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ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-06-013
LOCATION - NORTH CAROLINA
VEHICLE - 2005 MERCURY MARINER
CRASH DATE - May 2006

Submitted:

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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

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16. *Abstract* This report covers an on-site air bag investigation that involved a 2005 Mercury Mariner (case vehicle) and a 2005 Saturn Vue (other vehicle), which were involved in an offset frontal crash on a divided U.S. highway. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features and the case vehicle's driver (39-year-old, female) and front right passenger (39-year-old, female) sustained police reported “C” (possible) injuries as a result of the crash. In addition, the manufacturer of the case vehicle has certified that it meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The case vehicle was eastbound in an unknown lane. The Saturn was westbound in the outside westbound lane. The case vehicle departed the south side of the roadway, re-entered the roadway and then rotated across the median and entered the westbound lanes into the path of the Saturn. The case vehicle’s front left impacted the Saturn’s front right causing the case vehicle’s driver and front right passenger air bags to deploy. As a result of the impact, the case vehicle rotated clockwise, departed the north side of the westbound lanes and came to final rest heading northeast. The Saturn continued westbound and came to rest in the middle of the roadway heading southwest. Both the driver and front right passenger were restrained by their three-point, lap-and-shoulder safety belts. They sustained minor injuries and were transported by ambulance to a medical center, treated and released.			
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This investigation was brought to NHTSA's attention on or before June 9, 2006 by NASS CDS/GES sampling activities. This crash involved a 2005 Mercury Mariner (case vehicle) and a 2005 Saturn Vue (other vehicle), which were involved in an offset frontal crash on a divided, U.S. highway. The crash occurred in May 2006, at an unknown time (the time was not reported on the police crash report) in North Carolina and was investigated by the North Carolina State Highway Patrol. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features and the case vehicle's driver [39-year-old, Black (unknown if Hispanic) female] and front right passenger [39-year-old, Black (unknown if Hispanic) female] sustained police reported "C" (possible) injuries as a result of the crash. In addition, the manufacturer of the case vehicle has certified that it meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. This contractor inspected both vehicle's and the scene and downloaded the Saturn's Event Data Recorder (EDR) on June 20, 2006. This contractor was unable to contact the case vehicle's driver for and interview. This report is based on the police crash report, scene inspection, case vehicle and Saturn inspections, Saturn's EDR data, occupant medical records, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was eastbound in an unknown lane of a four-lane, divided U.S. highway. The Saturn was westbound in the outside westbound lane. Both drivers were intending to continue straight ahead. The case vehicle departed the south side of the roadway, reentered the roadway and then rotated across the median and entered the westbound lanes into the path of the Saturn. The case vehicle's front left impacted the Saturn's front right causing the case vehicle's driver and front right passenger air bags to deploy. As a result of the impact, the case vehicle rotated clockwise, departed the north side of the westbound lanes and came to final rest heading northeast. The Saturn continued westbound and came to rest in the middle of the roadway heading southwest. At the time of the crash, the light condition was daylight and the atmospheric condition was rain.

The CDC for the case vehicle was determined to be **10-FYEW-2** (**300** degrees). The maximum residual crush was measured as 24 centimeters (9.5 inches) occurring at C_2 The WinSMASH reconstruction program, missing vehicle algorithm, calculated the case vehicle's Total, Longitudinal, and Lateral Delta Vs respectively as: 19.0 km.p.h. (11.8 m.p.h.), -9.5 km.p.h. (-5.9 m.p.h.), and 16.5 km.p.h. (10.3 m.p.h.). This was a borderline reconstruction and the results appeared low. The case vehicle was towed due to damage.

The CDC for the Saturn was determined to be **12-FREE-3** (**350** degrees). The WinSMASH reconstruction program, missing vehicle algorithm, calculated the Saturn's Total, Longitudinal, and Lateral Delta Vs respectively as: 20.0 km.p.h. (12.4 m.p.h.), -19.7 km.p.h. (-12.2 m.p.h.), and 3.5 km.p.h. (2.2 m.p.h.). This was a borderline reconstruction and the results appeared low. The Saturn's EDR recorded a maximum longitudinal Delta V of -27.29 km.p.h. (-16.96 m.p.h.). The Saturn was towed due to damage.

The case vehicle's driver was restrained by her manual, three-point, lap-and-shoulder safety belt. She sustained a minor injuries and was transported by ambulance to a local medical center and treated and released. The driver's use of her safety belt system and the deployment of her advanced air bag mitigated her interaction with the case vehicle's interior components and reduced her injury potential.

