On-Site Rollover Investigation
Dynamic Science, Inc. (DSI), Case Number DS08029
2006 GMC Envoy
Arizona
July 2008

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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.

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16. Abstract

This on-site rollover investigation focused on the dynamics of a 2006 GMC Envoy sport utility vehicle that was involved in a vehicle-to-vehicle crash with a subsequent rollover. The crash occurred within a four-leg intersection. The traffic signals at the intersection were not functioning as designed at the time of the crash and were in the flash mode. The lights were flashing yellow for north/south traffic and red for eastbound traffic. The traffic lights for westbound traffic were not illuminated. The other vehicle was a 2000 Pontiac Firebird. The GMC was being driven westbound and the Pontiac was being driven northbound. The driver of the Pontiac observed the flashing yellow signal, slowed his vehicle, and entered the intersection. The driver of the GMC observed the non illuminated light and entered the intersection without slowing. The front end of the GMC impacted the right front corner of the Pontiac. The GMC rotated clockwise and impacted the right rear tire of the Pontiac in a side-slap configuration. The GM then overturned with its left side leading, rolled two quarter turns, and came to final rest back on its left side. According to the police report, the GMC's driver and three second row passengers sustained non-incapacitating injuries. The front row passenger did not report any injuries. The driver of the Pontiac did not report any injuries. Both vehicles were towed due to damage and were later declared total losses by their respective insurance companies.

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Dynamic Science, Inc.
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BACKGROUND

This on-site rollover investigation focused on the dynamics of a 2006 GMC Envoy sport utility vehicle that was involved in a vehicle-to-vehicle crash with a subsequent rollover (**Figure 1**). The crash occurred within a four-leg intersection. The traffic signals at the intersection were not functioning at the time of the crash and were in the flash mode. The lights were flashing yellow for north/south traffic and red for eastbound traffic. The lights for westbound traffic were not illuminated.

Figure 1. Subject vehicle, 2006 GMC Envoy

The other vehicle was a 2000 Pontiac Firebird. The GMC was being driven westbound and the Pontiac was being driven northbound. The driver of the Pontiac observed the flashing yellow signal, slowed his vehicle, and entered the intersection. The driver of the GMC observed the non functioning signal and entered the intersection without slowing. The front end of the GMC impacted the front right corner of the Pontiac. The GMC rotated clockwise and impacted the right rear tire of the Pontiac in a side-slap configuration. The GMC then overturned with its left side leading, rolled two quarter turns, and came to final rest back on its left side.

According to the police report, the GMC's driver and three second row passengers sustained non-incapacitating injuries. The front row passenger of the GMC and the driver of the Pontiac did not report any injuries. Both vehicles were towed due to damage and were later declared to be total losses by their respective insurance companies.

This on-site rollover investigation was initiated by the National Highway Traffic Safety Administration (NHTSA) during a review of General Estimate System (GES) police accident reports. On August 26, 2008, DSI was forwarded the police report and was instructed to obtain cooperation. On September 3, 2008, DSI obtained permission to inspect the subject vehicle, which was located at an insurance salvage lot. The case was assigned on September 4, 2008. The subject vehicle was inspected on September 16, 2008. The vehicle was supported by the Bosch Crash Data Retrieval (CDR) hardware and software and the Event Data Recorder (EDR) was imaged during the inspection. The Bosch report is included as Attachment 2 to this report. This is a truncated copy of the report that is devoid of the hexadecimal data.

SUMMARY

Crash Site

The crash site was a four-leg intersection of an east/west roadway and a north/south roadway (**Figure 2**). The east leg of the intersection consisted of a right turn lane, a westbound through lane and a left turn lane, which were separated by a double yellow stripe from a westbound lane. The profile measurement for the westbound lane was -2.7 percent at 61 m (200 ft) prior to impact, -3.1

percent at 30.5 m (100 ft) prior to impact, and level at the area of impact. The roadway surface was asphalt. There were bike lanes for each direction of travel, which were located outboard of the through lanes. The posted speed limit for both roadways was 64 km/h (40 mph).

The south leg of the intersection consisted of a left turn lane, two northbound through lanes, and a left turn lane, which were separated by a raised concrete median from two southbound lanes. The profile measurement of the northbound lane was 1.5 percent at 61 m (200 ft) prior to impact, 1.4 percent at 30 m (100 ft) prior to impact, and 1.2 percent at the area of impact.

Figure 2. Subject vehicle's westward approach to intersection

Pre-Crash

This crash occurred in July 2008 during daylight at 1904 hours in Arizona. The weather was raining and the roadway was wet. The GMC was being driven westbound by a 43-year-old male. There were four additional adults occupants within the GMC. The alignment of the westbound roadway was straight with a slight negative grade. There were traffic signals present in the intersection for east/westbound traffic. The driver of the GMC stated to the police that he observed the non-illuminated traffic signal and entered the intersection. According to the EDR readout, the GMC was traveling 47 km/h (29 mph) at 1 second prior to Algorithm Enable (AE) and the brake switch status was "ON."

