INDIANA UNIVERSITY

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

ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION INVESTIGATION

CASE NUMBER - IN09037
LOCATION - OHIO
VEHICLE - 2008 CHEVROLET IMPALA LT
CRASH DATE - August 2009

Submitted:

April 30, 2010

Contract Number: DTNH22-07-C-00044

Prepared for:

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

DISCLAIMERS

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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.* IN09037	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* On-Site Side Impact Inflatable Occupant Protection Investigation Vehicle - 2008 Chevrolet Impala LT Location - Ohio		5. *Report Date:* April 30, 2010 6. *Performing Organization Code*	
7. *Author(s)* Special Crash Investigations Team #2		8. *Performing Organization Report No.*	
9. *Performing Organization Name and Address* Transportation Research Center Indiana University 501 South Madison, Suite 105 Bloomington, Indiana 47403-2452		10. *Work Unit No. (TRAIS)* 11. *Contract or Grant No.* DTNH22-07-C-00044	
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation (NVS-411) 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: August 2009 14. *Sponsoring Agency Code*	
15. *Supplementary Notes* On-site side impact inflatable occupant protection investigation involving a 2008 Chevrolet Impala LT and a1991 Mazda Navajo.			
16. *Abstract* This on-site investigation focused on the side impact air bag system of a 2008 Chevrolet Impala LT. Additional focus was on the crash dynamics and the sources of the driver's injuries. The Chevrolet was occupied by a restrained 45-year-old male driver and a restrained 45-year-old female front passenger. The driver was traveling west on a bridge approaching a left curve at the end of the bridge. An eastbound 1991 Mazda Navajo crossed into the westbound lane as it entered the curve. The left side plane of the Chevrolet was impacted by the front plane of the Mazda (event 1). The direction of force on the Chevrolet was within the 11 o'clock sector and the impact force was sufficient to trigger deployment of the left and right side impact inflatable curtain (IC) air bags. The impact also triggered a first stage deployment of the driver's and front passenger's frontal air bags. The driver and front passenger of the Chevrolet were transported by ambulance to a hospital. They were treated in the emergency room for minor injuries and released. Both vehicles were towed from the crash scene due to damage.			
17. *Key Words* Side Impact Air Bag 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* 18	22. *Price*

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

TABLE OF CONTENTS IN09037

This on-site investigation focused on the side impact air bag system of a 2008 Chevrolet Impala LT (**Figure 1**). Additional focus was on the crash dynamics and the sources of the driver's injuries. This crash was brought to our attention on October 23, 2009 by the National Highway Traffic Safety Administration (NHTSA) through the sampling activities of the National Automotive Sampling System-General Estimates System (NASS-GES). This investigation was assigned on November 10, 2009. This crash involved the Chevrolet and a 1991 Mazda Navajo. The crash occurred in August, 2009, at 1539 hours in Ohio and was investigated by the Ohio State Highway Patrol. The Chevrolet was inspected on November 11, 2009. The Mazda and crash scene were inspected on November 12, 2009. The driver interview was completed on November 18, 2009. This report is based on the police crash report, scene and vehicle inspections, driver interview, occupant kinematic principles, exemplar Chevrolet inspection, and evaluation of the evidence.

Figure 1: The damaged 2008 Chevrolet Impala LT

CRASH CIRCUMSTANCES

Crash Environment: The trafficway that both vehicles were traveling on was a two-lane, undivided, rural roadway that traversed in an east-west direction. There was one 3.7 m (12.1 ft) wide through lane in each direction. The Chevrolet was traveling on a bridge and the roadway curved left just prior to the crash location. The roadway was level with bituminous shoulders 0.8 m (2.3 ft) in width and a steel, blocked-out, W-beam bridge rail. The roadway segment that the Mazda was traveling on was straight and the grade was positive 2.5% in the area where the curve began. The roadway was bordered by grass shoulders. Roadway pavement markings consisted of solid white edge lines and solid double yellow center lines. The speed limit was 72 km/h (45 mph) and the roadway surface was dry bituminous. At the time of the crash, the light condition was daylight and the weather was clear. The Crash Diagram is on page 12 of this report.

Pre-Crash: The Chevrolet was occupied by a restrained 45-year-old male driver and a restrained 45-year-old female front passenger. The driver was traveling west (**Figure 2**) on the bridge approaching a left curve and intended to continue west. The Mazda was traveling east approaching the curve (**Figure 3**) and the driver intended to continue eastbound. The Mazda crossed into the westbound lane immediately after it entered the curve. The Chevrolet's Event Data Recorder (EDR) recorded 2.5 seconds of pre-crash data.

Figure 2: Approach of the Chevrolet; arrow shows the area of impact in the westbound lane; number shows meters to impact area

The EDR recorded the vehicle traveling 60 km\h (37 mph) from 2.5 seconds to 1 second prior to Algorithm Enable (AE). At 0.5 seconds prior to AE, the vehicle was recorded as traveling 53 km/h (33 mph) and the brake switch circuit was recorded as "on." The crash occurred approximately 1.7 m (5.6 ft) into the westbound lane.

Crash: The left side plane of the Chevrolet (**Figure 4**) was impacted by the front plane of the Mazda (**Figure 5**, event 1). The direction of force on the Chevrolet was within the 11 o'clock sector and the impact force was sufficient to trigger deployment of the left and right side impact inflatable curtain (IC) air bags. The impact also triggered a first stage deployment of the driver's and front passenger's frontal air bags. The Chevrolet was redirected to the northwest and the right fender sustained a minor sideswipe impact with the bridge rail (event 2, **Figure 6**). The Chevrolet came to final rest next to the bridge rail heading west. The Mazda came to final rest on the westbound lane heading east.

