On-Site Rollover Investigation
Dynamic Science, Inc. (DSI), Case Number DS10003
2008 GMC Yukon Denali
Arizona
December 2009

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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.	2. Government Accession No.	3. Recipient Catalog No.
DS10003		

4. Title and Subtitle	5. Report Date
On-Site Rollover Investigation	July 29, 2010
	6. Performing Organization Report No.

7. Author(s)	8. Performing Organization Report No.
Dynamic Science, Inc.	

9. Performing Organization name and Address	10. Work Unit No. (TRAIS)
Dynamic Science, Inc. 299 West Cerritos Avenue Anaheim, CA 92805	11. Contract or Grant no. DTNH22-07-00045

12. Sponsoring Agency Name and Address	13. Type of report and period Covered [Report Month, Year]
U.S. Dept. of Transportation (NVS-411) National Highway Traffic Safety Administration 1200 New Jersey Ave, SE Washington, DC 20590	14. Sponsoring Agency Code

15. Supplemental Notes

16. Abstract

The focus of this on-site investigation was the rollover dynamics of a 2008 GMC Yukon Denali involved in a side-impact crash. The GMC was equipped with an Electronic Stability Control (ESC) system designed to mitigate the chance of rollover, a rollover sensor, and combination side impact/rollover inflatable curtain (IC) air bags. Following the side impact with another vehicle, the Yukon initiated a left side leading one-quarter turn rollover. During the crash, the vehicle's IC air bags deployed. The crash occurred in a four-leg intersection in December 2009 in the state of Arizona. The subject vehicle was being driven by a restrained 84-year-old male. The other vehicle was a 2007 GMC Sierra C1500 pickup that was being driven by a 55-year-old male. The police report stated that the Sierra entered the intersection against a stop sign and impacted the Yukon, which was traveling through the intersection. The driver of the Yukon sustained minor injuries and was transported to a local hospital where he was treated and released. The driver of the Sierra was not injured. Both vehicles were towed due to damage and were later declared to be total losses by their respective insurance companies. Photographs of the Sierra obtained from an auto auction website were used to conduct a partial inspection of the vehicle.

17. Key Words	18. Distribution Statement
Rollover, IC air bag, injury	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price

Form DOT F 1700.7 (8_72) Reproduction of this form and completed page is authorized

Dynamic Science, Inc.
Crash Investigation
Case Number: DS10003

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Background

The focus of this on-site investigation was the rollover dynamics of a 2008 GMC Yukon Denali involved in a side-impact crash. The GMC was equipped with an Electronic Stability Control (ESC) system designed to mitigate the chance of rollover, a rollover sensor, and combination side impact/rollover inflatable curtain (IC) air bags. Following the side impact with a 2007 GMC Sierra C1500, the Yukon initiated a left side leading one-quarter turn rollover. During the crash, the vehicle's IC air bags deployed.

Figure 1. Subject vehicle, 2008 GMC Yukon Denali

The crash occurred in a four-leg intersection in December 2009 in the state of Arizona. The subject vehicle was being driven by a restrained 84-year-old male and the Sierra was being driven by a 55-year-old male. The police report stated that the Sierra entered the intersection against a stop sign and impacted the Yukon, which was traveling through the intersection. The driver of the Yukon sustained minor injuries and was transported to a local hospital where he was treated and released. The driver of the Sierra was not injured. Both vehicles were towed due to damage and were later declared to be total losses by their respective insurance companies. Photographs of the Sierra obtained from an auto auction website were used to conduct a partial inspection of the vehicle.

This on-site rollover investigation was identified by the National Highway Traffic Safety Administration (NHTSA) during a review of General Estimates System (GES) police reports. On February 1, 2010 DSI was sent the police report and instructed to obtain cooperation. Permission to inspect the subject vehicle was obtained from the insurance company and the case was assigned on February 2, 2010. The vehicle inspection was completed on February 4, 2010 at an auto auction facility. The Yukon's Event Data Recorder (EDR) was supported by the Bosch Crash Data Retrieval (CDR) system and the EDR data was imaged during the vehicle inspection. The EDR data is summarized in this report and a truncated version with the hexadecimal data removed is included as Attachment 2.

Summary

Crash Site

The crash occurred in a four-leg intersection consisting of an undivided east/west roadway and an undivided north/south roadway. (**Figure 2**). The intersection was controlled by stop signs for east- and westbound traffic. Conditions at the time of the crash were daylight and clear, and the roadway was dry.

The north leg of the intersection consisted of one northbound lane, one southbound lane, and a

painted median separating the lanes. The south leg of the intersection consisted of one northbound lane, one southbound lane, and a two-way left turn lane. The west leg of the intersection consisted of one eastbound lane and one westbound lane. A painted stop line was located in the westbound lane at 4.0 m (13.0 ft) west of the intersection and a posted stop sign was located 0.6 m (19.7 ft) south of the south curb and lateral to the stop line.

Each roadway was bordered by raised concrete curbs measuring 15.0 cm (5.9 in) in height. The roadway composition was asphalt and all lanes were straight and level. The posted speed limit was 56 km/h (35 mph) for the north/south roadway and 40 km/h (25 mph) for the east/west roadway.

Figure 2. Crash site, southbound approach

Pre-Crash

The Yukon was traveling southbound at an EDR-recorded speed of 39 km/h (24 mph) at 0.5 seconds prior to Algorithm Enable (AE). The driver of the Yukon did not observe the other vehicle prior to impact and he did not brake or attempt any evasive maneuvers. The Sierra was traveling east at a police-estimated speed of 48 (30 mph). According to the police report, the Sierra did not stop for the stop sign. It entered the intersection and initiated a right turn across the path of the Yukon.

Crash

The crash sequence included two events. Initially, the front end of the Sierra impacted the right side of the Yukon (Event 1). The Yukon's EDR reported that the vehicle's IC air bags were commanded to deploy in response to the side impact. As a result of the side impact, the Yukon was displaced left and initiated a clockwise rotation. Following the first impact, the Yukon initiated a left side leading one-quarter turn-over type rollover (Event 2) and then came to rest on its left side. Its post impact trajectory and path to final rest was in the southeast direction.

The police marked the Yukon's final rest position on the roadway. Based on its at-rest location, the vehicle's estimated post-crash travel distance to final rest measured 12.8 m (42.0 ft) and the estimated roll distance measured 4.0 m (13.1 ft). The vehicle came to rest facing northwest in the center two-way left turn lane.

Following the first impact, the Sierra was displaced to the right and rotated clockwise in response to the direction of force. According to the police markings on the roadway the vehicle came to rest facing southeast in the southbound lane. Based on the vehicle's at-rest location, the vehicle's estimated post-crash travel distance to final rest measured 3.8 m (12.5 ft).

For the Yukon in Event 1, the Damage with CDC Only algorithm of WinSMASH calculated a Total Delta-V of 13.0 km/h (8.1 mph); the longitudinal and lateral components were -6.5 km/h (-4.0 mph)

and -11.3 km/h (-7.0 mph), respectively. The results appear reasonable based on the vehicle's crush profile and post-crash trajectory. The Yukon's EDR reported a maximum longitudinal Delta-V of -4.10 (-2.55 mph) and a maximum lateral Delta-V of -8.19 (-5.09 mph).

For the Sierra, WinSMASH calculated a Total Delta-V of 15.0 km/h (9.3 mph); the longitudinal and lateral components were -9.6 km/h (-6.0 mph) and 11.5 km/h (7.1mph), respectively. The results appear reasonable based on the vehicle's estimated CDC.

Post-Crash

Following the crash, the Yukon's right side doors were jammed shut and the roof glazing was disintegrated. On-scene responders cut a hole in the windshield and opened the sunroof cover so the driver could exit the vehicle. The driver was fitted with a cervical collar while still in the vehicle. Due to the cervical collar and his limited mobility, he could not exit the vehicle through the holed windshield or roof opening. His head restraint was then removed with bolt cutters and the vehicle's rear hatch was opened. The driver then moved from his seat to the cargo area and with assistance he exited the vehicle through the rear hatch. He was assisted into an ambulance and then was transported to a local hospital. He was admitted to the emergency room 42 minutes post-crash with a Glasgow Coma Score (GCS) of 15. The driver sustained minor injuries and he complained of pain to his ribs and left hip.

The driver stated during the interview that he was treated in the hospital emergency room for approximately one hour but did not undergo radiological imaging due to a shortage of staff at the facility. He was discharged from the emergency room and then was treated by his private physician two days following the crash, after which time he returned to the hospital and underwent radiological imaging. He continued to receive follow-up treatment for several weeks following the crash due to persistent pain in his left hip. The driver missed approximately 30 days from work due to his injuries.

Vehicle Data - 2008 GMC Yukon Denali

The Yukon was identified by the Vehicle Identification Number (VIN): IGKFK63808Jxxxxxx and the vehicle's date of manufacture was September 2007. The odometer reading obtained during the inspection was 14,628 km (9,090 mi). The vehicle was equipped with a 6.2-liter, 8-cylinder engine, automatic transmission, 4-wheel drive, electric power steering with tilt column functionality, a tire pressure monitoring system, and daytime running lights. The braking and suspension systems included 4-wheel anti-lock brakes, Assisted Braking System (ABS), Electronic Stability Control (ESC), and traction control.

