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ON-SITE CHILD SAFETY SEAT INVESTIGATION

CASE NUMBER - IN-06-030
LOCATION - LOUISIANA
VEHICLE - 1989 PONTIAC GRAND AM
CRASH DATE - September 2006

Submitted:

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

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

Technical Report Documentation Page

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15. *Supplementary Notes* On-site child safety seat investigation involving a 1989 Pontiac Grand Am equipped with manual safety belts and a rear-facing infant seat installed in the back right seat position.			
16. *Abstract* This report covers an on-site child safety seat investigation that involved a 1989 Pontiac Grand Am (case vehicle), a 2002 Western Star truck tractor with semi-trailer (1st other vehicle) and a 2002 Chevrolet Impala (2nd other vehicle). This crash is of special interest because the case vehicle's back right passenger [5-month-old, White (non-Hispanic) female] was restrained in a child safety seat and sustained no injury as a result of the crash. The case vehicle was traveling southeast on a two lane state highway approaching a "T" intersection. The Western Star was also traveling southeast behind the case vehicle. Meanwhile, the Chevrolet was traveling northwest approaching the "T" intersection. The case vehicle's driver stopped to turn left at the intersection. The front left of the Western Star impacted the back right of the case vehicle (event 1). The impact caused the case vehicle to rotate counterclockwise and it crossed into the northwestbound lane. The front of the Chevrolet then impacted the left side of the case vehicle (event 2). The impact caused the case vehicle and the Chevrolet to rotate clockwise and the left quarter panel of the case vehicle impacted the right front door of the Chevrolet (event 3). The case vehicle and Chevrolet remained engaged and traveled north coming to rest in the mouth of the intersecting county road. The Western Star skidded to final rest on the west shoulder heading southeast. The back right passenger was restrained in her rear-facing infant seat and was not injured. The unrestrained driver sustained fatal injury. The unrestrained back left passenger sustained police reported "B" (non-incapacitating-evident) injury and was transported to a hospital and admitted.			
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IN-06-030

This investigation was brought to NHTSA's attention on or before September 27, 2006 by a television news story. This crash involved a 1989 Pontiac Grand Am LE (case vehicle), a 2002 Western Star truck tractor and semi-trailer (1st other vehicle), and a 2002 Chevrolet Impala (2nd other vehicle). The crash occurred in September, 2006 at 8:56 a.m., in Louisiana and was investigated by the Louisiana State Police. This crash is of special interest because the case vehicle's back right passenger [5-month-old, White (non-Hispanic) female] was restrained in a child safety seat and sustained no injury as a result of the crash. This contractor inspected the case vehicle, Chevrolet and crash scene on October 9-10, 2006. This contractor interviewed the daughter (a non-occupant) of the case vehicle's driver on October 10, 2006. This report is based on the police crash report, scene inspection, case vehicle and Chevrolet inspections, an interview with the case vehicle driver's daughter, driver autopsy report, back right passenger's medical records, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling southeast on a two lane state highway approaching a "T" intersection. The Western Star was also traveling southeast behind the case vehicle. Meanwhile, the Chevrolet was traveling northwest approaching the "T" intersection. The case vehicle's driver stopped to turn left at the intersection. The front left of the Western Star impacted the back right of the case vehicle (event 1). The impact caused the case vehicle to rotate counterclockwise and it crossed into the northwestbound lane. The front of the Chevrolet then impacted the left side of the case vehicle (event 2). The impact caused the case vehicle and the Chevrolet to rotate clockwise and the left quarter panel of the case vehicle impacted the right front door of the Chevrolet (event 3). The case vehicle and Chevrolet remained engaged and traveled north coming to rest in the mouth of the intersecting county road. The case vehicle was heading northwest at final rest. The Chevrolet was heading north at final rest. The Western Star skidded to final rest on west shoulder heading southeast with the tractor in the southeastbound lane and the trailer on the west shoulder.

The CDCs for the case vehicle were determined to be: **06-BREE-5** (**180** degrees) for the impact with the front of the Western Star (event 1), **08-LDAW-6** (**230** degrees) for the impact with the Chevrolet (event 2) and **09-LZ99-9** (**270** degrees, extent zone unknown) for the side-slap impact to the Chevrolet's right front door [(event 3), only a partial CDC is known for event 3 due to overlapping damage]. An impact with a heavy truck is out-of-scope for the WinSMASH reconstruction program. However, the WinSMASH program was used to calculate a barrier equivalent speed (BES) for the case vehicle based on the crush to the back of the case vehicle. The BES was calculated as 44.7 km.p.h. (27.8 m.p.h.). The WinSMASH program, damage only algorithm, was used to calculate the case vehicle's Delta Vs for the left side impact with the front of the Chevrolet (event 2). The Total, Longitudinal, and Lateral Delta Vs are, respectively: 48.0 km.p.h (29.8 m.p.h), 30.9 km.p.h (19.2 m.p.h.), and 36.8 km.p.h. (22.9 m.p.h). The WinSMASH program, missing algorithm, was also used to calculate the case vehicle's Delta Vs for the side-slap impact with the Chevrolet. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 5.0 km.p.h (3.1 m.p.h), 0.4 km.p.h (0.2 m.p.h.), and 5.0 km.p.h. (3.1 m.p.h). The case vehicle was towed due to damage.

The CDCs for the Chevrolet were determined to be **11-FDEW-2** (**340** degrees) for the front impact with the left side of the case vehicle (event 2) and **03-RPMW-1** (**90** degrees) for the side-slap impact between the Chevrolet's right front door and the case vehicle's left quarter panel (event 3). The WinSMASH reconstruction program, damage algorithm, was used to calculate the Chevrolet's Delta Vs for the front impact with the case vehicle. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 37.0 km.p.h (23.0 m.p.h.), -34.8 km.p.h. (-21.6 m.p.h), and 12.7 km.p.h. (7.9 m.p.h). The Chevrolet's Event Data Recorder (EDR) recorded a maximum longitudinal Delta V of -42.6 km.p.h. (-26.48 m.p.h.) for this impact. The WinSMASH reconstruction program, missing vehicle algorithm, was also used to calculate the Chevrolet's Delta Vs for the side-slap impact with the case vehicle. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 4.0 km.p.g (2.5 m.p.h.), 0.0 km.p.h. (0.0 m.p.h), and -4.0 km.p.h. (-2.5 m.p.h). The Chevrolet was towed due to damage.