The case vehicle's front right passenger was restrained by her manual, three-point, lap-and-shoulder safety belt. She sustained minor injuries and was transported by ambulance to a local medical center and treated and released. The front right passenger's use of her safety belt system and the deployment of advanced air bag mitigated her interaction with the case vehicle's interior components and reduced her injury potential.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle and the Saturn were traveling was a four lane, divided, U.S. highway, traversing in an east and west direction. Both vehicle's roadways had two through lanes and bituminous shoulders. Each through lane was approximately 3.6 meters (11.9 feet) in width. The outside shoulder for the eastbound lanes was 1.5 meters (4.9 feet) in width while the median shoulder was 1.4 meters (4.6 feet) in width. The outside shoulder for the westbound lanes was 2.8 meters (9.2 feet) in width while the median shoulder was 1.2 meters (3.9 feet) in width. There was a blocked-out, W-beam, steel guardrail adjacent to the outside shoulders on each roadway. Roadway pavement markings consisted of solid white edge lines, broken white lane lines and solid yellow median lines. The trafficway was slightly curved to the north. The roadways were divided by a grass median 22.2 meters in width (72.8 feet). The approach of both vehicles was uncontrolled. The speed limit was 105 km.p.h. (65 m.p.h.). At the time of the crash the light condition was daylight, the atmospheric condition was rain, and the roadway pavement was wet, level bituminous with an estimated coefficient of friction of 0.45. Traffic density was moderate, and the site of the crash was rural. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was eastbound in an unknown lane (**Figure 1**). The Saturn was westbound in the outside westbound lane (**Figure 2** below). Both drivers were intending to continue straight ahead. The evidence indicated that the case vehicle most likely initially departed the south side of the roadway. The driver steered left to reenter the roadway, and the case vehicle began to rotate counterclockwise across the roadway on the wet pavement. The case vehicle departed the roadway (**Figure 3** below), crossed the median and entered the westbound lanes as it continued to rotate counterclockwise. The crash occurred in the outside westbound lane. The case vehicle rotated counterclockwise a total of approximately

Figure 1: Overview of case vehicle's eastbound approach roadway, arrow shows area of onset of case vehicle's yaw mark furrows in median

315 degrees prior to the impact. It is not known if the case vehicle's driver took any actions to avoid the crash with the Saturn.

Figure 2: Approach of Saturn westbound in outside lane and overview of impact area in foreground, arrow shows area where case vehicle entered westbound lanes

Figure 3: Case vehicle's yaw mark furrows in median, arrows show yaw marks, marks are from left to right: left front, right front, left rear and right rear

Figure 4: Damage to front of case vehicle from impact with the Saturn, increments on vertical scale in tenths of meter

Figure 5: Damage to Saturn's front right corner from impact with case vehicle, deformations at middle of hood are not crash related, hood was pried open

Crash: The case vehicle's front left (**Figure 4**) impacted the Saturn's front right (**Figure 5**) causing the case vehicle's driver and front right passenger air bags to deploy. The crash also caused the Saturn's driver and front right passenger air bags to deploy.

Post-Crash: As a result of the impact, the case vehicle rotated clockwise, departed the north side of the roadway and came to final rest heading northeast on the north side of the roadway near the guardrail. The case vehicle rotated clockwise post-impact a total of approximately 295 degrees. The Saturn continued westbound and came to rest in the middle of the roadway heading southwest.

The 2005 Mercury Mariner was a front wheel drive, four-door sport utility vehicle (VIN: 4M2YU56135D------) equipped with a 3.0L, V6 engine; three speed, automatic transmission and four wheel, anti-lock brakes. The front seating row was equipped with driver and front right passenger dual stage air bags, bucket seats with adjustable head restraints, tilt steering column and manual, three-point, lap-and-shoulder safety belts with adjustable upper anchors, safety belt usage sensors and pretensioners. The back seating row was equipped with a bench seat with folding backs, adjustable head restraints and three-point, lap-and-shoulder safety belt systems. In addition, the case vehicle was equipped with a LATCH system for securing child safety seats. Side thorax and side curtain air bags were an option, but the case vehicle was not so equipped. The case vehicle's wheelbase was 262 centimeters (103.1 inches). The case vehicle's odometer reading a the time of the vehicle inspection is unknown because the vehicle was equipped with an electronic odometer. Lastly, the manufacturer of the case vehicle has certified that it meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208.

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 safety 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.

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's impact with the Saturn involved the front end. The front bumper, grill, and hood were directly damaged and crushed rearward and to the right. The direct damage began at the front left bumper bar corner and extended 104 centimeters (40.9 inches) across the front end. The bumper fascia and grille were missing. Crush measurements were taken at the bumper bar, and the maximum residual crush was measured as 24 centimeters (9.5 inches) occurring at C_2 (**Figure 6**). The table below shows the case vehicle's front crush profile.

Figure 6: Top view of crush to front of case vehicle, each increment on the measurement rods is 5 cm (2 in)

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	104	24	108	6	24	20	17	10	3	-10	0
in		40.9	9.4	42.5	2.4	9.4	7.9	6.7	3.9	1.2	-3.9	0.0

The case vehicle's left side wheelbase was extended 3 centimeters (1.2 inches). The right side wheelbase was extended 1 centimeter (0.4 inch). Induced damage involved the hood and both fenders. The windshield was also cracked.

