Rollover/Child Safety Seat Investigation / Vehicle To Object
Dynamic Science, Inc. / Case Number: DS07007
2004 Chevrolet Tahoe
California
January 2007

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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 three child safety seats that were installed in the rear seats of a 2004 Chevrolet Tahoe. The case vehicle was being driven by a 25-year-old female. There were a total of nine additional occupants in the vehicle. Seven of the vehicle's occupants were children, ranging in age from one to fifteen years old.

This single vehicle crash occurred in January 2007 at 0120 hours in northern California. The crash occurred on a U.S. highway. The Chevrolet Tahoe was traveling at an unknown speed, when the driver lost control of the vehicle and struck a median guardrail. The vehicle tripped and rolled several times.

Four occupants were fully ejected and one occupant was partially ejected. The partially ejected 4-year-old female occupant was fatally injured. She was flown by helicopter to a local hospital where she died. A total of four helicopters were used to evacuate the injured. The driver was arrested for vehicular manslaughter and driving while intoxicated. The case vehicle was towed from the scene due to damage and was placed into police evidence.

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Dynamic Science, Inc.
Crash Investigation
Case Number: DS07007

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Background

This on site investigation focused on three child safety seats that were installed in the rear seats of a 2004 Chevrolet Tahoe (**Figure 1**). The case vehicle was being driven by a 25-year-old female. There were a total of nine additional occupants in the vehicle. Seven of the vehicle's occupants were children, ranging in age from one to fifteen years old.

Figure 1. Case vehicle, 2004 Chevrolet Tahoe

This single vehicle crash occurred in January 2007 at 0120 hours in northern California. The crash occurred on a U.S. highway. The Chevrolet Tahoe was traveling at an unknown speed when the driver lost control of the vehicle and struck a median guardrail. The vehicle tripped and rolled several times.

Four occupants were fully ejected and one was partially ejected. The partially ejected 4-year-old female occupant was fatally injured. She was flown by helicopter to a local hospital where she died. A total of four helicopters were used to evacuate the injured. The driver was arrested for vehicular manslaughter and driving while intoxicated. The Chevrolet Tahoe was towed from the scene due to damage and was placed into police evidence.

This Child Safety Seat (CSS) case was identified by DSI through an on-line news article. DSI was instructed to locate the vehicle and CSS on February 13, 2007. DSI located the vehicle and obtained permission to inspect it on February 16, 2007. DSI was assigned the case on February 17, 2007. The vehicle and scene inspections took place on February 22, 2007.

Efforts were undertaken to download data from the Event Data Recorder (EDR). There was a Collect Data Failed error message with an indication that there was no communication with the air bag module. Communications with vehicle interface were correct according to the Vetronix software. The vehicle was being held as evidence and the investigator was not allowed to do any tear down to access the module directly or to remove the module.

SUMMARY

Crash Site

This single vehicle crash occurred in the grassy median area of a state highway in January 2007. At the time of the crash, there were no adverse weather conditions and the asphalt roadway surface was dry. The northbound roadway was configured with two lanes that were separated by a dashed white line. The roadway was bordered on the right by a solid white line followed by a paved shoulder and a short curb. The roadway is bordered on the left by a solid yellow line followed by a paved shoulder, a dirt/gravel median, and a metal guardrail that separates the northbound and

southbound roadways. The northbound roadway curved to the left and had negative grade (**Figure 2**). The speed limit was 105 km/h (65 mph).

Pre-Crash

The Chevrolet Tahoe was traveling northbound on the state highway at an unknown speed. There were a total of 10 occupants in the vehicle. The vehicle was designed to accommodate nine passengers. An overview of seating positions, restraint usage, and injuries is shown in Table 1. The case vehicle was initially in the outboard lane. The driver lost control and the vehicle veered to the left (**Figure 3**).

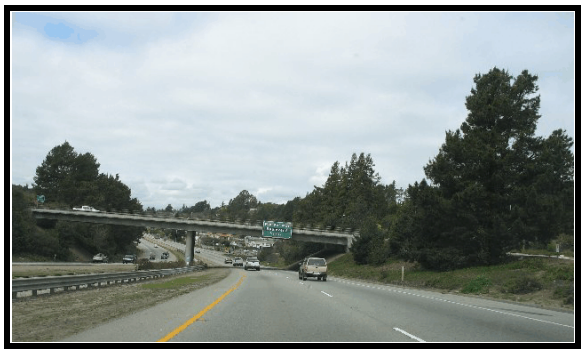

Figure 2. Approach to area of road departure (north)

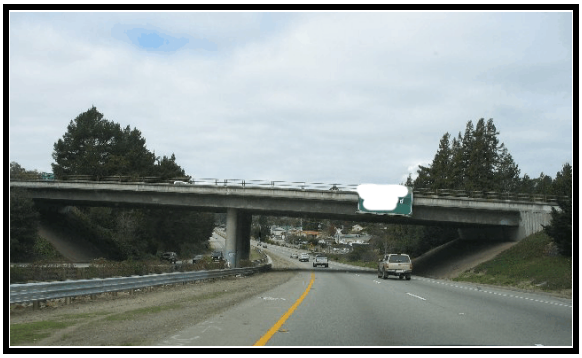

Figure 3. Area of road departure and impact with center guardrail (north)

Table 1. Overview of seating positions

Front left	25/Female	Lap and shoulder belt used	Complained of pain to left shoulder and abdomen
Front middle	15/Female(02)	Lap belt not used	Concussion, multiple lacerations and abrasions
Front right	23/Female (03)	Lap and shoulder belt not used	**Ejected**. Fractures to the left femur, left knee, right knee, pelvis, lumbar spine, and sacroiliac; multiple cruciate ligament tears and avulsions, a lung contusion, a bladder rupture, and multiple contusions and abrasions
Second row left	1 month/Female (04)	Lap and shoulder belt used with child safety seat. Unknown make/model.	Not injured