The vehicle manufacturer recommended P275/55R20 tires for the front and rear with a cold tire pressure of 221 kPa (32 psi). The vehicle was equipped with Bridgestone Dueler H/L Alenza P275/55R20 tires of the recommended size that were manufactured during the thirty-fourth week of 2007. The specific tire data was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	214 kPa (31 psi)	9 mm (11/32 in)	No	Sidewall scuffed
LR	221 kPa (32 psi)	9 mm (11/32 in)	No	Sidewall scuffed
RR	228 kPa (33 psi)	9 mm (11/32 in)	No	None
RF	214 kPa (31 psi)	9 mm (11/32 in)	No	None

The Yukon's interior was equipped with leather-covered four-occupant seating. The front row bucket seats were separated by a center console and were equipped with adjustable head restraints. Second row seating consisted of outboard bucket seats with folding inboard armrests and adjustable head restraints.

Vehicle Damage - 2008 GMC Yukon Denali

Exterior Damage

The Yukon sustained direct and induced damage to the right side resulting from the vehicle-to-vehicle impact and direct and induced damage to the left side from the rollover. Direct damage to the right side began 40.0 cm (15.7 in) aft of the rear axle, extended forward 254.0 cm (100.0 in), and ended 81.0 cm (31.9 in) aft of the front axle. The Field L was identical to the location of the direct damage. Six crush measurements were taken at mid-door level as follows: C_1 = 0 cm, C_2 = 4.0 cm (1.6 in), C_3 = 7.0 cm (2.8 in), C_4 = 5.0 cm (2.0 in), C_5 = 4.0 cm (1.6 in), C_6 = 0 cm. Maximum crush was located 58.0 cm (22.8 in) forward of the rear axle at C_3. The Collision Deformation Classification (CDC) for Event 1 was 02RZEW1.

Figure 3. Maximum lateral crush measurement

The vehicle-to-vehicle impact resulted in direct damage to the Yukon's right B- and C-pillars, and side doors. The height of maximum door crush measured 53.0 cm (20.9 in), the sill height measured 53.0 cm (20.9 in), and the Door Sill Differential (DSD) was 2.0 cm (0.8 in).

The vehicle rolled one quarter-turn and sustained damage to the left side. The direct damage to the left side began 91.0 cm (35.8 in) aft of the rear axle, extended forward 424.0 cm (166.9 in), and ended 37.0 cm (14.6 in) forward of the front axle. The direct damage began at the sill and extended upward 141.0 cm (55.5 in) to the roof side rail. Maximum lateral crush to the greenhouse was located at the C-pillar and measured 1.0 cm (0.4 in) (**Figure 3**). There was no vertical crush to the greenhouse. The CDC for the rollover was 00LDAO2.

Interior Damage - 2008 GMC Yukon Denali

The Yukon sustained interior damage resulting from intrusion, occupant loading and contact, and post-crash extrication activities. The roof glass and the left rearmost side glass disintegrated during the crash, and the windshield was holed during post-crash extrication activities. The right rear door was jammed shut and the passenger compartment sustained lateral intrusion of the right door panels, B-pillar, sill, and side panel.

Evidence of occupant loading was located on the driver's safety belt webbing, seat cushion, and left IC air bag. Evidence of occupant contact was located on the left door panel, lower left instrument panel (IP), and center console.

Manual Restraints - 2008 GMC Yukon Denali

The Yukon was equipped with manual 3-point lap and shoulder safety belts for the four seating positions. All the safety belts utilized continuous loop webbing and sliding latch plates. The front row safety belts were equipped with adjustable D-rings and retractor pretensioners. The driver's safety belt had an Emergency Locking Retractor (ELR) and the front right passenger's safety belt had a switchable ELR/Automatic Locking Retractor (ALR).

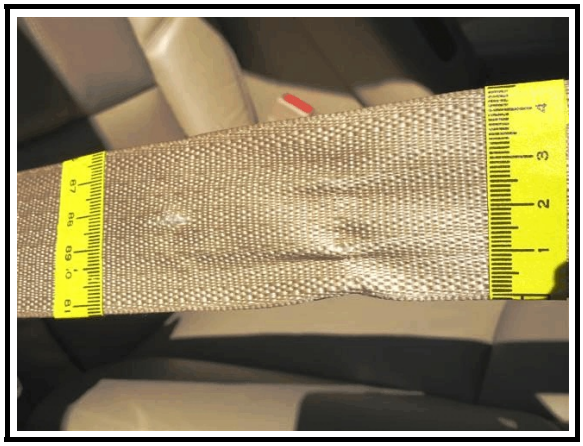


Figure 4. Damage to driver's safety belt webbing

The driver's safety belt D-ring was in the full-up position and the latch plate was scratched indicating historical usage. The safety belt retractor pretensioner had actuated during the crash and the safety belt was locked in the used position; the webbing measured 99.0 cm (39.0 in) in length in its post-crash state. The webbing exhibited a 5.0 x 9.0 cm (2.0 x 3.5 in) area of scuffs and stretch marks (**Figure 4**) beginning 30.0 cm (11.8 in) above the stop button. Based on the load marks on the safety belt webbing it was determined to have been used to restrain the driver during the crash.

The front row passenger's safety belt D-ring anchorage was set to the middle position and the latch plate was scratched indicating historical usage. The safety belt retractor pretensioner actuated during the crash and the safety belt webbing was locked in the stowed position.

Supplemental Restraint System - 2008 GMC Yukon Denali

The Yukon's Supplemental Restraint System (SRS) included an air bag control module (ACM), Rollover Sensor (ROS), driver and passenger frontal air bags, combination rollover/side impact IC air bags, and safety belt retractor pretensioners for the front row. The Yukon was a Certified Advanced 208-Compliant (CAC) vehicle that was certified by the manufacturer to be compliant with the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The

Yukon's advanced dual-stage frontal air bags were designed to deploy according to impact severity. The vehicle had been in no previous crashes, the air bags were original to the vehicle, and they had not been serviced. During the crash sequence the left and right IC air bags deployed and the safety belt retractor pretensioners actuated.

Figure 5. Left IC air bag

The left IC air bag deployed from the left roof side rail over the two passenger rows and the cargo area (**Figure 5**). It measured 270.0 cm (106.3 in) in length and 54.0 cm (21.3 in) in height, and covered the left side glass entirely. The air bag was configured without vent ports and was constructed with inflatable and non-inflatable sections. A 30.0 x 50.0 cm (11.8 x 19.7 in) sail and a 5.0 cm (2.0 in) tether attached the leading edge to the A-pillar and a 5.0 cm (2.0 in) tether attached the trailing edge to the C-pillar. A separate panel of the IC air bag covered the side glass in the cargo area.

The inboard panel of the left IC air bag exhibited a grease transfer and scuffs at the forward aspect. The grease transfer was determined to be a result of post-crash activities rather than an occupant loading. An area of scuffs measuring 3.0 x 4.0 cm (1.2 x 1.6 in) was located 45.0 cm (17.7 in) aft of the leading edge and 22.0 cm (8.7 in) above the bottom edge. The scuffs were consistent with occupant loading by the driver's left forearm which resulted in minor injuries. The outboard panel of the left IC air bag exhibited two abrasions at the rearward aspect where the air bag contacted the roadway.

The right IC air bag deployed from a module in the right roof side rail over the front and second rows and cargo area. The air bag was unremarkable.

Event Data Recorder - 2008 GMC Yukon Denali

The Yukon's EDR was imaged using the Bosch CDR Tool and software Version 3.3. Two modules were used to recover the recorded data: an ACM and a ROS. The ACM records two types of crash events: the non-deployment event and the deployment event. Both types may record pre-crash and crash data. The minimum recorded vehicle velocity change that is need to record a non-deployment event is 8 km/h (5.0 mph). For non-deployment events, the ACM can record up to the first 300 msec of data after AE. For deployment events, the ACM will record 220 milliseconds (msec) of data after deployment criteria are met and up to 70 msec of data before deployment criteria is met. The recorded data from the ACM was summarized as follows:

- The Low Tire Pressure Warning Lamp at AE was "Off".
- Pre-crash data from -1.0 to -0.5 seconds indicated the Cruise Control settings were inactive.
- Pre-crash data indicated the vehicle speed ranged from 35 km/h (21.7 mph) at -2.5 seconds to 39 km/h (24 mph) at -0.5 seconds.