The Pontiac was being driven northbound at a police estimated speed of 64 km/h (40 mph) by a 25-year-old male. The roadway's alignment was straight with a slight positive grade. At the intersection, northbound traffic was controlled by flashing yellow lights. The driver of the Pontiac stated to the police that he observed the traffic signal, slowed, and then entered the intersection. While crossing the intersection, the driver observed the approach of the GMC into the intersection, and attempted to steer left as an avoidance maneuver.

Crash

The front left corner of the GMC impacted the right front corner of the Pontiac (Event 1). For the GMC, the Missing Vehicle algorithm of WinSMASH computed a Total Delta-V of 11 km/h (6.8 mph), based on the GMC's front end crush profile. The longitudinal and lateral components were -3.8 km/h (-2.4 mph) and 10.3 km/h (6.4 mph), respectively. Due to the absence of the Pontiac's crush profile, these results should be considered a borderline representation of the crash.

For the GMC, the EDR reported a maximum velocity change of 21.4 km/h (13.3 mph) at 290 milliseconds (ms) after algorithm enable (AE). The maximum longitudinal Delta-V was -6.2 km/h (-3.8 mph) and occurred at 60 ms. The lateral Delta-V was 12.2 km/h (7.6 mph) at 90 ms, was stabile for 170 ms, and then rose to 20.5 km/h (12.7 mph) at 290 ms. The second spike was probably due to the side-slap impact.

Figure 3. Area of impact, heading northbound. Arrow marks area of final rest for the GMC.

The initial impact displaced the GMC to the right and the vehicle began a clockwise rotation. The Pontiac was displaced to the left in a counterclockwise rotation. The left side of the GMC impacted the right rear tire area of the Pontiac (Event 2). The GMC's tires tripped on the pavement and the vehicle overturned with its left side leading (Event 3). The vehicle rolled a total of two quarter turns and came to rest back on its left side facing north in the northbound lanes (**Figure 3**) near the center median.

There were no air bag deployments or pretensioner actuations within the GMC.

Post-Crash

All four doors of the GMC were jammed shut; the rear hatch remained closed and operational. According to a witness interviewee, the driver was able to exit the vehicle through the right front window. The front right passenger attempted to exit through the same window but was unable to pull himself out. A passerby responded and was able to help him exit the vehicle. The three rear seat occupants were all conscious, but were unable to extricate themselves. They were later extricated by rescue personnel through the windshield. The driver and second row occupants all sustained non-incapacitating injuries and were ground transported by rescue personnel to a local hospital. Their treatment status is not known. The front right occupant of the GMC and the driver of the Pontiac were not injured. Both vehicles were towed due to damage and declared total losses by their respective insurance companies

VEHICLE DATA - 2006 GMC Envoy

The GMC was identified by the Vehicle Identification Number (VIN): 1GKDS13S862xxxxxx. The vehicle's left front door was jammed shut and the VIN placard was not visible; therefore, the vehicle's date of manufacture was not known. The electronic odometer reading was 30,182 km (18,755 miles). The vehicle was equipped with a 4.2-liter, 6-cylinder engine, automatic transmission, rear wheel drive transmission, 4-wheel standard anti-lock braking system (ABS), and standard daytime lights. The vehicle manufacturer's recommended tire size was P245/65R17 for the front and rear and the recommended cold tire pressure was 210 kPa (30 psi) for the front and 240 kPa (35 psi) for the rear. The vehicle was equipped with Goodyear Fortera HL Edition P245/65R17 tires, which had a tire manufacturer's recommended maximum tire pressure of 303 kPa (44 psi). The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	234 kPa (34 psi)	6 mm (7/32 in)	No	None
LR	221 kPa (32 psi)	6 mm (8/32 in)	No	None
RR	214 kPa (31 psi)	6 mm (7/32 in)	No	None
RF	200 kPa (29 psi)	6 mm (8/32 in)	No	None

The GMC's front row seating was configured with fabric-covered bucket seats and adjustable head restraints. The second row seating was configured with a fabric-covered split bench seat with folding backs and adjustable head restraints for the outboard seating positions. The second row middle seat had no head restraint. The head restraints could be folded down and rearward when stowing the second row seats. The second row right head restraint was found to be in a stowed position behind the seat back. During the vehicle inspection, the SCI Investigator adjusted the head restraint to a usable position; the adjustment mechanism had not been compromised.

