INDIANA UNIVERSITY

TRANSPORTATION RESEARCH CENTER
School of Public and Environmental Affairs
501 S. Madison Street–Suite 105
Bloomington, Indiana 47403-2452
(812) 855-3908 Fax: (812) 855-3537

ON-SITE HYBRID VEHICLE INVESTIGATION

CASE NUMBER - IN10035
LOCATION - MICHIGAN
VEHICLE - 2002 TOYOTA PRIUS HYBRID
CRASH DATE - October 2010

Submitted:

April 15, 2011

Contract Number: DTNH22-07-C-00044

Prepared for:

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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 on-site investigation focused on the crash performance of the Nickel-Metal Hydride (NiMH) propulsion battery in a 2002 Toyota Prius. Secondary focus was on the child restraint systems (CRS) of the second row left and right passengers of the other involved vehicle, a 2003 Chevrolet Blazer. The Toyota was occupied by a restrained 18-year-old male driver, a restrained 19-year-old female front right passenger, a restrained 18-year-old male second row left passenger, and a restrained 18-year-old female second row right passenger. The Toyota was traveling north in the inside lane of a 4-lane divided U.S. highway. The vehicle traveled off the left road edge and traveled through the median. The vehicle entered the inside southbound lane where the front plane impacted the front plane of the southbound Chevrolet (event 1). The force direction on the Toyota was within the 12 o'clock sector and the impact force triggered a deployment of the driver's and front right passenger's frontal air bags. The front right passenger's seat-mounted side impact air bag also deployed. The Toyota rotated clockwise and departed the west side of the roadway where it rolled over one quarter turn onto its left side and came to final rest heading northeast. The driver, front right passenger, and second row right passenger of the Toyota sustained fatal injuries. The second row left passenger sustained serious injuries and was hospitalized. The second row left passenger (5-year-old male) of the Chevrolet was seated in a Dorel Highrise belt positioning booster CRS. The CRS was undamaged in the crash and the second row left passenger was transported by ambulance to a level trauma center and admitted for observation with minor injuries. The second row right passenger (3-year-old male) of the Chevrolet was seated in an unknown make/model belt positioning booster CRS. She sustained moderate injuries and was transported by ambulance to a trauma center and admitted.			
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This on-site investigation focused on the crash performance of the Nickel-Metal Hydride (NiMH) propulsion battery in a 2002 Toyota Prius (**Figure 1**). Secondary focus was on the child restraint systems (CRS) of the second row left and right passengers of the other involved vehicle, a 2003 Chevrolet Blazer. This crash was brought to our attention on October 19, 2010 by the National Highway Traffic Safety Administration (NHTSA) through the Auto Safety Hotline in Washington, D.C. This crash was also suggested as of potential interest to NHTSA on October 12, 2010 by this contractor. The 2002 Toyota Prius was subject to a recall (Recall number: 06 V 266 000) related to the crankshaft position sensor. However, the Vehicle Identification Number (VIN) for the Toyota in this crash was not part of that recall. This investigation was assigned on October 20, 2010. The crash occurred in October, 2010 at 1529 hours in Michigan and was investigated by the township police department. The Toyota was inspected on October 21, 2010. The Chevrolet and the crash scene inspections were completed on October 22, 2010. An interview was conducted with the second row left passenger of the Toyota on November 22, 2010. This report is based on the police crash report, Toyota and Chevrolet inspections, crash scene inspection, interview information, exemplar vehicle inspections, medical records, occupant kinematic principles, and evaluation of the evidence.

Figure 1: The damaged 2002 Toyota Prius

CRASH CIRCUMSTANCES

Crash Environment: The crash occurred during daylight hours and clear weather conditions on a 4-lane, divided, U.S. highway. The trafficway traversed in a north-south direction and had two straight through lanes in each direction. Each lane was 3.7 m (12 ft) in width. The roadway was bordered by bituminous outside shoulders 2.7 m (9 ft) in width. The trafficway was divided by a 19.5 m (64 ft) wide grass median. Each bituminous median shoulder was 2.7 m (9 ft) in width. Roadway pavement markings consisted of solid white outside edge lines, broken white lane lines and solid yellow median edge lines. Each roadway was dry, level bituminous. The speed limit was 113 km/h (70 mph). At the time of the crash, the traffic density was heavy. The crash site was located in a suburban residential area. The Crash Diagram is on page 25 of this report.

Pre-Crash: The Toyota was occupied by a restrained 18-year-old male driver, a restrained 19-year-old female front right passenger, a restrained 18-year-old male second row left passenger, and a restrained 18-year-old female second row right passenger. The Chevrolet was occupied by an unrestrained 62-year-old female driver and an unrestrained 56-year-old male front right passenger. Three children were seated in the second row: a 5-year-old male in the left seat, a 10-year-old male in the center seat, and a 3 year-old male in the right seat. The two children seated in the outboard seating positions were restrained in CRSs, while the center seat passenger was restrained by the lap safety belt.

The Toyota was traveling north in the inside lane (**Figure 2**). The vehicle traveled off the left road edge (**Figure 3**) and traversed approximately 55 m (180.4 ft) through the median. The Toyota had rotated counterclockwise approximately 40 degrees from its original northerly heading as it entered the inside southbound travel lane. The Chevrolet was traveling south in the inside lane and the driver applied hard braking in an attempt to avoid the crash. The Chevrolet's event data recorder (EDR) reported the Chevrolet traveling at 117 km/h (73 mph) 5 seconds prior to algorithm enable (AE) and decelerating to 106 km/h (66 mph) at 1 second prior to AE. The EDR reported the Chevrolet's brake switch circuit as "On" 1 second prior to AE. The driver of the Toyota tested positive for amphetamine (54 ng/ml), tetrahydrocannabinol (2.1 ng/ml), and THC metabolite (22.3 ng/ml).

Crash: The front plane of the Toyota (**Figure 4**) impacted the front plane of the Chevrolet (**Figure 5**, event 1). The engagement on the Toyota occurred at the front right bumper corner and continued onto the right side plane. The Toyota's right side wheelbase was reduced 92 cm (36.2 in) by the impact. The force direction on the Toyota was within the 12 sector and the impact force triggered a deployment of the driver's and front right passenger's frontal air bags. The front right passenger's seat-mounted side impact air bag also deployed. Both frontal air bags in the Chevrolet deployed. The Toyota rotated clockwise as it separated from the Chevrolet and rolled over (event 2), left side leading, one quarter turn. It came to final rest heading east 3 m (9.8 ft) west of the west road edge of the southbound roadway. The Toyota traversed a total distance of 15 m (49 ft) from impact to final rest. The Chevrolet traversed a distance of approximately 18 m (59 ft) after impact and came to final rest heading southwest in the inside lane of the southbound roadway.

Figure 2: Northbound approach of the Toyota to the area of roadway departure into the median

Figure 3: Path of travel of the Toyota northwest through the median to impact in the inside southbound lane

Figure 4: Damage on the front and right side planes of the Prius from the impact with the Chevrolet; crush measurement were documented on both front and side planes

Figure 5: Damage on the front plane of the Chevrolet from the impact with the Prius

Post-Crash: The police, emergency medical personnel, and rescue personnel responded to the crash scene. Rescue personnel mechanically removed the roof of the Toyota and cut the safety belts to extricate the four occupants. The front right passenger and second row right passenger of the Toyota were pronounced deceased at the crash scene. The driver and second row left passenger were transported by ambulance to a trauma center. The second row left passenger was admitted and the driver was pronounced deceased. The driver of the Chevrolet was transported by ambulance to a trauma center where she was pronounced deceased. The front row right passenger was pronounced deceased at the crash scene. The three child passengers of the Chevrolet were transported by ambulance to a trauma center and admitted for treatment of their injuries. Both vehicles were towed due to damage.

CASE VEHICLE

Case Vehicle: The 2002 Toyota Prius was a front wheel drive, 4-door, sedan (VIN: JT2BK18U020------) equipped with an 1.5-liter, 4-cylinder gasoline engine with a permanent-magnet AC-synchronous electric motor, a 274 volt sealed NiMH propulsion battery, a continuously variable automatic transmission, and 4-wheel anti-lock disc brakes. The front row was equipped with bucket seats, adjustable head restraints, lap-and-shoulder safety belts, driver and front right passenger redesigned frontal air bags, and seat-mounted side impact air bags. The second row was equipped with a bench seat, lap-and-shoulder safety belts, and adjustable head restraints at the outboard seating positions. The vehicle's mileage at the time of the inspection could not be determined since the vehicle was equipped with an electronic odometer and was without power. The vehicle's specified wheelbase was 255 cm (100.4.1 in).

