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REMOTE REDESIGNED AIR BAG REPORT

CASE NUMBER - IN01-005
LOCATION - ARIZONA
VEHICLE - 1999 CHEVROLET BLAZER
CRASH DATE - September, 2000

Submitted:

February 8, 2002

Revised Submission:

April 23, 2002

Contract Number: DTNH22-94-D-17058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
National Center for Statistics and Analysis
Washington, D.C. 20590-0003

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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

1. *Report No.* IN01-005	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* Remote Redesigned Air Bag Fatality Investigation Vehicle - 1999 Chevrolet Blazer Location - Arizona		5. *Report Date:* February 8, 2002; April 23, 2002 6. *Performing Organization Code*	
7. *Author(s)* Special Crash Investigations Team #2		8. *Performing Organization Report No.* Task # 0250	
9. *Performing Organization Name and Address* Transportation Research Center Indiana University 222 West Second Street Bloomington, Indiana 47403-1501		10. *Work Unit No. (TRAIS)* 11. *Contract or Grant No.* DTNH22-94-D-17058	
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation (NRD-32) National Highway Traffic Safety Administration National Center for Statistics and Analysis Washington, D.C. 20590-0003		13. *Type of Report and Period Covered* Technical Report Crash Date: September, 2000 14. *Sponsoring Agency Code*	

15. *Supplementary Notes*
Remote air bag deployment investigation involving a 1999 Chevrolet Blazer, four-door compact utility vehicle, with manual safety belts, dual front air bags, and an EDR, and a metal traffic signal/light pole

16. *Abstract*

This report covers a remote investigation of an air bag deployment crash that involved a 1999 Chevrolet Blazer (case vehicle) and a metal traffic signal/light pole. This crash is of special interest because the case vehicle was equipped with redesigned air bags and an Event Data Recorder (EDR), which was downloaded by the police department. The case vehicle was occupied by three, young, unrestrained males. The driver and front right passenger sustained serious or less injuries and were hospitalized. The back right passenger sustained critical injuries, resulting in his death. The case vehicle was traveling east, approaching a controlled intersection, in the inside eastbound lane of a five-lane, undivided, city street (i.e., there were two through lanes in both the east and westbound directions and an opposing left-hand turn lane on both the east and west legs of the four-leg intersection). A noncontact vehicle traveling westbound in the left-hand turn lane of the same roadway, began to turn left at the intersection in front of the case vehicle. But, the noncontact vehicle's driver saw the on-coming case vehicle and stopped. The case vehicle's driver steered to the right and successfully evaded the noncontact vehicle but was now headed toward the southeast corner of the intersection. The driver braked and most likely attempted to steer to the left to avoid traveling off the southeast corner of the intersection. The crash occurred on the southeast roadside. The front right of the case vehicle impacted a metal pole, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The back seat passenger (29-year-old male) was presumably seated and his seat track was not adjustable. He was not using his available, active, three-point, lap-and-shoulder, safety belt system and sustained (i.e., based on a single page of this occupant's medical records that was obtained by the police and the first hand observations of two police officers) critical injuries which included: a critical nonanatomic brain injury; a large subdural hematoma; an open left humerus fracture; a dislocated left elbow joint; a fractured ankle; and multiple abrasions, contusions, and lacerations. The driver (27-year-old male) was presumably seated with his seat track located near its middle position, but the location of the tilt steering wheel is unknown. He was not using his available, active, three-point, lap-and-shoulder, safety belt system and, according to the police, sustained possible ("C") injuries. His injuries are unknown, but bleeding was reported to his right knee. The front right passenger (27-year-old male) was presumably seated but the location of his seat track is unknown. He was not using his available, active, three-point, lap-and-shoulder, safety belt system, and he sustained a fractured right femur and, most likely, other unknown injuries.

17. *Key Words* Redesigned Air Bag Deployment Motor Vehicle Traffic Crash Injury Severity		18. *Distribution Statement* General Public	
19 *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 10	22. *Price* $4,200

