On-site Child Seat Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS02002
1996 Honda Accord LX four-door
California
July, 2001

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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 crash occurred in California in July, 2001 at 1641 hours. The crash took place on a four-lane divided county road. The weather was clear and there were no roadway defects indicated. The concrete roadway was dry. The posted speed limit is 105 km/h (65 mph).

The case vehicle, a 1996 Honda Accord driven by a restrained 30-year-old female, was traveling eastbound at a driver estimated speed of between 105 km/h (65 mph) and 113 km/h (70 mph). The rear left fabric covered bench seat was occupied by a 5-year-old male who was seated in a forward facing convertible child safety seat with tray shield. The rear right fabric covered bench seat was occupied by a 2-year-old female who was seated in a forward facing Century Encore convertible child safety seat with an overhead shield. The other vehicle was a 1993 Ford L8000 dump truck driven by a 39-year-old male. This vehicle was traveling westbound.

The case vehicle was traveling in the first lane. A non-contact vehicle (a 1992 Mazda sedan driven by a 43-year-old female) was traveling eastbound in front of and to the left of the case vehicle. The non-contact vehicle began to change lanes to the right. The driver of the case vehicle steered to the right. As the vehicle left the roadway, the driver steered back to the left and lost control of the vehicle. The vehicle crossed both eastbound lanes and went through the oleander bushes on the median. At this point the vehicle entered the westbound travel lanes and into the travel path of the Ford dump truck. The driver of the Ford braked but could not stop in time. The front of the Ford struck the right side of the case vehicle. At impact, both frontal air bags deployed. The case vehicle was pushed sharply into a clockwise rotation and there was a side slap type impact between the front right of the case vehicle and the front right (including the front right tire) of the other vehicle. The case vehicle continued rotation after this impact as it began traveling westbound and down the embankment. The case vehicle tripped and began a left side leading longitudinal rollover. The vehicle rolled six quarter turns. Between the third and fourth quarter turns, the right rear seat child and child seat were ejected through the right rear door area. The case vehicle came to rest on its roof facing north. The driver of the case vehicle sustained minor injuries of an unknown nature. Both rear seat child occupants were fatally injured.

17. Key Words	18. Distribution Statement
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Dynamic Science, Inc.
Accident Investigation
Case Number: DS02002

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BACKGROUND:

Description: This Child Safety Seat fatality case was developed initially through a newspaper article describing the crash. DSI was requested to obtain the police report on the case. The police report was obtained and forwarded to the NHTSA. The crash was discussed with the NHTSA on February 14, 2002. DSI was assigned the case on February 15, 2002. The case vehicle was placed on a police hold for nearly one year until it was determined that no charges would be filed. During this period DSI obtained the police and medical reports. On August 1, 2002, the case vehicle was inspected at one location, while the seatbelts and child safety seats were inspected at another. Various police officers were present during portions of the various inspections.

Investigation Type:	On-site
Crash Location:	California
Crash Date:	July, 2001
Notification Date:	February 15, 2002
Field Work Completed:	August 1, 2002

SUMMARY:

This crash occurred in California in July, 2001 at 1641 hours. The crash took place on a four-lane divided state route. There are two eastbound lanes and two westbound lanes. There is a slight left hand curve for westbound travel and a slight right hand curve for eastbound travel. The roadways are of concrete construction with asphalt shoulders. The roadways are separated by a dirt median with oleander bushes in the middle of the median. The weather was clear and there were no roadway defects indicated. The concrete roadway was dry. The posted speed limit is 105 km/h (65 mph).

Figure 1. Travel path of case vehicle prior to departure through median in the left of the photo

The case vehicle, a 1996 Honda Accord driven by a restrained 30-year-old female, was traveling eastbound at a driver estimated speed of between 105 km/h (65 mph) and 113 km/h (70 mph).

