INDIANA UNIVERSITY

TRANSPORTATION RESEARCH CENTER
School of Public and Environmental Affairs
222 West Second Street Suite A
Bloomington, Indiana 47403-1501
(812) 855-3908 Fax: (812) 855-3537

ON-SITE CHILD SAFETY SEAT INVESTIGATION

CASE NUMBER - IN08003
LOCATION - NEBRASKA
VEHICLE - 2000 TOYOTA CAMRY LE
CRASH DATE - December 2007

Submitted:

July 21, 2008
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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

Technical Report Documentation Page

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16. *Abstract* This report covers an on-site child safety seat investigation that involved a 2000 Toyota Camry LE and a 2002 Chevrolet Suburban, which were involved in an intersection collision. This crash is of special interest because the Toyota's second row left passenger (11-month-old, female) was seated in a Cosco Touriva child safety seat (CSS). The Toyota was traveling west and the Chevrolet was traveling north on city streets approaching an intersection. Both vehicles entered the intersection and the front of the Chevrolet impacted the left side of the Toyota. The impact caused the driver and front right passenger air bags in both vehicles to deploy. The Toyota rotated counterclockwise, departed the roadway and came to final rest heading northeast. The Chevrolet rotated counterclockwise and came to final rest heading northwest. The Toyota's unrestrained driver sustained critical injuries and was hospitalized. The second row left passenger was entrapped within the CSS due to the deformation of the seat by the intruding left rear door. She sustained critical head injuries due to contact with the left rear door window sill and succumbed to her injuries 34 minutes later.			
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BACKGROUND IN08003

This crash was brought to the National Highway's Traffic Safety Administration's attention on or before January 8, 2008 by a news story in a Nebraska newspaper. The crash involved a 2000 Toyota Camry LE and a 2002 Chevrolet Suburban. The crash occurred in December, 2007, at 13:40 hours in Nebraska and was investigated by the applicable city police department. This crash is of special interest because the Toyota's second row left passenger (11-month-old, female) was seated in a child safety seat (CSS). This contractor inspected the Toyota, the CSS, the crash scene, and the Suburban on January 24 and 25, 2008, and interviewed the Toyota's driver on February 7, 2008. This report is based on the police crash report, inspections of the vehicles, crash scene, and the CSS, occupant kinematic principles, medical records, autopsy report and this contractor's evaluation of the evidence.

SUMMARY

This crash occurred during daylight hours under cloudy, dry conditions. The Toyota was traveling west and the Chevrolet was traveling north on city streets approaching an intersection. Both vehicles entered the intersection and the front of the Chevrolet impacted the left side of the Toyota. The impact caused the driver and front right passenger air bags in both vehicles to deploy. The Toyota rotated counterclockwise, departed the roadway and came to final rest heading northeast. The Chevrolet rotated counterclockwise and came to final rest heading northwest. The Toyota's unrestrained driver sustained critical injuries and was hospitalized. The Toyota's second row left passenger was seated in a Cosco Touriva convertible CSS, which was installed in the forward facing position. She sustained critical head injuries due to contact with the left rear window sill and succumbed to her injuries 34 minutes later. She was entrapped within the CSS due to deformation of the CSS by the intruded left rear door.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the Toyota was traveling was a two-lane, undivided, city street, traversing in an east-west direction, and the Toyota was westbound approaching a four-leg intersection. The westbound lane was 4.4 meters (14.3 feet) in width and the eastbound lane was 3.9 meters (12.8 feet) in width. The roadway pavement markings consisted of double yellow no-passing lines and white edge lines. The Toyota's roadway had a positive 1.2% grade and the intersection was controlled by a stop sign. The trafficway on which the Chevrolet was traveling was a three-lane, undivided, city street, traversing in a north-south direction, and the Chevrolet was northbound approaching the same intersection. The roadway had one southbound lane 3.8 meters (12.5 feet) in width, one northbound lane 3.4 meters (11.2 feet) in width, and a left turn lane 3.5 meters (11.5 feet) in width. The Chevrolet's roadway was level and there were no traffic controls. There were large pine trees along the southeast quadrant of the intersection that constituted a vision obstruction for each driver. The police reported speed limit was 89 km/h (55 mph) for the Chevrolet and 72 km/h (45 mph) for the Toyota. There were no speed limit signs on either vehicle's approach to the intersection. At the time of the crash, the light condition was daylight, the atmospheric condition was cloudy, and the roadway pavement was dry bituminous. The traffic density was light and the site of the crash was rural residential. See the Crash Diagram on page 16 of this report.

Pre-Crash: The Toyota was traveling west (**Figure 1**) and the driver intended to continue west through the intersection. The Chevrolet was traveling north (**Figure 2**) and the driver intended to continue north through the intersection. Based on a police reported witness statement (the witness was traveling north behind the Chevrolet), the Chevrolet was traveling 80 to 88 km/h (50 to 55 mph) and the Toyota's driver did not stop for the stop sign. The Toyota's driver stated during the interview that she did not know if she took any actions to avoid the crash. The driver's blood test was positive for marijuana and amphetamines.

Crash: The Toyota and Chevrolet entered the intersection (**Figure 3**) and the front of the Chevrolet (**Figure 4**) impacted the left side of the Toyota (**Figure 5**). The impact caused the driver and front right passenger air bags to deploy in the Toyota and the Chevrolet. The impact also caused the Toyota's left rear door to intrude into the passenger compartment and deform the back left passenger's CSS. The Toyota rotated counterclockwise, departed the northeast quadrant of the intersection, traveled down a snow covered embankment and came to final rest heading northeast. The Toyota rotated approximately 190 degrees between impact and final rest. The Chevrolet rotated counterclockwise approximately 395 degrees and came to rest within the northwest quadrant of the intersection on the right turn lane heading northwest.

