CRASH DATA RESEARCH CENTER
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Buffalo, NY 14225

CALSPAN ON-SITE ROLLOVER CRASH INVESTIGATION
SCI CASE NO.: CA09032

VEHICLE: 2007 GMC SIERRA DENALI CREW-CAB PICKUP TRUCK

LOCATION: NORTH CAROLINA

CRASH DATE: FEBRUARY 2009

Contract No. DTNH22-07-C-00043

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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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.

TECHNICAL REPORT STANDARD TITLE PAGE

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16. Abstract This on-site investigation focused on a 2007 GMC Sierra Denali pickup truck that was involved in an intersection crash and a subsequent impact induced rollover. The vehicle was equipped with four-wheel anti-lock brakes, Electronic Stability Control (ESC), a Certified Advanced 208-Compliant (CAC) frontal air bag system, and roof rail-mounted Inflatable Curtain (IC) air bags. The manufacturer of the GMC certified that the vehicle is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system includes dual-stage frontal air bags for the driver and right front passenger positions, seat track positioning sensors, retractor pretensioners, and a front right occupant presence detection sensor. The right plane of the GMC was impacted by the front plane of a 2001 Volkswagen Jetta in a four-leg intersection. The IC air bags deployed as a result of the impact. Then the right rear tire of the GMC rode up onto the front of the Volkswagen initiating a left side leading two-quarter turn rollover event. The 42-year old female driver sustained police reported minor severity injuries.			
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BACKGROUND

This on-site investigation focused on a 2007 GMC Sierra Denali pickup truck **(Figure 1)** that was involved in an intersection crash and a subsequent impact-induced rollover. The vehicle was equipped with four-wheel anti-lock brakes, Electronic Stability Control (ESC), a Certified Advanced 208-Compliant (CAC) frontal air bag system, and roof rail-mounted Inflatable Curtain (IC) air bags. The manufacturer of the GMC certified that the vehicle is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system includes dual-stage frontal air bags for the driver and right front passenger positions, seat track positioning sensors, retractor pretensioners, and a front right occupant presence detection sensor. The right plane of the GMC was impacted by the front plane of a 2001 Volkswagen Jetta in a four-leg intersection. The IC air bags deployed as a result of the impact. Then the right rear tire of the GMC rode up onto the front of the Volkswagen initiating a left side leading two-quarter turn rollover event. The 42-year old female driver sustained police reported minor severity injuries.

Figure 1: 2007 GMC Sierra Denali case vehicle.

The crash was identified through a visit to a regional vehicle salvage facility on May 15, 2009. An image of the GMC was forwarded to the Calspan Special Crash Investigations (SCI) team for review on the same day. The Police Accident Report (PAR) was obtained from the local police department. Based on the rollover of the late model year vehicle and the deployment of the IC air bags, this case was assigned for an on-site investigation on May 18, 2009. The on-site investigation was conducted on May 19-20, 2009 and involved the inspection and documentation of the GMC, an interview with the driver of the GMC, and documentation of the crash scene. The Volkswagen Jetta was not available for inspection but images were obtained from the salvage facility. The GMC's Event Data Recorder (EDR) was imaged during the investigation and the recovered data is included as **Attachment A** of this report.

SUMMARY

Crash Site

This crash occurred during the morning daylight hours at a four-leg intersection of two, two-lane roadways in a residential neighborhood. The environmental conditions were police reported as cloudy and wet. The roadways measured 10.9 m (35.8 ft) in width and were bordered by barrier curbs 15.0 cm (5.9 in) in height. Traffic through the intersection was controlled by stop signs for the north/south travel direction. The roadways were surfaced in asphalt and were not delineated by pavement markings. Legal parallel parking was available at the roadsides. Beyond the curb lines were grass-surfaced residential properties. The grade was level in the vicinity of the intersection. The posted speed limit for both roadways was 56 km/h (35 mph). A scene schematic is included as **Figure 12** of this report.

VEHICLE DATA

2008 Chevrolet GMC Sierra Denali

The case vehicle was a 2007 GMC Sierra Denali Crew Cab 4x4 pickup truck. The GMC was manufactured in May 2007 and was identified by the Vehicle Identification Number (VIN): 2GTEK638471 (production number deleted). The vehicle was purchased new in 2007.