CASE VEHICLE DAMAGE

Exterior Damage Event 1: The Toyota sustained front plane and right side plane damage during the impact with the Chevrolet. The front bumper, fender, and hood were directly damaged. The direct damage also extended onto the right side plane and involved the right A-pillar and right front door. The direct damage on the front plane began at the front right bumper corner and extended 55 cm (21.7 in) across the bumper. The maximum residual crush was 103 cm (40.6 in) and occurred at C_6. The direct damage on the right side began 227 cm (89.4 cm) forward of the rear axle and extended 184 cm (72.4 in) forward along the side of the vehicle. A second set of crush measurements was taken at the mid-door level to document the crush to the right side plane. The residual maximum crush was 79 cm (31.1 in) and occurred 20 cm (7.9 in) right of C_4. The Toyota's left side wheelbase was reduced 7 cm (2.8 in) and the right side wheelbase was reduced 92 cm (36 in). There was induced damage to the left fender, right rear door, right quarter panel, right rear wheel, and trunk lid. The table below presents the Toyota's front plane 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	55	103	49	0	15	26	45	70	103	34	0
in		21.7	40.6	19.3	0.0	5.9	10.2	17.7	27.6	40.6	13.4	0.0

Damage Classification Event 1: The Collision Deformation Classification (CDC) for the Toyota's front impact was 12FZEW6 (10 degrees). The WinSMASH damage only algorithm calculated the total Delta V for this impact as 122 km/h (75.8 mph). The longitudinal and lateral velocity changes were -120 km/h (-74.6 mph) and -21 km/h (-13 mph), respectively. The results appeared high.

Exterior Damage Event 2: The Toyota sustained direct damage to the left side plane during the rollover. The direct damage began 230 cm (90.6 in) forward of the left rear axle and extended 300 cm (118.1 inn) rearward along the left side.

Damage Classification Event 2: The CDC for the Toyota's rollover was 00LDAO2. The WinSMASH program could not be used since a rollover is out of scope for the program. Based on the extent of crush on the left side, the severity of the damage was minor.

The vehicle manufacturer's recommended tire size was P175/65R14. The right front tire size could not be determined due to damage. The remaining tires were of the recommended size. The Toyota'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	32nd of an inch			
LF	207	30	241	35	6	8	None	Yes	No
LR	Flat	Flat	228	33	6	7	None	No	No
RR	207	30	228	33	5	6	None	Yes	No
RF	Flat	Flat	241	35	6	8	Cut Sidewall	Yes	Yes

Vehicle Interior: The interior of the vehicle was extensively damaged during the crash and from the rescue operations. The instrument panel was destroyed and the front seats had been removed. All of the doors were jammed shut. There was no deformation to the steering wheel rim.

The vehicle sustained numerous intrusions of the passenger compartment. The most severe intrusions occurred to the front right passenger's space. The right toe pan, A-pillar, and instrument panel intruded longitudinally 89 cm (35 in), 79 cm (31 in), and 69 cm (27.2 in), respectively. The front seats were also displaced into the second row but the extent of their displacement could not be determined since they had been removed from the vehicle. At the SCI inspection, the front seats were unsecured in the front row.

ROLLOVER DISCUSSION

The Toyota was not equipped with any rollover mitigation features. The NHTSA has given this vehicle a four star rollover rating on a five star scale and a Static Stability Factor (SSF) of 1.33[1]. The SSF is a calculation based on the vehicle's track width and height of its center of gravity. The result of the calculation is a measure of a vehicle's resistance to roll over. A higher SSF indicates a more stable vehicle. The majority of passenger vehicles have an SSF of 1.30 to 1.50[2]. This vehicle model also did not tip-up in the dynamic steering maneuver test in which the test vehicle was put through a fish-hook shaped steering maneuver (i.e., hard left and hard right steer) at a speed of between 56 km/h-80 km/h (35-50 mph).

The rollover of the Toyota was initiated following the impact with the Chevrolet. As the Toyota rotated clockwise and departed the west edge of the roadway, the force on the left side tires caused the vehicle to trip and roll over one quarter turn onto its left side. The distance traversed during the rollover was approximately 4 m (13 ft).

CONFORMANCE WITH FMVSS 305, SECTION 571, ELECTRIC POWERED VEHICLES

The Toyota's propulsion battery (**Figure 6**) was located in the back cargo area immediately rear of the second row seat. The battery pack consisted of 38, 7.2 volt NiMH modules connected in series in a water resistant stainless steel case. The battery cells contain an alkaline of potassium and sodium hydroxide, which is absorbed into the battery cell plates and will form a gel. The gel will not normally leak in the event of a crash[3]. Inspection of the propulsion battery revealed no evidence of movement or leakage. The mounting flange on the back of the battery (**Figure 7**) was slightly deformed due to the induced deformation of the floor of the trunk.

Figure 6: The Toyota's propulsion battery

[1] www.safecar.gov, 11/17/10

[2] "Trends in the Static Stability Factor of Passenger Cars, Light Trucks, and Vans," NHTSA Technical Report, DOT HS 809 868, June 2005

[3] Source: Toyota Prius Emergency Response Guide

The battery was equipped with a high voltage service disconnect switch, which was located on the back left corner the battery. The switch was in the locked position. The high voltage wiring that was accessible for inspection was not damaged. There was no evidence of electrical arching at the visible electrical connections on the battery. The voltage inverter and associated wiring and connectors could not be inspected since the hood was jammed shut from damage. An electrical isolation test was not conducted.

Figure 7: Minor deformation of the mounting flange on the back of the Toyota's propulsion battery

EVENT DATA RECORDER

The Air Bag Control Module (ACM) was removed from the vehicle by the police. An unsuccessful attempt to image any crash related data was conducted by this contractor via direct connection to the ACM using the manufacturer's Event Data Recorder (EDR) readout tool with software version 1.4.1.0.

AUTOMATIC RESTRAINT SYSTEM

The Toyota was equipped with redesigned driver and front right passenger frontal air bags. The driver's air bag was located within the steering wheel hub. The front right passenger's air bag was located within the top of the instrument panel. Both frontal air bags deployed during the crash.

The Toyota was also equipped with front seat-mounted side impact air bags. The front right passenger's seat-mounted side impact air bag deployed during the crash. The driver's seat-mounted side impact air bag did not deploy.

The driver's frontal air bag module cover was a three flap configuration constructed of pliable vinyl. The top flap was 15 cm (5.9 in) in width and 7 cm (2.8 in) in height. Each bottom flap was triangular-shaped and was 7.5 cm (3 in) in width and 8 cm (3.1 in) height. An inspection of the air bag module cover flaps revealed that they opened at the designated tear points and were undamaged. The deployed air bag was 62 cm (24.4 in) in diameter and had two 3 cm (1.2 in) diameter vent ports on the back of the air bag at the 1 and 11 o'clock positions. Inspection of the air bag revealed significant blood transfers on the bottom half of the front of the air bag. There was a melted area 3 cm in length on the upper right quadrant of the front of the air bag, which did not penetrate the air bag material. Fluid stains were present on the back of the air bag. Glass particles were also adhering to the back of the air bag. There were no discernable occupant contact evidence on the air bag.

The front right passenger's frontal air bag module cover was a single flap configuration constructed of medium gauge vinyl. The flap was 22 cm (8.7 in) in width and 6 cm (2.4 in) in height. The module cover flap opened at the designated tear points and was undamaged. The

deployed air bag was 46 cm (18.1 in) in width 60 cm (23.6 in) in height. Inspection of the air bag revealed several holes and small abrasions on the right side. The holes ranged in size from 0.5 cm (0.2 in) to 3 cm (1.2 in) and were related to flying glass fragments from the disintegrated right front window glazing. There was a large transfer of blood on the bottom half of the air bag. There were no discernable tissue transfers or occupant contact scuffs on the air bag.

The front right passenger's seat-mounted side impact air bag was located within the outboard side of the seat back and deployed through a tear seam. The deployed air bag was oval and was 27 cm (10.6 in) in width and 32 cm (12.6 in) in height. It was designed without tethers or vent ports. Inspection of the air bag revealed a few blood transfers but there was no discernable evidence of occupant contact scuff marks and the air bag was not damaged.

