

On-scene / Vehicle to Vehicle  
Dynamic Science, Inc. / Case Number: DS97028  
1998 Toyota RAV 4  
California  
December/1997

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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.*

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16. Abstract This collision occurred in Los Angeles, California in December 1997 at 1455 hours. The crash took place at the intersection of on an east/west oriented roadway. The roadway was dry and free of defects. The intersection was controlled by properly functioning tri-color traffic signals.  Vehicle 1, a 1998 Toyota RAV4 driven by a 19-year-old female (165 cm / 65 in., 61 kg / 135 lbs.), was traveling westbound approaching the intersection. There were three additional occupants in Vehicle 1. Vehicle 2, a 1995 Isuzu Rodeo driven by a 27-year-old female, was traveling eastbound approaching the intersection. As the vehicles neared the intersection, the driver of Vehicle 1 attempted to make a left hand turn to go south. The drivers of both vehicles braked prior to impact. Vehicle 1 left 6 M (20 ft.) of locked front wheel skids. Vehicle 2 left 11.5 M (38 ft.) of locked front and rear wheel skids. The front of Vehicle 1 struck the front of Vehicle 2. Both air bags in Vehicle 1 and Vehicle 2 deployed at this time.  The driver of Vehicle 1 sustained a right ankle sprain, and neck and back strain. The foot sprain occurred as a result of braking. The neck and back strain were due to impact forces. The right front occupant sustained "jammed" fingers to his right hand and an arm abrasion due to the deploying passenger side air bag. The left rear occupant complained of pain to his neck and right leg. The right rear occupant complained of pain to his right knee and left side of his face. All indicated that they would seek their own medical treatment. The driver of Vehicle 2 sustained lacerations to both legs and her lip. She indicated that she would also seek her own medical treatment. Both vehicles were towed from the scene.					
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**Dynamic Science, Inc.**  
**Accident Investigation**  
**Case Number: DS97028**

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**BACKGROUND:**

Description: This case was initiated in response to a report of de-powered air bag deployment in a 1998 Toyota RAV4.

Investigation Type: On-scene

Crash Location: California

Crash Date: December 1997

Notification Date: December 23, 1997

Field Work Completed: January 14, 1998

**SUMMARY:**

This collision occurred in Los Angeles, California in December 1997 at 1455 hours. The crash took place at the intersection of on an east/west oriented roadway. The roadway was dry and free of defects. The intersection was controlled by properly functioning tri-color traffic signals.

Vehicle 1, a 1998 Toyota RAV4 driven by a 19-year-old female (165 cm / 65 in., 61 kg / 135 lbs.), was traveling westbound

approaching the intersection. There were three additional occupants in Vehicle 1. Vehicle 2, a 1995 Isuzu Rodeo driven by a 27-year-old female, was traveling eastbound approaching the intersection. As the vehicles neared the intersection, the driver of Vehicle 1 attempted to make a left hand turn to go south. The drivers of both vehicles braked prior to impact. Vehicle 1 left 6 M (20 ft.) of locked front wheel skids. Vehicle 2 left 11.5 M (38 ft.) of locked front and rear wheel skids. The front of Vehicle 1 struck the front of Vehicle 2. Both air bags in Vehicle 1 and Vehicle 2 deployed at this time.

The driver of Vehicle 1 sustained a right ankle sprain, and neck and back strain. The foot sprain occurred as a result of braking. The neck and back strain were due to impact forces. The right front occupant sustained “jammed” fingers to his right hand and an arm abrasion due to the deploying passenger side air bag. The left rear occupant complained of pain to his neck and right leg. The right rear occupant complained of pain to his right knee and left side of his face. All indicated that they would seek their own medical treatment.