The back right passenger was seated in a Graco "Snug Ride" rear-facing infant seat, which was being used without the base. The infant seat was manufactured by Graco Children's Products Inc., on November 9, 2005 and was identified by model number 7241DDH2. The infant seat showed areas of stress due to loading during the crash; otherwise, the infant seat survived the crash without damage. The infant seat was secured with the lap portion of the case vehicle's three-point safety belt system, which was equipped with a lightweight locking latch plate. The lap belt was positioned through the safety belt paths located on the infant seat's arm rests. The back right passenger was restrained in the infant seat by the five-point harness. The harness retaining clip appeared to have been positioned approximately at chest level. The back right passenger was not injured in this cash. The proper installation of the rear-facing infant seat in the case vehicle and the proper restraint of the back right passenger in the infant seat prevented the back right passenger from sustaining any injuries in this severe crash.

The driver and back left passenger were both unrestrained. The driver sustained fatal injury and the back right passenger sustained police reported "B"(non-incapacitating-evident) injury and was transported by ground ambulance to a hospital. The back left passenger was hospitalized for treatment of her injuries.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which all vehicles were traveling was a two lane, undivided, state highway, traversing in a northwesterly and southeasterly direction and all vehicles were approaching a three-leg (i.e., "T") intersection located on the east side of the trafficway. The roadway had one through lane in each direction. The southeastbound lane was 3.7 meters (12.1 feet) in width. The northwestbound lane was 3.4 meters (11.2 feet) in width. Each bituminous shoulder was 2.3 meters (7.5 feet) in width. Roadway pavement markings consisted of solid white edge lines, broken yellow center line and solid yellow no-passing lines for each lane. The speed limit was 89 km.p.h. (55 m.p.h.). There was no regulatory speed limit sign posted near the scene. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry, level bituminous. Traffic density was light, and the site of the crash was rural. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was traveling southeast in the southeastbound lane (**Figure 1**). The case vehicle's driver was intending to turn left at the "T" intersection. A witness stated that the case vehicle stopped abruptly. The witness indicated she saw the case vehicle's left turn signal come on. The Western Star was also traveling southeast and was behind the case vehicle. The Western Star's driver was intending to continue straight ahead. Meanwhile, the Chevrolet was traveling northwest in the northwestbound lane and was approaching the "T" intersection (**Figure 1**). The initial impact occurred in the southeastbound lane (Figure 2). The second impact occurred in the northwestbound lane (**Figure 3**). It is unlikely that the case vehicle's driver made any avoidance maneuvers prior to the initial impact. The Chevrolet's EDR data indicated that the Chevrolet's driver applied the brakes just prior to the impact with case vehicle.

Crash: The front left of the Western Star impacted the back right of the case vehicle [event 1 (**Figure 4** below)]. The impact accelerated the case vehicle forward and caused it to rotate counterclockwise approximately 240 degrees and it crossed into the northwestbound lane (**Figure 3**). The front of the Chevrolet (**Figure 5** below) then impacted the left side of the case vehicle [event 2, (**Figure 6** below)]. The impact caused the case vehicle and the Chevrolet to rotate clockwise and the left quarter panel of the case vehicle impacted the right front door of the Chevrolet [event 3 (**Figure 7** below)].

Figure 1: Approach of case vehicle and Western Star southeastbound to area of impact (arrow), skid marks from Western Star, number on shoulder shows meters to initial impact area

Figure 2: Arrow shows impact location of case vehicle and Western Star

Figure 3: Post-impact travel of case vehicle approaching area of second impact (arrow)

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

Figure 6: Damage to left side of case vehicle from impact with front of Chevrolet

Figure 5: Overview of damage to front of Chevrolet from impact with left side of case vehicle

Figure 7: Damage to Chevrolet's right front door due to side-slap impact with case vehicle

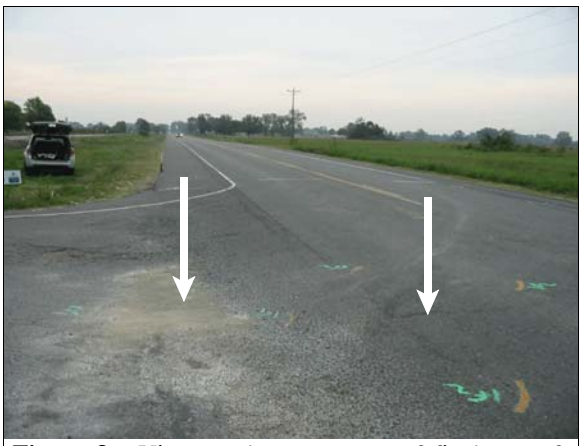


Figure 8: View southwest to area of final rest of case vehicle and Chevrolet and opposite view of Chevrolet's approach, arrow on right shows Chevrolet's area of final rest, arrow of left shows case vehicle's area of final rest, police marks on pavement show wheel positions

Post-Crash: The case vehicle and Chevrolet remained engaged and traveled north coming to rest in the mouth of the intersecting county road (**Figure 8**). The case vehicle was heading northwest at final rest. The Chevrolet was heading north at final rest. Meanwhile, the Western Star skidded to final rest on the west shoulder heading southeast with the tractor in the southeastbound lane and the trailer on the west shoulder.

CASE VEHICLE

The 1989 Pontiac Grand Am LE was a front wheel drive, two-door coupe (VIN: 1G2NE14D7KC------) equipped with a 2.3L, L4 engine and automatic transmission. The front seating row was equipped with bucket seats with folding backs and adjustable head restraints and door-mounted, automatic, three-point, lap-and-shoulder safety belts. The back seating row

was equipped with a bench seat with integral head restraints and three-point lap-and-shoulder safety belts in the outboard seating positions. The case vehicle was not equipped with anti-lock brakes and was not equipped with air bags. The case vehicle's specification wheelbase was 263 centimeters (103.5 inches). The case vehicle's odometer reading at the time of the inspection was 301,697 kilometers (187,471 miles).