Post-Crash: The Toyota's driver was unconscious following the crash. She was entrapped within the vehicle by the intruded left front door. Emergency personnel removed the door and extricated her from the vehicle. The second row left passenger was entrapped within the CSS due to the deformation of the left side of the CSS by the intruded left rear door. She was also removed from the vehicle by emergency personnel. The Toyota's driver and passenger were transported by

Figure 1: Approach of Toyota westbound to the intersection, number 50 on pavement indicates meters to impact area in intersection, indicated by arrow

Figure 2: Approach of Chevrolet northbound to the intersection

Figure 3: Arrow shows the impact area in intersection viewed from westbound approach of the Toyota

ambulance to a hospital. The Chevrolet's driver and five of the six passengers were also transported by ambulance to a hospital.

Figure 4: Front right view of damage to front of Chevrolet due to impact with left side of Toyota; each stripe on rods in 5 cm (2 in)

Figure 5: Damage to left side of Toyota due to impact with the front of the Chevrolet

CASE VEHICLE

The 2000 Toyota Camry LE was a front wheel drive, 4-door sedan (VIN: JT2BG22KXY0------) equipped with a 2.2L, 4-cylinder engine, automatic transmission and redesigned frontal air bags. The front row was equipped with bucket seats with adjustable head restraints. The second row was equipped with a bench seat with folding back and adjustable head restraints in the outboard seating positions. The vehicle's specified wheelbase was 267 centimeters (105.2 inches). The vehicle's mileage was not known because it was equipped with an electronic odometer. The driver did not know the vehicle's mileage.

CASE VEHICLE DAMAGE

Exterior Damage: The Toyota's impact with the Chevrolet involved the left side of the vehicle (**Figure 5**). The Toyota's left fender, left front door, left rear door and a small portion of the left quarter panel were directly damaged. The direct damage began 16 centimeters (6.3 inches) rear of the left rear axle and extended 240 centimeters (94.5 inches) forward along the left side. The crush measurements were taken at the mid-door level and the residual maximum crush was measured as 76 centimeters (29.9 inches) occurring at C_3 (**Figure 6**). The table below shows the vehicle's left side crush.

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	240	76	305	0	51	76	64	32	12	-5	9
in		94.5	29.9	120.1	0.0	20.1	29.9	25.2	12.6	4.7	-2.0	3.5

The left side wheelbase was reduced 8 centimeters (3.1 inches) while the right side wheelbase was extended 1 centimeter (0.4 inches). Induced damage involved the left fender, roof, left quarter panel, hood, trunk lid, right quarter panel, and the right rear door.

Damage Classification: The CDC for the Toyota was **10-LDAW-4** (**300** degrees). The Damage Only algorithm of the WinSMASH program calculated the Toyota's total Delta V as 66.0 km/h (41.0 mph). The longitudinal and lateral velocity changes were -33.0 km/h (-20.5 mph) and 57.2 km/h (35.5 mph), respectively. The collision conditions fit the reconstruction model and the results appeared reasonable. The Toyota was towed due to damage.

Figure 6: Arrow shows location of maximum crush; vertical scale is graduated in meters and tenths of meter

The manufacturer's recommended tire size was P205/65R15. The Toyota was equipped with P195/65R15 tires. The vehicle'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	32nd of an inch			
LF	Flat	Flat	221	32	3	4	None	No	Yes
LR	Flat	Flat	221	32	6	8	None	No	Yes
RR	221	32	221	32	5	6	None	No	No
RF	Flat	Flat	221	32	2	3	None	No	No

Vehicle Interior: Inspection of the Toyota's interior revealed a scuff mark on the left front door due to contact by the driver's left torso. The console mounted gear shift lever was bent to the right due to contact by the driver's right thigh. There was blood and some scuff marks on the left rear window sill due to contact by the second row left passenger's (**Figure 7**) head. There were also scuff marks on the left rear door from loading the CSS.

There were numerous intrusions involving the left side of the passenger compartment. The most severe intrusions involved the left roof side rail and the upper forward quadrant of the left rear door. The left roof side rail intruded 30 centimeters (11.8 inches) laterally into the driver's occupant space while the upper forward quadrant of the left rear door intruded 36 centimeters (14.2 inches) laterally into the second row left occupant space. The amount of left front door intrusion could not be determined because the door had been removed by rescue personnel. The steering assembly was displaced to the right due to the deformation of the instrument panel, but

there was no evidence of deformation of the steering wheel or compression of the energy absorbing steering column.

AUTOMATIC RESTRAINT SYSTEM

The Toyota's driver air bag was located in the steering wheel hub. The front right passenger air bag was located in the top of the instrument panel. Both air bags deployed as a result of this crash. It was not possible to inspect either air bag because they had been cut out of the vehicle by the police.

MANUAL RESTRAINT SYSTEM

The Toyota was equipped with lap-and-shoulder belts for all five seating positions. The driver's position consisted of continuous loop belt webbing, an Emergency Locking Retractor (ELR), and an adjustable upper anchor that was in the full-up position. The front right seat belt was similar but had a switchable ELR/Automatic Locking Retractor (ALR). Both front seat belts were also equipped with retractor mounted pretensioners that are designed to keep the occupant in place during a crash.

The inspection of the seat belt systems revealed that the driver's belt was not used during the crash. The pretensioner actuated during the impact and locked the belt webbing taut along the B-pillar in an unused position. The front right seat was not occupied.

