# INDIANA UNIVERSITY

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


# ON-SITE ROLLOVER INVESTIGATION

CASE NUMBER - IN10002
LOCATION - TEXAS
VEHICLE - 2008 HUMMER H3
CRASH DATE - December 2009

Submitted:

June 3, 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.*<br>IN10002 | 2. *Government Accession No.* | 3. *Recipient's Catalog No.* | |
| 4. *Title and Subtitle*<br>On-Site Rollover Investigation<br>Vehicle - 2008 Hummer H3<br>Location - Texas | | 5. *Report Date:*<br>June 3, 2010<br>6. *Performing Organization Code* | |
| 7. *Author(s)*<br>Special Crash Investigations Team #2 | | 8. *Performing Organization Report No.* | |
| 9. *Performing Organization Name and Address*<br>Transportation Research Center<br>Indiana University<br>501 South Madison Street, Suite 105<br>Bloomington, Indiana 47403-2452 | | 10. *Work Unit No. (TRAIS)*<br>11. *Contract or Grant No.*<br>DTNH22-07-C-00044 | |
| 12. *Sponsoring Agency Name and Address*<br>U.S. Department of Transportation (NVS-411)<br>National Highway Traffic Safety Administration<br>National Center for Statistics and Analysis<br>Washington, D.C. 20590-0003 | | 13. *Type of Report and Period Covered*<br>Technical Report<br>Crash Date: December 2009<br>14. *Sponsoring Agency Code* | |
| 15. *Supplementary Notes*<br>On-Site Rollover Investigation involving a 2008 Hummer H3. | | | |
| 16. *Abstract*<br>The focus of this on-site investigation was the rollover of a 2008 Hummer H3. The unrestrained 48-year-old male driver was traveling northeast in the left lane of a one-way three lane access roadway and was negotiating a right curve. The vehicle lost traction when it traveled onto a patch of ice on the roadway. The vehicle departed the left side of the road and the front plane impacted a blocked-out W-beam metal guardrail. The vehicle continued through the guardrail and rolled over left side leading (event 2) as it became airborne. The vehicle rolled over 10 quarter turns across a distance of approximately 45 m (147.6 ft). During the rollover, the left sill and undercarriage, the top plane, and the right fender impacted coniferous trees (events 3-5, respectively). During the rollover, the windshield was holed and the driver's head passed partially out of the holed windshield. He sustained severe injuries and was transported by ambulance to a hospital and was hospitalized for five days. | | | |
| 17. *Key Words*<br>Side Curtain Air Bag<br>Rollover<br>Motor Vehicle Traffic Crash<br>Injury Severity | | 18. *Distribution Statement*<br>General Public | |
| 19 *Security Classif. (of this report)*<br>Unclassified | 20. *Security Classif. (of this page)*<br>Unclassified | 21. *No. of Pages*<br>19 | 22. *Price* |

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

**TABLE OF CONTENTS** IN10002

This on-site investigation focused on the rollover of a 2008 Hummer H3 (**Figure 1**). This crash was brought to our attention by the National Highway Traffic Safety Administration (NHTSA) on January 13, 2010 through the sampling activities of the National Automotive Sampling System-General Estimates System (NASS-GES). This investigation was assigned on January 13, 2010. The crash involved the Hummer, which departed the road and rolled over after impacting a guardrail. The crash occurred in December, 2009, at 0620 hours, in Texas and was investigated by the city police department. The Hummer was inspected on January 15, 2010, while the crash scene was inspected on January 18, 2010. The driver of the Hummer was interviewed on January 26, 2010. This report is based on the police crash report, vehicle and crash scene inspections, exemplar vehicle inspection, driver interview, interview with the investigating police officer, driver medical records, occupant kinematic principles, and evaluation of the evidence.

**Figure 1:** The damaged 2008 Hummer H3

## CRASH CIRCUMSTANCES

***Crash Environment:*** This crash occurred on a 3-lane, undivided, one-way access roadway for a state highway. The roadway traversed in a northeasterly direction and had 3 through lanes and was curved to the right. The center lane was 4.1 m (13.4 ft) in width, while the other two lanes were 3.8 m (12.5 ft) in width. The grade was 1.6% positive. At the time of the crash, the light condition was dark with artificial lighting and the atmospheric condition was cloudy. The roadway was wet bituminous with patches of ice. The speed limit was 56 km/h (35 mph). There was no other traffic at the time of the crash and the site of the crash was urban commercial. The Crash Diagram is on page 11 of this report.

***Pre-Crash:*** The unrestrained 48-year-old male driver of the Hummer was traveling northeast in the third lane from the right and was negotiating a right curve (**Figure 2**). The driver stated during the SCI interview that he lost control of the vehicle after traveling onto a patch of ice on the roadway. The driver did not apply the brakes in an attempt to avoid the crash.

