



# 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-05-013  
LOCATION - MICHIGAN  
VEHICLE - 1994 FORD ESCORT LX STATION WAGON  
CRASH DATE - December 2004

Submitted:

September 18, 2006  
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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

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

**Technical Report Documentation Page**

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15. <i>Supplementary Notes</i> On-site child safety seat investigation involving a 1994 Ford Escort LX station wagon equipped with manual safety belts, driver air bag system and back right child safety seat.					
16. <i>Abstract</i> This report covers an on-site child safety seat investigation that involved a 1994 Ford Escort LX station wagon (case vehicle) and a 2000 Chevrolet K1500 Silverado pickup truck (other vehicle), which collided left side to front on a two-lane U.S. highway. This crash is of special interest because the case vehicle's back right passenger [4-year-old, White (non-Hispanic) male] was seated in a booster seat and was ejected, and sustained police reported "A" (incapacitating) injuries. The case vehicle was traveling northeast in the northeastbound lane in a right curve. The Chevrolet was traveling southwest in the southwestbound lane. The case vehicle entered the southwestbound lane and traveled almost off the north side of the roadway before the driver steered back to the right and across the path of the Chevrolet. The front of the Chevrolet impacted the left side of the case vehicle. The impact caused the case vehicle's driver air bag to deploy. The Chevrolet's driver air bag also deployed. As a result of the impact, the case vehicle's left front door, left rear door, left quarter panel and left rear wheel were torn off the vehicle. The case vehicle rotated counterclockwise across the northeastbound lane and rolled over, passenger side leading six quarter rolls and came to rest on its roof on the south side of the roadway facing northwest. The driver and back right passenger and his booster seat were ejected out of the open left side of the case vehicle during the last quarter roll. The Chevrolet continued southwestbound and came to rest in the northeastbound lane facing slightly southwest. The back right passenger sustained a closed head injury from an unknown source. He and his booster seat were ejected due to deformation and displacement of the case vehicle's back seat which allowed him and the booster seat to come out of the lap-and-shoulder belt during the rollover. He was transported by ambulance to a hospital and treated and released. The driver was restrained only by his motorized, two-point shoulder belt. He sustained a fatal brain injury due to contact with the front of the striking vehicle.					
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This on-site investigation was brought to NHTSA's attention on or about March 31, 2005 by NASS GES sampling activities. This crash involved a 1994 Ford Escort LX station wagon (case vehicle) and a 2000 Chevrolet K1500 Silverado pickup truck (other vehicle), which collided left side to front on a two-lane, undivided U.S. highway. The crash occurred in December 2004, at 2:22 p.m., in Michigan and was investigated by the county sheriff department. This crash is of special interest because the case vehicle's back right passenger [4-year-old, White (non-Hispanic) male] was seated in a booster seat, was ejected, and sustained police reported "A" (incapacitating) injuries. This contractor inspected the case vehicle April 7, 2005 and the crash scene on April 8, 2005. The Chevrolet was sold at auction and could not be located. The case vehicle driver could not be interviewed. He sustained fatal injuries as a result of the crash. This report is based on the police crash report, scene and vehicle inspections, Chevrolet's Event Data Recorder data, occupant kinematic principles, and this contractor's evaluation of the evidence.

## SUMMARY

The case vehicle and Chevrolet were traveling in opposite directions on a two-lane, undivided U.S. highway. The case vehicle was traveling northeast in the northeastbound lane in a right curve. The Chevrolet was traveling southwest in the southwestbound lane. The case vehicle entered the southwestbound lane and traveled almost off the north side of the roadway before the driver steered back to the right and toward the Chevrolet. The driver of the Chevrolet steered to the left and braked in an attempt to avoid the case vehicle. It is not known what, if any, avoidance actions were taken by the case vehicle's driver. The front of the Chevrolet impacted the left side of the case vehicle. The impact caused the case vehicle's driver air bag to deploy. The Chevrolet's driver air bag also deployed. As a result of the impact, the case vehicle's left front door, left rear door, left quarter panel and left rear wheel were torn off the vehicle. The case vehicle rotated counterclockwise across the northeastbound lane and rolled over, passenger side leading six quarter rolls and came to rest on the south side of the roadway on its roof facing northwest. The driver and back right passenger and his booster seat were ejected out of the open left side of the case vehicle during the last quarter roll. The Chevrolet continued southwestbound and came to rest in the northeastbound lane facing slightly southwest. At the time of the crash, the light condition was daylight and it was raining.

The CDCs for the case vehicle were determined to be: **11-LDAW-4 (330 degrees)** for the left side impact with the front of the Chevrolet and: **00-TDDO-9** (i.e., column 7, extent zone, unknown) for the rollover. The extent zone could not be determined because of severe damage to the left side which produced overlapping damage to the roof and pulled the left side of the roof downward. The WinSMASH reconstruction program, CDC only algorithm, calculated the case vehicle's Total, Longitudinal, and Lateral Delta Vs for its left side impact with the Chevrolet respectively as: 61km.p.h. (37.9 m.p.h.), -52.8 km.p.h. (-32.8 m.p.h.), and 30.5 km.p.h. (19 m.p.h.). The reconstruction was considered borderline due to the lack of crush data, and the results appeared high. The case vehicle was towed due to damage.

Based on the available photographs, the CDC for the Chevrolet was estimated to be: **12-FYEW-3 (0 degrees)**. The WinSMASH reconstruction program, CDC only algorithm, calculated the Chevrolet's Total, Longitudinal, and Lateral Delta Vs for its front impact with the case vehicle respectively as: 35.0 km.p.h. (21.7 m.p.h.), -35.0 km.p.h. (-21.7 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The reconstruction was considered borderline due to the lack of crush data. The Chevrolet's EDR recorded a maximum longitudinal Delta V of -25.57 km.p.h. (-15.89 m.p.h.). The Chevrolet was towed due to damage.