Second row middle	3/Female (05)	Lap and shoulder belt not used	Concussion, avulsion to right foot, multiple contusions and abrasions
Second row middle	8/Male (06)	Lap and shoulder belt not used	**Ejected.** Liver laceration, lung contusion, right shoulder fracture, multiple contusions and abrasions
Second row right	24/Male (07)	Lap and shoulder belt not used	**Ejected.** Left femur fracture, vertebra fracture, hip fracture, multiple contusions and abrasions
Third row left	4/Female (08)	Cosco/Dorel High Back Booster Seat. Seat not secured to vehicle, harness not used.	**Partially ejected**. Fatally injured. Comminuted calvarial skull fractures, lacerations and contusions to the left cerebral hemisphere, a basal skull fracture, a cerebral edema and subarachnoid hemorrhage.
Third row middle	10/Male (09)	Lap belt not used	**Ejected.** Lung contusions, a liver laceration, a spleen laceration, and a colon injury
Third row right	2/Female (10)	Evenflo Express Booster seat. Seat secured to vehicle, harness used	Orbit fracture, subarachnoid hemorrhage, subdural hemorrhages, a humerus fracture, a liver contusion and multiple contusions and abrasions.

Crash

The case vehicle crossed the inboard travel lane and then the grass median before striking a median guardrail with its front end. The guardrail gave way during the crash and the vehicle tripped and rolled, coming to rest on its left side.

Post-Crash

Four occupants were fully ejected and one occupant was partially ejected during the rollover sequence.

The driver of the Tahoe complained of pain to her left shoulder and abdomen. She was located in the driver's seat area. She was transported by ground to an area hospital where she was treated and later arrested.

The 15-year-old front row middle occupant (02) sustained a concussion and multiple lacerations and abrasions. She was transported by ground ambulance to a local hospital where she was hospitalized for four days.

The 23-year-old front row right occupant (03) was ejected during the rollover. She sustained fractures to the left femur, left knee, right knee, pelvis, lumbar spine, and sacroiliac. She also sustained multiple cruciate ligament tears and avulsions, a lung contusion, a bladder rupture, and multiple contusions and abrasions. She was transported to a local trauma center. She arrived at the trauma center at 0320 hours with Glasgow Coma Scale (GCS) score of 13. She was hospitalized for 12 days.

The 1-month-old second row left occupant (04) was not injured. She remained in the vehicle in her CSS. She and the CSS were removed by responding police officers. The vehicle's lap and shoulder belt was cut to remove the CSS. She was treated at the scene by paramedics who examined her and did not diagnose any injuries.

There were two children seated in the second row middle seat position. The first second row middle occupant (05), a 3-year-old female, sustained a concussion, an avulsion to the right foot and multiple contusions and abrasions. She was transported to a local hospital and arrived at the hospital at 0235 hours with GCS score of 15 and was awake upon admission. She was later transferred to a trauma center where she arrived at 0439 hours. She was hospitalized for an unknown number of days.

The second second row middle occupant (06), an 8-year-old male, was ejected during the rollover. He sustained a lung contusion, a liver laceration, a right shoulder fracture, and multiple contusions and abrasions. He was transported by helicopter to an area hospital for treatment. He arrived with a GCS score of 15. He was later transferred a local trauma center where he was hospitalized for an unknown number of days.

The 24-year-old second row right occupant (07) was ejected during the rollover. He sustained a left femur fracture, a lumbar vertebra fracture, a hip fracture, and multiple contusions and abrasions. He was transported by helicopter to an area trauma center for treatment where he arrived at 0316

hours with a GCS score of 13-14. He was hospitalized for nine days.

The 4-year-old third row left occupant (08) was partially ejected during the rollover. She was fatally injured. She sustained massive comminuted calvarial skull fractures, lacerations and contusions to the left cerebral hemisphere, a basal skull fracture, a cerebral edema and a subarachnoid hemorrhage.

The 10-year-old third row middle occupant (09) was ejected during the rollover. He was located in the center divider area approximately 23 m (75 ft) south of the case vehicle's final rest. He sustained lung contusions, a liver laceration, a spleen laceration, and a colon injury. He had a GCS score of 14 at the scene. He was transported to a local hospital by helicopter and arrived at 0252 hours. He underwent at least three operations and was hospitalized for an unknown number of days.

The 2-year-old third row right occupant (10) sustained an orbit fracture, subarachnoid hemorrhage, subdural hemorrhages, a humerus fracture, a liver contusion and multiple contusions and abrasions. She was located in her CSS, hanging down towards the driver's side of the vehicle. She appeared to be unconscious. One of the investigating police officers noted that the vehicle safety belt was across her neck and was possibly cutting off her airway, but he may have been referring to the CSS harness. The officer did use his knife to cut the vehicle safety belt while another officer held the child seat in place. She had a GCS score of 9-10 at the scene. She was transported by helicopter to an area trauma center for treatment and was hospitalized for 10 days.

VEHICLE DATA - 2004 Chevrolet Tahoe

The 2004 Chevrolet Tahoe was identified by the Vehicle Identification Number (VIN); 1GNEK13V54Jxxxxxx. There were 94,796 km (58,905 miles) on the digital odometer after the vehicle was powered up. The Tahoe was a four-door utility vehicle that was equipped with a 4.8 liter (293 CID) engine, a four-speed automatic transmission, four wheel drive, front/rear brakes with ABS and Dynamic Rear Proportioning, power steering, and a tilt steering wheel. The Tahoe was configured with Firestone Destination P265/70R16 tires. The vehicle manufacturer's recommended cold tire pressure was 241 kPa (35 psi). The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Flat	6 mm (8/32 in)	Yes	Rim cracked
LR	200 kPa (29 psi)	9 mm (11/32 in)	No	Leaves/grass in bead
RR	Flat	8 mm (10/32 in)	No	None. Tire debeaded
RF	Flat	6 mm (8/32 in)	No	Rim cracked

The seating in the Tahoe was configured with front split-bench 40-20-40 seats, a second row 60-40 split-bench seat, and a third row bench seat.

The second row left, middle and right seats were equipped with lower anchor points that were part of this vehicle's Lower Anchors and Tethers for Children (LATCH) system.