MANUAL RESTRAINT SYSTEM

Toyota was equipped with lap-and-shoulder safety belts for the front and second row seating positions. The driver's safety belt consisted of continuous loop belt webbing, an Emergency Locking Retractor (ELR), sliding latch plate, and an adjustable upper anchor that was in the middle position. The front right passenger's safety belt was equipped with a switchable ELR/Automatic Locking Retractor (ALR), a sliding latch plate, and an adjustable upper anchor that was located in the full-up position. The driver's retractor-mounted pretensioner actuated. Actuation of the front right passenger's pretensioner could not be confirmed due to the damaged condition of the B-pillar, which housed the retractor. The second row safety belts consisted of continuous loop belt webbing, switchable ELR/ALRs, sliding latch plates and fixed upper anchors.

Inspection of the safety belt assemblies revealed evidence that each of the passengers was restrained at the time of the crash. The webbing for each safety belt had been cut and there were load marks present on the webbing and D-ring for the driver and front right passenger. Load marks were also present on the webbing and latch plate belt guides for the second row left and right passengers.

CASE VEHICLE DRIVER KINEMATICS

The restrained driver [18-year-old male, 173 cm (68 in) and 80 kg (177 lbs)] of the Toyota was seated in an unknown posture. The position of the driver's seat track, seat back and steering column adjustment are unknown.

The frontal impact to the Toyota displaced the driver forward and slightly to the right and he loaded the safety belt. The driver loaded through the deployed frontal air bag and he contacted the steering wheel and center instrument panel. He sustained a herniated brain stem, multiple brain injuries, and multiple internal injuries from these contacts. When the vehicle rolled over onto its left side, the driver was redirected to the left. He remained restrained in the seat position and came to final rest against the left front door. Rescue personnel cut the safety belt and cut the roof off the vehicle to extricate the driver from the vehicle.

The driver was transported by ambulance to a trauma center where he was pronounced deceased three hours and twenty one minutes following the crash. A blood test was administered and the test was positive for amphetamine (54 ng/ml), tetrahydrocannabinol (2.1 ng/ml), and THC metabolite (22.3 ng/ml). The table below presents the driver's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Herniation brain stem, symmetrical, of unci and cerebellar tonsils[4]	critical 140202.5,8	Center instrument panel	Probable	Autopsy
2 3	Brain swelling, generalized, with lateral ventricles compressed symmetrically	serious 140662.3,1 140662.3,2	Center instrument panel	Probable	Autopsy
4	Hemorrhage, intraventricular, left lateral ventricle	moderate 140678.2,2	Center instrument panel	Probable	Autopsy
5 6	Hemorrhage, subarachnoid, posterobasilar, bilaterally	moderate 140694.2,1 140694.2,2	Center instrument panel	Probable	Autopsy
7	Contusions, large, bilateral subpleural lungs with blood in both upper lobes, not further specified	severe 441412.4,3	Steering wheel hub and/or spokes and rim	Probable	Autopsy
8	Hemopneumothorax[5] right pleural cavity with greater than 1 liter of blood evacuated and compression atelectasis involving right lung	severe 442206.4,1	Steering wheel hub and/or spokes and rim	Probable	Emergency room records

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[4] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

herniation (her"ne-a/shen): the abnormal protrusion of an organ or other body structure through a defect or natural opening in a covering, membrane, muscle, or bone.

descending transtentorial h.: the most common kind of transtentorial herniation, with downward displacement of the most medially-placed cerebral structures through the tentorial notch, compressing parts of the cerebrum and structures beneath the notch, including the brain stem; it is caused by a supratentorial mass. Symptoms depend on which structures are compressed and may include ocular changes or hemiparesis.

tentorial h.: *transtentorial h.*

tonsillar h.: protrusion of the cerebellar tonsils through the foramen magnum, exerting pressure on the medulla oblongata.

transtentorial h.: protrusion of brain structures through the tentorial notch; the two types are *descending transtentorial h.* and *ascending transtentorial h.* Called also *tentorial h.*

uncal h.: *tentorial h.*; *descending transtentorial herniation* in which the uncus protrudes through the notch.

unci (un/si): genitive and plural of uncus.

***uncus (ung/ks)* [L. "hook"]**: (1) *hook*: anatomical nomenclature for a structure that is long, thin, and curved. 2. the medially curved anterior end of the *parahippocampal gyrus*; called also *u. gyri fornicati*, *u. gyri hippocampi*, and *u. gyri parahippocampalis*.

[5] According to this patient's emergency room records, there was major hemothorax but only moderate pneumothorax.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
9	Hemothorax, bilaterally[6], right greater than left, not further specified	serious 442200.3,2	Steering wheel hub and/or spokes and rim	Probable	Autopsy
10 11	Contusion myocardium, infero-posterior interatrial septum with hemopericardium	severe 441006.4,4 serious 441603.3,4	Steering wheel hub and/or spokes and rim	Probable	Autopsy
12	Laceration, broadly, right hemi-diaphragm with liver protruding into right pleural space	severe 440610.4,1	Steering wheel hub and/or spokes and rim	Probable	Autopsy
13	Lacerations liver, deep, central and inferior accompanied by shallow middle lobe lacerations	serious 541824.3,1	Steering wheel hub and/or spokes and rim	Probable	Autopsy
14	Lacerations, multiple, medial spleen, not further specified	moderate 544220.2,2	Steering wheel hub and/or spokes and rim	Probable	Autopsy
15	Laceration (transection) right renal artery with abundant right retroperitoneal hemorrhage	severe 521408.4,1	Steering wheel hub and/or spokes and rim	Probable	Autopsy
16	Laceration, grade 3, right kidney, not further specified	serious 541624.3,1	Steering wheel hub and/or spokes and rim	Probable	Hospitalization records
17	Contusion, right adrenal gland, not further specified	minor 540210.1,1	Steering wheel hub and/or spokes and rim	Probable	Emergency room records
18	Fracture right occipital condyle[7], not further specified	serious 150202.3,8	Center instrument panel	Probable	Emergency room records
19	Dislocation (dissociation) atlanto-occipital joint with 1.3 cm (0.5 in) separation from basion to dens[8]	moderate 650208.2,6	Center instrument panel (indirect injury)	Probable	Autopsy with detail from Emergency room records

[6] Right side hemothorax was included in the lesion immediately above.

[7] The hospital discharge summary and the autopsy described this lesion as a C_1 (atlas) fracture but provided no detail; however, the hospital CT scans of the brain and C-spine indicated that it was the right occipital condyle that was fractured.

[8] The following terms are defined in Dorland's Illustrated Medical Dictionary as follows:

basion (ba/se-on): a craniometric landmark located at the midpoint of the anterior border of the foramen magnum in the median plane.

dens (dens): 1. *tooth* (q.v.): one of the small bonelike structures of the jaws of humans and other animals. 2. ***d. axis***. 3. a toothlike structure.

dens ax/is: tooth of axis: the toothlike process that projects from the superior surface of the body of the axis, ascending to articulate with the atlas; called also *d. epistrophei*, ***odontoid bone***, *odontoid apophysis*, ***odontoid process of axis***, and tooth of *epistropheus*.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
20	Dislocation (subluxation), rotary, with C_1 slightly rotated on C_2	serious 650206.3,6	Center instrument panel (indirect injury)	Probable	Emergency room records
21	Fractured teeth, #8 and #9, not further specified	minor 251404.1,8	Steering wheel rim	Probable	Autopsy
22	Avulsion (obviously missing) of dentation, not further specified	minor 251406.1,8	Steering wheel rim	Probable	Emergency room records
23	Fractured ribs, multiple, bilateral, anteriorly and left lateral with displaced ribs: anterior right 3rd-5th, anterior left 3rd-6th, and lateral left 7th	serious 450203.3,3	Steering wheel hub and/or spokes and rim	Probable	Autopsy
24	Fractures, non-displaced, sternum, not further specified	moderate 450804.2,4	Steering wheel hub and/or spokes and rim	Probable	Emergency room records
25 26 27	Fractures anterior superior endplates of T_4 through T_6, not further specified	moderate 650430.2,7 650430.2,7 650430.2,7	Steering wheel hub and/or spokes and rim	Possible	Emergency room records
28 29 30 31 32	Fracture spinous processes in lumbar region–L_1 though L_5 and most of the right transverse processes[9], not further specified	moderate 650618.2,8 650618.2,8 650618.2,8 650618.2,8 650618.2,8	Seat back, driver's	Possible	Emergency room records
33	Fracture, compound, palpable, mid-shaft right humerus	moderate 751222.2,1	Center instrument panel	Probable	Autopsy
34	Fracture, compound, palpable, distal left humerus	moderate 751222.2,2	Left front door panel, forward upper quadrant	Probable	Autopsy
35 36	Fracture, palpable, mid left forearm as well as left hand and left wrist, not further specified	moderate 751900.2,2 752000.2,2	Left front door panel, forward upper quadrant	Probable	Emergency room records

