

On-site Child Safety Seat Investigation / Single vehicle rollover
Dynamic Science, Inc. / Case Number: DS02031
1993 GMC Sierra extended cab pickup
Colorado
November, 2002

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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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16. Abstract This crash occurred in a rural area of Colorado at 2010 hours. The area of the crash was dark. The crash occurred on a level, two lane county road. The straight asphalt roadway was dry. The posted speed limit is 89 km/h (55 mph). The case vehicle is a 1993 GMC Sierra 1500 four-wheel pick-up driven by a restrained 28-year-old female. There were three of her children also in the vehicle in the bench rear seat. The rear left seat was occupied by a 4-year-old female who was seated in a forward facing child safety seat with a 5-point harness. The rear middle seat was occupied by an 18-month-old female who was seated in a forward facing child safety seat with a 5-point harness. The right rear seat was occupied by a lap and shoulder restrained 7-year-old male. The case vehicle was traveling northbound at a police reported speed of 105 km/h (65 mph). The driver of the case vehicle received a call on her cell phone. The phone was passed to one of the children. As the phone was being passed back to the driver, she unbuckled her seat belt to reach for it. Apparently she was distracted by this action. The case vehicle traveled off the right side of the roadway. The driver steered left and returned to the roadway. The vehicle continued into the opposing travel lane. The driver steered right and traveled off the right side of the roadway. The driver steered again to the left, but the two right side tires tripped and the vehicle began a right side leading rollover about the longitudinal axis. The driver of the case vehicle was ejected from the vehicle through the driver's window. The remaining three occupants remained in the vehicle and sustained only minor injuries. The 7-year-old occupant checked on the condition of the other children, then exited the vehicle through a window and located his mother. When he found her to be unconscious, he went back to the vehicle told the older of the two sisters that he was going for help. The 7-year-old left the scene of the crash and walked approximately 0.8 km (0.5 mile) toward the light of a dairy farm to get help. Workers at the dairy contacted authorities and reported that there had been a crash. The case vehicle was towed from the scene due to damage and later declared a total loss.					
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Accident Investigation
Case Number: DS02031

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BACKGROUND:

Description: This child safety seat case was generated in response to a newspaper article on the crash dated December 1, 2002. DSI was assigned the case on December 3, 2002. This single vehicle crash was investigated on-scene. The case vehicle and scene were inspected on January 17, 2003. An in-person interview of the driver was conducted on that same date.

Investigation Type: On-scene
 Crash Location: Colorado
 Crash Date: November, 2002
 Notification Date: December 3, 2002
 Field Work Completed: January 17, 2003

SUMMARY:

This crash occurred in a rural area of Colorado at 2010 hours. The area of the crash was dark and the temperature was -5 degrees C (23 degrees F). The crash occurred on a level, two lane county road. The straight asphalt roadway was dry and level. There is a broad grass/weed covered ditch on the east side of the roadway that descends at a 14 degree angle for 3.1 m (10.2 ft) and then rises at a 21 degree angle for 2.5 m (8.2 ft). The posted speed limit is 89 km/h (55 mph).

The case vehicle is a 1993 GMC Sierra 1500 four-wheel drive pick-up driven by a restrained 28-year-old female (155 cm/61 in, 52 kg/115 lbs). The driver was seated in a fabric covered bucket seat. The seat had been adjusted to the middle track position. There were three of her children also in the vehicle in the rear bench seat.



Figure 1. Approach to area of rollover, facing north

The rear left seat was occupied by a 4-year-old female (84 cm/33 in, 16 kg/36 lbs) who was seated in a forward facing child safety seat with a 5-point harness. The rear middle seat was occupied by an 18-month-old female (51 cm/20 in, 8 kg/18 lbs) who was seated in a forward facing child safety seat with a 5-point harness. The right rear seat was occupied by a lap and shoulder restrained 7-year-old male (104 cm/41 in, 18 kg/40 lbs). The driver placed the 4-year-old and the 18-month old into their respective seats and engaged the restraints. The 7-year-old got into the seat on his own and put on his own restraint.

The case vehicle was traveling northbound at a police reported speed of 105 km/h (65 mph).

The driver of the case vehicle received a call on her cell phone. The phone was passed to one of the children. As the phone was being passed back to the driver, she unbuckled her seat belt to reach for it. Apparently she was distracted by this action.