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's impact with the Western Star (event 1) involved the back right corner. The case vehicle's back bumper, trunk lid, right tail lamp assembly, and the right quarter panel were all directly damaged and crushed forward. The back bumper was knocked off the case vehicle during the crash, so the crush measurements were taken to the panel behind the bumper. Direct damage began at the back right corner and extended 39 centimeters (15.4 inches) along the back of the vehicle. Crush measurements were taken at the bumper level. The residual maximum crush was measured as 80 centimeters (31.5 inches) occurring at C_5 (**Figure 9**). The induced damage from this impact involved the trunk lid, right C-pillar, right front door, and roof. In addition, all the right side and backlite glazing was broken out. The table below shows the case vehicle's back crush profile.

Figure 9: Top view of crush to back of case vehicle

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	39	80	131	13	36	38	54	80	73	46	0
in		15.4	31.5	51.6	5.1	14.2	15.0	21.3	31.5	28.7	18.1	0.0

The case vehicle's impact with the Chevrolet (event 2) involved the left side. The left fender, left front door, left "A" and "B"-pillars and left quarter panel were all directly damaged and crushed inward. Direct damage began approximately 255 centimeters (100.4 inches) rear of the left front axle and extended approximately 289 centimeters (113.8 inches) along the left side of the vehicle. The impact separated the left front door latch and striker, so crush measurements were taken at both the sill and mid-door levels. Residual maximum crush at the sill level was measured as 23 centimeters (9.1 inches) occurring at C_3. The residual maximum crush at the mid-door level was measured as 89 centimeters (35 inches) occurring 27 centimeters forward of C_3. The side-slap impact with the Chevrolet (event 3) also involved the left quarter panel. The damage from the two impacts overlapped, but the side-slap impact was minor and did not appreciably alter the crush profile. The table below shows the average of the two levels of crush.

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	2	289	89	407	9	10	33	47	17	3	-4	54
in		113.8	35.0	160.2	3.5	3.9	13.0	18.5	6.7	1.2	-1.6	21.3

The case vehicle's left side wheelbase was shortened 12 centimeters (4.7. inches) while the right side wheelbase was extended 10 centimeters (3.9 inches). Induced damage due to the left side impact involved the hood, left fender, roof and left quarter panel.

The case vehicle's recommended tire size was: P215/60R14. The case vehicle was equipped with tires size P195/75R14. 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	207	30	207	30	6	8	None	Yes	No
RF	110	16	207	30	6	8	None	No	No
LR	Flat	Flat	207	30	5	6	Tread cut, cuts and holes in sidewall	No	Yes
RR	Flat	Flat	207	30	5	6	Bead separated	Yes	Yes

Vehicle Interior: Inspection of the case vehicle's interior revealed an occupant contact scuff on the driver's door arm rest and left front window sill. In addition, the driver's seat back was displaced rearward due to driver loading as a result of the back end impact by the Western Star. The case vehicle's passenger compartment sustained numerous intrusions. The most severe intrusion involved the lateral displacement of the driver's door (**Figure 10**). It intruded a total of 79 centimeters (31.1 inches) into the front seating row, which was 7 centimeters (2.8 inches) more than half the width of the front seating row. The side panel rear of the left "B"-pillar intruded 41

Figure 10: Overview of case vehicle's front seating area and intrusion of left front door (arrow)

centimeters (16.1 inches) laterally into the back seating row. The rear seat back intruded longitudinally 56 centimeters (22 inches) and 48 centimeters (18.9 inches) respectively into the back right and back center seat positions.

Damage Classification: Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **06-BREE-5** (**180** degrees) for the impact with the front of the Western Star (event 1), **08-LDAW-6** (**230** degrees) for the impact with the Chevrolet (event 2) and **09-LZ99-9** (**270** degrees, extent zone unknown) for the side-slap impact to the Chevrolet's right front door [(event 3), only a partial CDC is known for event 3 due to overlapping damage]. An impact with a heavy truck is out-of-scope for the WinSMASH reconstruction program. However, the WinSMASH program was used to calculate a barrier equivalent speed (BES) for the case vehicle based on the crush to the back of the case vehicle. The BES was calculated as 44.7 km.p.h. (27.8 m.p.h.). The WinSMASH program, damage only algorithm, was used to calculate the case vehicle's Delta Vs for the left side impact with the front of the Chevrolet. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 48.0 km.p.h (29.8 m.p.h), 30.9 km.p.h (19.2 m.p.h.), and 36.8 km.p.h. (22.9 m.p.h). The impact fit the reconstruction model and the results appeared reasonable. The WinSMASH program, missing algorithm, was also used to calculate the case vehicle's Delta Vs for the side-slap impact with the Chevrolet. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 5.0 km.p.h (3.1 m.p.h), 0.4 km.p.h (0.2 m.p.h.), and 5.0 km.p.h. (3.1 m.p.h). The impact fit the reconstruction model and the results were borderline. The case vehicle was towed due to damage.

CHILD SAFETY SEAT

The back right passenger was seated in a Graco "Snug Ride" rear-facing infant seat (**Figure 11**), which was being used without the base. The infant seat was manufactured by Graco Children's Products Inc., on November 9, 2005 and was identified by model number 7241DDH2. The infant seat consisted of a plastic, one-piece shell with a padded cloth cover approximately 2 centimeters (0.8 inch) thick, a five-point harness with harness retainer clip, a carrying handle and a level indicator located on the left side of the infant seat. The infant seat was designed with two sets of harness slots located in the seat back. The harness straps were threaded through the top slot. A belt path was located on each arm rest so the infant seat could be secured with a vehicle's manual safety belt system. In addition, a locking clip was stored in a slot on the bottom of the infant seat. The infant seat's height and weight limits were indicated respectively as: 73

Figure 11: Case vehicle's back right passenger's rear-facing infant seat

centimeters (29 inches) or less and 2.3 to 10 kilograms (5 to 22 pounds).

Inspection of the infant seat revealed evidence the seat was loaded during the crash. There were numerous locations on the infant seat where the plastic was lighter in color (**Figure 12**) indicating the plastic shell had been loaded during the crash stressing the plastic. This was most likely the result of the longitudinal intrusion of the case vehicle's seat back loading against the seat as it was held in place by the case vehicle's safety belt. Otherwise, the infant seat was intact and unremarkable.

Figure 12: Orange dots show some of stress spots on the back left passenger's infant seat

Figure 13: Back right lightweight locking latch plate

The case vehicle's back outboard seating positions were equipped with three-point, lap-and-shoulder safety belt systems with emergency locking retractors and lightweight locking latch plates (**Figure 13**). The infant seat was secured with the lap portion of the safety belt system, which was positioned through the safety belt paths located at the back of the infant seat's arm rests.

