

Child Safety Seat Fatality/ Vehicle to Objects
Dynamic Science, Inc. / Case Number: DS05001
1990 Chevrolet 1500 pickup
Colorado
January, 2005

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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 on-site investigation focused on a forward facing Graco Quest high back booster safety seat with a 5-point harness that was installed in the front middle seat of a 1990 Chevrolet K series 4x4 pickup. The safety seat was anchored to the vehicle using the available lap belt. The Chevrolet pickup was occupied by a 35-year-old male driver, a 3-year-old male seated in the child safety seat, and a 13-year-old restrained male front right seat passenger. This single vehicle, multiple impact crash occurred in January, 2005 at 1120 hours in an urban area of Colorado. The crash occurred off-road with the vehicle departing an eight-lane undivided roadway. The pickup departed the road on the right side, struck a series of loose tires, and then struck a building with its front end. The driver and front middle occupant were fatally injured. The front right seat occupant sustained a fractured jaw.				
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Dynamic Science, Inc.
Crash Investigation
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BACKGROUND:

Description

This on-site investigation focused on a forward facing Graco Quest high back booster safety seat with a 5-point harness that was installed in the front middle seat of a 1990 Chevrolet K series 4x4 pickup. The safety seat was anchored to the vehicle using the available lap belt. The Chevrolet pickup was occupied by a 35-year-old male driver, a 3-year-old male seated in the child safety seat, and a 13-year-old restrained male front right seat passenger. The pickup departed the road on the right side, struck a series of loose tires, and then struck a building with its front end. The driver and front middle occupant were fatally injured. The front right seat occupant sustained a fractured jaw.



Figure 1. Front left, Chevrolet K1500

This child safety seat fatality case was identified by NHTSA from a news report. DSI was notified on January 11, 2005. Dynamic Science, Inc. (DSI) located the vehicle and child safety seat and was assigned the case on January 12, 2005. Field work was completed on January 13, 2005.

SUMMARY

Crash Site

This single vehicle, multiple impact crash occurred in January, 2005 at 1120 hours in an urban area of Colorado. The crash occurred off-road with the vehicle departing an eight-lane undivided roadway. The roadway was straight and level. At the time of the crash, there were no adverse weather conditions and the asphalt roadway surface was dry. There was a posted speed limit of 72 m/h (45 mph). The eastern edge of the roadway is bordered by a 12.7 cm (5.0 in) curb. This is followed by a 1.4 m (54.0 in) wide concrete sidewalk. There were two businesses on the eastern side of the roadway. The first is a tire shop with a concrete parking lot. In the parking lot were a series of stacked tire displays. There were four tires in each display and at the time of the crash there were at least two displays present. Just north of this business is an office complex. It is separated from the tire shop by a



Figure 2. Area of roadway departure (north)

chain link fence followed by a 18.0 m (59.0 ft) parking lot. The office building is separated from the parking lot by a 1.8 m (6.0 ft) concrete sidewalk and a 1.8 m (6.0 ft) area of grass and bushes.

Pre-Crash

The case vehicle is a 1990 Chevrolet K series 4x4 pickup driven by a lap and shoulder belt restrained 35-year-old male. The front middle seat was occupied by a 3-year-old male who was seated in a Graco Quest high back booster safety seat. The front right seat was occupied by a lap and shoulder belt restrained 13-year-old male.

The Chevrolet pickup was traveling northbound at a police reported speed of 80 km/h (50 mph). The driver was incapacitated in some fashion. He may have passed out or had a heart attack.

Crash

The Chevrolet veered to the right and departed the roadway. There were no indications of any avoidance maneuvers. The Chevrolet first struck a tire display shortly after departing the roadway. The Chevrolet traveled a short distance and struck a second tire display. The Chevrolet continued in a northeast direction for 31 m (103 ft) where it next struck a fence. It then traveled 20 m (65 ft) where it contacted a curb. It then finally traveled an additional 4 m (12 ft) before striking and penetrating an unoccupied four-story office building. There was a height differential between ground level and the interior of the building. The police indicated a 1.2 m (4 ft) drop.

