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ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-05-037
LOCATION - TEXAS
VEHICLE - 2005 GMC ENVOY XUV
CRASH DATE - August 2005

Submitted:

May 8, 2006
Revised April 18, 2007

Contract Number: DTNH22-01-C-07002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
National Center for Statistics and Analysis
Washington, D.C. 20590-0003

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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.* IN-05-037	2. *Government Accession No.*	3. *Recipient's Catalog No.*
4. *Title and Subtitle* On-Site Certified Advanced 208-Compliant Vehicle Investigation Vehicle - 2005 GMC Envoy XUV Location - Texas		5. *Report Date:* May 8, 2006 6. *Performing Organization Code*
7. *Author(s)* Special Crash Investigations Team #2		8. *Performing Organization Report No.*
9. *Performing Organization Name and Address* Transportation Research Center Indiana University 222 West Second Street Bloomington, Indiana 47403-1501		10. *Work Unit No. (TRAIS)* 11. *Contract or Grant No.* DTNH22-01-C-07002
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation (NPO-122) National Highway Traffic Safety Administration National Center for Statistics and Analysis Washington, D.C. 20590-0003		13. *Type of Report and Period Covered* Technical Report Crash Date: August 2005 14. *Sponsoring Agency Code*

15. *Supplementary Notes*
On-site air bag investigation involving a 2005 GMC Envoy XUV with manual safety belts and dual front certified advanced 208-compliant air bag system.

16. *Abstract*
This report covers an on-site investigation of an air bag deployment crash that involved a 2005 GMC Envoy XUV (case vehicle),which ran-off-road, impacted a concrete median barrier and rolled over. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features, including certified advanced 208-compliant air bags, as well as an Event Data Recorder (EDR), and the case vehicle's driver (30 year-old, female) sustained a police reported "C" (possible) injury as a result of the crash. The case vehicle was traveling south in a left curve in the left center through lane of a divided, multi-lane Interstate highway. The case vehicle departed its travel lane to the left, crossed the inside travel lane and departed the roadway. The case vehicle's front left impacted the concrete median barrier causing a stage one deployment of the case vehicle's driver air bag. Following the front impact with the median barrier, the case vehicle deflected to the right off the barrier and began to rotate clockwise. The vehicle continued to rotate clockwise until it was approaching broadside and tripped and rolled over, driver side leading. The case vehicle rolled over a total of one-and-one-half rolls (i.e., six quarter rolls) and came to rest on its top in the center through lane facing northeast. Immediately prior to the crash, the case vehicle's driver was most likely seated in a nominal upright driving position. The driver most likely had a least one hand on the steering wheel and her feet in an unknown position. The driver's seat track was located between the middle and forward most position, the seat back was slightly reclined and the tilt steering column was located between its center and full down position. The driver was restrained by her integral, three-point, lap-and-shoulder safety belt system. The driver loaded her safety belt during the crash, her face and chest most likely contacted the deployed air bag, and her head contacted the intruding roof during the rollover. The driver was treated at the scene and not transported to a medical facility.

17. *Key Words*		18. *Distribution Statement*
Advanced Air Bag Deployment, Rollover	Motor Vehicle Traffic Crash Injury Severity	General Public

19 *Security Classif. (of this report)*	20. *Security Classif. (of this page)*	21. *No. of Pages*	22. *Price*
Unclassified	Unclassified	18	$4,500

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

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BACKGROUND

This investigation was brought to NHTSA's attention on October 6, 2005 by NASS CDS/GES sampling activities. This crash involved a 2005 GMC Envoy XUV (case vehicle) that ran-off-road into a concrete median barrier and rolled over. The crash occurred in August, 2005 at 7:25 p.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features, including certified advanced 208-compliant air bags, as well as an Event Data Recorder (EDR), and the case vehicle's driver [30-year-old,(unknown race, Hispanic) female] sustained a police reported "C" (possible) injury as a result of the crash. This contractor inspected the case vehicle and harvested the Sensing and Diagnostic Module (SDM), which contains the EDR, on October 27, 2005, and inspected the scene on October 28, 2005. The case vehicle's driver was not interviewed. This report is based on the police crash report, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling south in a left curve in the left center through lane of a divided, multi-lane Interstate highway. The EDR pre-crash data indicated that the case vehicle was traveling 118 km.p.h. (73 m.p.h) five seconds prior to algorithm enable (AE) slowing to 100 km.p.h (62 m.p.h.) prior to AE. The EDR also indicated the brakes were not applied during this time, indicating the driver may have fallen asleep. The case vehicle departed its travel lane to the left, crossed the inside travel lane and departed the roadway. The case vehicle's front left impacted a concrete median barrier causing a stage one deployment of the case vehicle's driver air bag. Following the front impact with the median barrier, the case vehicle deflected to the right off the barrier and began to rotate clockwise. The vehicle continued to rotate clockwise until it was approaching broadside and tripped and rolled over, driver side leading. The case vehicle rolled over a total of one-and-one-half rolls (i.e., six quarter rolls) and came to rest on its top in the center through lane facing northeast. It is not known if the driver made any pre-crash avoidance steering maneuvers. At the time of the crash the light condition was daylight, the weather was cloudy, and the roadway pavement was dry.

The CDCs for the case vehicle were determined to be: **11-FLEW-1** (**320** degrees) for the impact with the concrete median barrier and **00-TDDO-4** for the rollover. The WinSMASH reconstruction program, barrier algorithm, calculated the case vehicle's Total, Longitudinal and Lateral Delta Vs for the front impact, respectively as: 14.0 km.p.h. (8.7 m.p.h.), –10.7 km.p.h. (-6.6 m.p.h.), and 9.0 km.p.h. (5.6 m.p.h.). The collision fits the reconstruction model, but based on the crush to the front of the case vehicle, the results appear low. The EDR recorded Delta V data for the case vehicle's impact with the median barrier. The Total, Longitudinal and Lateral Delta Vs based on these data are, respectively: 25.30 km.p.h. (15.7 m.p.h.) -23.56 km.p.h. (-14.64 m.p.h.) 9.22 km.p.h. (5.73 m.p.h.). The EDR recorded Delta Vs appear consistent with the extent of crush to the front of the case vehicle. Based on the crush to the roof, the severity of the rollover was determined to be severe. The case vehicle was towed due to damage.

Immediately prior to the crash, the case vehicle's driver [30-year-old, (unknown race, Hispanic) female, unknown height and weight] was most likely seated in a nominal upright driving position. The driver most likely had a least one hand on the steering wheel and her feet in an unknown position. Based on the vehicle inspection, the driver's seat track was located between the middle and forward most position, the seat back was slightly reclined and the tilt steering column was located between its center and full down position. The driver was restrained by her integral, three-point, lap-and-shoulder safety belt system.