CASE VEHICLE BACK RIGHT PASSENGER KINEMATICS

Immediately prior to the crash, the case vehicle's back right passenger [5-month-old, White (non-Hispanic) female; unknown height and weight (i.e., there were no medical records on this occupant and the interviewee did not know and could not estimate the infant's height and weight)] was seated in a reclined position in her rear-facing infant seat. It is not known what type of clothing the back right passenger was wearing at the time of the crash.

The back right passenger was restrained in her infant seat by the five-point harness. The harness retaining clip appeared to have been positioned approximately at the infant's chest level.

Just prior to the crash, the case vehicle had come to a stop and the driver was preparing to turn left. The Western Star's impact to the case vehicle's back right corner caused the back right passenger to move rearward along a path opposite the case vehicle's 180 degree direction of principal force as the case vehicle was accelerated forward. The back right passenger loaded her harness straps causing a red mark on both shoulders near her neck. As the case vehicle rotated rapidly counterclockwise, the centrifugal force of the rotation caused the back right passenger to move right within her infant seat and she continued to load the harness straps. It is also likely that

the unrestrained back left passenger's upper torso contacted the right side of the infant seat. The case vehicle's left side impact with the Chevrolet then caused the back right passenger to move to the left and rearward within her infant seat and she loaded her harness straps. The back right passenger remained restrained in her infant seat as the case vehicle came to final rest. The damage to the right front door indicated it was forced open by rescue personnel, and the back right passenger was most likely removed through the right front door.

CASE VEHICLE BACK RIGHT PASSENGER INJURIES

The police crash report indicated that the back right passenger was not injured. She was transported by ambulance to a hospital and was treated and released. The table below shows the interviewee reported description of marks on the back right passenger's shoulders and the contact mechanism.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
	Red marks, 5.1-10.2 cm (2-4 in), on bilateral shoulders, near neck	Not coded	Child safety seat harness straps	Certain	Interviewee (relative)

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash, the case vehicle's driver [70-year-old, White (non-Hispanic) male; 180 centimeters and 94 kilograms (71 inches, 207 pounds)] was most likely seated in an upright driving position with both hands on the steering wheel and one of his feet on the brake pedal. His seat track was most likely located between the middle and forward position and the seat back was most likely slightly reclined.

Based on the vehicle inspection and the police crash report, the case vehicle's driver was not restrained by his door-mounted, automatic, three-point, lap-and-shoulder safety belt system.

Just prior to the crash, the case vehicle's driver stopped the case vehicle and was preparing to turn left. As a result, his seated position remained unchanged just prior to the crash. The Western Star's impact to the case vehicle's back right corner caused the driver to move rearward along a path opposite the case vehicle's 180 degree direction of principal force as the case vehicle was accelerated forward. The driver loaded his seat back and displaced the seat back rearward. As the case vehicle rotated rapidly counterclockwise, the centrifugal force of the rotation caused the driver to move right and he came out of his seat position and was projected into the front right seat. The case vehicle's left side impact with the Chevrolet then caused the driver to move to the left and rearward along a path opposite the case vehicle's 230 degree direction of principal force as the case vehicle was accelerated forward and to the right. The case vehicle's driver was projected into the intruding left front door and window frame causing a compound fracture and spinal cord laceration at C_7, fractures to his left ribs, fractured left clavicle, contusion left lung,

a spleen laceration and multiple abrasions. The driver also sustained fractures to his left tibia and fibula due to contact with the center console as he was projected to the left into the left front door. He rebounded off the left front door and came to rest in the front right seat area or possibly on the floor. The right front door was forced open by rescue personnel and the driver was removed through the right front door.

CASE VEHICLE DRIVER INJURIES

The police crash report indicated that the driver was fatally injured. The police crash report also indicated he was not transported to a medical facility indicating he was pronounced dead at the scene. The table below shows the case vehicle driver'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	Laceration, partial, spinal cord at C_7 with compound fracture at C_7, not further specified	critical 640264.5,6	Left front window frame	Probable	Autopsy
2	Contusions, multiple, pleural surfaces of left lung, not further specified	serious 441406.3,2	Left side interior surface, excluding hardware and/or armrest	Probable	Autopsy
3	Fracture, multiple, comminuted, left lateral and left posterior ribs, not further specified with 1.7 liters of left hemothorax	severe 450232.4,2	Left side interior surface, excluding hardware and/or armrest	Probable	Autopsy
4	Lacerations, multiple, spleen, not further specified	moderate 544220.2,2	Left side interior hardware and/or armrest	Probable	Autopsy
5	Fracture left clavicle, not further specified	moderate 752200.2,2	Left side interior surface, excluding hardware and/or armrest	Probable	Autopsy
6	Fracture, closed, left distal tibia, not further specified	moderate 853404.2,2	Floor, center console	Possible	Autopsy
7	Fracture, closed, left distal fibula, not further specified	moderate 851605.2,2	Floor, center console	Possible	Autopsy
8 9	Abrasions {dicing type injury}, 5.1 x 5.1 cm (2 x 2 in) over left forehead and left temple	minor 290202.1,2 290202.1,7	Noncontact injury: flying glass, left front glazing	Certain	Autopsy
10	Abrasions x 2, on left occipital scalp, not further specified	minor 190202.1,6	Noncontact injury: flying glass, left front glazing	Probable	Autopsy

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
11	Abrasions left shoulder and arm, including shoulder, upper arm, middle arm, antecubital fossa, and dorsal mid-forearm--7.6 x 5.1 cm (3 x 2 in)	minor 790202.1,2	Left side interior surface, excluding hardware and/or armrest	Probable	Autopsy
12	Abrasion, 2.5 cm (1 in), right elbow, not further specified	minor 790202.1,1	Floor, center console	Possible	Autopsy
13	Abrasion, 5.1 x 5.1 cm (2 x 2 in) dorsum left hand	minor 790202.1,2	Left side interior surface, excluding hardware and/or armrest	Probable	Autopsy
14	Abrasions dorsum right hand and over metatarsophalangeal joints	minor 790202.1,1	Center instrument panel and below	Possible	Autopsy
15	Abrasions lateral left knee, not further specified	minor 890202.1,2	Steering column	Possible	Autopsy
16	Abrasion, 15.2 cm (6 in) medial left calf	minor 890202.1,2	Seat cushion, driver's	Possible	Autopsy
17	Abrasions, multiple, right ankle including posterior ankle and over lateral malleolus	minor 890202.1,1	Floor, foot controls	Probable	Autopsy

CASE VEHICLE BACK LEFT PASSENGER KINEMATICS

Immediately prior to the crash, the case vehicle's back left passenger [72-year-old, White (non-Hispanic) female; 163 centimeters and 59 kilograms (64 inches, 131 pounds)] was seated in an unknown position. Both her feet were most likely on the floor. Her seat was not adjustable.