Form DOT 1700.7 (8-72) Reproduction of completed page authorized

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This remote report was brought to NHTSA's attention on March 1, 2001 by a detective with the applicable police department. This crash involved a 1999 Chevrolet Blazer (case vehicle) and a metal traffic signal/light pole. The crash occurred in September, 2000, at 10:57 p.m., in Arizona and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with redesigned air bags and an Event Data Recorder (EDR), which was essentially downloaded successfully by the police department. The case vehicle was occupied by three, young (i.e., 27-29-year olds), unrestrained males. The driver and front right passenger sustained serious or less injuries and were hospitalized. The back right passenger sustained critical injuries, resulting in his death. This contractor was unable to interview the case vehicle's driver or front right passenger. This report is based on the Police Crash Report, interviews with the investigating police officer, on-scene police photographs, occupant kinematic principles, a partial medical record for the back left passenger, and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The case vehicle was traveling east, approaching a controlled intersection, in the inside eastbound lane of a five-lane, undivided, city street (**Figure 1**) and intended to continue traveling eastward (i.e., there were two through lanes in both the east and westbound directions and an opposing left-hand turn lane on both the east and west legs of the four-leg intersection). A noncontact vehicle (i.e., a Geo Metro, according to eyewitnesses), traveling westbound in the left-hand turn lane of the same five-lane, undivided, city street, began to turn left at the intersection, in front of the case vehicle. But, the noncontact saw the on-coming case vehicle and braked, coming to a stop "midway" through the intersection. The case vehicle's driver steered to the right, depositing a critical curve scuff, while attempting to avoid the noncontact vehicle (**Figure 2** and **Figure 3** below) The driver's avoidance maneuver enabled case vehicle to successfully evade the noncontact vehicle, but the case vehicle was now headed toward the southeast corner of the intersection. Based on the available evidence, the case vehicle's driver braked, depositing skid marks (**Figure 4** below), and most likely attempted to steer to the left to avoid traveling off the southeast corner of the intersection. The crash occurred within the intersection of the two

Figure 1: On-scene view looking east at case vehicle's travel path prior to entering intersection and taking evasive action; Note: case vehicle at final rest (case photo #03)

Figure 2: On-scene view looking east-southeastward at case vehicle's final rest position; Note: scuff mark (highlighted) from left front tire (case photo #04)

trafficways but on their south and east roadsides, respectively (**Figure 2** above and **Figure 4**).

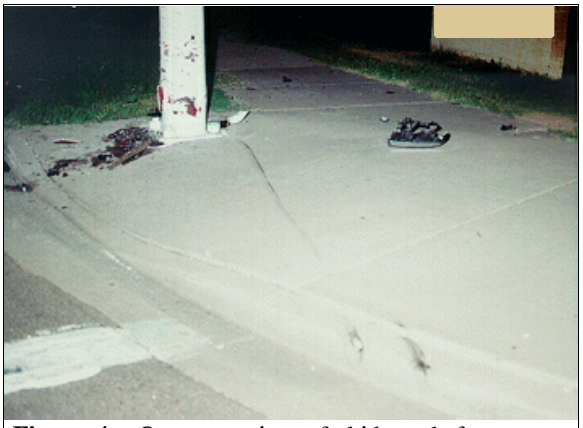

Figure 4: On-scene view of skid mark from case vehicle's right front tire leading into struck pole (case photo #09)

Figure 3: Police photo, taken next day, looking east-southeastward, clearly showing scuff mark from case vehicle's left front tire (case photo #06)

The city roadway was straight and level at the area of impact. The pavement was bituminous, but traveled, and the width of all of the travel lanes are unknown. The roadway was bordered by curbs of unknown type. Pavement markings consisted of a double solid yellow centerline for both east and westbound traffic, and the travel lanes were divided by a dashed white line. Furthermore, the eastbound left-hand turn lane was separated from the through lanes by a single solid white line. In addition, both the east and westbound lanes were bordered by a bicycle lane which was separated from the travel lanes by a solid white line. Finally, no edge lines were present. The estimated coefficient of friction was 0.65. There were four (4) on-colors, pre-timed, vertical mounted traffic control signals located controlling the eastbound traffic flow. The speed limit was 48 km.p.h. (30 m.p.h.). At the time of the crash the light condition was dark, but illuminated by overhead street lamps at the area of impact, the atmospheric condition was clear, and the road pavement was dry. Traffic density is unknown, and the site of the crash was primarily urban commercial.

The front right (**Figure 5**) of the case vehicle impacted a metal traffic signal/light pole (**Figures 6** and **7** below), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. As a result of the front right impact, the case vehicle rotated approximately 45 degrees clockwise around the pole and rebounded northward, coming to rest straddling the inside eastbound travel lane and a bicycle lane and heading, primarily, in a southern direction (**Figure 8** below). The engine compartment of the case vehicle was off the south edge of the roadway.