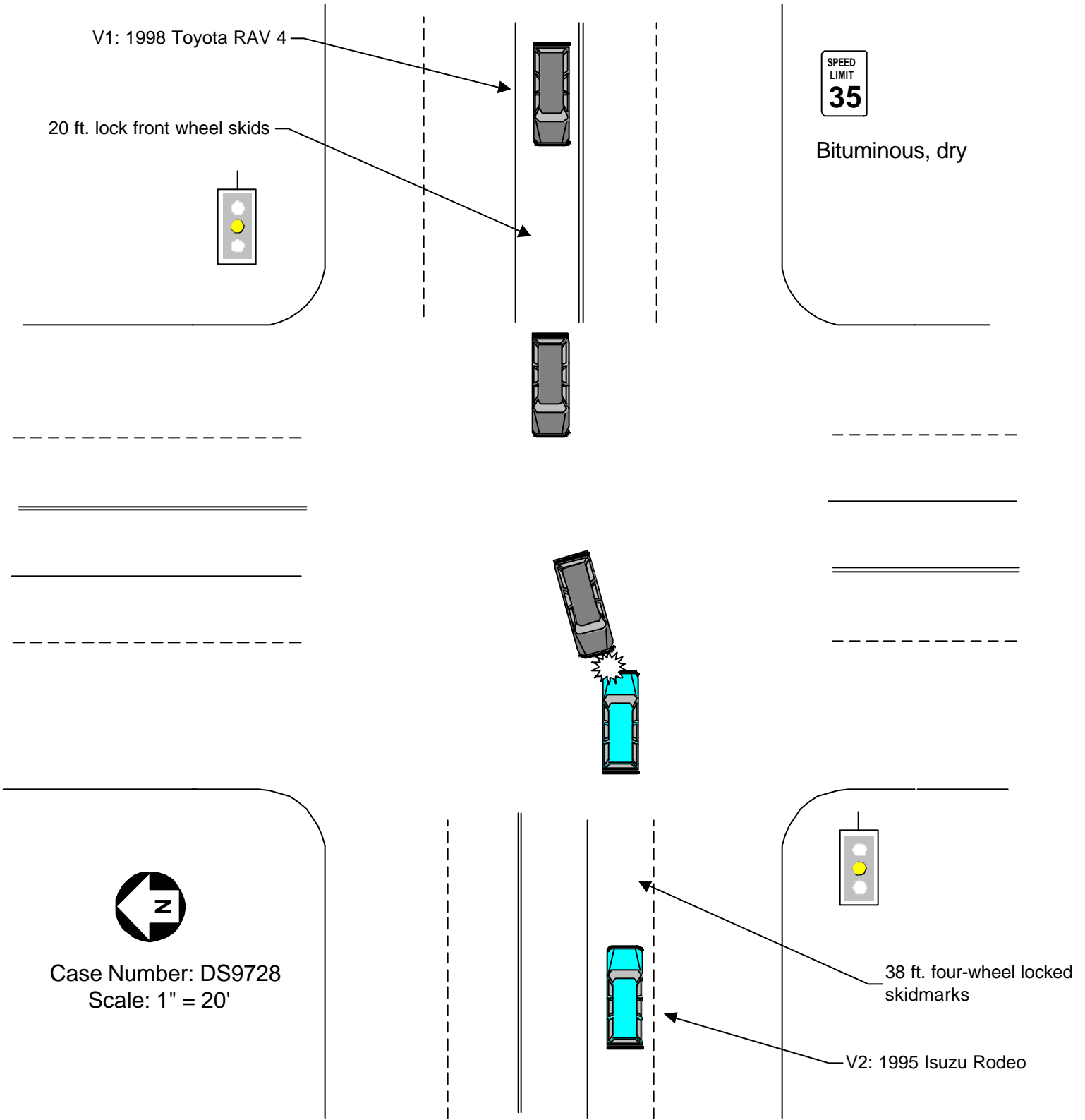


**Figure 1.** Exterior, Vehicle 1

The driver of Vehicle 2 sustained lacerations to both legs and her lip. She indicated that she would also seek her own medical treatment.

Both vehicles were towed from the scene.

Scene Diagram



**DETAILED INFORMATION****Vehicles**Vehicle 1

Description:	1998 Toyota RAV 4, four-door, 2 wheel drive	
VIN:	JT3GP10V8WXXXXXXX	
Odometer:	Unknown (Digital)	
Engine:	2.0 liter, 4 cyl.	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Moderate crush to front bumper and grille, left front tire was cut and the rim cracked, rear door buckled.	
CDC:	12FYEW2	
Minimum pre-braking travel speed, using slide to stop as one speed and the delta V as an impact speed: <sup>1</sup>	39.4 km/h (24.5)	
Delta V:	Total	21.6 km/h (13.4 MPH)
	Longitudinal	-21.3 km/h (-13.2 MPH)
	Lateral	-3.8 km/h (-2.3 MPH)
	Energy	39,589 joules (29,221 ft-lbs)

