

CRASH DATA RESEARCH CENTER

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Buffalo, NY 14225

**CALSPAN ON-SITE SIDE IMPACT INFLATABLE
OCCUPANT PROTECTION SYSTEM CRASH INVESTIGATION
SCI CASE NO: CA09044**

VEHICLE: 2007 GMC YUKON

LOCATION: TENNESSEE

CRASH DATE: APRIL, 2009

Contract No. DTNH22-07-C-00043

Prepared for:

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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 are 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.

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<i>16. Abstract</i> This on-site investigation focused on the deployment of the Inflatable Curtain (IC) air bags in a 2007 GMC Yukon. The Yukon was equipped with dual purpose rollover sensing/side impact Inflatable Curtain (IC) air bags and a Certified Advanced 208-Compliant (CAC) frontal air bag system for the driver and front right passenger positions. The crash occurred when the eastbound GMC departed the right side of the roadway in a tracking attitude and struck a wooden utility pole with its front right corner area. These impact forces deployed the driver's frontal air bag and both IC air bags. The struck pole subsequently fractured and fell across the hood of the GMC which resulted in a secondary non-horizontal impact event. The GMC was driven by a 31-year-old unrestrained female with a 7-year-old female rear left passenger. The 7-year-old female was seated in a high back booster Child Restraint System (CRS) and was not restrained by the manual safety belt system. The child passenger was displaced forward from the booster seat and came to rest on the floor of the rear left seat position. The child passenger was transported to a local hospital where she was treated for soft tissue injuries and released. The driver was not injured as a result of this crash.			
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BACKGROUND

This on-site investigation focused on the deployment of the Inflatable Curtain (IC) air bags in a 2007 GMC Yukon. The Yukon was equipped with dual purpose rollover sensing/side impact Inflatable Curtain (IC) air bags and a Certified Advanced 208-Compliant (CAC) frontal air bag system for the driver and front right passenger positions. The crash occurred when the eastbound GMC departed the right side of the roadway in a tracking attitude and struck a wooden utility pole with its front right corner area (**Figure 1**). These impact forces deployed the driver's frontal air bag and both IC air bags.



Figure 1: Front right view of the GMC Yukon.

The struck pole subsequently fractured and fell across the hood of the GMC which resulted in a secondary non-horizontal impact event. The GMC was driven by a 31-year-old unrestrained female with a 7-year-old female second row left passenger. The 7-year-old female was seated in a high back booster Child Restraint System (CRS) and was not restrained by the manual safety belt system. The child passenger was displaced forward from the booster seat and came to rest on the floor of the rear left seat position. The child passenger was transported to a local hospital where she was treated for soft tissue injuries and released. The driver was not injured as a result of this crash.

This crash was identified through the weekly sampling of Police Crash Reports (PAR) conducted by the National Automotive Sampling System (NASS). The Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) forwarded the PAR to the Calspan Special Crash Investigations (SCI) team on June 12, 2009. Calspan SCI initiated a follow-up investigation and established cooperation with the insurance carrier for the GMC. The GMC was considered a total loss and was available for inspection at a regional insurance salvage yard. The vehicle and scene inspections took place July 6, 2009. The Event Data Recorder (EDR) in the GMC was also imaged at that time. The driver was arrested for an impaired driving violation and refused an interview. The CRS was inspected at the driver's residence in the

presence of her husband. He would only provide minimal details of the crash and did not provide personal data relating to the child passenger.

SUMMARY

Crash Site

The crash occurred during the daylight hours in April 2009. At the time of the crash, the weather was clear and the bituminous roadway was dry. The crash sequence occurred within an undivided section of roadway that consisted of two westbound travel lanes, two eastbound travel lanes and a dual direction center left turn lane. The outboard westbound travel lane measured 3.4 m (11.2 ft) in width. The inside westbound travel lane measured 3.2 m (10.5 ft) and the left turn lane measured 3.8 m (12.5 ft) in width. The north side of the roadway was bordered by a 15 cm (6 in) raised concrete curb that extended the length of the roadway. A concrete sidewalk measuring 1.2 m (4.0 ft) wide was located directly north of the curb line. A 3.0 m (9.8 ft) wide grass area separated the sidewalk from an asphalt parking lot that was located on the north side of the road. The grass area measured 28.7 m (94.2 ft) in length and contained two light poles eight trees and one fire hydrant. The north side parking lot contained two driveways located at opposite ends of the grass median. The wooden utility pole was located within the width of the sidewalk and was centered 0.4 m (1.3 ft) outboard of the curb line. The posted speed limit was 64 km/h (40 mph). A schematic of the crash is included at the end of this report as **Figure 9**.

Vehicle Data - 2007 GMC Yukon

The 2007 GMC Yukon was a four-door sport utility vehicle that was manufactured in May 2006 and identified by the Vehicle Identification Number (VIN): 1GKFK63857J (production sequence deleted). The electronic odometer display was not visible due to the lack of 12-volt power to the vehicle. The power train consisted of 6.2-liter, V-8 engine linked to a 6-speed automatic transmission with all-wheel drive. The service brakes were a power-assisted 4-wheel disc brake system equipped with ABS. The GMC was also equipped with traction control, Electronic Stability Control (ESC), and a direct Tire Pressure Monitoring System (TPMS). The GMC was equipped with manufacturer specified size tires P275/55R20 mounted on aftermarket alloy wheels. The tires were Goodyear Eagle LS2. The vehicle manufacturer recommended front and rear cold tire pressure was 220 kPa (32 PSI). At the time of the SCI inspection the right front wheel had separated from its axle position and the right front tire was missing. The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Tread Depth	Restricted	Damage
LF	214 kPa (31 PSI)	4 mm (5/32 in)	No	None
LR	255 kPa (37 PSI)	5 mm (6/32 in)	No	None
RF	Unknown	Unknown	Unknown	Unknown
RR	248 kPa (36 PSI)	8 mm (10/32 in)	No	None