Vehicle Damage

Exterior Damage

The GMC sustained minor front end and left side damage as a result of the impact with the Pontiac (Event 1). The front bumper fascia was gouged and deformed, the front grille was completely detached, the left headlamp was cracked, and the left front fender was crushed (**Figure 4**). Contact damage to the left front fender began at the front left bumper corner and extended 43 cm (16.9 in) rearward down the left side plane. The maximum lateral crush to the fender was 20 cm (7.9 in).

Figure 4. Front and left side damage

The direct damage to the front bumper began at the front left bumper corner and extended 54 cm (21.2 in) to the right. Six crush measurements were documented at the bumper level as follows: C1 = 7 cm (2.8 in), C2 = 4 cm (1.6 in), C3 = 0 cm, C4 = 0 cm, C5 = 0 cm, C6 = 0 cm. The maximum crush to the bumper measured 7 cm (2.8 in) and was located at C1. The Collision Deformation Classification (CDC) for the first impact was 10FLEW1.

The GMC sustained minor damage to the area just forward of the left rear tire from a side-slap type impact with Pontiac (Event 2). The direct damage began along the frame rail 23 cm (9.0 in) forward of the wheel well and extended rearward to the wheel well (**Figure 5**). The damage extended vertically in an arc that ended at the wheel well and measured 38 cm (14.9 in) in height. The CDC for this impact was 09LPEN1.

The vehicle sustained moderate damage to the left and right sides and roof as a result of the rollover. The direct damage to the left side of the vehicle began at the front left bumper corner, extended rearward for 421 cm (165.8 in), and ended 66 cm (26.0 in) rearward of the rear axle. Vertically, the direct damage began at the door sill and ended at the roof side rail. There was direct damage to the left A- and B-pillars. The left rear door sustained hinge damage where the hinge separated from the door frame. The door was jammed shut and remained closed.

Figure 5. Left wheel well contact

There were areas of light scratching located along the upper right front door that measured 21 cm (8.3 in) and along the right rear door that measured 81 cm (31.8 in). Most of the damage on the right side occurred at the roof rail lateral to the B-pillar (**Figure 6**). The maximum lateral crush at this location measured 9 cm (3.5 in). The front right window frame was pulled outward, probably during extrication efforts.

Figure 6. Damage to right roof rail

The direct damage to the top began on the hood at 72 cm (28.4 in) forward of the front axle, extended longitudinally 105 cm (41.3 in) rearward, and ended 33 cm (13.0 in) rearward of the front axle. The lateral extent of the direct damage to the hood began at the left edge and extended 30 cm (11.8 in) to the right. There was direct contact damage to the roof began at the leading edge, extended 120 cm (47.2 in) rearward, and ended 41 cm (16.1 in) rearward of the B-pillar. The lateral extent of the direct damage to the roof measured 117 cm (46.1 in) in width and was distributed from roof side rail to side rail. The right roof side rail contacted the raised concrete median and the contact resulted in vertical crush. The maximum vertical crush measured 30 cm (11.8 in) and was located at the right roof rail forward of the B-pillar. The CDC for the rollover was 00TDDO4.

Interior Damage

The GMC sustained moderate interior damage as a result of impact damage, passenger compartment intrusions during the rollover, and post-impact extrication efforts. The windshield was cracked and out of place due to post-impact extrication efforts. The front and second row left and right windows were disintegrated. The front right head restraint was deformed as a result of roof intrusion. The right B-pillar cover was detached as a result of deformation of the B-pillar. The roof was deformed due to rollover damage. There were several dark colored transfers observed on the roof header, seat backs and cushions, and left and right interior side components. One source of these transfers was determined to be foot and hand prints which were made by occupants exiting the

vehicle; however, some of the transfers were evidence of occupant contact and are discussed in the Kinematics section of this report.

The right A- and B-pillar, roof side rail, and the roof intruded vertically (**Figure 7**). The right A-pillar, roof side rail, left front and second door panels intruded laterally.

Figure 7. Roof intrusion

Manual Restraints

The GMC was equipped with 3-point manual lap and shoulder belts for the five seating positions. The safety belts were configured with sliding latch plates, all of which displayed light scratching indicative of historical usage. The driver's belt was equipped with an Emergency Locking Retractor (ELR) and the remaining belts were equipped with switchable ELR/Automatic Locking Retractors (ALR). The front row safety belts were equipped with buckle pretensioners. The front row safety belts and the second row middle safety belt were integrated and the second row outboard safety belts were configured with D-ring anchorages on the B-pillars.

The driver's belt had an aftermarket comfort pad that wrapped around the shoulder belt webbing. The belt webbing and latch plate did not show evidence of occupant loading and the pretensioner did not actuate. The EDR report indicated that the driver's belt switch circuit status was "BUCKLED." Based on evidence of historical usage, the driver's kinematics, and the EDR report, it was determined that the safety belt was used to restrain the driver during the crash.