Figure 3: Approach of the Mazda to the area of impact (arrow)

Figure 4: Damage on the left side plane of the Chevrolet from the impact with the Mazda

Figure 5: The damage to the front plane and left fender of the Mazda from the impact with the Chevrolet

Figure 6: Top view of damage on the right fender of the Chevrolet; each increment is 5 cm (2 in)

Post-Crash: The police were notified of the crash and arrived on-scene at 1619 hours. Rescue personnel mechanically forced open the left front door of the Chevrolet and removed the driver from the vehicle. The front passenger exited the vehicle through the left rear door. The right side

of the vehicle was near the bridge rail and the passenger could not open the door. The driver and front passenger were transported by ambulance to a hospital. The driver of the Mazda was also transported by ambulance to a hospital. The second row right passenger of the Mazda was not injured. Both vehicles were towed from the crash scene due to damage.

CASE VEHICLE

The 2008 Chevrolet Impala LT was a front wheel drive, 4-door sedan (VIN: 2G1WC583881-------) equipped with a 3.9-liter, V6 engine, an automatic transmission, 4-wheel anti-lock brakes with electronic brake force distribution, and traction control. The front row was equipped with bucket seats, adjustable head restraints, lap-and-shoulder safety belts, driver and front passenger frontal air bags, and side impact IC air bags that provided protection for the front and second row. The second row was equipped with a split bench seat with folding backs, lap-and-shoulder seat safety belts, adjustable head restraints, and Lower Anchors and Tethers for Children (LATCH) in all seating positions. The vehicle's mileage was 34,198 miles (55,035 kilometers) and the specified wheelbase was 281 cm (110.6 in).

CASE VEHICLE DAMAGE

Exterior Damage: The impact by the front of the Mazda involved the left side plane of the Chevrolet. The fender, hood, A-pillar, front door, B-pillar, rear door, and quarter panel were directly damaged. The direct damage ended 44 cm (17.3 in) rear of the left rear axle and extended 401 cm (157.8 in) forward along the left side. The crush measurements were taken at the mid-door level and the residual maximum crush was 15 cm (5.9 in) occurring at C_4 (**Figure 7**). The vehicle's sill height was 26 cm (10.2 in) and the height of the maximum crush was 68 cm (26.8 in). The Door Sill Differential was 8 cm (3.1 in). The induced damage involved the hood, both left side doors, A-pillar, roof side rail, and quarter panel. The table below shows the vehicle's left side crush profile.

Figure 7: Arrow shows the location of the maximum 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	1	401	15	401	0	3	12	15	11	0	12	12
in		157.9	5.9	157.9	0.0	1.2	4.7	5.9	4.3	0.0	4.7	4.7

The impact with the bridge rail involved the right fender. The direct damage began 24 cm (9.4 in) forward of the right front axle and extended rearward 70 cm (27.6 in). The crush measurements were taken at the mid-fender level and the residual maximum crush was 1 cm occurring 7 cm (2.8 in) rear of C_6. There was no induced damage on the fender. The table below shows the crush profile on the right fender.

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	70	1	70	0	0	0	0	0	0	130	130
in		27.6	0.4	27.6	0.0	0.0	0.0	0.0	0.0	0.0	51.2	51.2

Damage Classification: The Collision Deformation Classification (CDC) was 11LDAS2 (330 degrees) for the left side plane impact with the Mazda and 12RFMS1 (10 degrees) for the right side plane impact with the bridge rail. The WinSMASH program could not be used to calculate the Delta V for either impact since sideswipes are out of scope for the program. The Chevrolet's EDR recorded the maximum longitudinal and lateral velocity changes as -13.76 km/h (-8.55 mph) and 10.33 km/h (6.42 mph), respectively for the impact with the Mazda.

The vehicle manufacturer's recommended tire size was P225/55R17. The Chevrolet was equipped with the recommended size tires. The vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	Flat	Flat	207	30	4	5	Sidewall cut	Yes	Yes
LR	221	32	207	30	4	5	None	No	No
RR	221	32	207	30	4	5	None	No	No
RF	193	28	207	30	5	6	None	No	No

Vehicle Interior: The interior inspection of the Chevrolet (**Figure 8**) revealed no discernable evidence of occupant contact. There was no deformation of the steering wheel and no compression of the energy absorbing steering column.

The left front door was jammed shut, while the other doors remained closed and operational. The pre-crash status of the window glazings was either fixed or closed. The left front window glazing was disintegrated from impact forces. The windshield was in place and holed (**Figure 9**)

during the crash as a result of contact by the left fender of the Mazda. The remaining glazings were undamaged.

The vehicle sustained two intrusions of the passenger compartment. The forward upper quadrant of the left front door was estimated to have intruded 5 cm (2 in). It was necessary to estimate the intrusion since the left front door had been mechanically forced open during rescue operations and could not be completely forced back into its post-crash position. The windshield also intruded into the driver's space an estimated 15 cm (5.9 in).

