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ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION INVESTIGATION

CASE NUMBER - IN08049
LOCATION - TEXAS
VEHICLE - 2004 HYUNDAI TIBURON GL
CRASH DATE - November 2008

Submitted:

August 24, 2009

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

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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.* IN08049	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* On-Site Side Impact Inflatable Occupant Protection Investigation Vehicle - 2004 Hundai Tiburon GL Location - Texas		5. *Report Date:* August 24, 2009 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: November 2008 14. *Sponsoring Agency Code*	
15. *Supplementary Notes* On-site Side Impact Inflatable Occupant Protection Investigation involving a 2004 Hyundai Tiburon GL, a 2008 Chevrolet Tahoe LTZ, a parked not-in-transport 1998 Ford Taurus LS, and a parked not-in-transport 1997 Ford Explorer XLT.			
16. *Abstract* This report covers an on-site investigation of a crash that involved a 2004 Hyundai Tiburon GL, a 2008 Chevrolet Tahoe LTZ, a parked, not-in-transport 1998 Ford Taurus LS, and a parked, not-in-transport 1997 Ford Explorer XLT. The focus of this investigation was the Hyundai, which was equipped with front seat back-mounted side impact air bags that deployed as a result of the crash. The front right passenger sustained a fatal injury. The Hyundai was occupied by an unrestrained 22-year-old male driver and a restrained 37-year-old male front right passenger. The front of the Chevrolet impacted the right side plane of the Hyundai (event 1) as both vehicles were passing though a 4-leg intersection. The impact force was sufficient to trigger deployment of the Hyundai's front right passenger's seat back mounted side impact air bag and the frontal air bags. The impact redirected both vehicle's in a southeast direction and the Chevrolet rolled over on top of the back portion of the Hyundai (events 2 and 3). The Hyundai's left side wheels impacted a curb (events 4 and 5), and its left fender impacted the right side plane of the parked Taurus (event 6). The Taurus' left fender impacted a residence (event 7) and its left quarter panel impacted the right side plane of the Explorer (event 8). The Hyundai came to final rest against the Ford heading southwest. The Hyundai sustained extensive intrusion of the right front door, and the front right passenger sustained brain, cervical spine, and internal injuries. He was pronounced deceased at the crash scene 44 minutes following the crash. The driver was transported by ambulance to a hospital. He sustained minor injuries and was treated in the emergency room and released.			
17. *Key Words* Side Impact Air Bag Fatal Injury 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* 20	22. *Price*

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

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This on-site investigation focused on a 2004 Hyundai Tiburon GL (**Figure 1**), which was equipped with seat back-mounted side impact air bags that deployed as a result of the crash. The front right passenger sustained a fatal injury. The crash was brought to the National Highway Traffic Safety Administration's attention on December 9, 2008 by this contractor. This investigation was assigned on December 12, 2008. The crash involved the Hyundai, a 2008 Chevrolet Tahoe LTZ, a parked not-in-transport 1998 Ford Taurus LS, and a parked not-in-transport 1997 Ford Explorer XLT. The crash occurred in November 2008, at 0231 hours, in Texas and was investigated by the city police department. This contractor inspected the crash scene, Hyundai, and Chevrolet on December 16-17, 2008. This report is based on the police crash report, police photographs, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

Figure 1: The damaged 2004 Hyundai Tiburon GL

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the Hyundai was traveling was a 5-lane, undivided, city street, traversing in a north-south direction. The Hyundai was traveling south approaching a 4-leg intersection. The roadway was level and had two through lanes in each direction with a center opposing left turn lane, and was bordered by 15 cm (6 in) curbs. The outside north and south travel lanes were 4.6 m (14.4 ft) and 4.4 m (14.4 ft) in width, respectively. The inside north and south travel lanes were 3.5 m (11.5 ft) and 4.2 m (13.8 ft) in width, respectively. The opposing left turn lane was 2.9 m (9.5 ft) in width. The roadway pavement markings consisted of broken white lane lines. The opposing left turn lane had solid yellow edge lines with broken yellow inside lane lines. The trafficway on which the Chevrolet was traveling was a level, 2-lane, undivided, city street, traversing in an east-west direction. The Chevrolet was traveling east approaching the same 4-leg intersection. The roadway was 10.7 m (35.1 ft) in width and parking was allowed on each side of the roadway. There were no pavement markings and the intersection was controlled by a stop sign. The speed limit for the Hyundai was 64 km/h (40 mph) and 48 km/h (30 mph) for the Chevrolet. At the time of the crash the light condition was dark with artificial lighting, the atmospheric condition was clear, the roadway pavement was dry bituminous, and the site of the crash was residential. See the Crash Diagram on page 15 of this report.

Pre-Crash: The Hyundai was occupied by an unrestrained 22-year-old male driver and a restrained 37-year-old male front right passenger. The Hyundai was traveling south in the inside through lane (**Figure 2**) and the driver intended to continue straight ahead. The Chevrolet's unrestrained 26-year-old male driver was traveling east (**Figure 3**). The police crash report stated that the Chevrolet was traveling at a high rate of speed as it was being pursued by a 2008 Pontiac G6 (non-contact vehicle), and the driver disregarded the stop sign. The Chevrolet's Event Data

Recorder (EDR) recorded the vehicle traveling 87 km\h (54 mph) at 73% throttle 2.5 seconds prior to Algorithm Enable (AE) increasing to 93 km\h (58 mph) at 93% throttle at 0.5 seconds prior to AE. It is unknown if the Hyundai's driver took any actions to avoid the crash. The Hyundai's driver's medical record reported his Blood Alcohol Concentration as 0.20 mg/dl.