The second row lap-and-shoulder belts were comparable to the front row, but they employed switchable ELR/ALR retractors and were not equipped with pretensioners. The second row left seat belt was used to install a forward facing CSS. At the inspection, the seat belt was still routed through the belt paths on the back of the CSS. The remaining two seating positions were not occupied.

Figure 7: Cosco Touriva CSS entrapped in Toyota's back left seat position; left arrow shows blood and tissue transfer on left side surface of CSS; right arrow shows blood and scuff marks on left rear window sill

Figure 8: Right side view of CSS in Toyota's second row left seat position

The Toyota's second row left passenger [11-month-old, female; 71 centimeters and 9 kilograms (28 inches, 20 pounds)] was seated in a Cosco Touriva convertible CSS (**Figure 7**) installed in the forward facing position. The CSS's information label indicated that the child's weight and height limitations for the forward facing position were 10-18 kilograms (22-40 pounds) and 86-109 centimeters (34-43 inches), respectively. The CSS was manufactured by the Dorel Juvenile Group Inc., on October 22, 2007. The model number was 22-111-FSM. The CSS was designed with a five-point harness, and there were three sets of slots in the seat back to thread the harness straps through. The harness straps were threaded through the middle set of slots and a harness retainer clip was attached to the harness straps. The CSS was designed with a belt path located on each side of the seat back for securing the CSS in the forward facing position. A belt path was also located below the seat cushion for securing the seat in the rear facing position. The CSS was equipped with a Lower Anchors and Tethers for Children (LATCH) system.

The CSS was found in the vehicle entrapped between the intruded left rear door and the seat back (**Figures 7** and **8**). It was still secured in the vehicle by the lap-and-shoulder belt, which had been routed through the belt guides on the back of the CSS. The CSS was constructed of a one piece plastic shell, which was fitted with a cloth covered foam pad. The left side of the shell was deformed to the right and broken, scratched, and scuffed in several places (**Figure 9**). There were also blood and tissue transfers on the left side surface of the CSS (**Figure 7**). The shell at the base of the right side was also broken and there were cracks in the right side of the seat (**Figure 10**). The harness strap and buckle were intact and undamaged.

Figure 9: Damage to left side of child safety seat

Figure 10: Damage to base and right side of child safety seat

CASE VEHICLE DRIVER KINEMATICS

The Toyota's driver [23-year-old, female; 157 centimeters and 68 kilograms (62 inches, 150 pounds)] stated during the interview that she was seated upright with her back against the seat back, right foot on the accelerator and left foot on the floor. She did not remember the position of her hands on the steering wheel, or if she had one or both hands on the steering wheel. The

seat track was adjusted to between the forward and middle track position and the seat back was slightly reclined. The tilt steering column was adjusted to between the center and full down position. The driver was not restrained by the lap-and-shoulder belt.

The Toyota's left side impact with the front of the Chevrolet displaced the driver forward and left opposite the Toyota's 300 degree direction of principal force. The left side of the driver's body loaded the intruding left front door and her head was partially ejected through the left front window opening and impacted the grille of the Chevrolet. The contact with the grille caused a nonanatomic brain injury and a fracture of the sphenoid sinus. The contact with the left front door caused left side rib fractures, pelvic fractures and internal injuries, including a contusion of the left lung and a lacerated spleen. The driver was displaced to the right by the intruding door and loaded the floor mounted gear shift lever bending it to the right. The driver remained in her seat position as the Toyota rotated counterclockwise to final rest. The police crash report indicated that the driver was entrapped in her seat position, probably by the intruded left front door, which was subsequently cut off the vehicle by rescue personnel in order to extricate the driver from the vehicle.

CASE VEHICLE DRIVER INJURIES

The Toyota's driver sustained critical injuries and was hospitalized for 16 days. The driver's injuries and injury sources are shown in the table below.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury, awake on initial observation but progressed to unconsciousness of unknown duration with amnesia to event, unequal pupils, dysconjugate gaze[1] and cognitive deficits (e.g., speech therapy)	serious 160412.3,0	Exterior of other motor vehicle: grille	Probable	Hospitalization records
2	Fracture through right lateral wall of sphenoid sinus with hemorrhage in sinus cavity	serious 150200.3,8	Exterior of other motor vehicle: grille	Probable	Hospitalization records
3	Fracture at least three left ribs[2], posterior central aspect, including: 9th and 10th, and 8th, 11th, and/or 12th	moderate 450220.2,2	Left side interior surface, excluding hardware and/or armrest	Certain	Hospitalization records

[1] The following terms are} defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
gaze (gaz): 1. to look steadily in one direction. 2. the act of looking steadily at something.
conjugate g.: the normal movement of the two eyes simultaneously in the same direction to bring something into view.
dysconjugate g.: ***dys-*** a combining form signifying difficult, painful, bad, disordered, abnormal

[2] It is unclear exactly how many posterior ribs were fractured because the medical records contain conflicting information; however, all sources agree that there were at least three fractured ribs.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
4	Contusion lower lobe left lung with left hemothorax, 450 cc, and small left pneumothorax	serious 441406.3,2	Left side interior surface, excluding hardware and/or armrest	Certain	Hospitalization records
5	Laceration spleen, multiple, grade V, with splenectomy with at least 2 liters of hemoperitoneum and retroperitoneal hematoma resulting in hypovolemic shock	critical 544228.5,2	Left side interior surface, excluding hardware and/or armrest	Certain	Hospitalization records s
6	Laceration {tears} sigmoid, ileal, and mesosalpinx mesentery requiring surgical repair	moderate 542020.2,8	Left side interior hardware and/or armrest	Probable	Hospitalization records
7	Injury right ovarian pedicle, not further specified, requiring surgical repair	moderate 542620.2,1	Left side interior hardware and/or armrest	Probable	Hospitalization records
8	Laceration, small, liver adjacent to falciform ligament	moderate 541822.2,1	Left side interior surface, excluding hardware and/or armrest	Probable	Hospitalization records
9	Contusion left proximal transverse colon, not further specified	moderate 540810.2,8	Left side interior surface, excluding hardware and/or armrest	Probable	Hospitalization records
10	Fracture left transverse process of L_5, not further specified	moderate 650620.2,8	Left side interior hardware and/or armrest	Certain	Hospitalization records
11	Fractured, comminuted, bilateral superior and inferior pubic rami requiring plate and screws between left anterior column {ischia} and left superior pubic bone	serious 852604.3,5	Left side interior hardware and/or armrest	Certain	Hospitalization records