Based on the vehicle inspection and the police crash report, the case vehicle's back left passenger was not restrained by her three-point, lap-and-shoulder safety belt system.

Just prior to the crash, the case vehicle's driver stopped the case vehicle and was preparing to turn left. As a result, the back left passenger's seated position remained unchanged just prior to the crash. The Western Star's impact to the case vehicle's back right corner caused the back left passenger to move rearward along a path opposite the case vehicle's 180 degree direction of principal force as the case vehicle was accelerated forward, and the passenger loaded her seat back. As the case vehicle rotated rapidly counterclockwise, the centrifugal force of the rotation caused the passenger to move right and her upper torso was most likely projected over into the back right seat position and contacted the right side of the rear-facing infant seat. The case vehicle's left side impact with the Chevrolet then caused the back left passenger to move to the left and rearward along a path opposite the case vehicle's 230 degree direction of principal force as

the case vehicle was accelerated forward and to the right. The back left passenger was projected into the intruding left side panel rear of the left "B"-pillar lacerating her spleen and causing fractures to her pubic rami and both acetabulums. In addition, the back left passenger sustained fractures to C_7, right ribs, left fibula, sacral, and left medial malleolus. The back left passenger most likely rebounded off the side panel and came to rest in the back seat or possibly on the floor. The right front door was forced open by rescue personnel and the back left passenger was removed through the right front door.

CASE VEHICLE BACK LEFT PASSENGER INJURIES

The police crash report indicated that the back left passenger sustained a "B"(non-incapacitating-evident) injury and was transported by ground ambulance to a hospital. The back left passenger was hospitalized for treatment of her injuries.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Laceration, grade 3, spleen, not further specified	serious 544224.3,2	Left side interior surface rearward of left "B"-pillar	Probable	Hospitalization records
2	Fracture ribs: right 4th through 6th, with small right pneumothorax, not further specified	serious 450222.3,1	Left side interior surface rearward of left "B"-pillar	Probable	Hospitalization records
3	Fracture C_7 with ligamentous injury, not further specified	moderate 650216.2,6	Left side interior surface rearward of left "B"-pillar	Probable	Hospitalization records
4	Fracture bilateral superior pubic rami with extension into acetabulum, not further specified	moderate 852602.2,5	Left side interior surface rearward of left "B"-pillar	Probable	Hospitalization records
5	Fracture sacral ala, not further specified	moderate 852602.2,6	Left side interior surface rearward of left "B"-pillar	Probable	Hospitalization records
6 7	Fracture left and right acetabulum as extensions of superior pubic rami fractures	moderate 852602.2,1 852602.2,2	Left side interior surface rearward of left "B"-pillar	Probable	Emergency room records
8	Fracture, comminuted, segmental, left distal fibula shaft without syndesmotic[1] injury	moderate 851606.2,2	Left side interior surface rearward of left "B"-pillar	Probable	Hospitalization records

[1] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
syndesmosis (sin"dz-mo/sis): a type of fibrous joint in which the intervening fibrous connective tissue forms an interosseous membrane or ligament.
syndesmosis tibiofibula'ris, tibiofibular syndesmosis: inferior tibiofibular articulation: a firm fibrous union formed at the distal ends of the tibia and fibula between the fibular notch of the tibia and a roughened triangular surface on the fibula, which frequently contains a synovial prolongation of the cavity of the talocrural articulation. Called also *articulatio tibiofibularis*.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
9	Fracture left medial malleolus, not further specified	moderate 853412.2,2	Left side interior surface rearward of left "B"-pillar	Probable	Hospitalization records
10	Laceration, small, above left eye, not further specified	minor 290602.1,7	Noncontact injury: flying glass, left rear glazing	Possible	Hospitalization records
11	Abrasions, integument, not further specified	minor 990200.1,9	Unknown contact mechanism	Unknown	Emergency room records

1ST OTHER VEHICLE

The 2002 Western Star was a conventional cab, 6x4 truck tractor (VIN: 2WKPDD3G32K------) equipped with a Caterpillar, C-15 diesel engine. The Western Star was pulling a 2004 Holden, flatbed semi-trailer.

Exterior Damage: The Western Star was not inspected. No TDC could be assigned for the damage to the Western Star because no photographs of the vehicle were available. The Western Star was driven from the scene.

Western Star's Driver: According to the police crash report, the Western Star's driver [44-year-old, (unknown race and ethnic origin) male] was restrained by his three-point, lap-and-shoulder, safety belt system. The police crash report indicated the driver was not injured in this crash.

2nd Other Vehicle

The 2002 Chevrolet Impala was a front wheel drive, four-door sedan (VIN: 2WKPDD3G32K------) equipped with a 3.4L, V6 engine; four-speed automatic transmission and dual stage driver and front right passenger air bags. Four wheel, anti-lock brakes and traction control were options, but it is not known if the Chevrolet was so equipped. The Chevrolet was also equipped with an Event Data Recorder (EDR). A hard copy of the EDR download was provided to this contractor by the investigating police agency. The EDR data are presented in **Figures 15-18** at the end of this report.

Exterior Damage: The Chevrolet's impact with the left side of the case vehicle (event 2) involved the front of the vehicle. The front bumper, left headlamp/turn signal assembly, front of the left fender, hood and grille were directly contacted and crushed rearward. The direct damage began at the front right bumper corner and extended 110 centimeters (43.3 inches) across the front end. Crush measurements were taken at the bumper level, and the maximum residual crush was measured as 40 centimeters (15.7 inches) occurring at C_4 (**Figure 14** below). The table below shows 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	2	110	40	108	0	12	26	40	31	22	22	0
in		43.3	15.7	42.5	0.0	4.7	10.2	15.7	12.2	8.7	8.7	0.0

The side-slap impact involved the Chevrolet's right front door. The direct damage began 146 centimeters (57.5 inches) forward of the right rear axle and extended 79 centimeters (31.2 inches) along the door. The residual maximum crush was determined to be approximately 2 centimeters (0.8 inch) occurring approximately 11 centimeters forward of C_2. The table below shows the Chevrolets right front door crush profile.