VEHICLE DAMAGE

Exterior Damage -2004 Chevrolet Tahoe

The 2004 Chevrolet Tahoe sustained severe front end damage as a result of the impact with the guardrail (**Figures 4-5**). The direct damage began at the left front bumper corner and extended 176 cm (68.9) laterally across the entire front end. The direct damage extended up to the hood and into the radiator area.

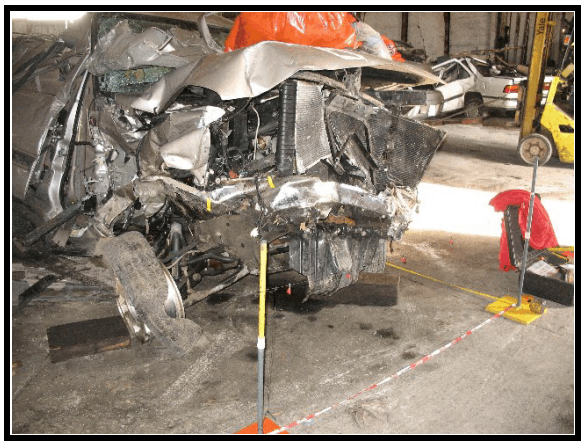

Figure 4. Front right, 2004 Chevrolet Tahoe

Six crush measurements were documented at the bumper level as follows: C1 = 36 cm (14.2 in), C2 = 29 cm (11.4 in), C3 = 15 cm (5.9 in), C4 = 32 cm (12.6 in), C5 = 36 cm (14.2 in), C6 = 36 cm (14.2 in).

The Collision Deformation Classification (CDC) for the impact with the guardrail was 01FDEW2.

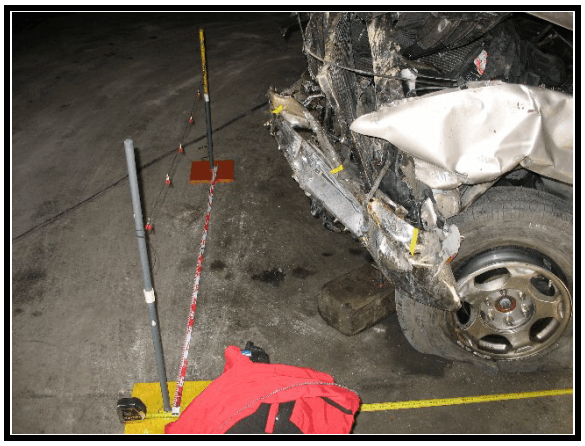

Figure 5. Left side view showing depth of crush at bumper level

The Tahoe sustained severe roof damage as a result of the rollover (**Figures 6-7**). The direct damage began at the rear hatch. It was approximately 110 cm (43.3 in) wide and extended 102 cm (40.2 in) forward. The roof skin was torn in several locations and bloodstains were present. The maximum vertical crush was located on the roof between the C and D pillars and measured 41 cm (16.1). There was also vertical crush to the B-C-D pillars. There was lateral crush to the C-D pillars. The maximum lateral crush was at the D pillar and measured 36 cm (14.2). The CDC for the rollover was 00TDDO4. There was contact damage to the roof from the guardrail.

The right side doors were both jammed closed. The front right door was removed by EMS personnel during the extrication of the passengers.

The left front, right front and right rear tires were flattened and debeaded. The wheelbase on the left side was compressed by 9.0 cm (3.5 in).

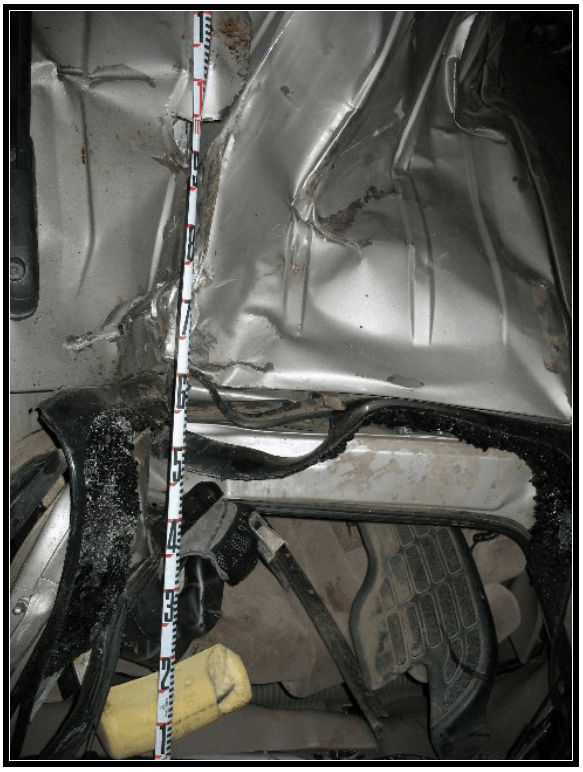

Figure 6. Top view of case vehicle (front of vehicle towards top of image)

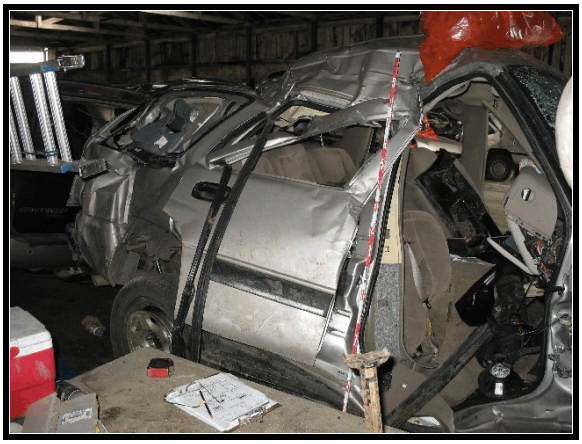

Figure 7. Right side, Chevrolet Tahoe

Interior Damage - 2004 Chevrolet Tahoe

The 2004 Chevrolet Tahoe sustained severe interior damage as a result of passenger compartment intrusion and occupant contacts. The right side door, sill, B pillar, C pillar and roof side rail sustained lateral intrusion. The third row seating area sustained vertical intrusion. The center console was deformed. The roof vent controls were deformed and cracked. The panel at the third row left seat position was cracked. Body fluids were found at a number of locations, including: the back of the driver's seat, third row left seat back, second row left seat back, left rear interior roof, and on the exterior roof. The driver's seat back was deformed rearward. The front right seat back and bottom were deformed laterally to the left.