The 4-wheel drive GMC was powered by a 6.2-liter, V-8 engine linked to a 6-speed automatic transmission and an electronic transfer case. The braking system consisted of power-assisted front and rear disc brakes with four-wheel antilock. The GMC was equipped with Electronic Stability Control (ESC) and an indirect Tire Pressure Monitoring System (TPMS). The driver reported in the interview that the TPMS warning light was not illuminated prior to the crash. All four side windows and the sliding backlight window were closed at the time of the crash. The GMC was equipped with Goodyear Eagle LS-2 P275/55R20 tires on OEM six-spoke alloy wheels. The tire size was the vehicle manufacturer recommended size. The recommended cold tire pressure was 207 kPa (30 PSI) for the front and the rear. The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Tire Pressure	Measured Tread Depth	Tire/Wheel Damage
Left front	186 kPa (27 PSI)	6 mm (8/32 in)	None
Left Rear	Flat	6 mm (8/32 in)	Wheel fractured, tire de-beaded
Right Front	193 kPa (28 PSI)	6 mm (8/32 in)	None
Right Rear	179 kPa (26 PSI)	6 mm (8/32 in)	None

The interior of the GMC was configured with cloth surfaced five-passenger seating. The front bucket seats were separated by a center console and equipped with height-adjustable head restraints. The left head restraint was adjusted 7.0 cm (2.8 in) above the full-down position, and the right head restraint was adjusted 5.0 cm (2.1 in) above the full-down position. The driver's seat was found at the time of the SCI inspection to be adjusted 5.0 cm (2.1 in) forward of the full-rear position and the seat back was 21.0 degrees aft of vertical. The front right passenger seat was found in the full-rear position and the seat back measured 33.0 degrees aft of vertical. The second row was equipped with a split 60/40 bench with seat cushions, that folded vertically upward, and a fixed seat back. Both cushions were folded down at the time of the crash. The

rear outboard seats were equipped with adjustable head restraints; both were in the full-down position. The rear outboard seats were LATCH equipped.

The interior occupant safety systems consisted of three-point lap and shoulder belts for all five seating positions, front safety belt pretensioners, CAC frontal air bags, and IC air bags that provide protection to the four outboard seat positions.

2001 Volkswagen Jetta GLS

The 2001 Volkswagen Jetta GLS was identified by the VIN 3VWSC29M71M (production sequence deleted). The front-wheel drive Jetta was powered by a 2.0-liter, inline 4-cylinder gasoline engine linked to a 4-speed automatic transmission, and was equipped with manual safety belts and redesigned frontal air bags.

The Jetta had been sent to the same regional salvage facility as the GMC for auction; however, the vehicle had been sold at auction prior to SCI involvement in this investigation. The salvage facility could not release information about the sale of the vehicle, but supplied images depicting its damage condition that were taken prior to the sale.

The interior of the Jetta was configured with five-passenger seating. The front bucket seats were separated by a center console and equipped with height-adjustable head restraints. Both head restraints were in the full-down position in available the images. The second row seat was a single bench with a 60/40 split forward folding seat backs; all three head restraints were in the full-down position in available images.

CRASH SEQUENCE

Pre-Crash

The restrained 42-year old female driver of the GMC was operating the vehicle on the northbound approach to the four-leg intersection **(Figure 2)**. The north and southbound approaches to the intersection were controlled by stop signs. The driver was traveling at an EDR recorded speed of 56.0 km/h (35.0 mph) at 2.5 seconds prior to Algorithm Enable (AE). The 18-year old driver of the Volkswagen was on the westbound approach to the intersection at a police estimated speed of 56.0 km/h (35.0 mph). Both vehicles entered the intersection, attempting to travel through on a straight path.

Figure 2: Northbound approach to the intersection

Crash

The front plane of the Volkswagen impacted the center aspect of the GMC's right plane. The directions of force were within the 1 o'clock sector for the GMC and the 10 o'clock sector for the Volkswagen. The Damage algorithm of the WINSMASH program was used to calculate the severity of the crash. The total delta-V of the GMC was 13.0 km/h (8.1 mph). The longitudinal

and lateral components of the delta-V were -8.4 km/h (-5.2 mph) and -10.0 km/h (-6.2 mph). The total delta-V of the Volkswagen was 24.0 km/h (14.9 mph) with longitudinal and lateral components of -18.4 km/h (-11.4 mph) and 15.4 km/h (9.6 mph). The IC air bags in the GMC deployed as a result of the impact. The deployment of the IC air bags due to the side impact was confirmed by the imaged EDR data.