Figure 5: On-scene view looking north-northeast at case vehicle's final rest position; Note: pole impact (highlighted) location (case photo #14)

Figure 6: Close-up police photo, taken next day, looking east at metal pole struck by case vehicle (case photo #10)

Figure 7: Next day police photo looking south at pole struck by case vehicle (case photo #12)

Figure 8: On-scene view looking west at case vehicle's final rest position straddling inside eastbound lane and bicycle lane (case photo #15)

CASE VEHICLE

The 1999 Chevrolet Blazer was a rear wheel drive, five-passenger, four-door sport utility vehicle (1GNCS13W9X2------) equipped with a 4.3L, V-6 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The case vehicle's wheelbase was 272 centimeters (107.0 inches), and the odometer reading is unknown because the case vehicle was not inspected.

Based on the available police photographs, the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat with a split bench and unknown head restraints for the back outboard seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the front and back outboard positions; and a two-point, lap belt system at the back center position. It is unknown if the front seat belt systems were equipped with manually operated height adjusters for the "D"-rings. The vehicle was equipped with knee bolsters for both the driver and front right passenger but it is unknown if they were deformed. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. Both frontal air bags deployed as a result of the case vehicle's front right impact with the metal traffic signal/light pole.

Based on the police photographs, the case vehicle's initial contact with the metal traffic signal/light pole involved the front right portion (**Figure 5** above). Maximum crush measured by the investigating officer was 134.6 centimeters (53 inches) at the front right corner (**Figure 9** below). According to the police, the wheelbase on the case vehicle's right side was shortened 48

centimeters (19 inches) while the left side was extended 25 centimeters (10 inches). Based on the available photographs, the case vehicle's front bumper, bumper fascia, grille, hood, radiator, right and left headlight and turn signal assemblies, and right fender were directly damaged and crushed rearward (**Figure 5** above). The case vehicle's front right tire was shoved rearward into the cowl area and front right passenger toe pan. The case vehicle's right front tire was physically restricted, and both right side tires were deflated. The right "A"-pillar was bent backwards with the roof buckled upwards (**Figure 9**). The front right door glazing and back light (**Figure 10**) were disintegrated from the shear force of the frontal impact. There appears to be a significant amount of intrusion to the passenger compartment primarily to the right side (**Figure 11**).

Figure 9: On-scene view looking east-southeast at case vehicle's final rest position; Note: extent of deformation (case photo #13)

Figure 10: On-scene view looking south at case vehicle's final rest position (case photo #16)

Figure 11: On-scene view of case vehicle's driver seating area showing deployed air bags and intrusion to right instrument panel (case photo #17)

The available photographs document damage to the windshield's glazing (**Figure 11**) and blood on the back left passenger's seat (**Figure 12**).

Figure 12: On-scene view of case vehicle's back left safety belt showing no blood or loading evidence on belt; Note: copious amount of blood on back left seat's cushion (case photo #18)

Based on the available photographs, the CDC for the case vehicle is estimated as: **12-FREN-6 (0)**. The WinSMASH reconstruction program, CDC only barrier algorithm, was used on the case vehicle's highest severity impact. The preliminary Total, Longitudinal, and Lateral Delta Vs are, respectively: 45.6 km.p.h. (28.3 m.p.h.), -45.6 km.p.h. (-28.3 m.p.h.), and 0.0 km.p.h.

(0.0 m.p.h.). This contractor believes these results are low and estimates the actual Delta V to be between 55 km.p.h. (34 m.p.h.) and 61 km.p.h. (38 m.p.h.). The case vehicle was towed due to damage.

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. Both air bags deployed as a result of the front right impact with the metal traffic signal/light pole. The case vehicle's driver air bag was located in the steering wheel hub (**Figure 11** above). Police photographs did not reveal the style of the module's flaps, the dimensions of the flaps, whether the cover flaps opened at their designated tear points, or if there was damage during the deployment to the air bag or cover flaps. Because this case is a remote investigation, the existence, number, and size of tethers or vent ports could not be assessed nor could the shape or size of the driver's air bag be described. The investigating police officer made no mention of any evidence of contact or damage to the air bag's fabric.

The case vehicle's front right passenger air bag was located in the top of the instrument panel. Police photographs did not reveal the shape of the module's flap, the dimensions of the flap, whether the cover flap opened at the designated tear points, or if there was damage during the deployment to the air bag or cover flaps. Because this case is a remote investigation, the existence, number, and size of tethers or vent ports could not be assessed nor could the shape or size of the front right passenger's air bag be described. The investigating police officer made no mention of any evidence of contact or damage to the air bag's fabric.