**Figure 2:** Approach of the Hummer to the area of road departure; arrow shows impacted guardrail; bent delineator post and marks in grass prior to guardrail and not related to this crash

***Event Data Recorder Pre-Crash Data:*** The vehicle was equipped with an Event Data

Recorder (EDR), which recorded 2.5 seconds of pre-crash data. The table below presents the pre-crash data recorded by the EDR. A row was added to convert mph to km/h.

| Time (sec) | -2.5 | -2.0 | -1.5 | -1.0 | -0.5 |
|---|---|---|---|---|---|
| Speed (mph) | 67 | 67 | 68 | 70 | 70 |
| Speed (km/h conversion) | 108 | 108 | 109 | 113 | 113 |
| Engine speed (rpm) | 2304 | 2304 | 2304 | 2368 | 2432 |
| Percent throttle | 23 | 23 | 23 | 40 | 40 |
| Brake switch circuit status | Off | Off | Off | Off | Off |

***Crash:*** As the vehicle departed the left side of the road, the front plane (**Figure 3**) impacted a blocked-out W-beam metal guardrail (**Figure 4**, event 1). The guardrail was anchored in the ground by wood posts and three of them were broken by the impact. The vehicle continued through the guardrail and rolled over left side leading (event 2) as it became airborne. During the rollover, the left sill and undercarriage, the top plane, and the right fender impacted coniferous trees (events 3-5, respectively). The vehicle was equipped with rollover/side impact inflatable curtain (IC) air bag and both deployed during the crash. The vehicle came to final rest on its top plane heading southeast.

**Figure 3:** Damage on the front plane of the Hummer from the guardrail impact and rollover

**Figure 4:** Damage on the guardrail from the impact by the front plane of the Hummer

***Post-Crash:*** The police were notified of the crash at 0625 hours and arrived on scene at 0630 hours. The driver was transported by ambulance to a hospital and the vehicle was towed due to damage.

The Hummer's rollover mitigation features consisted of rollover sensing and Electronic Stability Control (ESC). The vehicle was given a three star rollover rating on a five star scale and a Static Stability Factor of 1.12[1]. A three star rating indicates that the vehicle has a 20%-30% chance of a rollover when involved in a single vehicle crash. The specific chance of rollover for this vehicle model was given as 24%. The Static Stability Factor (SSF) is a calculation based on the vehicle's track width and height of its center of gravity. The result of the calculation is a measure of a vehicle's resistance to a rollover. A higher SSF indicates a more stable vehicle. The majority of passenger vehicles have an SSF of 1.30 to 1.50[2]. The NHTSA test vehicle also did not tip-up during the dynamic steering maneuver test in which the test vehicle was put through a fish-hook shaped steering maneuver (i.e., hard left and hard right steer) at between 56 km/h-80km/h (35-50 mph).

**Figure 5:** Mud deposits and damage on the front and left side plane from the rollover

**Figure 6:** Arrow shows the area of initial touchdown following the guardrail impact

The rollover of the Hummer was initiated following the impact with the guardrail. As the vehicle traveled over the guardrail, it acted like a ramp and the vehicle became airborne and began to roll over left side leading. The vehicle traversed approximately 21 m (68.9 ft) from the initial guardrail impact and touched down on its left side (**Figure 5**) in a muddy area (**Figure 6**) and continued to rollover. During the rollover the sill and undercarriage below the left front door (**Figure 7**) impacted and broke a coniferous tree. The top plane (**Figure 8**) impacted a second tree, which was not broken by the impact. The vehicle's right fender (**Figure 9**) impacted a third tree as the vehicle came to final rest (**Figure 10**) on its top plane heading southeast. Based on the crash scene physical evidence and the damage on the vehicle, it was estimated that the vehicle rolled over 10 quarter turns across a distance of approximately 45 m (147.6 ft).

---

[1] www.safercar.gov, 01/22/10

[2] "Trends in the Static Stability Factor of Passenger Cars, Light Trucks, and Vans", NHTSA Technical Report, DOT HS 809 868, June 2005

**Figure 7:** Damage on sill and undercarriage

**Figure 8:** Damage to the top plane from impact with a pine tree during the rollover

**Figure 9:** Damage from impact with pine tree

**Figure 10:** Arrow in center shows approximate location of tree that was broken when impacted by the Hummer's undercarriage; arrow on left shows tree impacted by top plane; arrow on right shows tree impacted by right fender as the Hummer came to final rest

## CASE VEHICLE

The 2008 Hummer H3 was a 4-wheel drive, 5-passenger, 4-door, sport utility vehicle (VIN: 5GTEN13E988------) equipped with a 3.7-liter, 5-cylinder engine, 4-speed automatic transmission, 4-wheel anti-lock disc brakes with electronic brake force distribution, traction control, electronic stability control, rollover sensing, and a tire pressure monitoring system. The front row was equipped with bucket seats, adjustable head restraints, lap-and-shoulder safety belts with pretensioners, dual stage driver and front right passenger frontal air bags, and rollover/side impact IC air bags that provided protection for the front and second rows. The second row was equipped with a split bench with folding backs, adjustable head restraints, lap-and-shoulder safety belts, and Lower Anchors and Tethers for Children (LATCH) in the outboard seating positions. The vehicle. The specified wheelbase was 284 cm (111.8 in).