The rear left fabric covered bench seat was occupied by a 5-year-old (23 kg/50 lbs) male who was seated in a forward facing Evenflo Ultara convertible child safety seat with tray shield (Model No.: 235115P2, Manufacture date: 3-10-1997). The maximum weight for the forward facing position is 18 kg (40 lbs). The seat was attached to the vehicle using the rear left lap and shoulder belt. The belt is a type 2 continuous loop belt. This seat belt had a switchable retractor[1]. According to police investigators, the retractor had been switched and it was found in the locked ALR mode. The child seat harness was positioned through the top most set of slots. The chest clip was present but its position is not known. No tethers were used.

Figure 2. Path of case vehicle as it emerges from median and into path of the other vehicle.

Figure 3. Configuration of child seats–Evenflo (left rear), Century (right rear).

[1]A switchable retractor is a vehicle belt retractor that can be changed from an emergency-locking retractor (ELR) to an automatic-locking retractor (ALR) for tight installation of a child restraint. This is usually accomplished by pulling the belt all the way out to the end, at which point the retractor mechanism changes modes. In ALR mode the belt can be pulled out initially but locks when the pull-out action stops and tension is again applied. The retractor keeps the belt from being pulled out farther until it is fully retracted again. In ELR mode the retractor locks when the vehicle stops suddenly, including sudden braking. Some have an additional back-up feature that locks when the belt webbing is rapidly pulled out. After the tension is released, the belt can again be pulled out gradually.

The rear right fabric covered bench seat was occupied by a 2-year-old female (89 cm/35 in, 12 kg/26 lbs) who was seated in a forward facing Century Encore convertible child safety seat with an overhead shield (Model No.: 4662WSC01, Manufacture date: 3-18-2000). The maximum weight for the forward facing position is 18 kg (40 lbs). The child seat harness was positioned through the middle set of slots. An adjustable chest clip was present but its position is not known. A locking clip was installed on the vehicle seat belt webbing approximately 10-20 cm (4-8 in) from the buckle. No tethers were used. It is not known if the switchable retractor was in the ELR or ALR mode.

Figure 5. Final rest, case vehicle.

The other vehicle was a 1993 Ford L8000 dump truck driven by a 39-year-old male. This vehicle was traveling westbound.

Figure 6. Right side, case vehicle.

The case vehicle was traveling in the first lane. A non-contact vehicle (a 1992 Mazda sedan driven by a 43-year-old female) was traveling eastbound in front of and to the left of the case vehicle. The non-contact vehicle began to change lanes to the right. The driver of the case vehicle steered to the right. As the vehicle left the roadway, the driver steered back to the left and lost control of the vehicle. The vehicle crossed both eastbound lanes and went through the oleander bushes on the median. At this point the vehicle entered the westbound travel lanes and into the travel path of the Ford dump truck. The driver of the Ford braked but could not stop in time. The front of the Ford struck the

Figure 4. Front, other vehicle.

right side of the case vehicle (03RZAW4). The case vehicle underwent a velocity change in excess of 89 km/h (55 mph). At impact, both frontal air bags deployed. The case vehicle was pushed sharply into a clockwise rotation and there was a side slap type impact between the front right of the case vehicle (03RFEW2) and the front right (including the front right tire) of the other vehicle. The case vehicle continued rotation after this impact as it began traveling westbound and down the embankment.

Figure 7. Reported final rest position of right rear child seat.

The case vehicle tripped and began a left side leading longitudinal rollover. The vehicle rolled six quarter turns. Between the third and fourth quarter turns, the right rear child and child seat were ejected through the right rear door area. The case vehicle came to rest on its roof facing north.

The other vehicle rotated 180 degrees and came to rest facing east on the north shoulder of the westbound roadway.

The driver of the Mazda fled the scene but was later found.

Figure 8. Final position of left rear child seat.

The driver of the case vehicle sustained minor injuries of an unknown nature.