The data downloaded from the case vehicle's **EDR** showed the vehicle's SIR warning lamp status, driver's seat belt buckle status, ignition cycles at deployment, time from algorithm enable to deployment (i.e., air bag deployments) and velocity change (i.e., Delta V). Downloaded data of interest indicated the following. The case vehicle's driver seat belt status showed it was not buckled, and the Delta V was 61.80 km.p.h. (38.40 m.p.h.); see **EVENT DATA RECORDER GRAPHS** (**Figures 13** and **14**) below. This investigator feels the recorded Delta V seems reasonable considering the amount of deformation to the case vehicle's front.

CASE VEHICLE BACK LEFT PASSENGER

The exact posture of the case vehicle's back seat passenger [29-year-old, White (unknown if Hispanic) male; 163 centimeters and 59 kilograms (64 inches, 130 pounds)], immediately prior to the crash, is unknown but, presumably, he was seated in an upright posture with his back leaning forward from the seat back, his feet on the floor, and both arms outstretched, bracing against the driver's seat back. According to the Police Crash Report, the back passenger was seated in the back left position. His seat track and seat back were not adjustable.

The case vehicle's back left passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system (**Figure 12** above). In addition, there was no mention in the obtained, one page of partial medical, of any belt pattern bruising and/or abrasions to the back left passenger's body.

The case vehicle's driver steered to the right, avoiding the noncontact vehicle. However, with the case vehicle now headed toward the southeast corner of the intersection, the driver braked and most likely attempted to steer to the left, trying to avoid the crash. As a result of these attempted avoidance maneuvers and the nonuse of his available safety belts, the back left passenger most likely moved slightly forward and slightly to his right just prior to impact. The case vehicle's impact with the metal traffic signal/light pole enabled the back left passenger to continue forward toward the **0** degree Direction of Principal Force as the case vehicle decelerated. Based on the limited available information, this contractor believes that the back left passenger's head and face struck the roof, over the driver's seating area, causing his critical brain injuries. The back left passenger most likely struck the driver's seat back support and/or left "B"-pillar with his left upper arm and torso causing the injuries to his left upper arm. At maximum engagement, the case vehicle rotated clockwise causing the back left passenger to move towards his right as the case vehicle rebounded and rotated. According to the investigating police officer, the back left passenger struck his head on the right "B"-pillar, causing his brain injuries. This contractor discounts this scenario because it is based on the assertion that the back left passenger's movement in response to the post-impact's clockwise rotation was of greater severity than the occupant's movement in response to the primary frontal impact with the pole. The back left passenger most likely contacted the front right passenger's seat back support; right "B"-pillar; and/or interior surfaces of the case vehicle's right rear door, sill, window frame, and/or glazing. Regardless of what right side surface or object the back left passenger contacted, he rebounded off the right surface and/or object onto the back seat and was found laying on the back seat with his head by the left rear door.

CASE VEHICLE BACK LEFT PASSENGER INJURIES

The back left occupant was transported by ambulance to the hospital. He sustained critical injuries and was pronounced dead 5 hours and 46 minutes post-crash. Based on a single page of this occupant's medical records that was obtained by the police and the first hand observations of two police officers who observed this patient's injuries at the hospital, the back left occupant's injuries included: a critical nonanatomic brain injury; a large subdural hematoma; an open left humerus fracture; a dislocated left elbow joint; a fractured ankle; abrasions to the top of his right head and right shoulder; contusions to his left eye, nose, right arm and right leg; and lacerations to his right arm, right leg, and left foot.

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 unconsciousness and inappropriate movements (i.e., flaccid extremities and no response to pain) and no brain reflexes; complications include neurogenic pulmonary edema and acute respiratory distress syndrome	160824.5 critical	Roof above driver's seat	Probable	Emergency room records
2	Hematoma, subdural, large, location not specified [Aspect = Unknown]	140656.5 critical	Roof above driver's seat	Probable	Emergency room records
3	Fracture, open, left proximal humerus, not further specified	752604.3 serious	Seat back, driver's	Probable	Emergency room records
4	Dislocation left elbow, not further specified	750630.1 minor	Left "B"-pillar	Possible	Emergency room records
5	Fracture ankle, not further specified [Aspect = Unknown]	852002.2 moderate	Seat back, driver's	Possible	Police
6	Abrasions {over} right top of skull	190202.1 minor	Roof above driver's seat	Probable	Police
7	Contusion {black} left eye	297402.1 minor	Right "B"-pillar	Possible	Police
8	Contusion to nose	290402.1 minor	Right "B"-pillar	Possible	Police
9	Abrasions right shoulder	790202.1 minor	Right rear door's window glazing	Possible	Police
10	Contusions {bruising} on right arm, not further specified	790402.1 minor	Right rear door's window sill	Possible	Police
11	Lacerations {cuts} on right arm, not further specified	790600.1 minor	Unknown contact mechanism	Unknown	Police
12	Contusions {badly bruised} right leg, not further specified	890402.1 minor	Unknown contact mechanism	Unknown	Police
13	Laceration {cut} right leg, not further specified	890600.1 minor	Unknown contact mechanism	Unknown	Police
14	Laceration left foot, not further specified	890600.1 minor	Seat back support	Possible	Police