Crash: The front of the Chevrolet (**Figure 4**) impacted the right side of the Hyundai (event 1). The Hyundai's direction of force was within the 2 o'clock sector and the impact force was sufficient to trigger deployment of the front right seat back-mounted side impact air bag and the frontal air bags. The impact caused the Hyundai and Chevrolet to rotate clockwise and be redirected southeast. As the vehicles rotated, the Chevrolet began to roll over, left side leading (event 2), and the left front portion of the Chevrolet rolled onto the top back portion of the Hyundai (event 3, **Figure 5**). The Hyundai's left side wheels impacted the curb (events 4 and 5) on the southeast quadrant of the intersection. The Hyundai continued into the yard of the residence with its left side leading and the left fender impacted the right quarter panel of the 1998 Ford Taurus (event 6, **Figures 6** and **7**). The impact force was not sufficient to trigger deployment of the Hyundai's driver's seat back-mounted side impact air bag. The Hyundai came to final rest in the front yard of the residence against the Taurus facing southwest (**Figure 7**). Following separation from the Hyundai, the Chevrolet was on its left side. It continued its clockwise rotation with its left side contacting the sidewalk and ground, and it came to final rest on its wheels in the yard of the residence heading southeast. Following impact with the Hyundai, the Taurus' left fender impacted the residence (event 7) and its left quarter panel impacted the Explorer's right side plane (event 8).

Figure 2: Hyundai's approach to the impact area; arrow shows approach of the Chevrolet

Figure 3: Chevrolet's approach to the impact area; arrow shows approach of the Hyundai

Figure 4: Damage to the front plane of the Chevrolet due to the impact with the right side plane of the Hyundai

Post-Crash: The emergency responders were notified and responded to the crash scene. The Hyundai's right front door was removed in order to extricate the front right passenger who was pronounced deceased at the crash scene. The drivers of the Hyundai and the Chevrolet were both taken by ambulance to a local hospital. The Hyundai and Chevrolet were towed due to damage. Neither parked vehicle was towed.

Figure 5: Damage to the top plane on the back of the Hyundai due to impact from the Chevrolet as it rolled over

Figure 6: Hyundai's damage from impact with parked Ford Taurus

Figure 7: Final rest position of the Hyundai and Chevrolet (arrow on left); arrow on right shows the Ford Taurus that was impacted by the Hyndai

CASE VEHICLE

Case Vehicle: The 2004 Hyundai Tiburon was a front wheel drive, 2-door hatchback (VIN: KMHHM65D74U------) that was manufactured on March 23, 2004. The vehicle was equipped with a 2.0L, 4-cylinder engine, 5-speed manual transmission, redesigned frontal air bags and front seat back-mounted side impact air bags. The front row was equipped with bucket seats with folding backs, adjustable head restraints, and lap-and-shoulder belts. The second row was equipped with a bench seat with folding backs and lap-and-shoulder belts in the outboard seating positions. There was no designated second row center seating position. The vehicle's mileage at the time of the inspection could not be determined since the vehicle was equipped with an electronic odometer and was without power. The vehicle's specified wheelbase was 253 cm (99.6 in).

CASE VEHICLE DAMAGE

Exterior Damage: The Hyundai's impact with the Chevrolet (event 1) involved the right side plane (**Figure 7**). The right fender, front wheel, door, A-pillar, roof rail, and quarter panel were all directly damaged. The direct damage began 278 cm (109.4 in) forward of the right rear axle and extended 243 cm (95.7 in) rearward. The crush measurements were taken at the mid-door

level, and the maximum residual crush was 46 cm (18.1 in) occurring at C_3 (**Figure 8**). Due to the missing right front door, the crush was estimated at C_3 and C_4 based on the crush at the lower A-pillar and quarter panel. The vehicle's sill height was 27 cm (10.6 in). The height of the maximum door crush was 26 cm (10.2 in) and the Door Sill Differential was 20 cm (7.9 in). The table below shows the vehicle's right side 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	243	46	293	0	37	46	36	2	0	39	24
in		95.7	18.1	115.4	0.0	14.6	18.1	14.2	0.8	0.0	15.4	9.4

The right side wheelbase was reduced 19 cm (7.5 in) while the left side wheelbase was extended 1 cm (0.4 in). Induced damage involved the windshield, hood, right quarter panel, and roof rail.

Figure 8: Top view of the crush to the Hyundai's right side plane from the impact with the Chevrolet

The Hyundai's second impact (event 3) with the Chevrolet (event 3) involved the Hyundai's right quarter panel and top of the rear hatch. The right quarter panel, backlight, rear hatch, and rear spoiler were all directly damaged. No crush measurements were taken due to the non-horizontal nature of the impact. The back panel of the hatch sustained induced damage from this impact.

The Hyundai's impacts with the curb (events 4 and 5) involved the left front and left rear wheels. The left front wheel was positively cambered 90 degrees. The left rear wheel rim was abraded and broken. The left rear tire sidewall was also abraded. Wheel impacts are out of scope of the crush measurement protocol.

The Hyundai's impact with the parked Ford Taurus (event 6) involved the front portion of the vehicle's left side plane (**Figure 6**). The bumper fascia, left fender, left front wheel, and door were directly damaged. The direct damage began 326 cm (128.3 in) forward of the left rear axle and extended 166 cm (65.4 in) rearward. The crush measurements were taken at the mid-door level and the maximum residual crush was 32 cm (12.6 in) occurring at C_5. The induced damage involved the hood, left fender and left front door. The table below shows the crush profile for this impact.