- Pre-crash data indicated the Brake Switch Circuit Status from -2.5 seconds to -0.5 seconds was “OFF”.
- Driver’s Belt Switch Circuit Status was “Buckled”.
- Passenger’s Belt Switch Circuit Status was “Unbuckled”.
- Driver’s Seat Position Switch Circuit Status was “Rearward”.
- Side Air Bag Deployment Status was “Side Air Bag(s) were First Commanded to Deploy Due to Side Impact Event.
- Rollover Sensor Status was “Rollover Event”.
- Time From Rollover Event Enable To Deployment was “0".[1]
- Rollover Occupant Containment Enable Status was “Enabled”.
- Rollover Sensor Status was “Rollover Event”.
- Maximum Longitudinal Axis Recorded Velocity Change was -4.1 km/h (-2.55 mph) at 100 msec after AE.
- Maximum Lateral Axis Recorded Velocity Change was -8.2 km/h (-5.09 mph) at 100 msec after AE.

The ROS records lateral acceleration, vertical acceleration, and roll rate data. For rollover events, the ROS records up to 750 msec of data before the deployment criteria are met. For non-rollover events, the ROS will record up to 750 msec of data before Event Conclusion. The ROS recorded one non-rollover event and one rollover event. The recorded data from the ROS was summarized as follows:

- Event Record “A” was a Rollover and was not recorded last in the engine cycle.
- Vehicle speed at Event Enable was 39 km/h (24 mph).
- Time from Event Enable to Deployment Command Criteria Met was 760 msec.
- The ROS enabled after the ROS internal system check.
- The ROS enabled without receipt of expected messages from the ACM.
- There were 0 non-deployment events during the ignition cycle.
- The range of recorded lateral acceleration during the event was1.30 gravity (G) at -750 msec to 0.78 G at 0 msec.
- The range of recorded vertical acceleration during the event was -2.61 G at -750 msec to -1.17 G at 0 msec.
- The range of recorded vehicle roll rate during the event was 38.0 degrees/second at -750 msec to -66.0 degrees/second at 0 msec.

- Event Record “B” was a Non-Rollover and was recorded last in the engine cycle.
- Vehicle speed at Event Enable was 22.5 km/h (14 mph).
- The number of Non-Rollover events during this engine cycle was 0.
- Vehicle power mode status at Event Enable was “Run”.
- The recorded lateral acceleration throughout the event was 16.68 G.
- The recorded vertical acceleration throughout the event was -16.68.
- The recorded vehicle roll rate throughout the event was 0.0 degrees/second.

[1] The side air bags were commanded to deploy as a result of the side impact and prior to the rollover

Rollover

The Yukon had a Static Stability Factor (SSF) rating of 1.14. The SSF of a vehicle is an at-rest calculation of its rollover resistance, which is based on its track width and center of gravity. The vehicle had a rollover resistance rating of 3 out of 5 stars and had a 22 percent chance of rollover. The vehicle was equipped with ESC and traction control technologies designed to mitigate the chance of rollover and enhance the effectiveness of driver steering and braking dynamics.

The ESC utilizes braking to individual wheels and adjusts engine speed when the vehicle responds inadequately to steering input. The purpose is to improve tracking and thus reduce the chance of rollover.[2]

At impact with the Sierra, the Yukon was displaced to the left and initiated a clockwise rotation in response to the 2 o'clock direction of force that was applied aft of the vehicle's longitudinal center of gravity. The Yukon rotated clockwise to a point at which the roadway's opposing lateral forces against the right side tires induced a left side fall-over type rollover. The relatively high coefficient of friction generated between the tires and the dry asphalt surface contributed to the rollover dynamic. The vehicle's left side tires exhibited scuffs to the sidewalls and damage to the rims indicating contact with the roadway during the rollover.

The vehicle rolled about its longitudinal axis for one quarter-turn and then came to final rest on its left side. Based on the post-impact trajectory and the number of quarter-turns of the rollover, the estimated roll distance was 4.0 m (13.0 ft).

The roadway was in good condition and the crash site yielded no evidence of the rollover. The Yukon's tire tread measured 9.0 mm (11/32 in) and inflated pressure that was at or near the manufacturer's recommended cold pressure. Based on the scene and vehicle inspections, it was determined the condition or maintenance of the tires were not contributory to the rollover. Based on the high coefficient of friction between the vehicle's tires and the roadway, coupled with the driver's loss of control, it was determined that driver input such as steering or braking did not contribute to the rollover. The vehicle's ESC was not activated due to the absence of braking or steering input during the crash.

Figure 6. Other vehicle, 2007 GMC Sierra (auction facility photo)

Vehicle Data - 2007 GMC Sierra C1500

The 2007 GMC Sierra C1500 (**Figure 6**) was identified by VIN: 1GTEC19J67Zxxxxxx and its date of manufacture was June 2007. The Sierra was a 4-door extended cab pickup equipped with a 5.3-liter, 8-cylinder engine, rear wheel drive, standard 4-wheel anti-lock brakes, power steering,

[2] http://www.gmc.com/yukon/safety

and daytime lights. The odometer reading was 37,592 km (23,359 mi). The vehicle manufacturer recommended P245/70R17 tires for the front and rear with a recommended cold tire pressure was 241 kPa (35 psi).

Auction facility photographs showed the Sierra sustained direct and induced damage distributed across the front end from bumper corner to bumper corner and from the frame to the hood. Based on the photographs the estimated CDC for the Sierra was 10FDEW1.

Occupant Demographics - 2008 GMC Yukon Denali

Driver

Age/Sex:	84 years/Male
Height:	183 cm (72 in)
Weight:	86 km (190 lb)
Seat type:	Bucket with adjustable head restraint
Seat track position:	Between middle and rear
Manual restraint usage:	Lap and shoulder belt
Usage source:	Vehicle inspection
Air bags:	Frontal air bag, not deployed; IC air bag, deployed
Alcohol, drug involvement:	None
Type of medical treatment:	Transported, treated and released

Occupant Kinematics - 2008 GMC Yukon Denali

Driver

The 84-year-old male driver was seated in an upright posture and was restrained by the vehicle's lap and shoulder belt. He was steering the vehicle with both hands, his right foot was on the accelerator, and his left foot was on the floor. The driver's seat track was set between the middle and rear track positions and his seat back was reclined slightly. He was wearing non-prescription sunglasses. The vehicle was traveling southbound at an EDR-recorded speed of 39 km/h (24 mph) at -0.5 seconds prior to AE.

The driver did not observe the Sierra approaching prior to impact and did not attempt any evasive maneuvers. At impact, the driver of the Yukon was displaced right and slightly forward in response to the direction of force. His retractor pretensioner actuated and the vehicle's IC air bags deployed. His chest loaded the safety belt webbing and his thighs loaded the seat cushion depositing two fabric

transfers on its forward aspect (**Figure 7**) .

During the left leading one-quarter turn rollover, the driver's left hip contacted the left armrest depositing a scuff measuring 3.0 x 8.0 cm (1.2 x 3.1 in). His left flank contacted the left door panel above the armrest depositing a scuff measuring 2.0 x 10.0 cm (0.8 x 3.9 in). The driver's left forearm loaded the left IC air bag and door panel below the side glass resulting in abrasions and contusions. A light-colored transfer measuring 2.0 x 17.0 cm (0.8 x 6.7 in) was deposited on the door panel as a result of occupant loading to the IC air bag and the air bag contacting the door panel.

Figure 7. Areas of occupant loading and contact evidence

When the Yukon came to rest, the driver's left shoulder and head were positioned on the left door panel and IC air bag. He unbuckled his safety belt and waited several minutes for on-scene responders to cut a hole in the windshield, open the retractable moon roof cover, and remove his head restraint. The driver then moved from the front row to the cargo area and exited with assistance through the open rear hatch. In the interview the driver stated his right forearm was abraded and contused from supporting his weight and from contacting multiple interior surfaces during his exit from the vehicle.