The case vehicle's front left impact with the median barrier caused the driver's safety belt retractor to lock and the pretensioner to deploy. The driver continued forward and to the left opposite the case vehicle's 320 degree direction of principal force, loaded her safety belt and her face and chest most likely impacted her deployed air bag. As the case vehicle deflected to the right and rotated clockwise, the driver moved to the left and up against the left front door as the case vehicle began to roll over driver side leading. The driver moved toward the roof and she continued to load her safety belt. Her head impacted the intruding roof as the vehicle landed on its top during the second quarter roll. The driver most likely moved to the right and back down into her seat as the case vehicle completed its third and fourth quarter rolls and landed on its wheels. The driver then moved to the left and against the left front door and toward the roof a second time as the case vehicle completed its fifth and sixth quarter rolls and landed on its top. The driver most likely contacted her head on the roof a second time when the case vehicle landed on its top. The driver remained restrained in her seat as the case vehicle slid on the pavement on its roof and came to final rest. The driver most likely remained restrained in her seat, upside down, as the case vehicle came to rest. It is not known if the driver was able to exit the case vehicle under her own power following the crash. The driver's use of her integral, three-point, lap-and-shoulder safety belt, and the deployment of her safety belt pretensioner and air bag mitigated her interaction with the case vehicle's frontal components and reduced her injury potential. The driver's use of her safety belt retained her in her seat and mitigated her interaction with the roof and interior vehicle components during the rollover. The police crash report indicated the driver was treated at the scene. The driver's injuries are unknown; however, they were most likely minor since she was not transported to a hospital.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle was traveling was a curved, eleven-lane, divided, Interstate highway, traversing in a north and south direction. The northbound roadway had five through lanes, an exit lane and improved shoulders. The southbound roadway had four through lanes, an exit lane and improved shoulders. Each lane was approximately 3.7 meters in width. Pavement markings consisted of broken white lane lines, solid yellow median line and solid white outside edge line. The trafficway was divided by a concrete median barrier, and the speed limit was 97 km.p.h. (60 m.p.h.). The case vehicle's approach roadway was curved left, and the vertical alignment was slightly positive. At the time of the crash the light condition was daylight, the weather was cloudy, and the roadway pavement was dry, traffic polished bituminous with an estimated coefficient of friction of 0.65. Traffic density at the time of the crash was moderate to heavy, and the site of the crash was urban. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was traveling south in a left curve in the left center through lane (**Figure 1**), and the driver was intending to continue southbound. The EDR pre-crash data indicated that the case vehicle was traveling 118 km.p.h. (73 m.p.h) five seconds prior to algorithm enable (AE) slowing to 100 km.p.h (62 m.p.h.) prior to AE. The EDR also indicated the brakes were not applied during this time, indicating the driver may have fallen asleep. The case vehicle departed its travel lane to the left and crossed the inside travel lane approaching the concrete median barrier. The driver most likely steered right just prior to the impact.

Crash: The case vehicle departed the roadway and crossed the median shoulder. The case vehicle's front left (**Figure 2**) impacted the concrete median barrier causing a stage one deployment of the case vehicle's driver air bag. The front right passenger's air bag did not deploy because there was no front right passenger in the vehicle at the time of the crash. Following the front impact with the median barrier, the case vehicle deflected to the right off the barrier and began to rotate clockwise. The vehicle continued to rotate clockwise until it was approaching broadside and tripped and rolled over, driver side leading. The vehicle landed hard on the right roof side rail (**Figures 2** and **3**) and continued over onto it wheels completing one full roll (i.e., four quarter rolls). The case vehicle then rolled onto its left side and onto its top and slid to final rest. The case vehicle rolled over a total of one-and-one-half rolls (i.e., six quarter rolls).

Post-Crash: The case vehicle came to rest in the left center through lane on its top facing northeast. The case vehicle's total rollover distance is not known.

Figure 1: Approach of case vehicle southbound in left center through lane

Figure 2: Damage to front of case vehicle from impact with concrete median barrier and to the roof from the rollover, numbers on tape measure on hood are tenths of meter

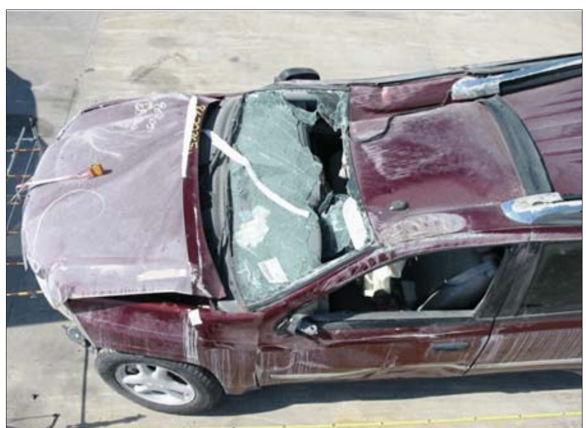


Figure 3: Top view of rollover damage to the case vehicle's roof, black marks on tape measure on ground are 0.31 meter (1 foot)

The 2005 GMC Envoy XUV was a rear-wheel drive, four door sport utility vehicle (VIN: 1GKES12S956------) equipped with a 4.2 L, L6 engine; four-speed automatic transmission with overdrive, and four wheel, anti-lock brakes. The front seating row was equipped with dual stage driver and front right passenger air bags, tilt steering column, driver and front right passenger integral, three-point, lap-and-shoulder safety belts with pretensioners and a front right passenger occupant detection and air bag suppression system. The back seating row was equipped with three-point, lap-and-shoulder safety belts in the outboard back seat positions and an integral, three-point, lap-and-shoulder safety belt in the center back seat position. In addition, the case vehicle was equipped with a LATCH system for securing child safety seats and an EDR housed within the air bag system's Sensing and Diagnostic Module (SDM). The case vehicle's wheelbase was 328 centimeters (129 inches). The case vehicle's odometer reading at the time of the inspection could not be determined because the vehicle was equipped with an electronic odometer.

The various sensors in the case vehicle's advanced occupant restraint system analyze a combination of factors including the predicted crash severity and driver and front right passenger seat belt usage to determine the front air bag inflation level appropriate for the severity of the crash. For the front right seat position, an occupant weight sensor in the seat cushion determines if an occupant is on the seat and enables or suppresses deployment of the air bag based on the amount of weight on the seat.

Figure 4: Left front overview of damage to case vehicle

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's impact with the median barrier involved the front left of the vehicle. The front bumper, left headlamp/turn lamp assembly, front of the left fender and the hood were directly contacted and crushed rearward and to the right (**Figures 4** and **5**). The direct damage began at the front left bumper corner and extended 54 centimeters (21.3 inches) across the bumper. The front crush measurements were taken at the bumper level, and the maximum residual crash was measured as 22 centimeters (13.7 inches) occurring at C_1. The direct damage from the rollover involved the left side (**Figures 6** and **7** below), left front and left rear wheel rims and the roof. The right side view mirror was turned in and there were a few scratches on the right front door and right fender. This appeared

Figure 5: Right front overview of damage to case vehicle

to be related to towing activities when the vehicle was rolled back onto its wheels. The evidence indicated that the right side of the vehicle cleared the ground during the passenger side leading rollover. The table below shows the case vehicle's front crush profile.