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	6	166	32	166	0	2	16	23	32	21	114	114
in		65.4	12.6	65.4	0.0	0.8	6.3	9.1	12.6	8.3	44.9	44.9

Damage Classification: The Collision Deformation Classifications (CDCs) for the Hyundai were **02-RYAW-4** (**50** degrees) for the impact with the Chevrolet (event 1), **00-TZDW-2** for the impact by the Chevrolet during its rollover (event 3), **09-LBWN-1** (**270** degrees) for the left rear wheel impact with the curb (event 4), **09-LFWN-1** (**270** degrees) for the left front wheel impact with the curb (event 5), and **09-LFEW-2** (**270** degrees) for the impact with the Taurus (event 6). The Damage algorithm of the WinSMASH program calculated for the Hyundai's total Delta-V as 55 km/h (34 mph) for the right side impact with the Chevrolet. The longitudinal and lateral velocity changes were -35 km/h (-22 mph) and -42 km/h (-26 mph), respectively. The Missing Vehicle algorithm of the WinSMASH program calculated the Hyundai's total Delta-V as 24 km/h (15 mph) for the impact with the Ford Taurus. The longitudinal and lateral velocity changes were 0 km/h and 24 km/h (15 mph), respectively. The results were based only on the Hyundai's crush profile and should be considered borderline. No reconstruction was completed for events 3, 4, and 5 since wheel impacts and non-horizontal impacts are out of scope for the WinSMASH program.

The vehicle manufacturer's recommended tire size was P195/65R15, but the vehicle was equipped with tires sized P205/55R16. The Hyundai'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	6	7	Unknown[1]	Yes	Yes
LR	124	18	207	30	6	7	Sidewall abraded	No	No
RR	179	26	207	30	6	7	None	No	No
RF	207	30	207	30	6	8	None	Yes	No

Vehicle Interior: Inspection of the Hyundai's interior revealed evidence of occupant contact on the center console. The console was broken adjacent to the front right passenger's seat cushion probably from contact by the passenger's left hip as well as the displacement of the seat. Blood transfers were also present on the driver's frontal air bag and the front right passenger seat back-mounted side impact air bag.

[1] The left front wheel was positively cambered 90 degrees and it was not possible to examine the outboard side of the tire.

The left front door remained closed and operational, while the right side door was jammed shut and had to be removed by rescue personnel. The pre-crash condition of the left front window glazing was open. All the remaining window glazing was either closed or fixed. The right front, right rear, roof, and backlight glazings were disintegrated as a result of the impact with the Chevrolet. The windshield was in place and holed by impact forces.

The Hyundai sustained numerous passenger compartment intrusions. The most severe intrusions occurred in the front right occupant space. It was estimated that the right front door intruded laterally 46 cm (18.1 in). The side panel forward of the A-pillar and the A-pillar intruded laterally 46 cm (18.1 in).

AUTOMATIC RESTRAINT SYSTEM

The Hyundai was equipped with a redesigned frontal air bag system. The driver's air bag was located within the steering wheel hub and the front right passenger's air bag was located in the middle of the instrument panel.

The driver's air bag module cover consisted of two flaps constructed of pliable vinyl. The top flap was 17 cm (6.9 in) in width and 4 cm (1.6 in) in height. The bottom flap was 17 cm (6.9 in) width and 10 cm (3.9 in) in height. The flaps opened at the designated tear points and were undamaged. The deployed driver's air bag (**Figure 9**) was 63 cm (25 in) in diameter. It had two vent ports located at the 10 and 2 o'clock positions and two tethers. There were several blood transfers on the air bag in the upper and lower left quadrants.

Figure 9: The driver's deployed frontal air bag

The front right passenger's air bag module cover consisted of a single flap constructed of pliable vinyl. It was was 30 cm (11.8 in) in width and 16 cm (6.3 in) in height. The flap opened at the designated tear points and was undamaged. The deployed front right passenger air bag was 48 cm (18.9 in) in width and 57 cm (22.4 in) in height. It was equipped with two wide tethers and one vent port on the left side at the 9 o'clock position. Inspection of the air bag revealed a 26 cm (10.2 in) tear in the fabric (**Figure 10**) on the top left. The source of the tear is unknown.

Figure 10: Tear in top of front right passenger's frontal air bag

The vehicle's side impact air bag system consisted of front seat back-mounted side impact air bags, which were located in the outboard side of the seat backs and deployed through a tear

seam (**Figure 11**). Based on the Holmatro Rescuer's Guide to Vehicle Safety Systems, the side impact sensors were located below the left and right B-pillars on the floorboard.

The deployed front right passenger seat back-mounted side impact air bag (**Figure 12**) was 63 cm (24.8 in) in height and 36 cm (14.2 in) in width. Inspection of the air bag revealed a small blood transfer on the upper right quadrant on the inboard side of the air bag. There was no damage on the air bag. The driver's side impact air bag did not deploy in this crash.

Figure 11: Location of the Hyundai's front right passenger's seat back-mounted side impact air bag

Figure 12: The deployed front right seat back-mounted side impact air bag

MANUAL RESTRAINT SYSTEM

The Hyundai was equipped with lap-and-shoulder belts for the front and second row seating positions. The driver's seat belt consisted of continuous loop belt webbing, a sliding latch plate, an adjustable upper anchor that was located in the full-up position, an Emergency Locking Retractor (ELR), and a retractor-mounted pretensioner. The front right seat belt was equipped with continuous loop belt webbing, a sliding latch plate, an ELR/Automatic Locking Retractor (ALR), an adjustable upper anchor that was located in the full-down position, and a retractor-mounted pretensioner. The front right seat belt retractor was jammed due to damage to the B-pillar. The driver's seat belt retractor spooled freely. Due to the post-crash condition of the driver and passenger retractors, it could not be determined if either pretensioner actuated. The second row lap and shoulder belts were not accessible due to the damage.

Inspection of the driver's seat belt system revealed a load abrasion (**Figure 13**) on the seat belt webbing that was 32 cm (12.6 in) in length. It was located 103 cm (40.6 in) above the stop button. Historical usage scratches were also found on the latch plate. This evidence indicated that the driver was restrained at the time of the crash.