***Exterior Damage:*** The impact with the guardrail (event 1) involved the front plane of the Hummer. The direct damage involved the lower portion of the chrome brush guard and the bumper bar. There was overlapping damage from the rollover on the plastic bumper fascia on each corner of the bumper. The direct damage involved the full width of the bumper bar, 94 cm (37 in). The maximum residual crush was 6 cm (2.4 in) occurring 7 cm (2.8 in) left of $C_4$. There was no rigid structure below the plastic bumper fascia at the corners.

| 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 | 94 | 6 | 94 | 2 | 0 | 3 | 4 | 0 | 0 | 0 | 0 |
| in | | 37.0 | 2.4 | 37.0 | 0.8 | 0.0 | 1.2 | 1.6 | 0.0 | 0.0 | 0.0 | 0.0 |

The damage from the rollover (event 2) involved the top, both side planes, and the undercarriage. The direct damage involved the full width and height of both side planes. The direct damage on the top plane also involved the full length of the vehicle and extended across the full width of the top, 107 cm (42.1 in). There was no crush on the A-pillars, windshield header, D-pillars of backlight header. Any crush between these points was masked by a subsequent impact with a coniferous tree.

**Figure 11:** Damage on the left sill and undercarriage

The direct damage on the undercarriage from the tree impact (event 3) began 215 cm (84.6 in) forward of the left rear axle and was 78 cm (30.7 in) in length. The maximum crush on the undercarriage occurred at the left sill (**Figure 11**) and was approximately 10 cm (3.9 in).

The direct damage on the top plane from the tree impact (event 4) began 130 cm (51.2 in) forward of the left rear axle and extended across the full width of the top. The width of the direct damage was 43 cm (16.9 in). The maximum vertical and lateral crush as a result of this impact was 29 cm (11.4 in) and 12 cm (4.7 in), respectively, which occurred on the right roof side rail (**Figure 12**).

**Figure 12:** Crush on the roof from impact with a tree

The direct damage on the right side plane from the tree impact (event 5) involved the right fender and front portion of the right front door. The contact with the tree involved the fender, which was off the vehicle and not present at the inspection. No crush profile could be measured.

***Damage Classification:*** The Collision Deformation Classifications were 12FDLW1 (0 degrees) for the front plane impact with the guardrail (event 1), 00TDDO9 (extent zone unknown) for the rollover (event 2), 00UPLW2 for the undercarriage impact with the first pine tree (event 3), 00TPDW4, for the top plane impact with the second pine tree (event 4), and 00RYEW3 for the impact with third pine tree (event 5). The WinSMASH program could not be used on any of the impacts since rollovers, yielding object impacts, and non-horizontal impacts are out of scope for the program.

The vehicle manufacturer's recommended tire size was P265/75R16. The Hummer was equipped with tires of the recommended size. The vehicle's tire data are shown in the table below.

| *Tire* | *Measured Pressure* | | *Vehicle Manufacturer'sRecommended Cold Tire Pressure* | | *Tread Depth* | | *Damage* | *Restricted* | *Deflated* |
|---|---|---|---|---|---|---|---|---|---|
| | kPa | psi | kPa | psi | milli-meters | 32nd of an inch | | | |
| LF | Flat | Flat | 207 | 30 | 9 | 11 | Sidewall cut | No | Yes |
| LR | 207 | 30 | 207 | 30 | 10 | 12 | None | No | No |
| RR | Flat | Flat | 207 | 30 | 11 | 14 | None | No | Yes |
| RF | Flat | Flat | 207 | 30 | 11 | 14 | Sidewall cut | No | Yes |

***Vehicle Interior:*** The inspection of the interior of the Hummer revealed no discernable evidence of occupant contacts. There was no deformation of the steering wheel or compression of the energy absorbing steering column.

The vehicle's left front, right front, and right rear doors were jammed closed. The left front door and the tailgate remained closed and operational. All the window glazings were either closed or fixed prior to the crash. The windshield was in place and holed from impact forces. The glazing in the left front, right front, right rear, backlight, and sunroof were disintegrated from impact forces.

The passenger compartment sustained 14 intrusions. The most severe intrusions in the driver's space involved the roof and floor pan, which intruded vertically 4 cm (1.6 in) and 3 cm (1.2 in), respectively. The most severe intrusions on the vehicle occurred in the second row right where the right roof side rail and roof intruded vertically 29 cm (11.4 in).

The Hummer's EDR was imaged using version 3.4 of the Bosch Crash Data Retrieval software via direct connection to air bag control module. The EDR recorded a rollover event and the IC air bags were commanded to deploy. The Supplemental Restraint System (SIR) warning lamp was recorded as "off". The driver and front passenger safety belt switch circuits were recorded as "unbuckled." The driver's seat position sensor was recorded as "rearward," and the front safety belt pretensioners were commanded to actuate. The maximum longitudinal velocity change was recorded as -7.64 mph (-12.30 km/h) occurring 180 msec after the IC air bag deployment criteria was met. The maximum lateral velocity change was recorded as 9.55 mph (15.37 km/h) occurring at 220 msec after the deployment criteria was met. The pre-crash data was discussed in the pre-crash section on page 1. The EDR report is attached at the end of this report[3].