The specific passenger compartment intrusions were documented as follows:

Position	Intruded Compartment	Magnitude of Intrusion	Direction
3rd row left	Roof	40 cm (15.7 in)	Vertical
Front right	B pillar	35 cm (13.8 in)	Lateral
2nd row right	B pillar	35 cm (13.8 in)	Lateral
3rd row right	Side panel	35 cm (13.8 in)	Lateral
3rd row left	Backlight header	34 cm (13.4 in)	Vertical
2nd row right	C pillar	34 cm (13.4 in)	Lateral
3rd row right	Roof	29 cm (11.4 in)	Vertical
2nd row right	Front passenger seat back	28 cm (11.0 in)	Longitudinal
3rd row right	D pillar	26 cm (10.2 in)	Lateral
2nd row right	Roof rail	15 cm (5.9 in)	Lateral
2nd row left	Driver's seat back	13 cm (5.1 in)	Longitudinal
Front right	Sill	8 cm (3.1 in)	Lateral
Front right	Door	Unknown	Lateral
Front right	Roof rail	Unknown	Lateral

MANUAL RESTRAINT SYSTEMS - 2004 Chevrolet Tahoe

The 2004 Chevrolet Tahoe was configured with integral 3-point lap and shoulder belts for the driver and front right passenger. Both front safety belts were equipped with pretensioners, which actuated during the crash; the driver's belt was found locked in place in the used position while the front right passenger belt was found locked in the stowed position. Body fluids were found on the driver's seat belt webbing.

The second and third row outboard safety belts were equipped with sliding latch plates and switchable ELR/ALR retractors. The second row left safety belt was used to secure a CSS. After the crash, the safety belt webbing was cut by emergency personnel and the CSS removed with the 1-month-old child. The third row right safety belt was used to secure a forward facing CSS. This safety belt webbing was also cut by rescue personnel. The first and third row middle seats were equipped with lap belts while the second row middle seat was equipped with an integral lap and shoulder belt.

Supplemental Restraint System - 2004 Chevrolet Tahoe

The 2004 Chevrolet Tahoe was configured with a Certified Advanced 208-Compliant (CAC) air bag system. The multi-stage air bags were certified by the manufacturer to meet the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The Tahoe was equipped with dual-stage frontal air bags and front row outboard safety belt retractor pretensioners. The driver's air bag deployed as a result of the longitudinal deceleration of the Tahoe during the impact with the guardrail. The front right passenger air bag did not deploy. The reason for the non-deployment is not known. Both front seat belt pretensioners actuated. The driver's seat belt was locked in the used position, the front right seat was locked in the stowed position.

The driver's air bag deployed from the center of the steering wheel hub through symmetrical H-configuration module cover flaps. Each flap measured 11.5 cm (4.5 in) in height and 8.0 cm (3.1 in) in width. The air bag had been removed prior to the vehicle inspection, presumably by the police investigators.

Child Safety Seats

Unknown Make/Model (2nd row left)

An unknown make/model CSS was positioned in the second row left seat of the Chevrolet Tahoe. The seat was secured to the vehicle in the rear facing mode using the 3-point lap and shoulder belt. The 1-month-old child occupant was still restrained to the CSS when the police arrived on the scene. One of the investigating officers cut the lap and shoulder belt and removed the child and the CSS. Both were then given to EMS personnel for evaluation. The CSS was apparently destroyed by the hospital.

Cosco/Dorel High Back Booster Seat (3rd row left, Occupant 08)

A Cosco/Dorel High Back Booster Seat was positioned in the third row left seat of the Chevrolet Tahoe (**Figures 8-10**). The model number was 22858 and the date of manufacture was January 17, 2006. The seat was configured with a five-point harness. The booster seat was rated for children who weigh between 10 and 36 kg (22-80 lbs) and whose height is between 74 and 132 cm (29 and 52 in). The 4-year-old child in this seating position was within the recommended height and weight limits for the child seat.

The booster seat was not secured to the vehicle and the child occupant was not wearing the safety harness. During the crash sequence, the seat pivoted within the confines of the passenger compartment. As the Tahoe landed on its roof, the booster seat became entrapped between the left side roof/roof rail and the plastic side panel. Efforts to remove the seat from the vehicle were unsuccessful. The seat was restricted within the vehicle and was totally immobile approximately 25 cm (10 in) above the vehicle seat bottom. The seat was rotated approximately 20 degrees in the clockwise direction. The plastic seat back was deformed forward, slightly downward and was twisted in a counterclockwise direction approximately 90 degrees. Long black hair transfers were found on the left arm rest of the CSS.