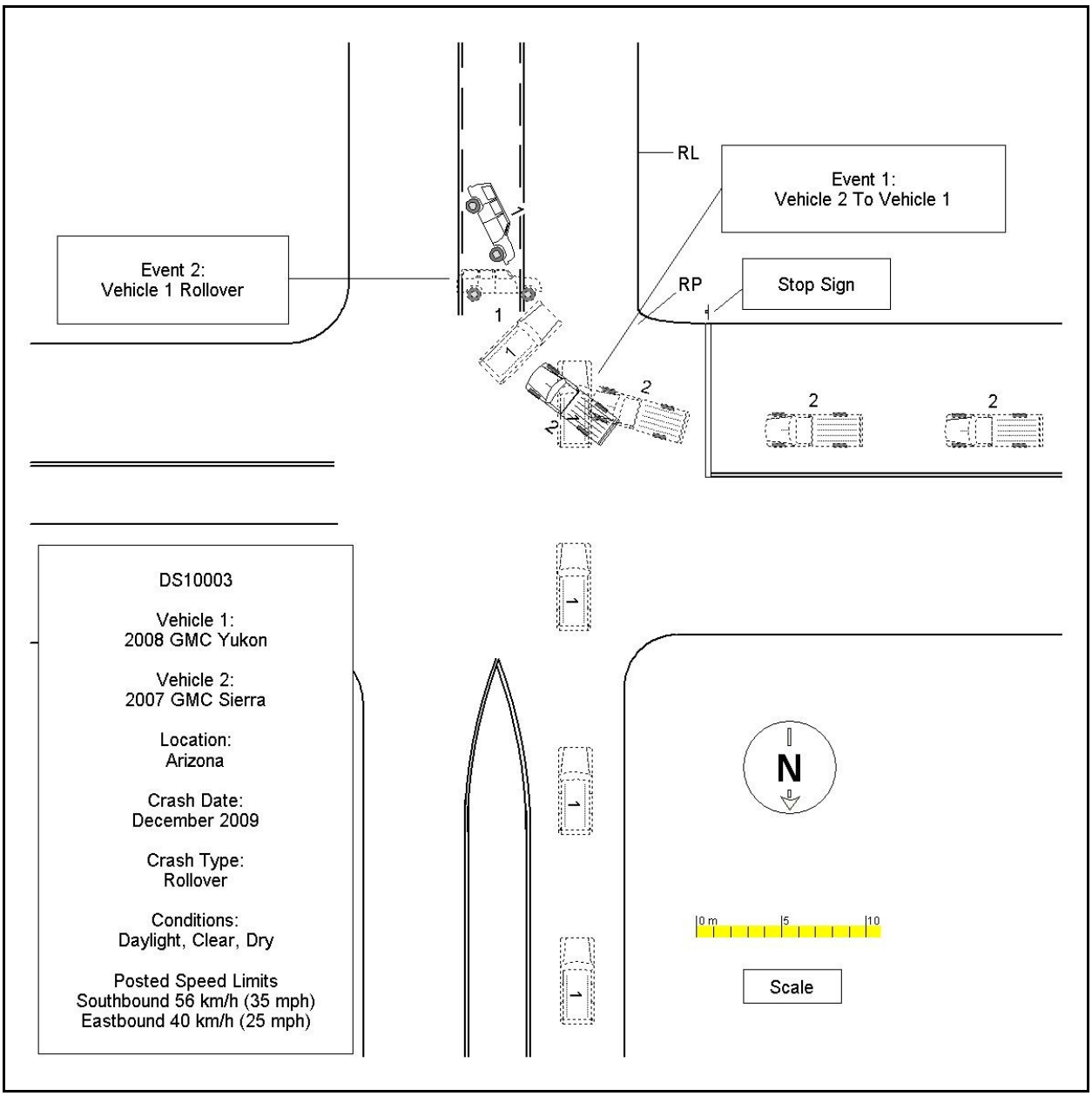
Occupant Injuries

Driver

The injury data was obtained from the driver's medical records and the interview.

Injury	OIC Code	Injury Mechanism	Confidence Level
Abrasions and contusions, left forearm	790202.1,2 790402.1,2	IC air bag	Probable
Abrasions and contusions, right forearm	Not codable	Post-crash activity	N/A

Attachment 1. Scene Diagram



Attachment 2. Bosch CDR Reports

CDR File Information

User Entered VIN	1GKFK63808J******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	
Saved on	
Collected with CDR version	Crash Data Retrieval Tool 3.3
Reported with CDR version	Crash Data Retrieval Tool 3.3
EDR Device Type	airbag control module
Event(s) recovered	Deployment

IMPORTANT NOTICE: Robert Bosch LLC recommends that the latest production release of Crash Data Retrieval software be utilized when viewing, printing or exporting any retrieved data from within the CDR program. This ensures that the retrieved data has been translated using the most recent information including but not limited to that which was provided by the manufacturers of the vehicles supported in this product.

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.

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)	129.08	126.87

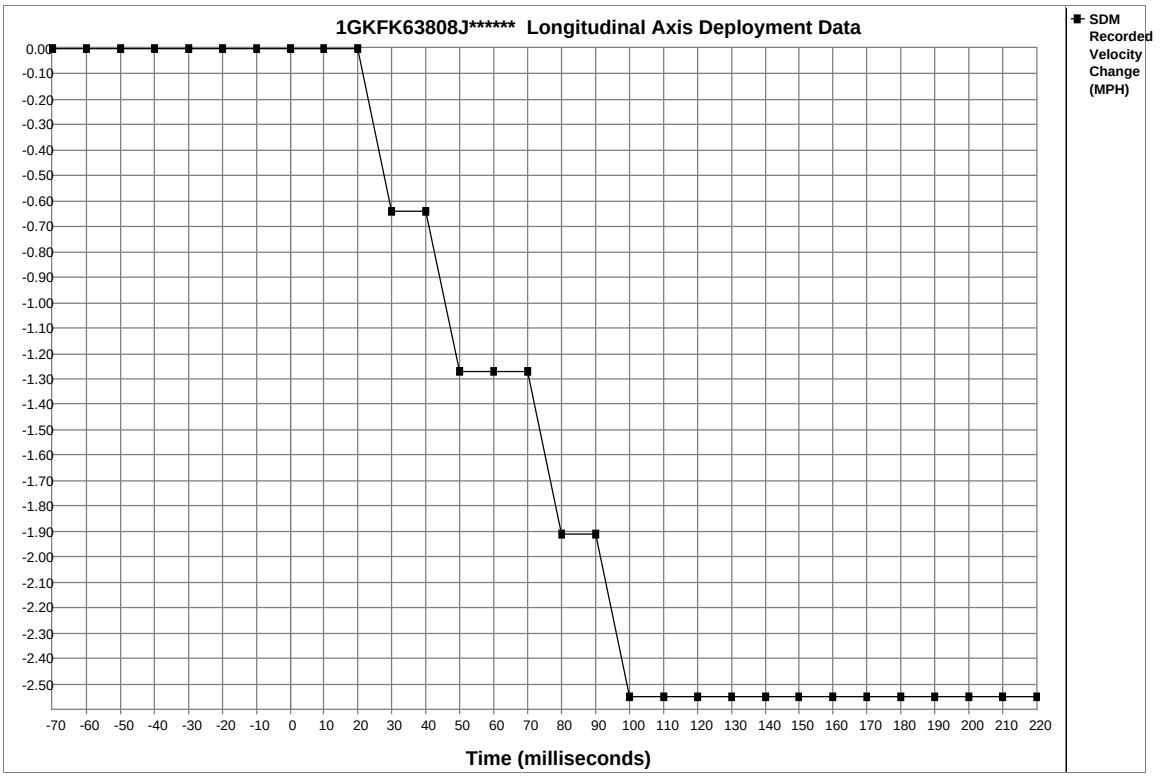
Pre-Crash Data

Parameter	-2.5 sec	-2.0 sec	-1.5 sec	-1.0 sec	-0.5 sec
Accelerator Pedal Position (percent)	9	12	16	16	15
Vehicle Speed (MPH)	22	22	23	23	24
Engine Speed (RPM)	1088	1216	1280	1408	1408
Percent Throttle	20	24	29	30	30
Brake Switch Circuit Status	OFF	OFF	OFF	OFF	OFF