## AUTOMATIC RESTRAINT SYSTEM

The Hummer was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that consisted of dual stage driver and front passenger air bags, driver seat position sensor, safety belt usage sensors, retractor-mounted pretensioners, and a front passenger weight sensor. The frontal air bag impact sensors were located on the left and right lower 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. Neither frontal air bag deployed in this crash.

The Hummer was also equipped with rollover/side impact IC air bags. Based on the Holmatro Rescuer's Guide to Vehicle Safety Systems, the vehicle's side impact sensors were located within the left and right front doors. Both IC air bags deployed in this crash.

The IC air bags were located along the roof side rails inside the headliner (**Figure 13**) and extended from the A-pillar to the C-pillar. There were no visible vent ports. The deployed IC air bags were 160 cm (63 in) in width and 38 cm (14.9 inches) in height. They were attached at the A-pillars by a fabric panel that was 20 cm (7.9 in) in width. The IC air bags extended approximately 6 cm (2.4 in) below the beltline. The gap between the bottom of the IC air bag and the front of the window frame was approximately 15 cm (5.9 in) at the beltline. Inspection of the IC air bags revealed no discernable evidence of occupant contact or damage.

**Figure 13:** The front portion of the left IC air bag

[3] Pages 8 and 9 of the EDR report have been deleted for confidentiality purposes.

The Hummer was equipped with lap-and-shoulder safety belts for the front and second row 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. The driver and front right passenger safety belts were equipped with retractor-mounted pretensioners. The second row lap-and-shoulder safety belts consisted of continuous loop belt webbing, switchable ELR/Automatic Locking Retractors (ALR) and fixed upper anchors. The second row safety belts were not equipped with pretensioners.

Inspection of the driver's safety belt assembly revealed that the retractor-mounted pretensioner had actuated and the safety belt was retracted tightly within the retractor. This evidence indicated that the driver was not restrained during the crash. The EDR recorded the driver's safety belt as unbuckled. The remaining seat positions were unoccupied at the time of the crash.

## CASE VEHICLE DRIVER KINEMATICS

Based on the SCI interview, the driver of the Hummer [48-year-old, male; 185 cm (73 in) and 122 kg (270 lb)] was seated in an upright posture with his back against the seat back and both hands on the steering wheel at the10 and 2 o'clock positions. The seat track was adjusted to the rear position and the seat back was slightly reclined. The distance from the top of the seat back to the top of head restraint was 27 cm (10.6 in). The tilt steering column was located between the center and full-down positions. The driver was not wearing glasses or contact lenses. It was reported in the driver's medical records that he has a history of seizures. He had been involved in a crash approximately one month prior due to a seizure, and had suffered a seizure three days prior to this crash.

**Figure 14:** The windshield was holed adjacent to the left A-pillar

The initial impact with the guardrail displaced the unrestrained driver forward opposite the 12 o'clock force direction and his chest probably contacted the steering wheel. As the vehicle rolled over left side leading, he was redirected to the left and then forward when the vehicle touched down with the front left corner leading. During this ground interaction, the windshield was holed adjacent to the left A-pillar (**Figure 14**). The driver was redirected forward and his chest contacted the steering wheel. While the driver's chest probably contacted the steering wheel during the initial impact, the damage from the ground interaction appeared more severe based on the damage on the vehicle and his chest injuries probably resulted from this impact. The contact with the steering wheel caused a contusion in the shape of the steering wheel, fractures of left ribs 6-8, and right posterior ribs 8-11 with pneumothraces. He was projected over the steering wheel and

his head probably contacted the left A-pillar and passed partially out of the holed windshield. Due to the soiling of the interior by dirt and water, a specific occupant contact on the A-pillar was not discernable, but the A-pillar was judged to be the probabe source of this injury since the driver's head passed out of the windshield adjacent to the A-pillar. He sustained a nonantomic brain injury from the A-pillar contact and a partial avulsion of the right pinna, laceration on the left ear, laceration on the right parietal head, abrasion on the right cheek, and a laceration on the left cheek from the windshield. The driver sustained bilateral dislocation of the knees, a dislocated right elbow, and a fractured right fibula from contact with the instrument panel. He also sustained two fractures of the lateral malleolus from contact with the toe pan. The driver remained in the vehicle during the rollover. He was unsure how he exited the vehicle. The emergency medical technician records indicated that he extricated himself from the vehicle.

## CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to a hospital. He sustained severe injuries and was hospitalized for five days. He lost 18 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 | Nonanatomic brain injury with suspected loss of consciousness on-scene, amnesia to event, GCS=14-12, unequal pupils; experience a transient seizure during radiographic evaluation[4] | serious 160608.3,0 | Left A-pillar | Probable | Hospitalization records |
| 2 | Pneumothoraces, bilateral, apical, with respiratory distress and decreased breath sounds on left | severe 450232.4,3 | Steering wheel hub and/or spokes and rim | Probable | Emergency room records |
| | Fractured right posterior ribs: 8th through 11th, not further specified | | | | Emergency room records |
| | Fracture left rib(s); crepitus and deformity noted over left 6th through 8th ribs | | | | Hospitalization records |
| 3 | Dislocation right elbow with radial head subluxation anteriorly; closed reduction | minor 750630.1,1 | Left instrument panel | Probable | Hospitalization records |
| 4<br>5 | Dislocation bilateral knees with gross instability bilaterally | moderate 850806.2,1<br>850806.2,2 | Left lower instrument panel (includes knee bolster) | Probable | Hospitalization records |

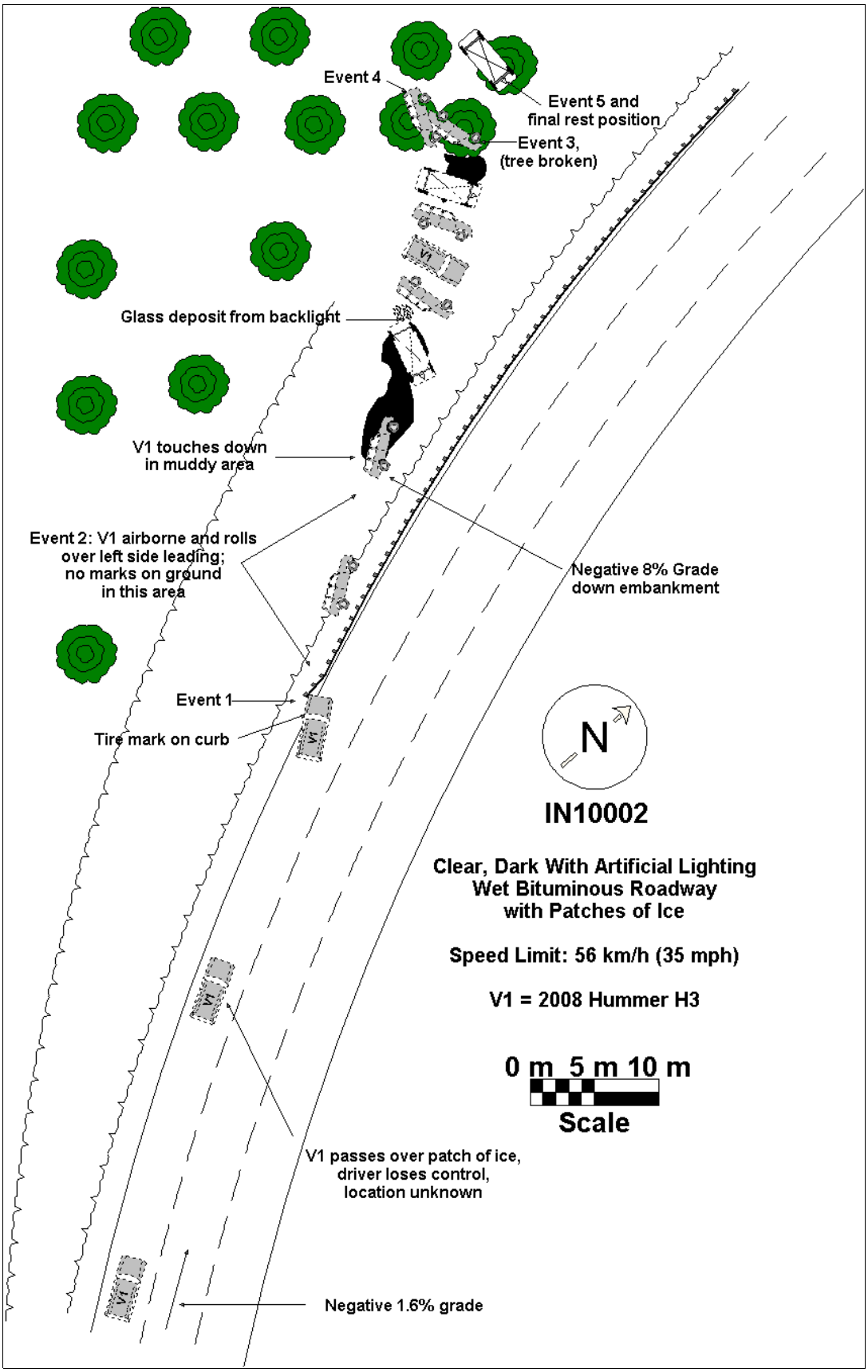
[4] Speech therapy noted that this patient presents with mild/moderate cognitive deficits comparable with a Rancho Los Amigos Scale Level VII.