An Evenflo "Big Kid LX" no-back, belt positioning booster seat was used to restrain the case vehicle's back right passenger. The booster seat was manufactured February 17, 2004. The model number was 3341476. The evidence indicates the booster seat and child were secured with the case vehicle's three-point, lap-and-shoulder safety belt system. It is not known if the safety belt was properly routed along the booster seat's belt guides located below the booster seat arm rests. In addition, it is not known how tight the safety belt was secured, or if the shoulder belt was positioned across the child's chest. There was no evidence of loading to the booster seat and crash damage consisted of only a few scratches.

Immediately prior to the crash the case vehicle's back right passenger [4-year-old, White (non-Hispanic) male; 84 centimeters and 16 kilograms (33 inches and 35 pounds)] was restrained in his no-back, belt positioning booster seat in an unknown position. His feet were most likely dangling over the front edge of the seat cushion, and his hands were in an unknown position. There was no seat track, and the case vehicle's seat back was not adjustable. It is not known if the child was wearing heavy clothing at the time of the crash.

Just prior to the crash, the case vehicle's driver had crossed into the southwestbound lane and steered right to avoid going off the roadway. As a result of this maneuver, the back right passenger most likely moved left within his booster seat just prior to the impact. The case vehicle's impact with the Chevrolet caused the back right passenger to move forward and left opposite to the case vehicle's 330 degree direction of principal force as the case vehicle decelerated longitudinally and accelerated laterally to the right. He then moved back to his right as the case vehicle rotated counterclockwise. As the left rear door and quarter panel were torn off the vehicle, the seat cushion was displaced from under the booster seat and the seat backs were displaced out of the vehicle during the rollover leaving no support structure to secure the booster seat. Near the end of the rollover, the booster seat and child came out from under the lap belt. The child and booster seat were ejected out of the open left side of the case vehicle and deposited near the left rear of the vehicle during the last quarter roll as the case vehicle came to rest on its top. The back right passenger sustained a closed head injury from an unknown contact source as well as a few abrasions, lacerations and a contusion. He was transported from the scene to a hospital and treated and released.

Immediately prior to the crash, the case vehicle's driver [25-year-old, White (non-Hispanic) male; unknown height and weight] was seated in an unknown position. It is likely that he had both hands on the steering wheel and was likely bracing for the impact. The position of his feet is unknown. The position of the seat track could not be determined due to the extent of damage to the case vehicle. The steering column was not adjustable. The driver was restrained by the

motorized, two-point shoulder belt. There was no evidence that the manual lap belt was used in this crash.

As a result of the driver's steer to the right just prior to the impact, he most likely leaned to the left within his seat at the moment of the impact. The impact with the Chevrolet caused the driver to move forward and left opposite the case vehicle's 330 degree direction of principal force as the case vehicle decelerated longitudinally and accelerated laterally to the right. He loaded his motorized shoulder belt and his face and chest most likely impacted his deployed air bag. In addition, the left side of his body probably impacted the intruding driver's door, and his head most likely impacted the hood of the Chevrolet as the case vehicle's left front door was crushed inward. This contact caused a traumatic brain injury. As the driver's door intruded and was being torn off the case vehicle, the driver's seat back was engaged by the door and the B-pillar and displaced rearward. In addition, the driver's motorized shoulder belt assembly was displaced inward as the left roof side rail was crushed and intruded into the vehicle. As the case vehicle rotated counterclockwise and rolled over passenger side leading, the driver moved toward the roof. His head contacted the roof in several locations. Near the end of the rollover, the driver came out from under his motorized shoulder belt, most likely due to his non-use of the lap belt and the inward displacement of the motorized shoulder belt assembly. As a result, he was ejected out the open left side of the case vehicle during the last quarter roll as the case vehicle came to rest on its roof. He was deposited on the ground near the case vehicle approximately adjacent to the driver's seat.

### **CRASH CIRCUMSTANCES**

***Crash Environment:*** The trafficway on which both vehicles were traveling was a curved, two-lane, undivided, U.S. highway, traversing in a northeasterly and southwesterly direction. Both travel lanes were bituminous. The northeastbound travel lane was 3.4 meters (11.2 feet) in width and was bordered by a bituminous shoulder 2.6 meters (8.5 feet) in width. The southwestbound travel lane was 3.3 meters (10.8 feet) in width and was bordered by a bituminous shoulder 2.7 meters (8.9 feet) in width. The roadway curved toward the northeast and southwest. The site of the crash was uncontrolled and roadway pavement markings consisted of solid white edge lines and a broken yellow center line. The northeastbound travel lane had a positive 2.3% grade on the approach to the impact area. The southwestbound travel lane had a negative 1.3% grade on the approach to the impact area. The curve had a 6% superelevation. The speed limit was 89 km.p.h. (55 m.p.h.). There was no regulatory speed limit sign posted near the crash site. At the time of the crash the light condition was daylight and it was raining. The estimated roadway coefficient of friction at the time of the crash was 0.60. 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 northeast in the northeastbound lane in a right curve (**Figure 1**). The Chevrolet was traveling southwest in the southwestbound lane (**Figure 2**). The case vehicle's driver was intending to continue northeastbound. The Chevrolet's driver was intending to continue southwestbound. According to a southwestbound witness, the case vehicle entered the southwestbound lane and traveled almost off the north side of the roadway before the driver steered back to the right. The witness vehicle nearly collided with the case vehicle. The Chevrolet was directly behind the witness vehicle, and the Chevrolet's driver steered left and braked in an attempt to avoid the crash. It is not known what, if any, avoidance actions were taken by the case vehicle's driver. The crash occurred in the southwestbound lane near the center line (**Figure 3**).