The interior was configured with leather-surfaced front bucket seats with adjustable head restraints that were adjusted 6 cm (2.4 in) above the seat backs. The second row consisted of forward-folding bucket seats with adjustable head restraints. Both second row head restraints were adjusted 5 cm (2 in) above the seat backs. The third row consisted of removable bucket seats that were lying loose in the cargo area of the vehicle at the time of the SCI inspection. The manual restraint systems consisted of continuous loop, 3-point lap and shoulder belts in all six seat positions. The front safety belts were equipped with retractor-mounted pretensioners. The GMC was equipped with side impact IC air bags with rollover sensing and CAC frontal air bags. The vehicle manufacturer has certified that the frontal air bags in the GMC were compliant with the advanced air bag requirements of the Federal Motor Vehicle Safety Standard No. 208. The GMC was also equipped with adjustable accelerator/brake pedals.

The driver's husband stated that the GMC was a lease vehicle that had a previous crash involving the right front area. He further related that there was an air bag deployment associated with this previous crash.

Crash Sequence

Pre-Crash

The GMC was westbound (**Figure 2**) in the outboard travel lane, driven by the 31-year-old unrestrained female. The EDR reported speed of the GMC was 66 km/h (41 mph) 2.5 seconds prior to Algorithm Enable (AE). The EDR also reported that the vehicle's brakes were not being applied during the recorded pre-crash travel of the vehicle. The recorded throttle position was fluctuating between 32 and 24 percent during the 2.5 second pre-crash recording. The driver relinquished directional control of the GMC and the vehicle departed the right road edge. The



Figure 2: Westbound view of the GMC's pre-crash path of travel

large diameter right side tires of the GMC overrode the north curb. There was no discernable rubber transfer marks on the curb edge identifying the departure point.

Crash

The front right corner of the GMC impacted the wooden utility pole. The pole had been replaced prior to the SCI scene inspection. The replacement pole measured 28 cm (11.0 in) in diameter and was located 0.4 m (1.3 ft) outboard of the curb line. The direction of the impact force was within the 12 o'clock sector for the GMC. This impact resulted in the actuation of the front safety belt pretensioners and the deployment of the driver CAC air bag and both IC air bags. The right CAC air bag was suppressed due to the unoccupied front right seat. The impact occurred outboard of the vehicle's frame and involved the right corner area of the front bumper beam. As the GMC continued forward, the right front fender, suspension and inner fender structure engaged the pole. The right front tire/wheel/brake system, the suspension, and the drive axle separated from the chassis as the vehicle began to rotate in a clockwise (CW) direction. During maximum engagement, the pole fractured at its base and fell in a southwesterly direction across the hood of the Yukon resulting in a non-horizontal impact lateral to the vehicle. The GMC rotated CW approximately 55 degrees before it came to final rest facing a northwesterly direction, approximately 2.5 m (8.2 ft) west of the struck pole. The combination of the corner impact and the yielding object exceeded the parameters of the WinSMASH model; therefore a velocity change could not be computed for the initial event. The EDR recorded longitudinal velocity change was -25.6 km/h (-15.91 mph) 220 milliseconds after the deployment command.

Post-Crash

Police and ambulance personnel responded to the crash site. The driver of the GMC exited the vehicle unassisted and was not injured. She failed a police administered field sobriety test, was arrested at the scene and transported to jail for processing. The child passenger came to rest on the floor of the second row with the CRS resting on top of the passenger. She was removed from the vehicle by rescue personnel and was transported by ground ambulance to a local hospital where she was treated for minor severity soft tissue injuries and released. The GMC sustained disabling damage and was towed from the crash site. This vehicle was subsequently deemed a total loss by the insurance company and was transferred to a regional vehicle salvage yard prior to the SCI inspection.

2007 GMC Yukon

Exterior

The exterior of the GMC sustained two separate areas of direct contact damage during the vehicle-to-object crash sequence. **Figure 3** is a view of the damage to the frontal plane of the GMC that occurred from the initial event with the utility pole. The direct contact damage was measured laterally along the front bumper fascia. It began 46 cm (18.1 in) right of center and extended 34 cm (13.4 in) to the projected front right bumper corner. The impact resulted in deformation to the front bumper fascia, radiator, bumper beam, right front axle and suspension, and right/front fender. The right side wheelbase was reduced in length by 15 cm (5.9 in). The combined induced and direct contact damage length was 122 cm (48 in) and involved the full width of the bumper beam. The front crush profile was measured at the bumper elevation and

was as follows: C1 = 1 cm (0.4 in), C2 = 4 cm (1.6 in), C3 = 3 cm (1.2 in), C4 = 3 cm (1.2 in), C5 = 3 cm (1.2 in), C6 = 7 cm (2.8 in). The direct contact wrapped around the corner and extended along the right side to the right A-pillar area. The Collision Deformation Classification (CDC) for this impact event was 12FREE5.