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	54	22	135	22	19	11	6	4	1	-51	0
in		21.3	8.7	53.2	8.7	7.5	4.3	2.4	1.6	0.4	-20.1	0.0

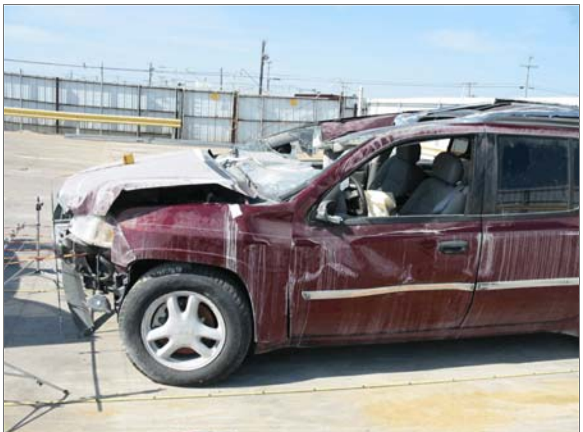


Figure 6: Rollover damage to left side of case vehicle

Figure 7: Rollover damage to left side of case vehicle, vertical streaks indicated by arrows are not rollover damage, they are streaks in dust from rain runoff

The case vehicle's left side wheelbase was reduced 8 centimeters (3.1 inches). The right side wheelbase was unchanged. Induced damage involved the entirety of the case vehicle with the exception of the tailgate, back bumper and right quarter panel.

The recommended tire size was P245/65R17; however, the case vehicle was equipped with P245/40R18 size tires. The case vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32^{nd} of an inch			
LF	124	18	207	30	9	11	None to tire, but rim abraded	No	No
RF	207	30	207	30	8	10	None	No	No
LR	0	0	241	35	9	11	None to tire, but rim flange broken	No	Yes

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32nd of an inch			
RR	207	30	241	35	9	11	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior (**Figures 8** and **9**) revealed a few hairs adhering to the roof above the driver's seat (**Figure 10** below) and a scuff on the left front corner of the driver's seat cushion. No other evidence of occupant contact to any interior surfaces or components was observed. Numerous passenger compartment intrusions were observed and documented. The most severe intrusions involved the roof, windshield header and right A-pillar. There was approximately 34 centimeters (13.4 inches) of roof and windshield header intrusion into the front right occupant space and approximately 18 centimeters (7.1 inches) of roof and windshield header intrusion into the driver's occupant space. In addition, the right "A"-pillar intruded approximately 10 centimeters (3.9 inches) vertically and 20 centimeters (7.9 inches) laterally into the front right occupant space. Lastly, there was no evidence of compression to the energy absorbing steering column or deformation of the steering wheel rim (**Figure 11** below).

Figure 8: Overview of case vehicle's steering wheel, left instrument panel and roof intrusion

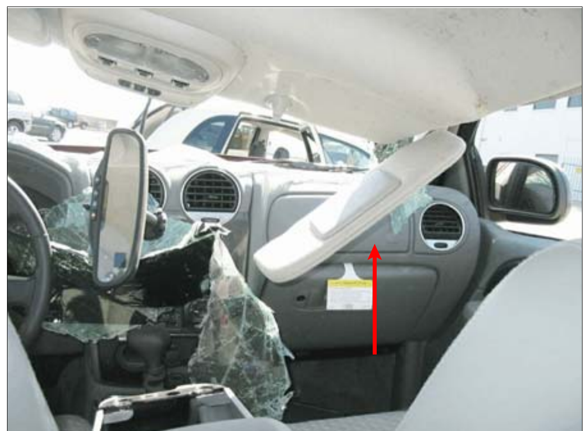


Figure 9: Overview of case vehicle's center and front right instrument panel and roof intrusion, arrow shows location of front right passenger air bag

Damage Classification: Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **11-FLEW-1** (**320** degrees) for the impact with the concrete median barrier and **00-TDDO-4** for the rollover. The WinSMASH reconstruction program, barrier algorithm, was used to reconstruct the case vehicle's Delta V for the impact with the concrete median barrier. The Total, Longitudinal and Lateral Delta Vs are, respectively: 14.0 km.p.h. (8.7 m.p.h.), –10.7 km.p.h. (-6.6 m.p.h.), and 9.9 km.p.h. (5.6 m.p.h.). The collision fits the reconstruction model, but based on the crush to the front of the case vehicle, the results appear low. The EDR recorded Delta V data for the case vehicle's impact with the median barrier. The Total, Longitudinal and Lateral Delta Vs based on these data are, respectively: 25.30 km.p.h. (15.7 m.p.h.) -23.56 km.p.h. (-14.64 m.p.h.) 9.22 km.p.h. (5.73 m.p.h.). The EDR recorded Delta Vs appears consistent with the extent of crush to the front of the case vehicle. Based on the crush to the roof, the severity of the rollover was determined to be severe. The case vehicle was towed due to damage.

Figure 10: Arrow shows area of hair deposit on roof above driver's seat

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with manufacturer certified advanced 208-compliant air bags at the driver and front right passenger positions. The case vehicle's SDM commanded a first stage deployment of the driver's air bag due to the impact with the concrete median barrier. The front right passenger's air bag did not deploy (**Figure 9** above) because there was no front right passenger seated in the vehicle at the time of the crash. The case vehicle's front right passenger sensor correctly determined the absence of a passenger and suppressed deployment of the front right passenger air bag.

Figure 11: Left side view of case vehicle's steering wheel and steering column showing lack of deformation

Figure 12: Case vehicle driver's air bag module cover flaps, each stripe on rod is 5 cm (2 in)

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points (**Figure 12**). There was no evidence of damage during the deployment to the air bag or the cover flaps. The module cover consisted of"I" configuration cover flaps made of pliable vinyl. Each cover flap was 7.3 centimeters (2.9 inches) in width at the top, 5 centimeters (2 inches) in width at the bottom and 12 centimeters in height along the vertical tear seam. The center section of the right cover flap was designed with a circular GMC emblem. Half of the emblem fit into a semi-circular contour on the left cover flap. The driver's air bag was designed with two tethers, each approximately 11 centimeters (4.3 inches) in width. The deployed driver's air bag (**Figure 13** below) was round with a diameter of approximately 62 centimeters (24.4 inches) and had two vent ports (**Figure 14** below), each approximately 3 centimeters (1.2 inches) in diameter, located at approximately the 10:30 and 1:30 o'clock positions. The distance between the mid-center of the driver's seat back, as positioned at the time of the vehicle inspection (i.e., seat between middle and forward most track position, seat back slightly reclined), and the front surface of the air bag fabric at approximate full excursion was 30 centimeters (11.8 inches). An inspection of the driver's air bag fabric revealed no evidence of occupant contact to the air bag. However, there were several dirt or grease scuffs on the front on the air bag that may have been related to the driver exiting the vehicle following the crash.