There was no damage from the curb impact. The impacts to the tire display and the chain link fence were generally insignificant. The frontal contact with the tire displays and fence was masked by the subsequent building impact. There were scratches found down both sides from contact with the fence. The impact with the building was essentially a two stage event. The initial contact was

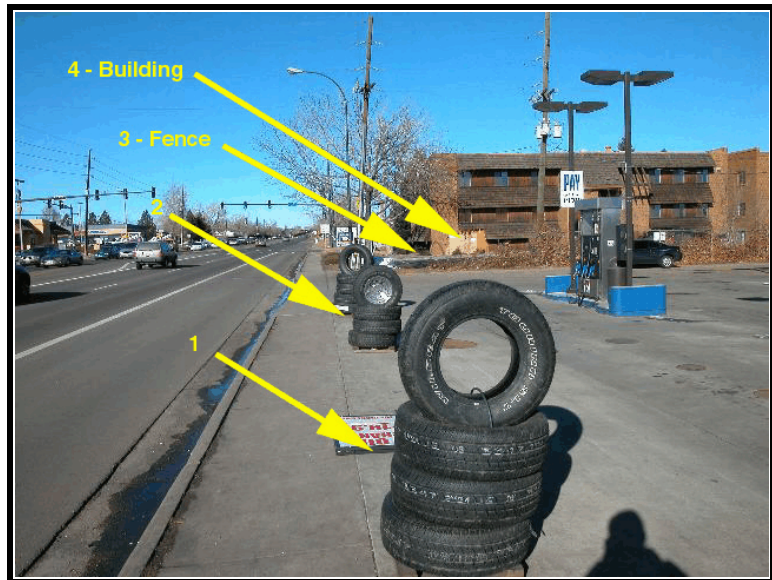


Figure 3. View showing four impacts



Figure 4. Impact with building



Figure 5. Front right, Chevrolet K1500

with the front bumper and grille. This stiff part of the vehicle penetrated the building. There was 87.0 cm (34.2 in) of direct contact found on the bumper from the building impact, but the entire front end was involved. As the vehicle continued forward the upper cab area of the vehicle engaged a slanted roof portion of the building above the original penetration point. This resulted in significant deformation and intrusion along the windshield header with the front header being pushed rearward into the rear header. The upper cab was cut away during extrication. At a minimum there was 60.0 cm (23.6 in) of crush near the center. A CDC of 12FDAW8¹ was assigned to describe the resultant damage to the bumper level and the damage to the cab. As the vehicle penetrated the building, the camper shell was forced off the vehicle and came to rest to the right of the vehicle next to the building. As the vehicle penetrated the building, it likely dropped down to the frame level as the tires went from the ground level to the office level.

Post-Crash

The driver of the Chevrolet sustained multiple facial injuries, including: fractures to the left orbit, nose, and maxilla, and lacerations to forehead, left eyelid, nose, and lips. He was transported to a local hospital by ground ambulance where he was hospitalized. He underwent a series of surgeries during this time. None of the injuries appeared to be life threatening. However, there were indications of some type of heart condition and the driver passed away seven days after the crash. The autopsy indicated that the driver sustained multiple pulmonary emboli² and multiple blunt trauma injuries. The 3-year-old front middle occupant was fatally injured. He was pronounced dead at the scene. He sustained a blunt trauma to the head, a circumferential fracture of the skull which disarticulated the skull from the vertebral column, and subdural and subarachnoid hemorrhages (bilateral, frontal, parietal, occipital). He also sustained an abrasion that ran from his forehead to his chin on the left side of his face, a laceration to the eyebrow, laceration over left cheek, laceration to bridge of nose, abrasions of right cheek, a chin laceration, abrasions to super clavicular area that also overly the sternum, and several abrasions to the right foot. The 13-year-old front right occupant sustained a jaw fracture. He was transported from the scene by ground ambulance for treatment.

The Chevrolet pickup was heavily damaged. It took police and towing companies approximately five hours to remove the vehicle from within the office building.

¹This was essentially an inverted step type impact that did not meet the 76 cm (30 in) horizontal separation distance specified in J224MAR80.

² Pulmonary emboli are blockages of the blood vessels of the lungs (pulmonary vessels).

VEHICLE DATA - 1999 Chevrolet 1500 pickup

The 1990 Chevrolet K series 4x4 pickup was identified by its Vehicle Identification number (VIN): 1GCDK14K9LZxxxxxx. The vehicle had been driven 207,722 km (129,073 miles). The Chevrolet conventional cab pickup was equipped with a 5.7 liter, eight cylinder engine, an automatic three-speed transmission, four wheel drive, front disc/rear drum brakes, power steering, and a tilt steering wheel. An Mpulse fiberglass truck cap was attached to the bed of the truck. The Chevrolet pickup was equipped with Uniroyal Laredo LT245/75R16 tires. The specific tire data is as follows:

Tire	Tread	Measured pressure	Manufacturer recommended pressure	Restricted	Damage
LF	5 mm (6/32 in)	Flat	552 kPa (80 psi)	Yes	Cut
LR	6 mm (7/32 in)	560 kPa (81 psi)	552 kPa (80 psi)	No	None
RR	6 mm (7/32 in)	538 kPa (78 psi)	552 kPa (80 psi)	No	None
RF	5 mm (6/32 in)	531 kPa (77 psi)	552 kPa (80 psi)	No	None

The seating in the Chevrolet pickup was configured with a single cloth-covered bench seat. The seat was adjusted to the rear most track position. The seat back angle was 58 degrees from horizontal; the seat bottom angle was 14.7 degrees.