**Figure 1:** Overview of case vehicle's northeastbound approach



**Figure 2:** Overview of Chevrolet's southwestbound approach



**Figure 3:** Approach of case vehicle to area of impact (arrow), view northeast



**Figure 4:** Front damage to Chevrolet, case vehicle's driver door sheet metal is jammed on bumper, arrow shows rest position of case vehicle, view northeast

**Crash:** The front of the Chevrolet (**Figure 4**) impacted the left side of the case vehicle (**Figures 5 and 6** below). The initial contact with the case vehicle began just behind the left front wheel. The impact tore the left front door, left rear door, left quarter panel and left rear wheel off the case vehicle. The impact caused the case vehicle's driver air bag to deploy. The Chevrolet's driver air bag also deployed. As a result of the impact, the case vehicle rotated counterclockwise across



the northeastbound lane and rolled over, passenger side leading. The rollover distance and distribution of debris at the scene indicates the case vehicle rolled over six quarter rolls.



**Figure 5:** Damage to left side of case vehicle due to impact with the Chevrolet



**Figure 6:** Damage to left side of case vehicle due to impact with the Chevrolet

**Post-Crash:** The case vehicle came to rest on its roof facing northwest on the south side of the roadway (**Figure 7** below). The front portion of the case vehicle was on the bituminous shoulder and the rear half was on the snow covered roadside. The Chevrolet continued southwest bound and came to rest in the northeastbound lane facing slightly southwest (**Figure 4** above and **Figure 7**).



**Figure 7:** Case vehicle's final rest position, arrow shows rest position of Chevrolet, view southwest

#### CASE VEHICLE

The 1994 Ford Escort LX was a front wheel drive, four-door station wagon (VIN: 1FARP15J4RW-----) equipped with a 1.9L, I4 engine and five-speed automatic transmission. The front seating row was equipped with a driver air bag, bucket seats with adjustable head restraints, and driver and front right passenger motorized, two-point shoulder belts with two point, manual lap belt. The back seating row was equipped with a bench seat with two folding seat backs, no head restraints; and manual, three-point, lap-and-shoulder safety belts in the outboard seat positions and a lap belt in the center position. Anti-lock brakes were listed as an option, but it is unknown if the case vehicle was so equipped. The case vehicle's wheelbase was 250 centimeters (98.4 inches). The case vehicle's odometer reading at the time of the inspection was 127,867 kilometers (79,455 miles).

#### CASE VEHICLE DAMAGE

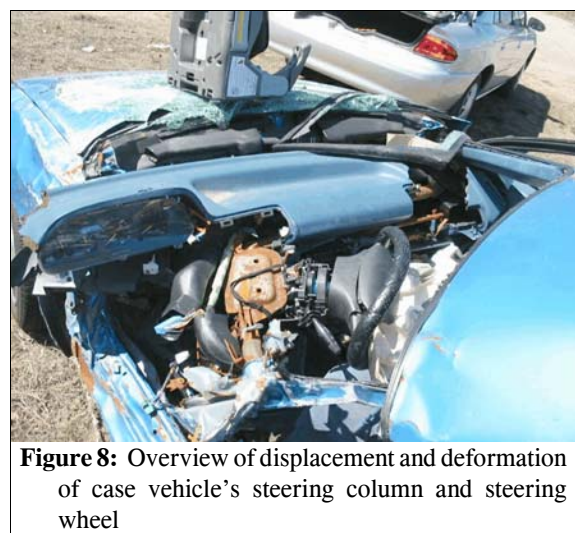
**Exterior Damage:** The case vehicle's impact with the Chevrolet involved most of the left side. The direct damage began 8 centimeters (3.1 inches) rear of the left front axle and extended 432 centimeters (170 inches) rearward along the left side. The left front door, left rear door, left side

pillars, quarter panel and left rear wheel were torn off the vehicle by the impact. In addition, the direct damage involved the left side of the roof. No crush measurements could be taken due to the missing left side structural components. The wheelbase on the case vehicle’s left side was extended 10 centimeters (3.9 inches) while the right side wheelbase was shortened 1 centimeter (0.4 inches). There was direct damage to the hood, roof, right quarter panel and roof side rail from the rollover. The induced damage involved the hood, both fenders, roof, tailgate, and right quarter panel. The windshield’s glazing was also separated from the vehicle.

The recommended tire size was: P175/65R14, and the vehicle was equipped with tires of this size. The left rear tire was not present at the inspection facility. The police crash report indicated this tire was flat. 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	32 <sup>nd</sup> of an inch			
LF	393	57	221	32	6	8	None	No	No
RF	365	53	221	32	5	6	None	No	No
LR	0	0	221	32	?	?	Unknown	No	Yes
RR	283	41	221	32	3	4	None	No	No

**Vehicle Interior:** Inspection of the case vehicle’s interior revealed blood deposit and a possible scuff on the ceiling to the right of the dome light. No other evidence of occupant contact was observed. There was likely driver contact to the left front door. However, the left front had been torn off in the crash and was not present at the case vehicle inspection. There was significant deformation of the steering wheel and lateral displacement of the steering column (**Figure 8**). The deformation to the steering wheel was due to crash damage and not occupant contact. There were numerous intrusions to the case vehicle’s passenger compartment. The majority of the intrusions were due to the damage to the roof (**Figure 9** below).



**Figure 8:** Overview of displacement and deformation of case vehicle’s steering column and steering wheel

The most severe intrusions were 55 centimeters (21.6) of vertical roof intrusion into the driver’s seat position, 53 centimeters (20.1 inches) of vertical and 35 centimeters (13.8 inches) of lateral left roof side rail intrusion into the driver’s seat position, 52 centimeters (20.5 inches) of vertical roof intrusion and 51 centimeters of vertical left roof side rail intrusion into the back left and back center seat positions.