Figure 13: Case vehicle's driver air bag, steering wheel is rotated 180 degrees, top of air bag is at bottom of photo


Figure 14: Arrows show driver air bag's vent ports

CRASH DATA RECORDING

The case vehicle's SDM was harvested from the vehicle and downloaded subsequent to the field investigation. The EDR reports for the downloaded data are presented at the end of this report (**Figures 16-24**). The downloaded data indicated that a non-deployment event and deployment event were recorded. The non-deployment event occurred after the deployment event and was associated with the rollover. In addition, two other non-deployment events occurred after the deployment event and were not recorded.

The deployment system status report shows that the driver's air bag, first stage deployment criteria was met 46.25 milliseconds after AE. The second stage deployment criteria was not met and a disposal of the second stage inflator was recorded. The deployment system status report also shows that the SIR warning lamp was recorded as "off", the driver's safety belt switch circuit was recorded as "buckled", her seat position switch circuit was recorded as "rearward" and her safety belt pretensioner was commanded to deploy. The EDR recorded a maximum longitudinal velocity change of -23.56 km.p.h. (-14.64 m.p.h.) occurring approximately 130 milliseconds after AE and a maximum lateral velocity change of 9.22 km.p.h. (5.73 m.p.h.) occurring approximately 110 milliseconds after AE. The pre-crash data indicated that the case vehicle was traveling 118 km.p.h. (73 m.p.h.) five seconds prior to AE slowing to 100 km.p.h. (62 m.p.h.) one second prior to AE. In addition, the brake switch circuit indicated that the brakes were not applied during the five seconds prior to AE.

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash, the case vehicle's driver [30-year-old, (unknown race, Hispanic) female, unknown height and weight] was most likely seated in a nominal upright driving posture. The driver most likely had a least one hand on the steering wheel and her feet in an unknown position. Based on the vehicle inspection, the driver's seat track was located between the middle and forward most position, and the seat back was slightly reclined. The tilt steering column was located between its center and full down position.

Based on this contractor's vehicle inspection, and supported by the EDR data, the case vehicle's driver was restrained by her integral, three-point, lap-and-shoulder safety belt system. The safety belt pretensioner had deployed and the belt was partially out of the retractor and the retractor was jammed (**Figure 15**).

Figure 15: Overview of driver's seat and safety belt, the safety belt was partially out of the retractor and the retractor was jammed

The case vehicle's front left impact with the median barrier caused the driver's safety belt retractor to lock and the pretensioner to deploy. The driver continued forward and to the left opposite the case vehicle's 340 degree direction of principal force, loaded her safety belt and her face and chest most likely impacted her deployed air bag. As the case vehicle deflected to the right and rotated clockwise, the driver moved to the left and up against the left front door as the case vehicle began to rollover driver side leading. The driver moved toward the roof and she continued to load her safety belt. Her head impacted the intruding roof as the vehicle landed on its top during the second quarter roll. The driver most likely moved to the right and back down into her seat as the case vehicle completed its third and fourth quarter rolls and landed on its wheels. The driver then moved to the left and against the left front door and toward the roof a second time as the case vehicle completed its fifth and sixth quarter rolls and landed on its top. The driver most likely contacted her head on the roof a second time when the case vehicle landed on its top. The driver remained restrained in her seat as the case vehicle slid on the pavement on its roof and came to final rest. The driver most likely remained restrained in her seat, upside down, as the case vehicle came to rest. It is not known if the driver was able to exit the case vehicle under her own power following the crash. The driver's use of her integral, three-point, lap-and-shoulder safety belt, and the deployment of her safety belt pretensioner and air bag mitigated her interaction with the case vehicle's frontal components and reduced her injury potential during the barrier impact. The driver's use of her safety belt retained her in her seat and mitigated her interaction with the roof and interior vehicle components during the rollover.

CASE VEHICLE DRIVER INJURIES

The case vehicle's driver sustained a police reported "C" (possible) injury. The police crash report indicated the driver was treated at the scene. The driver's injuries were most likely minor since she was not transported to a hospital.

CDR File Information

Vehicle Identification Number	1GKES12S956******
Investigator	
Case Number	
Investigation Date	
Crash Date	
Filename	ENVOY WO NMBER.CDR
Saved on	Thursday, May 4 2006 at 12:08:53 PM
Collected with CDR version	Crash Data Retrieval Tool 2.800
Collecting program verification number	9238B95E
Reported with CDR version	Crash Data Retrieval Tool 2.800
Reporting program verification number	9238B95E
Interface used to collected data	Block number: 00 Interface version: 4A Date: 11-08-05 Checksum: 7500
Event(s) recovered	Deployment Non-Deployment

SDM Data Limitations

SDM Recorded Crash Events:
There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). It contains 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 forward velocity change. This event will be cleared by the SDM after the ignition has been cycled 250 times.
The second type of SDM recorded crash event is the Deployment Event. It also contains Pre-Crash and Crash data. The SDM can store up to two different Deployment Events, if they occur within five seconds of one another. Deployment Events cannot be overwritten or cleared from the SDM. Once the SDM has deployed the air bag, the SDM must be replaced.
The data in the Non-Deployment Event file will be locked after a Deployment Event, if the Non-Deployment Event occurred within 5 seconds before the Deployment Event unless a Deployment Level Event occurs within 5 seconds after the Deployment Event, then the Deployment Level Event will overwrite the Non-Deployment Event file.

SDM Data Limitations:
-SDM Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Forward 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. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle forward velocity change. For Deployment Events and Deployment Level 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 will record up to the first 300 milliseconds of data after algorithm enable. The minimum SDM Recorded Vehicle Forward Velocity Change, that is needed to record a Non-Deployment Event, is 5 MPH.
-Maximum Recorded Vehicle Velocity Change is the maximum recorded velocity change in the vehicle's combine "X" and "Y" axis.
-Calculated Principal Direction of Force (PDOF) is the arctangent of the maximum observer lateral velocity change divided by the maximum observed longitudinal velocity change. PDOF is displayed where zero degrees is located at the front of the vehicle, with 90 degrees is displayed to the right side of the vehicle and so on, clockwise around the vehicle.
-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 if the vehicle has had the tire size or the final drive axle ratio changed from the factory build specifications.
-Brake Switch Circuit Status indicates the status of the brake switch circuit.
-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if the SDM receive an invalid message from the module sending 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 and Deployment Events is displayed in seconds. If the time between the two events is greater than 5 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. -Vehicle Status

Figure 16: Case vehicle's CDR File Information and SDM Limitations

Data (Pre-Crash) is transmitted to the SDM, by various vehicle control modules, via the vehicle's communication network.
-The SDM may obtain Belt Switch Circuit Status data a number of different ways, depending on the vehicle architecture. Some switches are wired directly to the SDM, while others may obtain the data from various vehicle control modules, via the vehicle's communication network.
SDM 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.