The case vehicle traveled off the right side of the roadway. The driver steered left and returned to the roadway. The vehicle continued into the opposing travel lane. The driver steered right and traveled off the right side of the roadway. The driver steered again to the left, but the two right side tires tripped and the vehicle began a right side leading rollover about the longitudinal axis (00TDDO2). Police report that the vehicle rolled two complete turns before coming to rest on its wheels facing west.



Figure 2. Area of rollover



Figure 3. Front left, case vehicle

The case vehicle sustained major damage to the roof and left side. There was intrusion to the roof, left A pillar, and left roof rail. Both left side windows disintegrated. The driver's door was bowed outward due to occupant loading.

The driver of the case vehicle was ejected from the vehicle through the driver's window. She engaged the left side door panel and bowed it outward as she was ejected. She sustained serious injuries that included: a concussion (with loss of consciousness), a left collar bone fracture, 10 left side rib fractures, a punctured left lung, and fractures to the thoracic spine (@ T3, T11, and T12). She was hospitalized for an unknown length of time. At the time of the interview, she was out of the hospital and was wearing an upper body cast. She was mobile and there was no paralysis.

The remaining three occupants remained in the vehicle and sustained only minor injuries. The 7-year-old occupant checked on the condition of the other children, then exited the vehicle through a window and located his mother. When he found her to be unconscious, he went back to the vehicle told the older of the two sisters that he was going for help.

The 7-year-old left the scene of the crash and walked approximately 0.8 km (0.5 mile) toward the light of a dairy farm to get help. Workers at the dairy contacted authorities and reported that there had been a crash.

The rear left and rear middle occupants were transported to the hospital by ambulance in their respective child seats. They were examined and released that same day.



Figure 4. Left side, case vehicle



Figure 5. Top view, showing lateral crush to roof rail and outward bowing of the driver's door

The case vehicle was towed from the scene due to damage and later declared a total loss.

The child seats were never located. The driver purchased new seats since the crash and does not know what had become of the seats. The child seats were not with the vehicle at the time of the inspection. The salvage facility indicated that it is their policy to destroy any unaccounted for child seats so that they cannot be reused. The driver did not know the makes and models of the old seats, but did indicate that she was the original owner of each. A child safety seat questionnaire was completed.