**Damage Classification:** Based on the vehicle inspection and police on-scene photographs, the CDCs for the case vehicle were determined to be: **11-LDAW-4** (330 degrees) for the impact with the Chevrolet and **00-TDDO-9** (i.e., column 7, extent zone, unknown) for the rollover. The extent zone could not be determined because of severe damage to the left side, which produced overlapping damage to the roof and pulled the left side of the roof downward. The WinSMASH reconstruction program, CDC only algorithm, was used to reconstruct the Delta V for the case vehicle's left side impact with the Chevrolet. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 61km.p.h. (37.9 m.p.h.), -52.8 km.p.h. (-32.8 m.p.h.), and 30.5 km.p.h. (19 m.p.h.). This is a borderline reconstruction due to the lack of crush data and the results appeared high. The case vehicle was towed due to damage.

#### AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a driver air bag which deployed as a result of the left side impact with the front of the Chevrolet.

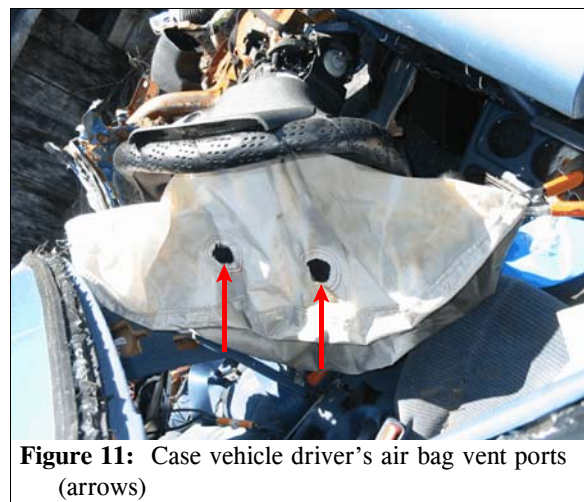
The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points and sustained no damage. The driver's air bag was designed with four tethers, each approximately 6 centimeters (2.4 inches) in width. The deployed driver's air bag (**Figure 10**) was round with a diameter of approximately 62 centimeters (24.4 inches) and had two vent ports (**Figure 11**), each approximately 5 centimeters (2 inches) in diameter, located at the 11 and 1 o'clock positions. . An inspection of the driver's air bag fabric revealed no evidence of occupant contact; however, there was a 5 centimeter (2 inches) cut in the lower center portion of the back of the air bag. This was most likely due to interaction with damaged components during the crash.



**Figure 9:** Overview of case vehicle's roof intrusion, back right safety belt found buckled (arrow) and was observed to be buckled in police on-scene photos



**Figure 10:** Case vehicle's driver air bag, each increment on rods in 5 cm (2 in)



**Figure 11:** Case vehicle driver's air bag vent ports (arrows)

An Evenflo “Big Kid LX” no-back, belt positioning booster seat (**Figures 12 and 13**) was used to restrain the case vehicle’s back right passenger. The booster seat was manufactured February 17, 2004. The model number was 3341476. It is unknown when the booster seat was purchased or how often it was used. It is also unknown if the driver had read the booster seat instructions or the case vehicle’s owner manual regarding installation of child seats. The evidence indicates the booster seat and child were secured with the case vehicle’s lap and shoulder safety belt system. It is not known if the safety belt was properly routed along the booster seat’s belt guides located below the arm rests. In addition, it is not known how tight the safety belt was secured, or if the shoulder belt was positioned across the child’s chest.

The belt positioning booster seat consisted of a plastic shell with pivoting arm rests and two retractable plastic cup holders with storage space located on each side of the seat. The lap belt guides were molded into the sides of the seat below each arm rest. The seat cushion was covered with a thin, removable foam pad.

Inspection of the booster seat revealed a few scratches on the left plastic cup holder, on the left arm rest and on the front corners of the seat. No evidence of loading of the seat by the occupant or the safety belt were observed.

There were manufacturer’s information and warning labels affixed to both sides of the booster seat that specified the seat’s weight, height, and age limitations and the proper safety belt routing (**Figures 14 and 15**). The booster seat was specified for ages four through 10 years, the weight range was 18 to 45.3 kilograms (40 to 100 pounds) and the child’s height range was 101 to 145 centimeters (40 to 57 inches).



**Figure 12:** Case vehicle back right passenger’s booster seat, yellow tape shows location of scratches on the seat



**Figure 13:** Left side view of booster seat, yellow tape shows location of scratches on retractable cup holders



**Figure 14:** Warning label on left side of booster seat

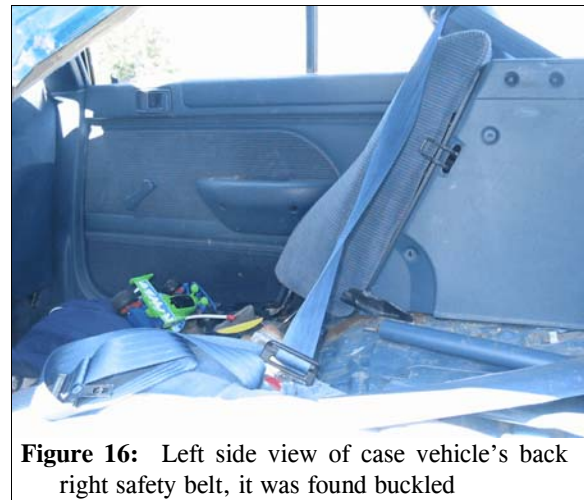


Immediately prior to the crash the case vehicle's back right passenger [4-year-old, White (non-Hispanic) male; 84 centimeters and 16 kilograms (33 inches and 35 pounds)] was seated in his no-back, belt positioning booster seat in an unknown position. His feet were most likely dangling over the front edge of the seat cushion, and his hands were in an unknown position. There was no seat track, and the seat back was not adjustable. It is not known if the child was wearing heavy clothing at the time of the crash.