Figure 8: Front row viewed from right front door

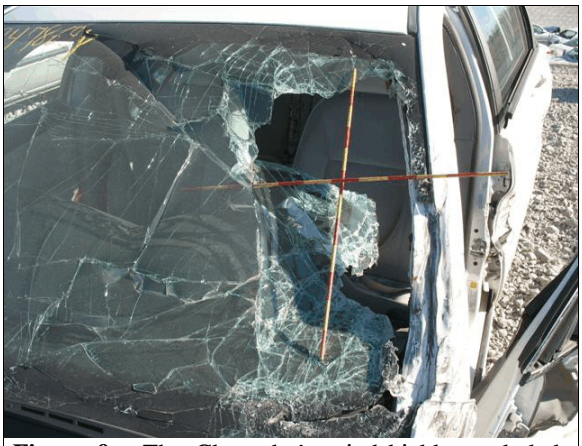


Figure 9: The Chevrolet's windshield was holed during the crash

EVENT DATA RECORDER

The Chevrolet's EDR was imaged using version 3.3 of the Bosch Crash Data Retrieval software via connection to the diagnostic link connector. The EDR file was subsequently read and printed using version 3.4. The EDR recorded a deployment event and the Supplemental Inflatable Restraint (SIR) warning lamp was recorded as "off." The driver's and front passenger's safety belt switch circuits were recorded as "buckled" and the pretensioners were commanded to actuate. The first stage deployment criteria for the frontal air bags was met at 34 msec following AE, and there was disposal of the second stage for both air bags. The deployment command criteria for both side impact IC air bags was met at 30 msec following AE. The maximum longitudinal and lateral velocity changes occurred at 40 msec following the deployment command and were recorded as -13.76 km/h (-8.55 mph) and 10.33 km/h (6.42 mph), respectively. The pre-crash data was discussed in the pre-crash section on page 1 of this report. The EDR report is attached at the end of this report[1].

AUTOMATIC RESTRAINT SYSTEM

The Chevrolet was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that consisted of dual stage driver and front passenger frontal air bags, driver seat position sensor, front passenger weight sensor, and retractor-mounted pretensioners. The frontal air bag sensors were located on the left and right radiator supports. The manufacturer has certified that the vehicle is compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208.

---

[1] Pages 8-10 of the EDR report have been deleted for confidentiality purposes.

The Chevrolet was also equipped with a side impact air bag system that consisted of roof rail-mounted IC air bags. Based on the Holmatro Rescuer's Guide to Vehicle Safety Systems, the side impact sensors were located within the front doors and the inflators were located within the C-pillars. Both IC air bags deployed in this crash.

The driver's frontal air bag was located within the steering wheel hub and the module cover was a two-flap configuration constructed of pliable vinyl. Each cover flap was 6.5 cm (2.6 in) in width and 13.5 cm (5.3 in) in height. The flaps opened at the designated tear points and were undamaged. The deployed air bag (**Figure 10**) was 61 cm (24 in) in diameter and was designed with four 5.5 cm (2.2 in) wide tethers and two 2.5 cm (1 in) diameter vent ports. The vent ports were located on the back of the air bag at the 11 and 1 o'clock positions. Inspection of the air bag revealed no discernable evidence of occupant contact. There was a 1.5 cm long cut on the back of the air bag adjacent to the left vent port (**Figure 11**). This damage probably occurred when the windshield was holed during the impact and intruded into the passenger compartment.

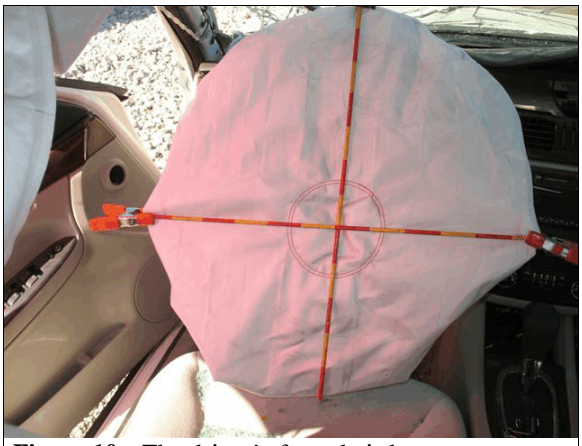


Figure 10: The driver's frontal air bag

Figure 11: Cut in the fabric of the driver's frontal air bag; cut is near the left vent port

The front passenger frontal air bag was located within the top of the instrument panel. There was no air bag cover flap. The top of the instrument panel was designed to displace vertically as the air bag deployed. The deployed air bag (**Figure 12**) was 43 cm (16.9 in) in width and 54 cm (21.3 in) in height. The air bag was designed with two tethers each 25 cm (6.5 in) in width. There was one vent port on each side of the air bag. The vent ports were located at the 3 and 9 o'clock positions and were 5 cm (2 in) in diameter. There was no discernable evidence of occupant contact on the air bag and no damage.

Figure 12: The front passenger's frontal air bag

The IC air bags were located along the roof side rails inside the headliner and extended from the A-pillar to the C-pillar. They were designed with inflation chambers adjacent to the outboard seating positions. There were no external vent ports. The deployed left IC air bag (**Figure 13**) was 167 cm (65.7 in) in width and 41 cm (16.1 in) in height. It was attached to the A-pillar by

a 51 cm (5.9 in) nylon rope. The gap between the front of the IC air bag and the window frame at the beltline was 25 cm (9.8 in). There was no gap between the back of the IC air bag and the C-pillar. The distance the IC air bag extended vertically below the beltline was 10 cm (3.9 in). There was no discernable evidence of occupant contact on the left IC air bag. There was an area of small punctures in the air bag material on the outboard side (**Figure 14**) caused by flying glass fragments from the disintegrated left front window glazing. The center of the damaged area was located 45 cm (17.7 in) rear of the forward edge of the IC air bag and 14 cm (5.5 in) from the top. The right IC air bag was of the same dimensions and features. It was not damaged and there was no discernable evidence of occupant contact.

