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ON-SITE CHILD SAFETY SEAT INVESTIGATION

CASE NUMBER - IN08046
LOCATION - OHIO
VEHICLE - 1998 CHEVROLET MALIBU LS
CRASH DATE - November 2008

Submitted:

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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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15. <i>Supplementary Notes</i> On-site investigation involving two child safety seats secured in a 1998 Chevrolet Malibu LS.					
16. <i>Abstract</i> <p>This report covers an On-Site Child Safety Seat Investigation that involved a 1998 Chevrolet Malibu LS and a 2004 Ford Escape Limited, which were involved in a frontal crash on a 2-lane rural roadway. The investigation focused on the sources of injuries for the Chevrolet's fatally injured second row left passenger (3-year-old, female). The passenger was seated in a Cosco Juvenile Booster Car Seat, which was used as a Forward-Facing Seat (FSS). The second row right passenger (10-month-old, male) was seated in a forward facing Evenflo Convertible Safety Seat (CSS). The second row right passenger sustained severe injuries. The Chevrolet was traveling southeast approaching a hill crest. The Ford was traveling northwest in the southeast lane and was in the process of passing an uninvolved tractor semitrailer. The front of the Ford impacted the front of the Chevrolet and both vehicles came to final rest on the roadway. The Chevrolet's unrestrained driver and restrained second row left passenger were pronounced deceased at the crash scene. The Chevrolet's restrained second row right passenger and the Ford's driver were transported by ambulance to a hospital. The Chevrolet's driver sustained a skull fracture, transection of the spinal cord, and multiple internal injuries due to loading the steering wheel. The Chevrolet's second row left passenger sustained a skull fracture and fractured right femur due to contacting the back of the driver's seat. She also sustained lung contusions due to loading the FSS harness straps. The FSS in which she was seated was secured in the vehicle by the lap-and-shoulder belt and was not damaged. The Chevrolet's second row right passenger sustained an intraventricular hemorrhage and compression fractures of the thoracic and lumbar vertebrae. He was hospitalized for seven days. The CSS was secured in the vehicle by the lap-and-shoulder belt. The plastic shell was fractured at the harness strap slots due to the passenger loading the harness straps during the crash.</p>					
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This on-site investigation focused on the sources of injuries for the Chevrolet's fatally injured second row left passenger (3-year-old, female). The passenger was seated in a Cosco Juvenile Booster Car Seat, which was used as a Forward-Facing Seat (FSS). The second row right passenger (10-month-old, male) was seated in a forward facing Evenflo Convertible Child Safety Seat (CSS) and sustained serious injuries. This crash was brought to the National Highway Traffic Safety Administration's attention on November 12, 2008 by a news article from a Kentucky newspaper. This on-site investigation was assigned on December 8, 2008. The crash involved a 1998 Chevrolet Malibu LS (**Figure 1**) and a 2004 Ford Escape Limited. The crash occurred in November, 2008, at 1345 hours, in Ohio and was investigated by the Ohio State Highway Patrol. This contractor inspected both vehicles, the crash scene, and interviewed the driver's husband (non-passenger) on December 11, 2008. Only the second row left passenger's CSS was available for inspection. This report is based on the police crash report, police photographs, scene and vehicle inspections, an interview with the Chevrolet driver's husband and investigating police officer, occupant medical records, occupant kinematic principles, and this contractor's evaluation of the evidence.



Figure 1: The damaged 1998 Chevrolet Malibu LS

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which both vehicles were traveling on was a 2-lane, undivided, county roadway, traversing in a northwesterly and southeasterly direction. The trafficway had one through lane in each direction and was bordered by bituminous and grass shoulders. The northwesterly travel lane was 3.0 m (9.8 ft) in width and the southeasterly travel lane was 2.8 m (9.2 ft) in width. Each shoulder was nominally 1.2 m (3.9 ft) in width. The roadway pavement markings consisted of solid white edge lines and each lane had a solid yellow no passing center line. The Chevrolet's roadway had a positive 5% grade while the Ford's roadway had a positive 5.2% grade. The impact occurred on the crest of a hill and the grade was level in this area. The speed limit for both vehicles was 89 km/h (55 mph). At the time of the crash the light condition was daylight and the atmospheric condition was rain. The roadway pavement was wet bituminous and the site of the crash was rural residential. See the Crash Diagram on page 15 of this report.