The case vehicle's driver [27-year-old, White (non-Hispanic) male; 165 centimeters and 113 kilograms (65 inches, 250 pounds)] was presumably seated in an upright posture with his back against the seat back, his left foot on the floor, his right foot on the brake, and both hands pressing on the steering wheel. Based on his height, the seat track was most likely located near its middle position, and the seat back was upright. The location of the tilt steering wheel is unknown.

Based on the **EDR**, the case vehicle's driver was not using his available, active, three-point, lap-and-shoulder, safety belt system. According to the Police Crash Report, the driver indicated that he was restrained. With no known reported injuries, it is unknown if there was any lesions that could be considered restraint system related.

The case vehicle's driver steered to the right, avoiding the noncontact vehicle. However, with the case vehicle now headed toward the southeast corner of the intersection, the driver braked and most likely attempted to steer to the left, trying to avoid the crash. As a result of these attempted avoidance maneuvers and the nonuse of his available safety belts, the driver most likely moved slightly forward and slightly to his right just prior to impact. The case vehicle's impact with the metal traffic signal/light pole enabled the driver to continue forward toward the **0** degree Direction of Principal Force as the case vehicle decelerated. Based on the limited available information, this contractor believes that the driver's chest and head loaded his deploying driver air bag and his knees most likely loaded the driver's knee bolster. The presumed loading of the knee bolster resulted in the bleeding reported to the driver's right knee. As the case vehicle reached maximum engagement, the driver most likely rebounded rearward, from loading the deployed air bag and/or steering column, and to his right toward the right side of his seat back and/or center console as the case vehicle rotated underneath him during its clockwise rotation. The exact posture of the case vehicle's driver at final rest is unknown, but according to the witnesses, he was able to exit the case vehicle under his own power.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital. He sustained police reported possible ("C") injuries and was hospitalized. The injuries sustained by the case vehicle's driver are unknown; however, bleeding was reported to his right knee.

CASE VEHICLE FRONT RIGHT PASSENGER

The case vehicle's front right passenger [27-year-old, White (unknown if Hispanic) male; 170 centimeters and 104 kilograms (67 inches, 230 pounds)] was presumably seated in an upright posture with his back leaning forward away from the seat back, both feet on the floor, and both arms outstretched, bracing from the front right instrument panel. The locations of his seat track and seat back are unknown.

The case vehicle's front right passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. This was confirmed in the police investigation.

The case vehicle's driver steered to the right, avoiding the noncontact vehicle. However, with the case vehicle now headed toward the southeast corner of the intersection, the driver braked and most likely attempted to steer to the left, trying to avoid the crash. As a result of these attempted avoidance maneuvers and the nonuse of his available safety belts, the front right passenger most likely moved slightly forward and slightly to his right just prior to impact. The case vehicle's impact with the metal traffic signal/light pole enabled the front right passenger to continue forward toward the **0** degree Direction of Principal Force as the case vehicle decelerated. Based on the limited available information, this contractor believes that the front right passenger's chest and head loaded his deploying front right passenger air bag while his knees loaded the front right passenger's knee bolster. The loading of the knee bolster combined with the intrusion into the front right seating area caused this occupant's right femur fracture. It is unknown, but likely, that the front right passenger's head moved upwards towards the right side of the windshield's header and/or sun visor area. At maximum engagement, the case vehicle rotated clockwise causing the front right passenger to move backwards and to his right toward the right front door's roof side rail, glazing, and/or right "B"-pillar. According to witnesses, at final rest, the front right passenger was lying partially ejected through the disintegrated right front window's glazing. Post-crash the front right passenger was at least semi-conscious as he was observed trying to climb out through the disintegrated glazing.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right passenger was transported by ambulance to the hospital. He sustained serious injuries and was hospitalized. The injuries sustained by the case vehicle's front right passenger are unknown but include a fractured right femur.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture right femur, not further specified	851800.3 serious	Knee bolster, front right	Probable	Police