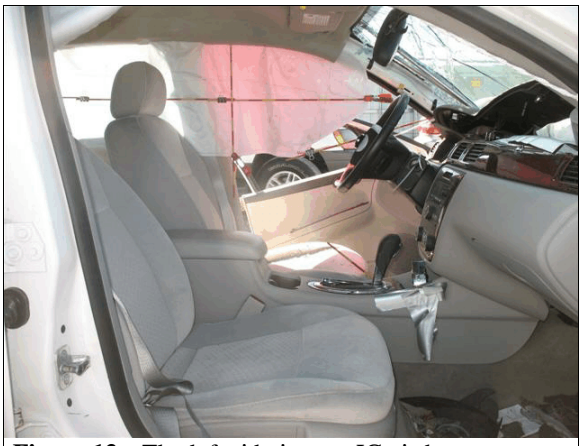


Figure 13: The left side impact IC air bag

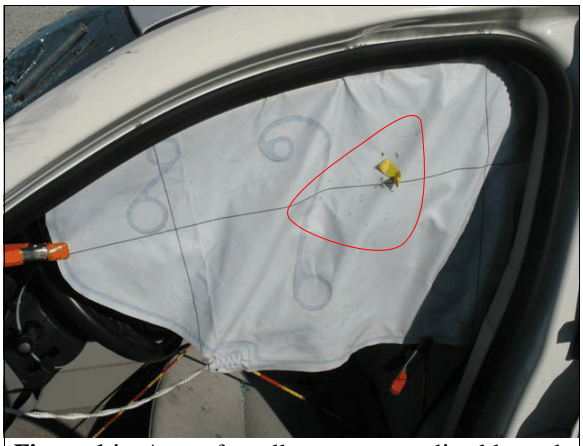


Figure 14: Area of small punctures outlined by red line; punctures caused by flying glass fragments from the disintegrated left front window glazing

MANUAL RESTRAINT SYSTEM

The Chevrolet was equipped with lap-and-shoulder safety belts in all the seating positions. The driver's safety belt consisted of continuous loop belt webbing, an Emergency Locking Retractor (ELR), sliding latch plate, and an adjustable upper anchor that was in the full-up position. The front passenger safety belt was similarly equipped, but the retractor type could not be determined since it was jammed due to pretensioner actuation. The adjustable upper anchor was located in the full-down position. The second row safety belts consisted of continuous loop belt webbing with switchable ELR/Automatic Locking Retractors, sliding latch plates, and fixed upper anchors.

The inspection of the driver's safety belt assembly revealed historical usage scratches on the latch plate. There was no evidence of loading on the latch plate belt guide, safety belt webbing or D-ring. The retractor was jammed due to pretensioner actuation. The driver stated during the SCI interview that he was restrained at the time of the crash, and the safety belt was snug across his hips and slightly loose on his shoulder. He stated that he sustained contusions on both hips, which supported usage of the safety belt. The EDR recorded the driver's safety belt switch circuit status as "buckled."

Inspection of the front passenger's safety belt assembly revealed similar findings as the inspection of the driver's safety belt. Based on the interview and supported by the EDR data, the front passenger was also restrained at the time of the crash.

Based on the SCI interview, the driver of the Chevrolet [45-year-old, male; 175 cm (69 in) and 73 kg (160 lbs)] was seated in an upright posture with his back against the seat back. He had both hands on the steering wheel at the 10 and 2 o'clock positions and his right foot on the brake. The seat track was adjusted between the middle and rear positions and the seat back was slightly reclined. The tilt steering column was adjusted to the full up position. The driver was wearing both sunglasses and contact lenses.

The left side impact on the Chevrolet displaced the driver forward and left opposite the 11 o'clock direction of force. The driver's chest and hips loaded the safety belt and his face loaded the deployed frontal air bag. He sustained a 5 cm (2 in) diameter contusion immediately above each hip from loading the safety belt and a 5 cm (2 in) contusion near the left temple from loading the frontal air bag. The driver's left forearm contacted the intruded windshield, which caused a 10 cm (4 in) diameter area of lacerations on the elbow with glass fragments. The driver also sustained a neck strain from loading the air bag and a lower back strain from loading the safety belt. The driver remained restrained within his seat position throughout the crash. He was removed from the vehicle through the left front door after rescue personnel mechanically forced the door open.

CASE VEHICLE DRIVER INJURIES

The driver sustained minor injuries and was transported by ambulance to a hospital where he was treated in the emergency room and released. He received no follow-up treatment and lost three work days as a result of the crash. The table below presents the driver's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Abrasion left temple, not further specified	minor 190202.1,2	Air bag, driver's	Probable	Interviewee (same person)
2	Strain, cervical, not further specified	minor 640278.1,6	Air bag, driver's	Probable	Interviewee (same person)
3 4	Contusions, 5.1 cm (2 in) just above each hip	minor 590402.1,1 590402.1,2	Lap portion of safety belt system	Certain	Interviewee (same person)
5	Strain, lower back, not further specified	minor 640678.1,8	Lap portion of safety belt system	Probable	Interviewee (same person)
6	Laceration, 10.2 cm (4 in) diameter on left elbow, not further specified	minor 790600.1,2	Front left windshield's glazing	Certain	Interviewee (same person)

The front passenger of the Chevrolet [45-year-old, female; 165 cm (65 in) and 45 kg (100 lbs)] was seated in an upright posture with her back against the seat back and both feet on the floor. Her hands were positioned on her lap. The seat track was adjusted between the middle and rear positions and the seat back was slightly reclined. The passenger was wearing glasses.