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
12	Fracture left sacral ala requiring fixation plate bridging sacrum, lateral sacroiliac joints, and left medial ilia[3] with compression displacement	serious 852604.3,6	Left side interior hardware and/or armrest	Certain	Hospitalization records
13	Fracture left hemipelvis involving left anterior column {ischia} and posterior ileum but not involving left acetabulum	moderate 852602.2,2	Left side interior hardware and/or armrest	Certain	Hospitalization records
14	Fracture right hemipelvis involving right anterior column including superior and inferior right ischia but not involving right acetabulum	moderate 852602.2,1	Left side interior hardware and/or armrest	Certain	Hospitalization records
15	Contusion {cephalohematoma} posterior occipital scalp near midline	minor 190402.1,6	Exterior of other motor vehicle: grille	Probable	Hospitalization records
16	Contusion left orbit, not further specified	minor 297402.1,2	Exterior of other motor vehicle: grille	Probable	Hospitalization records
17	Laceration left periorbital, not further specified	minor 297602.1,2	Exterior of other motor vehicle: grille	Probable	Hospitalization records
18 19	Lacerations, multiple, face including left ear, left forehead, and left cheek, not further specified	minor 290600.1,2 290600.1,7	Noncontact injury: flying glass, left front glazing	Probable	Hospitalization records
20	Contusions left shoulder, not further specified	minor 790402.1,2	Exterior of other motor vehicle: grille	Probable	Hospitalization records
21	Contusions left upper arm and left forearm, not further specified	minor 790402.1,2	Left front window sill	Probable	Hospitalization records
22	Contusion {ecchymosis} right hip, not further specified	minor 890402.1,1	Floor, center console parking brake lever	Certain	Emergency room records

[3] Patient was non-weight bearing on her left for over 30 days post-crash and developed ***paresthesias*** to her left foot and left leg, distal to knee. The right sacroiliac joint was intact, and the right leg was weight bearing as tolerated. The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

formication (for"mi-ka/shen): a tactile hallucination in which there is a sensation of tiny insects crawling over the skin; most commonly seen in cocaine or amphetamine intoxication.

paresthesia (par"es-the/zhe): an abnormal touch sensation, such as burning, prickling, or formication, often in the absence of an external stimulus.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
23	Contusion left lateral left hip and distal buttock	minor 890402.1,2	Left side interior hardware and/or armrest	Certain	Hospitalization records
24	Laceration lateral left hip, not further specified	minor 890602.1,2	Left side interior hardware and/or armrest	Possible	Hospitalization records
25	Contusion medial aspect right thigh, not further specified	minor 890402.1,1	Occupant's left thigh	Probable	Hospitalization records
26	Contusions x 2, left lateral lower leg, not further specified	minor 890402.1,2	Left side interior surface, excluding hardware and/or armrest	Certain	Hospitalization records
27	Contusion right medial lower leg, not further specified	minor 890402.1,1	Occupant's left lower leg	Probable	Hospitalization records

CASE VEHICLE SECOND ROW LEFT PASSENGER KINEMATICS

The Toyota's second row left passenger was seated upright in the forward facing CSS. Based on the driver interview and an interview with the investigating police officer, she was secured in the CSS by the five-point harness. The harness retainer clip was positioned at the passenger's armpit level, and the CSS was secured by the lap-and-shoulder seat belt. The driver switched the seat belt retractor to automatic locking mode and pulled the belt tight to secure the CSS.

The Toyota's left side impact with the front of the Chevrolet displaced the passenger to the left and forward opposite the Toyota's 300 degree direction of principal force. She loaded the harness system and the left side of her head impacted the left rear window sill. The passenger sustained an open, comminuted skull fracture and numerous brain injuries including extensive subdural hemorrhage of both cerebellar hemispheres, edema of the cerebrum and compression of the brainstem. The left side of the passenger's body also loaded the left side of the CSS and she was compressed within the CSS as it was deformed by the left rear door intrusion. She sustained multiple contusions of the right and left lobes of the lungs, contusion of the left lobe of the liver and a spleen laceration.