The front right passenger's seat belt was cut by rescue personnel to extricate the passenger. Inspection of the remainder of the seat belt system revealed that the webbing was partially folded over on itself and jammed in the latch plate belt guide (**Figure 14**). This evidence indicated that

the front right passenger was restrained at the time of the crash.

Figure 13: Load abrasion on the driver's seat belt

Figure 14: The front right passenger's seat belt webbing was folded over on itself and jammed in the latch plate belt guide

CASE VEHICLE DRIVER KINEMATICS

The Hyundai's driver [22-year-old, male, unknown height and 68 kg (150 lbs)] was seated in an unknown posture. At the time of the inspection, the driver's seat track was located in the middle position and the seat back was reclined 30 degrees. The seat back was probably not adjusted to this position at the time of the crash. The reclined position was probably the result of either rescue operations or other post-crash handling of the vehicle.

The Hyundai's right side plane impact with the Chevrolet initially displaced the driver forward and right, opposite the 2 o'clock direction of force. He loaded the seat belt and his face probably loaded the deployed air bag, which caused abrasions and contusions to his right eyelid, lateral right eye area, and right face. He also sustained abrasions on both arms and chest, probably due to loading the air bag. The driver sustained a dislocation the right acromioclavicular joint, which was probably the result of contacting the front right passenger.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to a hospital. He was treated in the emergency room and released. The table below shows 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	Dislocation {separation}, mild, right acromioclavicular joint	moderate 750230.2,1	Other occupant–front right passenger	Probable	Emergency room records
2	Laceration right scalp near right ear with glass foreign bodies	minor 190602.1,1	Noncontact injury: flying glass, right front glazing	Certain	Emergency room records

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
3 4	Abrasions and contusion, minor, right eyelid	minor 297202.1,1 297404.1,1	Air bag, driver's	Probable	Emergency room records
5	Abrasions lateral right eye area	minor 290202.1,1	Air bag, driver's	Possible	Emergency room records
6	Contusions right face, not further specified	minor 290402.1,1	Other occupant–front right passenger	Possible	Emergency room records
7	Laceration lateral right eye area	minor 290600.1,1	Noncontact injury: flying glass, right front glazing	Probable	Emergency room records
8	Abrasions right lateral and anterior chest, not further specified	minor 490202.1,1	Air bag, driver's	Possible	Emergency room records
9	Abrasion posterolateral left forearm, not further specified	minor 790202.1,2	Air bag, driver's	Probable	Emergency room records
10	Abrasions anterior right upper arm, not further specified	minor 790202.1,1	Air bag, driver's	Probable	Emergency room records

CASE VEHICLE FRONT ROW RIGHT PASSENGER KINEMATICS

The Hyundai's front right passenger [37-year-old, male, 170 cm and 80 kg (67 in, 176 lbs)] was seated in an unknown posture. At the time of inspection, the front right passenger's seat track was located in the middle position. The seat back position could not be determined due to the damage to the seat as a result of the right front door intrusion.

The Hyundai's right side plane impact with the Chevrolet initially displaced the front right passenger forward and right, opposite the 2 o'clock direction of force. The right side of his body loaded the intruding right front door and his head probably contacted the front of the Chevrolet. The driver sustained a laceration on the right forehead, cerebral edema, subarachnoid hemorrhage and a contusion of the spinal cord, probably due to contact with the Chevrolet's grille. He sustained a laceration of the thoracic aorta, right rib fractures, and lacerations of the right lung, liver, and spleen due to contacting the intruding right front door. Contact to the right front door also caused fractures of the symphis pubis, right tibia, and right fibula. The passenger's left arm probably contacted the driver during the initial impact, which fractured the passenger's left humerus. The passenger sustained multiple abrasions and lacerations due to flying glass from the disintegrated right front window glazing.

The front right passenger sustained fatal injuries and was pronounced deceased at the crash scene 44 minutes following the crash. The autopsy report recorded his Blood Alcohol Concentration was 0.29 mg/dl. The table below shows the passenger'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	Contusion {crushed} spinal cord at cranial-cervical junction with gaping dislocation {atlanto-occipital}	maximum 640234.6,6	Exterior of other motor vehicle: grille {Indirect injury}	Probable	Autopsy
2	Laceration {transection} thoracic aorta immediately distal to arch with hemorrhage not confined to mediastinum[2] (i.e., bilateral hemothoraces–1.4 liters right pleural cavity, 400 ml left pleural cavity)	maximum 420218.6,4	Right front door panel, rear upper quadrant	Certain	Autopsy
3 4	Cerebral edema, moderate, with symmetrical flattening of gyri over hemispheres but no herniation	severe 140664.4,1 140664.4,2	Exterior of other motor vehicle: grille	Probable	Autopsy
5	Hemorrhage, subarachnoid, over base of brain, not further specified	serious 140684.3,9	Exterior of other motor vehicle: grille	Probable	Autopsy
6	Fractures right ribs: 4th through 12th with associated lung lesions	serious 450230.3,1	Right front door panel, rear upper quadrant	Certain	Autopsy
7 8	Lacerations right parietal pleural and right upper lobe of lung	serious 441414.3,1 441802.3,1	Right front door panel, rear upper quadrant	Certain	Autopsy
9	Lacerations, numerous, liver up to 6.4 mm (0.25 in) in depth and 12.7 cm (5 in) in length, not further specified	moderate 541822.2,1	Right front door panel, rear upper quadrant	Certain	Autopsy
10	Lacerations, multiple, splenic capsule, not further specified	moderate 544222.2,2	Right front door panel, rear upper quadrant	Certain	Autopsy