The left side impact on the Chevrolet displaced the passenger forward and left opposite the 11 o'clock direction of force. The passenger's chest and hips loaded the safety belt, which caused a 17.8 cm (7 in) contusion on the right shoulder and chest and a contusion immediately above each hip. The passenger's left hip also contacted the center console, which caused a 5 cm (2 in) diameter contusion on the hip. The passenger remained restrained in her seat position throughout the crash. The right side of the vehicle was near the guardrail at final rest and the passenger was unable to exit the vehicle on that side. She crawled into the back seat and forced the left rear door open to exit the vehicle.

CASE VEHICLE FRONT ROW PASSENGER INJURIES

The front passenger sustained minor injuries and was transported by ambulance to a hospital where she was treated in the emergency room and released. She received no follow-up treatment and lost two work days as a result of the crash.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1 2	Abrasion, 17.8 cm (7 in) in total area, beginning on right shoulder and extending onto right chest	minor 790202.1,1 490202.1,1	Torso portion of safety belt system	Certain	Interviewee (driver)
3 4	Contusions, 5.1 cm (2 in) just above each hip	minor 590402.1,1 590402.1,2	Lap portion of safety belt system	Certain	Interviewee (driver)
5	Contusion, 5.1 cm (2 in) on left lateral hip	minor 890402.1,2	Interior, center console first row	Probable	Interviewee (driver)

OTHER VEHICLE

1991 Mazda Navajo was a 4-wheel drive, 4-passenger sport utility vehicle (VIN: 4F2CU44X9MU------) equipped with a 4.0-liter, V6 engine, and a 5-speed automatic transmission. The Mazda was equipped with 2-wheel (rear) anti-lock brakes.

The impact with the Chevrolet involved the front plane of the Mazda (**Figure 16**). The front bumper, left headlamp/turn signal assembly, grille, hood, left fender, left front wheel, and left front door were directly damaged. The direct damage began at the front left bumper corner and extended 40 cm (15.7 in) across the bumper. The crush measurements were taken at the bumper

level and the residual maximum crush was 32 cm (12.6 in) occurring at C_1 (**Figure 17**). The induced damage involved the bumper, grille, hood, and left front door. The left side wheelbase was reduced 41 cm (16.1 in), while the right side wheelbase was extended 4 cm (1.6 in). The table below shows the front crush profile.

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	40	32	141	32	7	0	0	0	0	-57	0
in		15.7	12.6	55.5	12.6	2.8	0.0	0.0	0.0	0.0	-22.4	0.0

Damage Classification: The CDC for the front impact with the Chevrolet was 12FLEE6 (10 degrees). The crash involved a sideswipe impact, which is out of scope for WinSMASH.

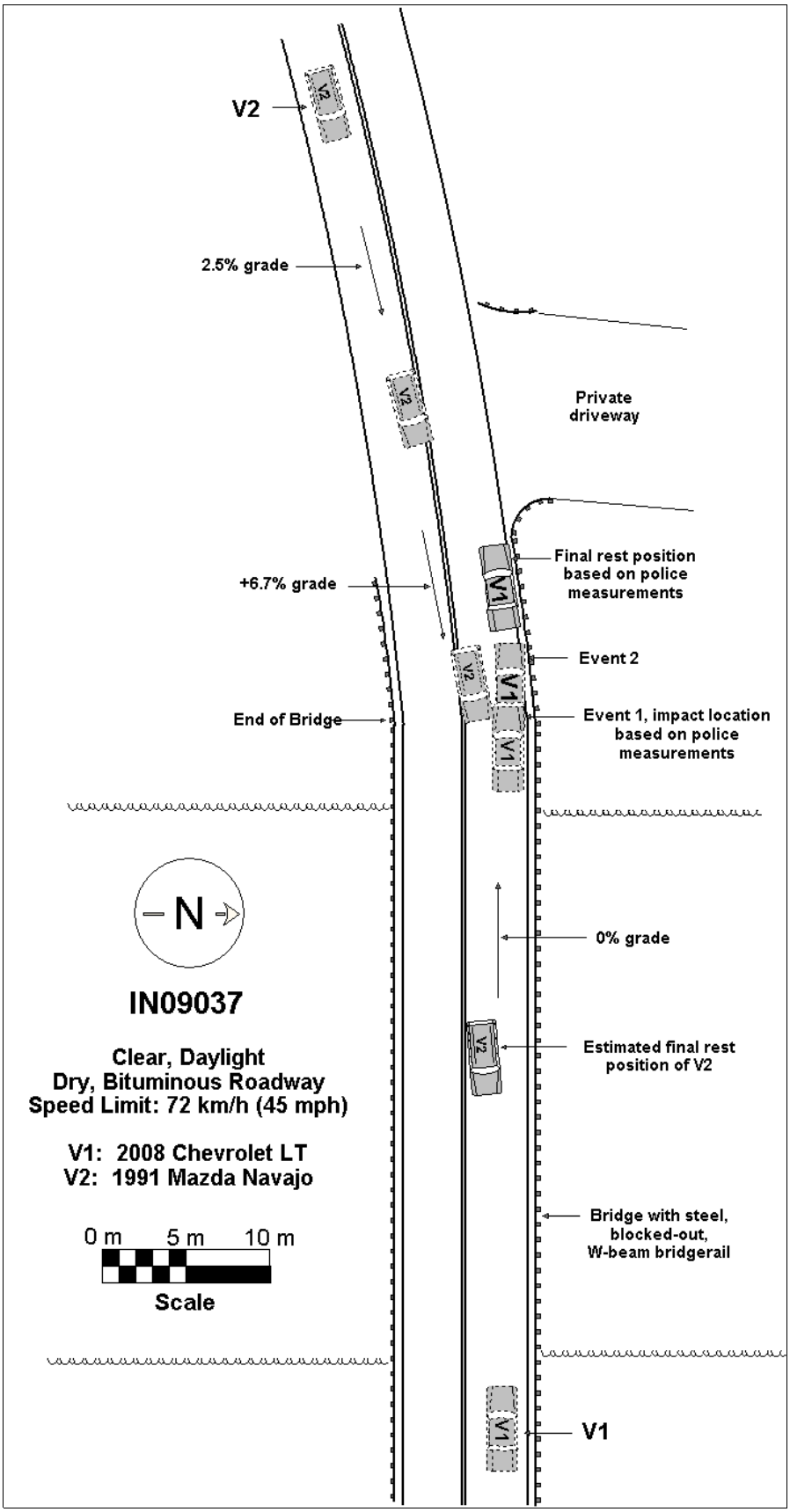
Figure 16: Damage to the front plane of the Mazda