The 5-year-old male left rear occupant was fatally injured. The paramedics noted that he had some agonal respirations but no response to tactile stimulation. He was transported to a local hospital by ground ambulance. At the emergency room, his pupils were fixed and unresponsive. There were no spontaneous respirations and no discernible neurologic activity. He was then transported to a second hospital by air. A CT scan revealed edema, obliteration of cisterns, and subarachnoid hemorrhage. From this hospital he was moved to a third hospital with a pediatrics intensive care unit. He was kept on life support until being pronounced dead at 1245 hours the following day. The cause of death was declared to be craniocerebral trauma due to blunt impact. An invasive autopsy was not performed.
The 2-year-old female right rear occupant was fatally injured. She sustained numerous serious injuries, including: skull fractures, brain contusions, cerebral edema, right rib fractures, right lung contusions, a splenar laceration, and a kidney laceration. She also sustained numerous abrasions and contusions.

Scene Diagram

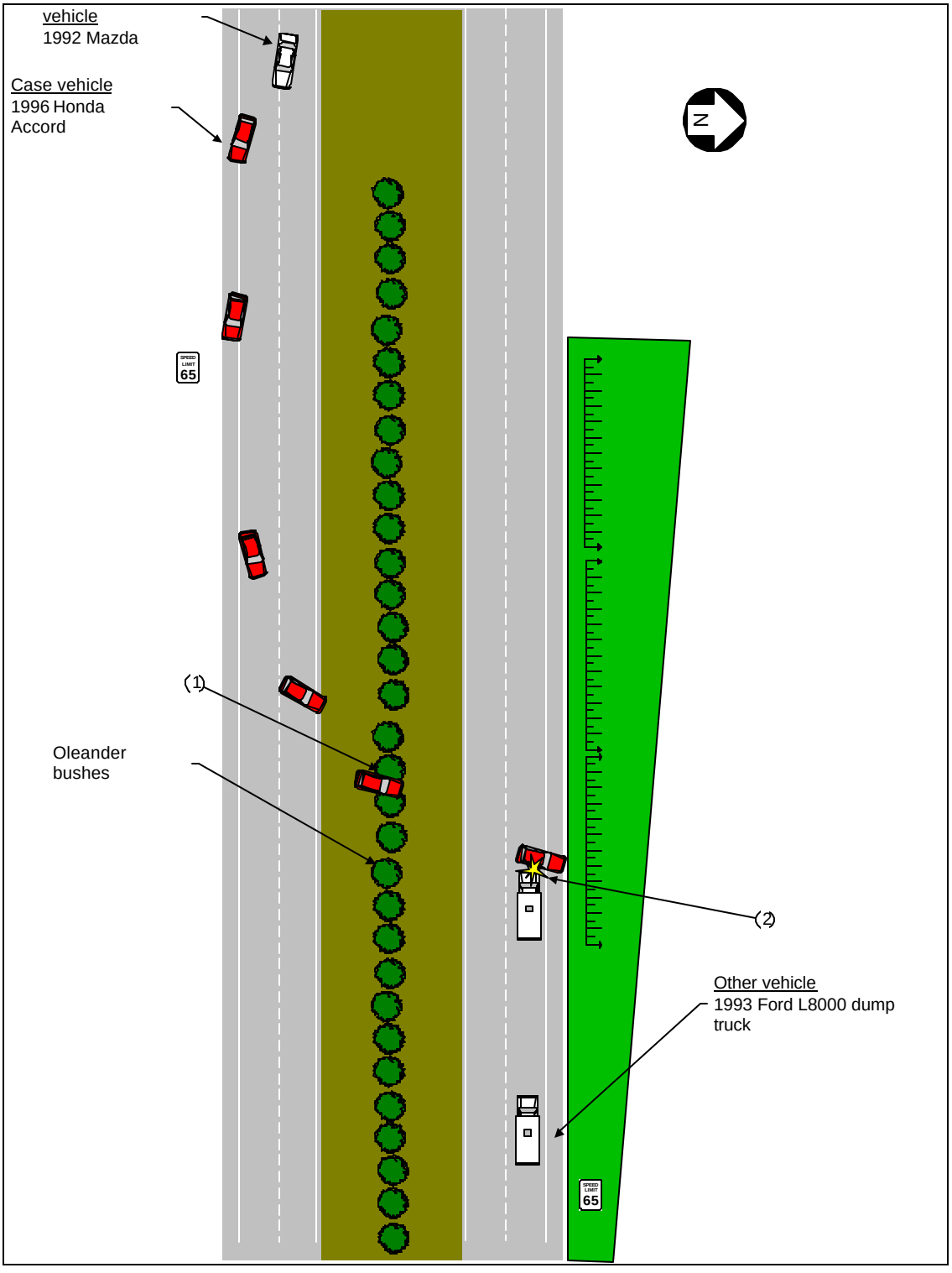

Figure 9. Scene diagram (1 of 2)