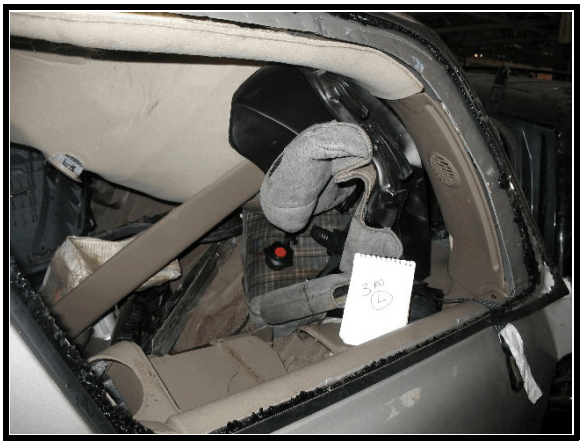

Figure 8. Booster seat as seen from outside left side of vehicle

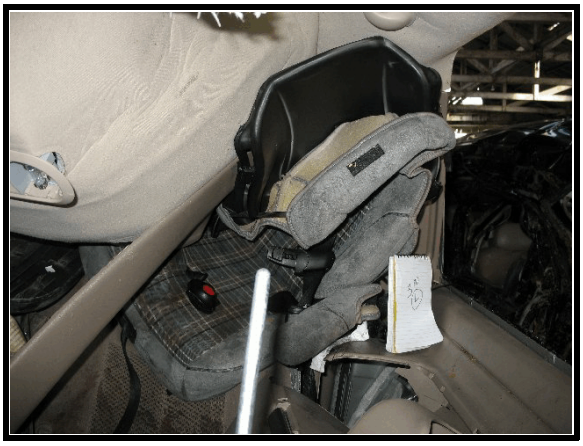

Figure 9. Booster seat as seen looking toward the rear of the vehicle

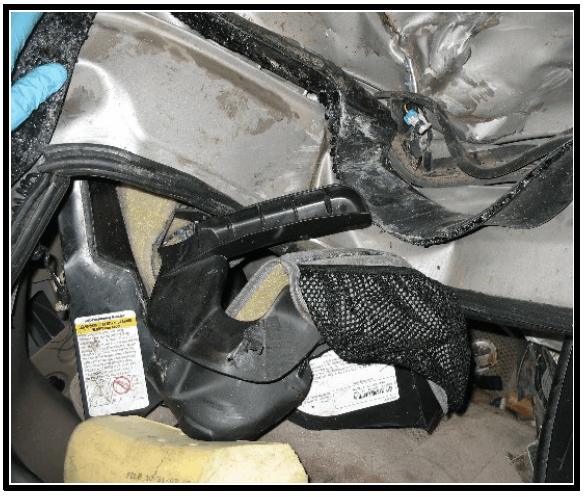

Figure 10. Booster seat as view from the rear hatch window

Evenflo Express Booster Seat (3rd row right, Occupant 10)

An Evenflo Express Booster seat was positioned in the third row right position of the Chevrolet Tahoe (**Figure 11**). The model number was 2481198 and the date of manufacture was May 8, 2002. The seat was configured with a five-point harness and a two piece, locking retainer clip.

A label on the seat outlined the recommended use of the seat as follows:

- When used with the 5-point harness, this child restraint is designed for use only with children who weigh between 8 and 18 kg (20 and 40 lbs) and whose height is between 74 and 109 cm (29 and 43 in).
- When used without the 5-point harness and as a belt positioning booster, this child restraint is designed for use only by children who weigh between 14 and 36 kg (30 and 80 lbs)and whose height is between 94 and 137 cm (37 and 54 in), and whose ears are below the top of the back of the child restraint.

The 2-year-old child in this seat position was within the recommended height and weight limits for the child seat. The 5-point harness was being used at the time of the crash.

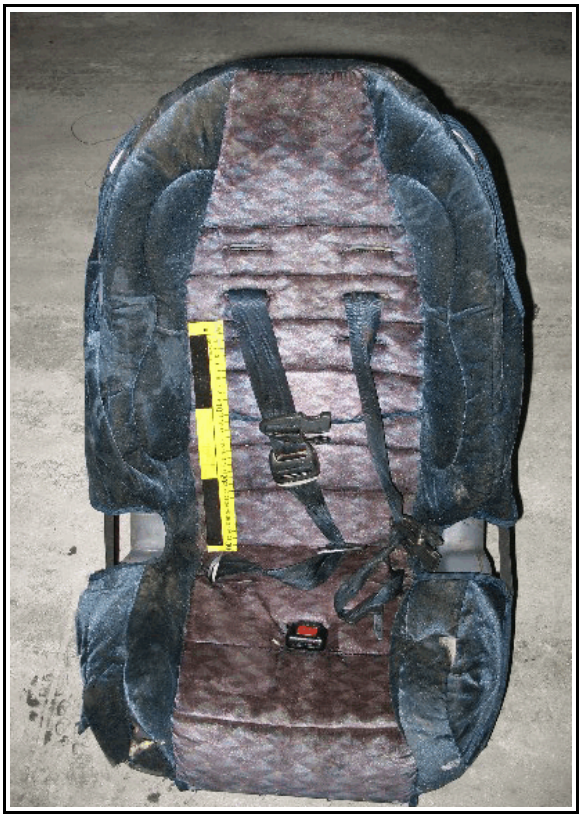

Figure 11. Evenflo booster seat

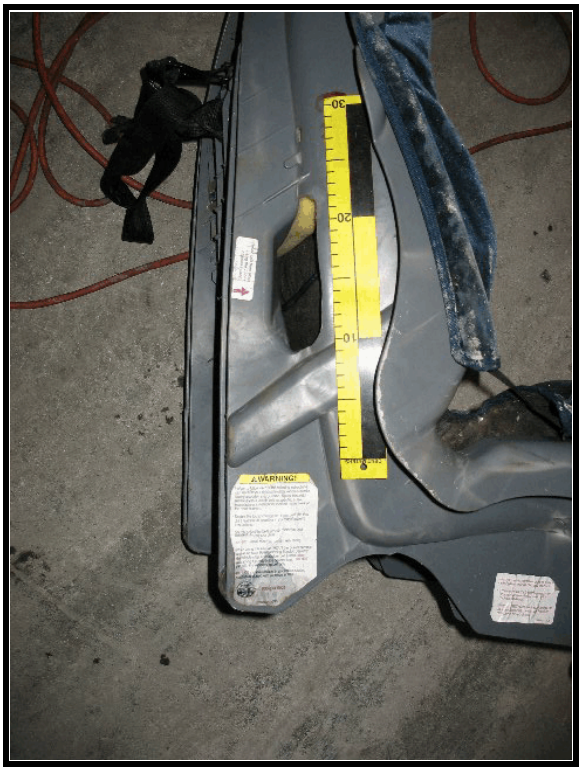

Figure 12. Load marks to booster seat anchor point on right

At the time of the inspection, the harness straps were routed through the middle set of harness slots. The harness retainer clip was positioned 20.0 cm (7.9 in) below the harness slot. The seat was generally old and the fabric was worn in several places. There were light fluid stains on the right side of the seat back and dark stains on the right towards the top of the seat back. The booster seat was installed forward facing using the vehicle lap and shoulder belt. The lap and shoulder belt was routed through the proper slot. There were indications of loading to the booster seat and the seat belt slot locations (**Figure 12**).