[9] AIS code 651607.2 was not chosen because it is unclear where the transverse process fractures actually occurred. It also is not clear whether the transverse process fractures were limited to the lumbar region or also occurred in the thoracic region. Instead, what is know was encoded.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
37	Fractures pelvis, non-displaced, involving left pubic symphysis, bilateral inferior pubic rami, and sacrum–most of neuroforamen without involving sacroiliac joints	moderate 856151.2,4	Center lower instrument panel (indirect injury)	Probable	Autopsy with detail from Emergency room records
38	Fracture, complex, right midfemur with adjacent lateral, 5 cm (2 in), and posterior, 3 cm (1.2 in) lacerations	serious 853272.3,1	Center lower instrument panel (indirect injury)	Probable	Autopsy with detail from Emergency room records
39	Abrasion, linear, across sternum and downward	minor 410202.1,4	Torso portion of safety belt system	Certain	Autopsy
40	Abrasions, (1) horizontal, overlying right rib fractures, (2) irregular, oblique, medial left breast, and (3) linear, vertical, oblique, epigastrum	minor 410202.1,0	Steering wheel hub and/or spokes and rim	Probable	Autopsy
41	Abrasion, 5.1 cm (2 in), broad, overlying inferomedial right scapula	minor 410202.1,6	Seat back, driver's	Probable	Autopsy
42	Abrasion, linear, obliquely oriented, right flank	minor 510202.1,1	Torso portion of safety belt system	Certain	Autopsy
43	Abrasion, horizontal, overlying right iliac crest, continuing intermittently across lower abdominal quadrants	minor 510202.1,8	Lap portion of safety belt system	Certain	Autopsy
44	Abrasion, deep, oblique, at left base of neck on top of left shoulder	minor 710202.1,2	Torso portion of safety belt system	Certain	Autopsy
45	Abrasions, irregular, oblique, right mid-thigh and lower anterolateral thigh	minor 810202.1,1	Interior, center console first row	Probable	Autopsy
46	Contusion (hematoma), swelling, along right thigh at fracture site	minor 810402.1,1	Interior, center console first row	Probable	Emergency room records
47	Abrasions, multiple, irregular, covering anterior left knee and anterior left lower leg	minor 810202.1,2	Left lower instrument panel (includes knee bolster)	Probable	Autopsy
48	Abrasions, multiple, horizontal, anterior right knee	minor 810202.1,1	Center lower instrument panel	Probable	Autopsy

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
49	Abrasion, small, oblique, overlying right fibula, anteriorly	minor 810202.1,1	Interior, center console first row	Probable	Autopsy
50	Contusions, dorsum, bilateral feet overlying proximal great toes	minor 810402.1,3	Floor, including toe pan	Probable	Autopsy

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The restrained front right passenger [19-year-old female, 157 cm (62 in) and 57 kg (125 lbs)] of the Toyota was seated in an unknown posture. The position of the passenger's seat track and seat back are unknown.

The frontal impact displaced the front right passenger forward and slightly to the right and she loaded the safety belt. The passenger loaded through the deployed frontal air bag and contacted the intruded instrument panel and right A-pillar. The contact to the A-pillar caused an open fracture of the right frontal and parietal skull, a lacerated cerebrum, a laceration through the pontomedullary junction, a fracture-dislocation of the atlanto-occipital joint, and a crushed spinal cord. The passenger was redirected to the left as the vehicle rolled over onto its left side. She remained restrained in her seat position during the crash and was entrapped by the intruded instrument panel, A-pillar, and right front door. Rescue personnel removed the roof and cut the safety belt to extricate her from the vehicle.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The passenger sustained fatal injuries and was pronounced deceased at the crash scene. The table below presents the passenger's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Laceration, partial thickness, extending through pontomedullary junction	maximal 140212.6,8	Right A-pillar	Probable	Autopsy
2	Crush proximal spinal cord, not further specified, with fracture-dislocation of atlanto-occipital joint, not further specified	maximal 640276.6,6	Right A-pillar	Probable	Autopsy
3	Fracture, open[10], right frontal and parietal skull	severe 150406.4,1	Right A-pillar	Probable	Autopsy

[10] Laceration, 10.2 cm (4 in), full thickness, right forehead with skull fractured underneath.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
4	Lacerated cerebrum beneath right frontoparietal skull fracture	serious 140688.3,1	Right A-pillar	Probable	Autopsy
5	Fracture anterior left ribs: 3rd through 7th, not otherwise specified	serious 450203.3,2	Right instrument panel	Probable	Autopsy
6	Laceration (rupture) left hemi-diaphragm, not further specified	severe 440610.4,2	Lap portion of safety belt system	Probable	Autopsy
7	Laceration (rupture) stomach with some gastric contents and portion of stomach within left pleural cavity	severe 544426.4,7	Lap portion of safety belt system	Probable	Autopsy
8	Lacerations mesentary of small intestine in left upper quadrant, not further specified	moderate 542020.2,8	Lap portion of safety belt system	Probable	Autopsy
9	Laceration (rupture) left adrenal gland with small hemorrhage	serious 540226.3,2	Right instrument panel	Probable	Autopsy
10	Laceration and crush spleen, not further specified	serious 544240.3,2	Right instrument panel	Probable	Autopsy
11	Fractured pelvis in multiple locations, not further specified	moderate 856100.2,4	Right instrument panel	Probable	Autopsy
12	Fracture right tibia, not further specified	moderate 854000.2,1	Right lower instrument panel (includes knee bolster)	Probable	Autopsy
13	Dislocation left ankle, not further specified	moderate 877130.2,2	Floor, including toe pan	Probable	Autopsy
14 15	Abrasions left periorbital and right anterior face	minor 210202.1,2 210202.1,1	Air bag, front right passenger's	Possible	Autopsy
16	Abrasion right side of neck, not further specified	minor 310202.1,1	Torso portion of safety belt system	Certain	Autopsy
17	Abrasions anterior chest, not further specified	minor 410202.1,4	Torso portion of safety belt system	Certain	Autopsy
18	Abrasions anterior abdomen, not further specified	minor 510202.1,9	Torso portion of safety belt system	Probable	Autopsy
19	Abrasion left shoulder, not further specified	minor 710202.1,2	Right instrument panel	Probable	Autopsy
20 21	Abrasion right shoulder and right arm and avulsion, 5.1 cm (2 in) right lateral shoulder	minor 710202.1,1 710802.1,1	Torso portion of safety belt system	Certain	Autopsy

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
22	Contusion dorsum (back) right hand, not further specified	minor 710402.1,1	Right instrument panel	Probable	Autopsy
23	Abrasions medial proximal thighs, bilaterally	minor 810202.1,3	Lap portion of safety belt system	Possible	Autopsy
24	Abrasion right lateral thigh, not further specified	minor 810202.1,1	Right front door panel, forward upper quadrant	Probable	Autopsy
25	Abrasions right anterior knee and right anterior proximal leg	minor 810202.1,1	Right lower instrument panel (includes knee bolster)	Probable	Autopsy
26	Laceration, L-shaped, 15.2 x 12.7 cm (6 x 5 in), full thick-ness, right anterior knee and lower leg[11]	minor 810602.1,1	Right lower instrument panel (includes knee bolster)	Probable	Autopsy
27	Abrasion left distal anterior thigh, not further specified	minor 810202.1,2	Interior, center console first row	Probable	Autopsy
28	Laceration, 7.6 cm (3 in), full thickness, left anteromedial distal thigh	minor 810602.1,2	Interior, center console first row	Probable	Autopsy

CASE VEHICLE SECOND ROW LEFT PASSENGER KINEMATICS

The restrained second row left passenger [18-year-old male, 183 cm (72 in) and 61 kg (135 lbs)] of the Toyota was seated in an unknown posture.

The frontal impact on the Toyota displaced the second row left passenger forward and slightly to the right. The passenger loaded his safety belt and contacted the back of the driver's seat. He sustained a depressed fracture of the right temporofrontal bone, a basilar skull fracture, fracture of the right orbit, multiple brain injuries, fractures of the right forearm, right distal radius, right ulnar, and right hand. He also sustained bilateral contusions of lungs, a lacerated pleura, and pneumothorax from loading the torso portion of the safety belt. His hips loaded the lap portion of the safety belt, which caused a fracture of the neck of the right femur. He also sustained fractures of the left transverse process of L_3 and the body of the L_4 vertebrae. As the vehicle rolled over onto its left side, the passenger was redirected to the left. He remained restrained in his seat position and came to final rest against the left rear door. Rescue personnel cut the safety belt and extricated him from the vehicle.