VEHICLE DAMAGE**Exterior Damage - 1999 Chevrolet 1500 pickup**

Damage Description: There was no damage from the initial curb impact. The impacts to the tire displays and the chain link fence were generally insignificant. The frontal contact with the tire display and fence was masked by the subsequent building impact. There were scratches found down both sides from contact with the fence and building.

CDC (Impact 4): 12FDAW8

Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

A field L of 184.0 cm (72.4 in) was assigned at the bumper level. The residual crush measured along the bumper was as follows: C1=40.0 (15.7 in), C2 =25.0 cm (9.8 in), C3=14.0 cm (5.5 in), C4=4.0 cm (1.6 in), C5=2.0 cm (0.8 in), C6=6.0 cm (2.3 in).

Interior Damage - 1999 Chevrolet 1500 pickup

The 1990 Chevrolet K1500 sustained major interior damage as a result of passenger compartment intrusion. There was longitudinal intrusion by both A pillars, the windshield header, and the roof. This intrusion included all three seat positions. The extent of the intrusion is uncertain, the upper cab had been cut away during extrication. At a minimum there was 60.0 cm (23.6 in) of crush near the center which actually pushed the front header into contact with the backlight header. There was 17.0 cm (6.7 in) of lateral intrusion through the right door. The instrument panel was cracked and deformed due to intrusion. The steering wheel was covered in blood. There was blood pooling on the driver's seat back. There were blood spatters and smears on the seat and on the left side of the booster seat. The glove box was separated from the instrument panel. The speedometer was broken and the speed was fixed at 24 km/h (15 mph).

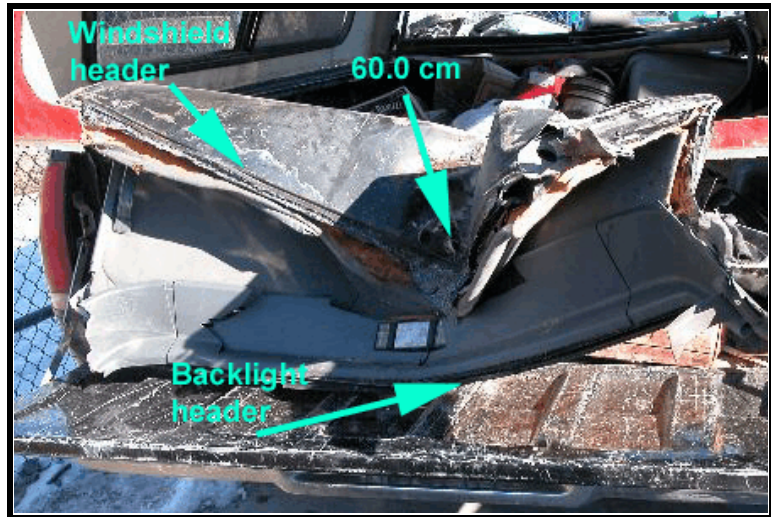


Figure 6. Damage to upper portion of the cab



Figure 7. Right door intrusion

MANUAL RESTRAINT SYSTEMS - 1999 Chevrolet 1500 pickup

The 1990 Chevrolet K1500 was configured with manual 3-point lap and shoulder belts at the two outboard positions and a manual lap belt at the middle seat position with a locking latch plate. Both outboard seat belts were configured with sewn-on latch plates and emergency locking retractors. The driver's belt showed evidence of loading and had been cut off the driver during his extrication. The front right seat belt showed evidence of loading. The lap belt in the middle seat position was being used in conjunction with the high back booster seat. There were load marks to the lap belt indicating usage in this crash.



Figure 8. Driver's seated position

CHILD SAFETY SEAT - 1999 Chevrolet 1500 pickup

The front middle seat occupant was seated in a Graco Quest high back booster safety seat (Model No. 44812) with a manufacture date of 11/9/99. The child seat had been placed in the forward facing mode on a fabric covered bench seat. When the child seat is being used with the 5-point harness, the manufacturer recommends that the seat be used for children who weigh between 14-18 kg (30-40 lbs) with a height between 89-110 cm (34-43 in). When the seat is being used without the five-point harness and the vehicle lap and shoulder belt is in place, the manufacturer recommends that the seat be used for children who weigh between 14.9-29.5 kg (30-65 lbs) with a height between 89-127 cm (34-50 in).