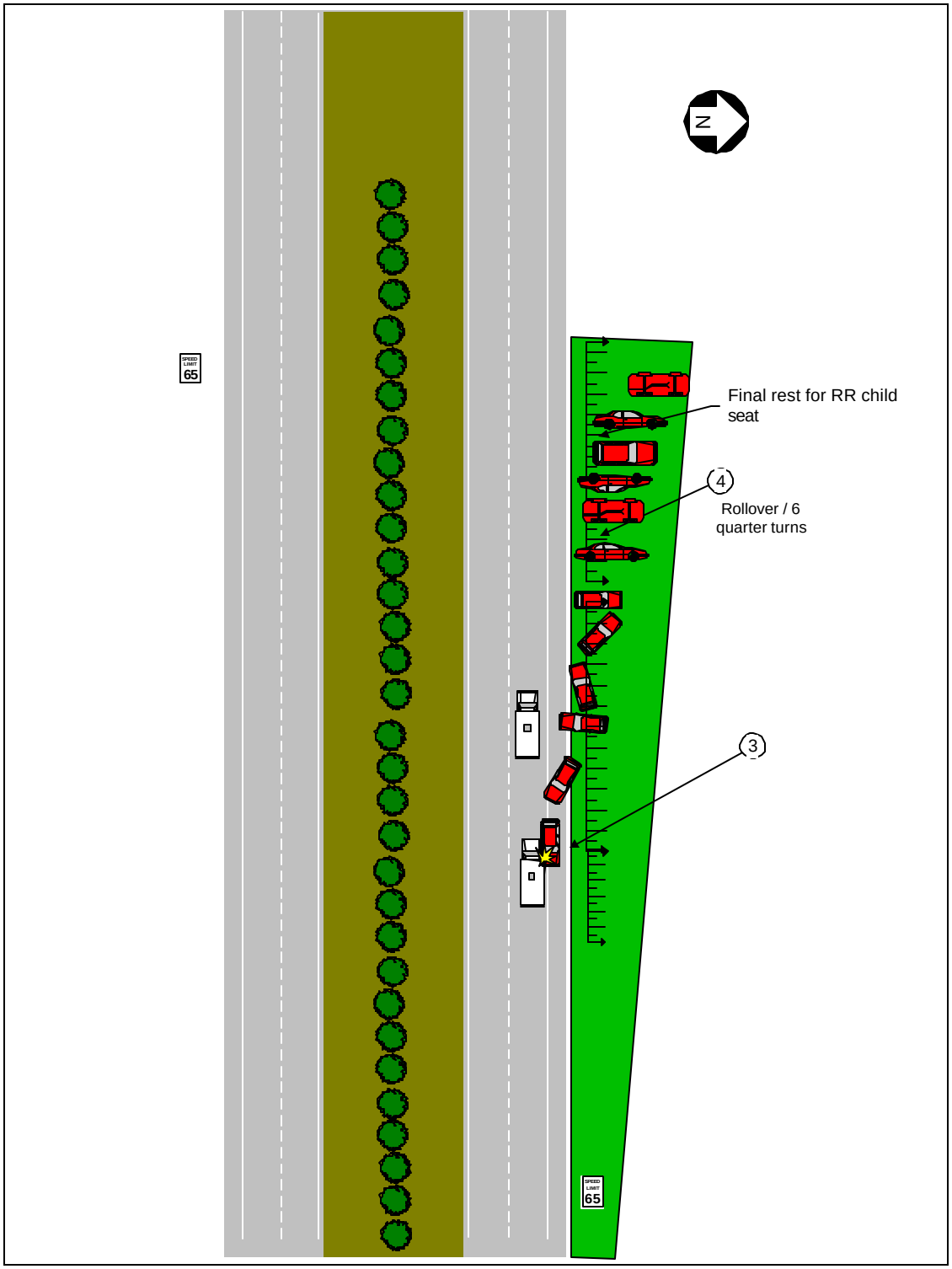

Figure 10. Scene diagram (2 of 2)

DETAILED INFORMATION

Vehicles

Case vehicle

Description:	1996 Honda Accord LX four-door	
VIN:	1HGCD5631TAXXXXXX	
Odometer:	211,866 km (131,651 miles)	
Engine:	Unknown	
Reported Defects:	None	
Cargo:	Carriage, child seats	
Damage Description:	Major right side lateral crush. Intrusion through right side plane. Vehicle declared a total loss.	
CDC:	Impact 1: Unknown Impact 2: 03RZAW4 Impact 3: 03RFEW2 Impact 4: 00TDDO3	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

Other vehicle

Description:	1993 Ford L8000 dump truck, 26,000-33,000 lbs GVWR	
VIN:	1FDXR82E1PVAxxxxxx	
Odometer:	Unknown	
Engine:	8.3 L, I6 diesel	
Reported Defects:	Brake on left front out of adjustment.	
Cargo:	None. Dump body empty.	
Damage Description:	Minor contact damage to front bumper and grille.	
TDC:	Impact 2: 12FZEW1 Impact 3: 03RFEW1	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

Occupants

Case vehicle	Occupant 1	Occupant 2	Occupant 3
Age/Sex:	30/Female	5/Male	2/Female
Seated Position:	Front left	Rear left	Rear right
Seat Type:	Fabric covered bucket. Seat adjusted to rear most track position	Fabric covered bench with folding back	Fabric covered bench with folding back
Height:	163 cm (64 in)	Unknown	89 cm (35 in)
Weight:	64 kg (140 lbs)	23 kg (50 lbs)	12 kg (26 lbs)
Occupation:	Unknown	NA	NA
Pre-existing Medical Condition:	None noted	None	None
Alcohol/Drug Involvement:	None	NA	NA
Driving Experience:	Presumed to be greater than 10 years	NA	NA
Body Posture:	Unknown	Normal, upright in CSS	Normal, upright in CSS
Hand Position:	Steering left	NA	NA
Foot Position:	Left on floor, right presumed to be on brake	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt used	Evenflo Ultara convertible child safety seat with tray shield. Lap and shoulder belt used.	Century Encore convertible child seat with tray shield. Lap and shoulder belt used. Locking clip used.
Air bag:	Air bag available, deployed	None	None

Other vehicle

Age/Sex:	39/Male
Seated Position:	Front left
Seat Type:	Bucket
Height:	180 cm (71 in)
Weight:	88 kg (195 lbs)
Occupation:	Truck driver
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown, presumed to be greater than 10 years
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Right foot on brake, left possibly on clutch
Restraint Usage:	Lap and shoulder belt used, per police