[2] The following term is defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
mediastinum (me"de-as"tī'nam): The mass of tissues and organs separating the two pleural sacs, between the sternum anteriorly and the vertebral column posteriorly *{i.e., the bodies of the 12 thoracic vertebrae}* and from the thoracic inlet superiorly to the diaphragm inferiorly. It contains the heart and its pericardium, the bases of the great vessels *{e.g., aorta, aortic arch, vena cava, pulmonary arteries and veins}*, the trachea and bronchi, esophagus, thymus, lymph nodes, thoracic duct, phrenic and vagus nerves, and other structures and tissues.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
11	Fracture, palpable, over mid left humerus, not further specified	moderate 752602.2,2	Interior object: other occupant–driver	Probable	Autopsy
12	Fracture, palpable, symphysis pubis	serious 853000.3,5	Right front door panel, rear lower quadrant	Probable	Autopsy
13 14	Fractures, palpable, right tibia and fibula, not further specified	moderate 851605.2,1 853404.2,1	Right front door panel, front lower quadrant	Certain	Autopsy
15 16	Abrasions, including dicing type lacerations, and lacerations {scratches} over anterior scalp, not further specified	minor 190202.1,5 190602.1,5	Noncontact injury: flying glass, right front glazing	Certain	Autopsy
17	Abrasions, including dicing type lacerations, over forehead, not further specified	minor 290202.1,7	Noncontact injury: flying glass, right front glazing	Certain	Autopsy
18	Laceration, irregular, right forehead and lacerations {scratches} over forehead, not further specified	minor 290602.1,7	Exterior of other motor vehicle: grille	Probable	Autopsy
19	Abrasions, including dicing type lacerations, and lacerations {scratches} over face–especially right side, not further specified	minor 290202.1,1 290602.1,1	Noncontact injury: flying glass, right front glazing	Certain	Autopsy
20	Abrasion dorsal surface right wrist	minor 790202.1,1	Noncontact injury: flying glass, right front glazing	Probable	Autopsy
21	Abrasions, irregular, several, over posterior right leg, not further specified	minor 890202.1,1	Noncontact injury: flying glass, right front glazing	Probable	Autopsy
22	Lacerations {scratches}, several, over posterior right leg, not further specified	minor 890602.1,1	Noncontact injury: flying glass, right front glazing	Probable	Autopsy

The 2008 Chevrolet Tahoe LTZ (**Figure 15**) was a 2-wheel drive, 4-door, sport utility vehicle (VIN: 1GNFC13J88R------). It was equipped with a 5.3L, V8 engine, automatic transmission, 4-four wheel anti-lock disc brakes with electronic brake force distribution, driver and front right passenger frontal air bags, inflatable side curtain air bags with rollover sensing, and Electronic Stability Control. The vehicle's frontal air bags were certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208.

Figure 15: The damaged 2008 Chevrolet Tahoe LTZ

Exterior Damage: The Chevrolet's impact with the Hyundai involved the Chevrolet's front plane. The direct damage involved the front bumper, grille, hood, right and left headlamp/turn lamp assemblies, and left fender. The direct damage began on the front left bumper corner and extended 145 cm (57.1 in) across the front (**Figure 15**). The maximum residual crush was 43 cm (16.9 in) occurring at C_4. The table below shows the vehicle's front crush profile.

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	145	43	145	13	28	36	43	34	30	0	0
in		57.1	16.9	57.1	5.1	11.0	14.2	16.9	13.4	11.8	0.0	0.0

The right side wheelbase was reduced 14 cm (5.5 in) and the left side wheelbase was unchanged. The induced damage involved the windshield, right fender, both front doors, and the left roof rail.

The Chevrolet's rollover and the impact with the top back of the Hyundai, which occurred during the rollover involved the left side of the vehicle. The left fender, doors, hood, both wheels, quarter panel, and turn lamp assembly were all directly damaged.

Damage Classification: The Chevrolet's CDC for the front impact with the Hyundai (event 1) was **71-FDEW-2** (**320** degrees). The force direction was incremented by 60 to account for the right shift of the end structure, which exceeded the 10 cm (4 in) threshold. The CDC for the rollover (event 2) was **00-LDAO-2** and **00-LFEW-2** for the impact to the Hyundai during the rollover (event 3). The Damage algorithm of the WinSMASH program calculated the vehicle's total Delta-V for the front impact as 33 km/h (21 mph). The longitudinal and lateral velocity changes were -25 km/h (-16 mph) and 21 km/h (13), respectively.

The vehicle manufacturer's recommended tire size was P275/55R20. The vehicle was equipped with recommended size tires. The Chevrolet'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	248	36	221	32	8	10	None	No	No
LR	Flat	Flat	221	32	8	10	Sidewall cut	No	Yes
RR	241	35	221	32	7	9	None	No	No
RF	255	37	221	32	9	11	None	No	No

Event Data Recorder: The Chevrolet's EDR was imaged by the police using version 3.0 of the Bosch Crash Data Retrieval tool and a copy was provided to this contractor. The EDR recorded a deployment event. The downloaded data indicated that the SIR warning lamp was off and the driver's seat belt switch circuit was recorded as unbuckled. The first stage deployment criteria for the driver's frontal air bag was met at 132.5 msec following AE and stage two was met at 135 msec following AE. There was no front right passenger in the vehicle and the deployment of the passenger air bag was suppressed. The EDR recorded the maximum longitudinal and lateral velocity changes as -38.94 (-24.2 mph) and 26.63 (16.55 mph), respectively. The pre-crash data is discussed in the pre-crash section of this report on page 1. The EDR report is attached at the end of this report[3].

Other Vehicle's Driver: The police crash report indicated that the 26-year-old male driver was unrestrained. The driver sustained a C-injury as a result of the crash.