[11] It is not know whether this laceration was overlying the right tibial fracture.

The second row left passenger was transported by ambulance to a trauma center. He was hospitalized for 23 days. The table below presents the passenger's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Hemorrhage, subdural, 2 mm (0.08 in) over right parietal, not further specified	serious 140650.3,1	Seat back, driver's	Probable	Hospitalization records
2	Hemorrhage, subarachnoid, right frontoparietal, not further specified	moderate 140694.2,1	Seat back, driver's	Probable	Hospitalization records
3	Edema, cerebral, diffuse with midline shift, approximately 0.5 cm (0.2 in) right to left, with mild effect upon right lateral ventricle; all four ventricles and basal cisterns were patent	serious 140668.3,9	Seat back, driver's	Probable	Hospitalization records
4	Contusionsal lobe, inferior right and anterior temporal, not further specified	serious 140612.3,1	Seat back, driver's	Probable	Hospitalization records
5	Pneumocephalus, scattered within extra-axial space anterior and lateral to right frontal and temporal lobes	serious 140682.3,1	Seat back, driver's	Probable	Hospitalization records
6	Contusions bilateral lungs, involving entire right lobe and small area left upper lobe	serious 441410.3,3	Torso portion of safety belt system	Probable	Hospitalization records
7	Laceration (tear), pleura, not further specified	moderate 441800.2,9	Torso portion of safety belt system	Probable	Hospitalization records
8	Pneumothorax, small, right apical, not further specified	moderate 442202.2,1	Torso portion of safety belt system	Probable	Hospitalization records
9	Fracture, depressed, right temporofrontal bone, extending downward from coronal suture, sparing otic capsule[12], and right glenoid (condyloid, mandibular) fossa[13] of temporomandibular joint	moderate 150402.2,1	Seat back, driver's	Probable	Hospitalization records

[12] Otic capsule is the skeletal element enclosing the inner ear mechanism.

[13] glenoid fossa - a deep concavity in the temporal bone at the root of the zygomatic arch that receives the condyle of the mandible

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
10	Fracture, basilar, complex, involving right anterior cranial fossa–right sphenoid bone and orbital roof (i.e., right frontal sinus), and middle cranial fossa (i.e., squamous portion of temportal bone)	serious 150206.4,8	Seat back, driver's	Probable	Hospitalization records
11	Fracture, right orbit, blowout, involving right maxillary sinus and lamina papyracea[14]	moderate 251205.2,1	Seat back, driver's	Probable	Hospitalization records
12	Conjunctival chemosis[15], right, with exposure and elevated intraocular pressure (IOP)	minor 240416.1,1	Seat back, driver's	Probable	Hospitalization records
13	Fracture, L_3 left transverse process, minimally displaced	moderate 650620.2,8	Second row seat cushion	Probable	Hospitalization records
14	Fracture, burst, L_4 body with 25% loss of body height and retropulsion of fragments into central canal compromising 75% to 80% of the canal	moderate 650634.3,8	Second row seat cushion	Probable	Hospitalization records
15 16	Fracture, open, comminuted, transverse, grade 2, midshaft right forearm, both bones	serious 752272.3,1 752274.3,1	Seat back, driver's	Probable	Hospitalization records
17	Fracture right distal radius, involving radiocarpal joint	moderate 752311.2,1	Seat back, driver's	Probable	Hospitalization records
18	Fracture, non-displaced, right ulnar styloid process	moderate 752353.2,1	Seat back, driver's	Probable	Hospitalization records
19 20 21	Fracture metacarpals of right hand, including ring finger–displaced, and diaphysis–non-displaced, 4th and 5th fingers	moderate 752553.2,1 752553.2,1 752553.2,1	Seat back, driver's	Probable	Hospitalization records
22	Compartment syndrom right hand with fasciotomies (10 compartment release) performed	moderate 712008.2,1	Seat back, driver's	Probable	Hospitalization records

[14] Synonym for the orbital plate of the ethmoid bone, which forms part of the medial wall of the orbit. It is thus named because it is as thin as paper and this may contribute to an infection of an ethmoidal sinus spreading into the orbit and resulting in orbital cellulitis.

[15] The following term is defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
chemosis (ke-mo/sis): excessive edema of the ocular conjunctiva.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
23 24	Fracture right femur through neck, non-displaced, and comminuted, displaced, intratrochanteric with subtrochanteric extension and hematoma within thigh	serious 853161.3,1 853151.3,1	Lap portion of safety belt system	Probable	Hospitalization records
25	Contusion (hematoma) right scalp overlying fractures	minor 110402.1,1	Seat back, driver's	Probable	Hospitalization records
26	Laceration right external auditory canal, not further specified	minor 210600.1,1	Seat back, driver's	Probable	Hospitalization records
27	Contusion (hematoma) with swelling over right face, right orbit, and upper and lower eyelids	minor 210402.1,1	Seat back, driver's	Probable	Hospitalization records
28	Contusion (seat belt sign) across chest, not further specified	minor 410402.1,4	Torso portion of safety belt system	Certain	Emergency room records
29	Abrasions, small, scattered, superficial over left clavicle and left shoulder	minor 710202.1,2	Torso portion of safety belt system	Certain	Emergency room records
30	Contusion (ecchymosis) right hand palmar surface	minor 710402.1,1	Seat back, driver's	Probable	Hospitalization records
31	Contusion (ecchymosis) with swelling right thigh, not further specified	minor 810402.1,1	Lap portion of safety belt system	Probable	Emergency room records

CASE VEHICLE SECOND ROW RIGHT PASSENGER KINEMATICS

The restrained second row right passenger [18-year-old female, 165 cm (65 in) and 76 kg (167 lbs) of the Toyota was seated in an unknown posture.

The frontal impact displaced the second row right passenger forward and slightly to the right. She loaded the safety belt and contacted the intruding right rear door and the front right passenger's seat back. The contact to the right rear door caused a laceration of the aorta, multiple rib fractures, a crushed spleen, and a laceration of the left hemidiaphragm. As the vehicle rolled over onto its left side, the passenger was redirected to the left. She remained restrained in her seat position during the crash. Rescue personnel cut the safety belt and extricated her from the vehicle.

The passenger sustained fatal injuries and was pronounced deceased at the crash scene.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Laceration (transection) aorta at ligamentum arteriosum[16]	maximal 420218.6,4	Right rear door panel, forward upper quadrant	Probable	Autopsy
2	Laceration (rupture) left hemidiaphragm with stomach extending into left pleural cavity	severe 440610.4,2	Right rear door panel, forward upper quadrant	Probable	Autopsy
3	Hemothorax, left, 1.2 liters of blood admixed with gastric contents in left pleural cavity	severe 442201.4,2	Right rear door panel, forward upper quadrant	Probable	Autopsy
4	Laceration (rupture) stomach	severe 544426.4,7	Lap portion of safety belt system	Probable	Autopsy
5	Lacerations, multiple, diaphragmatic surface of liver; largest laceration 12 cm (4.7 in) in length and 1 cm (0.4 in) in depth	moderate 541822.2,1	Right rear door panel, forward upper quadrant	Probable	Autopsy
6	Lacerations mesentery, not further specified	moderate 542020.2,8	Lap portion of safety belt system	Probable	Autopsy
7	Lacerations (crushed) spleen with multiple severe lacerations	critical 544228.5,2	Right rear door panel, forward upper quadrant	Probable	Autopsy
8	Fractured left ribs: 3rd through 9th, not further specified	serious 450203.3,2	Right rear door panel, forward upper quadrant	Probable	Autopsy
9	Fractured left humerus, not further specified	moderate 751100.2,2	Seat back, front right passenger's	Probable	Autopsy
10	Fracture, open, right distal humerus with bone protruding through full thickness laceration distal posterior arm	moderate 751332.2,1	Right rear door panel, rear upper quadrant	Certain	Autopsy
11	Fractures, palpable, pelvis, not further specified	moderate 856100.2,4	Seat mount, front right passenger's (indirect injury)	Possible	Autopsy