As the front of the Jetta engaged the right side of the GMC, the right rear tire of the GMC rode up the left front aspect of the Jetta. This caused the GMC to initiate a collision-induced rollover event. The GMC rolled left side leading, two-quarter turns onto its roof. The vehicle traveled approximately 15.0 m (49.2 ft) during the rollover sequence in an arced path to the northwest. The GMC came to rest straddling the west curb in the north leg of the intersection (**Figure 3**). The final rest location was evidenced by a gouge still visible in the grass at the time of the scene inspection and abrasions to the curb. The Volkswagen was redirected to a northwest trajectory by the initial impact with the GMC and rotated clockwise as it separated from the impact. The Volkswagen came to rest on the north leg of the intersection facing southeast.

Figure 3: Trajectory of GMC during the rollover.

Post-Crash

The emergency response was initiated by the GMC's ONSTAR system. The driver was contacted by ONSTAR immediately after the crash as a result of the air bag deployment. The driver indicated that she required assistance. Police, emergency medical and tow personnel responded to the crash. Both drivers exited their vehicles unassisted and sustained police reported minor severity injuries. Neither driver required medical transport. Both vehicles were towed from the scene due to disabling damage and were considered total losses.

EXTERIOR DAMAGE

2007 GMC Sierra Denali

The right, left and top planes of the GMC Sierra Denali were damaged in this multiple event crash. The initial impact involved moderate severity damage to the center aspect of the right plane of the GMC **(Figure 4)**. The direct contact damage began 46.0 cm (18.1 in) rear of the right front axle and extended rearward to the right rear wheel area. Lateral crush was present on the right sill and the lower aspect of both doors. The right front and right rear door hinges were intact and remained attached to the A- and B-pillars, respectively. Both right side doors remained closed. The right rear

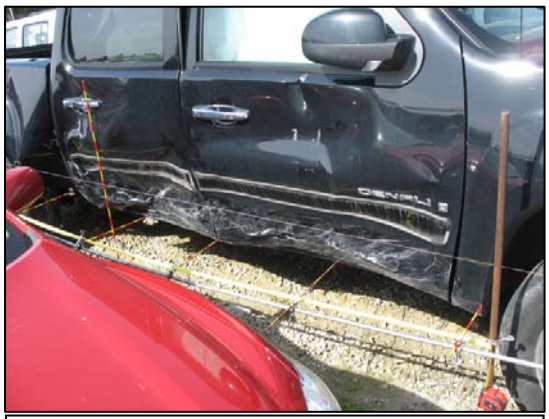


Figure 4: Initial impact damage to the right side of the GMC.

wheel engaged the Jetta, but was not damaged in the crash. A crush profile for the initial impact was documented at the sill elevation and was as follows: C1 = 0 cm, C2 = 20.0 cm (7.9 in), C3 = 25.0 cm (9.8 in), C4 = 16.0 cm (6.3 in), C5 = 15.0 cm (5.9 in), C6 = 0 cm. The maximum crush was located at C3, 192.0 cm (75.6 in) aft of the right front axle and measured 25.0 cm (9.8 in). The elevation of the maximum crush was 44 cm (17.3 in) which was located at the sill level. As a result of the maximum crush occurring on the right sill, the Door Sill Differential (DSD) was 0 cm. The Collision Deformation Classification (CDC) for the initial impact was 02RPEW2.

The left and top planes of the GMC were damaged in the rollover event. The scratches on the roof were oriented longitudinally, indicating that the vehicle slid forward on its roof after rolling over two-quarter turns. The direct contact damage to the roof extended laterally from side rail to side rail 153.0 cm (60.2 in). The longitudinal direct contact damage extended longitudinally from the front left of the hood rearward 542.0 cm (213.4 in) to the left rear taillight area. The maximum vertical crush to the roof was 6.0 cm (2.4 in), located at the junction of the left roof side rail and the windshield header. The maximum lateral crush was 1.0 cm (0.4 in), located at the left C-pillar. **Figures 5 and 6** depict the damage sustained by the GMC in the rollover. The CDC for this rollover event was 00TDDO2.

Figure 5: GMC rollover damage from top left.

Figure 6: Top damage from rear right.

The left front, left rear and right rear doors were operational post-crash. The right front door was jammed shut. The windshield was 50 percent fractured, with the damage concentrated towards the left side. The left front side window was disintegrated during the rollover. The remaining side windows, the backlight, and the sunroof were closed prior to the crash and were not damaged.