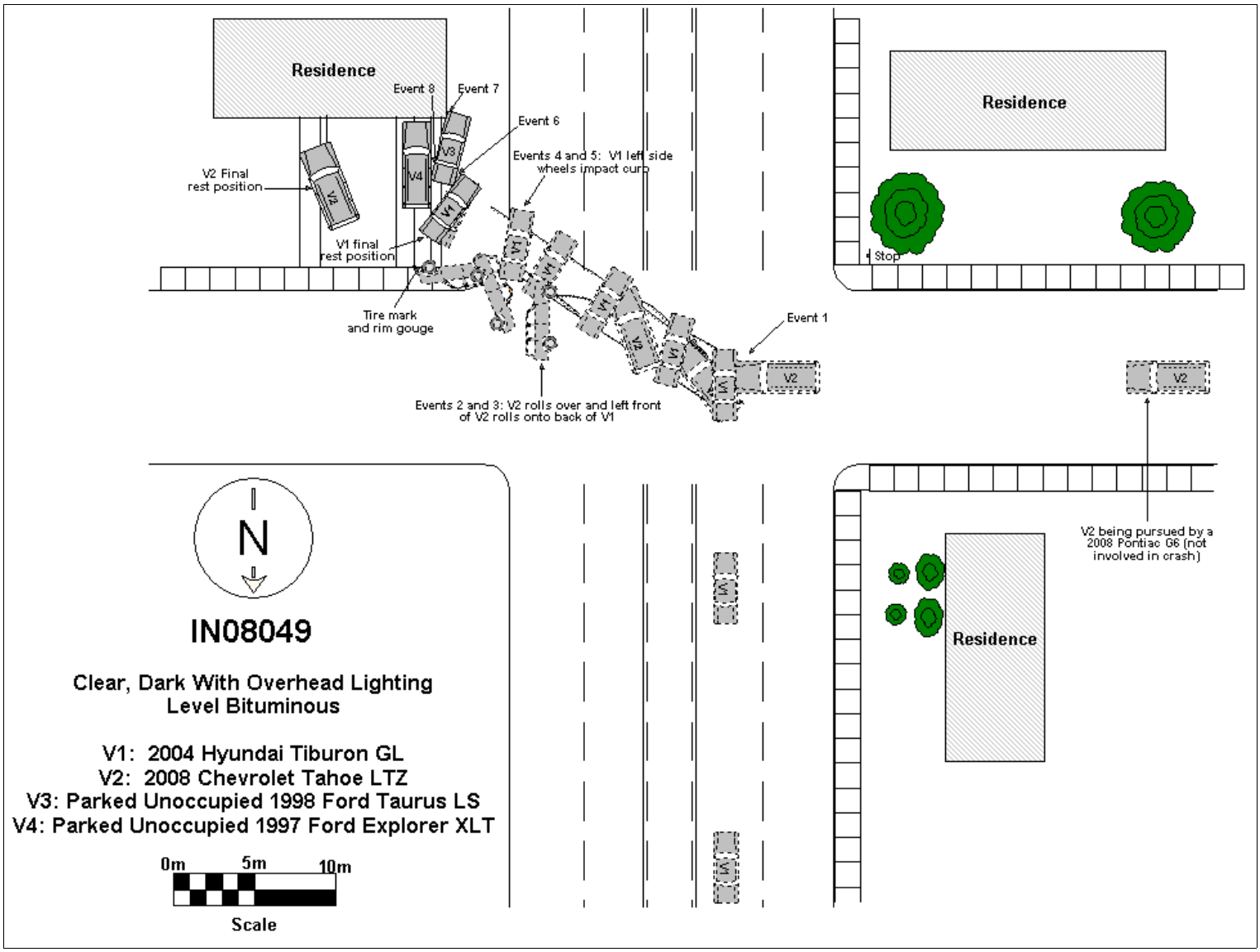
FIRST PARKED VEHICLE

The 1998 Ford Taurus was a front wheel drive, 4-door sedan (VIN: 1FAFP52S6WA------). It was equipped with a 3.0L, V6 engine, and redesigned frontal air bags. The vehicle was an unoccupied, parked vehicle and was not inspected.

Damage Classification: Based on the police on-scene photographs, the Ford's impact with the Hyundai (event 6) involved the Ford's right quarter panel and rear portion of the right rear door. Based on the police on-scene photographs, the CDC was **03-RZEW-2** (**90** degrees).

[3] Pages 6-8 of the EDR report have been omitted for confidentiality reasons.

The 1997 Ford Explorer was an 4-wheel drive, 4-door sport utility vehicle (VIN: 1FMDU35PXVZ------) equipped with a 5.0L, V8 engine. The vehicle was an unoccupied, parked, not-in-transport vehicle and was not inspected. It was not involved in an impact with the case vehicle.


Residence
Event 8
Event 7
Event 6
Events 4 and 5: V1 left side wheels impact curb
V2 Final rest position
V1 final rest position
Tire mark and rim gouge
Event 1
Events 2 and 3: V2 rolls over and left front of V2 rolls onto back of V1
Residence
Stop
V2
V2 being pursued by a 2008 Pontiac G6 (not involved in crash)
Residence
N
IN08049
Clear, Dark With Overhead Lighting
Level Bituminous
V1: 2004 Hyundai Tiburon GL
V2: 2008 Chevrolet Tahoe LTZ
V3: Parked Unoccupied 1998 Ford Taurus LS
V4: Parked Unoccupied 1997 Ford Explorer XLT
0m 5m 10m
Scale

CDR File Information

Vehicle Identification Number	1GNFC13J88R[redacted]
Investigator	[redacted]
Case Number	
Investigation Date	[redacted]
Crash Date	
Filename	1GNFC13J88R[redacted]
Saved on	
Collected with CDR version	Crash Data Retrieval Tool 3.00
Reported with CDR version	Crash Data Retrieval Tool 3.00
EDR Device Type	airbag control module
Event(s) recovered	Deployment