OCCUPANT DEMOGRAPHICS - 2004 Chevrolet Tahoe

	Driver	Occupant 2
Age/Sex:	25/Female	15/Female
Seated Position:	Front left	Front right
Seat Type:	Split bench	Split bench
Height:	165 cm (65 in)	Unknown
Weight:	59 kg (130 lbs)	64 kg (140 lbs)
Alcohol/Drug Involvement:	Tested positive for alcohol	Tested positive for ampetamines and cannibis
Body Posture:	Upright	Upright
Hand Position:	Unknown	Unknown
Foot Position:	Right foot presumed to be on brake, left on floor	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap belt available, not used
Air bag:	Steering wheel mounted frontal air bag, deployed	N/A

	Occupant 3	Occupant 4
Age/Sex:	23/Female	1-month/Female
Seated Position:	Front right	Second row left
Seat Type:	Split bench	Split bench
Height:	Unknown	Unknown
Weight:	65 kg (143 lbs)	Unknown
Alcohol/Drug Involvement:	None	None
Body Posture:	Upright	Seated in child safety seat
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, not used	Lap and shoulder belt available, used with child safety seat
Air bag:	Instrument panel mounted frontal air bag, did not deploy	N/A

	Occupant 5	Occupant 6
Age/Sex:	3/Female	8/Male
Seated Position:	Second row middle	Second row middle
Seat Type:	Split bench	Split bench
Height:	102 cm (40 in)	Unknown
Weight:	15 kg (33 lbs)	Unknown
Alcohol/Drug Involvement:	N/A	N/A
Body Posture:	Seated side by side with Occupant 6.	Seated side by side with Occupant 5.
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, not used	Lap and shoulder belt available, not used

	Occupant 7	Occupant 8
Age/Sex:	24/Male	4/Female
Seated Position:	Second row right	Third row left
Seat Type:	Split bench	Bench
Height:	Unknown	109 cm (43 in)
Weight:	73 kg (160 lbs)	15 kg (34 lbs)
Alcohol/Drug Involvement:	N/A	N/A
Body Posture:	Unknown	In child seat
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, not used.	Lap and shoulder belt available, not used. Seated in child safety seat.

	Occupant 9	Occupant 10
Age/Sex:	10/Male	2/Female
Seated Position:	Third row middle	Third row right
Seat Type:	Bench	Bench
Height:	Unknown	91 cm (36 in)
Weight:	Unknown	15 kg (33 lbs)
Occupation:	N/A	N/A
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	N/A	N/A
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap belt available, not used	Lap and shoulder belt used with child safety seat.

OCCUPANT INJURIES -2004 Chevrolet Tahoe

Driver: No reported injuries.

Front row middle occupant (2): Injuries obtained from History and Physical report, Discharge Summary, and Radiology reports.

Injury	OIC Code	Injury Mechanism	Confidence Level
Concussion	160499.1,0	Unknown	Unknown
Lacerations, right upper extremity	790602.1,1	Glass	Possible
Lacerations, right lateral pelvis and buttock area	590600.1,1	Glass	Possible
Abrasion, lateral left clavicle	790202.1,2	Unknown	Unknown
Contusion, left lateral neck	390402.1,1	Unknown	Unknown
Abrasions, contusions, both arms	790202.1,1 790202.1,2	Unknown	Unknown
Contusion and abrasion, right flank area	590202.1,1 590402.1,1	Unknown	Unknown
Contusion and abrasion, right lower chest area	490402.1,1 490202.1,1	Unknown	Unknown

Front row right occupant (03): Injuries obtained from ER Records, Radiology Records, Post-ER Medical Records and Discharge Report.

Injury	OIC Code	Injury Mechanism	Confidence Level
Fracture, open, left femur, mid shaft, resulting in 3 cm wound of posterior thigh and exposed femur	851814.3,2	Ground	Probable
Fractures, comminuted, medial and lateral tibial plateaus (condyles) Fracture, fibular head	853408.3,2 851606.2,2	Ground	Probable
Fracture, tibial condyle (plateau), right Fracture, medial femoral condyle, right	853406.2,1 851804.3,1	Ground	Probable

Avulsion, anterior cruciate ligament, right knee;	840404.2,1	Ground	Probable
Partial tear, posterior cruciate ligament, right knee;	840404.2,1	Ground	Probable
Tears, medial and lateral menisci, right knee	850822.2,1 850822.2,1	Ground Ground	Probable Probable
Fracture, transverse process, L5 vertebra	650620.2,8	Ground	Probable
Contusion, with pneumothorax, left lung	441406.3,2	Ground	Probable
Multiple comminuted pelvic fractures, right superior and inferior pubic rami;	852600.2,1	Ground	Probable
Pelvic fracture, left sacrum;	852600.2,2	Ground	Probable
Sacriolium fracture, with dislocation	852800.3,6	Ground	Probable
Rupture (laceration) NFS, urinary bladder, and associated retroperitoneum hemorrhage	540620.2,8	Ground	Probable
Abrasion, chin	290202.1,8	Ground	Probable

Second row left occupant (04): No reported injuries.

1st Second row middle occupant (05): Injuries obtained from ER Records, Radiology Records, Post-ER Medical Records and Discharge Report.

Injury	OIC Code	Injury Mechanism	Confidence Level
Length of unconsciousness known to be less than one hour; occupant was found unconscious, several feet from vehicle; occupant regained consciousness at scene, was awake on admission, and had GCS of 15 in ER	160202.2,0	Unknown	Unknown
Avulsion, superficial, right foot; laceration extended from anterior midline around to posterior midline, plantar; exposure of bone and tendons	890802.1,1	Unknown	Unknown

Abrasion, right eyebrow	290202.1,7	Unknown	Unknown
Multiple contusions, right lung, without hemo-/pneumothorax	441406.3,1	Unknown	Unknown
Contusion (hematoma), left posterior parietal scalp	190402.1,6	Unknown	Unknown

2nd second row middle occupant (06): Injuries obtained from Admitting Records, ER Records and, Radiology Records.