[16] The following term is defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
ligamenta arterio/sum: a short, thick, strong fibromuscular cord extending from the pulmonary artery to the arch of the aorta; it is the remains of the ductus arteriosus. Called also *ligament of Botallo*.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
12	Injured left leg with shortening and external rotation	moderate 852002.2,2	Seat mount, front right passenger's (indirect injury)	Probable	Autopsy
13	Laceration, 1.3 cm (0.5 in), full thickness, right nose	minor 210602.1,4	Noncontact injury: flying glass, right rear glazing	Probable	Autopsy
14 15	Abrasions face: right and central areas, not further specified	minor 210202.1,1 210202.1,4	Noncontact injury: flying glass, right rear glazing	Probable	Autopsy
16	Abrasions right mandibular region of neck, not further specified	minor 310202.1,1	Noncontact injury: flying glass, right rear glazing	Probable	Autopsy
17	Abrasions over upper anterior chest wall and right chest wall, not further specified	minor 410202.1,0	Torso portion of safety belt system	Probable	Autopsy
18	Abrasions over anterior abdomen, not further specified	minor 510202.1,9	Lap portion of safety belt system	Possible	Autopsy
19	Abrasions over lower lumbar region of back, not further specified	minor 410202.1,6	Second row seat back	Probable	Autopsy
20	Abrasions on dorsal (back) surface of hands, not further specified	minor 710202.1,3	Seat back, front right passenger's	Possible	Autopsy
21	Abrasions over right and left anterior thighs, not further specified	minor 810202.1,3	Second row seat back	Probable	Autopsy
22	Contusions ventral (top) surface left foot, not further specified	minor 810402.1,2	Seat mount, front right passenger's	Probable	Autopsy
23	Laceration, 7.6 cm (3 in), full thickness, ventral (top) surface right foot, extending to medial ankle	minor 810602.1,1	Seat mount, front right passenger's	Probable	Autopsy

OTHER VEHICLE

The 2003 Chevrolet Blazer was a 4-wheel drive, 4-door, sport utility vehicle (VIN: 1GNDT13X63K------) equipped with a 4.3-liter, V6 engine, a 4-speed automatic transmission, 4-wheel anti-lock brakes with electronic brake force distribution, and redesigned driver and front right passenger frontal air bags. The second row was equipped with a split bench seat with folding backs, adjustable head restraints, lap-and-shoulder safety belts in the outboard seating positions, and a lap belt in the middle seating position. The second row was also equipped with Lower

Anchors and Tethers for Children (LATCH) in the outboard seating positions and a tether anchor in the center seating position.

Exterior Damage: The Chevrolet sustained front plane damage from the impact with the Toyota. The front bumper, grille, hood, both fenders, and both headlamp/turn signal assemblies were directly damaged. The direct damage began at the front right bumper corner and involved the full front plane of the vehicle. The crush measurements were taken at the bumper level and the maximum residual crush was 156 cm (61.4 in) occurring at C_6. The table below presents the Chevrolet'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	135	156	103	64	87	93	124	154	156	0	0
in		53.2	61.4	40.6	25.2	34.3	36.6	48.8	60.6	61.4	0.0	0.0

Damage Classification: The CDC for the Chevrolet was 11FDEW6 (340 degrees). The Damage algorithm of the WinSMASH program calculated the Chevrolet's total Delta-V as 88 km/h (54.7 mph). The longitudinal and lateral velocity changes were –83 km/h (-51.6 mph) and 30 km/h (18.6 mph), respectively. The results appeared high.

The vehicle manufacturer's recommended tire size was P235/70R15. The size of the tires on the vehicle was not determined. The vehicle's tire data is presented 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	32nd of an inch			
LF	Flat	Flat	221	32	9	11	None	No	No
LR	214	31	221	32	7	9	None	Yes	Yes
RR	207	30	221	32	7	9	None	Yes	Yes
RF	Flat	Flat	221	32	8	10	None	No	No

Event Data Recorder: The Chevrolet's EDR was imaged by the police using version 3.5 of the Bosch Crash Data Retrieval (CDR) software. A copy of the imaged data was provided to this contractor and was read and reported with version 3.7 of the CDR software. The EDR recorded a deployment and non-deployment event. The ignition cycle count for the non-deployment event was not the same as for the deployment event, which indicated that the non-deployment event was not related to this crash. The EDR reported the Supplemental Inflatable Restraint (SIR) warning

lamp as "Off." The driver's safety belt switch circuit status was reported as "Unbuckled." The maximum recorded velocity change was reported at 60.38 km/h (-37.52 mph) occurring at 100 ms following algorithm enable (AE). The time from AE to the deployment command criteria being met was 5 ms. The pre-crash data was discussed in the pre-crash section on page 1. The EDR report is attached at the end of this report[17].

Manual Restraints: The Chevrolet was equipped with lap-and-shoulder safety belts for the front row and the outboard seating positions in the second row. The front row safety belts were not equipped with pretensioners. The second row center seating position was equipped with a lap belt. The driver's safety belt consisted of continuous loop belt webbing, an Emergency Locking Retractor (ELR), sliding latch plate, and a fixed upper anchor. The front right passenger's safety belt was equipped with a switchable ELR/Automatic Locking Retractor (ALR), sliding latch plate, and fixed upper anchor. The second row outboard safety belts consisted of continuous loop belt webbing, switchable ELR/ALRs, sliding latch plates and fixed upper anchors. The second row center lap belt was equipped with a sewn latch plate.

Inspection of the driver and front right passenger safety belt assemblies revealed no evidence of usage in this crash. The vehicle's EDR recorded the driver's safety belt switch circuit status as "Unbuckled."

The inspection of the second row left safety belt assembly revealed historic usage scratches on the latch plate and slight scuff marks on the latch plate belt guide. Load abrasions from the safety belt were also found on the edge of each belt guide on this passenger's CRS. This evidence indicated that the second row left passenger was restrained by the lap-and-shoulder safety belt.

The inspection of the second row center passenger's lap safety belt revealed slight historic usage scratches on the latch plate. There were also scuff marks on the belt webbing, which had a slight stretched appearance. This evidence indicated that the second row center passenger was restrained by the lap belt.

The inspection of the second row right passenger's safety belt assembly revealed historic usage scratches on the latch plate and load abrasions on the D-ring, the latch plate belt guide, and the safety belt webbing. This evidence indicated that the second row right passenger was restrained by the lap-and-shoulder safety belt.

Child Restraint Systems: The Chevrolet's second row left passenger (5-year-old male, unknown height and weight) was seated in a Dorel Highrise belt positioning booster CRS (**Figure 8**) that was manufactured on May 3, 2007. The model number was 22-297-CCC. The CRS was designed for children who weigh between 13.6 kg and 45.4 kg (30 and 100 lbs) and who are between 86 and 145 cm (34 and 57 in) in height.

[17] Page 7 of the EDR report have been deleted for confidentiality purposes.

The CRS was constructed of plastic and had two fixed arm rests. The CRS typically has a padded cushion but no cushion was present at the time of the SCI inspection. Inspection of the CRS revealed no crash related damage. There were load abrasions from the safety belt on the edge of each belt guide (**Figure 9**).

Figure 8: The Chevrolet's second row left passenger's CRS

The second row right passenger [3-year-old male, unknown height and 19 kg (42 lbs)] was seated in an unknown make and model belt positioning booster CRS. It was not present at the SCI vehicle inspection and its location could not be determined.

Figure 9: Load abrasions (arrow) on the right side safety belt guide of the CRS

Driver and Front Right Passenger: The unrestrained driver (62-year-old female, unknown height and weight) of the Chevrolet was transported by ambulance to a trauma center where she was subsequently pronounced deceased. The unrestrained front right passenger (56-year-old male, unknown height and weight) sustained fatal injuries and was pronounced deceased at the crash scene.

Second Row Left Passenger: The second row left passenger (5-year-old male, unknown height and weight) was seated in a belt positioning booster CRS. He sustained police-reported A (incapacitating) injuries. He was transported by ambulance to a trauma center where he was admitted. No medical records could be obtained for this passenger.

Second Row Center Passenger: The restrained second row center passenger [10-year-old male, unknown height and 41 kg (90 lbs)] was seated in an unknown posture. The impact displaced him forward and to the left opposite the 11 o'clock direction of force. He loaded his lap safety belt and his right knee contacted the center console. He rebounded and contacted the second row right CRS. The contact to the CRS was based on the passenger's statement to medical personnel reported in the medical records that he contacted the CRS. He sustained multiple contusions and abrasions from these contacts. He was transported by ambulance to a trauma center and admitted overnight for observation. The table below presents the passenger's injuries and injury sources.