CASE VEHICLE SECOND ROW LEFT PASSENGER INJURIES

The second row left passenger sustained critical injuries and was pronounced dead 34 minutes following the crash. 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
	Nonanatomic brain injury with loss of consciousness; flaccid, unresponsive, pupils fixed and dilated, GCS=3	not coded	Left rear window sill	Certain	Emergency room records
1	Compression brainstem with bilateral herniation of cerebellar tonsils and unci hippocami gyri	critical 140202.5,8	Left rear window sill	Certain	Autopsy
2	Hemorrhage, subdural, bilateral cerebellar hemispheres[4], not further specified	severe 140438.4,6	Left rear window sill	Certain	Autopsy
3	Hemorrhage, subarachnoid, in cerebellum, not further specified	serious 140466.3,6	Left rear window sill	Certain	Autopsy
4	Hemorrhage, subdural, extensive, bilateral cerebral hemispheres over convexity [20.0 x 23.0 cm (7.9 x 9.1 in)] and base of skull [14.0 x 4.0 cm (5.5 x 1.6 in) on right; 15.0 x 4.0 cm (5.9 x 1.6 in) on left] involving anterior cranial fossa, bilateral middle cranial fossa, bilateral frontal lobes and frontal portion of bilateral temporal lobes	critical 140654.5,3	Left rear window sill	Certain	Autopsy
5	Swelling/edema of cerebrum, markedly, with congestion resulting in brainstem herniation, not further specified	critical 140666.5,9	Left rear window sill	Certain	Autopsy
6 7	Hemorrhage, subarachnoid, diffuse, in cerebral cortices, bilateral ventricles, and basal ganglia	serious 140684.3,1 140684.3,2	Left rear window sill	Certain	Autopsy
	Contusion, extensive, thymus gland involving anterior [1.5 x 3.0 cm (0.6 x 1.2 in)] and posterior [9.0 x 6.5 cm (3.5 x 2.6 in)] surfaces	not coded	Left rear window sill	Certain	Autopsy
8	Contusion, small, 1.0 x 0.5 cm (0.4 x 0.2 in) right atrium of heart	minor 441004.1,4	Child safety seat's left side surface	Probable	Autopsy

[4] According to the autopsy, there was also subdural and subarachnoid hemorrhage overlying the brainstem.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
9	Hemopericardium, 20 ml, not further specified	moderate 441699.2,4	Child safety seat's left side surface	Probable	Autopsy
10	Contusions, multiple, right and left lobes of lungs with parenchymal hemorrhages and bilateral hemothoraces, 20 ml each pleural cavity	severe 441410.4,3	Child safety seat's left side surface	Probable	Autopsy
11	Contusion left lobe of liver, superior surface, 4.5 x 1.5 cm (1.8 x 0.6 in)	moderate 541812.2,1	Child safety seat's left side surface	Probable	Autopsy
12	Laceration, spleen, 3.5 cm (1.4 in), superior surface with moderate hemoperitoneum	moderate 544222.2,2	Child safety seat's left side surface	Probable	Autopsy
13	Fracture, open[5], comminuted, left frontal skull with exposed brain matter	severe 150406.4,5	Left rear window sill	Certain	Autopsy
14 15	Fractures, linear, from 11.0 to 16.0 cm (4.3 - 6.3 in) involving left frontal, parietal, and occipital calvarium	moderate 150402.2,2 150402.2,6	Left rear window sill	Certain	Autopsy
16	Fractures, basilar skull, multiple, radiating, involving left anterior cranial fossa, bilateral occipital cranial fossa, right middle cranial fossa, and petrous ridge	severe 150206.4,8	Left rear window sill	Certain	Autopsy
17	Contusion, subgaleal, extensive, 23.0 x 12.0 (9.1 x 4.7 in) area involving left frontal, parietal, temporal, and occipital scalp	minor 190402.1,2	Left rear window sill	Certain	Autopsy
18	Abrasions, multiple, left forehead in 7.0 x 2.0 cm (2.8 x 0.8 in) area	minor 290202.1,7	Left rear window sill	Probable	Autopsy
19	Contusion, 2.0 x 1.5 cm (0.8 x 0.6 in) above left eyebrow	minor 290402.1,7	Left rear window sill	Certain	Autopsy
20	Abrasions, multiple, left face in 13.0 x 6.0 cm (5.1 x 2.4 in) area, not further specified	minor 290202.1,2	Left rear window sill	Probable	Autopsy
21 22	Abraded contusions, 2.0 x 1.0 cm (0.8 x 0.4 in) back right forearm, not further specified	minor 790202.1,1 790402.1,1	Child safety seat's right side surface	Probable	Autopsy

[5] There was a gaping laceration [3.5 x 1.0 cm (1.4 x 0.4 in)] to the left forehead, just below the reported left forehead abrasions.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
23	Abrasions x 7 on back right hand in 6.0 x 7.0 cm (2.4 x 2.8 in) area, not further specified	minor 790202.1,1	Noncontact injury: flying glass, left rear glazing	Probable	Autopsy
24	Laceration on back right hand, within abrasions above	minor 790600.1,1	Noncontact injury: flying glass, left rear glazing	Probable	Autopsy
25	Contusion, 2.5 x 2.0 cm (1.0 x 0.8 in) back left forearm, not further specified	minor 790402.1,2	Child safety seat's left side surface	Probable	Autopsy
26 27	Abraded contusions back left hand in 5.5 x 3.0 cm (2.2 x 1.2 in) area and involving knuckles of left hand	minor 790202.1,2 790402.1,2	Child safety seat's left side surface	Probable	Autopsy
28 29	Abraded contusions anterior bilateral knees, not further specified	minor 890202.1,3 890402.1,3	Child safety seat's left side surface	Probable	Autopsy
30	Contusion, 1.0 x 1.0 cm (0.4 x 0.4 in) back left ankle	minor 890402.1,2	Left side interior hardware and/or armrest	Probable	Autopsy
31	Contusion, 1.0 x 1.5 cm (0.4 x 0.6 in) dorsal right ankle	minor 890402.1,1	Left side interior hardware and/or armrest	Probable	Autopsy

OTHER VEHICLE

The 2002 Chevrolet Suburban was a 4-wheel drive, 4-door, sport utility vehicle (VIN: 1GNFK16Z82J------) equipped with a 5.3L, V8 engine, automatic transmission, 4-wheel anti-lock brakes, redesigned air bags and front seat back-mounted side impact air bags. The vehicle was also equipped with an Event Data Recorder (EDR). The vehicle's specified wheelbase was 330 centimeters (130 inches).