Injury	OIC Code	Injury Mechanism	Confidence Level
Fracture, displaced, right clavicle	752200.2,1	Ground	Probable
Laceration minor, Grade-1, liver	541822.2,1	Ground	Probable
Contusion, right lung	441406.3,1	Ground	Probable
Contusions, left cheek	290402.1,2	Ground	Probable
Abrasion, left eye, orbit	297202.1,2	Ground	Probable
Abrasion, right hip	890202.1,1	Ground	Probable
Fracture(chip), lower tooth	251404.1,8	Ground	Probable

Second row right occupant (07): Injuries obtained from ER Records, Radiology Records, Operative Report and Discharge Summary.

Injury	OIC Code	Injury Mechanism	Confidence Level
Fracture, comminuted and displaced, left femur, subtrochanteric	851818.3,2	Ground	Probable
Fracture, L4 vertebra	650616.2,8	Interior side surface	Possible
Fracture, non-displaced, anterior superior, R10 rib	450212.1,1	Interior side surface	Possible

Multiple lacerations(2 total, each is 2 cm), minor, left wrist	790602.1,2	Flying glass	Possible
Laceration (4 cm), minor, right wrist	790602.1,1	Flying glass	Possible
Contusion,(subcutaneous hematoma), back, right, measuring 2.8 cm x 15.3 cm	690402.1,1	Interior side surface	Possible
Abrasion, right temple	190202.1,1	Ground	Probable
Abrasion, left shoulder	790202.1,2	Ground	Probable
Abrasion, left knee	890202.1,2	Ground	Probable

Third row left occupant (08): Injuries obtained from Coroner's report.

Injury	OIC Code	Injury Mechanism	Confidence Level
Massive comminuted calvarial skull fractures	150404.3,9	Exterior of vehicle	Probable
Lacerations and contusions of left cerebral hemisphere	140602.3,2 140688.4,2	Exterior of vehicle	Probable
Basal skull fracture	150200.3,8	Exterior of vehicle	Probable
Cerebral edema and subarachnoid hemorrhage	140684.3,9	Exterior of vehicle	Probable
Contusion, right upper eyelid	297402.1,1	Unknown	Unknown
Abrasion, left forehead	290202.1,7	Unknown	Unknown
Laceration, midline of upper lip	290600.1,8	Unknown	Unknown

Third row middle occupant (09): Injuries obtained from ER Records, Radiology Records, and Operative Report.

Injury	OIC Code	Injury Mechanism	Confidence Level
Contusions, lungs, bilateral, without hemo-or pneumothorax	441410.4,3	Child seat shells	Possible
Laceration, liver, major	541826.4,1	Ground	Possible

Laceration NFS, spleen	544220.2,2	Ground	Possible
Adrenal gland hemorrhage (hematoma) NFS, right	540210.1,1	Ground	Possible
Colon (large bowel)injury NFS, described as diffuse bowel wall thickening and enhancement, consistent with shock bowel	540899.2,8	Ground	Possible

Third row right occupant (10): Injuries obtained from EMS Records, ER Records, Radiology Records, Operative Report, Discharge Summary.

Injury	OIC Code	Injury Mechanism	Confidence Level
Fracture, comminuted, orbital roof, left, extending to frontal bone and right orbital roof	150206.4,8	Roof rail	Probable
Subarachnoid hemorrhage, right frontal lobe, cerebrum	140684.3,1	Roof rail	Probable
Subdural hemorrhages, right frontal and right temporal lobes, middle crania fossa, cerebrum	140652.4,1	Roof rail	Probable
Avulsion, superficial, forehead, full thickness covering area 2.5 cm square	290802.1,7	Roof rail	Probable
Fracture, comminuted and displaced, humerous, distal shaft, left	752604.3,2	Unknown	Unknown
Contusion, (hematoma) liver	541810.2,1	Unknown	Unknown
Abrasions, hand, left	790202.1,2	Unknown	Unknown
Laceration, minor, nose	290602.1,4	Flying glass	Possible

OCCUPANT KINEMATICS - 2004 Chevrolet Tahoe

Driver Kinematics

The 24-year-old female driver was seated in an upright posture and was restrained by the 3-point lap and shoulder belt (**Figure 13**). The seat track was positioned to the mid track position. Prior to impact, the driver had lost control of the vehicle and it was beginning a counterclockwise rotation. The driver was likely steering back to the right to regain control of the vehicle. Roadway evidence suggested that the driver was braking. At impact with the guardrail, the frontal air bag deployed and the belt pretensioner actuated. The driver initiated a forward and slightly right trajectory in response to the 1 o'clock direction of force. She loaded the safety belt and contacted the deployed air bag. As the vehicle began to overturn to the right, she was displaced sharply in that direction, but did remain in her seat position. The vehicle overturned three quarter turns and came to rest on the driver's side. The driver was found in her original seating position after the crash. She was reportedly holding one of the other occupants in her arms when found.

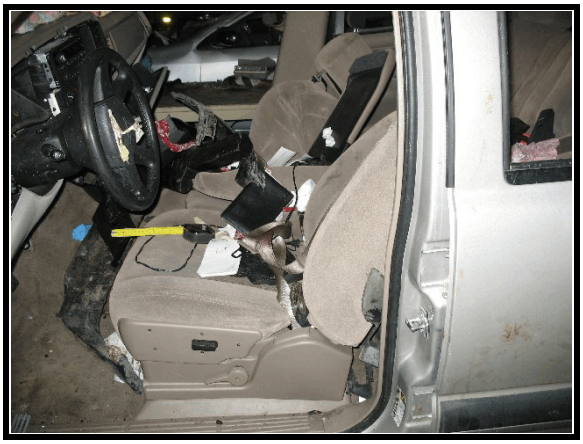

Figure 13. Driver's seated position

First Row Middle Occupant Kinematics

The unrestrained 15-year-old female first row middle occupant was seated in an unknown manner. At impact with the guardrail, she initiated a forward and slightly right trajectory. She likely engaged the center instrument panel to some degree. As the vehicle began to overturn to the right, she was displaced sharply in that direction. It is not known if she stayed in her original seating position. She sustained multiple lacerations and abrasions and was transported by ground ambulance to a local hospital.