Data Limitations

SDM Recorded Crash Events:
There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). The minimum SDM Recorded Vehicle Forward Velocity Change, that is needed to record a Non-Deployment Event, is 5 MPH. It can contain Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by a Deployment Level Event, if the Non-Deployment Event is not locked. This event will be cleared by the SDM, after 250 ignition cycles.
The second type of SDM recorded crash event is the Deployment Event. It also can contain Pre-Crash and Crash data. The SDM can store up to two different Deployment Events. Deployment Events cannot be overwritten or cleared from the SDM. Once the SDM has deployed the air bag, the SDM must be replaced.
The data in the Non-Deployment Event file will be locked after a Deployment Event, if the Non-Deployment Event occurred within 5 seconds before the Deployment Event. If a Deployment Level Event occurs any time after the Deployment Event, the Deployment Level Event will overwrite any non-locked Non-Deployment Event.

SDM Data Limitations:
-SDM Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Forward Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle forward velocity change. For Deployment Events and Deployment Level Events, the SDM will 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 will record up to the first 300 milliseconds of data after algorithm enable. The minimum SDM Recorded Vehicle Forward Velocity Change, that is needed to record a Non-Deployment Event, is 5 MPH.
-Maximum Recorded Vehicle Velocity Change is the maximum recorded velocity change in the vehicle's combined "X" and "Y" axis. It is calculated every 10 ms by taking the square of the "X" axis value and adding it to the square of the "Y" axis value and then taking the square root of the sum. The greatest calculated value is the one that is stored.
-Event Recording Complete will indicate if data from the recorded event has been fully written to the SDM memory or if it has been interrupted and not fully written.
-SDM Recorded Vehicle Speed accuracy can be affected if the vehicle has had the tire size or the final drive axle ratio changed from the factory build specifications.
-Brake Switch Circuit Status indicates the status of the brake switch circuit.
-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if the SDM receive an invalid message from the module sending 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 and Deployment Events is displayed in seconds. If the time between the two events is greater than 5 seconds or the events overlap one another, "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.
-Driver and Passenger Pretensioner Deployment Loop Commanded data will be displayed as "No", if they were the only restraint device commanded to be deployed in an event.

SDM 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.

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)	OFF
Vehicle Power Mode Status	Run
Remote Start Status (If Equipped)	Inactive
Run/Crank Ignition Switch Logic Level	Active

Pre-crash data

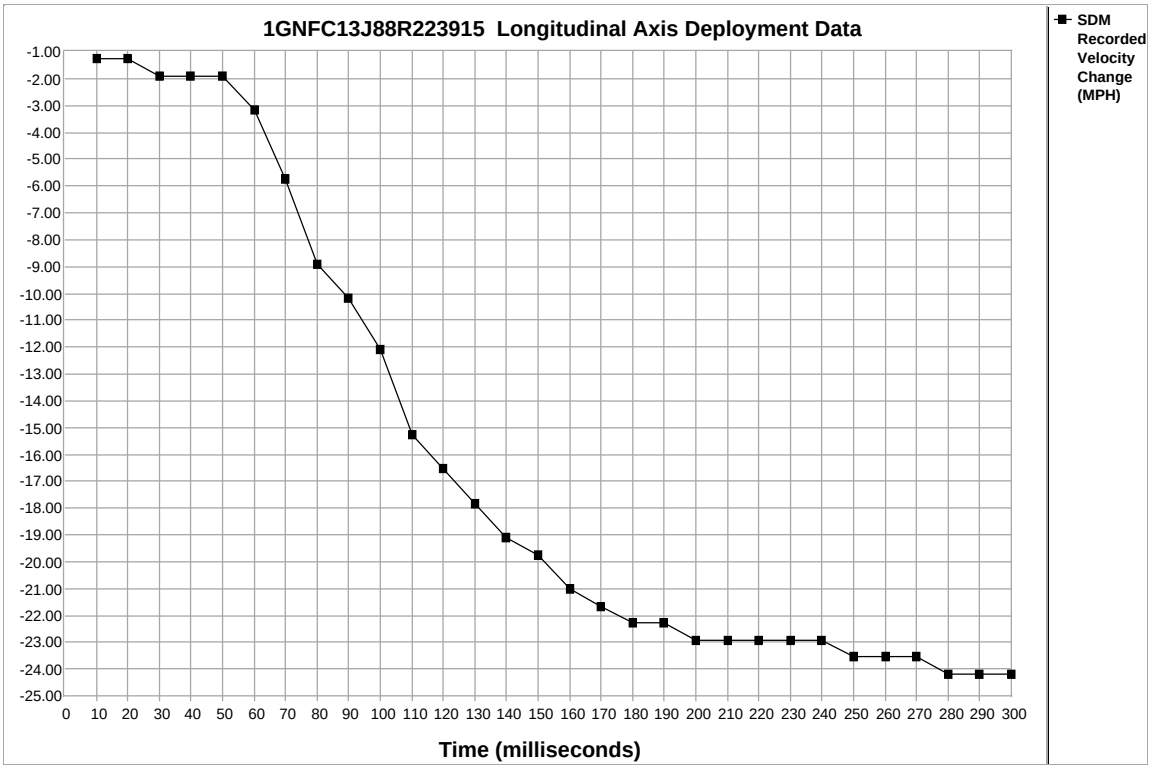
Parameter	-1.0 sec	-0.5 sec
Reduced Engine Power Mode	OFF	OFF
Cruise Control Active (If Equipped)	No	No
Cruise Control Resume Switch Active (If Equipped)	No	No
Cruise Control Set Switch Active (If Equipped)	No	No
Engine Torque (foot pounds)	122.07	289.51

