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

ON-SITE CHILD SAFETY SEAT INVESTIGATION

CASE NUMBER - IN-06-012
LOCATION - MARYLAND
VEHICLE - 1999 OLDSMOBILE ALERO GX
CRASH DATE - May 2006

Submitted:

February 21, 2007
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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

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

Technical Report Documentation Page

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15. *Supplementary Notes* On-site child safety seat investigation involving a 1999 Oldsmobile Alero GX equipped with manual safety belts, redesigned front air bags and three child safety seats secured in the back seat.			
16. *Abstract* This report covers an on-site child safety seat investigation that involved a 1999 Oldsmobile Alero GX (case vehicle), a 1998 Nissan Sentra (1st other vehicle), and a 2003 Chevrolet Malibu (2nd other vehicle). This crash is of special interest because the case vehicle's back right passenger (6-year-old, male), was restrained in a child safety seat and sustained critical injuries during the crash, resulting in his death. The case vehicle was southwestbound in the left turn lane of a multi-lane, divided U.S. highway and was stopped at an intersection for a red left turn signal. The case vehicle was impacted in the back end at high speed by the Nissan, which was involved in a speed contest with the Chevrolet and a non-contact vehicle. The Nissan and case vehicle both rolled over following the impact. The case vehicle came to final rest on its roof in the mouth of the southeast leg of the intersection heading northeast. The Nissan came to final rest on its roof in the intersection also heading northeast. The Chevrolet continued southwestbound through the intersection an unknown distance and stopped. The back right passenger was seated in a no-back belt positioning booster seat. The booster seat was severely damaged when it was compressed between the front right seat back and the intruding back right passenger's seat back of the case vehicle during the crash. The back right passenger sustained a subarachnoid hemorrhage, bilateral lung contusions, a spleen laceration, multiple mesentery contusions, a fractured right pelvis and fractured left femur due to impact with the back of the front right passenger's seat back.			
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This investigation was brought to NHTSA's attention on or before June 7, 2006 by the investigating police department. This crash involved a 1999 Oldsmobile Alero GX (case vehicle), a 1998 Nissan Sentra (1st other vehicle), and a 2003 Chevrolet Malibu (2nd other vehicle). The crash occurred in May 2006, at 6:58 p.m., in Maryland and was investigated by the Maryland State Police. This crash is of special interest because the case vehicle's back right passenger [6-year-old, White (non-Hispanic) male], was restrained in a child safety seat and sustained critical injuries during the crash, resulting in his death. In addition, the back left and back center passengers were also seated in child safety seats. This contractor inspected the child safety seats, interviewed the case vehicle's driver and front right passenger and obtained copies of the Event Data Recorder (EDR) reports for the case vehicle and Chevrolet and copies of the on-scene photographs from the state police investigator on June 21, 2006. The case vehicle and the Nissan were inspected on June 22, 2006. The scene was inspected on June 23, 2006. The Chevrolet was under repair and was not inspected. This report is based on the police crash report, case vehicle and Chevrolet EDR reports, police on-scene photographs, an interview with the case vehicle's driver and front right passenger; inspections of the scene, vehicles and child safety seat; back right passenger's autopsy report, occupant medical records, occupant kinematic principles and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was southwestbound in the left turn lane of a multi-lane, divided U.S. highway and was stopped at an intersection for a red left turn signal. The Nissan and Chevrolet were southwestbound in the inside through lane. The Nissan and Chevrolet were involved in a speed contest with a non-contact vehicle, and the Nissan was behind and closing on the Chevrolet. The Nissan's driver made a quick right lane change maneuver to pass the Chevrolet. The Nissan's left side sideswiped the Chevrolet's right side (event 1). The Nissan then traveled past the Chevrolet, entered the left turn lane and its front impacted the back of the case vehicle (event 2) as it was stopped for the red left turn signal. The impact forced the case vehicle into the intersection and it rolled over (event 3) passenger side leading two quarter rolls onto its roof. The Nissan also rolled over (event 4) passenger side leading and rolled over six quarter rolls. The Chevrolet's left fender then sideswiped (event 5) an unknown plane of the Nissan as the Nissan was rolling over. The case vehicle came to final rest on its roof in the mouth of the southwest leg of the intersection heading northeast. The Nissan came to final rest on its roof in the intersection also heading northeast. The Chevrolet continued southwestbound through the intersection an unknown distance and stopped. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was level, dry bituminous.

The CDC for the case vehicle's rear end impact (event 2) was determined to be: **06-BDEW-7** (**180** degrees). The CDC for the case vehicle's rollover (event 3) was determined to be: **00-TYDO-3**. The case vehicles maximum residual crush to the back bumper was determined to be 134 centimeters (52.8 inches) occurring at C_6. The WinSMASH reconstruction program, damage algorithm, calculated the case vehicle's Total, Longitudinal, and Lateral Delta Vs for the back end impact (i.e., most severe impact) respectively as: 65.0 km.p.h. (40.4 m.p.h.), -65.0 km.p.h. (-40.4 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The crash fit the WinSMASH reconstruction model,

but the results appeared high. Based on the extent of roof crush, the rollover severity was determined to be moderate. The case vehicle was towed due to damage.

The CDC for the Nissan's sideswipe impact with the Chevrolet (event 1) was determined to be: **12-LDES-1** (**0** degrees). The CDC for the Nissan's front impact to the case vehicle's back end (event 2) was determined to be: **12-FDEW-3** (**0** degrees). The CDC for the Nissan's rollover (event 4) was determined to be: **00-TDDO-3**. The CDC for the impact with the Chevrolet (event 5) is unknown. The maximum residual crush to the front bumper was determined to be 63 centimeters (24.8 inches) occurring at C_1. The WinSMASH reconstruction program, damage algorithm, calculated the Nissan's Total, Longitudinal, and Lateral Delta Vs for the front impact (i.e., most severe impact) respectively as: 90.0 km.p.h. (55.9 m.p.h.), -90.0 km.p.h. (-55.9 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The crash fit the WinSMASH reconstruction model, but the results appeared high. Based on the extent of roof crush, the rollover severity was determined to be moderate. Based on the damage, the left sideswipe severity was determined to be minor. The Nissan was towed due to damage.

The CDC for the Chevrolet's right sideswipe impact with the left side of the Nissan (event 1) was estimated from police photographs to be: **06-RYES-1** (**180** degrees). The CDC for Chevrolet's front left bumper and left fender sideswipe impact with the Nissan (event 5) was estimated from police photographs to be: **12-FLES-1** (**0** degrees). Sideswipe impacts are out of scope for the WinSMASH reconstruction program, however; the crash severity for each impact was estimated to be minor based on the damage. The Chevrolet was towed due to damage.

The case vehicle's back right passenger [6-year-old, male; 117 centimeters and 25 kilograms (46 inches, 55 pounds)]) was seated in a no-back belt positioning booster seat. The booster seat was manufactured by Dorel Juvenile group on May 22, 2003 and was identified by Model number 22-298HRS. The booster seat was severely damaged in the crash. The damage indicated it was severely compressed between the intruding back right passenger's seat back and the front right passenger's seat back during the crash.

The case vehicle's back center passenger [3-year-old, female; 91 centimeters and 11 kilograms (36 inches, 25 pounds)] was seated in a convertible child safety seat with five-point harness. It was used in the forward facing position. The child safety seat was manufactured by the Dorel Juvenile group and was indicated as a Cosco, Eddie Bauer child safety seat. No model number and manufacture date label was found on the child safety seat. The child safety seat was extensively damaged during the crash. The damage indicated that the seat was compressed between the front seat backs and the intruding back center passenger's seat back during the crash.

The case vehicle's back left passenger [5-year-old, male; 102 centimeters and 19 kilograms (40 inches, 42 pounds)] was seated in a no-back belt-positioning booster seat. The booster seat was manufactured by Graco Children's Products on March 15, 2005 and was identified by model name "Turbo Booster" and model number 8491AST. The booster seat sustained severe damage during the crash. The damage indicated it had been compressed between the driver's seat back and the intruding back left passenger's seat back during the crash.