The secondary event produced a vertical crush pattern that extended laterally across the top of the GMC's hood, forward of the windshield. This damage resulted from the fractured pole as it fell on top of the GMC. **Figure 4** is a right side view of the damage caused by the secondary impact. The direct contact damage began 114 cm (44.9 in) rearward of the front reference line that was established to represent the original length of the vehicle and extended 11 cm (4.3 in) rearward. The damage also extended 140 cm (55 in) laterally across the width of the vehicle. The residual crush profile was not measured due to the non-horizontal impact force associated with this event. The assigned CDC was 00TFDW6.

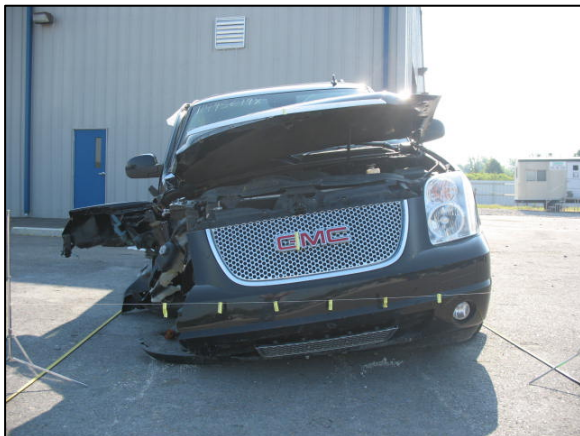


Figure 3: The GMC's crush profile of the front plane damage

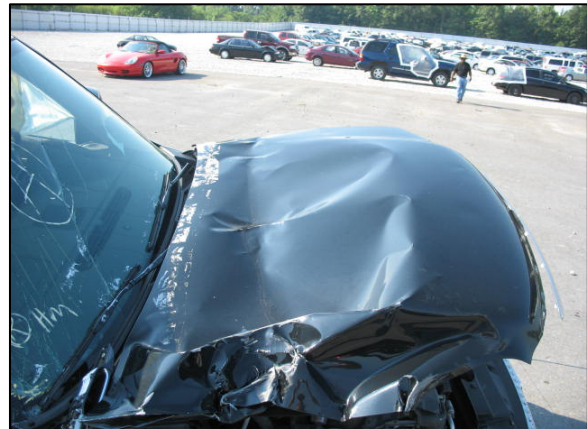


Figure 4: Right side view of the damage to the GMC's hood from the falling utility pole

The glazing damage was limited to fracturing of the windshield. The left front door glazing was down at the time of the inspection, but was intact within the door. All other door, side, backlight and roof glazing remained intact. The front right door was jammed closed due to the frontal deformation and was forced open by rescue personnel. Rescue tool marks and related damage were found on the right front door and the adjacent B-pillar. The right rear, tailgate, and left side doors remained closed during the crash and were operational post-crash.

Interior Damage

The interior damage to the GMC consisted of intrusion of the passenger compartment, the deployment of the vehicle's air bag systems, actuation of the pretensioners, and an interior occupant contact point. The intrusions were limited to 14 cm (5.5 in) of rearward displacement of the right toe pan and 4 cm (1.6 in) of right instrument panel displacement. An occupant contact was identified on the aft surface of the driver's seatback (**Figure 5**) which consisted of deformation to the original contour of this component. The area of direct contact measured 8 cm x 15 cm (3.1 in x 5.9 in) width x height and was located 12 cm (4.7 in) inboard of the left side and 15cm (5.9 in) below the top of the of the seatback. The driver's rigid plastic knee bolster was soiled with dirt and grease. Further examination of this component revealed no discernable contact points.



Figure 5: View of the contact point on the back of the driver seatback

Manual Restraint Systems

The driver's safety belt system consisted of continuous loop webbing, a sliding latch plate, a rigid buckle assembly that was mounted to the seat frame, an adjustable D-ring, and an Emergency Locking Retractor (ELR) with a pretensioner. The D-ring was adjusted to the full-up position. The safety belt webbing was stowed and taut against the B-pillar. The actuated pretensioner locked the safety belt webbing against the B-pillar. The driver was unrestrained at the time of the crash. The imaged EDR data indicated the driver's belt was unbuckled.

The front right safety belt system utilized an ELR/Automatic Locking Retractor (ALR). This seat position was unoccupied. This retractor pretensioner also actuated during the crash and locked the stowed webbing.

The second row left safety belt system consisted of continuous loop webbing, a sliding latch plate, a seat frame-mounted belt buckle, a fixed D-ring and an ELR/ALR. The safety belt webbing was stowed in the retractor at initial inspection. Further investigation revealed that the metal tab of the latch plate contained linear abrasions indicative of historical use; however, the plastic surface of the latch plate contained no discernable evidence of occupant loading. Based upon the post-crash condition of this safety belt system, the second row left occupant was unrestrained at the time of the crash.

Frontal Air Bag System

The GMC was equipped with a CAC frontal air bag system that consisted of dual-stage frontal air bags for the driver and front right passenger positions. In addition to the air bags, the CAC

system utilized front seat track positioning sensors, safety belt buckle switches, and a front right occupant presence sensor. The driver's air bag was located in the center hub of the steering wheel and was concealed by an I-shaped cover flap configuration. The front right CAC air bag was mounted within the top aspect of the right instrument panel. The front right position was unoccupied; therefore the CAC system suppressed the deployment of the front right air bag. The driver's air bag deployed as a result of impact with the utility pole.

The deployed driver air bag measured 60 cm (23.6 in) in its deflated state. The air bag contained two tether straps located in the 12/6 o'clock sectors that limited the excursion of the air bag to 26 cm (10.2 in). The back side of the air bag contained two vent ports located in the 11/1 o'clock sectors. The air bag's excursion from the module measured 26 cm (10.2 in). There was no noted contact evidence to either the cover flaps or the deployed air bag.