Exterior Damage: The Chevrolet's impact with the Toyota involved its front end. The front bumper, hood, grille, radiator, both turn signal and headlamp assemblies, and the right fender were directly damaged. The direct damage began at the front left bumper corner and extended 171 centimeters (67.3 inches) across the front end. The crush measurements were taken at the bumper level and the residual maximum crush was measured as 40 centimeters (15.7 inches) occurring at C_1 (**Figure 11**). 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	171	40	171	40	30	29	26	21	16	0	0
in		67.3	15.7	67.3	15.7	11.8	11.4	10.2	8.3	6.3	0.0	0.0

The Chevrolet's left side wheelbase was reduced 8 centimeters (3.1 inches) while the right side wheelbase was reduced 1 centimeter (0.4 inch). Induced damage involved the right and left fenders and the hood.

Figure 11: Top view of crush to front of Suburban

Damage Classification: The CDC for the Chevrolet was **01-FDEW-2** (**30** degrees). The Damage Only algorithm of the WinSMASH program calculated the Chevrolet's total Delta V as 35.0 km/h (21.7 mph). The longitudinal and lateral velocity changes were -30.3 km/h (-18.8 mph) and -17.5 km/h (-10.9 mph), respectively. The collision fit the reconstruction model and the results appeared reasonable. The Chevrolet was towed due to damage.

Event Data Recorder: The EDR data was downloaded by the investigating police officer and a copy of the electronic file was provided to this contractor. Version 2.8 of the Vetronix Crash Data Retrieval tool was used to download the EDR and version 2.9 was used to read the file. The data indicated that the SIR warning lamp was recorded as off and the driver's seat belt circuit switch was recorded as unbuckled. The time from algorithm enable (AE) to the deployment command criteria being met was 7.5 milliseconds, and the maximum forward velocity change was recorded as -33.9 km/h (-21.08 mph). The time from AE to the maximum recorded velocity change was 95 milliseconds. The EDR report is attached at the end of this report.

The manufacturer's recommended tire size was P265/70R16. The vehicle was equipped with P285/50R20 size tires. The Chevrolet'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	32nd of an inch			
LF	255	37	241	35	8	10	None	No	No
LR	214	31	241	35	7	9	None	No	No

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
RR	262	38	241	35	8	10	None	No	No
RF	276	40	241	35	6	8	None	No	No

Chevrolet's Occupants: According to the police crash report, the Chevrolet's driver (37-year-old, male) was restrained by the lap-and-shoulder seat belt. He sustained B (non-incapacitating) injuries and was transported by ambulance to a hospital.

The front row right passenger (14-year-old, male) was restrained by the lap-and-shoulder seat belt. He sustained C (possible) injuries and was transported by ambulance to a hospital.

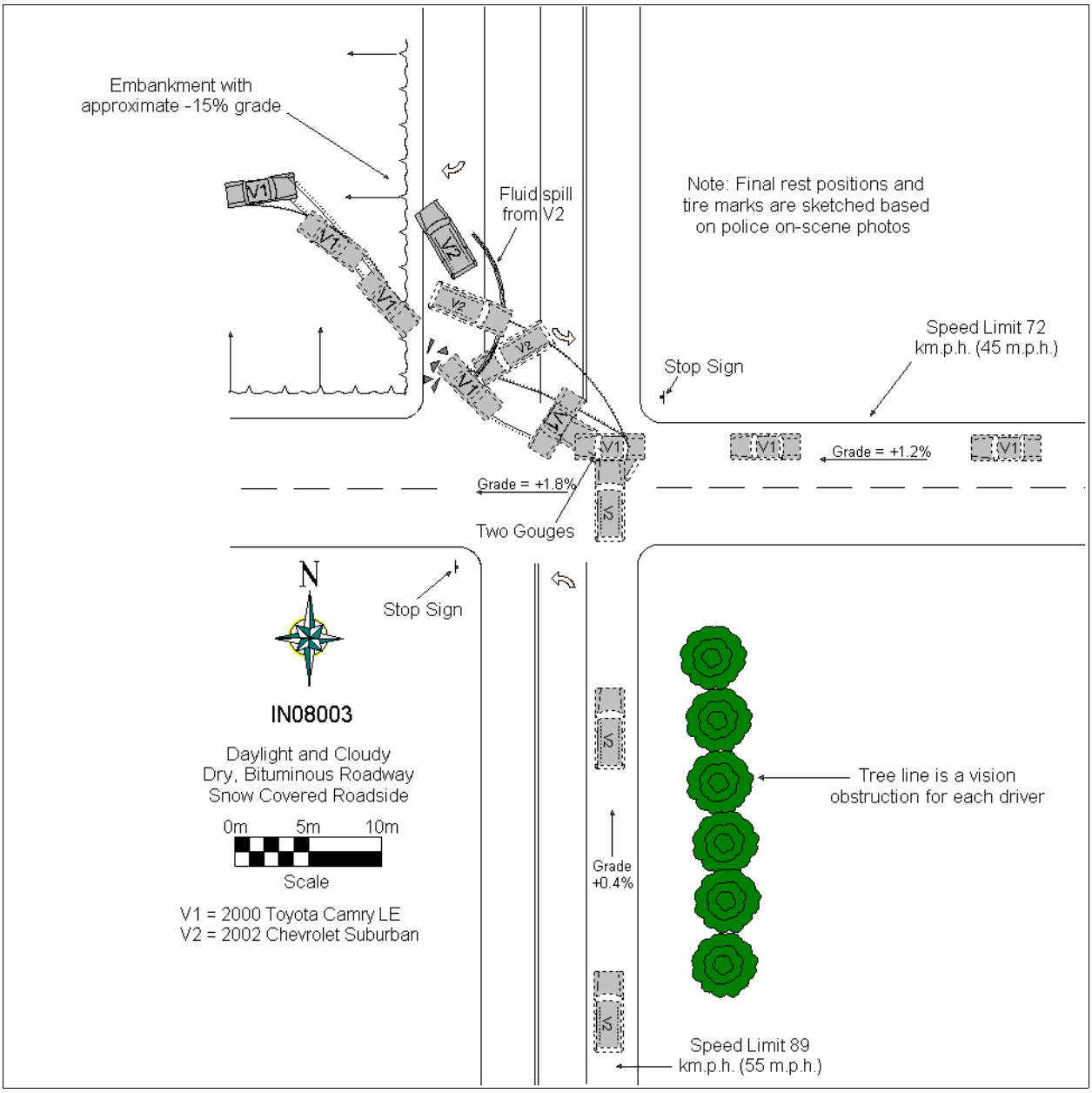
The second row left passenger (unknown age and sex) was restrained in a CSS. The passenger did not sustain any police-reported injuries and was not transported to a hospital.