The child safety seat was being used with the integral 5-point harness. The harness was routed through the bottom set of slots. There were load marks to the shoulder portions of the harness. The harness was cut off the child during extrication. The child seat was anchored to the vehicle using the available lap belt. There were load marks to the lap belt indicating usage in this crash. There was 20.0 cm (7.9 in) of tip distance at the top and 19.0 cm (7.5 in) tip distance at the bottom of the child seat. The distance from the interior of the child seat back to the center instrument panel was 87.0 cm (34.3 in).



Figure 9. Graco high back booster seat



Figure 11. Top tip distance



Figure 10. Load marks to middle seat lap belt

OCCUPANT DEMOGRAPHICS - 1999 Chevrolet 1500 pickup

	Driver	Occupant 2	Occupant 3
Age/Sex:	35/Male	3/Male	13/Male
Seated Position:	Front left	Front middle	Front right
Seat Type:	Bench	Bench	Bench
Height:	178 cm (70 in)	Unknown	Unknown
Weight:	88 kg (194) lbs	Unknown	Unknown
Occupation:	Unknown	NA	NA
Pre-existing Medical Condition:	Hypertension	None noted	None noted
Alcohol/Drug Involvement:	None	None	None
Driving Experience:	Unknown	NA	NA
Body Posture:	Unknown	Upright, seated in CSS	Upright
Hand Position:	Unknown	Unknown	Unknown
Foot Position:	Unknown, both presumed to be on floorboard	Unknown	Unknown, both presumed to be on floorboard
Restraint Usage:	Lap and shoulder belt available, used.	Lap belt used with child safety seat	Lap and shoulder belt available, used.
Air bag:	None available	None available	None available

OCCUPANT INJURIES - 1999 Chevrolet 1500 pickup

Driver: Injuries obtained from medical records and the autopsy report.

<u>Injury</u>	<u>OIC Code</u>	<u>ICD-9</u>	<u>Injury Source</u>	<u>Confidence</u>
Nasal fractures	251004.2,4	802.1	Windshield header	Certain
Bilateral maxilla fractures	250800.2,3	802.5	Windshield header	Certain
Hyphema of the left eye (contusion)	240604.1,2	921.3	Windshield header	Certain
Laceration of the left corneal	240606.1,2	871.0	Windshield header	Certain
Laceration of the left sclera	241200.1,2	871.0	Windshield header	Certain
Laceration of the forehead	290600.1,7	873.42	Windshield header	Certain
Laceration of the left eyelid	297602.1,2	870.1	Windshield header	Certain
Nasal transection / laceration	290602.1,4	873.29	Windshield header	Certain
Lacerations of the upper and lower lips	290602.1,8	873.43	Windshield	Probable
Laceration of the left cheek	290602.1,2	873.41	Windshield	Probable
Laceration of the right cheek	290602.1,1	873.41	Windshield	Probable
Contusion of the right bicep (upper arm)	790402.1,1	923.03	Unknown	Unknown
Abrasions to the left mid chest	490202.1,2	911.0	Steering wheel	Possible
Laceration of the right elbow	790602.1,1	881.01	Unknown	Unknown
Abrasions to the dorsal aspect of the left wrist, 1 st finger and knuckle	790202.1,2	913.0	Windshield	Possible

Occupant believed to have had a syncopal (fainting) episode prior to the crash. Occupant hospitalized, but subsequently expired seven days after the crash due to pulmonary embolus.

Front seat middle occupant: Injuries obtained from autopsy report.

<u>Injury</u>	<u>OIC Code</u>	<u>ICD-9</u>	<u>Injury Source</u>	<u>Confidence</u>
Circumferential fracture of the base of skull (dis-articulation of skull from column)	150206.4,8	801.2	Windshield header	Certain
Sub-dural hemorrhage (left and right frontal, parietal, temporal and occipital regions)	140652.4,1 140652.4,2	801.2 801.2	Windshield header	Certain
Sub-arachnoid hemorrhage	140684.3,9	801.2	Windshield header	Certain
Multiple abrasions to facial area	290202.1,0	910.0	Windshield header	Certain
Multiple lacerations to facial area	290602.1,0	873.49	Windshield header	Certain
Contusion to the forehead (above left eye)	190402.1,5	920	Windshield header	Certain
Abrasions to left shoulder area (anterior)	790202.1,2	912.0	Unknown	Unknown
Abrasions to right foot (dorsal / lateral)	890202.1,1	917.0	Instrument panel	Possible

Front seat right occupant: Injury obtained from police report.