Figure 17: Case Vehicle's SDM Data Limitations continued

Multiple Event Data

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
Associated Events Not Recorded	2

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

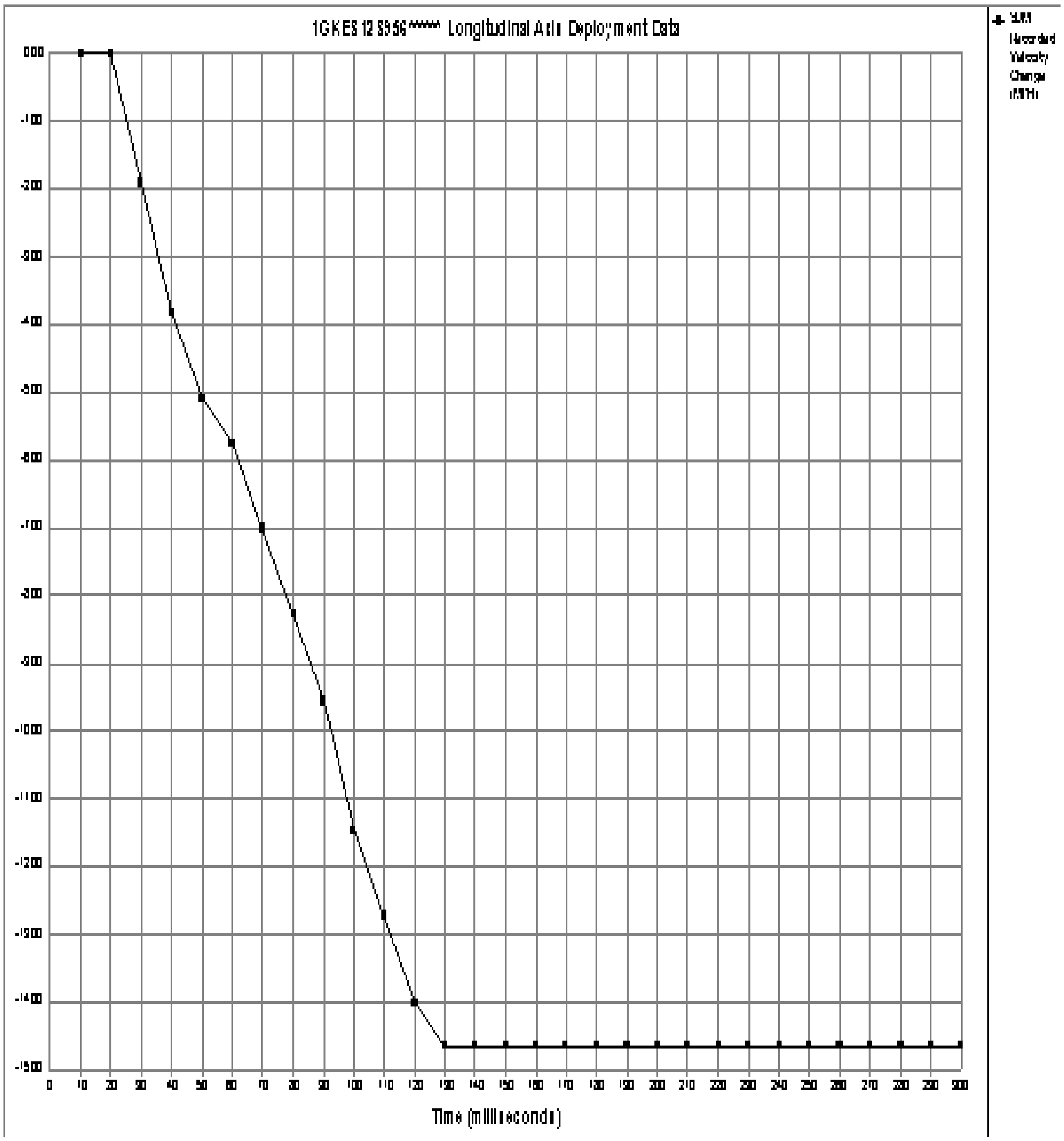
Parameter	-5 sec	-4 sec	-3 sec	-2 sec	-1 sec
Vehicle Speed (MPH)	73	72	70	67	62
Engine Speed (RPM)	2176	2112	2048	2048	1856
Percent Throttle	0	0	0	0	0
Brake Switch Circuit Status	not applied	not applied	not applied	not applied	not applied

Figure 18: Case vehicle's Multiple Event Data, System Status At 1 Second and Pre-Crash Data