Figure 17: Left side view of the crush on the front bumper of the Mazda

The vehicle manufacturer's recommended tire size was P225/70R15. The Mazda was equipped with the P235/75R15 size tires. The vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	Flat	Flat	241	35	4	5	None	Yes	Yes
LR	200	29	241	35	8	10	None	No	No
RR	207	30	241	35	9	11	None	No	No
RF	48	7	241	35	4	5	None	No	No

Mazda's Driver: The police crash report indicated that the driver of the Mazda (42-year-old, male) was restrained by the lap-and-shoulder safety belt. The second row right passenger (3-year-old, male) was restrained in a child safety seat. The driver sustained an A (incapacitating) injury and the second row right passenger was not injured. Neither frontal air bag deployed during the crash.


V2
2.5% grade
Private driveway
Final rest position based on police measurements
+6.7% grade
Event 2
End of Bridge
Event 1, impact location based on police measurements
N
0% grade
IN09037
Clear, Daylight
Dry, Bituminous Roadway
Speed Limit: 72 km/h (45 mph)
V1: 2008 Chevrolet LT
V2: 1991 Mazda Navajo
Estimated final rest position of V2
0 m 5 m 10 m
Scale
Bridge with steel, blocked-out, W-beam bridgerail
V1

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

CDR File Information

User Entered VIN	2G1WC583881******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	IN09037EDR.CDR
Saved on	Wednesday, November 11 2009 at 10:54:18 AM
Collected with CDR version	Crash Data Retrieval Tool 3.3
Reported with CDR version	Crash Data Retrieval Tool 3.4
EDR Device Type	airbag control module
Event(s) recovered	Deployment

Comments

No comments entered.

Data Limitations

Recorded Crash Events:

There are two types of recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event records data but does not deploy the air bag(s). The minimum SDM Recorded Vehicle Velocity Change, that is needed to record a Non-Deployment Event, is five MPH. A Non-Deployment Event may contain Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event will be cleared by the SDM, after approximately 250 ignition cycles. This event can be overwritten by a second Deployment Event, referred to as Deployment Event #2, if the Non-Deployment Event is not locked. A locked Non Deployment Event cannot be overwritten by the SDM.
The second type of SDM recorded crash event is the Deployment Event. It also may contain Pre-Crash and Crash data. The SDM can store up to two different Deployment Events. If a second Deployment Event occurs any time after the Deployment Event, the Deployment Event #2 will overwrite any non-locked Non-Deployment Event. Deployment Events cannot be overwritten or cleared by the SDM. Once the SDM has deployed an air bag, the SDM must be replaced.

Data:

-SDM Recorded Vehicle Velocity Change reflects the change in velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle 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. For Deployment Events, the SDM can record 220 milliseconds of data after deployment criteria is met and up to 70 milliseconds before deployment criteria is met. For Non-Deployment Events, the SDM can record up to the first 300 milliseconds of data after algorithm enable. Velocity Change data is displayed in SAE sign convention.

-The CDR tool displays time from Algorithm Enable (AE) to time of deployment command in a deployment event and AE to time of maximum SDM recorded vehicle velocity change in a non-deployment event. Time from AE begins when the first air bag system enable threshold is met and ends when deployment command criteria is met or at maximum SDM recorded vehicle velocity change. Air bag systems such as frontal, side, or rollover, may be a source of an enable. The time represented in a CDR report can be that of the enable of one air bag system to the deployment time of another air bag system.

-Maximum Recorded Vehicle Velocity Change is the maximum square root value of the sum of the squares for the vehicle's combined "X" and "Y" axis change in velocity.

-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 by various factors, including but not limited to the following:
- -significant changes in the tire's rolling radius
- -final drive axle ratio changes
- -wheel lockup and wheel slip

-Brake Switch Circuit Status indicates the status of the brake switch circuit.

-Pre-Crash data is recorded asynchronously.

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

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

-Driver’s and Passenger’s Belt Switch Circuit Status indicates the status of the seat belt switch circuit.

-The Time Between Non-Deployment to Deployment Events is displayed in seconds. If the time between the two events is greater than five seconds, “N/A” is displayed in place of the time. If the value is negative, then the Deployment Event occurred first. If the value is positive, then the Non-Deployment Event occurred first.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
-The ignition cycle counter relies upon the transitions through OFF->RUN->CRANK power-moding messages, on the GMLAN communication bus, to increment the counter. Applying and removing of battery power to the module will not increment the ignition cycle counter.
-All data should be examined in conjunction with other available physical evidence from the vehicle and scene.

Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Status Data (Pre-Crash) is transmitted to the SDM, by various vehicle control modules, via the vehicle’s communication network.
-The Belt Switch Circuit is wired directly to the SDM.

01004_SDMC-autoliv_r001

Multiple Event Data

Associated Events Not Recorded	0
An Event(s) Preceded the Recorded Event(s)	No
An Event(s) was in Between the Recorded Event(s)	No
An Event(s) Followed the Recorded Event(s)	No
The Event(s) Not Recorded was a Deployment Event(s)	No
The Event(s) Not Recorded was a Non-Deployment Event(s)	No

System Status At AE

Low Tire Pressure Warning Lamp (If Equipped)	Invalid
Vehicle Power Mode Status	Run
Remote Start Status (If Equipped)	Inactive
Run/Crank Ignition Switch Logic Level	Active

Pre-crash data

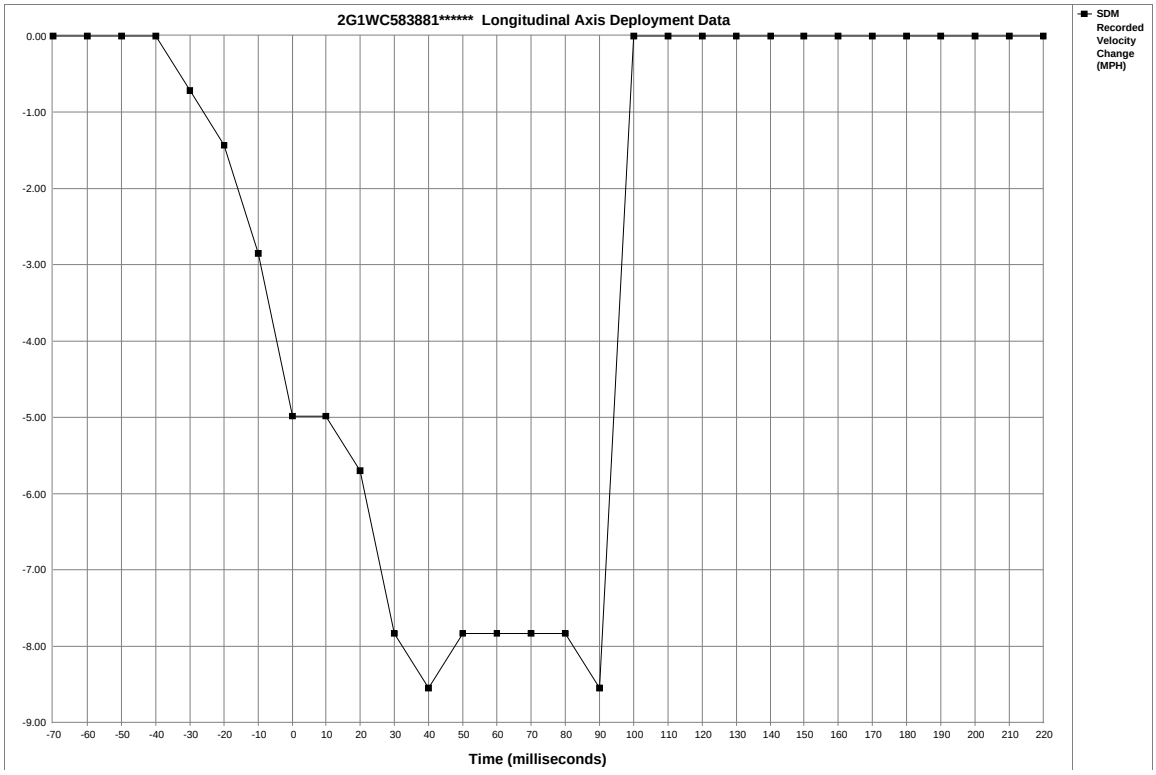
Parameter	-1.0 sec	-0.5 sec
Reduced Engine Power Mode	OFF	OFF
Cruise Control Active (If Equipped)	No	No
Cruise Control Resume Switch Active (If Equipped)	No	No
Cruise Control Set Switch Active (If Equipped)	No	No
Engine Torque (foot pounds)	-14.38	-10.33