Pre-crash data

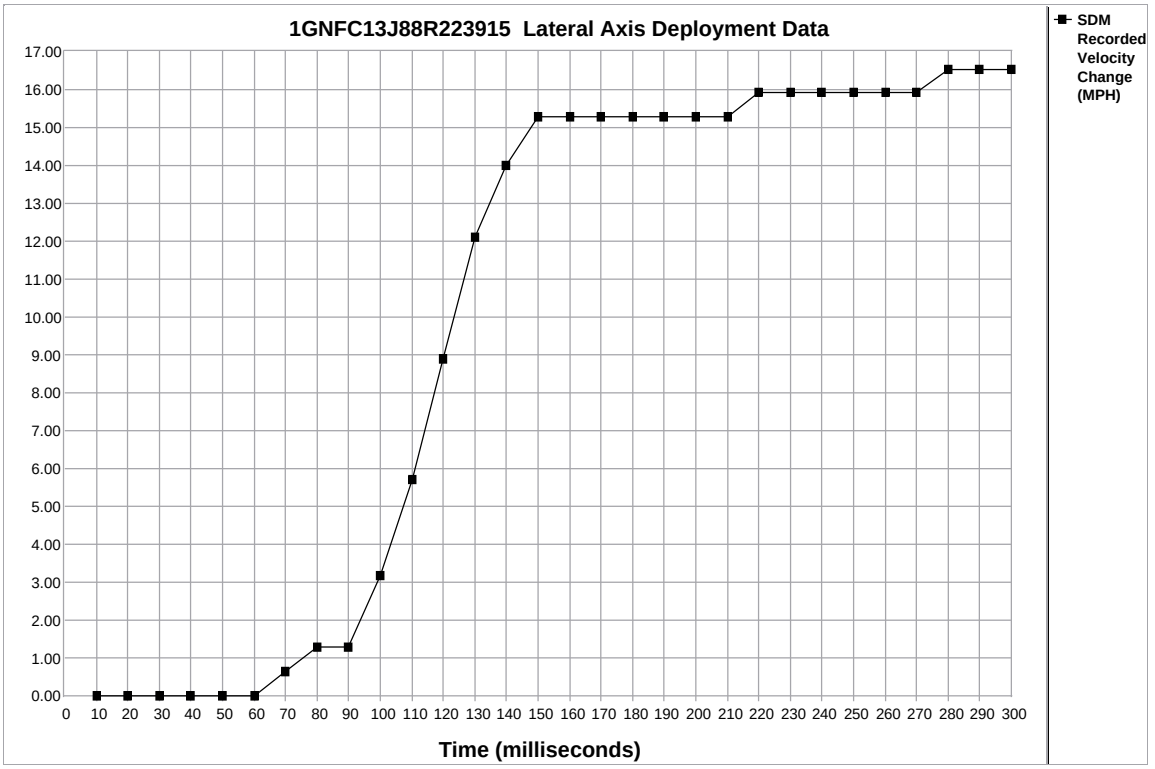
Parameter	-2.5 sec	-2.0 sec	-1.5 sec	-1.0 sec	-0.5 sec
Vehicle Speed (MPH)	54	56	57	57	58
Engine Speed (RPM)	3392	3520	3392	3520	3648
Percent Throttle	73	80	26	40	93
Brake Switch Circuit Status	OFF	OFF	OFF	OFF	OFF

System Status At Deployment

Ignition Cycles At Investigation	2615
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/Off Time Continuously (seconds)	178900
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	174
Ignition Cycles At Event	2614
Ignition Cycles Since DTCs Were Last Cleared	255
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger's Belt Switch Circuit Status	UNBUCKLED
Driver Seat Position Switch Circuit Status	Rearward
Passenger Classification Status at Event Enable	Passenger Seat Empty
Current Passenger Position Status at Event Enable	Unknown
Previous Passenger Position Status at Event Enable	Unknown
Passenger Air Bag Indicator Status at Event Enable	OFF
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)	132.5
Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	135
Passenger 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Suppressed
Passenger 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Suppressed
Driver Side or Roof Rail/Head Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Passenger Side or Roof Rail/Head Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Rollover Occupant Containment Enable Status	Enabled
Side Air Bag Deployment Status Due to Rollover Commanded	No Side Air Bags Were Deployed
Rollover Sensor Status	Rollover Event
Time From Rollover Event Enable to Deployment (ms)	0
Crash Record Locked	Yes
Vehicle Event Data (Pre-Crash) Associated With This Event	Yes
SDM Synchronization Counter	2614
Time Between Events (sec)	N/A
Event Recording Complete	Yes
Driver First Stage Deployment Loop Commanded	Yes
Passenger First Stage Deployment Loop Commanded	No
Driver Second Stage Deployment Loop Commanded	Yes
Driver 2nd Stage Deployment Loop Commanded for Disposal	No
Passenger Second Stage Deployment Loop Commanded	No
Passenger 2nd Stage Deployment Loop Commanded for Disposal	No
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	Yes
Passenger (Initiator 3) Roof Rail/Head Curtain Loop Commanded	Yes
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)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Longitudinal Axis Recorded Velocity	-1.27	-1.27	-1.91	-1.91	-1.91	-3.18	-5.73	-8.91	-10.19	-12.10	-15.28	-16.55	-17.83	-19.10	-19.74
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Longitudinal Axis Recorded Velocity	-21.01	-21.65	-22.29	-22.29	-22.92	-22.92	-22.92	-22.92	-22.92	-23.56	-23.56	-23.56	-24.20	-24.20	-24.20



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Lateral Axis Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.64	1.27	1.27	3.18	5.73	8.91	12.10	14.01	15.28
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Lateral Axis Recorded Velocity Change (MPH)	15.28	15.28	15.28	15.28	15.28	15.28	15.92	15.92	15.92	15.92	15.92	15.92	16.55	16.55	16.55