1GNCS13W9X2	System Status At Deployment
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	ON
Ignition Cycles At Deployment	0
Ignition Cycles At Investigation	3866
Time From Algorithm Enable To Deployment Command (msec)	2.5
Time From Near Deployment To Deployment (msec)	0

Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-1.76	-3.29	-5.27	-7.02	-11.41	-14.70	-18.43	-21.28	-25.01	-28.52	-31.59	-33.57	-35.10	-36.20	-37.08

Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Recorded Velocity Change (MPH)	-37.74	-38.18	-38.40	-38.40	-38.40	-38.18	-37.96	-37.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 13: Case vehicle's pre-crash brake switch status and driver's restraint system status, and the case vehicle's change in velocity (Delta V) over the first 150 milliseconds post deployment

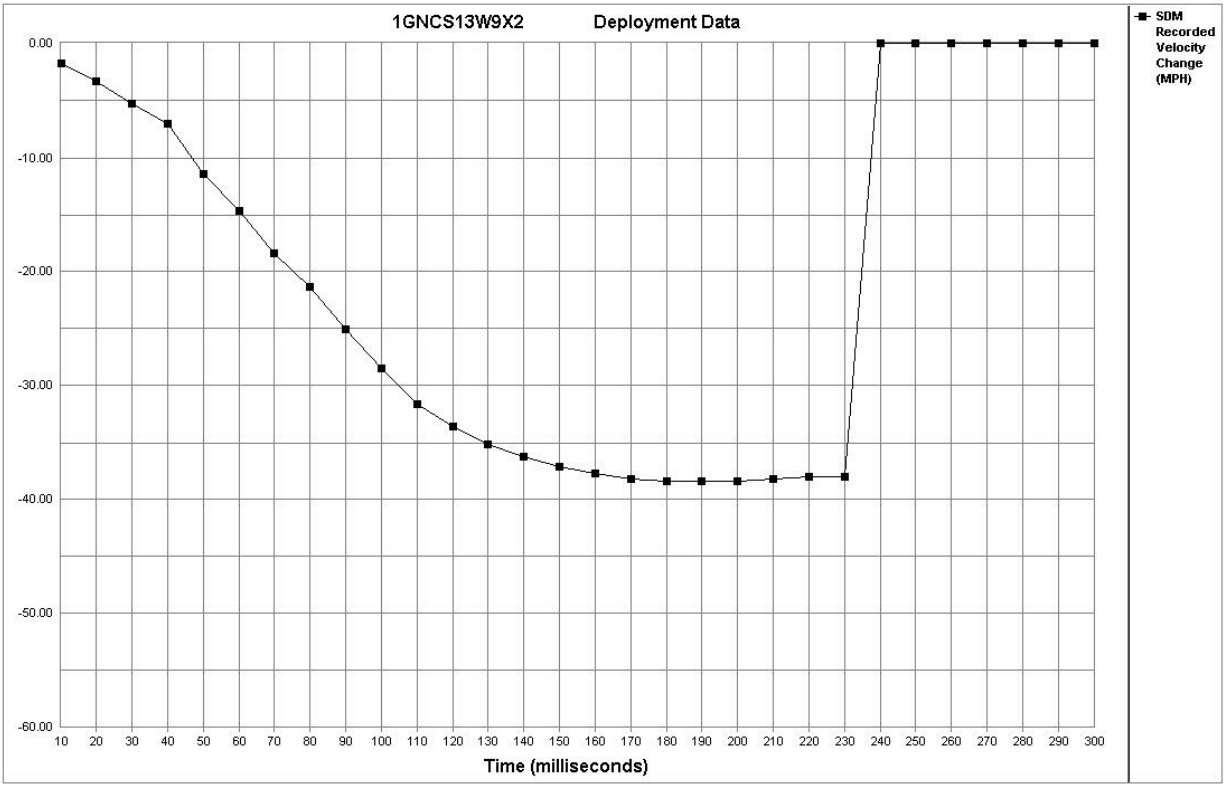

Figure 14: The case vehicle sustained a velocity change of approximately 61 km.p.h. (38 m.p.h.) during the first 180 milliseconds after deployment