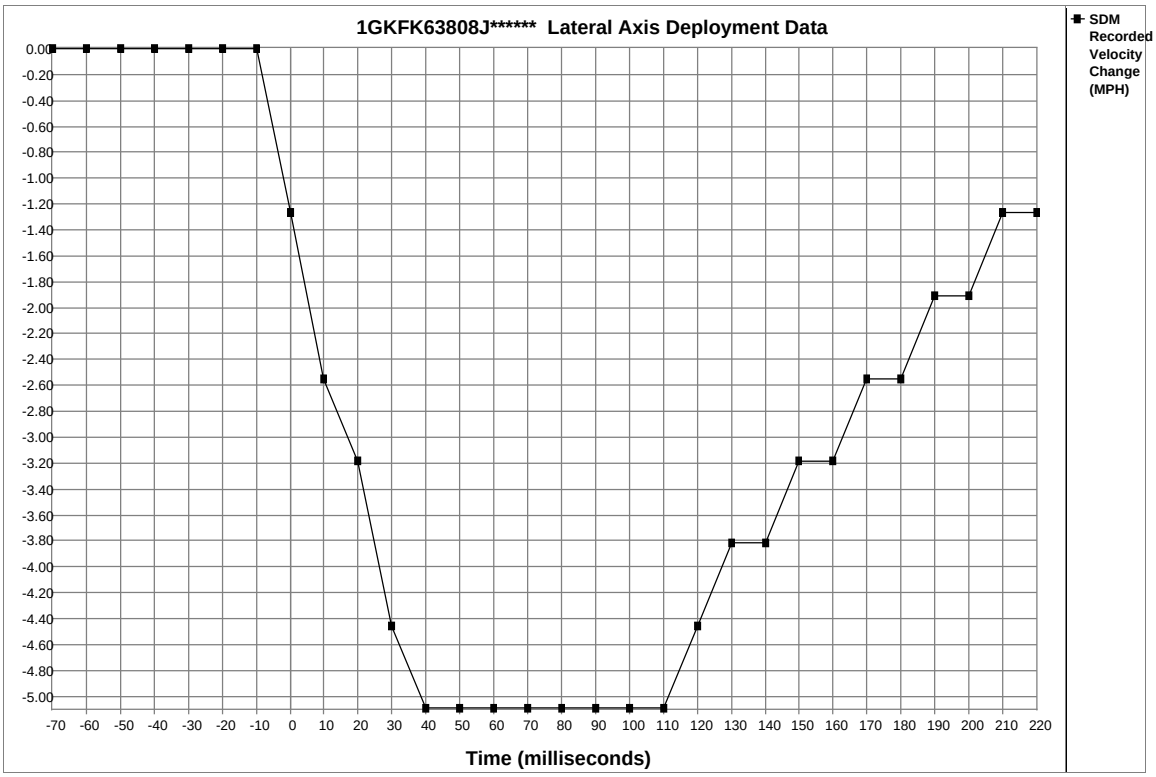
System Status At Deployment

Ignition Cycles At Investigation	1509
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	1486
Ignition Cycles At Event	1497
Ignition Cycles Since DTCs Were Last Cleared	255
Driver's Belt Switch Circuit Status	BUCKLED
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)	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 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	Side Air Bag(s) Were First Commanded to Deploy Due to Side Impact Event
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	1497
Time Between Events (sec)	N/A
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	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	0.00	0.00	0.00	0.00	-0.64	-0.64	-1.27	-1.27	-1.27
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Longitudinal Axis Recorded Velocity Change (MPH)	-1.91	-1.91	-2.55	-2.55	-2.55	-2.55	-2.55	-2.55	-2.55	-2.55	-2.55	-2.55	-2.55	-2.55	-2.55



Time (milliseconds)	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70
SDM Lateral Axis Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.27	-2.55	-3.18	-4.46	-5.09	-5.09	-5.09	-5.09
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Lateral Axis Recorded Velocity Change (MPH)	-5.09	-5.09	-5.09	-5.09	-4.46	-3.82	-3.82	-3.18	-3.18	-2.55	-2.55	-1.91	-1.91	-1.27	-1.27

CDR File Information

User Entered VIN	1GKFK63808J******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	
Saved on	
Collected with CDR version	Crash Data Retrieval Tool 3.3
Reported with CDR version	Crash Data Retrieval Tool 3.3
EDR Device Type	Roll-over Sensor
Event(s) recovered	Event Record "A" Event Record "B"

IMPORTANT NOTICE: Robert Bosch LLC recommends that the latest production release of Crash Data Retrieval software be utilized when viewing, printing or exporting any retrieved data from within the CDR program. This ensures that the retrieved data has been translated using the most recent information including but not limited to that which was provided by the manufacturers of the vehicles supported in this product.

Data Limitations

Recorded Crash Events:

There are two types of recorded crash events. The first is the Non-Rollover Event. A Non-Deployment Event records data but does not deploy the air bag(s). The ROS can store one Non-Rollover Event. This event will be overwritten by the next Non-Rollover Event or by a second Rollover Event. A locked Non-Rollover Event cannot be overwritten or cleared by the ROS. The second type of ROS recorded crash event is the Rollover Event. The ROS can store up to two different Rollover Events. Rollover Events cannot be overwritten or cleared from the ROS. Once the ROS records two Rollover Events, the ROS must be replaced.

Data:

-The ROS Records Lateral Acceleration, Vertical Acceleration, and Roll Rate data. This data reflects what the sensing system experienced during the recorded portion of the event. For Rollover Events, the ROS will record 750 milliseconds of data before the deployment criteria is met. For Non-Rollover Events, the ROS will record 750 milliseconds of data before Event Conclusion. Acceleration and Roll Rate data are displayed in SAE sign convention.
-Event Recording Complete will indicate if data from the recorded event has been fully written to the ROS memory or if it has been interrupted and not fully written.
-ROS 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

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

-If power to the ROS is lost during a crash event, all or part of the crash record may not be recorded.
-Event Recorded Last in the Ignition Cycle is used to determine the order of recorded events, if they occur in the same ignition cycle.
-Ignition Cycles Since DTCs Were Last Cleared can record a maximum value of 255 cycles and can only be reset by a scan tool.
-Event Recorded Last in the Ignition Cycle: This data is used to determine event order if more than one event is recorded in the same ignition
-Rollover Occupant Containment Enable Status
- Enabled: Indicates that the ROS system enabled after the ROS internal system check
- Disabled: Indicates that the ROS system disabled after the ROS internal system check

-Rollover Occupant Containment Enable Override Status
- Normal: Indicates that the ROS system enabled after recite of expected messages from the SDM
- Override: Indicates that the ROS system enabled without recite of expected messages from the SDM (This does not inhibit ROS performance)

-When reviewing ROS crash data, associated SDM crash data should also be reviewed.
-All data should be examined in conjunction with other available physical evidence from the vehicle and scene.

Data Source:

All ROS recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Status Data (Pre-Crash) is transmitted to the ROS, by various vehicle control modules, via the vehicle's communication network.

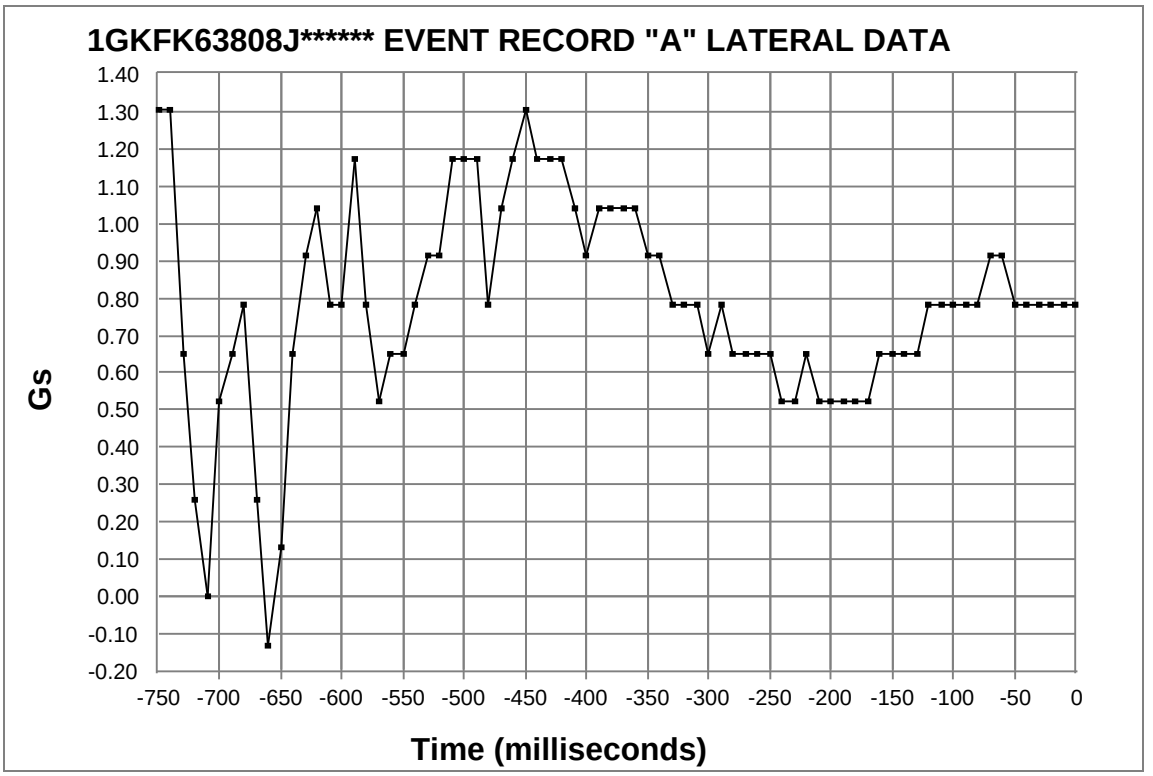
Event Record "A" Data

Crash Record Locked	Yes
Event Recording Complete	Yes
Event Record Type	Rollover
Event Recorded Last in the Ignition Cycle	No
SDM Event Synchronization Counter at Event Enable	1497
Ignition Cycles Since DTCs Were Last Cleared	255
Non-Rollover Data Overwritten	No
Vehicle Speed at Event Enable (MPH)	24
Vehicle Power Mode Status at Event Enable	Run
Remote Start Status at Event Enable (If Equipped)	Inactive
Run/Crank Ignition Switch Logic Level at Event Enable	Inactive
Diagnostic Trouble Code at Event Enable, fault number: 1	N/A
Diagnostic Trouble Code at Event Enable, fault number: 2	N/A
Diagnostic Trouble Code at Event Enable, fault number: 3	N/A
Diagnostic Trouble Code at Event Enable, fault number: 4	N/A
Diagnostic Trouble Code at Event Enable, fault number: 5	N/A
Diagnostic Trouble Code at Event Enable, fault number: 6	N/A
Time from Event Enable to Deployment Command Criteria Met (msec)	760
Rollover Occupant Containment Enable Status	Enabled
Rollover Occupant Containment Enable Override Status	Override
Energy Source Rollover System Used	Battery
Number of Non-Rollover Events During this Ignition Cycle	0
Deployment Mode	REC