First Row Right Occupant Kinematics

The unrestrained 23-year-old female first row right occupant was seated in an unknown fashion. At impact, she initiated a forward and slightly right trajectory. As the vehicle rolled she was ejected through the right side window. She sustained a right fibula fracture, a torn anterior cruciate ligament (ACL), a torn medial collateral ligament (MCL), and multiple contusions and abrasions. She was transported to a local trauma center and admitted.

Second Row Left Occupant Kinematics

The 1-month-old female second row left occupant was seated in a rear facing child safety seat. The make/model of the seat is unknown. The child seat was secured to the vehicle. According to the police, the child was secured using the child seat internal harness. At impact, she initiated a forward and slightly right trajectory into the child seat shell. As the vehicle rolled over, the child and child

seat remained in place. She and the child seat were removed by emergency personnel. The vehicle's lap and shoulder belt was cut to remove the child seat. She was evaluated by paramedics who did not diagnose any injuries.

1st Second Row Middle Occupant Kinematics

The unrestrained 3-year-old female second row middle occupant was seated in an unknown fashion. This seat position was also occupied by another occupant. This occupant remained in the vehicle throughout the crash sequence. The 3-year-old sustained a severe laceration to the right foot and multiple contusions and abrasions. She was transported by helicopter to an area trauma center where she was treated and released.

2nd Second Row Middle Occupant Kinematics

The unrestrained 8-year-old male second row middle occupant was seated in an unknown fashion. This seat position was also occupied by another occupant. As the vehicle overturned onto its right side, he was ejected–possibly through the right side window. He sustained a liver laceration, a right shoulder fracture, and multiple contusions and abrasions. He was transported by helicopter to an area trauma center for treatment and admitted. He was hospitalized an unknown number of days.

Second Row Right Occupant Kinematics

The unrestrained 24-year-old male second row right occupant was seated in an unknown fashion. At impact, he initiated a forward and slightly right trajectory. As the vehicle overturned onto its right side, he was ejected through the right side window. He sustained a left femur fracture, a hip fracture, and multiple contusions and abrasions. He was transported by helicopter to an area trauma center for treatment.

Third Row Left Occupant Kinematics (08)

The 4-year-old female child was seated in a Cosco/Dorel High Back Booster seat (**Figure 14**). The seat was not secured to the vehicle and the child was not using the seat's internal harness. At impact, she initiated a forward and slightly right trajectory and likely came into contact with the second row seat back. During the rollover sequence, the CSS pivoted within the passenger compartment. As the Tahoe landed on its roof, the booster seat became entrapped between the left side roof/roof siderail and the plastic side panel. The seat was being held in place and was totally immobile above the vehicle seat bottom. The seat was rotated approximately 20 degrees in the clockwise direction. The plastic seat back was deformed forward, slightly downward and was

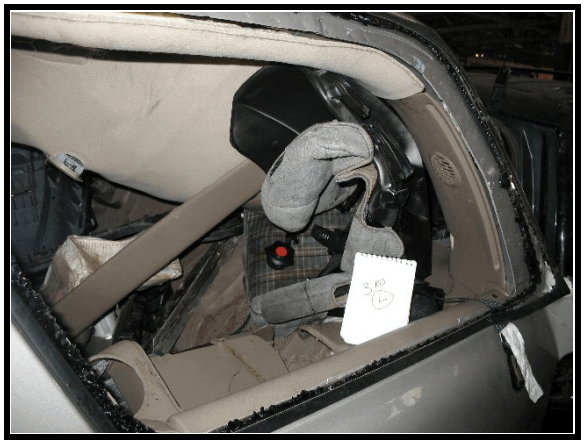

Figure 14. Booster seat as seen from outside left side of vehicle

twisted in a counterclockwise direction approximate 90 degrees. According to one investigating officer, the child was partially ejected from the vehicle. Her head and torso were completely outside of the vehicle and she was being held in place a component in the vehicle that was trapping her leg or foot. She sustained a visible head injury and was fatally injured.

Third Row Middle Occupant Kinematics

The unrestrained 10-year-old male third row middle occupant was seated in an unknown fashion. At impact, he initiated a forward and slightly right trajectory. As the vehicle overturned onto its right side, he was ejected through the right side window. He was ejected early in the rollover sequence. He was located in the center divider area approximately 23 m (75 ft) south of the case vehicle's final rest. He sustained a liver laceration, a neck fracture, and multiple contusions and abrasions. He was transported by helicopter to a local hospital where he was admitted and hospitalized for an unknown number of days.

Third Row Right Occupant Kinematics

The 2-year-old third row right occupant was seated in an Evenflo Express Booster seat. The child seat was secured to the vehicle by the vehicle's 3-point lap and shoulder belt. The child was wearing the 5-point internal harness. At the time of the inspection, the harness straps were routed through the middle set of harness slots. The harness retainer clip was positioned 20.0 cm (7.9 in) below the middle harness slot. At impact, she initiated a forward and slightly right trajectory and loaded the child seat internal harness. As the vehicle rolled, the right side roof was crushed and likely came into contact with this occupant's head. She sustained a brain injury with bleeding, a right arm fracture, and internal bleeding. She was located still in her car seat, hanging down towards the driver's side of the vehicle. She appeared to be unconscious. One of the investigating police officers noted that the vehicle safety belt was across her neck and was possibly cutting off her air way. He used his knife to cut off the safety belt while another officer held the child seat in place. She was transported by helicopter to an area trauma center for treatment.

Attachment 1. Scene Diagram