The case vehicle's back right passenger was restrained in his no-back belt positioning booster seat by the three-point, lap-and-shoulder safety belt. The back right passenger was compressed between the intruding back right passenger's seat back and the front right passenger's seat back during the crash. He sustained a subarachnoid hemorrhage, bilateral lung contusions, a spleen laceration, multiple mesentery contusions, a fractured right pelvis and fractured left femur due to impact with the back of the front right passenger's seat back. He died as a result of his injuries.

The case vehicle's back center passenger was seated in a convertible child safety seat with five-point harness. It was used in the forward facing position. The child safety seat was secured in the case vehicle via the case vehicle's two-point lap belt. The back center passenger was forced forward into both front seat backs due to the intruding back center passenger's seat back during the crash. She sustained a nonanatomic brain injury, a fractured right femur, a fractured left fibia and left tibia and a fractured nose due to impact with the front seat backs.

The back left passenger was restrained in a no-back belt positioning booster seat by the case vehicle's three-point, lap-and-shoulder safety belt system. The back left passenger was compressed between the driver's seat back and the intruding back left passenger's seat back during the crash. He sustained a fractured skull from contact with the left "B"-pillar during the rollover and a fractured tibia and fibula due to contact with the driver's seatback .

The driver and front right passenger were both restrained by their manual, three-point, lap-and-shoulder safety belt systems. They both sustained an "A" (incapacitating) injury and were transported by ambulance to a hospital.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which all the vehicles were traveling was a nine lane, divided, U.S. highway, traversing in a northeasterly and southwesterly direction. The Nissan and Chevrolet were southwestbound approaching a four-leg, signalized intersection. The case vehicle was also southwestbound and stopped in the left turn lane at the intersection. The southwestbound roadway had four through lanes and a left turn lane. The left turn lane was 4.3 meters (14 feet) in width. The average width of each of the three inside through lanes was 3.7 meters (12.1 feet), and the outside through lane was 4.8 meters (15.7 feet) in width. Roadway pavement markings consisted of solid yellow median edge line, solid white turn lane and inside through lane lines, broken white lane lines, solid white edge line and solid white stop bar. The trafficway was divided by a curbed, grass median 6.9 meters (22.6 feet) in width. There was a line of trees within the median. At the time of the crash, the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was level, dry bituminous with an estimated coefficient of friction of 0.70. The speed limit was 72 km.p.h. (45 m.p.h), traffic density was moderate and the site of the crash was urban commercial. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was southwestbound in the left turn lane and was stopped at the intersection for a red left turn signal (**Figure 1** below). The Nissan and the Chevrolet were

southwestbound in the inside through lane. The Chevrolet's driver was intending to continue southwestbound. Based on the police crash report, the Nissan and Chevrolet were involved in a speed contest with a non-contact vehicle, and the Nissan was behind and closing on the Chevrolet. The Nissan driver's intention was to pass the Chevrolet on the right. The crash sequence began when the Nissan's driver made a quick right lane change maneuver to pass the Chevrolet. The initial impact occurred as the Nissan was passing the Chevrolet.

Figure 1: View southwest of approach roadway to impact, case vehicle stopped in left turn lane at intersection, Nissan and Chevrolet initially in inside through lane, number shows meters to impact

Crash: The Nissan's left side (**Figure 2**) sideswiped the Chevrolet's right side (**Figure 3**, event 1). The Nissan then traveled past the Chevrolet, entered the left turn lane and its front (**Figure 4** below) impacted the back of the case vehicle (**Figure 5** below, event 2) as it was stopped for the red left turn signal (**Figure 6** below). The impact was offset slightly to the right of the case vehicle's centerline (**Figure 7** below). The impact forced the case vehicle into the intersection and it rolled over (event 3) passenger side leading two quarter rolls onto its roof. The Nissan rolled over (event 4) passenger side leading six quarter rolls onto its roof. It landed on its left front wheel during the third quarter roll, then continued over and landed hard on its right roof side rail and roof. Lastly, the Chevrolet's left front bumper corner and left fender most likely sideswiped an unknown plane of the Nissan (event 5) during the Nissan's rollover.

Figure 2: Damage to left side of Nissan from sideswiping right side of Chevrolet, arrows show tire marks from Chevrolet's left front wheel, damage on upper quarter panel is from rollover

Figure 3: Police photo showing sideswipe damage to right side of Chevrolet from impact with left side of Nissan

Post-Crash: As the case vehicle rolled over, it traveled southeast through the intersection into the mouth of the southwest leg of the intersection and came to final rest on its roof in the inside through lane heading northeast (**Figure 8** below). As the Nissan rolled over, it traveled southeast into the intersection and came to final rest on its roof in the intersection also heading northeast (**Figure 9** below). Based on the police crash schematic, the Chevrolet continued southwestbound through the intersection an unknown distance and stopped.

Figure 4: Damage to front of Nissan from impact with back of case vehicle, increments on vertical scale are tenths of meter, each increment on rods is 5 cm (2 in)

Figure 6: Point of impact in southwestbound left turn lane, arrow shows gouge marks in pavement from crash

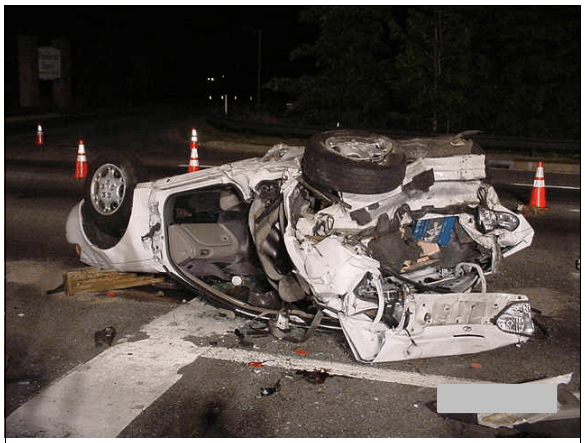


Figure 8: Police on-scene photo showing case vehicle's final rest position, view to east

Figure 5: Damage to back of case vehicle from impact with front of Nissan, baseline set 100 cm (39.4 in) short of overall length due to insufficient length of measurement rods to capture totality of crush

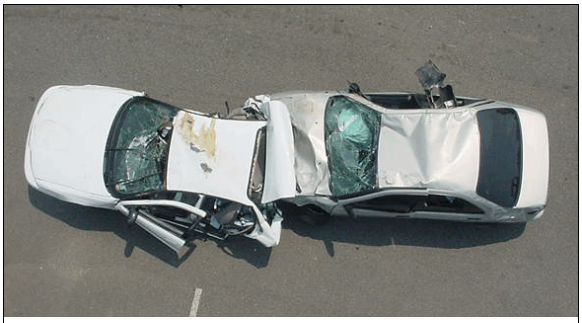


Figure 7: Police photo showing their reconstructed impact orientation of the case vehicle and Nissan

Figure 9: Police on-scene photo showing Nissan's final rest position, view is northeast back to approach of all vehicles

The 1999 Oldsmobile Alero GX was a front wheel drive, four-door sedan (VIN: 1G3NK52T7XC------) equipped with a 2.4L, L4 engine; four speed automatic transmission; four wheel, anti-lock brakes and electronic traction control. The front seating row was equipped with bucket seats with adjustable head restraints, tilt steering column; driver and front right passenger three-point, lap-and-shoulder safety belt systems and driver and front right passenger redesigned air bags with a front right passenger air bag suppression switch. The back seating row was equipped with a bench seat with separate back cushions; three-point, lap-and-shoulder safety belt systems; integral head restraints in the outboard seating position, and a two-point lap belt in the center seat position. The case vehicle's wheelbase was 272 centimeters (107.1 inches). The case vehicle's odometer reading at the time of the vehicle inspection is unknown because the case vehicle was equipped with an electronic odometer.