Pre-Crash: The Chevrolet was occupied by an unrestrained 23-year-old female driver, a 3-year-old female second row left passenger, and an 10-month-old male second row right passenger, who were both restrained in child seats. The Chevrolet was traveling southeast and the driver intended to continue straight ahead (**Figure 2**). The Ford was driven by a restrained 54-year-old female driver and was traveling northwest in the southeast lane (**Figure 3**). The Ford's driver was in the process of passing an uninvolved tractor semitrailer. The crash scene inspection revealed no

evidence of pre-impact braking and the police crash report made no mention of any avoidance actions taken by either driver. The crash occurred on the hill crest in the southeast lane.

Crash: The front of the Ford (**Figure 4**) impacted the front of the Chevrolet (**Figure 1**, event 1). The vehicle's remained engaged during the impact and the Ford was pushed backward 1.5 m (5 ft) as it rotated 20 degrees counterclockwise. Both vehicles came to final rest on the southeast lane with the Ford heading northwest and the Chevrolet heading southeast (**Figure 5**). A fire ignited (event 2) in the right side of the Ford's engine compartment and burned components in the engine compartment and the hood, right fender, and right front wheel, as well as the Chevrolet's left fender, left front wheel, left A-pillar, and left front door. A nearby homeowner used household fire extinguishers to put out the fire.

Post-Crash: The police, fire rescue, and emergency medical services were notified and responded to the crash scene. The Chevrolet's driver and second row left passenger were pronounced deceased at the crash scene while the second row right passenger was transported by ambulance to a hospital. The Ford's driver was also transported by ambulance to a hospital. Both vehicles were towed from the scene due to damage.

CASE VEHICLE

The 1998 Chevrolet Malibu LS was a front wheel drive, 4-door sedan (VIN: 1G1ND52T6W6-----) that was manufactured in August of 1997. The vehicle was equipped with a 2.4L, L4 engine, automatic transmission and an Event Data Recorder (EDR). The front row was equipped with bucket seats, adjustable head restraints, driver and front right passenger redesigned frontal air bags, and lap-and-shoulder belts with adjustable upper anchors. The second row was equipped with a bench seat, integral head restraints, lap-and-shoulder belts at the outboard seating positions, and a lap belt in the center seating position. The vehicle was not equipped with Lower



Figure 2: Chevrolet's approach to the impact area



Figure 3: Police on-scene photo showing Ford's approach to impact area and final rest positions of both vehicles



Figure 4: Damage to the front of the Ford from impact with the front of the Chevrolet

Anchors and Tethers for Children (LATCH). The vehicle’s mileage could not be determined due to the extent of the damage to the instrument panel. The driver’s husband estimated the vehicle’s mileage was approximately 209,209 kilometers (130,000 miles) The vehicle’s specified wheelbase was 272 cm (107 in).

CASE VEHICLE DAMAGE

Exterior Damage: The Chevrolet’s impact with the Ford involved the front plane (Figure 6). The bumper, bumper fascia, grille, hood, both turn signal and headlamp assemblies, left fender, left front wheel, left front door, and left A-pillar were all directly damaged. The direct damage began at the front left bumper corner and extended 125 cm (49.2 in) along the bumper. The crush measurements were taken on the front bumper and the maximum residual crush was 146 cm (57.5 in) occurring at C₁ (Figure 7). The table below shows the vehicle’s front crush profile.



Figure 5: Police on-scene photo showing the Chevrolet and Ford at final rest

Units	Event	Direct Damage		Field L	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	125	146	69	146	136	126	122	120	73	-10	0
in		49.2	57.5	27.2	57.5	53.5	49.6	48.0	47.2	28.7	-3.9	0.0

The left side wheelbase was reduced 79 cm (31.1 in) and the right side wheelbase was reduced 10 cm (3.9 in). The induced damage involved the windshield, all the doors, left quarter panel, roof, left roof side rail, the right fender, and right A-pillar.