The front row right safety belt webbing and latch plate did not show evidence of occupant loading and the pretensioner did not actuate. The EDR report indicated that the front right passenger's belt switch circuit status was "BUCKLED." Based on evidence of historical usage, the driver's kinematics, and the EDR report, it was determined that the safety belt was used to restrain the driver during the crash.

There was no evidence of occupant loading to the belts for the second row left and middle positions, but the interviewed witness stated that the rear seat occupants in those positions were wearing the safety belts. The second row right position safety belt exhibited 15 cm (5.9 in) of stretch marks to the webbing due to occupant loading. Based on the interview, evidence of historical usage, evidence of occupant loading to the second row right safety belt webbing, and the occupants kinematics, it was determined the three second row safety belts were used to restrain the occupants during the crash.

Rollover Dynamics

The GMC Envoy had a Static Stability Factor (SSF) of 1.17. 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 height. The GMC had a rollover resistance rating of 3 out of 5 stars, and the vehicle had a risk of rollover

of 20%[1]. The vehicle was equipped with rear wheel drive, 4-wheel Assisted Braking System (ABS), and 4-wheel disc brakes. The vehicle was equipped with GMC's StabiliTrak Electronic Stability Control (ECS) system. The system was designed to help improve stability, particularly on slick surfaces and during emergency maneuvers. This crash occurred on wet asphalt. The system utilized a control module that measured the vehicle's steering wheel angle, wheel speed and brake pressure. The system works by comparing driver input with the vehicle's actual steering arc, and then applying individual brake pressure and adjusting engine torque when necessary.

At impact, the GMC rotated clockwise and its left side contacted the right rear of the Pontiac. The GMC continued the rotation until it tripped and began a left side leading rollover. The vehicle rolled two quarter turns in a diagonal path to the northwest until it came to rest briefly with the right side of the roof against the center concrete median and the front left portion of the hood on the road. The vehicle then rocked back onto its left side and came to rest facing north in the north leg of the intersection. The center concrete median measured 19 cm (7.5 in) in height. The estimated distance from the trip point to final rest was 7 m (23 ft).

The driver of the GMC was braking at impact with the Pontiac. Due to the GMC's abrupt change in direction, and the resulting trip and the rollover, the vehicle's ESC system did not have adequate time or distance in which to help the vehicle regain traction. Also, once the vehicle began its rotation on the wet pavement there was diminished tracking and the braking system had little input in the driver's ability to regain control of the vehicle.

Supplemental Restraint Systems

The GMC was equipped with advanced dual-stage Certified Advanced 208-Compliant (CAC) driver and front passenger frontal air bags. The air bags were certified by the manufacturer to be compliant with the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The frontal air bags did not deploy during the crash. This vehicle was not equipped with side curtain air bags or seat-mounted side air bags.

The EDR was imaged during the inspection and the Bosch report is included as Attachment 2 to this report. The GMC's supplemental restraint system consisted of a control module, or event data recorder (EDR), driver and passenger air bag modules, front impact sensors, and front row safety belt pretensioners. The system recorded a non-deployment event as a result of the impact with the Pontiac.

The Bosch report revealed the following data:

- The driver and front passenger belt switch circuit status was BUCKLED.
- The driver and front passenger seat position circuit status was REARWARD.
- The front passenger air bag switch circuit was AIR BAG NOT SUPPRESSED.
- No air bag or pretensioner loop deployment commands were initiated.
- The maximum recorded velocity change (Delta-V) was 21.4 km/h (13.3 mph).
- At -1 second prior to AE the vehicle speed was 47 km/h (29 mph).

[1] http://www.safercar.gov

- At -1 second prior to AE the brake switch circuit status was ON.

There was one non-deployment event that was not recorded which followed the recorded event. The non-recorded non-deployment was probably the rollover event.

Vehicle Data - 2000 Pontiac Firebird Formula/Trans Am

The 2000 Pontiac Firebird was identified by the VIN: 2G2FV22G0Y2xxxxxx. The Pontiac was a 3-door hatchback that was equipped with a 5.7-liter, 8-cylinder engine, rear-wheel drive, and 4-wheel ABS. The vehicle manufacturer's recommended tire size was P245/50R16. The 25-year-old driver was not injured. The Pontiac was towed from the scene and later declared a total loss by the insurance company. The vehicle was not inspected. Based on the front end profile of the GMC, the Missing Vehicle algorithm of WinSMASH computed a Total Delta-V of 17 km/h (10.6 mph) for the Pontiac's impact with the GMC (Event 1); the longitudinal and lateral components were -13 km/h (-8.1 mph) and -10.9 km/h (-6.8 mph), respectively.