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's impact with the Nissan involved the back end. The case vehicle's back bumper, both quarter panels and the trunk lid were directly damaged and extensively crushed forward. The direct damage began at the back right bumper corner and extended 145 centimeters (57.1 inches) across the bumper. Crush measurements were taken at the back bumper bar. The maximum residual crush was determined to be 134 centimeters (52.8 inches) occurring at C_6. The table below shows the case vehicle's back 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	145	134	117	93	110	127	130	133	134	0	0
in		57.1	52.8	46.1	36.6	43.3	50.0	51.2	52.4	52.8	0.0	0.0

The case vehicle's rollover involved only the hood and roof. There was no evidence of direct rollover damage to the front or either side of the case vehicle, indicating the vehicle was airborne during the rollover and simply landed on its roof and slid to final rest. The direct rollover damage was distributed across the hood and the roof.

The case vehicle's right side wheelbase was shortened 65 centimeters (25.6 inches). The left side wheelbase was shortened 43 centimeters (16.9 inches). The induced damage from both impacts involved the front bumper fascia, both fenders, both quarter panels, the trunk lid and most likely all the doors. The right front, right rear and left rear doors had been removed by the rescue crew.

The case vehicle's recommended tire size was: P215/60R15 and the vehicle was equipped with tires of this size. The case vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32nd of an inch			
LF	276	40	207	30	6	8	None	No	No
RF	290	42	207	30	5	6	Cut in sidewall	No	No
LR	0	0	207	30	7	9	Bead separated	Yes	Yes
RR	0	0	207	30	7	9	Bead separated	Yes	Yes

Vehicle Interior: Inspection of the case vehicle's interior revealed occupant contact evidence on the roof over the front and back seating rows, on the backs of the front seats, on the back seating row seat backs, on the right sunvisor and on the right windshield. The case vehicle sustained numerous passenger compartment intrusions. The most severe intrusions occurred to the back seat (**Figure 10**). The back seat, seat back intruded longitudinally 65 centimeters (25.6 inches) into the back left occupant space, 74 centimeters (29.1 inches) into the back center occupant space and 82 centimeters (32.3 inches) into the back right occupant space. Lastly, there was no deformation of the steering wheel and no compression of the energy absorbing steering column.

Figure 10: Intrusion of case vehicle's back seat, view from passenger side

Damage Classification: Based on the vehicle inspection, the CDC for the case vehicle's back end impact with the Nissan (event 2) was determined to be: **06-BDEW-7** (**180** degrees). The CDC for the case vehicle's rollover (event 3) was determined to be: **00-TYDO-3**. The WinSMASH reconstruction program, damage algorithm, was used to reconstruct the case vehicle's Delta Vs for the back end impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 65.0 km.p.h. (40.4 m.p.h.), -65.0 km.p.h. (-40.4 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The crash fit the WinSMASH reconstruction model, but the results appeared high. Rollovers are out-of-scope for the WinSMASH program. However, based on the extent of roof crush, the rollover severity was determined to be moderate. The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle's driver air bag was located in the steering wheel hub and the front right passenger's air bag was located in the top of the instrument panel. The deployment of these air bags was not required because the impact was to the back of the case vehicle.

A download of the case vehicle's EDR was done by the investigating police agency. A hard copy of the EDR report was supplied to this contractor. The EDR recorded a non-deployment event. The report showed that the SIR warning lamp was recorded off, the driver's safety belt switch circuit was recorded buckled and the front right passenger air bag was not suppressed. The maximum recorded velocity change was reported as -2.83 km.p.h. (-1.76 m.p.h.) occurring 21.25 milliseconds following algorithm enable. The case vehicle's EDR reports are presented in **Figures 20** and **21** at the end of this report. No pre-crash data was recorded by this version EDR.

CHILD SAFETY SEATS

Back Right Child Safety Seat: The back right passenger [6-year-old, male; 117 centimeters and 25 kilograms (46 inches, 55 pounds)] was seated in a no-back belt positioning booster seat. The booster seat was manufactured by Dorel Juvenile group on May 22, 2003, was a Highrise model, and was identified by Model number 22-298HRS. The booster seat consisted of a plastic one-piece shell with a padded seat cushion and padded arm rests. It was designed to be used with a vehicle's safety belt system. The booster seat's information label indicated it was designed for use with children who weigh between 14 and 45 kilograms (30 and 100 pounds) and whose height is less than 132 centimeters (52 inches), as long as the child's head is not above the vehicle's seat back.

Figure 11: Case vehicle's back right passenger's booster seat

Inspection of the back right passenger's booster seat revealed severe damage to the entirety of the booster seat (**Figure 11**). The damage to the booster seat indicated it had been severely compressed between the front right seat back and the intruding back right passenger's seat back causing numerous breaks in the plastic throughout the seat.

Back Center Child Safety Seat: The back center passenger [3-year-old, female; 91 centimeters and 11 kilograms (36 inches, 25 pounds)] was seated in a convertible child safety seat with five-point harness (**Figure 12**). It was used in the forward facing position. The child safety seat was manufactured by the Dorel Juvenile group and was indicated as a Cosco, Eddie Bauer child

Figure 12: Overview of case vehicle's back center child safety seat

safety seat. No model number and manufacture date label was found on the child safety seat. The child seat's information label indicated it was designed for children who weigh between 2.3 and 18 kilograms(5 and 40 pounds), whose height is between 48 and 102 centimeters (19 and 40 inches) and the midpoint of the child's head is not above the child restraint's seat back. The child safety seat consisted of a plastic one-piece shell with a padded, cloth seat back and seat cushion. It was equipped with a five-point harness and a harness retainer clip. The harness retainer clip was positioned at the child's chest level. There was a single pair of slots on the back of the child seat to route the harness straps through. There was also a harness strap adjustment bar on the back of the child seat with five adjustment detents (**Figure 13**). A warning label was present that informed the user to place the harness straps over the adjustment bar when re-lacing the harness. The harness straps were found not routed over this adjustment bar as instructed. The child seat was also designed with a three slot, shoulder belt guide on each side of the seat, as well as tether and lower anchor attachments. The child seat was secured in the case vehicle via the case vehicle's two-point lap belt. The lap belt was routed through the belt path in the back of the child seat. The child seat was pressed down as the lap belt was tightened. The driver indicated that the seat would not move from side-to-side after the lap belt had been tightened.

Figure 13: Back of back center passenger's child safety seat showing harness strap slots and harness adjuster mechanism

Figure 14: Damage to back center passenger's child safety seat, red arrow show fabric transfer on front of seat cushion, green arrow shows fractures in plastic

Inspection of the back center passenger's child safety seat revealed that the front and bottom of the seat cushion and the lower right side had been bent causing stress marks in the plastic. There was a fabric transfer from the child seat cover on the front left portion of the seat cushion (**Figure 14**) indicating the child seat had been forced into the driver's seat back during the crash. The lower left side of the child seat also had been heavily deformed, and the lower left portion of the seat cushion had been deformed to the extent that the plastic had broken (**Figure 14**). On the back of the child seat, the recline adjuster was broken. The damage to the child safety seat indicated that the seat was compressed between the front seat backs and the intruding back center passenger's seat back during the crash.

Back Left Child Safety Seat: The back left passenger [5-year-old, male; 102 centimeters and 19 kilograms (40 inches, 42 pounds)] was seated in a no-back belt-positioning booster seat. The booster seat was manufactured by Graco Children's Products on March 15, 2005 and was identified by model name "Turbo Booster" and model number 8491AST. The booster seat consisted of a plastic two-piece shell with a padded seat cushion cover and padded arm rests. It was designed to be used with a vehicle's safety belt system. The booster seat's information label indicated it was designed for use with children who weigh between 14 and 45 kilograms (30 and 100 pounds) and whose height is 97 to 145 centimeters (38 to 57 inches).

Figure 15: Deformation to case vehicle's back left passenger's booster seat

Inspection of the back left passenger's booster seat revealed extensive bending and stress marks to the entirety of the booster seat (**Figure 15**). In addition, the base of the seat was partially separated from the seat cushion. The damage to the booster seat indicated it had been compressed between the driver's seat back and the intruding back left passenger's seat back during the crash.