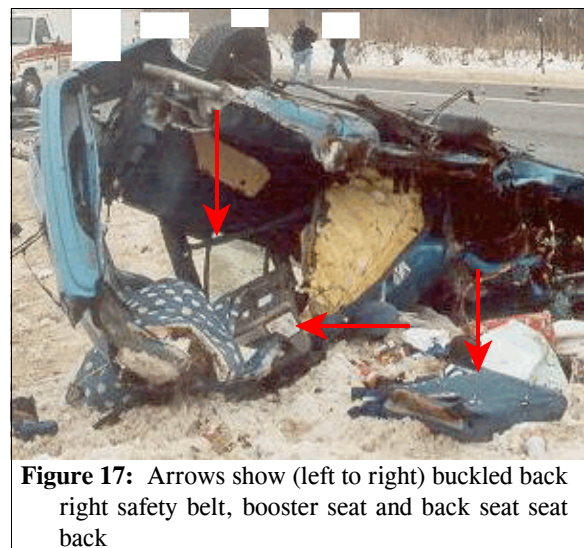
The police crash report indicated that this passenger was seated in the back left seat position. However, the evidence indicates that this passenger was seated in the back right seat position. He was seated in his booster seat restrained by the manual, three-point, lap-and-shoulder safety belt system. The basis for this determination is the evidence found in the case vehicle and evidence observed in the on-scene police photographs. The back right safety belt was found buckled during the vehicle inspection (**Figure 9** above and **Figure 16**), and an on-scene photograph (**Figure 17**) shows that it was buckled at the crash scene as well. The police crash report indicated that this passenger and his booster seat were ejected from the case vehicle and were found just a few feet from the left rear of the case vehicle. An on-scene photograph (**Figure 17**) does show the booster seat at the left rear of the vehicle. The evidence indicates that the impact damage displaced the back seat cushion and the seat backs allowing the booster seat to come out from under the safety belt during the rollover. One seat back can be seen near the left rear of the case vehicle (**Figure 17**), and the other (probably the left seat back) is on the shoulder (**Figure 18** below) approximately 14 meters (46 feet) prior to the case vehicle's rest position. In addition, the crash broke the back left safety belt (**Figure 19** below) as the left rear door and quarter panel were torn off the vehicle. Had the child been seated in the back left seat position, he would have most



**Figure 15:** Information label showing proper belt routing and booster seat age, height and weight limits



**Figure 16:** Left side view of case vehicle's back right safety belt, it was found buckled



**Figure 17:** Arrows show (left to right) buckled back right safety belt, booster seat and back seat seat back

likely been ejected and deposited in the same area as the damaged left quarter panel and left rear door (**Figure 18**), which were located approximately 17 meters (56 feet) prior to the case vehicle's rest position. Lastly, it is likely the child would have sustained fatal injuries had he been seated in the back left seat position.

Just prior to the crash, the case vehicle's driver had crossed into the southwestbound lane and steered right to avoid going off the roadway. As a result of this maneuver, the back right passenger most likely moved left within his booster seat just prior to the impact. The case vehicle's impact with Chevrolet caused the back right passenger to move forward and left opposite to the case vehicle's 330 degree direction of principal force as the case vehicle decelerated longitudinally and accelerated laterally to the right. He then moved back to his right as the case vehicle rotated counterclockwise. As the left rear door and quarter panel were torn off the vehicle, the seat cushion was displaced out from under the booster seat and the seat backs were displaced out of the vehicle during the rollover leaving no support structure to secure the booster seat. Near the end of the rollover, the booster seat and child came out from under the lap belt. The child and booster seat were ejected out of the open left side of the case vehicle and deposited near the left rear of the vehicle during the last quarter roll as the case vehicle came to rest on its top.



**Figure 18:** Arrows show (left to right) back seat seat back and case vehicle's left front door, left rear door/quarter panel and left rear wheel assembly



**Figure 19:** Top view of case vehicle's broken back left safety belt

**CASE VEHICLE BACK RIGHT PASSENGER INJURIES**

The police crash report indicated that the back right passenger sustained an "A" (incapacitating) injury and was transported by ambulance to the hospital. The passenger's medical records indicated that he was treated and released. The table below shows the back right passenger's injuries.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion left lung, lateral apex	serious 441406.3,2	Unknown contact mechanism	Unknown	Emergency room records
2	Abrasions forehead, not further specified	minor 290202.1,7	Unknown contact mechanism	Unknown	Emergency room records
3	Lacerations forehead, not further specified with glass foreign bodies in left frontoparietal scalp	minor 290600.1,7	Unknown contact mechanism	Unknown	Emergency room records
4	Closed head injury with intermittent levels of consciousness at scene but awake and alert on arrival; GCS = 15	unknown 115099.7,0	Unknown contact mechanism	Unknown	Emergency room records

#### CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash, the case vehicle's driver [25-year-old, White (non-Hispanic) male; unknown height and weight] was seated in an unknown position. It is likely that he had both hands on the steering wheel and was likely bracing for the impact. The position of his feet is unknown. The position of his seat track could not be determined due to the extent of damage to the case vehicle. The steering column was not adjustable.

The case vehicle's driver was restrained by his motorized, two-point, shoulder belt. This belt had a slight stretched appearance to it and there were blood stains on it in an area that would have been inside the retractor had it not been in use. There was no evidence that the manual lap belt was used in this crash.