Pre-Crash Data

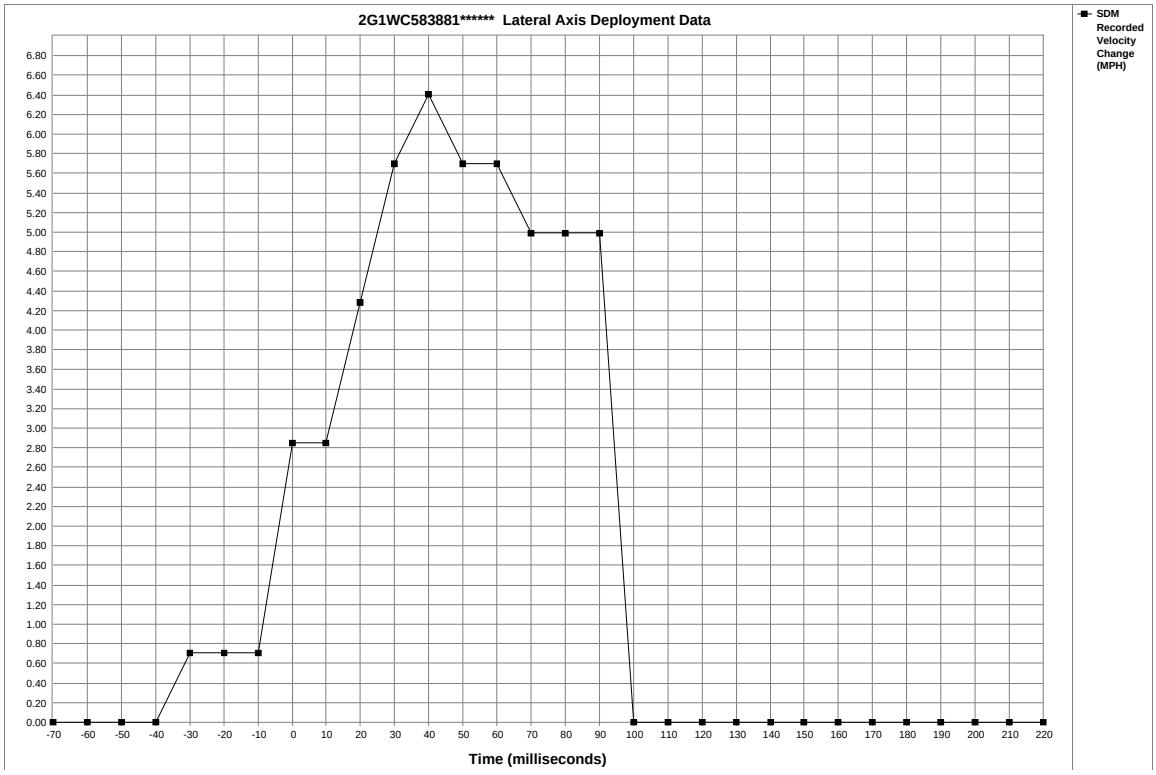
Parameter	-2.5 sec	-2.0 sec	-1.5 sec	-1.0 sec	-0.5 sec
Accelerator Pedal Position (percent)	0	0	0	0	0
Vehicle Speed (MPH)	37	37	37	37	33
Engine Speed (RPM)	1024	960	960	960	896
Percent Throttle	14	13	13	13	12
Brake Switch Circuit Status	OFF	OFF	OFF	OFF	ON

System Status At Deployment

Ignition Cycles At Investigation	3184
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON Time Continuously (seconds)	0
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	3139
Ignition Cycles At Event	3184
Ignition Cycles Since DTCs Were Last Cleared	255
Driver's Belt Switch Circuit Status	BUCKLED
Passenger's Belt Switch Circuit Status	BUCKLED
Passenger Classification Status at Event Enable	Large Occupant Classification Type #1
Current Passenger Position Status at Event Enable	Position Not Applicable
Previous Passenger Position Status at Event Enable	Unknown
Passenger Air Bag Indicator Status at Event Enable	ON
Diagnostic Trouble Codes at Event, fault number: 1	N/A
Diagnostic Trouble Codes at Event, fault number: 2	N/A
Diagnostic Trouble Codes at Event, fault number: 3	N/A
Diagnostic Trouble Codes at Event, fault number: 4	N/A
Diagnostic Trouble Codes at Event, fault number: 5	N/A
Diagnostic Trouble Codes at Event, fault number: 6	N/A
Diagnostic Trouble Codes at Event, fault number: 7	N/A
Diagnostic Trouble Codes at Event, fault number: 8	N/A
Diagnostic Trouble Codes at Event, fault number: 9	N/A
Driver 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	34
Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Disposal
Passenger 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	34
Passenger 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Disposal
Driver Side or Roof Rail/Head Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	30
Passenger Side or Roof Rail/Head Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	30
Time Between Events (sec)	0
Crash Record Locked	Yes
Vehicle Event Data (Pre-Crash) Associated With This Event	Yes
SDM Synchronization Counter	3183
Event Recording Complete	Yes
Driver First Stage Deployment Loop Commanded	Yes
Passenger First Stage Deployment Loop Commanded	Yes
Driver Second Stage Deployment Loop Commanded	Yes
Driver 2nd Stage Deployment Loop Commanded for Disposal	Yes
Passenger Second Stage Deployment Loop Commanded	Yes
Passenger 2nd Stage Deployment Loop Commanded for Disposal	Yes
Driver Pretensioner Deployment Loop Commanded	Yes
Passenger Pretensioner Deployment Loop Commanded	Yes
Driver Side Deployment Loop Commanded	No
Passenger Side Deployment Loop Commanded	No
Second Row Left Side Deployment Loop Commanded	No
Second Row Right Side Deployment Loop Commanded	No
Driver (Initiator 1) Roof Rail/Head Curtain Loop Commanded	Yes
Passenger (Initiator 1) Roof Rail/Head Curtain Loop Commanded	Yes
Driver (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Driver (Initiator 3) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 3) Roof Rail/Head Curtain Loop Commanded	No
Driver Knee Deployment Loop Commanded	No
Passenger Knee Deployment Loop Commanded	No
Second Row Left Pretensioner Deployment Loop Commanded	No
Second Row Right Pretensioner Deployment Loop Commanded	No
Second Row Center Pretensioner Deployment Loop Commanded	No



Time (milliseconds)	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70
SDM Longitudinal Axis Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	-0.71	-1.43	-2.85	-4.99	-4.99	-5.70	-7.84	-8.55	-7.84	-7.84	-7.84
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Longitudinal Axis Recorded Velocity Change (MPH)	-7.84	-8.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Time (milliseconds)	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70
SDM Lateral Axis Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.71	0.71	0.71	2.85	2.85	4.28	5.70	6.41	5.70	5.70	4.99
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Lateral Axis Recorded Velocity Change (MPH)	4.99	4.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00