CASE VEHICLE BACK RIGHT PASSENGER KINEMATICS

Immediately prior to the crash, the case vehicle's back right passenger [6-year-old, White (non-Hispanic) male; 117 centimeters and 25 kilograms (46 inches, 55 pounds)] was seated upright in his no-back belt-positioning booster seat. He was restrained by the case vehicle's three-point, lap-and-shoulder safety belt system.

Figure 16: Yellow tape shows occupant contact and scuff marks on back of front right passenger's seat back

The Nissan's impact to the back of the stopped case vehicle caused the back right passenger to move rearward opposite the case vehicle's 180 degree direction of principal force as the case vehicle was accelerated forward. The passenger's back and back of his head loaded into the case vehicle's intruding seat back. As the case vehicle's seat back intruded forward, the back right passenger and his booster seat were displaced forward and upward and impacted the back of the front right passenger's seat back (**Figure 16**), which was moving rearward due to the crash force and load on the seat back by the front right passenger. The back right passenger's head impacted the front right passenger's seat head restraint bending the head restraint forward and causing a subarachnoid hemorrhage. The back right passenger also sustained bilateral lung contusions, a spleen laceration, multiple mesentery contusions, a fractured right pelvis and fractured left femur due to impact with the back of the

front right passenger's seat back. As the case vehicle rolled over and landed on its roof, the back right passenger moved toward the roof and may have impacted his head on the roof (**Figure 17**). The police crash report indicated that the back right passenger was entrapped in the case vehicle. The back right passenger was removed from the case vehicle by rescue personnel.

Figure 17: Blood stains and possible occupant contact on roof above back right seat position

CASE VEHICLE BACK RIGHT PASSENGER INJURIES

The police crash report indicated the back right passenger sustained a fatal injury. He was pronounced deceased at the scene. The table below shows the back right passenger's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1 2	Hemorrhage, subarachnoid involving bilateral frontal and parietal lobes, along the midline	serious 140684.3,1 140684.3,2	Head restraint, front right seat	Probable	Autopsy
3	Contusions bilateral lungs {pulmonary}, not further specified	severe 441410.4,3	Seat back, front right passenger's	Certain	Autopsy
4	Laceration, small, spleen, not further specified	moderate 544220.2,2	Seat back, front right passenger's	Probable	Autopsy
5	Contusions, multiple, stomach, serosal surface, not further specified	moderate 544410.2,7	Seat back, front right passenger's	Probable	Autopsy
6	Contusions, multiple, mesentery, serosal surface, not further specified	moderate 542010.2,8	Seat back, front right passenger's	Probable	Autopsy
7	Fracture right pelvis, not further specified	moderate 852600.2,1	Seat back, front right passenger's	Probable	Autopsy
8	Fracture left femur, not further specified	serious 851800.3,2	Seat back, front right passenger's	Probable	Autopsy
9	Contusion, 10.2 x 5.1 cm (4 x 2 in) mid to right forehead	minor 290402.1,7	Head restraint, front right seat	Probable	Autopsy
10	Abrasion tip of nose, not further specified	minor 290202.1,4	Head restraint, front right seat	Probable	Autopsy
11	Contusions, multiple, inner mucosa upper and lower lips	minor 243202.1,8	Head restraint, front right seat	Probable	Autopsy

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
12	Lacerations, multiple, inner mucosa upper and lower lips and	minor 243204.1,8	Head restraint, front right seat	Probable	Autopsy
13	Laceration frenulum[1], not further specified	minor 243099.1,8	Head restraint, front right seat	Probable	Autopsy
14	Abrasions chin, right lower jaw and left chin, not further specified	minor 290202.1,8	Head restraint, front right seat	Probable	Autopsy
15	Abrasion left and right upper chest, not further specified	minor 490202.1,0	Seat back, front right passenger's	Probable	Autopsy
16	Abrasion right lower abdomen, not further specified	minor 590202.1,1	Lap portion of safety belt system	Probable	Autopsy
17	Contusion, 5.1 x 5.1 cm (2 x 2 in) inguinal area, not further specified	minor 590402.1,8	Seat back, front right passenger's	Probable	Autopsy
18	Abrasion, 5.1 x 2.5 cm (2 x 1 in), left elbow, not further specified	minor 790202.1,2	Seat back, front right passenger's	Probable	Autopsy
19	Contusion, 5.1 x 5.1 cm (2 x 2 in), posterior {back} left forearm	minor 790402.1,2	Seat back, front right passenger's	Probable	Autopsy
20	Laceration lateral left thigh, not further specified	minor 890600.1,2	Child safety seat's left side surface	Probable	Autopsy
21	Laceration, 5.1 cm (2 in) right knee, not further specified	minor 890602.1,1	Seat back, front right passenger's	Certain	Autopsy
22	Abrasions x 2, anterior {front} right leg, not further specified	minor 890202.1,1	Seat back, front right passenger's	Certain	Autopsy
23	Abrasions x 2, posterior {back} right leg, not further specified	minor 890202.1,1	Child safety seat's bottom surface	Probable	Autopsy

[1] The following term is defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

frenulum (fren/u-lam) pl. ***frenula (fren/u-la)***: a small bridle; a general term for a small fold of integument or mucous membrane that checks, curbs, or limits the movement of an organ or part

f. of inferior lip, f. la/bii inferio/ris: the fold of mucous membrane on the inside of the middle of the lower lip, connecting the lip with the gums.

f. of superior lip, f. la/bii superio/ris: the fold of mucous membrane on the inside of the middle of the upper lip, connecting the lip with the gums.

f. of tongue, f. lin/guae: the vertical fold of mucous membrane inferior to the tongue, attaching it to the floor of the mouth.

Immediately prior to the crash, the case vehicle's back center passenger [3-year-old, White (non-Hispanic) female; 99 centimeters and 15 kilograms (39 inches, 33 pounds)] was seated in a forward facing convertible child safety seat with five-point harness.

Figure 18: Occupant contact marks on driver's seat back

The Nissan's impact to the back of the stopped case vehicle caused the back center passenger to move rearward opposite the case vehicle's 180 degree direction of principal force as the case vehicle was accelerated forward. The passenger's back and back of her head loaded into the back of her child seat. As the case vehicle's seat back was intruded forward, the back center passenger and her child safety seat were displaced forward and upward and impacted the back of the driver and front right passenger's seat backs (**Figure 16** above and **Figure 18**), which were moving rearward due to the crash force and occupant loading on the seat backs. The impact to the seat backs caused fractures to her right femur, left fibula and left tibia. In addition, the back center passenger impacted her head on back of front right passenger's seat back causing a nonanatomic brain injury. As the case vehicle rolled over and landed on its roof, the back center passenger moved toward the roof, but there was no evidence she impacted her head on the roof. The police crash report indicated that the back center passenger was entrapped in the case vehicle. The back center passenger was removed from the case vehicle by rescue personnel.