OCCUPANT DEMOGRAPHICS

	Driver	**Front Row Right Occupant (02)**
Age/Sex:	43/Male	45/Male
Seated Position:	Front left	Front right
Seat Type:	Bucket	Bucket
Seat Track Position:	Mid-track	Mid-track
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Alcohol/Drug Involvement:	None	None
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt	Lap and shoulder belt
Air Bag:	Steering wheel mounted air bag, not deployed	Mid instrument panel mounted air bag, not deployed

	Second Row Left Occupant (03)	Second Row Middle Occupant (04)	Second Row Right Occupant (05)
Age/Sex:	46/Female	62/Female	20/Female
Seated Position:	Second row left	Second row middle	Second row right
Seat Type:	Split bench with folding back	Split bench with folding back	Split bench with folding back
Height:	Unknown	Unknown	Unknown
Weight:	Unknown	Unknown	Unknown
Alcohol/Drug Involvement:	N/A	N/A	N/A
Body Posture:	Unknown	Unknown	Unknown
Hand Position:	Unknown	Unknown	Unknown
Foot Position:	Unknown	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt	Lap and shoulder belt	Lap and shoulder belt

OCCUPANT KINEMATICS

Driver Kinematics

The 43-year-old male driver was seated in an unknown posture and was restrained by the 3-point manual lap and shoulder belt. The GMC approached the intersection traveling at approximately 47 km/h (29 mph). Just prior to impact, the driver saw the Pontiac and began braking. The driver was displaced forward in response to the braking. The left front of the GMC impacted the front right of the Pontiac. The driver was displaced forward and left in response to the 10 o'clock direction of force and was held in place by the safety belt. The GMC initiated a clockwise rotation and was displaced to the right. There was a minor side-slap type contact between the two vehicles. The vehicle rotated approximately 45 degrees, tripped, and began a right side leading rollover. During the first quarter turn, the driver was displaced to the right. During the second quarter turn, the vehicle was upside down and the driver's lower extremities probably contacted the lower IP. During the final quarter turn, the driver was displaced to the left and came to rest against the left door. According to the police report, the driver sustained a non-incapacitating injury and was transported from the scene by ambulance.

Front Row Right Occupant Kinematics

The 45-year-old male occupant was seated in an unknown posture and was restrained by the 3-point manual lap and shoulder belt. At impact, he was displaced forward and left. During the first quarter turn of the rollover, the occupant was displaced to the right, but was secured in his seat by the safety belt. During the second quarter turn, the vehicle was upside down and the roof intruded into the

passenger compartment. The occupant's head contacted the roof slightly forward of the head restraint and deposited a hair oil transfer. A 2 cm (0.8 in) black scuff mark was deposited on the right roof side rail that was attributed to the front row right occupant but the body region or aspect source of this deposit was not known.

The first row right side window was closed and during the crash the glazing disintegrated. Glass kernels were found on the occupant's seat cushion and probably contacted the occupant during the rollover. The vehicle came to rest on its left side and the occupant was in his seat with his weight shifted to the left. According to a witness, this occupant was able to exit the vehicle with the assistance of a passerby. The occupant sustained no injury according to the police report, but the witness indicated that this occupant did cut his hands in his first attempts to exit the vehicle on his own.

Second Row Left Occupant Kinematics

The 46-year-old female occupant was seated in an unknown posture and was restrained by the vehicle's 3-point manual lap and shoulder belt. At impact, the occupant was displaced forward and left, and her left hip contacted the left door panel in the rear upper quadrant. There was a 3 cm (1.2 in) crack in the panel that was probably caused by this occupant either during the initial impact or as the vehicle rolled to its left side. During the rollover, the occupant possibly contacted the second row center occupant. The left occupant sustained a police-reported non-incapacitating injury. The witness stated that this occupant sustained some type of injury to her left hand. This occupant was extricated from the vehicle by rescue personnel and transported to a local hospital for treatment.

Second Row Middle Occupant Kinematics

The 62-year-old female occupant was seated in an unknown posture and was restrained by the vehicle's 3-point manual lap and shoulder belt. At impact, the occupant was displaced forward and left. During the rollover, the occupant was displaced both left and right, and probably contacted the second row left and right occupants due to their shifting weight and close proximity within the row. The middle occupant sustained a non-incapacitating injury, according to the police report. She was extricated from the vehicle by rescue personnel and transported to a local hospital for treatment.