Figure 14: Top view of crush to front of Chevrolet from impact with the left side of the case vehicle

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	3	79	2	110	0	1	1	0	1	0	48	41
in		31.1	0.6	43.3	0.0	0.4	0.4	0.0	0.4	0.0	18.9	16.1

The Chevrolet's right side wheelbase was reduced 7 centimeter's (2.8 inches) while the left side wheelbase was extended 1 centimeter (0.4 inch). The Chevrolet sustained induced damage to its hood, right fender and right front door. In addition, the windshield was cracked.

The Chevrolet's recommended tire size was: P225/60R16, and the vehicle was equipped with tires of this size. The Chevrolet'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	179	26	207	30	9	11	None	No	No
RF	Flat	Flat	207	30	9	11	Cut in Sidewall	No	Yes
LR	179	26	207	30	4	5	None	No	No
RR	172	25	207	30	3	4	None	No	No

Damage Classification: Based on the vehicle inspection, the CDCs for the Chevrolet were determined to be **11-FDEW-2** (**340** degrees) for the front impact with the left side of the case vehicle (event 2) and **03-RPMW-1** (**90** degrees) for the side-slap impact between the Chevrolet's right front door and the case vehicle's left quarter panel (event 3). The WinSMASH reconstruction program, damage algorithm, was used to calculate the Chevrolet's Delta Vs for the front impact with the case vehicle. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 37.0 km.p.h (23.0 m.p.h.), -34.8 km.p.h. (-21.6 m.p.h), and 12.7 km.p.h. (7.9 m.p.h). The impact fit the reconstruction model and the results appeared reasonable. The Chevrolet's EDR recorded a maximum longitudinal Delta V of 42.6 km.p.h. (-26.48 m.p.h.) for the front impact. The WinSMASH reconstruction program, missing vehicle algorithm, was also used to calculate the Chevrolet's Delta Vs for the side-slap impact with the case vehicle. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 4.0 km.p.h (2.5 m.p.h.), 0.0 km.p.h. (0.0 m.p.h), and -4.0 km.p.h. (-2.5 m.p.h). The impact fit the reconstruction model and the results were borderline. The Chevrolet was towed due to damage.

Chevrolet's Driver: According to the police crash report and supported by the EDR data, the driver of the Chevrolet [79-year-old, Black (unknown if Hispanic) female] was restrained by her manual, three-point, lap-and-shoulder safety belt system. The police crash report indicated that the driver sustained a "C" (possible) injury and was transported from the scene by ambulance to a hospital.

Chevrolet's Front Right Passenger: According to the police crash report, the Chevrolet's front right passenger [82-year-old, Black (unknown if Hispanic) female] was restrained by her manual, three-point, lap-and-shoulder safety belt system. The police crash report indicated that the front right passenger sustained a "C" (possible) injury and was transported from the scene by ambulance to a hospital.

CDR File Information

Vehicle Identification Number	2G1WF55E029 [redacted]
Investigator	[redacted]
Case Number	
Investigation Date	[redacted]
Crash Date	[redacted]
Filename	[redacted]
Saved on	
Data check information	E1F9316A
Collected with CDR version	Crash Data Retrieval Tool 2.40
Collecting program verification number	32B7A917
Reported with CDR version	Crash Data Retrieval Tool 2.40
Reporting program verification number	32B7A917
Interface used to collected data	Block number: 00 Interface version: 3D Date: 06-18-04 Checksum: 5C00
Event(s) recovered	Deployment 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 can be overwritten by an event that has a greater SDM recorded vehicle 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. 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 can not 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.

-Event Recording Complete will indicate if data from the recorded event has been fully written to the SDM memory or if it has been interrupted and not fully written.

-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

-The Time Between Non-Deployment and Deployment Events is displayed in seconds. If the time between the two events is greater than 25.4 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.

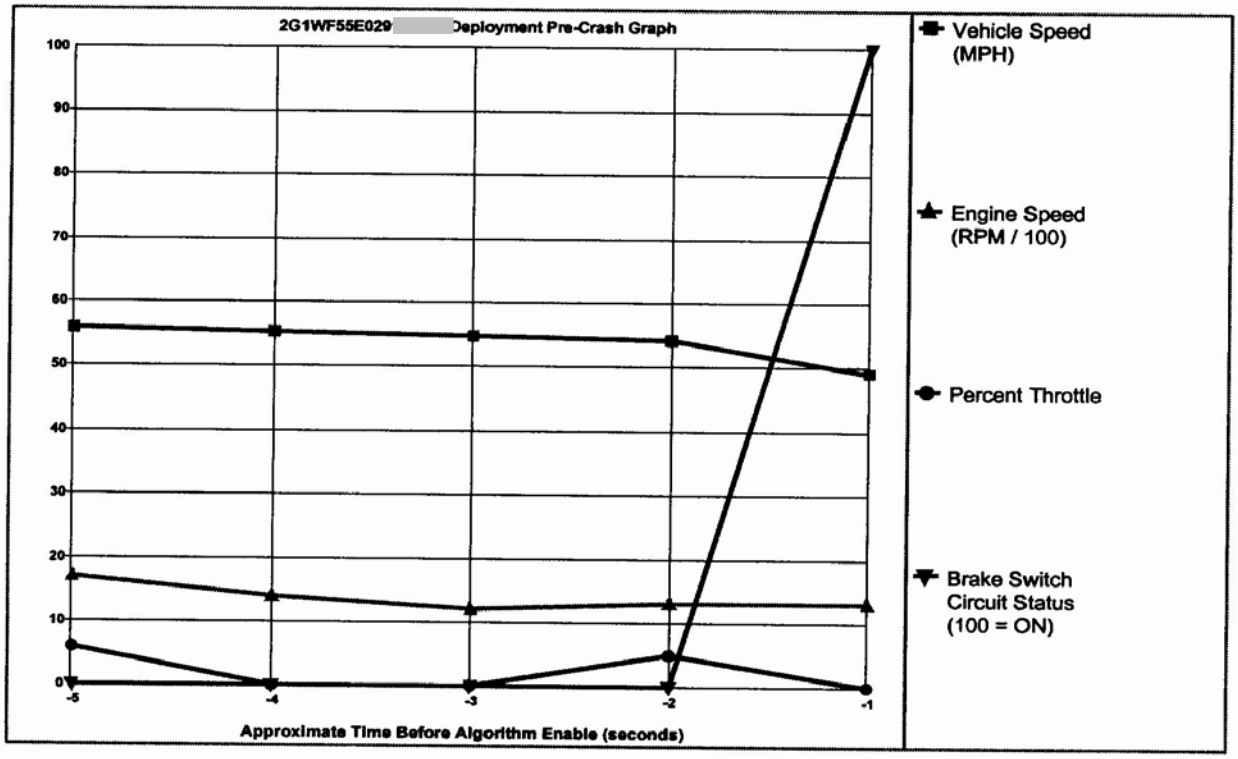
-Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the Class 2 data link, to the SDM.