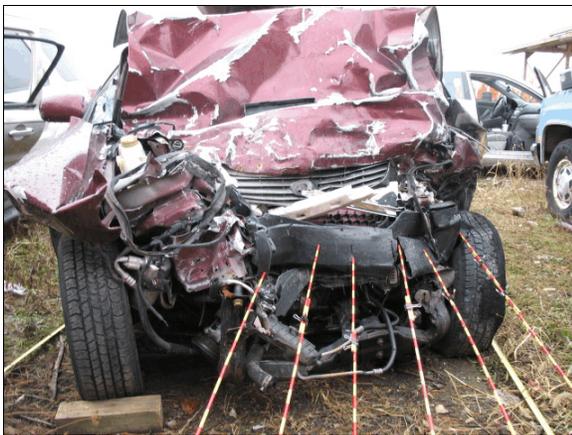


Figure 6: Damage to front plane of the Chevrolet from the impact with the front of the Ford



Figure 7: Overhead view of Chevrolet’s front crush profile

Damage Classification: The Chevrolet’s Collision Deformation Classification (CDC) was **12-FDEW-6 (0 degrees)** for the impact with the Ford. The Damage algorithm of the WinSMASH program calculated the Chevrolet’s total Delta V as 109 km/h (67.7 mph). The longitudinal and lateral velocity changes were -109 km/h (67.7 mph) and 0 km/h, respectively. The crush to the Chevrolet was severe enough to collapse the passenger compartment and left sill (**Figure 8**), which indicated that the severity of this crash was beyond the scope of the program’s stiffness coefficients to properly model the Chevrolet’s crush characteristics. The stiffness coefficients used in the reconstruction are derived from 56 km/h (35 mph) barrier tests, which do not adequately model the dynamics of the crush sustained by the Chevrolet in this crash. The results were therefore considered high.



Figure 8: Collapse of the Chevrolet’s passenger compartment and left sill

The manufacturer’s recommended tire size was P215/60R15, but the vehicle was equipped with tires sized P195/65R15. The Chevrolet’s tire data are shown in the table below.

Tire	Measured Pressure		Vehicle Manufacturer’s Recommended Cold Tire Pressure		Tread Depth		Damage	Restricted	Deflated
	kPa	psi	kPa	psi	milli-meters	32 nd of an inch			
LF	Flat	Flat	200	29	4	5	Charred from fire	Yes	Yes
LR	207	30	179	26	6	7	None	No	No
RR	221	32	179	26	6	8	None	No	No
RF	193	28	200	29	6	8	None	No	No

Vehicle Interior: Inspection of the Chevrolet’s interior revealed occupant contacts on the driver’s air bag, steering wheel, and lower instrument panel (**Figure 9**). The steering wheel rim was completely collapsed and the steering column was displaced vertically due to loading by the driver. The instrument panel was significantly deformed on both sides of the steering column due to loading by the driver’s knees. There was no discernable evidence of occupant contact in the second row.

The vehicle’s left side doors were jammed shut and had been cut off the vehicle by rescue personnel to extricate the occupants. The right side doors remained closed during the crash. They were open at the inspection and would not close due to the induced damage. All of the window glazing was either fixed or closed at the time of the crash. The left front window glazing was

disintegrated due to impact forces. The police on-scene photos showed that the left rear and second left rear window glazing were not damaged. The windshield was in place and holed by impact forces.

The Chevrolet sustained significant passenger compartment intrusions into the front row, which all occurred on the longitudinal axis. The most severe intrusions occurred in the driver's space and involved the left A-pillar, toe pan, and instrument panel. The left A-pillar and toe pan intruded 63 cm and 58 cm (24.8 in and 22.8 in), respectively. The left and center instrument panel intruded 48 cm and 52 cm (19 in and 20 in), respectively. The second row seat back was loaded by an object in the trunk. The seat back intruded longitudinally into the left, middle, and right seating positions 12 cm, 20 cm, and 10 cm (4.7 in, 7.9 in, and 3.9 in), respectively.



Figure 9: The Chevrolet's damaged instrument panel and steering assembly

EVENT DATA RECORDER

The Chevrolet's EDR was removed by the police reconstruction unit. Attempts to obtain the EDR data were unsuccessful.