1

$$S = \sqrt{30 * D * f * n}$$

where D = skid distance, f = coefficient of friction, n = braking efficiency

$$D = 20 \text{ ft}, f = 0.7, n = 1.00$$

$$S = \sqrt{30 * 20 * 0.7 * 1.0}$$

$$S = 20.49 \text{ mph}$$

$$\text{Combined speed} = \sqrt{20.49^2 + 13.4^2} = 24.5 \text{ mph} = 39.4 \text{ km / h}$$



This vehicle is equipped with fabric-trimmed reclining front bucket seats and rear reclining/folding rear seats. The left front seat was positioned between middle and rear most track positions--10.5 cm (4 in.) from the rear most position. The driver's seat back was 39 cm (15.3 in.) from the maximum excursion. The driver's seat was adjusted to 10.5 cm from the rear most position.

The right front seat was positioned between the forward most and middle track position--11.5 cm (4.5 in.) from the rear most position. The vehicle was equipped with front shoulder belt pretensioners with force limiters, and adjustable front outboard shoulder belt anchors. Both shoulder belts were found in the locked position at the time of the inspection. The three spoke steering wheel was equipped with driver's side air bag. The driver's side air bag is 54 cm (21.2 in.) in diameter with a maximum excursion of 30 cm (11.8 in.). It has two tethers and two vents. There was a blue 20 x 10 cm (7.9 x 3.9 in.) fabric transfer found on this air bag.

The module cover is tri-seamed configuration. The passenger side air bag is 52 x 53 cm (20.5 x 20.8 in.). The seat was adjusted to 11.5 cm from the rear most position. It has one tether and two vents. There are four horizontal and two vertical folds. The module cover is rectangular, measuring 34 cm (13.4 in.) wide by 22 cm (8.6 in.) high.

There was a small amount of intrusion to the toe pan area. There was no integrity loss, but the rear door was buckled somewhat.



**Figure 3.** Exterior, Vehicle 1



**Figure 4.** Exemplar view of Vehicle 1

Vehicle 2

Description:	1995 Isuzu Rodeo	
VIN:	Unknown	
Odometer:	Unknown	
Engine:	Unknown	
Reported Defects:	None	
Cargo:	Unknown	
Damage Description:	Major front end damage according to traffic collision report	
CDC:	Unknown	
Minimum pre-braking travel speed: <sup>2</sup>	47.6 km/h (29.6 MPH)	
Delta V:	Total	14.5 km/h (9.0 MPH)
	Longitudinal	-14.4 km/h (-8.9 MPH)
	Lateral	-1.3 km/h (-0.8 MPH)
	Energy	28,699 joules (21,183 ft-lbs)

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2

$$S = \sqrt{30 * D * f * n}$$

where D = skid distance, f = coefficient of friction, n = braking efficiency

$$D = 38 \text{ ft}, f = 0.7, n = 1.00$$

$$S = \sqrt{30 * 38 * .7 * 1.0}$$

$$S = 28.25 \text{ mph} = 45.5 \text{ km / h}$$

$$\text{Combined speed} = \sqrt{28.25^2 + 9.0^2} = 29.6 \text{ mph} = 47.6 \text{ km / h}$$

**Occupants**

<u>Vehicle 1</u>	Driver	Occupant 2
Age/Sex:	19/Female	19/Male
Seated Position:	Left front	Right front
Seat Type:	Bucket	Bucket
Height:	165 cm (65 in.)	188 cm (74 in.)
Weight:	61 kg (135 lbs.)	88 kg (193 lbs.)
Occupation:	Student	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	NA
Driving Experience:	3 years	NA
Body Posture:	Upright, normal	Upright, normal
Hand Position:	Both hands on steering wheel, 10-2 o'clock positions	Arms were raised, palms facing outward toward front of vehicle.
Foot Position:	Right foot on brake, left on floorboard.	Both feet on floorboard.
Restraint Usage:	Lap and shouder belts used properly	Lap and shouder belts used properly
Air bag	Deployed	Deployed

**Occupants**

<u>Vehicle 1</u>	Occupant 3	Occupant 4
Age/Sex:	18/Male	18/Male
Seated Position:	Left rear	Right rear
Seat Type:	Split bench with folding back	Split bench with folding back
Height:	188 cm (74 in.)	183 cm (72 in.)
Weight:	98 kg (215 lbs.)	79 kg (175 lbs.)
Occupation:	Unknown	Unknown
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 shouder belts not used	Lap and shouder belts used properly