Figure 7. Right rear seat



Figure 6. Left rear seat

Scene Diagram

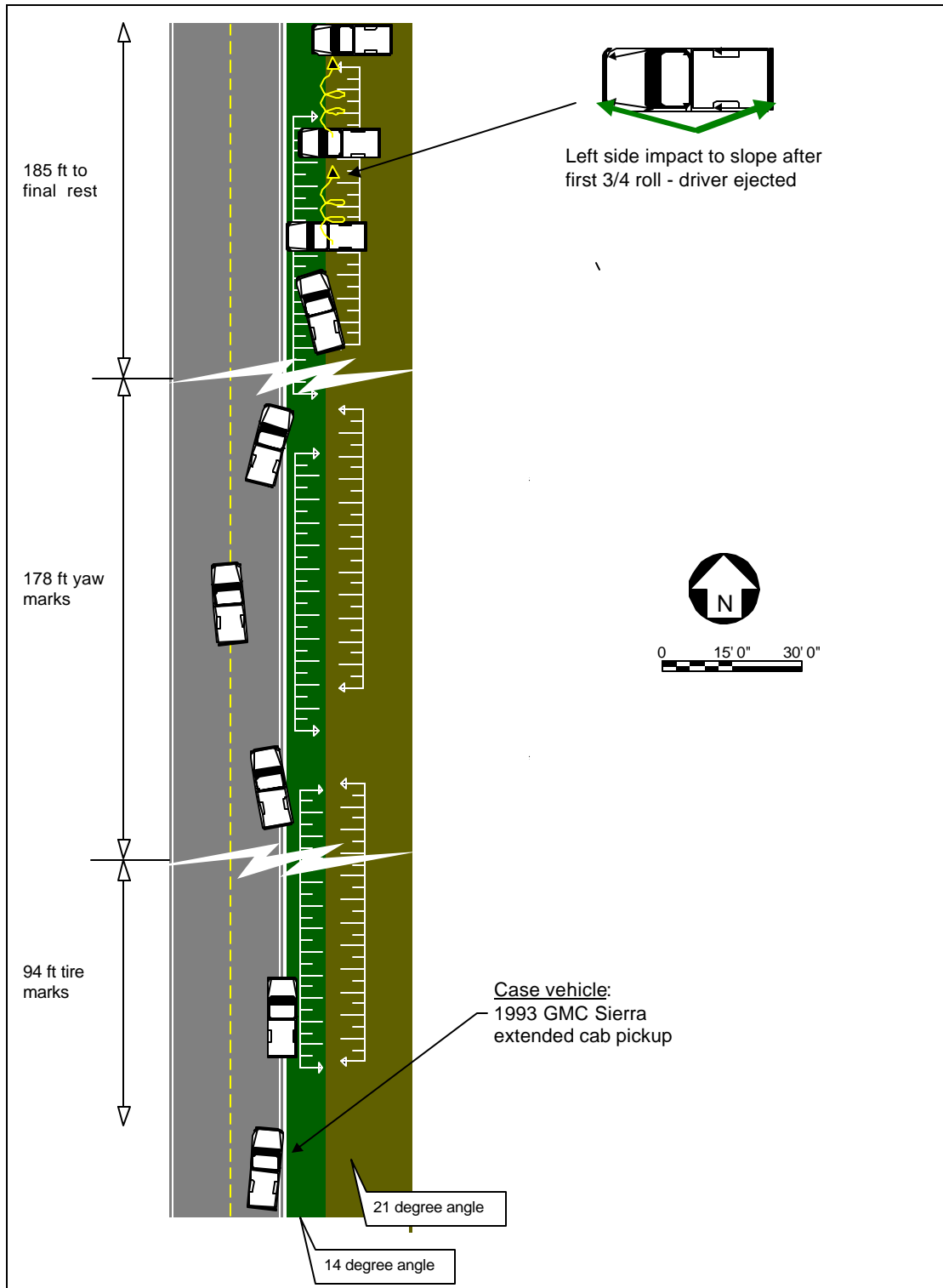


Figure 8. Scene diagram

DETAILED INFORMATION**Vehicles**Case vehicle

Description:	1993 GMC Sierra extended cab pickup	
VIN:	2GTEK19K8P1xxxxxx	
Odometer:	Unknown (electronic display)	
Engine:	5.7L/V8	
Reported Defects:	None	
Cargo:	Two child seats	
Damage Description:	Major rollover damage to roof, left side, truck bed. Vehicle towed from scene due to damage. Vehicle declared a total loss by insurance company.	
CDC:	00TDDO2	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown



Figure 9. Front, case vehicle

Safety systems discussion

The driver's and front right passenger's manual restraint system consisted of a continuous loop 3-point lap and shoulder with fixed latch plates.

The rear seat outboard manual restraint system consisted of a continuous loop 3-point lap and shoulder belts with locking latch plates. Both belts were found to be locked into the spooled out position at the time of inspection. It is presumed that during the rollover the pawl in the retractor had somehow become locked with the ratchet.

The middle rear seat position was equipped with a manual lap belt with a locking latch plate.

Child safety seat discussion

The rear left seat was occupied by a 4-year-old female (16 kg/36 lbs) who was seated in an unknown make/model forward facing child safety seat with a 5-point harness. The seat was designed for use with children who weigh between 8-27 kg (18-60 lbs)¹. The harness straps were located in the middle slots. The harness straps were at shoulder level. The restraint clip was used at the time, but its level is not known. The driver described the space between the child's chest and the harness as being two fingers wide. Nothing was placed between the harness and the child's chest. The driver had owned the child seat for two years and had bought it new. The child seat was used on a daily basis. The driver stated that the seat had been tightly anchored to the vehicle. This was corroborated by the fire department responders who stated that both seats were properly installed.

The rear middle seat was occupied by an 18-month-old female (8 kg/18 lbs) who was seated in a forward facing child safety seat with a 5-point harness. The seat was designed for use with children who weigh between 8-27 kg (18-60 lbs). This would have put the child into the low end of the proper weight scale. The harness straps were located in the bottom slots. The harness straps were at shoulder level. The restraint clip was used at the time, but its level is not known. The driver described the space between the child's chest and the harness as being two fingers wide. Nothing was placed between the harness and the child's chest. The driver had owned the child seat for 12 months and had bought it new. The child seat was used on a daily basis. The driver stated that the seat had been tightly anchored to the vehicle. As stated earlier, this was corroborated by the fire department who stated that both seats were properly installed.