Event Record "A" ROS Recorded Vehicle Lateral Acceleration

Time (ms)	Acceleration (G)
-750	1.30
-740	1.30
-730	0.65
-720	0.26
-710	0.00
-700	0.52
-690	0.65
-680	0.78
-670	0.26
-660	-0.13
-650	0.13
-640	0.65
-630	0.91
-620	1.04
-610	0.78
-600	0.78
-590	1.17
-580	0.78
-570	0.52
-560	0.65
-550	0.65
-540	0.78
-530	0.91
-520	0.91
-510	1.17
-500	1.17
-490	1.17
-480	0.78
-470	1.04
-460	1.17
-450	1.30
-440	1.17
-430	1.17
-420	1.17
-410	1.04
-400	0.91
-390	1.04
-380	1.04

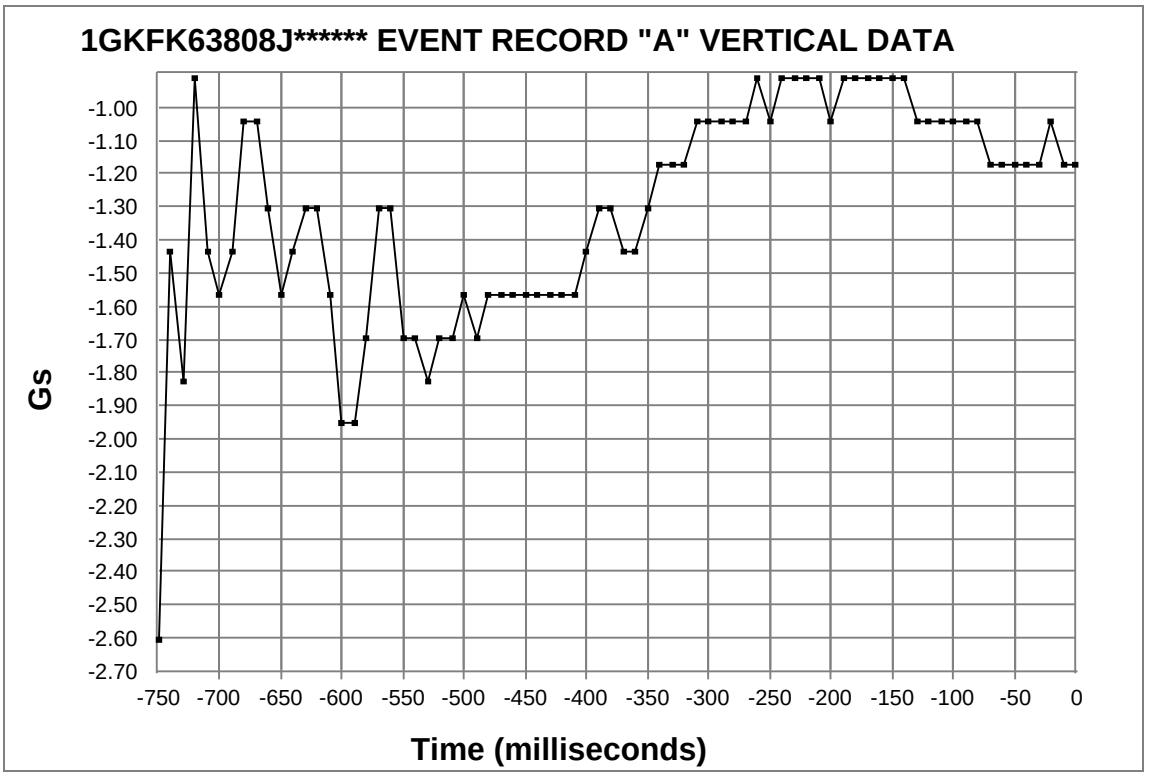
Time (ms)	Acceleration (G)
-370	1.04
-360	1.04
-350	0.91
-340	0.91
-330	0.78
-320	0.78
-310	0.78
-300	0.65
-290	0.78
-280	0.65
-270	0.65
-260	0.65
-250	0.65
-240	0.52
-230	0.52
-220	0.65
-210	0.52
-200	0.52
-190	0.52
-180	0.52
-170	0.52
-160	0.65
-150	0.65
-140	0.65
-130	0.65
-120	0.78
-110	0.78
-100	0.78
-90	0.78
-80	0.78
-70	0.91
-60	0.91
-50	0.78
-40	0.78
-30	0.78
-20	0.78
-10	0.78
0	0.78


1GKFK63808J****** EVENT RECORD "A" LATERAL DATA
Gs
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-750 -700 -650 -600 -550 -500 -450 -400 -350 -300 -250 -200 -150 -100 -50 0
Time (milliseconds)

Event Record "A" ROS Recorded Vehicle Vertical Acceleration

Time (ms)	Acceleration (G)
-750	-2.61
-740	-1.43
-730	-1.82
-720	-0.91
-710	-1.43
-700	-1.56
-690	-1.43
-680	-1.04
-670	-1.04
-660	-1.30
-650	-1.56
-640	-1.43
-630	-1.30
-620	-1.30
-610	-1.56
-600	-1.95
-590	-1.95
-580	-1.69
-570	-1.30
-560	-1.30
-550	-1.69
-540	-1.69
-530	-1.82
-520	-1.69
-510	-1.69
-500	-1.56
-490	-1.69
-480	-1.56
-470	-1.56
-460	-1.56
-450	-1.56
-440	-1.56
-430	-1.56
-420	-1.56
-410	-1.56
-400	-1.43
-390	-1.30
-380	-1.30

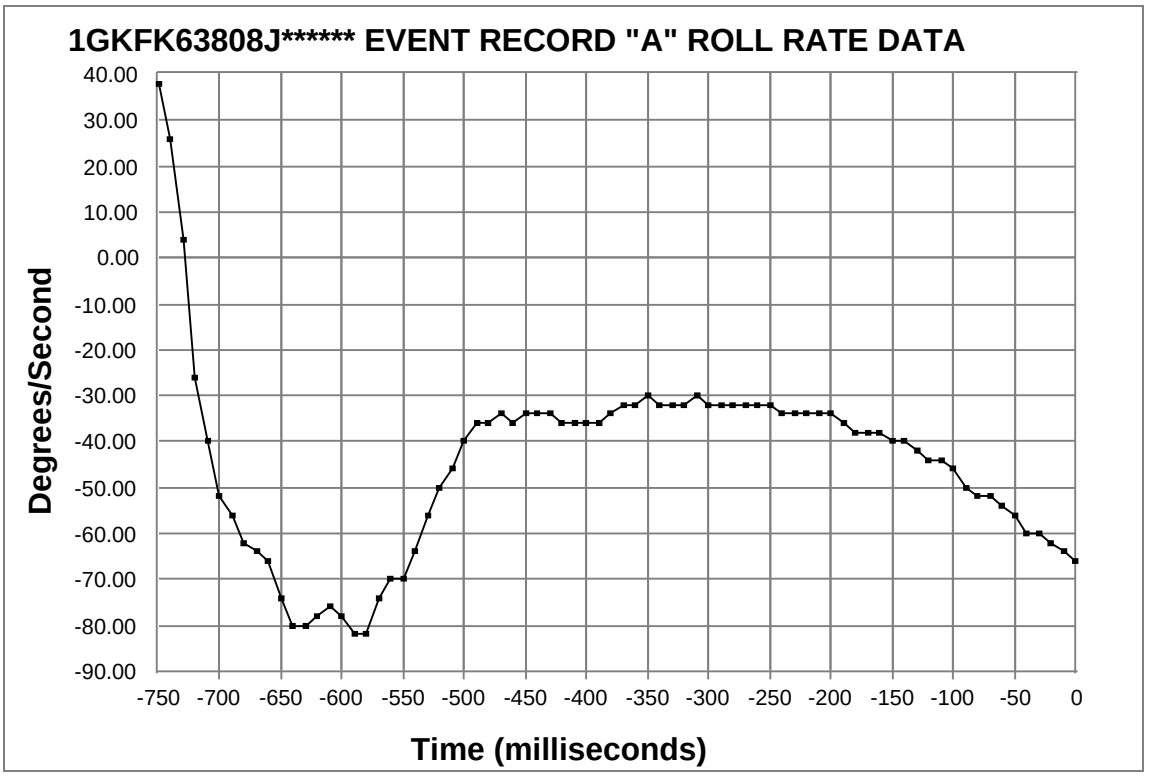
Time (ms)	Acceleration (G)
-370	-1.43
-360	-1.43
-350	-1.30
-340	-1.17
-330	-1.17
-320	-1.17
-310	-1.04
-300	-1.04
-290	-1.04
-280	-1.04
-270	-1.04
-260	-0.91
-250	-1.04
-240	-0.91
-230	-0.91
-220	-0.91
-210	-0.91
-200	-1.04
-190	-0.91
-180	-0.91
-170	-0.91
-160	-0.91
-150	-0.91
-140	-0.91
-130	-1.04
-120	-1.04
-110	-1.04
-100	-1.04
-90	-1.04
-80	-1.04
-70	-1.17
-60	-1.17
-50	-1.17
-40	-1.17
-30	-1.17
-20	-1.04
-10	-1.17
0	-1.17