CASE VEHICLE BACK CENTER PASSENGER INJURIES

The police crash report indicated the back center passenger sustained an "A" (incapacitating) injury and was transported from the scene via helicopter to a children's hospital and admitted for treatment of her injuries. She was hospitalized for 5 days. The table below shows the back center passenger's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury with loss of consciousness of unknown duration and GCS=11 on initial observation; consciousness varied {waxing and waning[2]} with GCS between 8-11; intubated as a result	moderate 160606.2,0	Seat back, front right passenger's	Probable	Hospitalization records
2	Fracture, comminuted, right proximal mid-shaft femur with mild anterior angulation and lateral displacement	serious 851814.3,1	Seat back, front right passenger's	Certain	Hospitalization records
3	Fracture, closed, left distal tibia with lateral displacement of distal fragment	serious 853422.3,2	Seat back, driver's	Certain	Hospitalization records
4	Fracture, closed, left distal fibula with lateral displacement of distal fragment	moderate 851606.2,2	Seat back, driver's	Certain	Hospitalization records
5	Fracture, closed, left nasal bone at bridge with septal hematoma	minor 251002.1,4	Seat back, front right passenger's	Probable	Hospitalization records
6	Hemorrhage {epitaxis} nares, not further specified	minor 251090.1,4	Seat back, front right passenger's	Probable	Emergency room records
7	Contusion nose, not further specified	minor 290402.1,4	Seat back, front right passenger's	Probable	Hospitalization records
8	Contusion {bruising} right periorbital, not further specified	minor 297402.1,1	Seat back, front right passenger's	Probable	Hospitalization records
9	Contusion {bruise} right humerus, not further specified	minor 790402.1,1	Seat back, front right passenger's	Certain	Emergency room records
10	Contusion {hematoma} right quadriceps muscle	minor 890402.1,1	Seat back, front right passenger's	Certain	Emergency room records
11	Abrasions anteromedial lower legs, just below knees	minor 890202.1,3	Seat back, front right passenger's	Probable	Emergency room records

[2] According to the RANDOM HOUSE WEBSTER'S UNABRIDGED DICTIONARY, these terms are defined as follows:

***wax[2] (waks)* v.i., waxed; waxed**: 1. to increase in extent, quantity, intensity, power, etc.; 2. (of the moon) to increase in the extent of its illuminated portion before the full moon. Cf. wane (def. 4).; 3. to grow or become

***wane (wan)* v.i., waned, waning**: 1. to decrease in strength, intensity, etc.; 2. to decline in power, importance, prosperity, etc.; 3. to draw to a close; approach an end; 4. (of the moon) to decrease periodically in the extent of its illuminated portion after the full moon. Cf. wax[2] (def. 2);

–n. 5. a gradual decrease or decline in strength, intensity, power, etc.; 6. the drawing to a close of life, an era, a period, etc.; 7. the waning of the moon; 8. a period of waning; 9. a defect in a plank or board characterized by bark or insufficient wood at a corner or along an edge, due to the curvature of the log; 10. on the wane, decreasing; diminishing

Immediately prior to the crash, the case vehicle's back left passenger [5-year-old, White (non-Hispanic) male; 102 centimeters and 19 kilograms (40 inches, 42 pounds)] was seated in a no-back belt positioning booster seat. He was restrained by the case vehicle's three-point, lap-and-shoulder safety belt system.

The Nissan's impact to the back of the stopped case vehicle caused the back left passenger to move rearward opposite the case vehicle's 180 degree direction of principal force as the case vehicle was accelerated forward. The passenger's back and back of his head loaded into the case vehicle's seat back. As the case vehicle's seat back was intruded forward, the back left passenger and his booster seat were displaced forward and upward and impacted the back of the driver's seat which was moving backward due to the crash force and driver loading on the seat. The back left passenger sustained a fractured right tibia and fibula from contact with the driver's seat back. As the case vehicle rolled over and landed on its roof and left roof side rail, the back left passenger moved left and toward the roof and impacted his head on left "B"-pillar fracturing his skull. The police crash report indicated that the back left passenger was entrapped in the case vehicle. The passenger was removed from the case vehicle by rescue personnel.

CASE VEHICLE BACK LEFT PASSENGER INJURIES

The police crash report indicated the back left passenger sustained an "A" (incapacitating) injury and was transported from the scene via helicopter to a children's hospital and admitted for treatment of his injuries. The table below shows the back left passenger's interviewee reported injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture skull, not further specified	moderate 150400.2	"B"-pillar, left	Probable	Interviewee (driver)
2	Fracture right tibia, not further specified	moderate 853404.2,1	Seat back, driver's	Certain	Interviewee (driver)
3	Fracture right fibula, not further specified	moderate 851605.2,1	Seat back, driver's	Certain	Interviewee (driver)

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash, the case vehicle's driver [28-year-old, White (non-Hispanic) male; 180 centimeters and 93 kilograms (71 inches, 205 pounds) was seated in an upright position with his back against the seat back, both hands on the steering wheel and his right foot on the brake. His seat track was most likely adjusted to between its middle and rear-most position, the seat back was slightly reclined and the tilt steering column was adjusted to between it center and full down position.

Based on the vehicle inspection, the police crash report and supported by the EDR data, the case vehicle's driver was restrained by his manual, three-point, lap-and-shoulder safety belt system. The driver's safety belt had been cut off of him by rescue personnel.

Figure 19: Yellow tape outlines driver's head contact on roof, driver's head restraint in at left side of photo frame

The Nissan's impact to the back of the stopped case vehicle caused the driver to move rearward opposite the case vehicle's 180 degree direction of principal force as the case vehicle was accelerated forward. The driver's back loaded his seat back and the back of his head impacted his head restraint. As the driver's seat back was forced forward during the dynamic intrusion of the back seat and loading on his seat back by the back left and back center child safety seats, the driver loaded his safety belt fracturing one of his upper left ribs. He then impacted his head on the roof (**Figure 19** below) as the case vehicle landed on its roof and left roof side rail during the rollover causing a concussion and chipping one of his teeth. The driver remained in his seat as the case vehicle came to rest on its roof. He was removed from the case vehicle by emergency medical personnel while unconscious.

CASE VEHICLE DRIVER INJURIES

The police crash report indicated that the driver sustained an "A" (incapacitating injury) and was transported from the scene via helicopter to a hospital and admitted for treatment of his injuries. The driver was hospitalized for two days. The table below shows the case vehicle driver's interviewee reported injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Traumatic brain injury, not further specified	unknown 115099.7,0	Roof	Certain	Interviewee (driver)
2	Fracture {chipped} teeth, not further specified	minor 251404.1,8	Roof {indirect}	Certain	Interviewee (driver)
3	Fracture left rib, not further specified	minor 450212.1,2	Torso portion of safety belt system	Probable	Interviewee (driver)

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash, the case vehicle's front right passenger [29-year-old, White (non-Hispanic) female; 180 centimeters and 75 kilograms (71 inches, 165 pounds) was seated in an upright position with her feet on the floor. The position of her hands and arms is not known.

The front right passenger's seat track was most likely located between its middle and rear-most position, and her seat back was slightly reclined.

Based on the vehicle inspection and the police crash report, the front right passenger was restrained by her manual, three-point, lap-and-shoulder safety belt system. The front right passenger's safety belt had been cut off her by rescue personnel.

The Nissan's impact to the back of the stopped case vehicle caused the front right passenger to move rearward opposite the case vehicle's 180 degree direction of principal force as the case vehicle was accelerated forward. The front right passenger loaded her seat back and the back of her head impacted her head restraint. The front right passenger was then forced forward and loaded her safety belt as her seat back was forced forward during the dynamic intrusion of the back seat and loading on her seat back by the back center and back right child safety seats. She then impacted her head on the roof as the case vehicle landed on its roof during the rollover causing a concussion. The front right passenger remained in her seat as the case vehicle came to rest on its roof. The police crash report indicated she was entrapped. She was removed from the case vehicle by emergency medical personnel while unconscious.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The police crash report indicated that the front right passenger sustained an "A" (incapacitating injury) and was transported from the scene via helicopter to a hospital and admitted for treatment of her injuries. The front right passenger was hospitalized for five days. The table below shows the front right passenger's interviewee reported injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Traumatic brain injury, not further specified	unknown 115099.7,0	Roof	Certain	Interviewee (driver)

1ST OTHER VEHICLE

The 1998 Nissan Sentra was a front wheel drive, four-door sedan (VIN: 3N1AB41D3WL------). The Nissan was equipped with a 1.6L engine an a manual five-speed transmission. Four-wheel, anti-lock brakes were an option, but it is not known if the Nissan was so equipped. The front seating row was equipped with bucket seats with adjustable head restraints; manual, three-point, lap-and-shoulder safety belts with pretensioners and driver and front right passenger redesigned air bags, which deployed as a result of the impact with the case vehicle. The Nissan's wheelbase was 254 centimeters (99.8 inches). The Nissan's odometer reading at the time of the vehicle inspection is not known because the interior was not inspected.