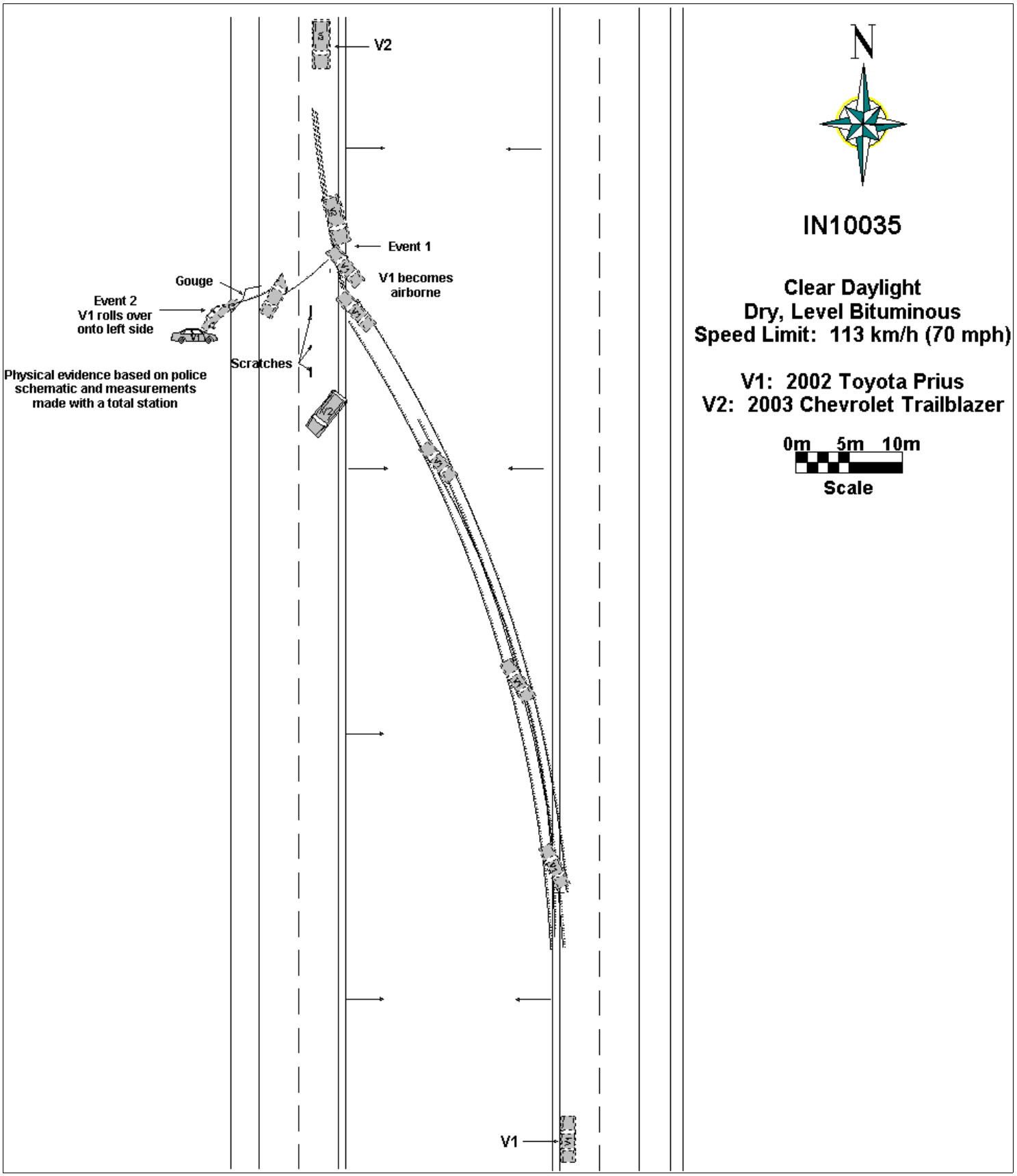
Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Contusion (ecchymosis, bruise) right side of head, not further specified	minor 110402.1,1	Child safety seat's left side surface	Certain	Emergency room records
2	Abrasion, large, over right temple and along right cheek	minor 210202.1,1	Child safety seat's left side surface	Certain	Hospitalization records
3	Abrasions noted over hips, bilaterally	minor 510202.1,3	Lap portion of safety belt system	Certain	Emergency room records
4	Contusion (bruise), horizontal, across abdomen from one anterior superior iliac spine to the other	minor 510402.1,8	Lap portion of safety belt system	Certain	Hospitalization records
5	Abrasion (scraping) right arm, not further specified	minor 710202.1,1	Child safety seat's left side surface	Certain	Hospitalization records
6	Abrasion (scraping) right proximal lateral leg	minor 810202.1,1	Child safety seat's left side surface	Certain	Hospitalization records
7	Contusion (bruise) right knee, not further specified	minor 810402.1,1	Interior, center console first row	Probable	Emergency room records

Second Row Right Passenger: The restrained second row right passenger [3-year-old female, unknown height and 19 kg (42 lbs)] was seated in a belt positioning booster CRS. The impact displaced her forward and to the left opposite the 11 o'clock direction of force. She loaded the safety belt and contacted the front right passenger's seat back. She sustained a concussion with loss of consciousness and transverse fractures of the distal tibia and fibula from contacting the front right seat back. She also sustained a mesenteric hematoma from loading the safety belt. She was transported by ambulance to a level 1 trauma center and hositalized for four days. The table below presents the passenger's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Concussion with loss of consciousness at scene; slowly regain consciousness en route to hospital; GCS=14 in ER	moderate 161002.2,0	Seat back, front right passenger's	Probable	Hospitalization records
2	Hematoma, paraduodeal[18]/mesenteric, not further specified	moderate 542010.2,8	Lap portion of safety belt system	Certain	Hospitalization records

[18] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
paraduodenal (par"a-doo"o-de/nal) (-doo-od/e-nal): alongside, near, or around the duodenum.
metaphysis (me-taf'-e-sis): the wider part at the extremity of the shaft of a long bone, adjacent to the epiphyseal disk. During development it contains the growth zone and consists of spongy bone; in the adult it is continuous with the epiphysis.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
3 4	Fractures, transverse, non-displaced, distal tibia metaphysis[14] and distal fibula	moderate 854251.2,1 854471.2,1	Seat back, front right passenger's (indirect injury)	Probable	Hospitalization records
5	Abrasion, small, on inner lower lip, not further specified	minor 210202.1,8	Seat back, front right passenger's	Probable	Emergency room records
6	Contusion (very prominent seat belt mark) anterior lower pelvis, left to right across abdomen	minor 510402.1,8	Lap portion of safety belt system	Certain	Hospitalization records
7	Abrasion noted on right hip, not further specified	minor 510202.1,1	Lap portion of safety belt system	Certain	Emergency room records
8	Contusion (hematoma) over right flank, not further specified	minor 510402.1,1	Lap portion of safety belt system	Certain	Emergency room records


V2
Event 1
V1 becomes airborne
Gouge
Event 2
V1 rolls over onto left side
Scratches
Physical evidence based on police schematic and measurements made with a total station
V1
N
IN10035
Clear Daylight
Dry, Level Bituminous
Speed Limit: 113 km/h (70 mph)
V1: 2002 Toyota Prius
V2: 2003 Chevrolet Trailblazer
0m 5m 10m
Scale

Event Data Recorder Report
2003 Chevrolet Blazer

IMPORTANT NOTICE: Robert Bosch LLC and the manufacturers whose vehicles are accessible using the CDR System urge end users to use the latest production release of the Crash Data Retrieval system software when viewing, printing or exporting any retrieved data from within the CDR program. Using the latest version of the CDR software is the best way to ensure that retrieved data has been translated using the most current information provided by the manufacturers of the vehicles supported by this product.

CDR File Information

User Entered VIN	1GNDT13X63K******
User	
Case Number	
EDR Data Imaging Date	10/11/2010
Crash Date	10/10/2010
Filename	IN10035CHEVBLAZER.CDRX
Saved on	Monday, October 11 2010 at 07:32:54
Collected with CDR version	Crash Data Retrieval Tool 3.5
Reported with CDR version	Crash Data Retrieval Tool 3.7
EDR Device Type	airbag control module
Event(s) recovered	Deployment Non-Deployment

Comments

Data Limitations

Recorded Crash Events:

There are two types of Recorded Crash Events. The first is the Non-Deployment Event. A Non-Deployment Event records data but does not 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 approximately 250 ignition cycle. This event can be overwritten by a second Deployment Event, referred to as a Deployment Level Event, if the Non-Deployment Event is not locked. The data in the Non-Deployment Event file will be locked, if the Non-Deployment Event occurred within five seconds before a Deployment Event. A locked Non Deployment Event cannot be overwritten or cleared by the SDM.

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. If a Deployment Level Event occurs within five seconds after the Deployment Event, the Deployment Level Event will overwrite any non-locked Non-Deployment Event. Deployment Events cannot be overwritten or cleared by the SDM. Once the SDM has deployed an air bag, the SDM must be replaced.