Second Row Right Occupant Kinematics

The 20-year-old female occupant was seated in an unknown posture and was restrained by the vehicle's 3-point manual lap and shoulder belt. At impact, the occupant was displaced forward and left. She loaded the safety belt and the contact evidence was a 15 cm (5.9 in) area of stretch marks on the safety belt webbing. The stretch to the webbing occurred where the belt was routed through the latch plate. During the rollover, the occupant was displaced first to the right and then to the left. The occupant probably contacted the center occupant during the rollover, due to the close proximity of the occupants within the seat. The right side occupant sustained a police-reported non-incapacitating injury, was extricated by rescue personnel, and transported to a local hospital for treatment.

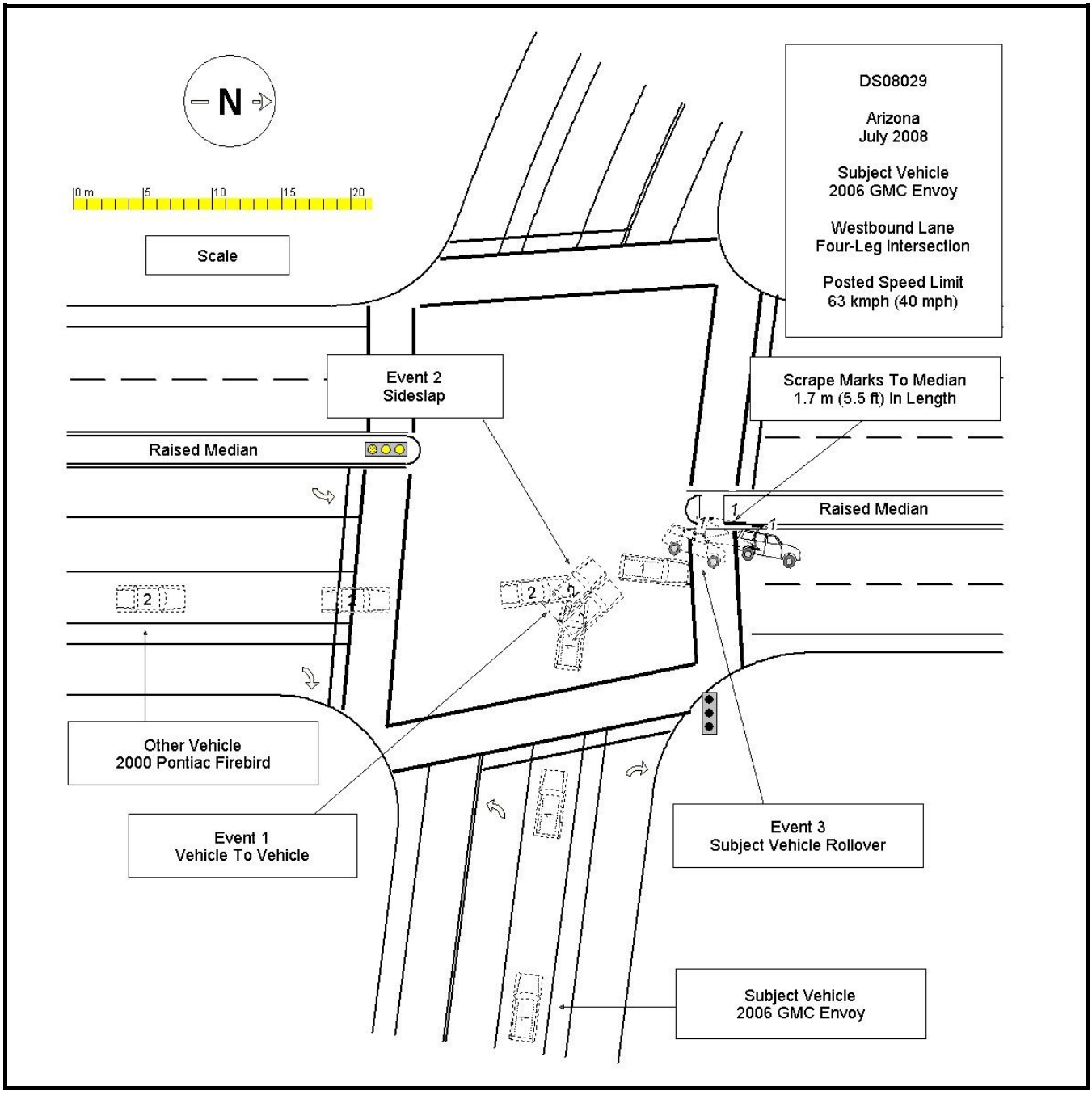
OCCUPANT INJURIES

The driver and Occupants 02, 04, and 05 sustained non-incapacitating injuries of an unknown nature.

Second Row Left Occupant Injuries (03): Injury obtained from witness.

