself.

The front right passenger air bag module was a mid mount design which incorporated a horizontally oriented dual flap tear seam with an H configuration. The top cover measured 3.5 cm (1.4 in) high by 29.0 cm (11.4 in) wide. The bottom cover measured 7.0 cm (2.8 in) high by 29.0 cm (11.4 in) wide. The air bag was vaguely rectangular in shape. It measured 45.0 cm (17.7 in) wide seam to seam, 36.0 cm (14.2 in) wide near the base, and 80.0 cm (31.5 in) high in its deflated state. The air bag had a maximum excursion of 64.0 cm (25.2 in) which placed the air bag 11.0 cm (4.3 in) from the seat back as positioned at the time of impact. There were no tethers or vent ports. The module covers were undamaged. The air bag face exhibited a skin contact which measured 23.0 cm (9.1 in) high by 2.0-4.0 cm (0.8-1.6 in) wide. It was located 24.0 cm (9.5 in) to the right of the left seam and 45.0 cm (17.7 in) from the top edge.



Figure 7. Face of driver's air bag



Figure 8. Front view, passenger air bag



Figure 9. Side view, passenger air bag

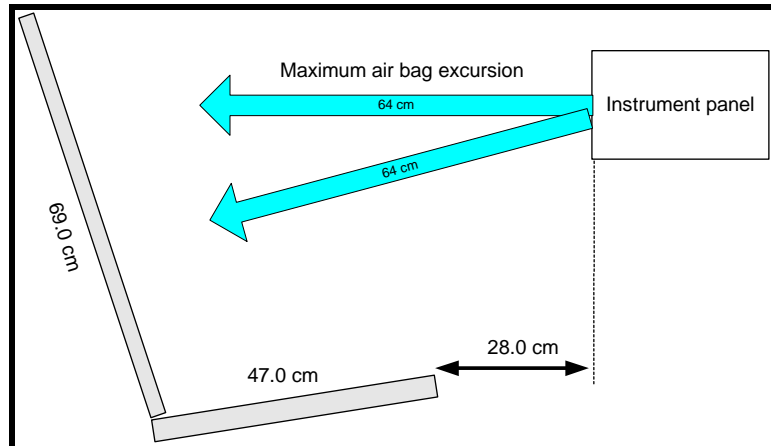


Figure 10. Overview of front right passenger air bag deployment range

VEHICLE DATA - 1996 Lexus GS 300

Description:	1996 Lexus GS 300	
VIN:	Unknown	
Odometer:	Unknown	
Engine:	3.0 L, in-line 6 cylinder	
Reported Defects:	None per police report.	
Cargo:	Unknown	
Damage Description:	Minor damage to the rear bumper, the deck lid, and to the front bumper. Vehicle driven from scene.	
CDC:	Unknown	
Delta V:	Total	30.4 km/h (18.9 mph)
	Longitudinal	30.4 km/h (18.9 mph)
	Latitudinal	0 km/h (0 mph)
	Energy	113,878 joules (83,992 ft-lbs)

VEHICLE DATA - 1997 Chrysler Town and Country

Description:	1997 Chrysler Town and Country	
VIN:	Unknown	
Odometer:	Unknown	
Engine:	3.3L or 3.8L V6	
Reported Defects:	None per police report.	
Cargo:	Unknown	
Damage Description:	Minor damage to rear bumper, right and left rear quarter panels, and to the license plate. Towed from the scene.	
CDC:	Unknown	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

VEHICLE DATA - 1998 Pontiac Sunfire

Description:	1998 Pontiac Sunfire	
VIN:	Unknown	
Odometer:	Unknown	
Engine:	2.2L, 4 cylinder	
Reported Defects:	None per police report.	
Cargo:	Unknown	
Damage Description:	Minor damage to the rear bumper. Vehicle driven from the scene.	
CDC:	Unknown	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

OCCUPANT DEMOGRAPHICS - 1996 Dodge Grand Caravan

	Driver	Occupant 2
Age/Sex:	34/Female	9/Male
Seated Position:	Front left	Front right
Seat Type:	Leather covered bucket seat. Seat back slightly reclined. Seat adjusted to rear most track position.	Leather covered bucket seat. Seat back adjusted to 73 degrees from horizontal. Seat bottom at 10 degree angle. Seat adjusted to rear most track position. Face of seat cushion 28.0 cm (11.0 in) rearward of face of instrument panel.
Height:	168 cm (66 in)	152 cm (60 in)
Weight:	57 kg (125 lbs)	39 kg (85 lbs)
Occupation:		None
Pre-existing Medical Condition:	None noted	40 percent hearing loss bilaterally, believed to be congenital. Wears hearing aids in noisy situations. On Adderall for ADHS.
Alcohol/Drug Involvement:	None	None
Driving Experience:	>10 years	NA
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Both hands on steering wheel, unknown clock direction	Unknown
Foot Position:	Right foot on brake, left on floor board	Unknown
Restraint Usage:	Lap and shoulder belt available, used.	Lap and shoulder available, used.
Air bag:	Steering wheel mounted air bag available, deployed.	Instrument panel mounted front air bag available, deployed.