System Status At Deployment

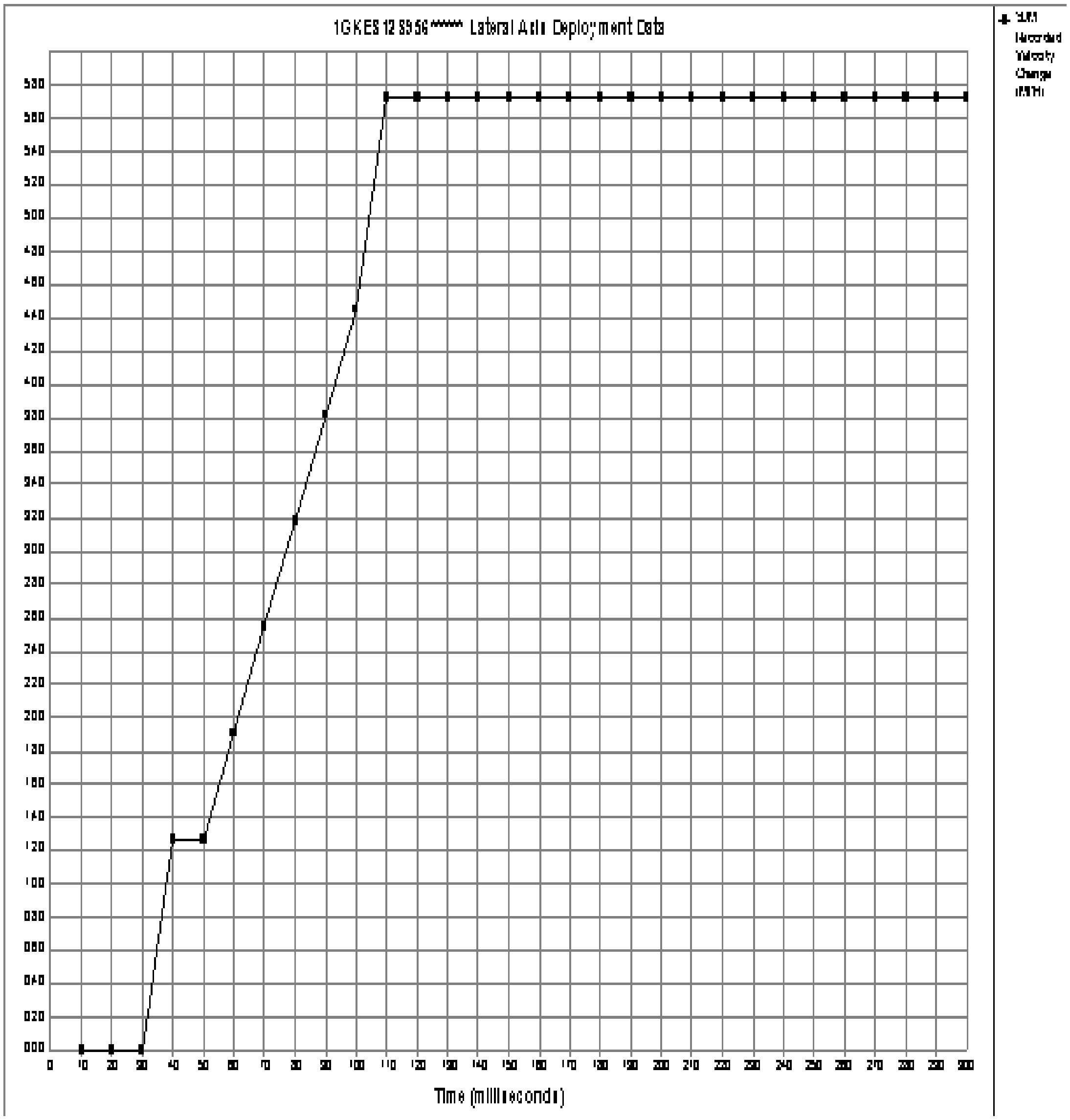
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/OFF Time (seconds)	140450
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	183
Ignition Cycles At Investigation	187
Ignition Cycles At Event	183
Ignition Cycles Since DTCs Were Last Cleared	182
Driver's Belt Switch Circuit Status	BUCKLED
Passenger's Belt Switch Circuit Status	UNBUCKLED
Driver Seat Position Switch Circuit Status	Rearward
Passenger Seat Position Switch Circuit Status	Rearward
Automatic Passenger SIR Suppression System Status at AE	Air Bag Suppressed
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	46.25
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	Disposal
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	Suppressed
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	Suppressed
Driver Side or Roof Rail/Head Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	0
Passenger Side or Roof Rail/Head Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	0
Driver 1st Stage Deployment Loop Commanded	Yes
Driver 2nd Stage Deployment Loop Commanded	Yes
Driver Side Deployment Loop Commanded	No
Driver Pretensioner Deployment Loop Commanded	Yes
Driver Roof Rail/Head Curtain Loop Commanded	No
Supplemental Deployment Loop #1 Commanded	No
Passenger 1st Stage Deployment Loop Commanded	No
Passenger 2nd Stage Deployment Loop Commanded	No
Passenger Side Deployment Loop Commanded	No
Passenger Pretensioner Deployment Loop Commanded	Yes
Passenger Roof Rail/Head Curtain Loop Commanded	No
Supplemental Deployment Loop #2 Commanded	No
Second Row Left Side Deployment Loop Commanded	No
Second Row Left Pretensioner Deployment Loop Commanded	No
Supplemental Deployment Loop #3 Commanded	No
Second Row Right Side Deployment Loop Commanded	No
Second Row Right Pretensioner Deployment Loop Commanded	No
Supplemental Deployment Loop #4 Commanded	No
Second Row Center Pretensioner Deployment Loop Commanded	No
Diagnostic Trouble Codes at Event, fault number: 1	B1000
Diagnostic Trouble Codes at Event, fault number: 2	B1184
Diagnostic Trouble Codes at Event, fault number: 3	N/A
Diagnostic Trouble Codes at Event, fault number: 4	N/A
Diagnostic Trouble Codes at Event, fault number: 5	N/A
Diagnostic Trouble Codes at Event, fault number: 6	N/A
Diagnostic Trouble Codes at Event, fault number: 7	N/A
Diagnostic Trouble Codes at Event, fault number: 8	N/A
Diagnostic Trouble Codes at Event, fault number: 9	N/A
Crash Record Locked	Yes
Vehicle Event Data (Pre-Crash) Associated With This Event	Yes
Event Recording Complete	Yes
Estimated Principal Direction of Force (PDOF) degrees	340

Figure 19: Case vehicle's System Status at Deployment report



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Longitudinal Axis Recorded Velocity	0.00	0.00	-1.91	-3.82	-5.09	-5.73	-7.00	-8.28	-9.55	-11.46	-12.73	-14.01	-14.64	-14.64	-14.64
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Longitudinal Axis Recorded Velocity	-14.64	-14.64	-14.64	-14.64	-14.64	-14.64	-14.64	-14.64	-14.64	-14.64	-14.64	-14.64	-14.64	-14.64	-14.64