AUTOMATIC RESTRAINT SYSTEM

The Chevrolet was equipped with a redesigned frontal air bag system. The driver's air bag was located within the steering wheel hub and the front right passenger's air bag was located within the top of the instrument panel. Both air bags deployed as a result of this crash.

The deployed driver's air bag was 62 cm (24 in) in diameter. It had two vent ports and two tethers. The air bag sustained a tear 4 cm (1.6 in) in length and a few small holes on the air bag's upper left quadrant. The tear was probably due to contact with the intruded left A-pillar while the small holes were the result of flying side glass particles from the left front window glazing. Also, the air bag was partially melted along the outer portions of the upper and lower left quadrants due to the fire.

The deployed front right passenger air bag was 48 cm (19 in) in width and 65 cm (26 in) in height. It was equipped with one wide tether and had no visible vent ports. The air bag sustained no damage.

MANUAL RESTRAINT SYSTEM

The Chevrolet was equipped with lap-and-shoulder belts for both front row seating positions and the second row outboard seating positions. The second row middle seat position was equipped

with a lap belt. The driver's seat belt consisted of continuous loop belt webbing and an Emergency Locking Retractor (ELR). The front right seat belt was equipped with continuous loop belt webbing, a switchable ELR/Automatic Locking Retractor (ALR), sliding latch plate, and an adjustable upper anchor that was located in the full up position. The second row outboard seat belts consisted of continuous loop belt webbing, locking latch plates, ELRs, and tethered shoulder belt clips (**Figure 10**). The second row middle lap belt was equipped with a locking latch plate.



Figure 10: Shoulder belt clip attached to elastic tether cord for second row left seat belt

The driver's seat belt had been cut out of the vehicle and was not available for inspection. Based on the driver's injuries and autopsy report, she was unrestrained.

The inspection of the second row left passenger's seat belt assembly revealed historic usage scratches on the latch plate, stretched belt webbing (**Figure 11**), and a jammed retractor. The stretched condition of the webbing and the jammed retractor indicated that the second row left passenger's FSS was secured by the lap-and-shoulder belt at the time of the crash.



Figure 11: Arrow shows stretched belt webbing of second row left seat belt

Inspection of the second row right passenger's seat belt assembly revealed historic usage scratches on the latch plate. The webbing had also been cut by rescue personnel to facilitate extrication of the passenger. The passenger's medical records indicated he was removed from the vehicle while still in the CSS. This evidence and information indicated that the second row right passenger's CSS was probably secured by the lap-and-shoulder belt at the time of the crash.

CHILD SAFETY SEATS

Second Row Left Child Safety Seat: The Chevrolet's second row left passenger [3-year-old, female; 97 cm and 17 kg (38 in and 38 lbs)] was seated in a Cosco Juvenile Booster Car Seat (**Figure 14**), which was designed to be used as a High Back Booster Seat or an FSS. It was used as an FSS in this crash. The FSS was manufactured on January 6, 2000 and the model number was 02-442-PRI. When used with the 5-point harness, the FFS was designed for children who

weighed 10-18 kg (22-40 lbs) and were less than 102 cm (40 in) in height. When used as a belt positioning booster seat, the FFS was designed for children who weighed 14-36 kg (30-80 lbs) and who were 94 cm (37 in) to 130 cm (51 in) in height.

The FFS was constructed of a one piece plastic shell and had a 5-point harness and harness retainer clip. There were two sets of harness slots on the seat back. The top slots were equipped with a steel reinforcement bar. The purpose of this design feature is to minimize forward flexing of the seat back during a crash. The harness straps must be routed through the top slots in order for this feature to be effective. In this crash, the harness straps were routed through the bottom set of slots. The plastic shell was fitted with a cloth covered foam pad. The FFS was not equipped with a LATCH system or tether.

At the SCI vehicle inspection, the FFS was located on the second row unsecured by the vehicle's second row left seat belt. The police photographs showed that the FFS had been removed from the vehicle at some point, either at the crash scene or during the subsequent police inspection of the vehicle. The SCI inspection of the FFS revealed load abrasions on both seat belt guides located on the back of the FFS. A significant accumulation of blood was present under the pad and on the lower portion of the right harness strap. The harness straps were twisted and the left harness strap was routed through the harness retainer clip. The FFS was not damaged and no load marks were present on the plastic shell. A determination of the distance between the FFS and the driver's seat back could not be made since the driver's seat back had been cut out of the vehicle.