Inflatable Curtain Air Bags

The GMC was equipped with dual-purpose side impact/rollover IC air bags mounted to the roof side rails. The IC air bag system consisted of a large rectangular curtain that provided coverage for the first two rows and a separate smaller curtain, connected by a common tether, which covered the third row. All four curtains deployed as a result of the crash. The forward IC air bags (**Figure 6**) measured 155 cm x 48 cm (61.0 in x 18.9 in) length x height in overall dimensions and provided coverage from the upper aspect of the A-pillar to the C-pillar area. A 26 cm (10.2 in) long triangular shaped sail-panel filled the void at the area of the A-pillars. The vertical coverage of this curtain extended 4 cm (1.6 in) below the beltline in the first row and 5 cm (2 in) below the beltline in the second seating row. The right IC air bag was cut by the first responders to provide greater access to the rear seat of the vehicle. The cut line was below the roof side rail, starting at the B-pillar and extending 83 cm (32.7 in) rearward.

The third row IC air bags (**Figure 7**) measured 55 cm x 47 cm (21.7 in x 18.5 in) length x height in overall dimensions and provided coverage from the rear aspect of the C-pillar to the forward aspect of the D-pillar area. The vertical



Figure 6: View of the left side forward IC air bag located in the first two seating rows



Figure 7: View of the left rearward IC airbag located in the third seating row

coverage of this curtain extended 12 cm (4.7 in) below the beltline in the third seating row. This IC contained two rectangular tether panels which extended to their respectively adjacent pillars. The forward tether panel measured 22 cm x 47 cm (8.7 in x 21.7 in) length x height and the rear tether panel measured 11 cm x 47 (4.3 in x 21.7 in) length x height. There were no discernable contact points to any of the deployed IC air bags.

Event Data Recorder

The air bag systems in the GMC were controlled by a Sensing and Diagnostic Module (SDM) that was located under the center console. The SDM controlled the diagnostic, sensing and deployment command functions of the air bag systems. The SDM also had Event Data Recorder (EDR) capabilities. The EDR was imaged during this SCI investigation utilizing the diagnostic link connector and the Bosch Crash Data Retrieval scan tool and software version 3.2. The imaged data was reread and has been reported with version 3.4.

The GMC’s EDR recorded one non-deployment event and one deployment event pertaining to this crash. The non-deployment event occurred first. The time between the two events was 0.04 seconds. The recorded non-deployment event was most likely associated with the vehicle’s mounting of the curb. The recorded deployment event was linked to the pole impact that caused the pretensioner actuation and the driver CAC air bag deployment. Due to the limitations of the EDR, two other associated events were not recorded. One of the associated events occurred prior to the recorded non-deployment event and one associated event occurred after the recorded deployment event. Data fields within the recording indicated the later not-recorded event was a deployment. This event may be associated to the deployment of the IC air bags. For further detail, please refer to the imaged data report *Attachment A* at the end of this report.

The recorded non-deployment and deployment data were locked and the recording was complete. The imaged data indicated that the driver safety belt was unbuckled with a forward seat position at the time of the recorded events. The air bag warning lamp status was in the Off-position. The ignition cycles at deployment were 5,978 and 5,981 at investigation. The EDR recorded 2.5 seconds of pre-crash data for the multiple vehicle parameters, which are listed in the following table.

Parameter	-2.5 Sec	-2 Sec	-1.5 Sec	-1 Sec	-0.5 Sec
Vehicle Speed (MPH)	41	41	41	42	42
Engine Speed (RPM)	1280	1280	1344	1344	1344
Percent Throttle	32	20	26	30	24
Brake Switch Circuit Status	Off	Off	Off	Off	Off
Accelerator Pedal Position (percent)	5	5	10	14	0

Child Restraint System

The CRS was identified as a Cosco/Dorel Eddie Bauer Auto Booster Seat (**Figure 8**), with a Model Number of 22888-SDU. The date of manufacture was August 02, 2007. The high back belt positioning booster seat was inspected at the GMC driver's residence. The driver's husband stated that the CRS had been purchased new by the family. The CRS was constructed of a 3-piece molded plastic shell with foam padding and a polyester cloth lining with integrated armrests.



Figure 8: Front view of the Forward-facing Child Safety Seat.

The 7-year old female was sitting within the CRS; however, she was not restrained by the vehicle's safety belt system. The CRS was not secured to the vehicle. The manufacturer of the CRS rated the booster seat in the high back mode for use by children within 13.6-45.4 kg (30-100 lb) with a height range of 110.1-144.8 cm (43-57 in). The CRS was appropriate for the child based on her 20 kg (44 lb) weight. The inspection of this CRS revealed indications of historical use; however, no discernable loading evidence or damage was observed on the CRS.

Driver Demographics/Data

Age/Sex:	31-year-old/Female
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Full-forward
Safety Belt Usage:	None used
Usage Source:	SCI vehicle inspection/EDR data
Egress from Vehicle:	Exited vehicle unassisted
Type of Medical Treatment:	Not injured

Driver Kinematics

The 31-year-old female driver of the GMC was seated in the full-forward track position and was unrestrained. The driver's seatback was reclined to a measured angle of 20 degrees. In this seat adjusted position, the horizontal distance from the seatback to the driver air bag module measured 61 cm (24.0 in). The 4-spoke adjustable steering wheel was in the center tilt position.