As a result of the driver's steer to the right just prior to the impact, he most likely leaned to the left within his seat at the moment of the impact. The impact with the Chevrolet caused the driver to move forward and left opposite the case vehicle's 330 degree direction of principal force as the case vehicle decelerated. He loaded his motorized shoulder belt, his face and chest most likely impacted his deployed air bag and his knees impacted the knee bolster. In addition, the left side of his body impacted the intruding driver's door, and his head most likely impacted the hood of the Chevrolet as the case vehicle's left front door was crushed inward. This contact caused a traumatic brain injury. As the driver's door intruded and was being torn off the case vehicle, the driver's seat back was engaged by the door and the B-pillar and displaced rearward. In addition, the driver's motorized shoulder belt assembly was displaced inward as the left roof side rail was crushed and intruded into the vehicle. As the case vehicle rotated counterclockwise and rolled over passenger side leading, the driver moved toward the roof. His head contacted the roof in several locations. Near the end of the rollover, the driver came out from under his motorized shoulder belt, most likely due to his non-use of the lap belt and the inward displacement of the motorized shoulder belt assembly due to the left roof side rail crush. As a result, he was ejected

out the open left side of the case vehicle during the last quarter roll as the case vehicle came to rest on its roof. He was deposited on the ground near the case vehicle approximately adjacent to the driver's seat.

#### CASE VEHICLE DRIVER INJURIES

The police crash report indicated that the driver was transported by ambulance to a hospital. He sustained fatal injuries as a result of the crash. The following table shows the 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	Traumatic brain injury, massive, not further specified with blood in ears, nose, and mouth	unknown 115999.7,0	Exterior of other motor vehicle: hood	Probable	Post-mortem examination
2	Abrasions right chest, not further specified	minor 490202.1,1	Air bag, driver's	Possible	Post-mortem examination
3	Abrasions left side of chest wall, not further specified	minor 490202.1,2	Left side interior surface, excluding hardware and/or armrest	Probable	EMS treatment record
4	Laceration, 3-4 cm (1.2-1.6 in) across lateral side of left chest	minor 490600.1,2	Left side interior surface, excluding hardware and/or armrest	Probable	EMS treatment record
5	Laceration {wound}, 3.0 x 3.0 cm (1.2 x 1.2 in), left shoulder, not further specified	minor 790602.1,2	Noncontact injury: flying glass, left front glazing	Possible	Post-mortem examination
6	Abrasions, large, left upper arm, not further specified	minor 790202.1,2	Left side interior surface, excluding hardware and/or armrest	Probable	EMS treatment record
7	Laceration, 3-4 cm (1.2-1.6 in) over mid-shaft of left humerus	minor 790600.1,2	Left side interior surface, excluding hardware and/or armrest	Probable	EMS treatment record
8	Abrasion on back left hand, not further specified	minor 790202.1,2	Noncontact injury: flying glass, left front glazing	Possible	Post-mortem examination
9	Abrasions, small, on knees {bilaterally}, not further specified	minor 890202.1,3	Knee bolster, driver's	Probable	Post-mortem examination



Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
10	Laceration {wound}, 4.5 x 2.0 cm (1.8 x 0.8 in), gaping, on knee, aspect not specified	minor 890602.1,9	Unknown contact mechanism	Unknown	Post-mortem examination

## OTHER VEHICLE

The 2000 Chevrolet K1500 Silverado was a four wheel drive, two-door pickup truck (VIN: 1GCEK14W3YZ-----) equipped with a 4.3L, V6 engine. The Chevrolet was equipped with redesigned driver and front right passenger air bags and an Event Data Recorder (EDR). The driver's air bag deployed in this crash, but the front right passenger's air bad did not deploy. The EDR data (a hard copy was included in the police crash report) indicated the front right air bag suppression switch was set to suppress deployment of the air bag.

**Exterior Damage:** Based on the police on-scene photographs, the Chevrolet's impact with the case vehicle directly damaged the front bumper, left headlamp/turn lamp assembly, grille and the hood (**Figures 19 and 20**). The Chevrolet's crush profile could not be determined because the Chevrolet was not inspected. It had been sold at auction. The Chevrolet's wheelbase was 302 centimeters (118.9 inches).



**Figure 20:** Front damage to Chevrolet from impact with left side of case vehicle, case vehicle's left front door sheet metal stuck to front bumper