1GKFK63808J****** EVENT RECORD "A" VERTICAL DATA
Gs
-1.00
-1.10
-1.20
-1.30
-1.40
-1.50
-1.60
-1.70
-1.80
-1.90
-2.00
-2.10
-2.20
-2.30
-2.40
-2.50
-2.60
-2.70
-750 -700 -650 -600 -550 -500 -450 -400 -350 -300 -250 -200 -150 -100 -50 0
Time (milliseconds)

Event Record "A" ROS Recorded Vehicle Roll Rate Data

Time (ms)	Roll Rate (degrees/second)
-750	38.00
-740	26.00
-730	4.00
-720	-26.00
-710	-40.00
-700	-52.00
-690	-56.00
-680	-62.00
-670	-64.00
-660	-66.00
-650	-74.00
-640	-80.00
-630	-80.00
-620	-78.00
-610	-76.00
-600	-78.00
-590	-82.00
-580	-82.00
-570	-74.00
-560	-70.00
-550	-70.00
-540	-64.00
-530	-56.00
-520	-50.00
-510	-46.00
-500	-40.00
-490	-36.00
-480	-36.00
-470	-34.00
-460	-36.00
-450	-34.00
-440	-34.00
-430	-34.00
-420	-36.00
-410	-36.00
-400	-36.00
-390	-36.00
-380	-34.00

Time (ms)	Roll Rate (degrees/second)
-370	-32.00
-360	-32.00
-350	-30.00
-340	-32.00
-330	-32.00
-320	-32.00
-310	-30.00
-300	-32.00
-290	-32.00
-280	-32.00
-270	-32.00
-260	-32.00
-250	-32.00
-240	-34.00
-230	-34.00
-220	-34.00
-210	-34.00
-200	-34.00
-190	-36.00
-180	-38.00
-170	-38.00
-160	-38.00
-150	-40.00
-140	-40.00
-130	-42.00
-120	-44.00
-110	-44.00
-100	-46.00
-90	-50.00
-80	-52.00
-70	-52.00
-60	-54.00
-50	-56.00
-40	-60.00
-30	-60.00
-20	-62.00
-10	-64.00
0	-66.00


1GKFK63808J****** EVENT RECORD "A" ROLL RATE DATA
Degrees/Second
40.00
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
-90.00
-750 -700 -650 -600 -550 -500 -450 -400 -350 -300 -250 -200 -150 -100 -50 0
Time (milliseconds)

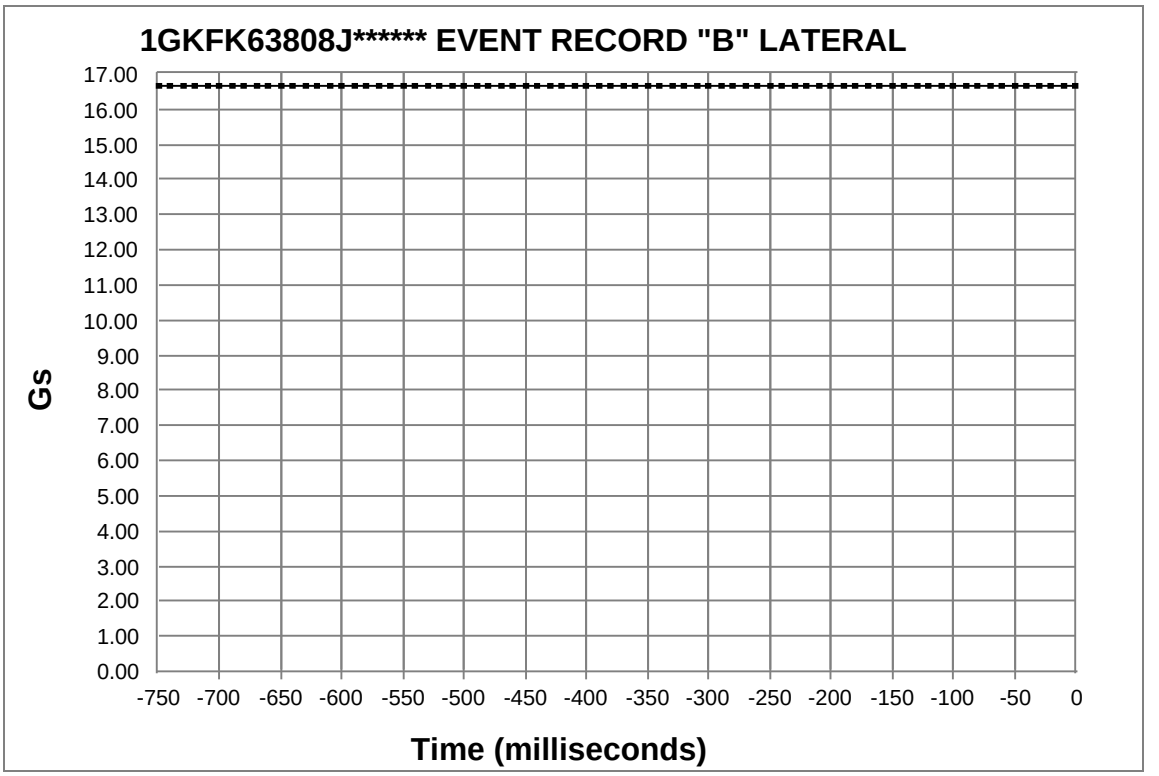
Event Record "B" Data

Crash Record Locked	Yes
Event Recording Complete	Yes
Event Record Type	Non-Rollover
Event Recorded Last in the Ignition Cycle	Yes
SDM Event Synchronization Counter at Event Enable	1497
Ignition Cycles Since DTCs Were Last Cleared	255
Non-Rollover Data Overwritten	No
Vehicle Speed at Event Enable (MPH)	14
Vehicle Power Mode Status at Event Enable	Run
Remote Start Status at Event Enable (If Equipped)	Inactive
Run/Crank Ignition Switch Logic Level at Event Enable	Inactive
Diagnostic Trouble Code at Event Enable, fault number: 1	N/A
Diagnostic Trouble Code at Event Enable, fault number: 2	N/A
Diagnostic Trouble Code at Event Enable, fault number: 3	N/A
Diagnostic Trouble Code at Event Enable, fault number: 4	N/A
Diagnostic Trouble Code at Event Enable, fault number: 5	N/A
Diagnostic Trouble Code at Event Enable, fault number: 6	N/A
Time from Event Enable to Deployment Command Criteria Met (msec)	5100
Rollover Occupant Containment Enable Status	Enabled
Rollover Occupant Containment Enable Override Status	Override
Energy Source Rollover System Used	No Information
Number of Non-Rollover Events During this Ignition Cycle	1
Deployment Mode	N/A

Event Record "B" ROS Recorded Vehicle Lateral Acceleration

Time (ms)	Acceleration (G)
-750	16.68
-740	16.68
-730	16.68
-720	16.68
-710	16.68
-700	16.68
-690	16.68
-680	16.68
-670	16.68
-660	16.68
-650	16.68
-640	16.68
-630	16.68
-620	16.68
-610	16.68
-600	16.68
-590	16.68
-580	16.68
-570	16.68
-560	16.68
-550	16.68
-540	16.68
-530	16.68
-520	16.68
-510	16.68
-500	16.68
-490	16.68
-480	16.68
-470	16.68
-460	16.68
-450	16.68
-440	16.68
-430	16.68
-420	16.68
-410	16.68
-400	16.68
-390	16.68
-380	16.68