2001 Volkswagen Jetta GLS

The exterior of the Volkswagen sustained moderate severity damage as a result of the initial impact with the GMC. The direct damage extended from the left bumper corner to the right bumper corner and a profile was estimated from images obtained from the salvage yard that had sold the vehicle. This estimated crush profile was as follows: C1 = 3.0 cm (1.2 in), C2 = 3.0 cm (1.2 in), C3 = 4.0 cm (1.6 in), C4 = 6.0 cm (2.4 in), C5 = 5.0 cm (2 in), C6 = 0 cm. The estimated maximum crush was located left of the centerline of the vehicle. The CDC based on the images of the damaged vehicle was 11FDEW1. **Figures 7 and 8** depict the frontal damage sustained by the Volkswagen in the initial impact.

Figure 7: Impact damage to the Volkswagen from the front left.

Figure 8: Frontal damage to the Volkswagen.

INTERIOR DAMAGE

2007 GMC Sierra Denali

The GMC sustained moderate severity interior damage that resulted from intrusion and driver contact. The right side of the passenger compartment intruded laterally as a result of the initial impact, and the roof and related components intruded vertically as a result of the rollover event. The intrusion of the GMC is listed on the following table:

Position	Component	Direction	Magnitude
Row 1 Left	Windshield	Longitudinal	19 cm (7.5 in)
Row 1 Left	Roof	Vertical	5 cm (2 in)
Row 1 Center	Roof	Vertical	2 cm (0.8 in)
Row 2 Left	Roof	Vertical	5 cm (2 in)
Row 2 Left	Roof side rail	Vertical	3 cm (1.2 in)
Row 1 Left	Roof side rail	Vertical	5 cm (2 in)
Row 1 Left	A-pillar	Vertical	5 cm (2 in)
Row 1 Right	RF door Rear Lower Quadrant	Lateral	7 cm (2.8 in)
Row 1 Right	B-pillar	Lateral	6 cm (2.4 in)
Row 1 Right	Floor pan/sill	Lateral	7cm (2.8 in)
Row 2 Right	Floor pan/sill	Lateral	11 cm (4.3 in)
Row 2 Right	RR door Forward Lower Quad.	Lateral	11 cm (4.3 in)

The interior of the GMC sustained damage attributed to occupant contact. There was a scuff with hair on the headliner **(Figure 9)** located 13-23.0 cm (5.1-9.1 in) inboard of the left roof side rail and 29.0 - 45.0 cm (11.4 - 17.7 in) rear of the windshield header.

Figure 9: Roof contact attributed to driver's head.

MANUAL RESTRAINT SYSTEMS

2007 GMC Sierra Denali

The manual restraint systems in the GMC consisted of three-point lap and shoulder belts for all designated seating positions. All belt systems utilized continuous loop webbing and sliding latch plates. The driver's belt utilized an Emergency Locking Retractor (ELR) with a retractor pretensioner. The driver's D-ring was height adjustable and set to the full-up position. The driver used the safety belt at the time of the crash, which was supported by loading evidence on the belt webbing. This evidence consisted of a frictional abrasion near the D-ring. The abrasion was located from 159.0 – 162.0 cm (62.6 - 63.8 in) above the floor anchor. Additionally, the actuated retractor pretensioner locked the safety belt in the used position.

The front right and the second row safety belt systems utilized a switchable ELR/Automatic Locking Retractor (ALR). In addition, the front right belt system contained a retractor-mounted pretensioner that actuated in this crash. The height adjustable D-ring found in the full-down position. This seat position was unoccupied.

FRONTAL AIR BAG SYSTEM

2007 GMC Sierra Denali

The GMC was equipped with CAC frontal air bags. The driver's air bag was concealed within the center hub of the four-spoke steering wheel and did not deploy in this side impact/rollover crash. The front right air bag was mounted within the top aspect of the right instrument panel and did not deploy.

SIDE IMPACT AIR BAG SYSTEM

2007 GMC Sierra Denali

The GMC was equipped with roof rail-mounted IC air bags. The IC air bags deployed from their respective roof rails as a result of the initial impact to the side of the GMC. The imaged EDR data confirmed that the deployment command was related to the side impact event.. The GMC was also equipped with a rollover sensor.

The IC air bag measured 164.0 cm (64.6 in) in length. The air bag measured 57.0 cm (22.4 in) in height. There was a cutout to the un-inflated section of the air bag, adjacent to the B-pillar, to accommodate the front safety belt webbing. This cutout was semicircular in shape and measured 12.0 cm (4.7 in) in width and 18.0 cm (7.1 in) in height.