-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.

Figure 15: Chevrolet's CDR File Information and SDM Data Limitations

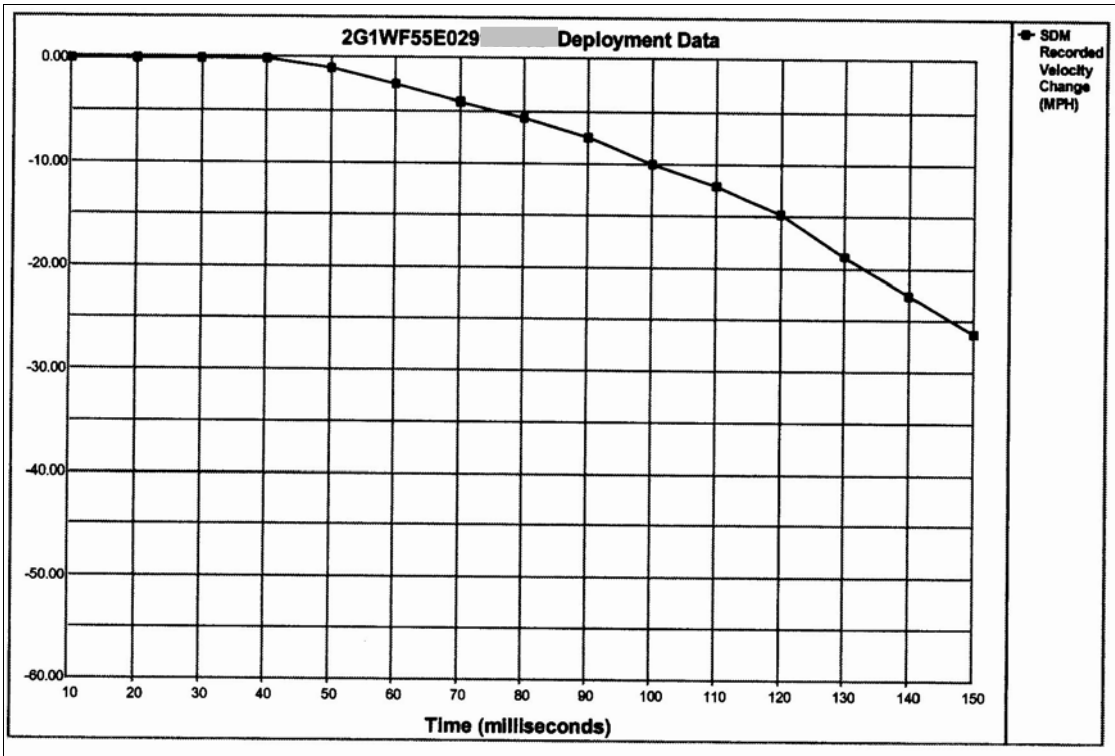
System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Deployment	7884
Ignition Cycles At Investigation	7885
Maximum SDM Recorded Velocity Change (MPH)	-26.48
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	157.5
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	67.5
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	67.5
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Time Between Non-Deployment And Deployment Events (sec)	N/A
Frontal Deployment Level Event Counter	1
Event Recording Complete	Yes
Multiple Events Associated With This Record	No
One Or More Associated Events Not Recorded	No



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	56	1728	6	OFF
-4	55	1408	0	OFF
-3	55	1216	0	OFF
-2	54	1280	5	OFF
-1	49	1344	0	ON