Injury	OIC Code	Injury Mechanism	Confidence Level
Left hand injury	715099.7,2	Unknown	Unknown

Attachment 1. Scene Diagram



Attachment 2. Bosch CDR Report

CDR File Information

User Entered VIN	1GKDS13S862******
User	
Case Number	DS08029
EDR Data Imaging Date	Tuesday, September 16 2008
Crash Date	Friday, July 4 2008
Filename	CDR WO SEQUENCE.CDR
Saved on	Tuesday, September 16 2008 at 09:20:46 AM
Collected with CDR version	Crash Data Retrieval Tool 2.900
Reported with CDR version	Crash Data Retrieval Tool 3.3
EDR Device Type	airbag control module
Event(s) recovered	Non-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 230 milliseconds of data after deployment criteria is met and up to 70 milliseconds before deployment criteria is met. For Non-Deployment Events, the SDM can record up to the first 300 milliseconds of data after algorithm enable. Velocity Change data is displayed in SAE sign convention.

-The CDR tool displays time from Algorithm Enable (AE) to time of deployment command in a deployment event and AE to time of maximum SDM recorded vehicle velocity change in a non-deployment event. Time from AE begins when the first air bag system enable threshold is met and ends when deployment command criteria is met or at maximum SDM recorded vehicle velocity change. Air bag systems such as frontal, side, or rollover, may be a source of an enable. The time represented in a CDR report can be that of the enable of one air bag system to the deployment time of another air bag system.

-Maximum Recorded Vehicle Velocity Change is the maximum square root value of the sum of the squares for the vehicle's combined "X" and "Y" axis change in velocity.

-Event Recording Complete will indicate if data from the recorded event has been fully written to the SDM memory or if it has been interrupted and not fully written.

-SDM Recorded Vehicle Speed accuracy can be affected by various factors, including but not limited to the following:

- -significant changes in the tire's rolling radius
- -final drive axle ratio changes
- -wheel lockup and wheel slip

-Brake Switch Circuit Status indicates the open/closed state of the brake switch circuit.

-Pre-Crash data is recorded asynchronously.

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

- -the SDM receives a message from the module sending the pre-crash data
- -no data is received from the module with an "invalid" flag sending the pre-crash data
- -no module present to send the pre-crash data

-Driver's and Passenger's Belt Switch Circuit Status indicates the status of the seat belt switch circuit.

-The Time Between Non-Deployment to Deployment Events is displayed in seconds. If the time between the two events is greater than five seconds, "N/A" is displayed in place of the time. If the value is negative, then the Deployment Event occurred first. If the value is positive, then the Non-Deployment Event occurred first.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
-All data should be examined in conjunction with other available physical evidence from the vehicle and scene.

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

Multiple Event Data

Associated Events Not Recorded	1
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)	Yes
The Event(s) Not Recorded was a Deployment Event(s)	No
The Event(s) Not Recorded was a Non-Deployment Event(s)	Yes

System Status At 1 second

Left Front Door Ajar	No
Right Front Door Ajar	No
Left Rear Door Ajar	No
Right Rear Door Ajar	No