| Injury Number | Injury Description (including Aspect) | NASS Injury Code & AIS 90 | Injury Source | Source Confidence | Source of Injury Data |
|---|---|---|---|---|---|
| 6 | Fracture right proximal fibula shaft, closed reduction | moderate 851606.2,1 | Left lower instrument panel (includes knee bolster) | Probable | Hospitalization records |
| 7<br>8 | Fracture x 2 left distal fibula (lateral malleolus) with syndesmosis[5] obstruction; open reduction and internal fixation[6] | moderate 851608.2,2<br>851605.2,2 | Floor, including toe pan | Probable | Hospitalization records |
| 9 | Laceration, 4 cm (1.2 in) right parietal head | minor 190602,1,1 | Front left windshield's glazing | Probable | Hospitalization records |
| 10 | Avulsion, partial, right pinna | minor 290802.1,1 | Front left windshield's glazing | Probable | Hospitalization records |
| 11 | Laceration left ear, not further specified | minor 290602.1,2 | Front left windshield's glazing | Probable | Interviewee (same person) |
| 12 | Abrasion right cheek, not further specified | minor 290202.1,1 | Front left windshield's glazing | Probable | Hospitalization records |
| 13 | Laceration, small, left cheek, not further specified | minor 290602.1,2 | Front left windshield's glazing | Probable | Hospitalization records |
| 14 | Abrasion, small, anterior neck, not further specified | minor 390202.1,5 | Steering wheel rim | Possible | Hospitalization records |
| 15 | Abrasion center chest, not further specified | minor 490202.1,4 | Steering wheel hub and/or spokes and rim | Certain | EMS treatment record |
| 16 | Contusion center chest in shape of steering wheel | minor 490402.1,4 | Steering wheel hub and/or spokes and rim | Certain | Interviewee (same person) |
| 17 | Abrasion right hand, not further specified | minor 790202.1,1 | Left instrument panel | Probable | Hospitalization records |
| 18 | Abrasions left forearm and left hand, not further specified | minor 790202.1,2 | Left front door panel, forward upper quadrant | Probable | Hospitalization records |

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

[6] Five screws were used to secure the lateral malleolar fracture whereas only two syndesmotic screws were used in the fracture more distal.

| Injury Number | Injury Description (including Aspect) | NASS Injury Code & AIS 90 | Injury Source | Source Confidence | Source of Injury Data |
|---|---|---|---|---|---|
| 19 | Abrasions bilateral knees, anterior right shin, and anterior left shin x 2, not further specified | minor 890202.1,3 | Left lower instrument panel (inludes knee bolster) | Probable | Hospitalization records |


Event 4
Event 5 and
final rest position
Event 3,
(tree broken)
Glass deposit from backlight
V1 touches down
in muddy area
Event 2: V1 airborne and rolls
over left side leading;
no marks on ground
in this area
Negative 8% Grade
down embankment
Event 1
Tire mark on curb
N
IN10002
Clear, Dark With Artificial Lighting
Wet Bituminous Roadway
with Patches of Ice
Speed Limit: 56 km/h (35 mph)
V1 = 2008 Hummer H3
0 m 5 m 10 m
Scale
V1 passes over patch of ice,
driver loses control,
location unknown
Negative 1.6% grade

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 | 5GTEN13E988****** |
| User | |
| Case Number | |
| EDR Data Imaging Date | |
| Crash Date | |
| Filename | IN10002.CDR |
| Saved on | Friday, January 15 2010 at 03:37:11 PM |
| 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 can be overwritten by an event that has a greater SDM recorded vehicle velocity change. 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. The data in the Non-Deployment Event file will be locked, if the Non-Deployment Event occurred within five seconds of a Deployment Event. A locked Non Deployment Event cannot be overwritten or cleared 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 will record 230 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 open/closed state 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.
-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.