<u>Vehicle 2</u>	Occupant 1
Age/Sex:	27/Female
Seated Position:	Left front
Seat Type:	Unknown
Height:	157 cm (62 in.)
Weight:	49.9 kg (110 lbs.)
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	> 10 years
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Right presumed to be on brake
Restraint Usage:	Lap and shoulder belts used per police.
Air bag	Equipped with dual air bags, deployed

**Injuries and Injury Mechanisms**

## Vehicle 1

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Right foot/ankle sprain	850206.1,1	845.00	Brake pedal
	Cervical strain	640278.1,6	847.0	Impact forces
	Thoracic strain	640478.1,7	847.1	Impact forces
Right front:	Jammed right hand (sprain)	751420.1,1	842.10	Air bag
	Abrasion, right arm	790202.1,1	959.3	Air bag
Left rear:	Complained of pain to neck	Not codeable		
	Complained of pain to right leg	Not codeable		
Right rear:	Complained of pain to right knee	Not codeable		
	Complained of pain to left side of face	Not codeable		

## Vehicle 2

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Leg laceration, left	890600.1,1	916.8	Instrument panel (left)
	Leg laceration, right	890600.1,2	916.8	Instrument panel (left)
	Lip laceration	290600.1,8	873.43	Air bag

## Occupant Kinematics (Vehicle 1)

The 19-year-old female driver (165 cm /65 in., 61 kg /135 lbs.) was seated in a bucket seat. She was wearing the lap and shoulder belt. The shoulder belt was equipped with a pretensioner, and was adjusted to the full up position. The seat was positioned 10.5 cm from the rear most position. This occupant was aware of the pending collision and she stepped on the brake with her right foot. The pre-impact braking allowed this occupant to move closer to the steering wheel. At impact, the air bag deployed and engaged this occupant. The driver's foot slipped off the brake and deformed the accelerator pedal. There were no injuries due to the air bag deployment. The driver sustained an ankle sprain due to the braking action. The neck and upper back strain were attributed to the driver's forward motion by the driver.

The 18-year-old male right front occupant (188 cm /74 in., 88 kg /193 lbs.) was seated in a bucket seat. He was wearing the lap and shoulder belt. The shoulder belt was equipped with a pretensioner, and was adjusted to the full up position. The seat was positioned 11.5 cm from the rear most position. This occupant was aware of the pending collision. He raised his arms with the palms facing outward toward the front of the vehicle. At impact, the passenger side air bag deployed. The deploying air bag struck the passenger's right hand and arm, spraining the hand and abrading the arm.

The 18-year-old male left rear occupant (188 cm/74 in., 98 kg/215 lbs.) was seated in a split bench seat with a folding back. He was not wearing the lap and shoulder belt. The 18-year-old male right rear occupant (183 cm/72 in., 79 kg/175 lbs.) was seated in a split bench seat with a folding back. He was wearing the lap and shoulder belt. At impact, both occupants went forward and to the right. Both likely impacted the rears of the front seats given their size relative to the available space, but there were no injuries recorded. Both rear seats were deformed likely due to loading and rebounding.