Figure 20: Case vehicle's Longitudinal Axis Deployment data



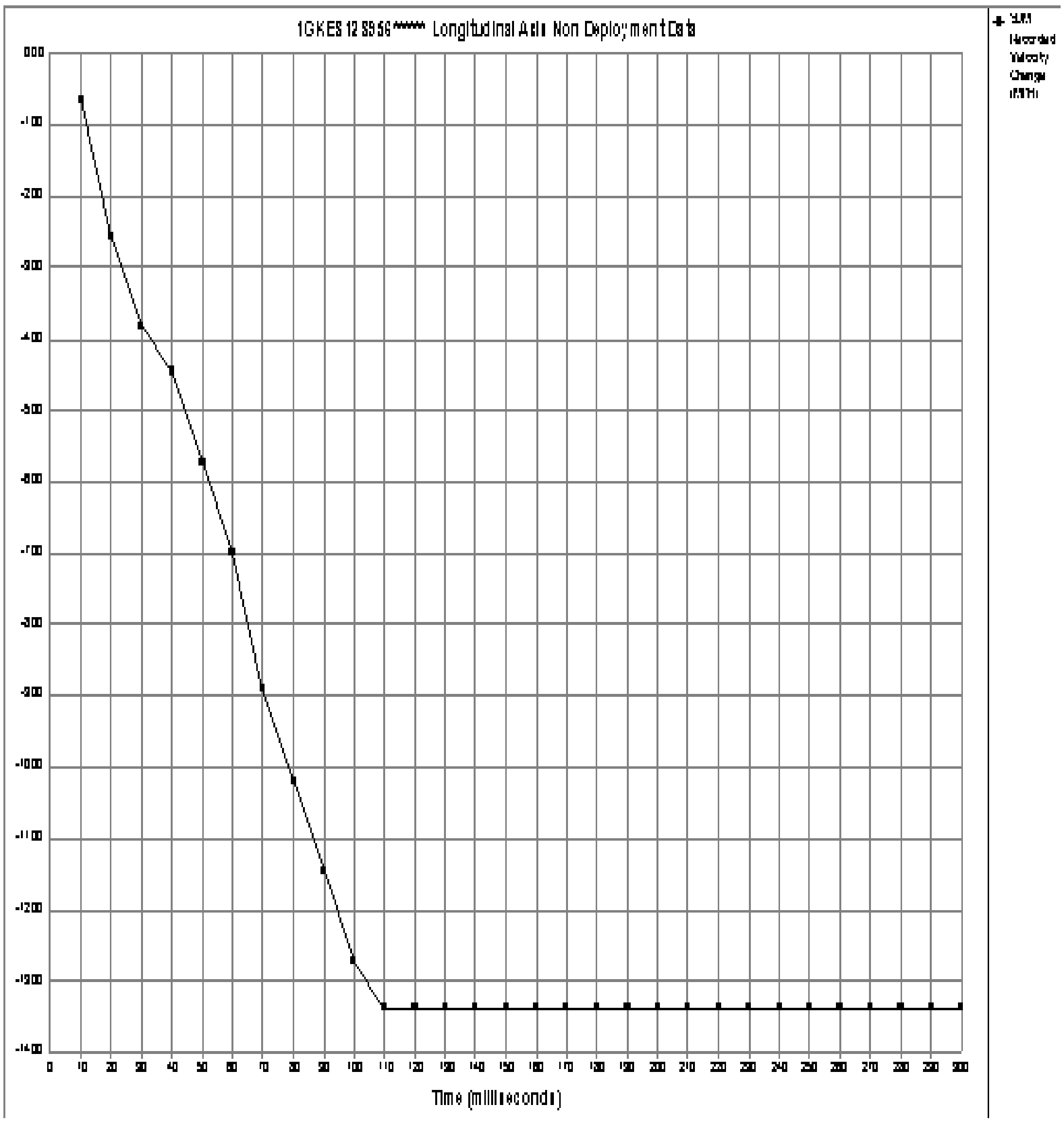
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Lateral Axis Recorded Velocity Change (MPH)	0.00	0.00	0.00	1.27	1.27	1.91	2.55	3.18	3.82	4.46	5.73	5.73	5.73	5.73	5.73
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Lateral Axis Recorded Velocity Change (MPH)	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73

Figure 21: Case vehicle's Lateral Axis Deployment Data

System Status At Non-Deployment

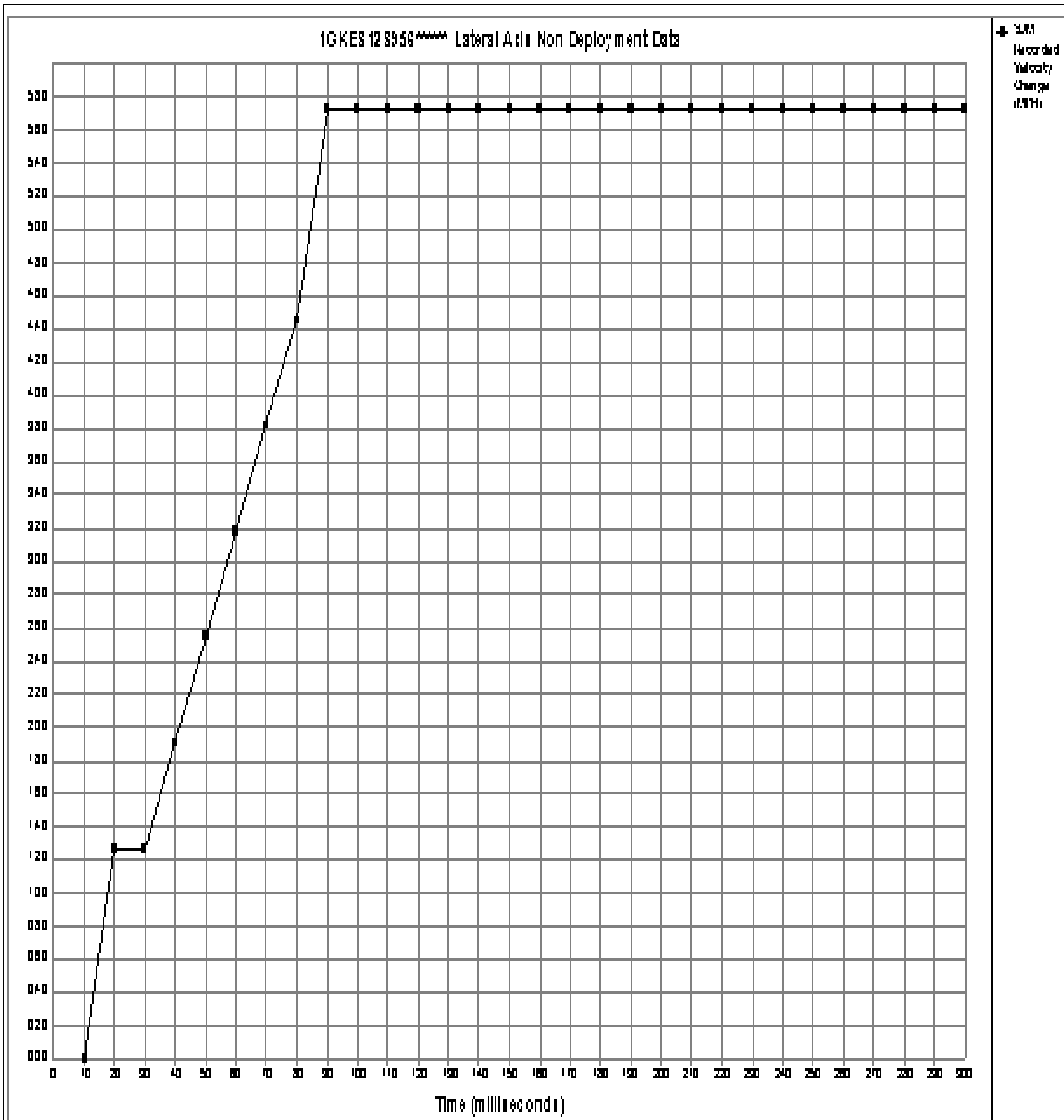
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/OFF Time (seconds)	140450
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	183
Ignition Cycles At Investigation	187
Ignition Cycles At Event	183
Ignition Cycles Since DTCs Were Last Cleared	182
Driver's Belt Switch Circuit Status	BUCKLED
Passenger's Belt Switch Circuit Status	UNBUCKLED
Driver Seat Position Switch Circuit Status	Rearward
Passenger Seat Position Switch Circuit Status	Rearward
Automatic Passenger SIR Suppression System Status at AE	Air Bag Suppressed
Time Between Events (sec)	N/A
Driver 1st Stage Deployment Loop Commanded	No
Driver 2nd Stage Deployment Loop Commanded	No
Driver Side Deployment Loop Commanded	No
Driver Pretensioner Deployment Loop Commanded	No
Driver Roof Rail/Head Curtain Loop Commanded	No
Supplemental Deployment Loop #1 Commanded	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	No
Supplemental Deployment Loop #2 Commanded	No
Second Row Left Side Deployment Loop Commanded	No
Second Row Left Pretensioner Deployment Loop Commanded	No
Supplemental Deployment Loop #3 Commanded	No
Second Row Right Side Deployment Loop Commanded	No
Second Row Right Pretensioner Deployment Loop Commanded	No
Supplemental Deployment Loop #4 Commanded	No
Second Row Center Pretensioner Deployment Loop Commanded	No
Diagnostic Trouble Codes at Event, fault number: 1	B1000
Diagnostic Trouble Codes at Event, fault number: 2	B1184
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)	41.98
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	1760
Crash Record Locked	Yes
Deployment Event Recorded in the Non-Deployment Record	No
Vehicle Event Data (Pre-Crash) Associated With This Event	No
Event Recording Complete	Yes
Estimated Principal Direction of Force (PDOF) degrees	335