01010_SDMDC_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 |

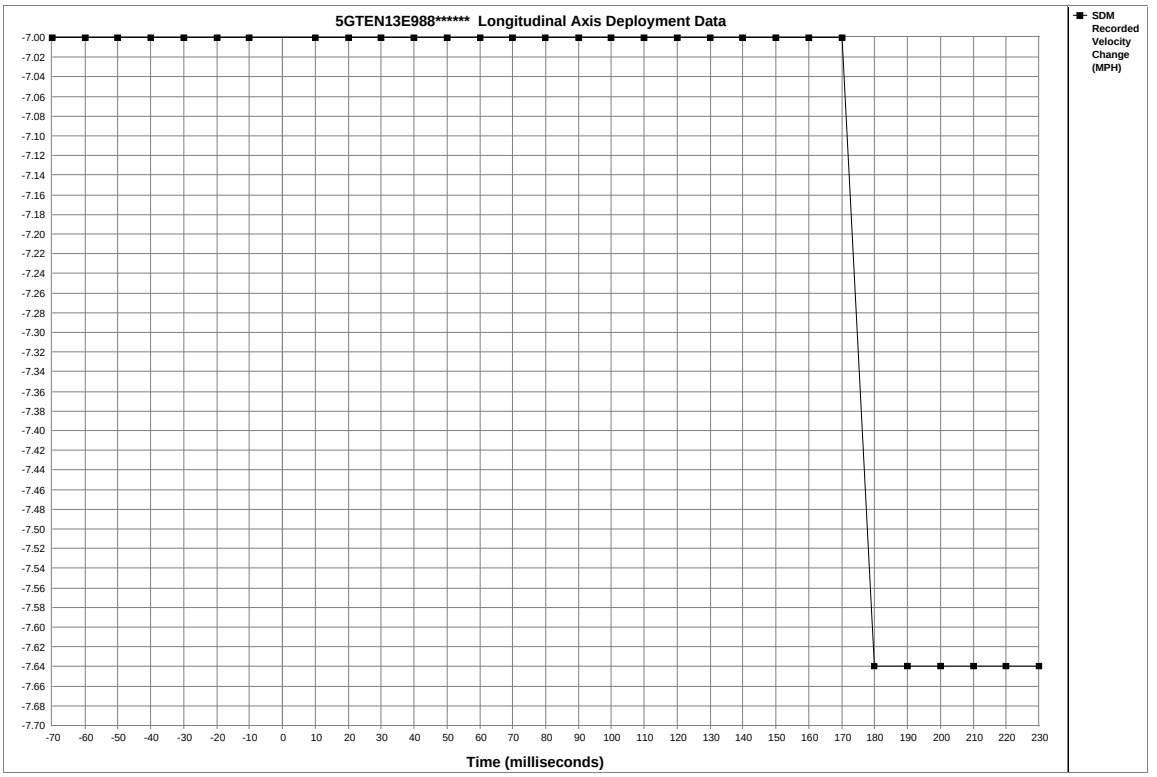
### Pre-Crash Data

| Parameter | -2.5 sec | -2.0 sec | -1.5 sec | -1.0 sec | -0.5 sec |
|---|---|---|---|---|---|
| Vehicle Speed (MPH) | 67 | 67 | 68 | 70 | 70 |
| Engine Speed (RPM) | 2304 | 2304 | 2304 | 2368 | 2432 |
| Percent Throttle | 23 | 23 | 23 | 40 | 40 |
| Brake Switch Circuit Status | OFF | OFF | OFF | OFF | OFF |