Exterior Damage: The Nissan's initial sideswipe with the Chevrolet involved the entire left side of the vehicle. There was overlapping damage to the left fender due to the subsequent impact with

the case vehicle; however, it appeared that the damage began at the front of the left fender. The direct damage then extended down the Nissan's entire left side. There was also rubber transfer on the left side of the Nissan from contact with the Chevrolet's left front wheel during the sideswipe.

The Nissan's impact with the back of the case vehicle involved the front end. The Nissan's front bumper, left fender, grille and hood were directly contacted and crushed rearward. The direct damage began at the front left bumper corner and extended 128 centimeters (50.4 inches) across the front end. The Nissan's maximum residual crush was determined to be 63 centimeters (24.8 inches) occurring at C_1. The table below shows the Nissan's 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	2	128	63	128	63	55	47	35	21	7	-8	0
in		50.4	24.8	50.4	24.8	21.7	18.5	13.8	8.3	2.8	-3.2	0.0

The rollover involved the Nissan's top and left side. The primary top crush was to the right roof side rail and right front area of the roof. There was damage to the Nissan's right side that the police on-scene photos showed was due to pulling the vehicle over onto its right side and onto its wheels during the removal process. The damage for the likely impact with the Chevrolet during the Nissan's rollover could not be determined.

The Nissan's left side wheelbase was reduced 23 centimeters (9.1 inches) while the left side wheelbase was reduced 5 centimeters (2 inches). The induced damage from the three impacts involved the roof, left side doors, right quarter panel and the right fender.

The Nissan's recommended tire size was: P175/65R14. The vehicle was equipped with P215/35R18 tires. The Nissan's tire data are shown in the table below.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32nd of an inch			
LF	90	13	228	33	6	8	None	Yes	No
RF	228	33	228	33	7	9	None	No	No
LR	221	32	200	29	8	10	None	No	No
RR	234	34	200	29	8	10	None	No	No

Damage Classification: Based on the vehicle inspection, the CDC for the Nissan's left sideswipe impact with the right side of the Chevrolet (event 1) was determined to be: **12-LDES-1** (**0** degrees). The CDC for the Nissan's front impact to the case vehicle's back end (event 2) was determined to be: **12-FDEW-3** (**0** degrees). The CDC for the Nissan's rollover (event 4) was determined to be: **00-TDDO-3**. The CDC for the impact with the Chevrolet (event 5) is unknown. The WinSMASH reconstruction program, damage algorithm, was used to reconstruct the Nissan's Delta Vs for the front impact (i.e., most severe impact). The Total, Longitudinal, and Lateral Delta Vs are, respectively: 90.0 km.p.h. (55.9 m.p.h.), -90.0 km.p.h. (-55.9 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The crash fit the WinSMASH reconstruction model, but the results appeared high. Rollovers are out-of-scope for the WinSMASH program. However, based on the extent of roof crush, the rollover severity was determined to be moderate. Sideswipe impacts are also out-of-scope for the WinSMASH program. However, based on the damage to the Nissan, the sideswipe severity was determined to be minor. The Nissan was towed due to damage.

Nissan's Driver: According to the police crash report, the Nissan's driver [19-year-old, (unknown race and ethnic origin) male] was restrained by his manual, three-point, lap-and-shoulder safety belt system. The police crash report indicated the driver sustained a "A" (incapacitating) injury and was transported by ambulance to a hospital.

2nd Other Vehicle

The 2003 Chevrolet Malibu was a front wheel drive, four-door sedan (VIN:1G1ND52J1EM-----) equipped with a 3.1L, V6 engine; four speed automatic transmission and dual stage driver and front right passenger air bags. Four-wheel, anti-lock brakes were an option, but it is not known if the Chevrolet was so equipped. The Chevrolet's wheelbase was 274 centimeters (107 inches). The Chevrolets odometer reading is not known. The Chevrolet was not inspected.

Exterior Damage: The Chevrolet's sideswipe impact with the Nissan involved the right front door, right fender and right corner of the front bumper. The direct damage began at the back of the right front door and extended to the front right bumper corner. The right front wheel was also involved and was flat. The Chevrolet's other sideswipe impact involved the front left bumper corner and the left fender. The direct damage began at the front left bumper corner and extended rearward to the front of the left front wheelhouse. The Chevrolet was under repair at the time of this contractor's investigation and was not inspected. Therefore, no damage measurements were obtained.

Damage Classification: Based on the police photographs, the CDC for the Chevrolet's right sideswipe impact with the left side of the Nissan (event 1) was estimated to be: **06-RYES-1** (**180** degrees). The police photos also showed a minor sideswipe impact to the left corner of the front bumper and left fender. The source of this damage could not be determined but was most likely related to this crash. It may have occurred due to minor contact with the Nissan following the Nissan's impact with the case vehicle as the Nissan rotated counterclockwise and rolled over and the Chevrolet traveled past it. The CDC for this damage (event 5) was estimated to be: **12-FLES-1** (**0** degrees). The WinSMASH reconstruction program could not be used to reconstruct the

Chevrolet's Delta Vs because sideswipe impacts are out of scope for the program. However, based on the damage to the Chevrolet depicted in the police photographs, the crash severity for each impact was estimated to be minor. The Chevrolet was towed due to damage.

Crash Data Recording: A download of the Chevrolet's EDR was done by the investigating police agency. A hard copy of the EDR report was supplied to this contractor. The EDR report showed that the Chevrolet recorded a non-deployment event. The report showed that the SIR warning lamp was recorded off, the driver's safety belt switch circuit was recorded unbuckled and the front right passenger air bag was not suppressed. The maximum SDM recorded velocity change was reported as -0.89 km.p.h. (-0.55 m.p.h.) occurring 80 milliseconds following algorithm enable (AE). The pre-crash data showed that the Chevrolet was traveling 129 km.p.h. (80 m.p.h.) at 0% throttle five seconds prior to AE with the brake switch recorded off. The brake switch was recorded on at 4 and 3 seconds prior to AE and then off at 2 and 1 seconds prior to AE with 0% throttle recorded for the 2-4 second sample periods. The Chevrolet's travel speed was then recorded as 114 km.p.h. (71 m.p.h) at 12% throttle 1 second prior to AE. The Chevrolet's EDR reports are presented in **Figures 22-24** at the end of this report.

Chevrolet's Driver: According to the police crash report, the Chevrolet's driver [16-year-old (unknown race and ethnic origin) male] was restrained by his manual, three-point, lap-and-shoulder safety belt system. The police crash report indicated the front right passenger was not injured in this crash and was not transported from the scene.

CDR File Information

Vehicle Identification Number	1G3NK52T7XC[redacted]
Investigator	[redacted]
Case Number	[redacted]
Investigation Date	[redacted]
Crash Date	[redacted]
Filename	1G3NK52T7XC[redacted]CDR
Saved on	[redacted]
Collected with CDR version	Crash Data Retrieval Tool 2.710
Collecting program verification number	3F8F669A
Reported with CDR version	Crash Data Retrieval Tool 2.710
Reporting program verification number	3F8F669A
Interface used to collected data	Block number: 00 Interface version: 42 Date: 03-10-05 Checksum: 1300
Event(s) recovered	Non-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). The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded forward velocity change. 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. 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 file will be locked after a deployment, if the non-deployment occurred within 5 seconds before the deployment or a deployment level event occurs within 5 seconds after the deployment.

SDM Data Limitations:

-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. The SDM records the first 300 milliseconds of Vehicle Forward Velocity Change after Algorithm Enable. The maximum value that can be recorded for Vehicle Forward Velocity Change is 56 MPH.

-Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt 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. An indication of a loss of power would be if the ignition cycles at Deployment or Non-Deployment is recorded as zero. Data recorded after that may not be reliable, such as Time Between Non-Deployment and Deployment Events, Driver Belt Switch Circuit Status, and Passenger SIR Suppression Switch Circuit Status.