The air bags were attached to the A-pillars by a non-inflatable sail panel. This panel allowed for complete longitudinal coverage across the entire front glazing. This sail panel was 43.0 cm (16.9 in) in height. The upper edge of the sail panel measured 28.0 cm (11.0 in) and the lower edge of the sail panel measured 49.0 cm (19.3 in). Vertically, the IC air bags extended below the beltline at each outboard position. The IC air bags provided head protection from the roof side rail to the belt line and from the A-pillar to the C-pillar of the vehicle. The air bags were labeled with the following numbers: 6100819A, SI/PA 6.6

The left IC contained an abrasion on the outboard side, in the area of the left front glazing, which disintegrated during the crash sequence. The abrasion was located 26.0 – 42.0 cm (10.2 - 16.5 in) above the lower edge of the curtain and 37.0 – 56.0 cm (14.6 – 22.0 in) rear of the front. This abrasion was attributed to contact with the ground as the GMC rolled onto its left side plane. There were no identified contacts to the interior side of the left IC. The right IC was free from occupant contact points and damage. **Figures 10 and 11** depict the left and right IC air bags.

Figure 10: Forward aspect of left Inflatable Curtain.

Figure 11: Right Inflatable Curtain.

EVENT DATA RECORDER

2007 GMC Sierra Denali

The Event Data Recorder (EDR) of the GMC was imaged at the time of the inspection by applying power to the air bag system and imaging the data through the DLC port located under the left instrument panel. The imaged data indicated a deployment event had been stored in the module and that there were no other associated events.

The data indicated that at 2 seconds prior to Algorithm Enable (AE), the vehicle speed was 57.9 km/h (36.0 mph) and the cruise control was "off". The brake switch circuit status was "off" throughout the entire 2.5 second pre-crash data recording.

The deployment occurred on ignition cycle 5593 and the data was imaged on cycle 5594. The driver's safety belt was recorded as buckled and the front right passenger's belt was unbuckled. The front right passenger seat was recorded as empty. The driver and passenger frontal air bags were not commanded to deploy in this crash sequence. The IC air bags were commanded to deploy as a result of the side impact event. The time between AE and the deployment of the IC

air bags was 7.5 milliseconds. The maximum recorded longitudinal delta-V was (-5.73 mph) at 220 milliseconds after AE. The maximum recorded lateral delta-V was -6.37 mph) 160 milliseconds post-AE.

The rollover sensor detected the rollover condition, but a separate event was not stored in memory. There were no historical diagnostic trouble codes stored at the time of the deployment. **Attachment A** at the end of this report is the data file imaged from the EDR of the GMC.

OCCUPANT DEMOGRAPHICS/DATA

2007 GMC Sierra Denali

Driver Age/Sex:	42-year old/Female
Height:	170 cm (67 in)
Weight:	54 kg (119 lb)
Eyewear:	None
Seat Track Position:	Rear-track, 5 cm (2 in) fwd. of full-rear
Manual Safety Belt Use:	Lap and shoulder belt
Usage Source:	SCI vehicle inspection
Egress from Vehicle:	Exited the vehicle unassisted
Mode of Transport from Scene:	None
Type of Medical Treatment:	Treated at home by family member who was a physician

DRIVER INJURIES

2007 GMC Sierra Denali

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Mild Concussion	Not coded under AIS rules	Roof
Forehead contusion	Minor (290402.1,7)	Roof
Left scalp contusion	Minor (190402.1,2)	Roof

DRIVER KINEMATICS

2007 GMC Sierra Denali

The 42-year old female driver of the GMC was seated in a rear-track position and was restrained by the manual three-point lap and shoulder belt system. The driver was approaching a four-leg intersection in a residential area. As the GMC passed through the intersection, it was impacted on the right plane by the Volkswagen. This impact actuated the front safety belt retractor pretensioners and deployed the left and right IC air bags. The driver initiated a right and forward trajectory in response to the 2 o'clock direction of the impact. The driver loaded the belt system and the center console. As the vehicle began to roll over to the left, the driver initiated an upward trajectory. The driver remained in contact with the belt system and her head contacted the roof to the left of the sunroof opening, resulting in the scalp and forehead contusions and the mild concussion. When the vehicle came to rest on its roof, the driver was suspended by the belt system. The driver was not medically transported from the scene. She was treated at home for a mild concussion and the contusions by her father, who is a physician.