At impact with the wooden utility pole, the driver's CAC frontal air bag and the IC air bags deployed. The front row retractor-mounted pretensioners actuated. The driver responded to the 12 o'clock impact force by initiating a forward trajectory. She loaded the deployed frontal air bag with her chest and face as she rode down the forces of the crash. As the GMC rotated CW, the driver probably engaged the forward aspect of the deployed left IC air bag. There was no

contact evidence on the deployed air bags or to the interior surfaces surrounding the driver’s position. There was no deformation of the steering wheel rim and no displacement of the shear capsules. She was not injured in the crash.

Second Row Left Passenger Demographics

Age/Sex: 7-year-old/Female
 Height: Unknown
 Weight: 20 kg (44 lbs)
 Seat Track Position: Fixed
 Safety Belt Usage: None used
 Usage Source: SCI vehicle inspection, on-scene driver statements to police
 Egress from Vehicle: Assisted from the vehicle by rescue personnel
 Type of Medical Treatment: Transported to a local trauma center where she was treated and released

Second Row Left Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Right facial abrasion	Minor (290202.1,1)	Front left seatback
Right eye (infra-orbital) abrasion	Minor (297202.1,1)	Front left seatback
Facial contusion, NFS	Minor (290402.1,9)	Front left seatback

Source: Emergency room records

Second Row Left Passenger Kinematics

The 7-year-old female passenger was seated in a high back booster CRS that was positioned in the second row left position of the GMC. The child had a physical disability that required an adult to buckle her into the CRS. Neither the CRS nor the child was restrained by the vehicle’s safety belt system prior to the crash.

At impact with the wooden utility pole, the child passenger responded to the 12 o’clock impact force and initiated a forward trajectory. Her head and upper body pitched forward as her pelvic region began to slide forward in the CRS. Her head impacted the aft surface of the driver’s seat back as she separated from the CRS. As a result of seatback contact, the child passenger sustained an abrasion to her right face, an abrasion to the dermis surrounding her right eye, and an unspecified facial contusion. This unrestrained passenger rode down the forces of the crash by loading the seatback. As the GMC rotated CW, the child passenger fell onto the floor between the driver’s seatback and the second row seat where she came to rest. Rescue personnel found the child passenger face down within the left side of the second row floor with the CRS on

top of her. She was removed from the vehicle and transported to a local hospital where she was treated for her injuries and released.

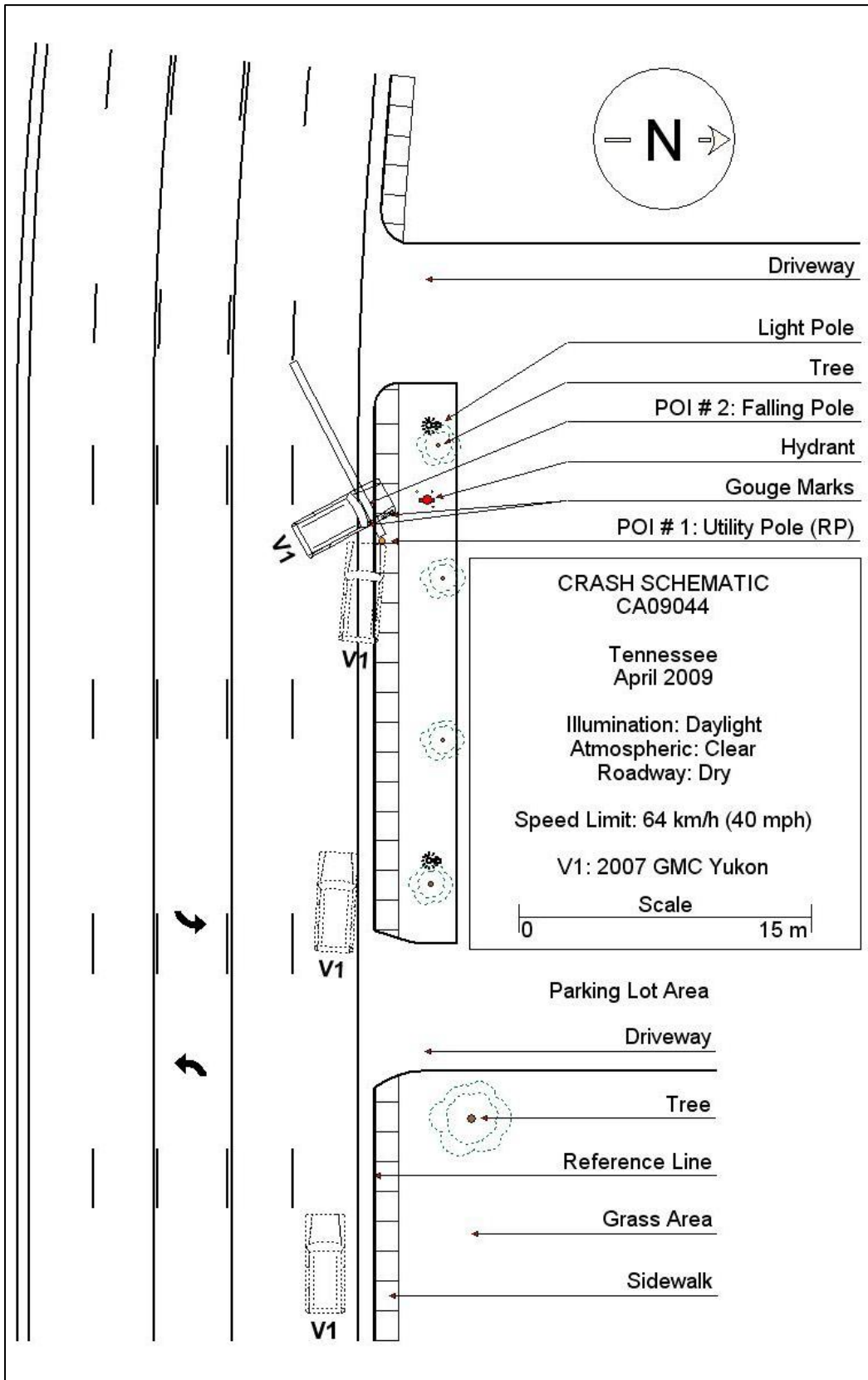


Figure 9: Crash schematic.