Second Row Right Child Safety Seat: The forward facing convertible CSS (**Figure 15**) used by the second row right passenger [10-month-old, male; 79 cm and 11 kg (31 in and 24 lbs)] was not available for inspection and all information contained herein was obtained from photographs provided by the police. The CSS was an Evenflo Tribute, but the date of manufacture could not be determined. The CSS was constructed of a one-piece plastic shell that was fitted with a cloth



Figure 14: The second row left passenger's FFS



Figure 15: The second row right CSS



Figure 16: Damage on back of second row right CSS

covered foam pad. It was equipped with a 5-point harness, harness retainer clip, and a tether strap. The CSS had three sets of harness slots and the harness straps were threaded through the middle slots. The top harness slots were reinforced for forward facing use, while the middle and lower slots are not reinforced. Since the harness straps were routed through the middle slots, the plastic shell fractured due to the passenger loading the harness straps during the crash (**Figures 16 and 17**) and the splitter plate was stuck within the shell. The damage to the plastic shell was confined to this area (**Figure 17**).



Figure 17: Close view of damage to the shell of the second row right CSS

CASE VEHICLE DRIVER KINEMATICS

The Chevrolet’s driver [23-year-old, female; 163 cm and 79 kg(64 in and 174 lbs)] was seated in an unknown posture. The seat track was located between the middle and rear-most position. The seat back had been cut off the seat by rescue personnel. The position of the tilt steering column was also unknown due to the damage to the steering wheel and column due to loading by the driver.

The Chevrolet’s impact with the Ford displaced the driver forward, opposite the 12 o’clock direction of force and she loaded the air bag. The crash was severe and the driver rode down the air bag and contacted the steering wheel. As a result, the driver sustained a skull fracture, transection of the spinal cord, laceration of the aorta, multiple rib fractures, and lacerations of the lung, liver, and spleen. The driver also sustained fractures of the upper and lower extremities and pelvis from loading the instrument panel, as well as multiple lacerations, abrasions, and contusions. The driver remained in her seat following the crash.

CASE VEHICLE DRIVER INJURIES

The Chevrolet’s driver was pronounced deceased at the scene. The table below shows the driver’s injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Fracture (ring) base of skull with fracture running across middle cranial fossa and posterior cranial fossa, enclosing foramen magnum	severe 150206.4,8	Steering wheel rim, upper portion	Certain	Autopsy

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
2 3	Laceration {transection} of thoracic spinal cord with fractures of T ₅ and T ₆ , not further specified	critical 640464.5,7 650416.2,7	Steering wheel hub and/or spokes and rim	Certain	Autopsy
4	Laceration {transection} of descending aorta, not further specified	serious 420206.4,4	Steering wheel hub and/or spokes and rim	Certain	Autopsy
5	Fractured ribs: 5 th through 9 th on right; 1 st through 5 th , and 9 th , and 10 th on left with 500 ml of left hemothorax ¹	critical 450242.5,3	Steering wheel hub and/or spokes and rim	Certain	Autopsy
6	Laceration right lower lobe of lung with 150 ml of right hemothorax	serious 441430.3,1	Steering wheel hub and/or spokes and rim	Certain	Autopsy
7	Lacerations, multiple, both lobes of liver through capsule and parenchyma	moderate 541820.2,1	Steering wheel hub and/or spokes and rim	Certain	Autopsy
8	Lacerations, multiple, spleen through capsule and parenchyma	moderate 544220.2,2	Steering wheel hub and/or spokes and rim	Certain	Autopsy
9	Fracture left ulna, not further specified	moderate 753200.2,2	Left instrument panel	Probable	Autopsy
10	Fracture anterior pelvis {pubic ramus}, not further specified	moderate 852600.2,5	Left lower instrument panel {indirect injury}	Probable	Autopsy
11	Fracture, palpable, right femur, not further specified	serious 851800.3,1	Left lower instrument panel, right of steering column {indirect injury}	Certain	Autopsy
12	Fracture, open, left femur, not further specified	serious 851801.3,2	Left lower instrument panel, left of steering column {indirect injury}	Certain	Autopsy
13	Contusion left temporal scalp, not further specified	minor 190402.1,2	Air bag, driver's	Probable	Autopsy
14	Abrasions lower lip and chin	minor 290202.1,8	Air bag, driver's	Certain	Autopsy
15	Abrasions, multiple left and right upper chest	minor 490202.1,3	Air bag, driver's	Probable	Autopsy