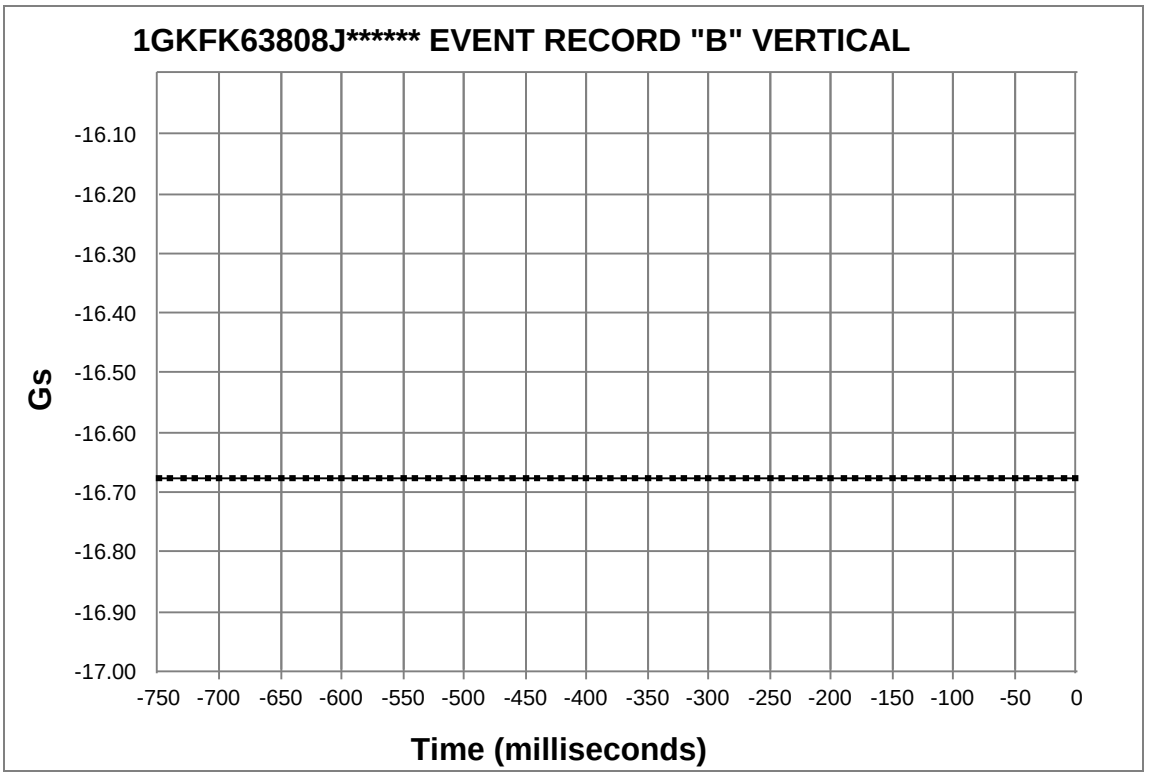
Time (ms)	Acceleration (G)
-370	16.68
-360	16.68
-350	16.68
-340	16.68
-330	16.68
-320	16.68
-310	16.68
-300	16.68
-290	16.68
-280	16.68
-270	16.68
-260	16.68
-250	16.68
-240	16.68
-230	16.68
-220	16.68
-210	16.68
-200	16.68
-190	16.68
-180	16.68
-170	16.68
-160	16.68
-150	16.68
-140	16.68
-130	16.68
-120	16.68
-110	16.68
-100	16.68
-90	16.68
-80	16.68
-70	16.68
-60	16.68
-50	16.68
-40	16.68
-30	16.68
-20	16.68
-10	16.68
0	16.68


1GKFK63808J****** EVENT RECORD "B" LATERAL
Gs
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-750 -700 -650 -600 -550 -500 -450 -400 -350 -300 -250 -200 -150 -100 -50 0
Time (milliseconds)

Event Record "B" ROS Recorded Vehicle Vertical Acceleration

Time (ms)	Acceleration (G)
-750	-16.68
-740	-16.68
-730	-16.68
-720	-16.68
-710	-16.68
-700	-16.68
-690	-16.68
-680	-16.68
-670	-16.68
-660	-16.68
-650	-16.68
-640	-16.68
-630	-16.68
-620	-16.68
-610	-16.68
-600	-16.68
-590	-16.68
-580	-16.68
-570	-16.68
-560	-16.68
-550	-16.68
-540	-16.68
-530	-16.68
-520	-16.68
-510	-16.68
-500	-16.68
-490	-16.68
-480	-16.68
-470	-16.68
-460	-16.68
-450	-16.68
-440	-16.68
-430	-16.68
-420	-16.68
-410	-16.68
-400	-16.68
-390	-16.68
-380	-16.68

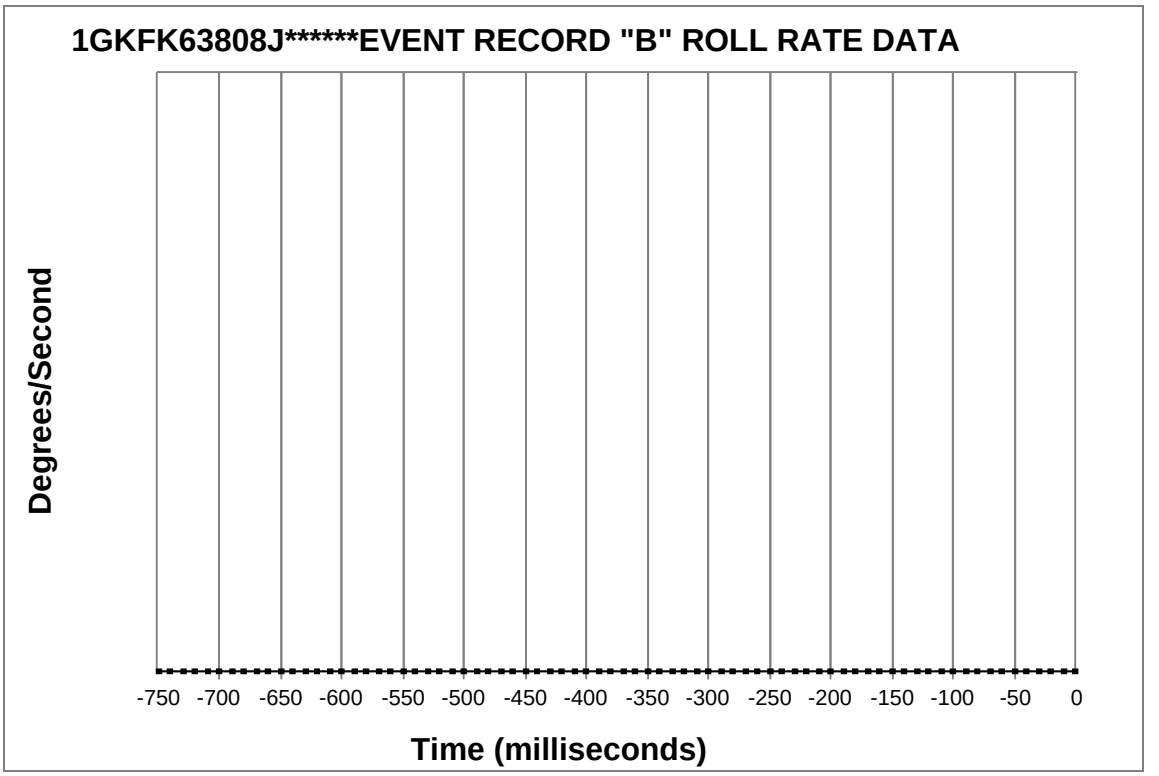
Time (ms)	Acceleration (G)
-370	-16.68
-360	-16.68
-350	-16.68
-340	-16.68
-330	-16.68
-320	-16.68
-310	-16.68
-300	-16.68
-290	-16.68
-280	-16.68
-270	-16.68
-260	-16.68
-250	-16.68
-240	-16.68
-230	-16.68
-220	-16.68
-210	-16.68
-200	-16.68
-190	-16.68
-180	-16.68
-170	-16.68
-160	-16.68
-150	-16.68
-140	-16.68
-130	-16.68
-120	-16.68
-110	-16.68
-100	-16.68
-90	-16.68
-80	-16.68
-70	-16.68
-60	-16.68
-50	-16.68
-40	-16.68
-30	-16.68
-20	-16.68
-10	-16.68
0	-16.68


1GKFK63808J****** EVENT RECORD "B" VERTICAL
Gs
-16.10
-16.20
-16.30
-16.40
-16.50
-16.60
-16.70
-16.80
-16.90
-17.00
-750 -700 -650 -600 -550 -500 -450 -400 -350 -300 -250 -200 -150 -100 -50 0
Time (milliseconds)

Event Record "B" ROS Recorded Vehicle Roll Rate Data

Time (ms)	ACC (degrees/second)
-750	0.00
-740	0.00
-730	0.00
-720	0.00
-710	0.00
-700	0.00
-690	0.00
-680	0.00
-670	0.00
-660	0.00
-650	0.00
-640	0.00
-630	0.00
-620	0.00
-610	0.00
-600	0.00
-590	0.00
-580	0.00
-570	0.00
-560	0.00
-550	0.00
-540	0.00
-530	0.00
-520	0.00
-510	0.00
-500	0.00
-490	0.00
-480	0.00
-470	0.00
-460	0.00
-450	0.00
-440	0.00
-430	0.00
-420	0.00
-410	0.00
-400	0.00
-390	0.00
-380	0.00

Time (ms)	ACC (degrees/second)
-370	0.00
-360	0.00
-350	0.00
-340	0.00
-330	0.00
-320	0.00
-310	0.00
-300	0.00
-290	0.00
-280	0.00
-270	0.00
-260	0.00
-250	0.00
-240	0.00
-230	0.00
-220	0.00
-210	0.00
-200	0.00
-190	0.00
-180	0.00
-170	0.00
-160	0.00
-150	0.00
-140	0.00
-130	0.00
-120	0.00
-110	0.00
-100	0.00
-90	0.00
-80	0.00
-70	0.00
-60	0.00
-50	0.00
-40	0.00
-30	0.00
-20	0.00
-10	0.00
0	0.00


1GKFK63808J******EVENT RECORD "B" ROLL RATE DATA
Degrees/Second
-750 -700 -650 -600 -550 -500 -450 -400 -350 -300 -250 -200 -150 -100 -50 0
Time (milliseconds)