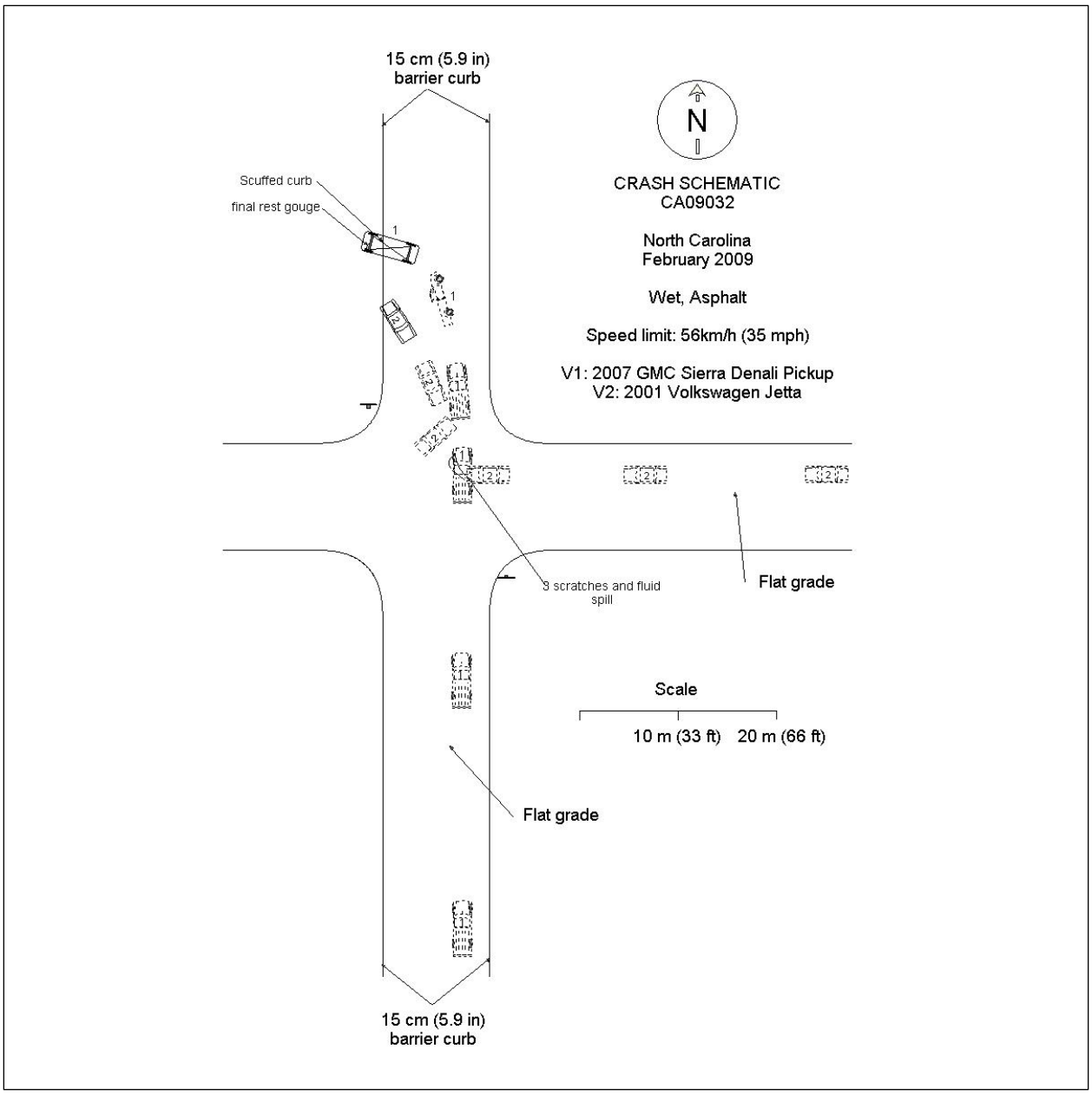


Figure 12: Crash Schematic

ATTACHMENT A

2007 GMC SIERRA 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	2GTEK638471******
User	
Case Number	
EDR Data Imaging Date	Tuesday, May 19 2009
Crash Date	Tuesday, February 3 2009
Filename	
Saved on	Tuesday, May 19 2009 at 09:35:47 AM
Collected with CDR version	Crash Data Retrieval Tool 3.1
Reported with CDR version	Crash Data Retrieval Tool 3.4
EDR Device Type	airbag control module
Event(s) recovered	Deployment

Comments

No comments entered.