¹ This patient's hemothorax was separated between lesions because of the differences between the number of rib fractures from side-to-side and the corresponding differences in volume of hemothorax.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
16	Contusions {abrasive} right upper chest, not further specified	minor 490402.1,1	Air bag, driver's	Probable	Autopsy
17	Abrasions, 15.2 x 10.2 cm (6 x 4 in) in aggregate, right lower chest and upper abdomen	minor 590202.1,7	Air bag, driver's	Probable	Autopsy
18	Abrasion, 7.6 x 2.5 cm (3 x 1 in) left lower abdomen	minor 590202.1,2	Steering wheel rim, lower portion	Probable	Autopsy
19	Abrasion posterior right forearm, not further specified	minor 790202.1,1	Center instrument panel	Probable	Autopsy
20	Abrasion posterior left forearm associated with fractured left ulna	minor 790202.1,2	Left instrument panel	Probable	Autopsy
21	Abrasions, 12.7 x 10.2 cm (5 x 4 in) in aggregate, right thigh associated with fractured femur	minor 890202.1,1	Center lower instrument panel	Certain	Autopsy
22	Abrasions 12.7 x 12.7 cm (5 x 5 in) in aggregate, anterior left thigh associated with open left femur fracture	minor 890202.1,2	Left lower instrument panel, left of steering column	Certain	Autopsy
23	Avulsion, 20.3 x 17.8 cm (8 x 7 in) left medial thigh	moderate 890804.2,2	Left lower instrument panel, left of steering column	Certain	Autopsy
24	Abrasion, 20.3 x 0.3 cm (8 x 1/8 in) anterior right leg, not further specified	minor 890202.1,1	Center lower instrument panel	Certain	Autopsy
25	Laceration anterior right leg, location not further specified	minor 890602.1,1	Center lower instrument panel	Certain	Autopsy
26	Abrasions x 2, anterior left leg, location not further specified	minor 890202.1,2	Left lower instrument panel, left of steering column	Certain	Autopsy
27	Laceration, 5.1 x 2.5 cm (2 x 1 in) left leg, not further specified	minor 890602.1,2	Left lower instrument panel, left of steering column	Certain	Autopsy
28	Avulsion, 6.4 x 2.5 cm (2.5 x 1 in) left leg, not further specified	minor 890802.1,2	Left lower instrument panel, left of steering column	Certain	Autopsy

The Chevrolet's second row left passenger [3-year-old, female; 97 cm and 17 kg (38 in and 38 lbs)] was seated in an unknown posture in the FSS.

The Chevrolet's impact with the Ford displaced the second row left passenger forward, opposite the 12 o'clock direction of force and she loaded the FSS harness, and the FSS loaded the seat belt, which was securing it in the vehicle. While the inspection of the driver's seat back revealed no discernable evidence of occupant contact, it is probable that due to the severity of the crash, the FSS and the passenger were displaced forward and the passenger contacted the driver's seat back. Since the harness straps were not routed through the FSS's top reinforced slots, it is possible that the FSS seat back flexed. The flexing action in combination with the stretching of the vehicle's seat belt allowed the passenger right left and face to contact the back of the driver seat. As a result, she sustained a basilar skull fracture, fractured right femur, and multiple facial abrasions. The passenger also sustained bilateral lung contusions from loading the harness and multiple contusions and abrasions.