	Occupant 3	Occupant 4
Age/Sex:	7/Male	10/Male
Seated Position:	Second row, left	Third row, left
Seat Type:	Leather covered bucket seat.	Leather covered bench seat with folding back.
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	None	None
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	NA	NA
Driving Experience:	NA	NA
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used

OCCUPANT DEMOGRAPHICS - Lexus

	Driver	
Age/Sex:	18/Male	Unknown age/Male
Seated Position:	Front left	Front right
Seat Type:	Unknown	Unknown
Height:	175 cm (69 in)	Unknown
Weight:	68 kg (150 lbs)	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None noted	Unknown
Alcohol/Drug Involvement:	None	NA
Driving Experience:	Unknown	NA
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt used, per police report	Lap and shoulder belt used, per police report

OCCUPANT DEMOGRAPHICS - Chrysler Town and Country

	Driver
Age/Sex:	67/Male
Seated Position:	Front left
Seat Type:	Unknown
Height:	165 cm (65 in)
Weight:	77 kg (170 lbs)
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt used, per police report

OCCUPANT DEMOGRAPHICS - Pontiac Sunfire

	Driver
Age/Sex:	26/Male
Seated Position:	Front left
Seat Type:	Unknown
Height:	188 cm (74 in)
Weight:	129 kg (285 lbs)
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt used, per police report

OCCUPANT INJURIES -1996 Dodge Grand Caravan

Driver: Not injured.

Front right occupant: Injuries obtained from intensive care unit discharge report, rehabilitation unit discharge report, and various imaging reports.

Injury	OIC Code	Injury Mechanism	Confidence Level
Non hemorrhagic contusions of the posterior aspect of the left temporal lobe	140612.3,2	Air bag	Certain
Petechial hemorrhage of the left thalamus	140210.5,8	Air bag	Certain
Peritentorial and perifalcine ⁵ subdural hemorrhage	140629.4,	Air bag	Certain
Loss of consciousness with neurological deficits, including: muscle weakness, sensory loss, and seizures. Length of unconsciousness is not known.	160804.4,0	Air bag	Certain
Right ethmoid sinus fracture	250400.1,1	Air bag	Certain

There were no other parties injured.

⁵Falcine refers to the falx cerebri, a tissue division between the right and left hemispheres.

OCCUPANT KINEMATICS - 1996 Dodge Grand Caravan

Driver kinematics:

The 34-year-old driver of the Caravan was seated in a normal, upright fashion. At the time of the vehicle inspection the leather covered bucket seat was adjusted to the full rearward track position. The driver was wearing the available 3-point manual lap and shoulder belt. The shoulder belt anchorage adjustment was in the full down position. The driver was braking with her right foot. Her left foot was on the floor board. Both hands were on the steering wheel. This occupant pitched forward and likely began to load the shoulder harness as she braked. As the impact occurred, the driver's air bag deployed. There was a scuff to the center of the air bag that may have come from the driver, but the driver was not injured.

Front right seat occupant kinematics:

The 9-year-old male (152 cm/60 in, 39 kg/85 lbs) front right occupant of the Caravan was seated in a normal, upright fashion. At the time of the vehicle inspection the leather covered bucket seat was adjusted to the full rearward track position—28.0 cm (10.7 in) from the front of the seat bottom to the face of the instrument panel. The seat back was found to be at 73 degree angle from horizontal. The seat bottom was 10 degrees from horizontal. He was wearing the available 3-point manual lap and shoulder belt. The shoulder belt anchorage adjustment was in the full down position. Prior to impact, the driver began braking. This occupant pitched forward and likely began to load the shoulder harness. As the impact occurred, the front right passenger air bag deployed and this occupant contacted the front of the air bag with his face. It appears likely that the occupant contacted the air bag while it was still deploying—as evidenced by the 23.0 cm (9.0 in) long contact streak. This contact likely caused the brain injuries (temporal) and the soft tissue injuries to his face. He was likely forced back into the seat back but there was no indication of any contact to the seat back or any other structures behind this occupant. He was rendered unconscious and came to rest in this seat belt with his head/face leaning to the left (as evidenced by the blood drip pattern down the left side of the seat). It is not clear how this occupant was removed from the vehicle. At some point post-crash he was transported by helicopter to children's trauma center. He sustained a concussive head injury with loss of consciousness, a small left subdural hematoma, and a right ethmoid sinus fracture.