<u>Injury</u>	<u>OIC Code</u>	<u>ICD-9</u>	<u>Injury Source</u>	<u>Confidence</u>
Fractured jaw (mandible)	250600.1,9	802.20	Windshield header	Probable

OCCUPANT KINEMATICS - 1999 Chevrolet 1500 pickup

Driver kinematics

The 35-year-old male driver (178 cm/70 in, 88 kg/195 lbs) was seated facing forward. He was wearing the available lap and shoulder belt. It appears that he was likely unconscious. It is also likely that he was still seated in a generally upright fashion, but with his head rotated downward to some degree. During the first three relatively minor impacts, the driver likely remained generally in place. There may have been some bouncing involved but very little longitudinal deceleration. At impact with the office building, the driver initiated a forward trajectory. He loaded the lap and shoulder belt. As the vehicle continued forward, the upper portion of the cab struck the overhanging roof structure. The windshield fractured and the windshield header intruded into the passenger compartment. Some portion of the header and windshield engaged the driver's face causing the nasal and maxilla fractures, the orbit fracture and the lacerations to forehead, left eyelid, nose, and lips.

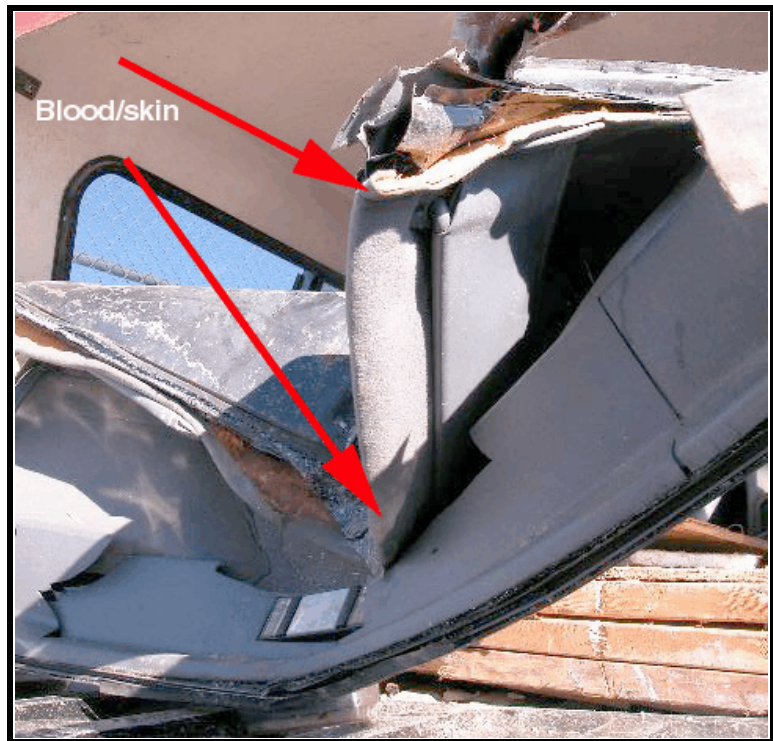


Figure 12. Inside portion of left windshield header. Arrows indicate areas of blood/tissue transfer.

Front seat middle occupant kinematics

The 3-year-old front middle occupant (unknown height and weight) was seated in a Graco Quest high back booster safety seat. The child safety seat was being used with the integral 5-point harness and the seat was anchored to the vehicle using the available lap belt. At impact with the office building, this occupant initiated a forward trajectory. He loaded the child safety seat harness. The child seat in turn loaded the lap belt in the middle seat position. As the vehicle continued forward, the upper portion of the cab struck the overhanging roof structure. The windshield fractured and the windshield header intruded into the passenger compartment. Some portion of the header and windshield engaged this occupant's face at the forehead level—causing the forehead abrasions and the head trauma. This occupant's head was forced rearward—which likely caused the skull/spine disarticulation. He was pronounced dead at the scene.

Front seat right occupant kinematics

The 13-year-old front right male occupant (unknown height and weight) was likely seated upright, and likely facing forward. He was wearing the available lap and shoulder belt. Given his age, he was likely aware of the previous impacts to some degree and may have been bracing. At impact with the office building, this occupant initiated a forward trajectory. He was held in place by the lap and shoulder belt and may not have sustained any injury up to this point. As the vehicle continued forward, the upper portion of the cab struck the overhanging roof structure. The windshield fractured and the windshield header intruded into the passenger compartment. Some portion of the header and windshield likely engaged this occupant's face—causing a jaw fracture.

Attachment 1. Scene Diagram