Injuries and Injury Mechanisms

Case vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Minor, unknown injuries			
LR Occupant:	Marked edema, obliteration of cisterns	140666.5,9	Unk	CSS
	Subarachnoid hemorrhage	140466.3,6	852.06	CSS
	No brain activity	Not codeable	NA	NA
	Lacerations, forehead	290600.1,7	873.42	Unknown
	Laceration, right ear lobe	290600.1,1	872.00	CSS
	Bilateral abrasions, forearms	790202.1,1 790202.1,2	913.0 913.0	Unknown
	Contusion, left shoulder	790402.1,2	923.0	Inside, left CSS
	Contusion, upper right arm	790402.1,1	923,03	CSS
	Swelling over orbits and frontal region, face swollen	215099.7,0	920.0	Unknown
RR Occupant	Depressed comminuted right skull fracture–centered in the right temporal region, just above the zygomatic process	150404.3,1	801.2	CSS, related to heavy intrusion from right side of vehicle
	Non-displaced basilar skull fracture	150200.3,8	801.2	CSS
	Contusion (2 in), left temporalis muscle	190402.1,2	920.0	Unknown
	Subdural hemorrhage	140650.4,9	800.2	CSS

Right inferior frontal cortical contusions, involving the crests of the gyri	140612.3,1	800.1	CSS
Acute cerebral edema	140660.3,9	348.5	CSS
Multiple posterior right rib fractures (2-9) with right hemothorax	450232.4,1	807.17	CSS
Posterior contusions, right lung	441406.3,1	861.21	CSS
Contusions, thymus gland	442299.7,4	NA	Unknown
Spleen laceration (1 x ½ in)	544220.2,2	865.00	Unknown
Large laceration of right kidney with extensive retroperitoneal hemorrhage (100 cc)	541626.4,1	865.02	CSS, related to heavy intrusion from right side of vehicle
Lacerations/abrasions, middle of forehead	290600.1,7 290202.1,7	873.43 910.0	Unknown Unknown
Laceration, bridge of nose	290600.1,4	873.30	Unknown
Laceration, near left eye	290600.1,2	873.40	Unknown
Contusion, right lower eyelid	290402.1,1	921.1	Unknown
Abrasion, right cheek (2 x 1 in)	290202.1,1	910.0	CSS
Contusions, right upper chest	490402.1,1	922.1	CSS
Contusion, right upper abdomen	590402.1,1	922.2	CSS
Contusion, anterior right shoulder	790402.1,1	923.0	CSS
Linear abrasions, medial aspect of left thigh. Three parallel abrasions.	890202.1,2	916.0	CSS tray shield
Abrasions, medial aspect of right thigh	890202.1,1	916.0	CSS tray shield
Abrasion, right knee	890202.1,1	916.0	Unknown

	Abrasions (3), anterior right ankle	890202.1,1	916.0	Unknown
	Laceration, below patella	890600.1,9	890.0	Unknown
	Abrasion, lateral aspect, left hip	590202.1,2	916.0	CSS harness
	Abrasion, left lower leg	890202,1,2	916.0	Unknown

Other vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	No reported injuries			

Occupant Kinematics

The 30-year-old female driver of the case vehicle was seated in an upright manner. She was using the available type 2 continuous loop lap and shoulder belt. The driver was steering to the right and braking as the vehicle passed through the oleander bushes. There was little kinematic response to this minimal contact. The case vehicle was then struck by the truck. At impact, the driver responded to the 3 o'clock direction of force by moving sharply to the right. She was held in place by the lap and shoulder belt. The driver's air bag likely deployed during the initial vehicle to vehicle impact. The driver likely contacted the air bag to some degree but there were no indications of contact on the air bag. There was a second impact between the two vehicles as the case vehicle rotated sharply in a clockwise direction. The driver likely rebounded after the first impact and then again moved to the right in response to the second impact. The case vehicle tripped and began a left side leading longitudinal rollover. The vehicle rolled six quarter turns. The driver was likely pitched in all directions during the rollover sequence but did remain within the confines of the seat belt. She sustained minor injuries of an unknown nature.