ATTACHMENT A

2007 GMC Yukon EDR Data

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	1GKFK63857J*****
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	CA09044 V1 ACM.CDR
Saved on	Wednesday, July 8 2009 at 11:28:48 AM
Collected with CDR version	Crash Data Retrieval Tool 3.2
Reported with CDR version	Crash Data Retrieval Tool 3.4
EDR Device Type	airbag control module
Event(s) recovered	Deployment Non-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 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 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 is 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.

01005_SDMC-delphi_r001

Multiple Event Data

Associated Events Not Recorded	2
An Event(s) Preceded the Recorded Event(s)	Yes
An Event(s) was in Between the Recorded Event(s)	No
An Event(s) Followed the Recorded Event(s)	Yes
The Event(s) Not Recorded was a Deployment Event(s)	Yes
The Event(s) Not Recorded was a Non-Deployment Event(s)	No

System Status At AE

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

Pre-crash data

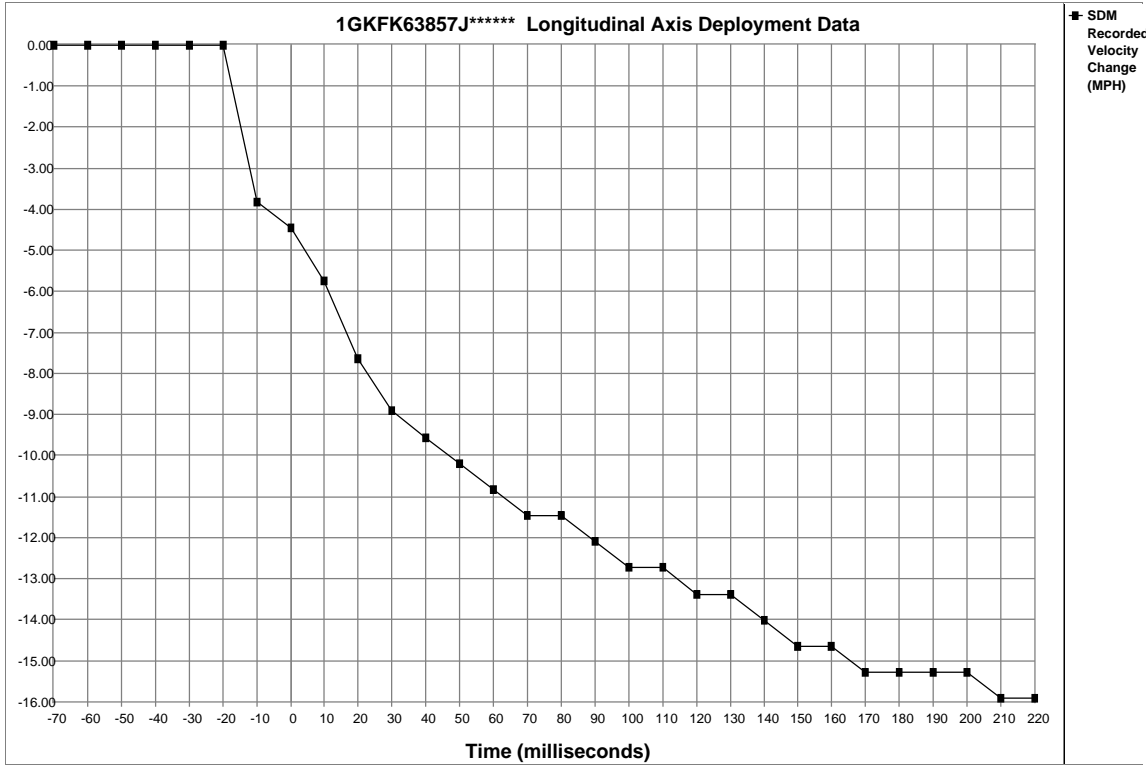
Parameter	-1.0 sec	-0.5 sec
Reduced Engine Power Mode	OFF	OFF
Cruise Control Active (If Equipped)	No	No
Cruise Control Resume Switch Active (If Equipped)	No	No
Cruise Control Set Switch Active (If Equipped)	No	No
Engine Torque (foot pounds)	116.91	127.42