Figure 22: Case Vehicle's System Status at Non-deployment report



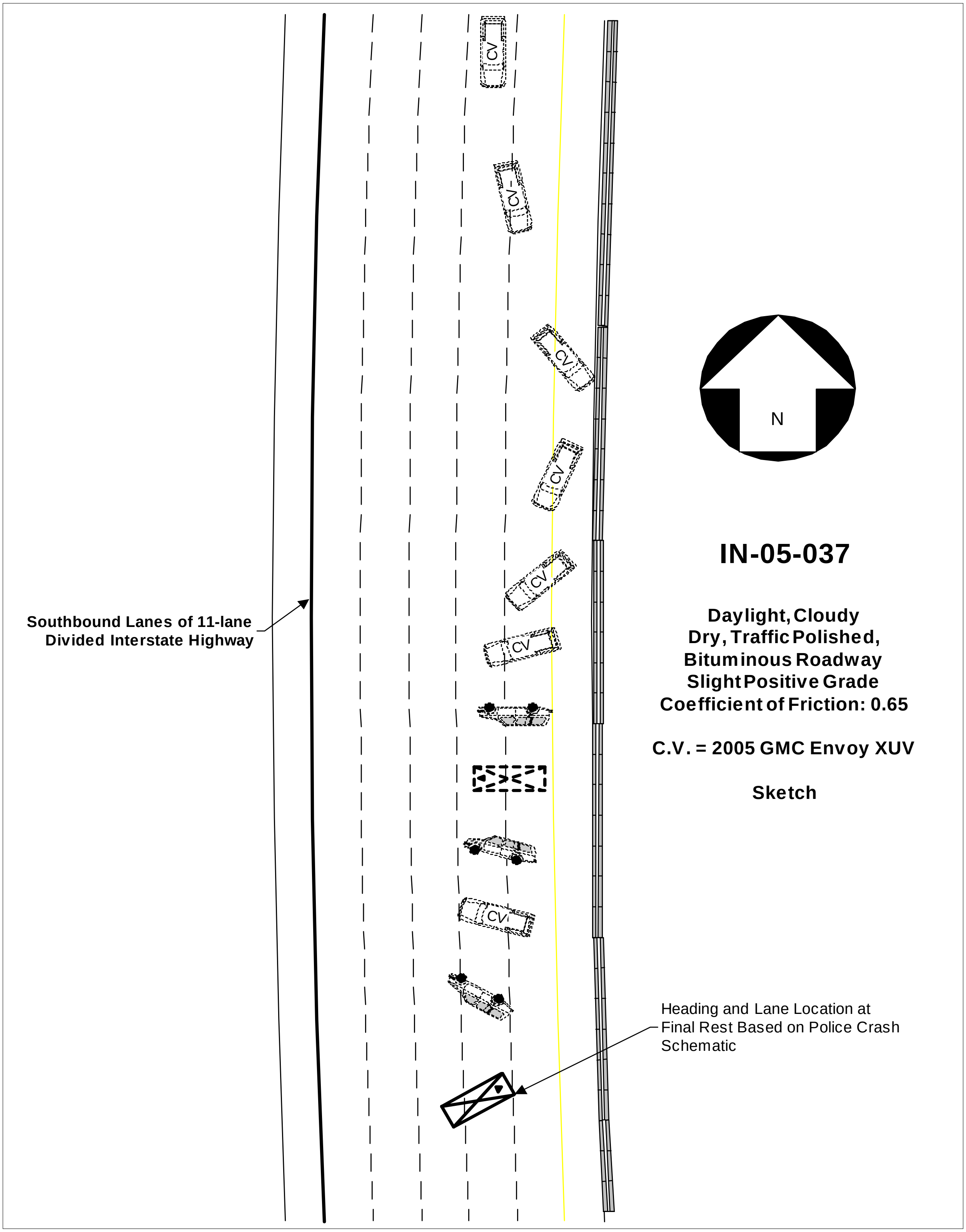
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Longitudinal Axis Recorded Velocity	-0.64	-2.55	-3.82	-4.46	-5.73	-7.00	-8.91	-10.19	-11.46	-12.73	-13.37	-13.37	-13.37	-13.37	-13.37
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Longitudinal Axis Recorded Velocity	-13.37	-13.37	-13.37	-13.37	-13.37	-13.37	-13.37	-13.37	-13.37	-13.37	-13.37	-13.37	-13.37	-13.37	-13.37

Figure 23: Case vehicle's Longitudinal Axis Non-Deployment Data



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Lateral Axis Recorded Velocity Change (MPH)	0.00	1.27	1.27	1.91	2.55	3.18	3.82	4.46	5.73	5.73	5.73	5.73	5.73	5.73	5.73
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Lateral Axis Recorded Velocity Change (MPH)	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73

Figure 24: Case vehicle's Lateral Axis Non-deployment Data


CV
CV
CV
CV
CV
CV
CV
N
IN-05-037
Daylight, Cloudy
Dry, Traffic Polished,
Bituminous Roadway
Slight Positive Grade
Coefficient of Friction: 0.65
C.V. = 2005 GMC Envoy XUV
Sketch
Southbound Lanes of 11-lane
Divided Interstate Highway
Heading and Lane Location at
Final Rest Based on Police Crash
Schematic