Figure 11. Left rear child seat (Evenflo).

The rear left fabric covered bench seat was occupied by a 5-year-old (23 kg/50 lbs) male who was seated in a forward facing Evenflo Ultara convertible child safety seat with tray shield. The maximum weight for the forward facing position is 18 kg (40 lbs). The seat was attached to the vehicle using the second seat rear left lap and shoulder belt. The belt is a type 2 continuous loop belt. This seat belt had a switchable ALR/ELR retractor. According to police investigators, the retractor had been switched to ALR mode and it was found in the locked ALR postion. The child seat harness was positioned through the top most set of slots. The chest clip was present but its position is not known. No tethers were used. At impact, this occupant responded to the 3 o'clock direction of force by moving sharply to the right. As the right side of the vehicle was penetrated by the other vehicle, the right side surface pushed the right side child seat laterally and the two child seats engaged one another. The head injuries sustained by this occupant likely came about as a result of contact to the inner shell of his seat and the outer shell of the other child seat. As the intrusion continued, the base of this seat was compressed and pushed laterally–forcing the bottom to the left and the top to the right. Eventually, the seat was forced over onto its right side.

The rear right fabric covered bench seat was occupied by a 2-year-old female (89 cm/35 in, 12 kg/26 lbs) who was seated in a forward facing Century Encore convertible child safety seat with an overhead shield. The maximum weight for the forward facing position is 18 kg (40 lbs). The child seat harness was positioned through the middle set of slots. An adjustable chest clip was present but its position is not known. The belt is a type 2 continuous loop belt. A locking

clip was installed on the vehicle seat belt webbing approximately 10-20 cm (4-8 in) from the buckle. No tethers were used. It is not known if the switchable retractor was in the ELR or ALR mode. At impact, this occupant responded to the 3 o'clock direction of force by moving sharply to the right. As the right side of the vehicle was penetrated by the other vehicle, the right inside portion of the child seat shell was fractured and likely contacted the head of this occupant. The child's entire right side also engaged the right inside portion of the shell. As the two seats came into contact with one another the seat belt buckle was contacted and the seat belt released. As the vehicle rolled, the child seat was ejected from the vehicle and came to rest near the left rear of the vehicle.

Figure 12. Right side of Century child seat showing shell fracture.

Ejection discussion:

Both child seats had been placed in the vehicle and were attached to the vehicle using the available lap and shoulder belts. At impact, both child seats would have initially moved to the right. This movement was almost immediately negated by the massive intrusion through the right side. The right child seat (Century) was essentially driven into the side of the left child seat (Evenflo)–particularly the base of the seat. This internal impact caused fractures to the facing side of the child seat shells. It appears that some portion of the left child seat struck the vehicle buckle release on the seat belt securing the right child seat. The buckle came open as the vehicles separated and restitution began. As the case vehicle rolled, the right side child seat was ejected from the vehicle.

Figure 13. Reported final rest position of right rear child seat.

The left rear child seat remained in the vehicle. It was found lying on its right side with the seatbelt still latched and locked in ALR mode. Once the seatbelt is locked, the available length of the belt would remain fixed. As the right side of the vehicle (and the right side child seat), moved into the base of this child seat it was being compressed. The base is essentially a hollow object. As pressure was brought to bear, the base of this seat was compressed–allowing some rotational movement. The seat was pushed laterally–forcing the bottom to the left and the top to the right. Eventually, the seat was forced over onto is right side.

Figure 14. Final position of left rear child seat.

Figure 15. Right side, left rear child seat (Evenflo).

Figure 16. Left side, right rear child seat (Century).