Pre-Crash Data

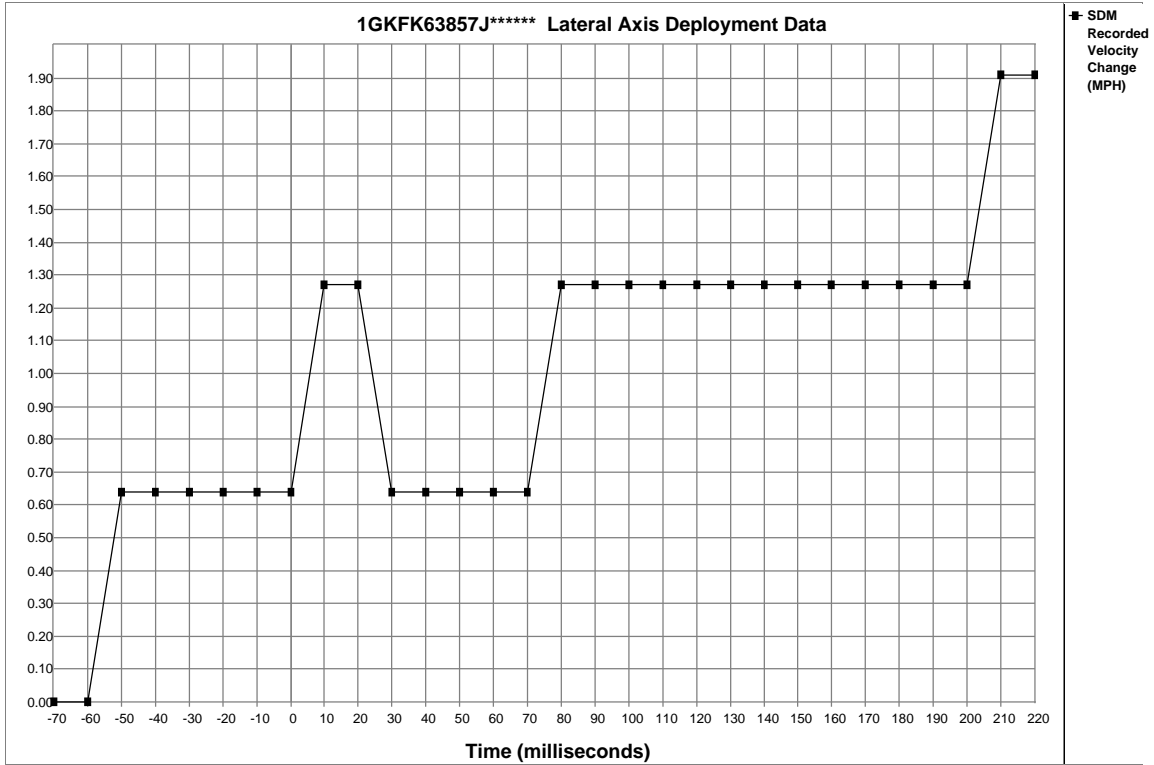
Parameter	-2.5 sec	-2.0 sec	-1.5 sec	-1.0 sec	-0.5 sec
Accelerator Pedal Position (percent)	5	5	10	14	0
Vehicle Speed (MPH)	41	41	41	42	42
Engine Speed (RPM)	1280	1280	1344	1344	1344
Percent Throttle	32	20	26	30	24
Brake Switch Circuit Status	OFF	OFF	OFF	OFF	OFF

System Status At Deployment

Ignition Cycles At Investigation	5981
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/OFF Time Continuously (seconds)	260
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	0
Ignition Cycles At Event	5978
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	Forward
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)	637.5
Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	637.5
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	No Side Air Bags Were Deployed
Rollover Sensor Status	No Rollover
Time From Rollover Event Enable to Deployment (ms)	0
Crash Record Locked	Yes
Vehicle Event Data (Pre-Crash) Associated With This Event	No
SDM Synchronization Counter	5978
Time Between Events (sec)	.04
Event Recording Complete	Yes
Driver First Stage Deployment Loop Commanded	Yes
Passenger First Stage Deployment Loop Commanded	No
Driver Second Stage Deployment Loop Commanded	No
Driver 2nd Stage Deployment Loop Commanded for Disposal	Yes
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



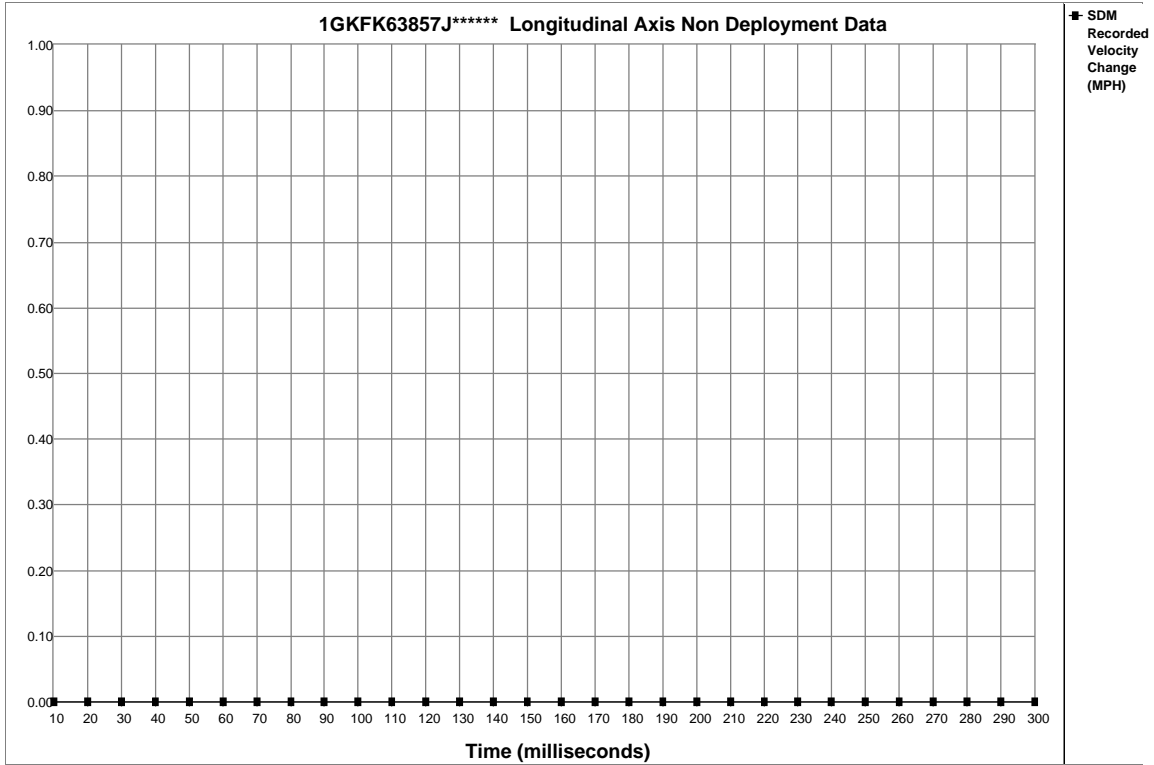
Time (milliseconds)	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70
SDM Longitudinal Axis Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	-3.82	-4.46	-5.73	-7.64	-8.91	-9.55	-10.19	-10.82	-11.46
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Longitudinal Axis Recorded Velocity Change (MPH)	-11.46	-12.10	-12.73	-12.73	-13.37	-13.37	-14.01	-14.64	-14.64	-15.28	-15.28	-15.28	-15.28	-15.91	-15.91