Figure 16: Chevrolet's System Status at Deployment and Deployment Pre-Crash Data

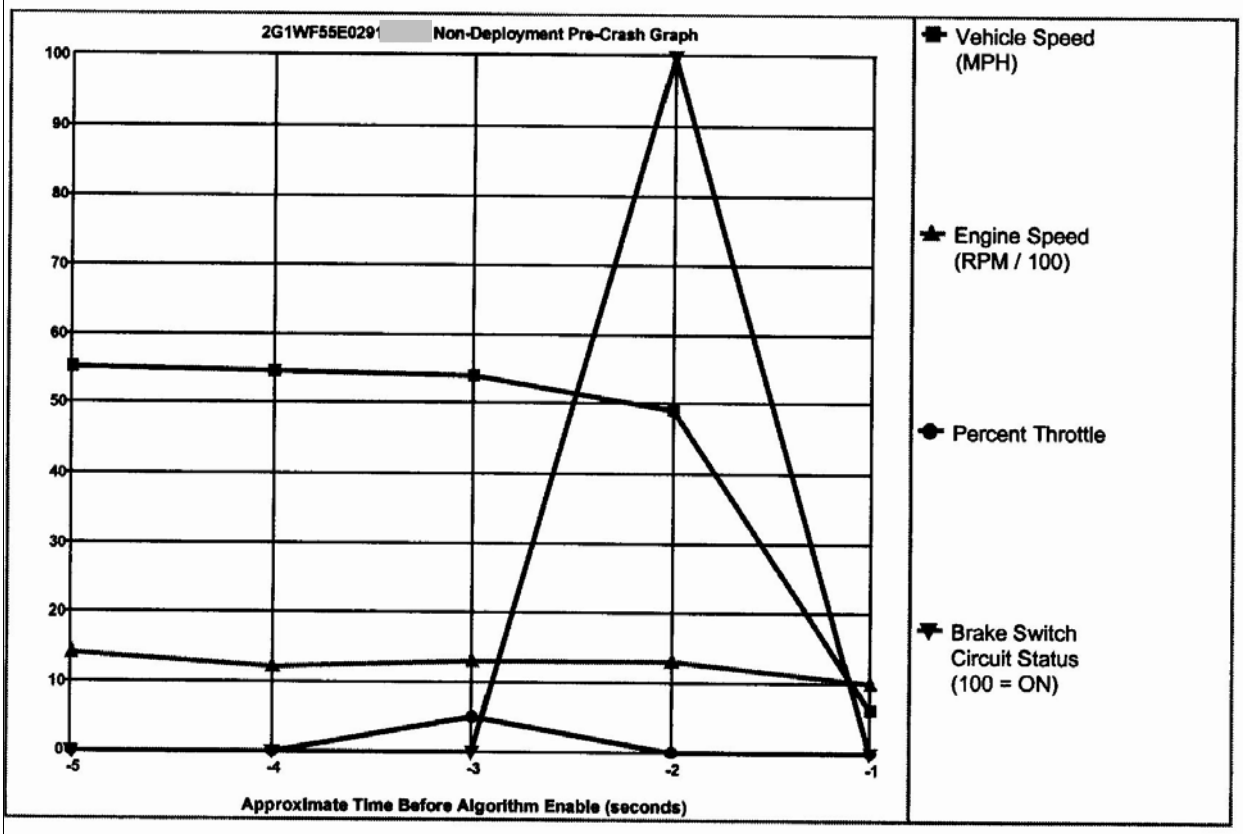


Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	-0.93	-2.48	-4.03	-5.58	-7.44	-9.92	-12.09	-14.88	-18.91	-22.63	-26.35

Figure 17: Chevrolet's Deployment SDM Recorded Velocity Change Graph

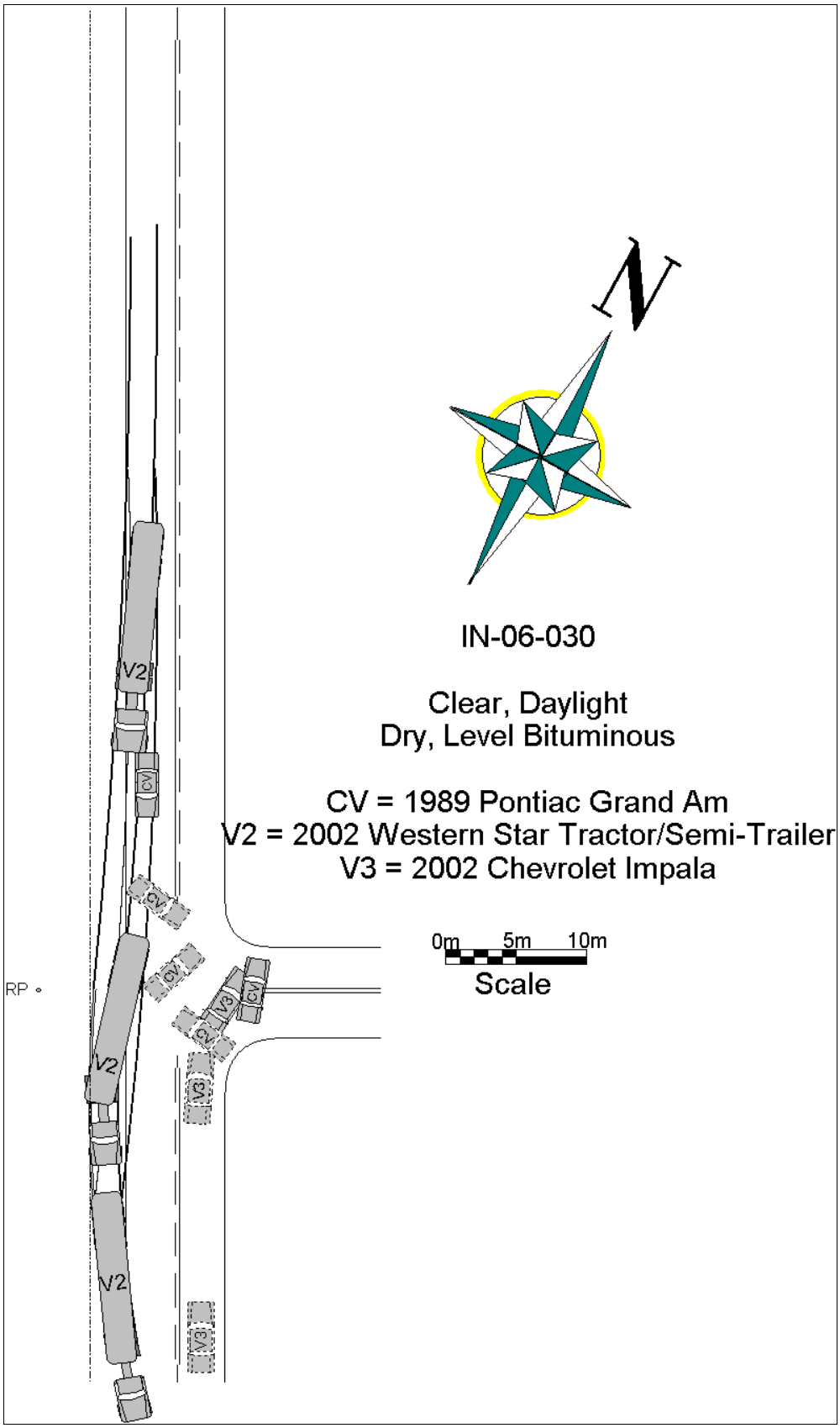
System Status At Non-Deployment

SIR Warning Lamp Status	ON
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Non-Deployment	7884
Ignition Cycles At Investigation	7885
Maximum SDM Recorded Velocity Change (MPH)	-0.04
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	0
Event Recording Complete	Yes
Multiple Events Associated With This Record	No
One Or More Associated Events Not Recorded	No



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	55	1408	0	OFF
-4	55	1216	0	OFF
-3	54	1280	5	OFF
-2	49	1344	0	ON
-1	6	1024	0	OFF

Figure 18: Chevrolet's System Status at Non-Deployment and Non-Deployment Pre-Crash Data


N
IN-06-030
Clear, Daylight
Dry, Level Bituminous
CV = 1989 Pontiac Grand Am
V2 = 2002 Western Star Tractor/Semi-Trailer
V3 = 2002 Chevrolet Impala
0m 5m 10m
Scale
RP
V2
CV
V3