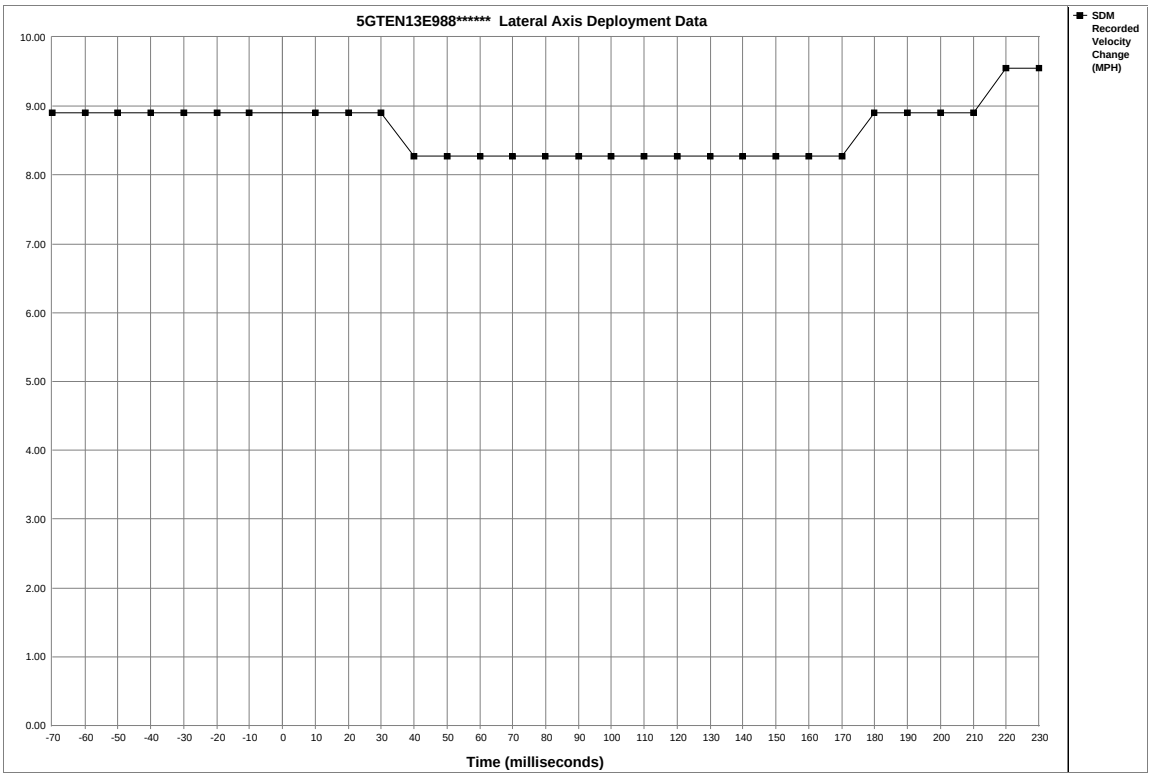
## System Status At Deployment

| | |
|---|---|
| SIR Warning Lamp Status | OFF |
| SIR Warning Lamp ON/OFF Time Continuously (seconds) | 655350 |
| Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously | 3924 |
| Ignition Cycles At Investigation | 3927 |
| Ignition Cycles At Event | 3926 |
| 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 |
| Automatic Passenger SIR Suppression System Status at AE | Air Bag Suppressed |
| Rollover Sensor Status | Rollover Event |
| Number of Consecutive Error Free Messages Received From Rollover Sensor | Last 8 Consecutive Messages Were Error Free |
| SDM Synchronization Counter | 5472 |
| Side Air Bag(s) Were First Commanded to Deploy Due to Side Impact Event | No |
| Side Air Bag(s) Were First Commanded to Deploy Due to Rollover Event | Yes |
| Time Between Events (sec) | 0 |
| Driver 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec) | N/A |
| Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec) | N/A |
| Passenger 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec) | N/A |
| Passenger 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec) | N/A |
| Driver 1st Stage Time From Arming Signal to Deployment Command Signal | N/A |
| Driver 2nd Stage Time From Arming Signal to Deployment Command Signal | N/A |
| Passenger 1st Stage Time From Arming Signal to Deployment Command Signal | N/A |
| Passenger 2nd Stage Time From Arming Signal to Deployment Command Signal | N/A |
| Driver 1st Stage Field Effect Transistor (FET) on time | N/A |
| Driver 2nd Stage Field Effect Transistor (FET) on time | N/A |
| Passenger 1st Stage Field Effect Transistor (FET) on time | N/A |
| Passenger 2nd Stage Field Effect Transistor (FET) on time | N/A |
| Driver 1st Stage Deployment Loop Commanded | No |
| Driver 2nd Stage Deployment Loop Commanded | No |
| Driver Side Deployment Loop Commanded | No |
| Driver Pretensioner Deployment Loop Commanded | Yes |
| Driver Roof Rail/Head Curtain Loop Commanded (If Equipped) | Yes |
| Supplemental Deployment Loop #1 Commanded (If Equipped) | No |
| Passenger 1st Stage Deployment Loop Commanded | No |
| Passenger 2nd Stage Deployment Loop Commanded | No |
| Passenger Side Deployment Loop Commanded | No |
| Passenger Pretensioner Deployment Loop Commanded | Yes |
| Passenger Roof Rail/Head Curtain Loop Commanded (If Equipped) | Yes |
| Supplemental Deployment Loop #2 Commanded (If Equipped) | No |
| Second Row Left Side Deployment Loop Commanded | No |
| Second Row Left Pretensioner Deployment Loop Commanded (If Equipped) | No |
| Supplemental Deployment Loop #3 Commanded (If Equipped) | No |
| Second Row Right Side Deployment Loop Commanded (If Equipped) | No |
| Second Row Right Pretensioner Deployment Loop Commanded | No |
| Supplemental Deployment Loop #4 Commanded (If Equipped) | No |
| Supplemental Deployment Loop #4 Suppressed (If Equipped) | No |
| 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 |
| Crash Record Locked | Yes |
| Vehicle Event Data (Pre-Crash) Associated With This Event | Yes |
| Driver 1st Stage Deployment Algorithm Mode (Unbelted) | No Trigger Mode |
| Driver 1st Stage Deployment Algorithm Mode (Belted) | No Trigger Mode |
| Passenger 1st Stage Deployment Algorithm Mode (Unbelted) | No Trigger Mode |

| | |
|---|---|
| Passenger 1st Stage Deployment Algorithm Mode (Belted) | No Trigger Mode |
| Event Recording Complete | Yes |




| Time (milliseconds) | -70 | -60 | -50 | -40 | -30 | -20 | -10 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDM Longitudinal Axis Recorded Velocity Change (MPH) | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 |
| Time (milliseconds) | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 |
| SDM Longitudinal Axis Recorded Velocity Change (MPH) | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.00 | -7.64 | -7.64 | -7.64 | -7.64 | -7.64 | -7.64 |




| Time (milliseconds) | -70 | -60 | -50 | -40 | -30 | -20 | -10 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDM Lateral Axis Recorded Velocity Change (MPH) | 8.91 | 8.91 | 8.91 | 8.91 | 8.91 | 8.91 | 8.91 | 8.91 | 8.91 | 8.91 | 8.28 | 8.28 | 8.28 | 8.28 | 8.28 |
| Time (milliseconds) | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 |
| SDM Lateral Axis Recorded Velocity Change (MPH) | 8.28 | 8.28 | 8.28 | 8.28 | 8.28 | 8.28 | 8.28 | 8.28 | 8.28 | 8.91 | 8.91 | 8.91 | 8.91 | 9.55 | 9.55 |