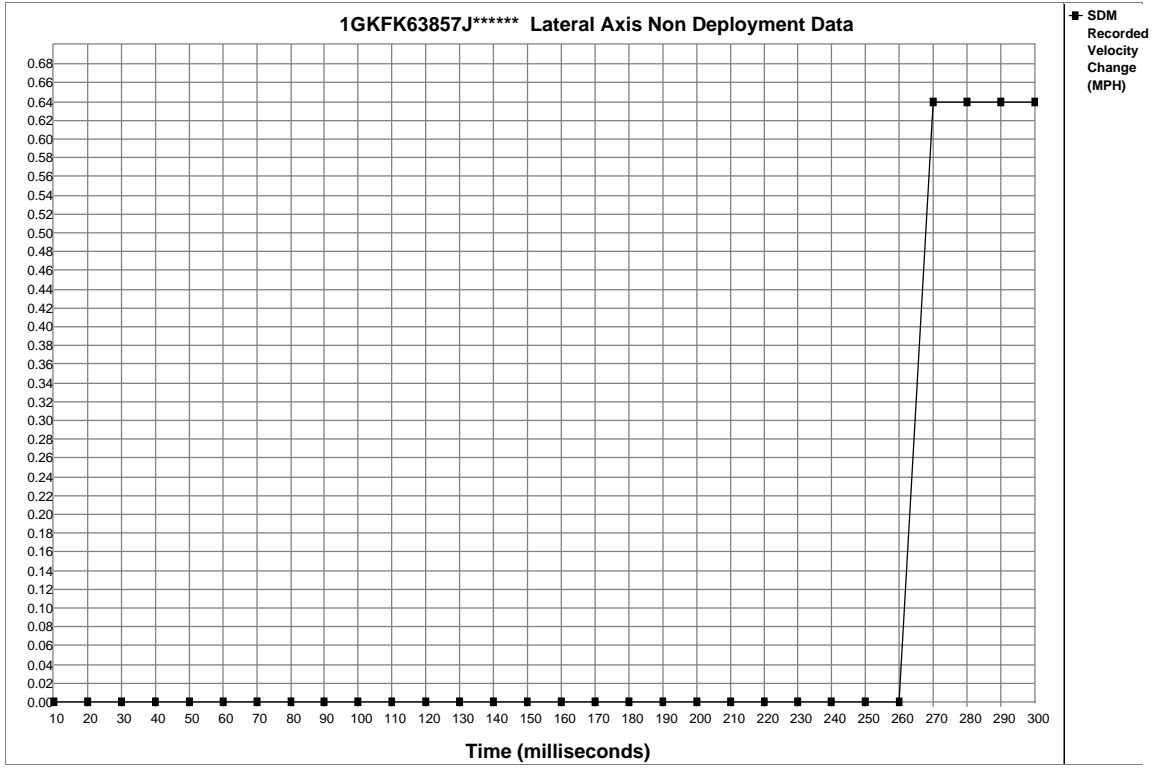
Time (milliseconds)	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70
SDM Lateral Axis Recorded Velocity Change (MPH)	0.00	0.00	0.64	0.64	0.64	0.64	0.64	0.64	1.27	1.27	0.64	0.64	0.64	0.64	0.64
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Lateral Axis Recorded Velocity Change (MPH)	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.91	1.91

System Status At Non-Deployment

Ignition Cycles At Investigation	5981
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/OFF Time Continuously (seconds)	260
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	0
Ignition Cycles At Event	5978
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	Forward
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
Maximum SDM Recorded Velocity Change (MPH)	2.55
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	840
Crash Record Locked	Yes
Deployment Event Recorded in the Non-Deployment Record	No
Vehicle Event Data (Pre-Crash) Associated With This Event	No
SDM Synchronization Counter	5978
Event Recording Complete	Yes
Driver First Stage Deployment Loop Commanded	No
Passenger First Stage Deployment Loop Commanded	No
Driver Second Stage Deployment Loop Commanded	No
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	No
Passenger Pretensioner Deployment Loop Commanded	No
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	No
Passenger (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
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)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Longitudinal Axis Recorded Velocity Change (MPH)	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	0.00	0.00
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
SDM Longitudinal Axis Recorded Velocity Change (MPH)	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	0.00	0.00



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