SDM Data Source:

All SDM recorded data is measured, calculated, and stored internally, except for the following:

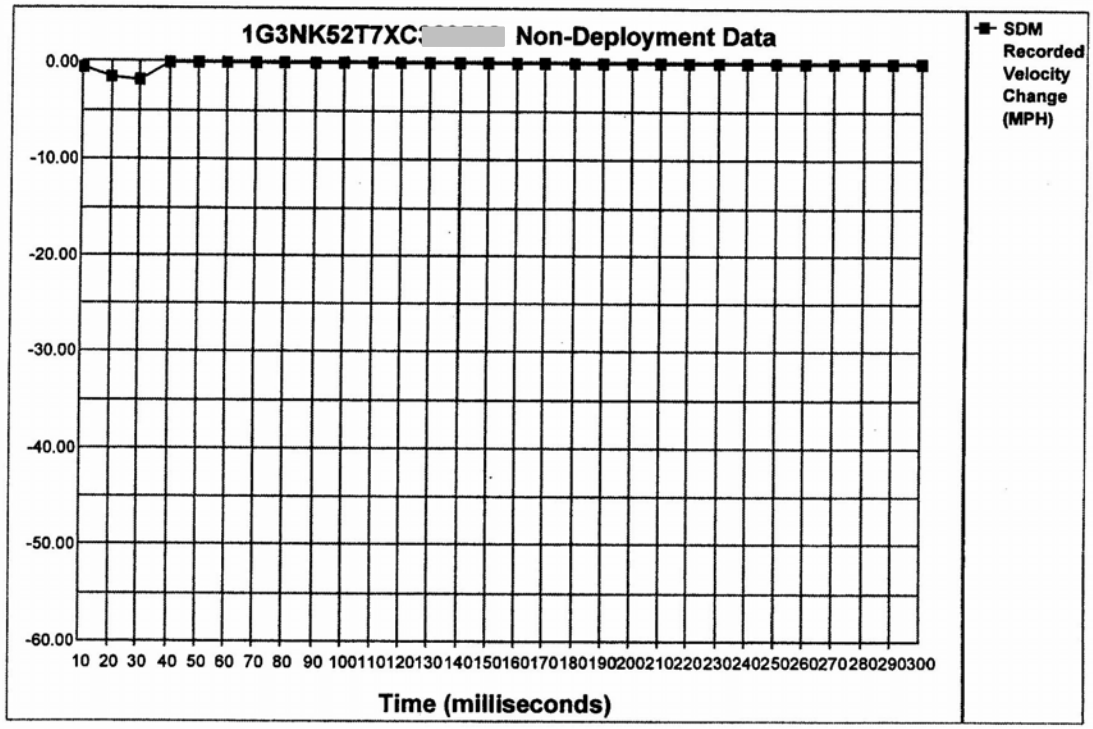
-The Driver's Belt Switch Circuit is wired directly to the SDM.

-The Passenger Front Air Bag Suppression Switch Circuit is wired directly to the SDM.

Figure 20: Case vehicle's CDR File Information and SDM Data Limitations

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Not Suppressed
Ignition Cycles At Non-Deployment	9688
Ignition Cycles At Investigation	9689
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	21.25
Maximum SDM Recorded Velocity Change (MPH)	-1.76
A Deployment was Commanded Prior to this Event	No



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.44	-1.54	-1.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 21: Case vehicle's System Status at Non-deployment data and SDM recorded velocity change data

CDR File Information

Vehicle Identification Number	1G1ND52J13M[redacted]
Investigator	[redacted]
Case Number	[redacted]
Investigation Date	[redacted]
Crash Date	[redacted]
Filename	1G1ND52J13M[redacted].CDR
Saved on	[redacted]
Collected with CDR version	Crash Data Retrieval Tool 2.710
Collecting program verification number	3F8F669A
Reported with CDR version	Crash Data Retrieval Tool 2.710
Reporting program verification number	3F8F669A
Interface used to collected data	Block number: 00 Interface version: 42 Date: 03-10-05 Checksum: 1300
Event(s) recovered	Non-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 file will be locked after a deployment, if the non-deployment occurred within 5 seconds before the deployment or a deployment level event occurs within 5 seconds after the deployment.

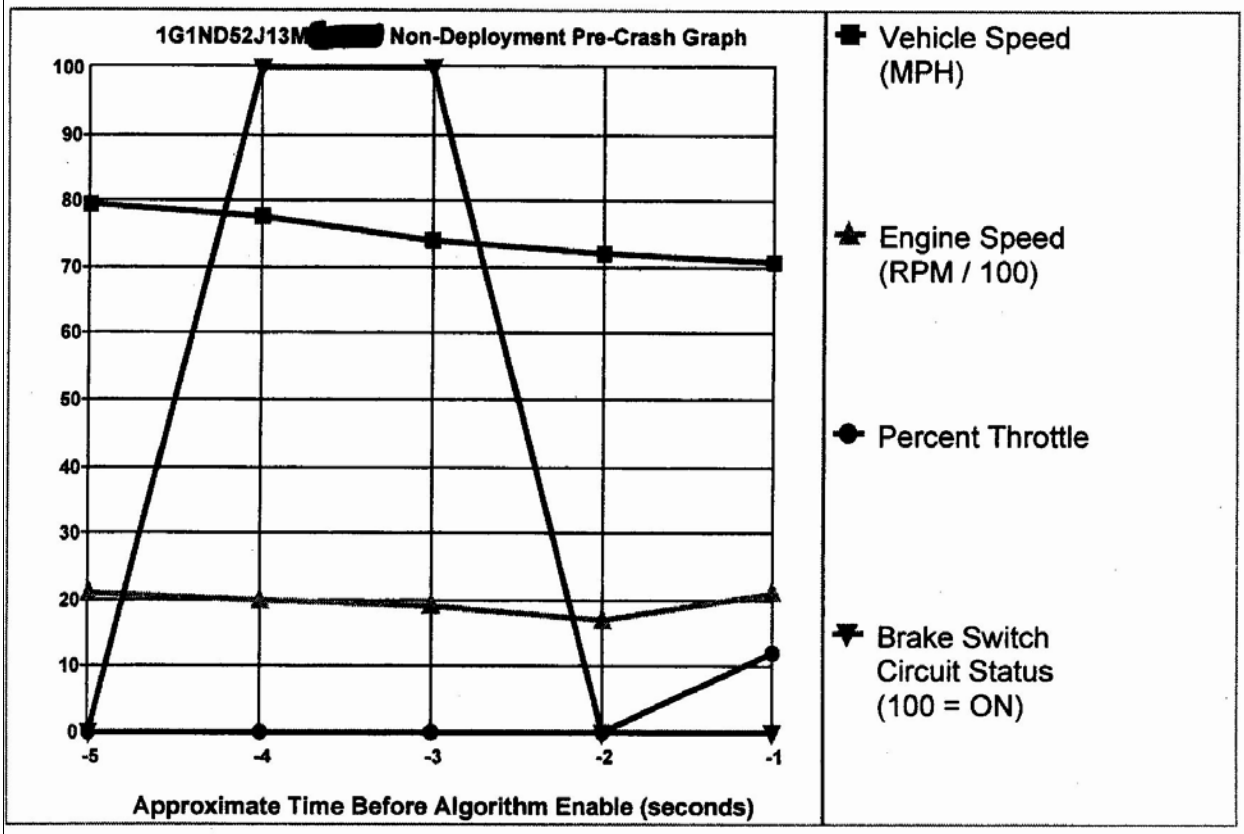
SDM Data Limitations:
-SDM Recorded Vehicle Forward Velocity Change is one of the measures used to make air bag deployment decisions. SDM Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced during the recorded portion of the event. SDM 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 deployments 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-deployments, 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 does not receive a valid message.
-Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit
-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.

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 Class 2 data link, to the SDM.
-Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the Class 2 data link, to the SDM. Depending on vehicle option content, the Brake Switch Circuit Status data may not be available.
-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".
-In most vehicles, the Driver's Belt Switch Circuit is wired directly to the SDM. In some vehicles, the Driver's Belt Switch Circuit Status data is transmitted from the Body Control Module (BCM), via the Class 2 data link, to the SDM.
-The Passenger Front Air Bag Suppression Switch Circuit is wired directly to the SDM.