Data:

-SDM Recorded Vehicle Longitudinal Velocity Change reflects the change in longitudinal velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Longitudinal Velocity Changeis 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. For Deployment 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 up to the first 150 milliseconds of data after algorithm enable. Velocity Change data is displayed in SAE sign convention.

-SDM Recorded Vehicle Speed accuracy can be affected by various factors, including but not limited to the following:

- -significant changes in the tire's rolling radius
- -final drive axle ratio changes
- -wheel lockup and wheel slip

-Brake Switch Circuit Status indicates the open/closed state of the brake switch circuit.

-Pre-Crash data is recorded asynchronously.

-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if:

- -the SDM receives a message with an "invalid" flag from the module sending the pre-crash data
- -no data is received from the module sending the pre-crash data
- -no module present to send the pre-crash data

-Engine Speed is reported at two times the actual value in the following vehicles, if the vehicle is equipped with a 6.6L Duramax diesel engine (RPO LB7, LBZ, LLY, or LMM):

- -2001-2006 Chevrolet Silverado
- -2007 Chevrolet Silverado Classic
- -2001-2006 GMC Sierra
- -2007 GMC Sierra Classic
- -2006-2007 Chevrolet Express
- -2006-2007 GMC Savana

-2003-2009 Chevrolet Kodiak
-2003-2009 GMC Topkick

-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 This Event and the Previous 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".
-All data should be examined in conjunction with other available physical evidence from the vehicle and scene.

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 by the Powertrain Control Module (PCM), via the vehicle's communication network, to the SDM.
-Brake Switch Circuit Status data is transmitted 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.

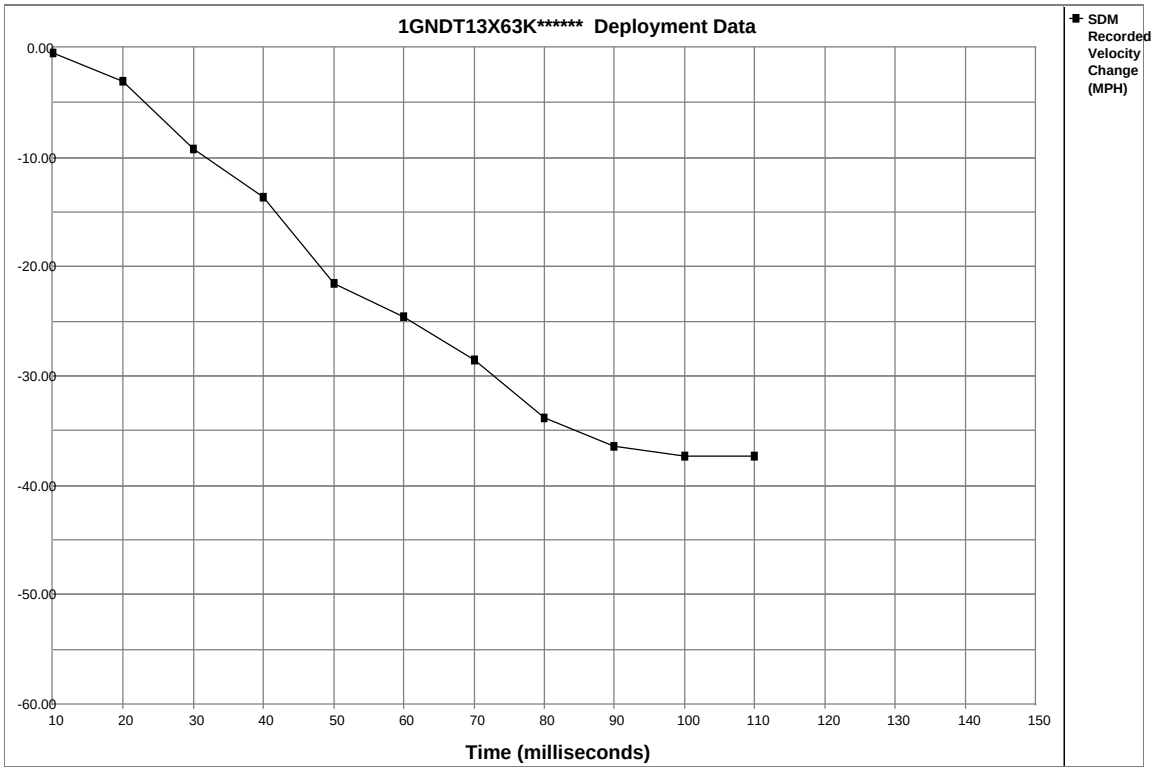
01025_SDMG-99JXZ09-10_r002

System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger SIR Suppression Switch Circuit Status (if equipped)	Air Bag Not Suppressed
Ignition Cycles At Deployment	16152
Ignition Cycles At Investigation	16153
Maximum SDM Recorded Velocity Change (MPH)	-37.52
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	100
Time Between Non-Deployment And Deployment Events (sec)	.3
Time From Algorithm Enable to Deployment Command Criteria Met (msec)	5

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	73	2176	27
-4	73	2176	21
-3	73	2176	21
-2	73	2112	21
-1	66	1984	0

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



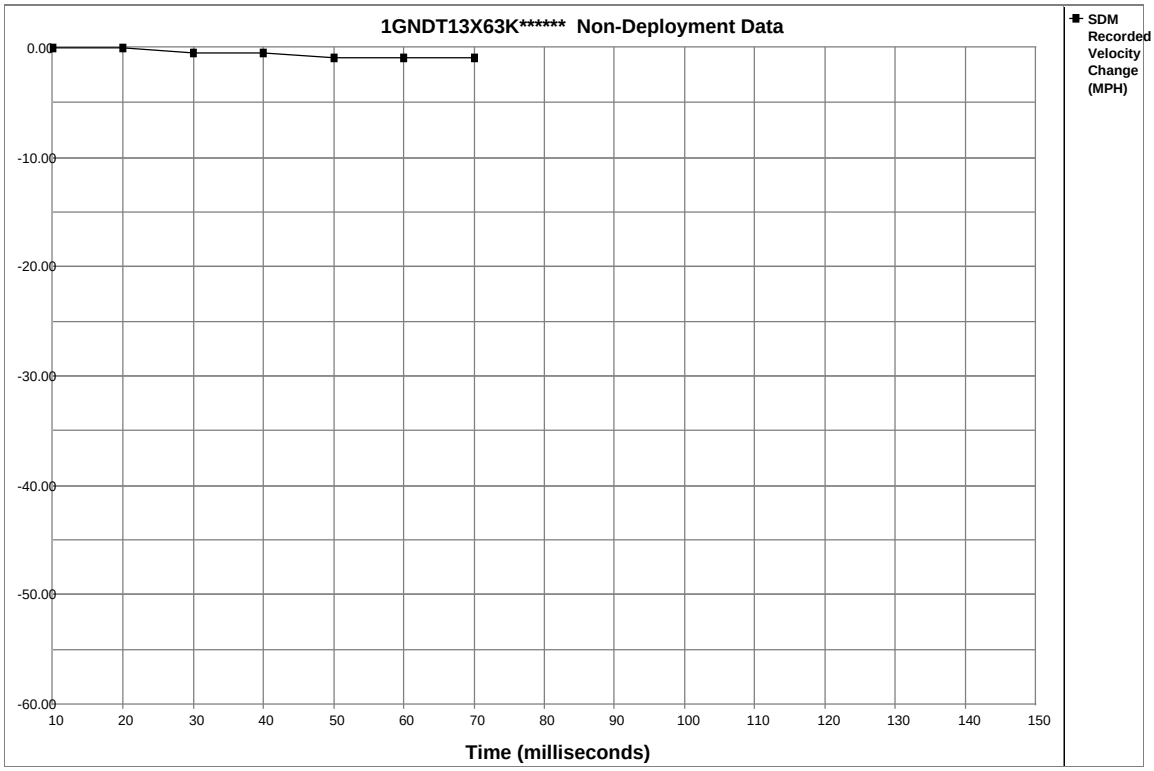
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	-0.44	-3.07	-9.21	-13.60	-21.50	-24.57	-28.52	-33.79	-36.42	-37.30	-37.30	N/A	N/A	N/A	N/A

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger SIR Suppression Switch Circuit Status (if equipped)	Air Bag Not Suppressed
Ignition Cycles At Non-Deployment	16131
Ignition Cycles At Investigation	16153
Maximum SDM Recorded Velocity Change (MPH)	-1.48
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	75

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	73	2176	27
-4	73	2176	27
-3	30	2176	21
-2	29	2176	21
-1	28	2112	21

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



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	0.00	0.00	-0.44	-0.44	-0.88	-0.88	-0.88	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A