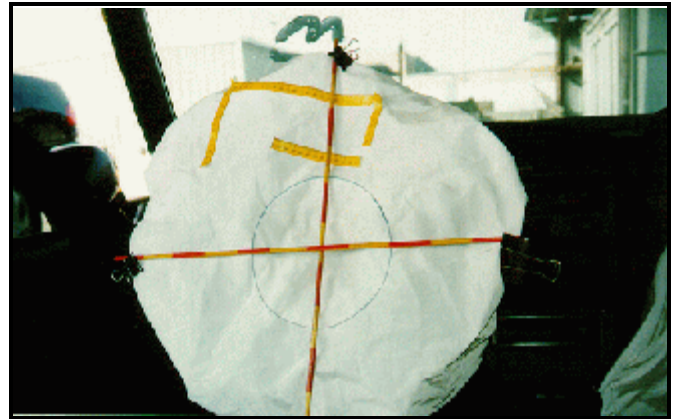


Figure 6. Driver's side air bag



Figure 5. Exemplar steering wheel showing intact module cover

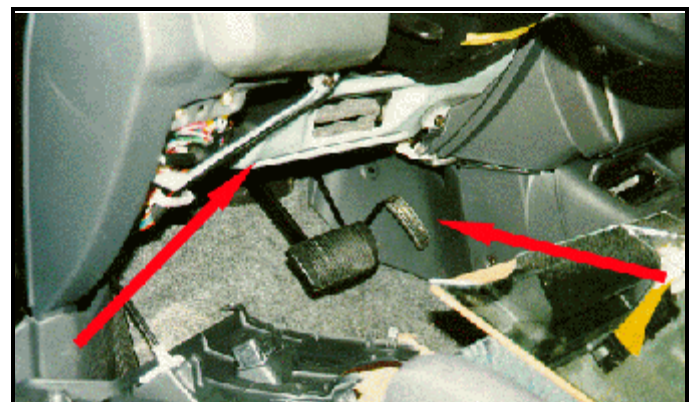


Figure 7. Damaged lower IP, shifted accelerator

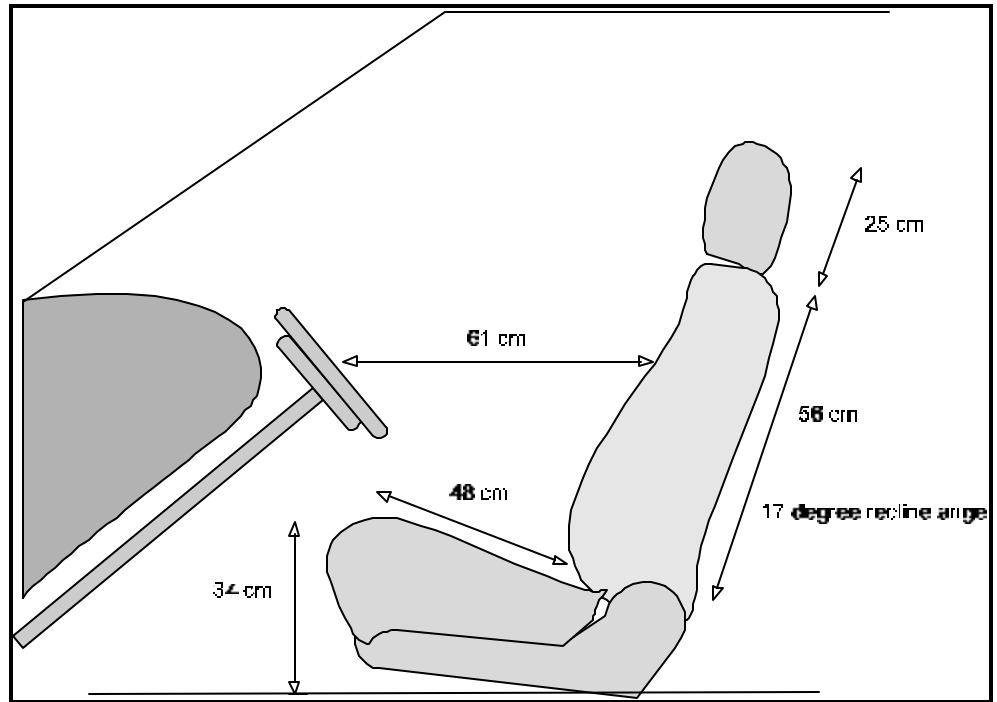


Figure 8. Driver's seat



Figure 9. Passenger side air bag



## Photo Index

Photo No.	Vehicle No.	Direction of Picture	Subject Matter
DS97028-1 - DS97028-3	1	West	Approach to area of impact.
DS97028-4	1	West	Area of impact.
DS97028-5 - DS97028-8	2	East	Approach to area of impact.
DS97028-9 - DS97028-11	2	East	Area of impact.
DS97028-12 - DS97028-45	1	CCW	Exterior of vehicle.  DS97028-25 shows removed left front fender. DS97028-28 - 30 show buckled rear hatch.
DS97028-46 - DS97028-117	1	NA	Interior of vehicle.  DS97028-51 shows deformed lower instrument panel. DS97028-55 shows deformed accelerator pedal. DS97028-67 - 71 shows fabric transfer on driver air bag. DS97028-89 shows fingerprint smudge on module cover. DS97028-114 - 117 shows deformed rear seat.