Data Limitations

Recorded Crash Events:

There are two types of recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event records data but does not deploy the air bag(s). The minimum SDM Recorded Vehicle Velocity Change, that is needed to record a Non-Deployment Event, is five MPH. A Non-Deployment Event may contain Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded vehicle velocity change. This event will be cleared by the SDM, after approximately 250 ignition cycles. This event can be overwritten by a second Deployment Event, referred to as Deployment Event #2, if the Non-Deployment Event is not locked. The data in the Non-Deployment Event file will be locked, if the Non-Deployment Event occurred within five seconds of a Deployment Event. A locked Non Deployment Event cannot be overwritten or cleared by the SDM.

The second type of SDM recorded crash event is the Deployment Event. It also may contain Pre-Crash and Crash data. The SDM can store up to two different Deployment Events. If a second Deployment Event occurs any time after the Deployment Event, the Deployment Event #2 will overwrite any non-locked Non-Deployment Event. Deployment Events cannot be overwritten or cleared by the SDM. Once the SDM has deployed an air bag, the SDM must be replaced.

Data:

-SDM Recorded Vehicle Velocity Change reflects the change in velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. For Deployment Events, the SDM will record 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	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)	172.97	170.2

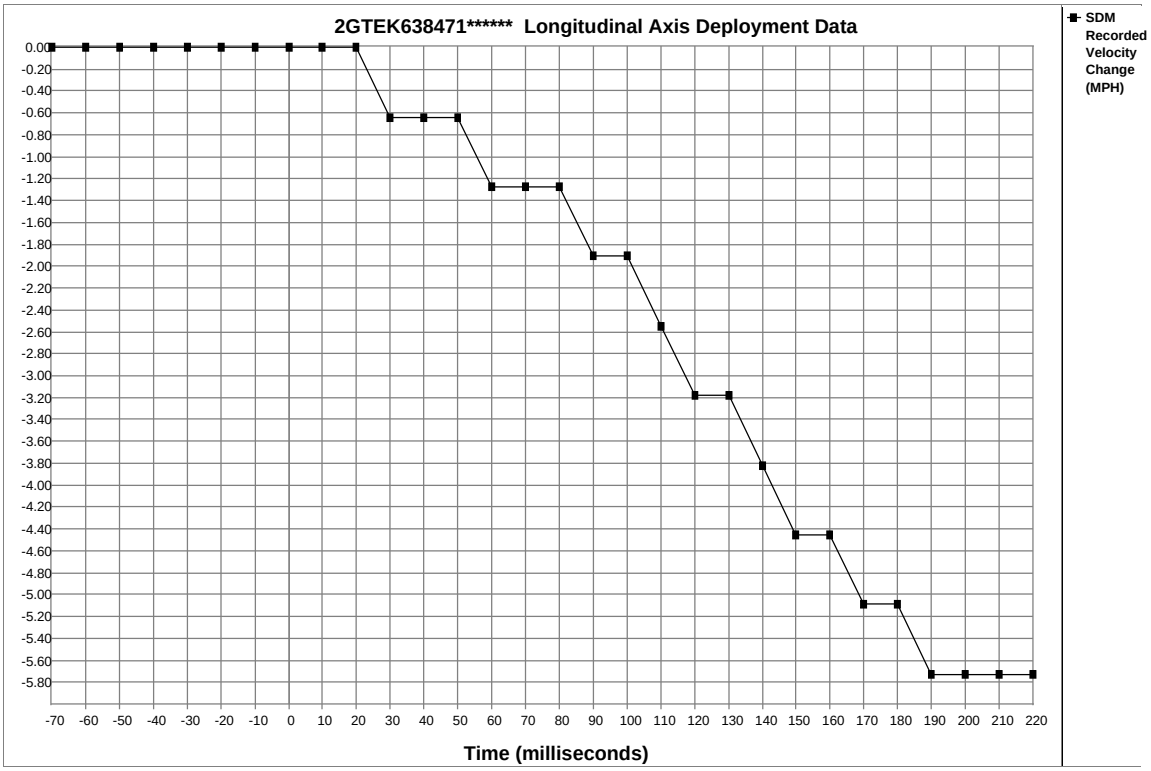
Pre-Crash Data

Parameter	-2.5 sec	-2.0 sec	-1.5 sec	-1.0 sec	-0.5 sec
Accelerator Pedal Position (percent)	2	0	0	0	0
Vehicle Speed (MPH)	35	36	36	36	36
Engine Speed (RPM)	1536	1280	1216	1152	1152
Percent Throttle	29	18	18	17	16
Brake Switch Circuit Status	OFF	OFF	OFF	OFF	OFF