Figure 22: Chevrolet's CDR File Information and SDM Data Limitations

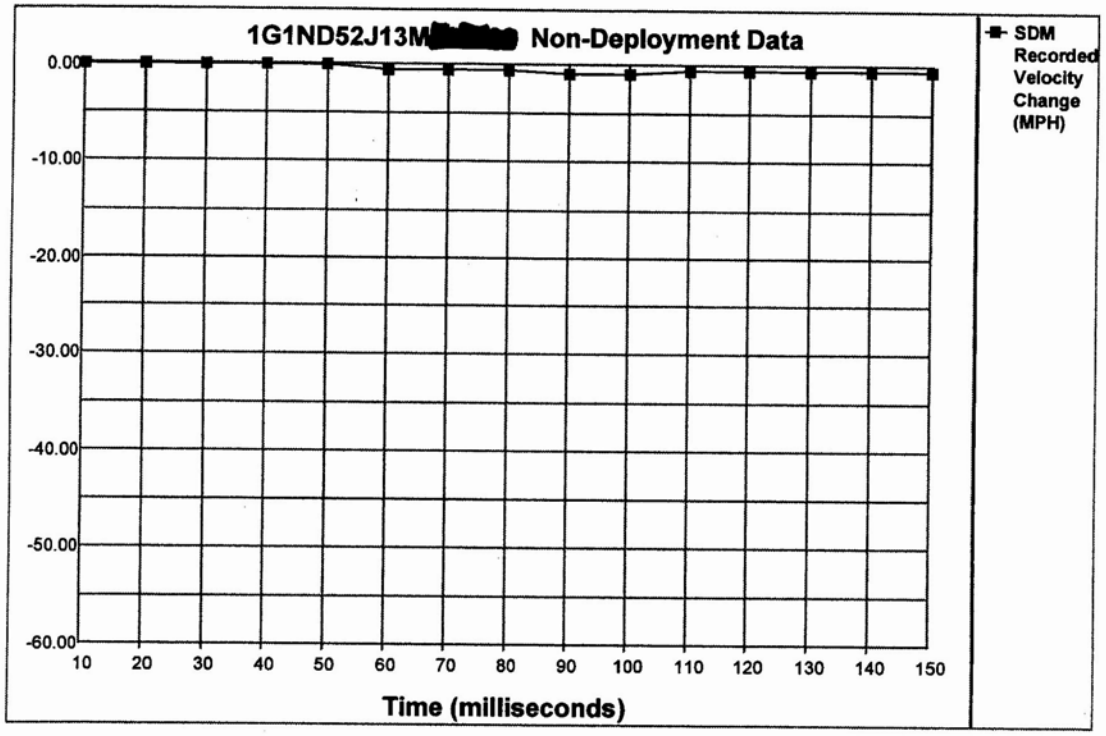
System Status At Non-Deployment

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 Non-Deployment	7910
Ignition Cycles At Investigation	7913
Maximum SDM Algorithm Forward Velocity Change (MPH)	-0.89
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	80



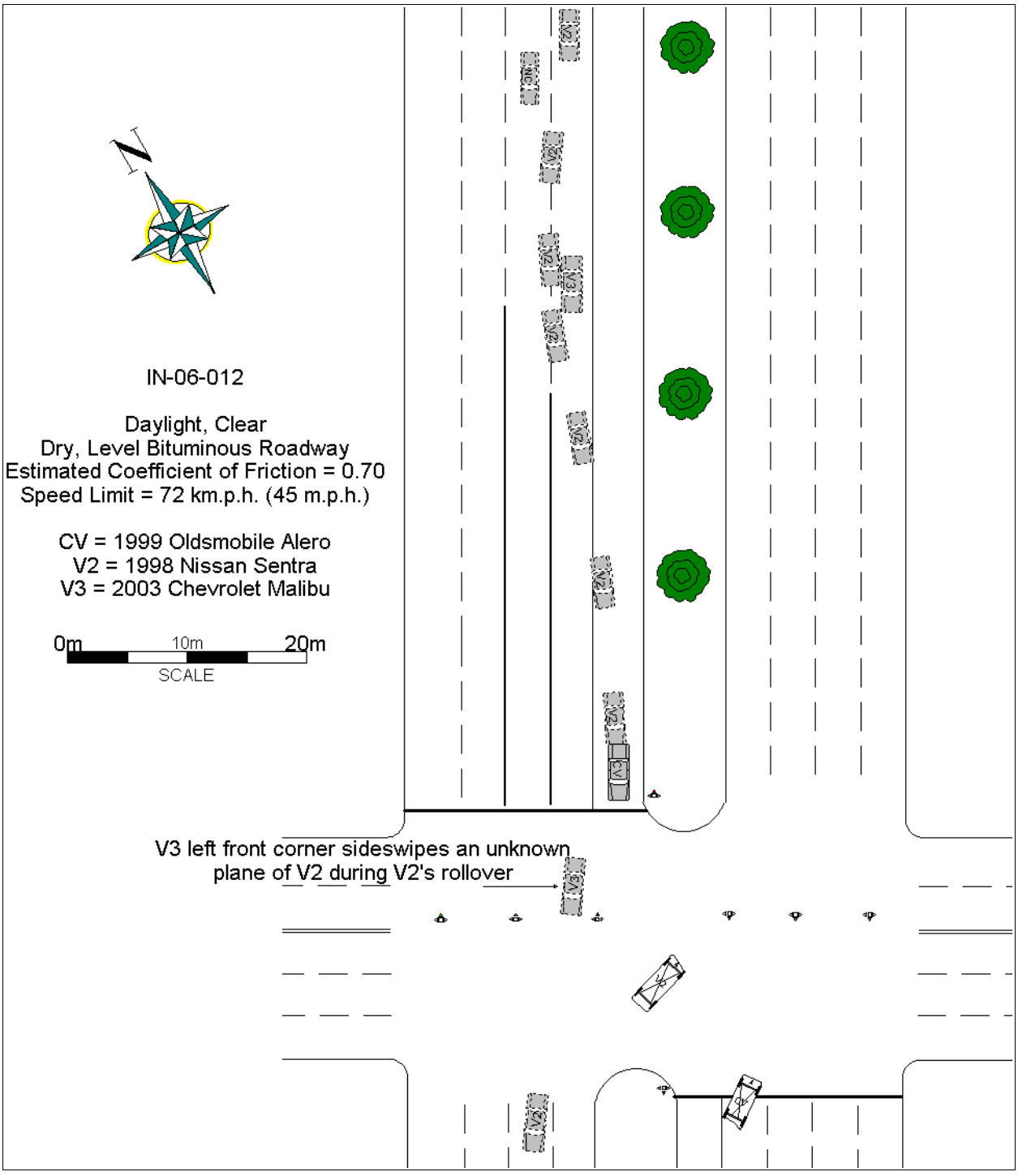
Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	80	2112	0	OFF
-4	78	2048	0	ON
-3	74	1856	0	ON
-2	72	1728	0	OFF
-1	71	2112	12	OFF

Figure 23: Chevrolet's System Status at Non-deployment report and pre-crash data



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	0.00	0.00	0.00	-0.44	-0.44	-0.44	-0.88	-0.88	-0.44	-0.44	-0.44	-0.44	-0.44

Figure 24: Chevrolet's non-deployment SDM recorded velocity change data


N
IN-06-012
Daylight, Clear
Dry, Level Bituminous Roadway
Estimated Coefficient of Friction = 0.70
Speed Limit = 72 km.p.h. (45 m.p.h.)
CV = 1999 Oldsmobile Alero
V2 = 1998 Nissan Sentra
V3 = 2003 Chevrolet Malibu
0m
10m
20m
SCALE
V3 left front corner sideswipes an unknown plane of V2 during V2's rollover
V2
V3