CASE VEHICLE SECOND ROW LEFT PASSENGER INJURIES

The second row left passenger was pronounced deceased at the scene. The table below shows the passenger's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Fracture (ring) base of skull with fracture running across middle cranial fossa and posterior cranial fossa, encircling foramen magnum	severe 150206.4,8	Seat back, driver's	Probable	Autopsy
2	Contusions bilateral lungs, pleural surfaces and parenchyma, not further specified	severe 441410.4,3	Child safety seat harness straps	Probable	Autopsy
3	Fracture, palpable, right femur with right lower extremity externally rotated, location not further specified	serious 851800.3,1	Seat back, driver's	Probable	Autopsy
4	Abrasion right forehead, location not further specified	minor 290202.1,7	Seat back, driver's	Probable	Autopsy
5	Abrasions, multiple, 15.2 x 5.1 cm (6 x 2 in) in aggregate, right side of face	minor 290202.1,1	Seat back, driver's	Probable	Autopsy
6	Abrasion on chin, location not further specified	minor 290202.1,8	Seat back, driver's	Probable	Autopsy
7	Abrasion right side of neck, not further specified	minor 390202.1,1	Child safety seat harness straps	Certain	Autopsy

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
8	Abrasions, multiple, largest 10.2 x 2.5 cm (4 x 1 in), along lower abdomen	minor 590202.1,8	Child safety seat harness straps	Certain	Autopsy
9	Abrasion left posterior forearm, location not further specified	minor 790202.1,2	Child safety seat's left side surface	Probable	Autopsy
10	Contusion, 2.5 x 2.5 cm (1 x 1 in) right elbow	minor 790402.1,1	Child safety seat's right side surface	Probable	Autopsy
11	Abrasion right upper thigh, location not further specified	890202.1,1	Child safety seat harness straps	Possible	Autopsy
12	Contusion x 2, anterior right leg, not further specified	minor 890402.1,1	Seat back, driver's	Probable	Autopsy
13	Contusion, 5.1 x 2.5 cm (2 x 1 in) dorsum left foot	minor 890402.1,2	Seat back, driver's	Probable	Autopsy

CASE VEHICLE SECOND ROW RIGHT PASSENGER KINEMATICS

The Chevrolet's second row right passenger [10-month-old, male; 79 cm and 11 kg (31 in and 24 lbs)] was seated in an unknown posture in the forward facing CSS.

The Chevrolet's impact with the Ford displaced the second row right passenger forward, opposite the 12 o'clock direction of force. He loaded the CSS harness, which was routed through the unreinforced middle harness slots, and the CSS's plastic shell fractured displacing the harness straps from the harness slots. The passenger sustained lung contusions, fractured right and left clavicles, and compression fractures of T₁₂, L₁, and L₂ due to loading the harness straps. While there was no discernable evidence of occupant contact on the front right seat back, the passenger's left leg probably loaded the seat back, which resulted in fractures of the distal tibia and fibula. He rebounded and his head loaded the CSS's seat back. The passenger sustained a small intraventricular hemorrhage, probably due to this contact. The passenger's medical records indicated that he was taken out of vehicle while still in his CSS.

CASE VEHICLE SECOND ROW RIGHT PASSENGER INJURIES

The second row right passenger was transported by ambulance to a local hospital, and subsequently transferred to an urban children's medical center where he was hospitalized for seven days. The table below shows the passenger's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Hemorrhage, small, intraventricular, right occipital horn or ventricle	severe 140678.4,1	Child safety seat's back top surface	Certain	Hospitalization records
2	Contusions, small, bilateral apical portions of upper lobes of lungs	severe 441410.4,3	Child safety seat harness straps	Certain	Hospitalization records
3 4 5	Fractures, compression, mild, anterior portion of T ₁₂ , L ₁ , and L ₂ , without compromise of spinal canal	moderate 650432.2,7 650632.2,8 650632.2,8	Child safety seat harness straps	Certain	Hospitalization records
6	Fracture, closed, middle 1/3 {shaft} left clavicle with mild angulation	moderate 752200.2,2	Child safety seat harness straps	Certain	Hospitalization records
7	Fracture, closed, right clavicle, with mild angulation	moderate 752200.2,1	Child safety seat harness straps	Certain	Hospitalization records
8	Contusion {ecchymosis} superior back, not further specified	minor 690402.1,7	Child safety seat's back top surface	Certain	Emergency room records
9 10	Fractures, Salter-Harris II ² , left distal tibia and fibula with mildly displaced distal metaphysis with slight angulation	moderate 851606.2,2 serious 853422.3,2	Seat back, front right passenger's	Probable	Hospitalization records
11 12	Abrasions left and right sides of neck with swelling	minor 390202.1,1 390202.1,2	Child safety seat harness straps	Certain	Hospitalization records
13 14	Contusion {ecchymoses} on bilateral sides of neck, 4 x 3 cm (1.6 x 1.2 in) on left and 4 x 2 cm (1.6 x 0.8 in) on right	minor 390402.1,1 390402.1,2	Child safety seat harness straps	Certain	Emergency room records
15 16	Contusions over left and right iliac crests, not further specified	minor 590402.1,1 590402.1,2	Child safety seat harness straps	Certain	Hospitalization records
17 18	Abrasions over left and right clavicles	minor 790202.1,1 790202.1,2	Child safety seat harness straps	Certain	Hospitalization records