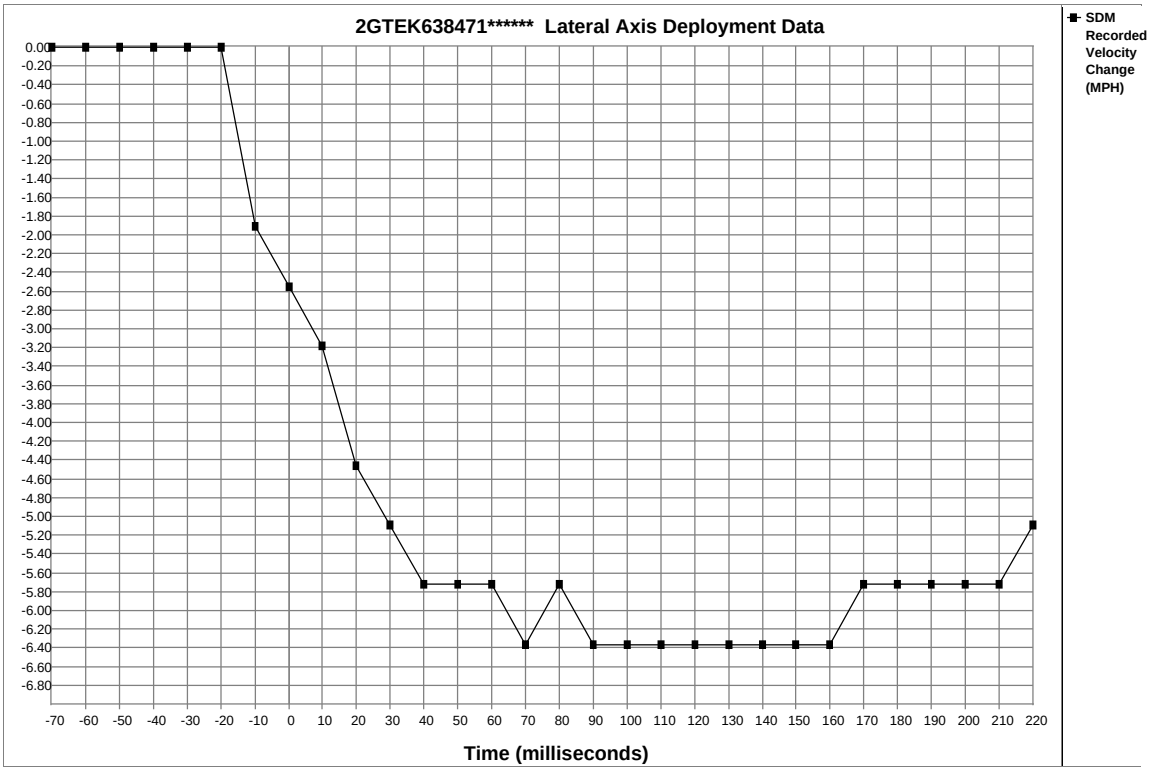
System Status At Deployment

Ignition Cycles At Investigation	5594
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/OFF Time Continuously (seconds)	1290
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	0
Ignition Cycles At Event	5593
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)	7.5
Passenger Side or Roof Rail/Head Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	7.5
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	5593
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	No
Passenger (Initiator 3) Roof Rail/Head Curtain Loop Commanded	No
Driver Knee Deployment Loop Commanded	No
Passenger Knee Deployment Loop Commanded	No

Second Row Left Pretensioner Deployment Loop Commanded	No
Second Row Right Pretensioner Deployment Loop Commanded	No
Second Row Center Pretensioner Deployment Loop Commanded	No



Time (milliseconds)	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70
SDM Longitudinal Axis Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.64	-0.64	-0.64	-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)	-1.27	-1.91	-1.91	-2.55	-3.18	-3.18	-3.82	-4.46	-4.46	-5.09	-5.09	-5.73	-5.73	-5.73	-5.73



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	-1.91	-2.55	-3.18	-4.46	-5.09	-5.73	-5.73	-5.73	-6.37
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Lateral Axis Recorded Velocity Change (MPH)	-5.73	-6.37	-6.37	-6.37	-6.37	-6.37	-6.37	-6.37	-6.37	-5.73	-5.73	-5.73	-5.73	-5.73	-5.09