The second row right passenger (8-year-old, female) was restrained by the lap-and-shoulder seat belt. She sustained C (possible) injuries and was transported by ambulance to a hospital.

The third row left passenger (5-year-old, female) was restrained by the lap-and-shoulder seat belt. She sustained C (possible) injuries and was transported by ambulance to a hospital.

The third row center passenger (35-year-old, female) was restrained by the lap belt. She sustained C (possible) injuries and was transported by ambulance to a hospital.

The third row right passenger (3-year-old, female) was restrained in a booster CSS. She sustained C (possible) injuries and was transported by ambulance to a hospital.


Embankment with
approximate -15% grade
Fluid spill
from V2
Note: Final rest positions and
tire marks are sketched based
on police on-scene photos
Speed Limit 72
km.p.h. (45 m.p.h.)
Stop Sign
Grade = +1.2%
Grade = +1.8%
Two Gouges
N
Stop Sign
IN08003
Daylight and Cloudy
Dry, Bituminous Roadway
Snow Covered Roadside
0m 5m 10m
Scale
V1 = 2000 Toyota Camry LE
V2 = 2002 Chevrolet Suburban
Tree line is a vision
obstruction for each driver
Grade
+0.4%
Speed Limit 89
km.p.h. (55 m.p.h.)

CDR File Information

Vehicle Identification Number	1GNFK16Z82J******
Investigator	
Case Number	
Investigation Date	
Crash Date	
Filename	IN08003.CDR
Saved on	
Collected with CDR version	Crash Data Retrieval Tool 2.800
Reported with CDR version	Crash Data Retrieval Tool 2.900
Event(s) recovered	Deployment

SDM Data Limitations

SDM Recorded Crash Events:
There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). It contains Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event may be overwritten by another Non-Deployment Event. This event will be cleared by the SDM after the ignition has been cycled 250 times.
The second type of SDM recorded crash event is the Deployment Event. It also contains Pre-Crash and Crash data. The SDM can store up to two different Deployment Events, if they occur within five seconds of one another. Deployment Events cannot be overwritten or cleared from the SDM. Once the SDM has deployed the air bag, the SDM must be replaced.
The data in the Non-Deployment Event file will be locked after a Deployment Event, if the Non-Deployment Event occurred within 5 seconds before the Deployment Event unless a Deployment Level Event occurs within 5 seconds after the Deployment Event, and then the Deployment Level Event will overwrite the Non-Deployment Event file.