² The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
fracture (frak'cher): 1. the breaking of a part, especially a bone. 2. a break or rupture in a bone.
epiphyseal f.: fracture at the point of union of an epiphysis with the shaft of the bone.
Salter-Harris f.: an epiphyseal fracture in children that involves the epiphyseal growth plate.

The 2004 Ford Escape Limited was a 4-wheel drive, 4-door, sport utility vehicle (VIN: 1FMCU94194K-----) that was manufactured in August, 2003. It was equipped with a 3.0L, V6 engine, automatic transmission, and 4-four wheel anti-lock disc brakes. Frontal and seat back-mounted side impact air bags are standard on the vehicle. The vehicle's specified wheelbase was 262 cm (103.1 in).

Exterior Damage: The Ford's impact with the Chevrolet involved the entire front plane. The direct damage involved the left fender, front bumper, grille, and hood (**Figure 4**). The direct damage began at the front left bumper corner and extended 119 cm (46.9 in) across the front bumper. The maximum residual crush was 78 cm (30.7 in) occurring at C₃. The table below shows the vehicle's front crush profile.

Units	Event	Direct Damage		Field L	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	119	78	89	68	72	78	69	65	23	-17	0
in		46.9	30.7	35.0	26.8	28.3	30.7	27.2	25.6	9.1	-6.7	0.0

The vehicle's left side wheelbase was reduced 37 cm (15 in) and right side wheelbase was extended 1 cm (0.4 in). The induced damage involved both fenders, the windshield, roof, left roof side rail, and both front doors. The engine compartment components, hood, right fender, and right front wheel were charred as a result of the engine compartment fire.

Damage Classification: The Ford's CDC for the front impact with the Chevrolet was **12-FDEW-4** (0 degrees). The Damage algorithm of the WinSMASH program calculated the vehicle's total Delta V as 102 km/h (63.4 mph). The longitudinal and lateral velocity changes were -102 km/h (-63.4 mph) and 0.0 km/h, respectively. The results appeared to be high for the reasons specified in the Chevrolet's exterior damage section on page 4.

The manufacturer's recommended tire size was P235/70R16. The vehicle was equipped with the recommended size tires. The Ford's tire data are shown in the table below.

Tire	Measured Pressure		Vehicle Manufacturer's Recommended Pressure		Tread Depth		Damage	Restricted	Deflated
	kPa	psi	kPa	psi	milli-meters	32 nd of an inch			
LF	Flat	Flat	207	30	6	8	Torn inner sidewall	Yes	Yes
LR	207	30	207	30	8	10	None	No	No

<i>Tire</i>	<i>Measured Pressure</i>		<i>Vehicle Manufacturer's Recommended Pressure</i>		<i>Tread Depth</i>		<i>Damage</i>	<i>Restricted</i>	<i>Deflated</i>
	kPa	psi	kPa	psi	milli-meters	32 nd of an inch			
RR	90	13	207	30	8	10	None	No	No
RF	Flat	Flat	207	30	7	9	Charred from fire	No	Yes

Ford's Occupants: The police crash report indicated that it was unknown if the Ford's driver [54-year-old, female] was restrained by the lap-and-shoulder belt. The driver's air bag deployed. The driver sustained an A (incapacitating) injury and was transported by ambulance to a local hospital. She was subsequently transferred to a trauma center. According to the police crash report, she sustained a fracture of C2, fractures of both legs, and internal injuries.