Figure 11. Overview of passenger air bag face

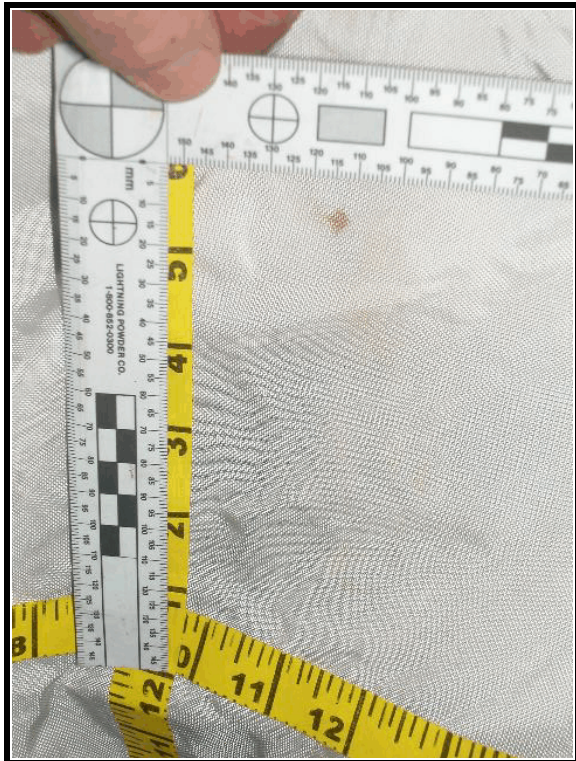


Figure 12. Skin contact to face of passenger air bag



Figure 13. Blood spill pattern to shoulder harness and left arm rest (front right seat)



Figure 14. Blood spill pattern down left side of front right seat

Second row left seat occupant kinematics:

The 7-year-old male second row left seat occupant was seated in a normal, upright fashion in the leather covered bucket seat. He was wearing the available 3-point manual lap and shoulder belt. The shoulder belt anchorage adjustment was in the full down position. Prior to impact, the driver began braking. This occupant pitched forward and likely began to load the shoulder harness. At impact, this occupant loaded the lap and shoulder belt. He was held in place by the belt system and did not sustain any injuries.

Third row left seat occupant kinematics:

The 4-year-old male third row left seat occupant was seated in a normal, upright fashion in the leather covered bench seat. He was wearing the available 3-point manual lap and shoulder belt. Prior to impact, the driver began braking. This occupant pitched forward and likely began to load the shoulder harness. At impact, this occupant loaded the lap and shoulder belt. He was held in place by the belt system and did not sustain any injuries.

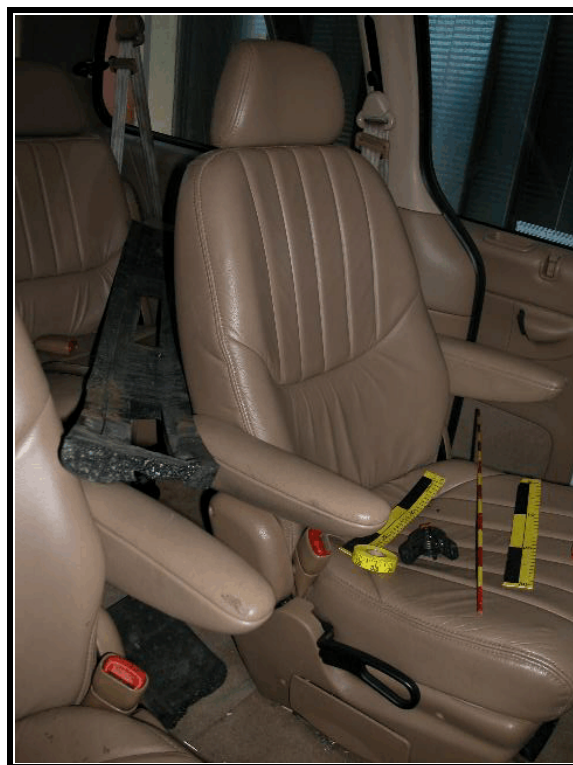


Figure 15. Second row left occupant seating position



Figure 16. Third row left seating position

Attachment 1. Scene Diagram