¹Based on information provided by the driver in the child seat questionnaire

Occupants

<u>Case vehicle</u>	Occupant 1	Occupant 2	Occupant 3	Occupant 4
Age/Sex:	28/Female	4/Female	18 month / Female	7/Male
Seated Position:	Front left	Rear left	Rear middle	Rear right
Seat Type:	Cloth covered bucket seat, seat track adjusted to middle position. The seat back was slightly reclined.	Cloth covered bench	Cloth covered bench	Cloth covered bench
Height:	155 cm (61 cm)	84 cm (33 in)	51 cm (20 in)	104 cm (41 in)
Weight:	52 kg (115 lbs)	16 kg (36 lbs)	8 kg (18 lbs)	18 kg (40 lbs)
Occupation:	Not employed	NA	NA	NA
Pre-existing Medical Condition:	None noted	None noted	None noted	None noted
Alcohol/Drug Involvement:	None	NA	NA	NA
Driving Experience:	Approximately 10 years	NA	NA	NA
Body Posture:	Normal, upright	Normal, upright. Leaning to right.	Normal, upright. Leaning to right.	Normal, upright
Hand Position:	Both hands on steering wheel	Unknown	Unknown	Unknown
Foot Position:	Right foot on brake, left on floorboard	Unknown	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, not used	Lap and shoulder belt, used with child safety seat	Lap belt available, used with child safety seat	Lap and shoulder belt available, used
Air bag:	None available	None available	None available	None available

Injuries and Injury Mechanisms

Case vehicle

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Concussion, with loss of consciousness	161000.2,0	850.9	Ground
	Left clavicle fracture	752200.2,2	810.00	Door side panel
	10 left side rib fractures	450230.3,2	807.08	Door side panel
	Left lung puncture	441414.3,2	861.22	Door side panel
	Fractures to the thoracic spine @ T3, T11, and T12	650416.2,7 650416.2,7 650416.2,7	805.2	Door side panel
Rear left occupant:	Minor contusions/abrasions	990200.1,9 990400.1,9	924.9 919.0	Unknown
Rear middle occupant:	Minor contusions/abrasions	990200.1,9 990400.1,9	924.9 919.0	Unknown
Rear right occupant:	Not injured			

Occupant Kinematics

The 28-year-old female driver of the case vehicle was unrestrained just prior to the crash. She was seated in a fabric covered bucket seat. The seat had been adjusted to the middle track position. Both of her hands were on the steering wheel and she was actively steering first to the left and then more sharply to the right. Her right foot was on the brake; the left was on the floorboard. As the vehicle went into a counterclockwise rotation—just prior to tripping, the driver would have been shifting to the right. As the vehicle tripped, it completed a 3/4 roll and struck the ground with its left side. This contractor believes that the driver shifted sharply to the left, struck and loaded the left door—scuffing the inside door panel and deforming the door outward—and was then ejected through the left side glass.

The 4-year-old female left rear occupant was seated in a forward facing child safety seat with a 5-point harness. She was leaning to her right. The child seat was anchored to the vehicle using the available lap and shoulder belt. The 4-year-old was restrained by the child seat harness. This occupant reacted to the steering maneuvers by first shifting to the right, then to the left. As the vehicle tripped and completed the first 3/4 roll, she would have responded by pitching sharply to the left. There were no indications of occupant contact. She essentially stayed in place throughout the rollover.

The 18-month-old female rear middle occupant was seated in a forward facing child safety seat with a 5-point harness. She was leaning to her right. The child seat was anchored to the vehicle using the available lap belt. The 18-month-old was restrained by the child seat harness. This occupant reacted to the steering maneuvers by first shifting to the right, then to the left. As the vehicle tripped and completed the first 3/4 roll, she would have responded by pitching sharply to the left. There were no indications of occupant contact. She essentially stayed in place throughout the rollover.

The 7-year-old male right rear occupant was seated in a forward facing fashion. He was wearing the available lap and shoulder belt. This occupant reacted to the steering maneuvers by first shifting to the right, then to the left. His side-to-side movement was likely limited to some degree by the vehicle structure on the right and the middle child safety seat. As the vehicle tripped and completed the first 3/4 roll, he would have responded by pitching sharply to the left. There were no indications of occupant contact.



Figure 10. Top view, shows occupant loading to left door