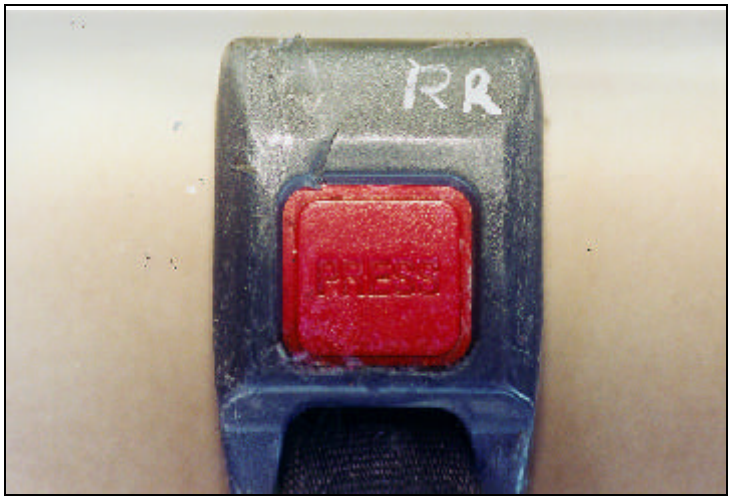

Figure 17. Indication that right rear seat belt latch button had been contacted by external object.

Seat belt/locking clip damage discussion

Both the right rear lap and shoulder belt and child safety seat locking clip were damaged during the crash. The damage to the seat belt was due to both lateral loading as the truck penetrated the passenger compartment and a tearing action from sharp metal surrounding the door. The seat belt was not severed. The damage to the clip was due to loading against the child seat shell as the seat was forced sideways. It is not known why the locking clip was being used since the seat belt at this seat position is equipped with a switchable retractor.

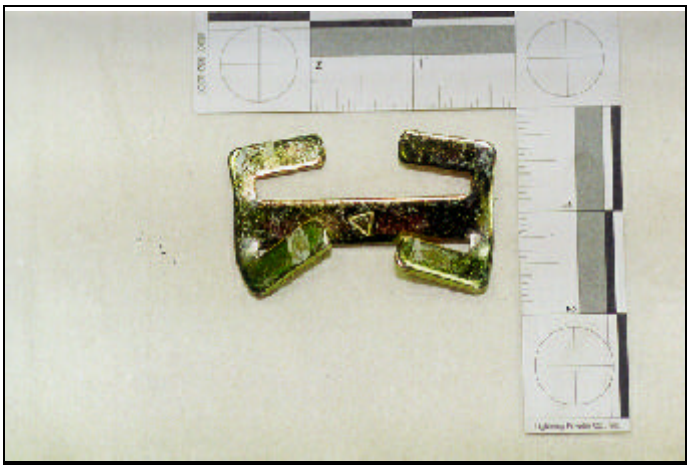

Figure 18. Deformed locking clip for right side child seat.

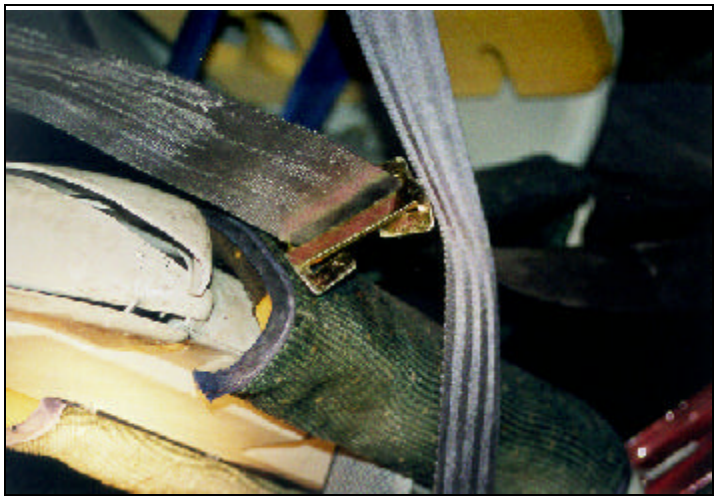

Figure 19. Locking clip attached to seat belt.

Figure 20. Tearing damage from torn metal.

Figure 21. Locking clip damage.