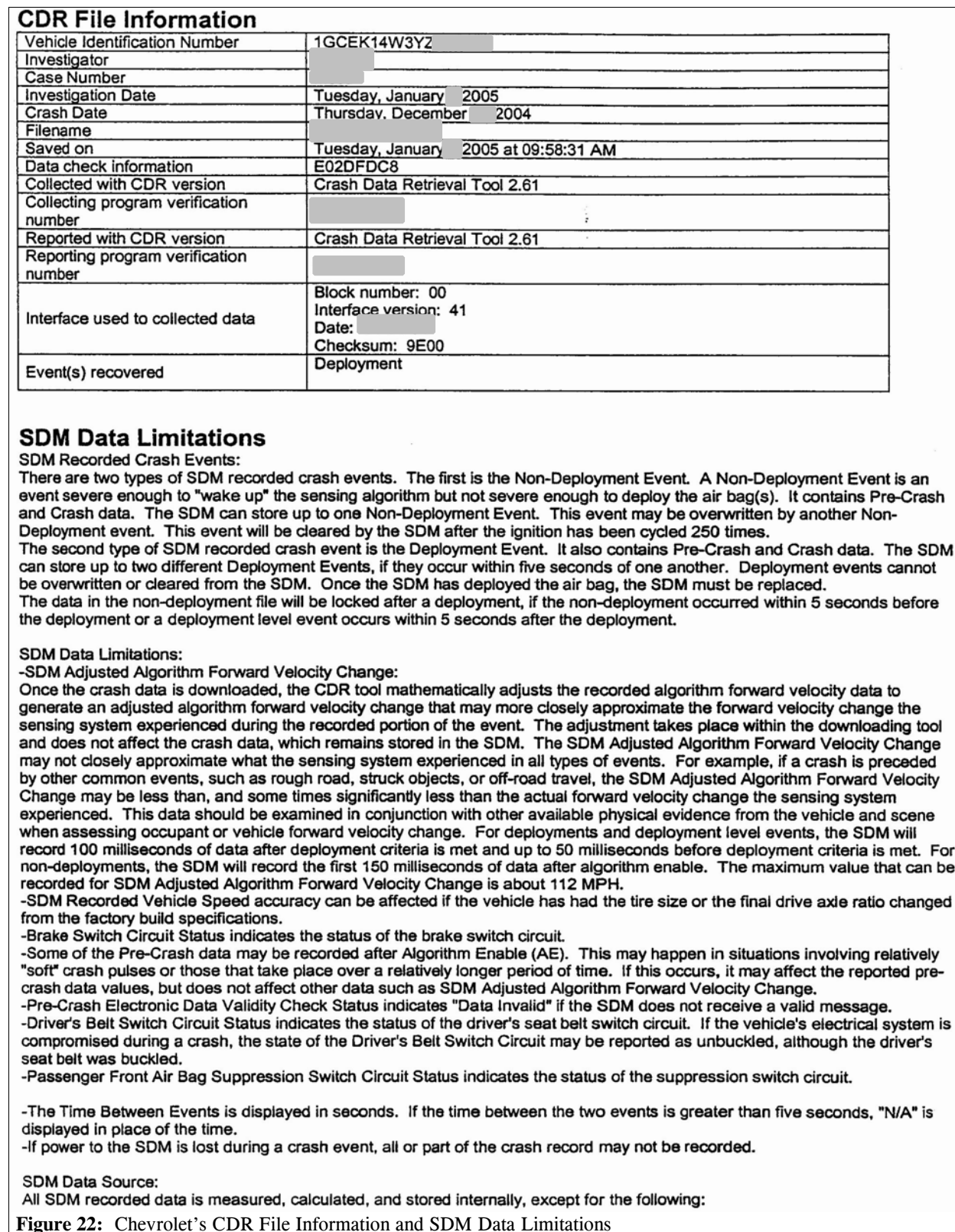
**Figure 21:** Police on-scene photo of front damage to Chevrolet

**Damage Classification:** Based on the available photographs, the CDC for the Chevrolet was estimated to be: **12-FYEW-3 (0 degrees)**. The WinSMASH reconstruction program, CDC only algorithm, was used to reconstruct the Delta Vs for the Chevrolet's front impact with the case vehicle. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 35.0 km.p.h. (21.7 m.p.h.), -35.0 km.p.h. (-21.7 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). This is a borderline reconstruction and the results appear to be high. The Chevrolet's EDR recorded a maximum longitudinal Delta V of -25.57 km.p.h. (-15.89 m.p.h.). The Chevrolet was towed due to damage.

**Chevrolet's EDR Data:** The police crash report contained a hard copy of the Chevrolet's EDR reports. The EDR reports are presented at the end of this report in **Figures 22-25**. The EDR data

indicated that the SIR warning lamp was recorded off, the driver's safety belt circuit switch was recorded buckled and the front right passenger air bag suppression switch circuit was recorded as suppressed. The adjusted algorithm velocity change data indicated that the deployment criteria was met at approximately 20 milliseconds following algorithm enable (AE) and the maximum recorded longitudinal Delta V was: -25.57 km.p.h. (-15.89 m.p.h.) occurring at 90 milliseconds following AE. In addition, the pre-crash data indicated that the Chevrolet was traveling 83 km.p.h. (52 m.p.h.) five seconds prior to AE at 11% throttle. The Chevrolet's brake switch was recorded on at 2 seconds prior to AE and remained on at one second prior to AE with the Chevrolet's speed recorded as 69 km.p.h. (43 m.p.h.).

***Chevrolet's Occupants:*** According to the police crash report, the Chevrolet's driver [54-year-old, (unknown race and ethnic origin) male] and front right passenger [45-year-old, (unknown race and ethnic origin) female] were restrained by their manual, three-point, lap-and-shoulder safety belt systems. Both occupants were transported by ambulance to the hospital with police reported "A" (incapacitating) injuries. Their treatment status is not known.