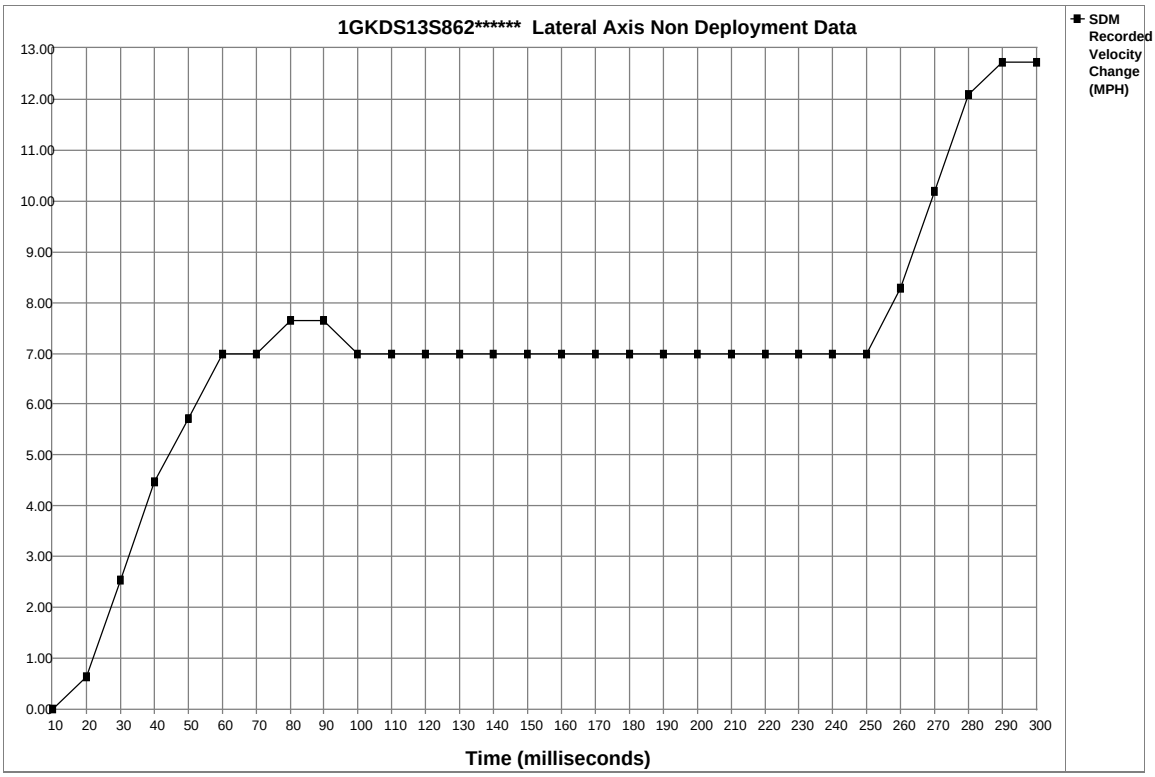
Pre-Crash Data

Parameter	-5 sec	-4 sec	-3 sec	-2 sec	-1 sec
Vehicle Speed (MPH)	26	26	27	29	29
Engine Speed (RPM)	1280	1280	1344	1344	1280
Percent Throttle	5	5	6	0	0
Brake Switch Circuit Status	OFF	OFF	OFF	OFF	ON

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/OFF Time Continuously (seconds)	655350
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	3455
Ignition Cycles At Investigation	3458
Ignition Cycles At Event	3455
Ignition Cycles Since DTCs Were Last Cleared	255
Driver's Belt Switch Circuit Status	BUCKLED
Passenger's Belt Switch Circuit Status	BUCKLED
Driver Seat Position Switch Circuit Status	Rearward
Passenger Seat Position Switch Circuit Status	Rearward
Automatic Passenger SIR Suppression System Status at AE	Air Bag Not Suppressed
Driver 1st Stage Deployment Loop Commanded	No
Driver 2nd Stage Deployment Loop Commanded	No
Driver Side Deployment Loop Commanded	No
Driver Pretensioner Deployment Loop Commanded	No
Driver Roof Rail/Head Curtain Loop Commanded (If Equipped)	No
Supplemental Deployment Loop #1 Commanded (If Equipped)	No
Passenger 1st Stage Deployment Loop Commanded	No
Passenger 2nd Stage Deployment Loop Commanded	No
Passenger Side Deployment Loop Commanded	No
Passenger Pretensioner Deployment Loop Commanded	No
Passenger Roof Rail/Head Curtain Loop Commanded (If Equipped)	No
Supplemental Deployment Loop #2 Commanded (If Equipped)	No
Second Row Left Side Deployment Loop Commanded	No
Second Row Left Pretensioner Deployment Loop Commanded (If Equipped)	No
Supplemental Deployment Loop #3 Commanded (If Equipped)	No
Second Row Right Side Deployment Loop Commanded (If Equipped)	No
Second Row Right Pretensioner Deployment Loop Commanded	No
Supplemental Deployment Loop #4 Commanded (If Equipped)	No
Second Row Center Pretensioner Deployment Loop Commanded	No
Diagnostic Trouble Codes at Event, fault number: 1	N/A
Diagnostic Trouble Codes at Event, fault number: 2	N/A
Diagnostic Trouble Codes at Event, fault number: 3	N/A
Diagnostic Trouble Codes at Event, fault number: 4	N/A
Diagnostic Trouble Codes at Event, fault number: 5	N/A
Diagnostic Trouble Codes at Event, fault number: 6	N/A
Diagnostic Trouble Codes at Event, fault number: 7	N/A
Diagnostic Trouble Codes at Event, fault number: 8	N/A
Diagnostic Trouble Codes at Event, fault number: 9	N/A
Maximum SDM Recorded Velocity Change (MPH)	13.30
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	290
Crash Record Locked	No
Deployment Event Recorded in the Non-Deployment Record	No
Vehicle Event Data (Pre-Crash) Associated With This Event	Yes
Event Recording Complete	Yes

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	-0.64	-1.27	-1.91	-3.18	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
SDM Longitudinal Axis Recorded Velocity Change (MPH)	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82	-3.82



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	0.64	2.55	4.46	5.73	7.00	7.00	7.64	7.64	7.00	7.00	7.00	7.00	7.00	7.00
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
SDM Lateral Axis Recorded Velocity Change (MPH)	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	8.28	10.19	12.10	12.73	12.73