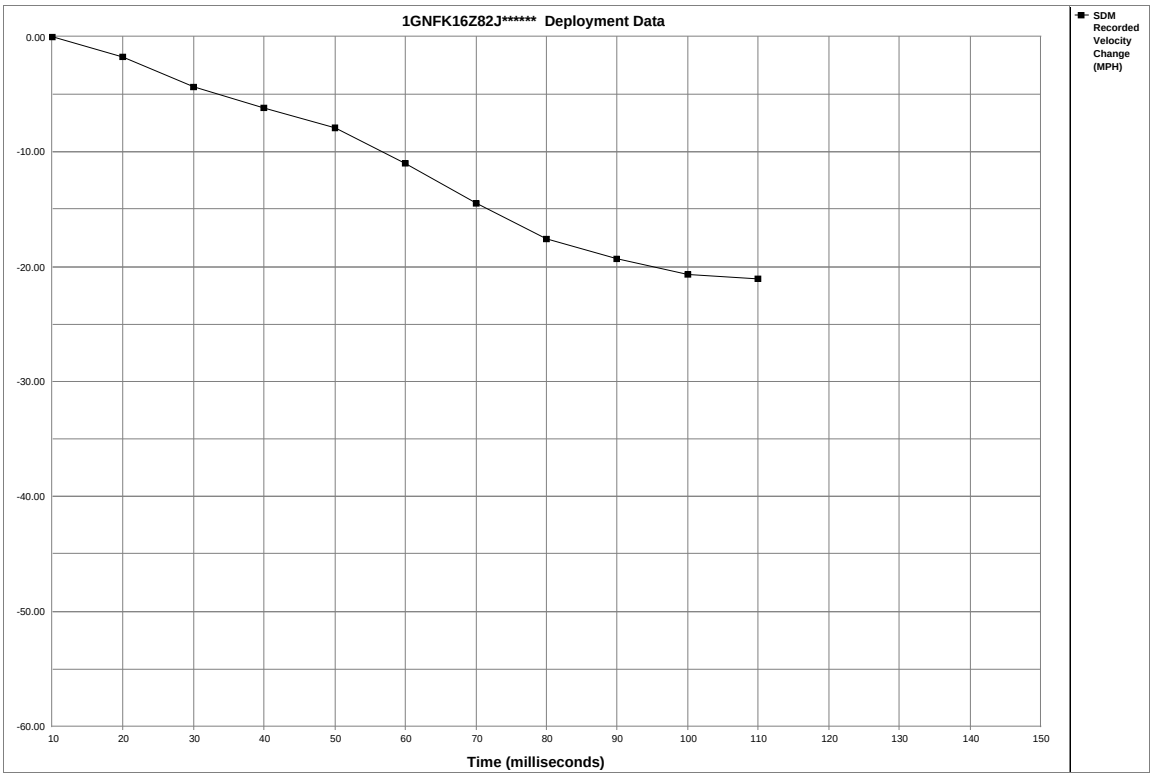
SDM Data Limitations:
-SDM Recorded Vehicle Forward Velocity Change is one of the measures used to make air bag deployment decisions. SDM Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Forward Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle forward velocity change. For Deployment Events and Deployment Level Events, the SDM will record 100 milliseconds of data after deployment criteria is met and up to 50 milliseconds before deployment criteria is met. For Non-Deployment Events, the SDM will record the first 150 milliseconds of data after algorithm enable.
-SDM Recorded Vehicle Speed accuracy can be affected if the vehicle has had the tire size or the final drive axle ratio changed from the factory build specifications.
-Brake Switch Circuit Status indicates the status of the brake switch circuit.
-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if the SDM receive an invalid message from the module sending the pre-crash data.
-Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit. If the vehicle's electrical system is compromised during a crash, the state of the Driver's Belt Switch Circuit may be reported other than the actual state.
-Passenger Front Air Bag Suppression Switch Circuit Status indicates the status of the suppression switch circuit.
-The Time Between Non-Deployment and Deployment Events is displayed in seconds. If the time between the two events is greater than five seconds, "N/A" is displayed in place of the time.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
-If the vehicle is a 2000 - 2002 Chevrolet Cavalier Z24 or a Pontiac Sunfire GT, with a manual transmission (RPO MM5) and a 2.4L engine (RPO LD9), the Brake Switch Circuit Status data will be reported in the opposite state than what actually occurred, e.g. an actual brake switch status of "ON" will be reported as "OFF".
SDM Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Speed, Engine Speed, and Percent Throttle data are transmitted once a second by the Powertrain Control Module (PCM), via the vehicle's communication network, to the SDM.
-Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the vehicle's communication network, to the SDM.
-The SDM may obtain Belt Switch Circuit Status data a number of different ways, depending on the vehicle architecture. Some switches are wired directly to the SDM, while others may obtain the data from various vehicle control modules, via the vehicle's communication network.
-The Passenger Front Air Bag Suppression Switch Circuit is wired directly to the SDM.

System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Not Suppressed
Ignition Cycles At Deployment	12918
Ignition Cycles At Investigation	12919
Maximum SDM Recorded Velocity Change (MPH)	-21.08
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	95
Time Between Non-Deployment And Deployment Events (sec)	N/A
Time From Algorithm Enable to Deployment Command Criteria Met (msec)	7.5

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	52	1536	28
-4	52	1536	23
-3	52	1536	0
-2	52	1600	17
-1	51	1472	0

Seconds Before AE	Brake Switch Circuit Status
-8	OFF
-7	OFF
-6	OFF
-5	OFF
-4	OFF
-3	OFF
-2	OFF
-1	ON



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	0.00	-1.76	-4.39	-6.14	-7.90	-10.97	-14.48	-17.55	-19.31	-20.62	-21.06	N/A	N/A	N/A	N/A

Hexadecimal Data

```
$01  08 23 2C 2C
$02  AB A9
$03  41 53 32 31 33 33
$04  4B 4E 56 54 39 31
$05  00
$06  15 07 13 91
$10  F9 B1 80
$11  93 94 95 FC 9B 00
$14  0F C4 34 A0
$18  7A 79 7B 81 7F 82
$1C  FA FA FA FA FA FA
$1D  FA FA FA FA FA FA
$1E  FA FA
$1F  FF 02 10 10 00
$20  FF FF FF FF FF FF
$21  FF FF FF FF FF FF
$22  FF FF FF FF FF FF
$23  FF FF FF FF FF FF
$24  FF FF FF FF FF FF
$25  FF FF FF FF FF FF
$26  FF FF FF FF FF FF
$27  FF FF FF FF FF FF
$28  FF FF FF FF FF FF
$29  FF FF FF FF FF FF
$2A  FF FF FF FF FF FF
$2B  FF FF FF FF FF FF
$2C  FF FF FF FF
$2D  FF FF FF FF
$30  A0 00 00 FF 7D 80
$31  FF BF FF FF FF FF
$32  FF FF FF FF FF FF
$33  7C 06 03 00 00 04
$34  0A 0E 12 19 21 28
$35  2C 2F 30 FF FF FF
$36  FF 0B 4D 06 03 52
$37  54 54 54 54 00 80
$38  00 00 2C 00 3B 48
$39  00 17 19 18 18 18
$3A  00 F9 B1 C0 00 00
$3B  00 04 00
$3C  03 26 4E 27
$40  FF FF FF FF FF FF
$41  FF FF FF FF FF FF
$42  FF FF FF FF FF FF
$43  FF
```

Comments