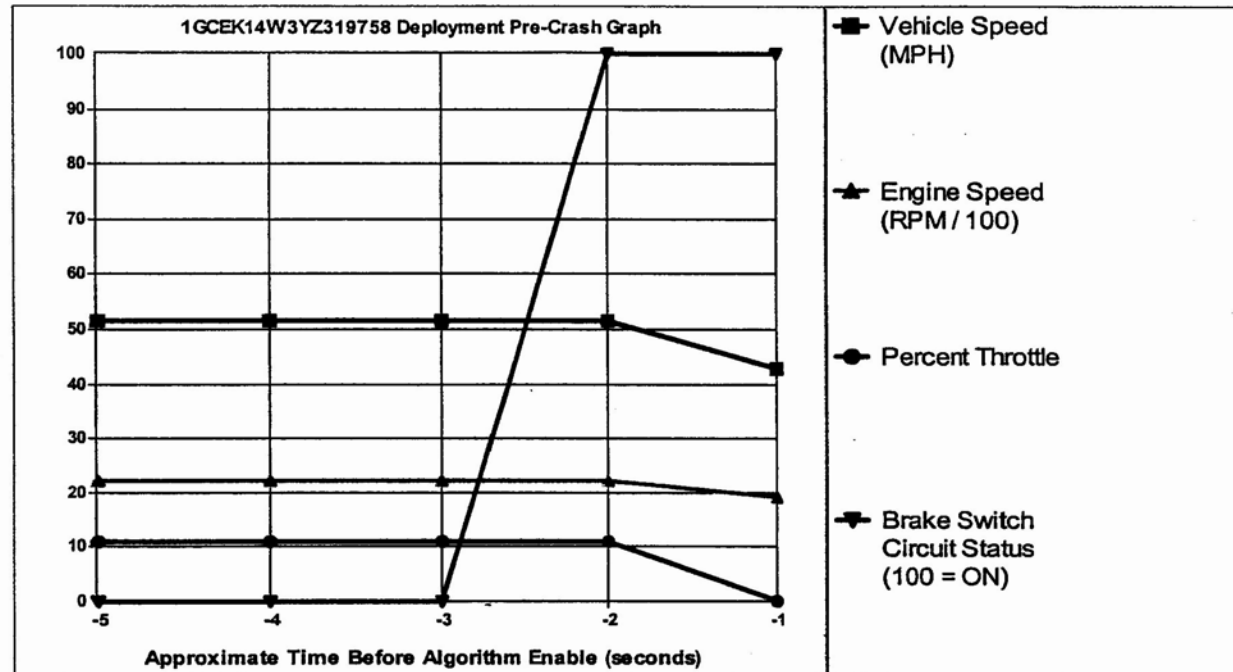


- Vehicle Speed, Engine Speed, and Percent Throttle data are transmitted once a second by the Powertrain Control Module (PCM), via the Class 2 data link, to the SDM.
- Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the Class 2 data link, to the 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 23: Chevrolet's SDM Data Limitations continued

**System Status At Deployment**

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Suppressed
Ignition Cycles At Deployment	8662
Time Between Non-Deployment And Deployment Events (sec)	N/A



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	52	2240	11	OFF
-4	52	2176	11	OFF
-3	52	2176	11	OFF
-2	52	2176	11	ON
-1	43	1856	0	ON

Figure 24: Chevrolet's System Status at Deployment and Pre-Crash Data

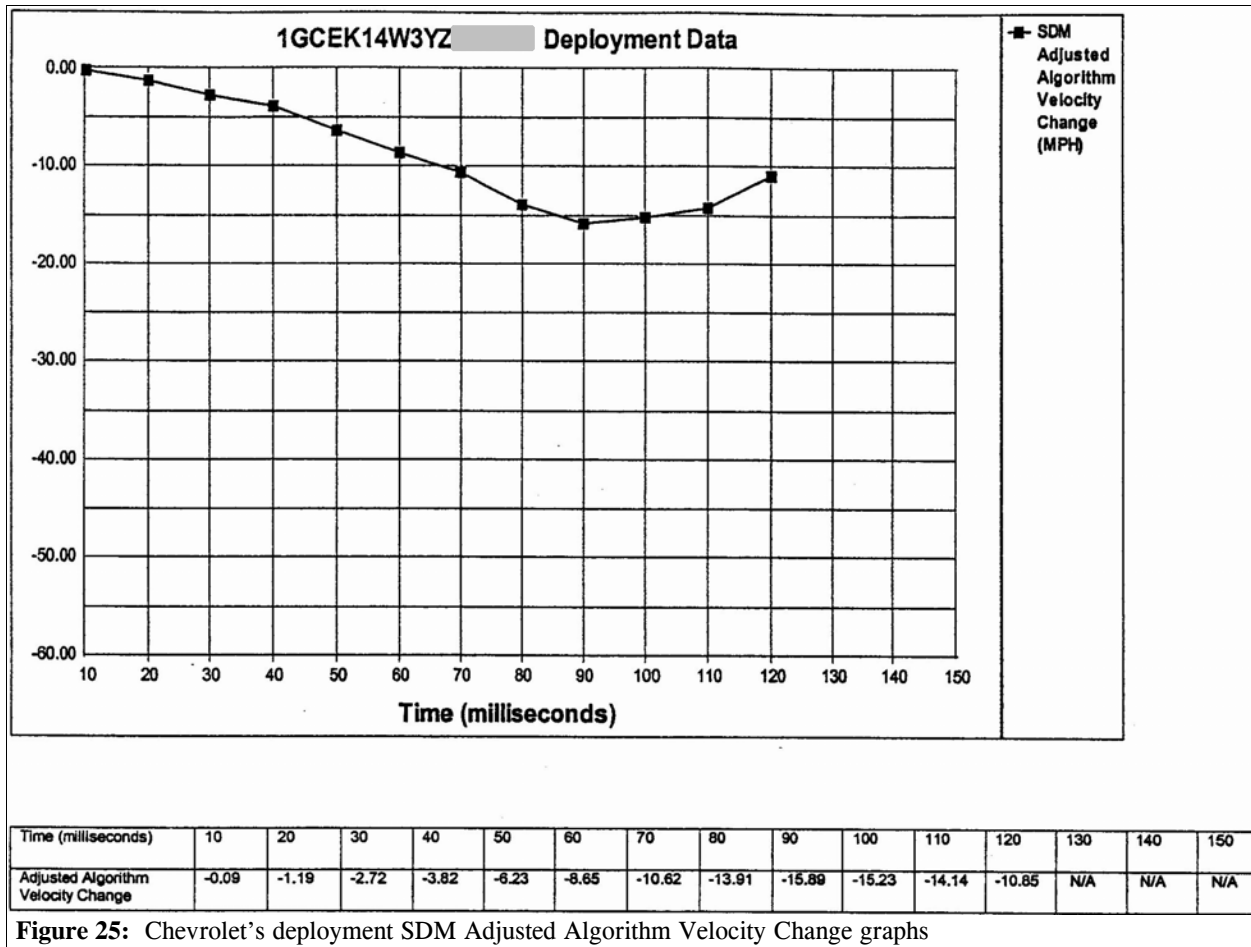


Figure 25: Chevrolet's deployment SDM Adjusted Algorithm Velocity Change graphs