The case vehicle's recommended tire size was: P235/70R16, and the case vehicle was equipped with tires of this size. 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	32nd of an inch			
LF	207	30	207	30	6	8	None	No	No
RF	214	31	207	30	7	9	None	No	No
LR	214	31	207	30	2	3	None	No	No
RR	214	31	207	30	2	3	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior (**Figures 7** and **8**) revealed a possible make-up scuff at the top of the driver's air bag and a possible skin transfer on the upper right quadrant of the front right air bag. There was no other evidence of occupant contact to any of the vehicle's interior surfaces or components. There were no passenger compartment intrusions and no evidence of deformation of the steering wheel or energy absorbing steering column.

Figure 7: Case vehicle's steering wheel, instrument panel and windshield

Figure 8: Case vehicle's center and right instrument panel, arrow shows front right passenger air bag module cover flap

Damage Classification: Based on the vehicle inspection, the CDC for the case vehicle was determined to be **10-FYEW-2** (**300** degrees). The WinSMASH reconstruction program damage algorithm was initially used to reconstruct the case vehicle's Delta Vs. However, the results were unreasonably low. This was due to the small amount of bumper crush sustained by the Saturn as a result of the impact occurring at the front right corner. During the impact, the Saturn's right front wheel was primarily engaged with little engagement of the front bumper bar. Therefore, the WinSMASH missing vehicle algorithm was used and the Saturn was treated as the missing vehicle. The missing vehicle run improved the

results, but the reconstruction was borderline and the results still appeared low. The case vehicle's Total, Longitudinal, and Lateral Delta Vs from the missing vehicle run are, respectively: 19.0 km.p.h. (11.8 m.p.h.), -9.5 km.p.h. (-5.9 m.p.h.), and 16.5 km.p.h. (10.3 m.p.h.). The case vehicle was towed due to damage.

Figure 9: Case vehicle's driver air bag module cover flaps

Figure 10: Case vehicle's driver air bag

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a manufacturer certified advanced 208-compliant air bag system. Both the driver's and front right passenger's air bags deployed as a result of the front impact with the Saturn.

The case vehicle's driver air bag was located in the steering wheel hub. The air bag module was constructed with "H"-configuration cover flaps (**Figure 9**) constructed of pliable vinyl. The upper cover flap was constructed with the manufacturer's logo in the middle, which created a rounded contour at the horizontal tear seat. This contour fit into a rounded cut-out in the lower cover flap. The upper cover flap's overall dimensions were 15 centimeters (5.9 inches) in width and 9 centimeters (3.5 inches) in height. The lower cover flap's dimension's were 15 centimeters (5.9 inches) in width and 3 centimeters (1.2 inches) in height at the middle and 5 centimeters (2 inches) in height on each side. 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. There was no evidence of damage during the deployment to the air bag module cover flaps or the air bag fabric. The deployed driver's air bag (**Figure 10**) was round with a diameter of approximately 54 centimeters (21.3 inches). The air bag was designed with two tether straps, each approximately 10 centimeters (3.9 inches) in width and had two vent ports, each 3 centimeters (1.2 inches) in diameter, located at the 3 and 9 o'clock positions. The distance between the mid-center of the driver's seat back, as positioned at the vehicle inspection (seat track in middle position, seat back slightly reclined), and the air bag at approximate full excursion was 35 centimeters (13.8 inches). Inspection of the driver's air bag revealed a possible make-up scuff on the top right quadrant of the air bag. In addition, there were a few dark scuffs, possibly related to deployment, and an area of discoloration on the left portion of the air bag that appeared to be a liquid stain.

The front right passenger air bag was located in the middle of the right instrument panel (**Figure 8** above). The air bag module was constructed with a single rectangular-shaped cover flap. The cover flap's overall dimensions were 33 centimeters (13 inches) in width and 22 centimeters (8.7 inches) in height. An inspection of the cover flap and the air bag fabric revealed that the cover flap opened at the designated tear points. There was no evidence of damage during the deployment to the air bag module cover flap or the air bag fabric. The deployed front right air bag (**Figure 11**) was rectangular and was approximately 60 centimeters (23.6 inches) in height and approximately 39 centimeters (15.4 inches) in width. The air bag was designed without tether straps and had two vent ports, each 6 centimeters (2.4 inches) in diameter, located at the 9:30 and 2:30 o'clock positions. The distance between the mid-center of the front right passenger's seat back, as positioned at the vehicle inspection (seat track between rear-most and middle position, seat back slightly reclined), and the air bag at approximate full excursion was 43 centimeters (16.9 inches). Inspection of the air bag revealed a possible skin transfer on the right upper quadrant. There were also numerous dark scuffs, possibly related to the deployment, as well as an area of discoloration on the left portion of the air bag that appeared to be liquid stains.

Figure 11: Case vehicle's front right passenger air bag

Figure 12: Case vehicle driver's safety belt buckle stalk, arrow shows retracted buckle stalk due to activation of the pretensioner

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash, the case vehicle's driver [39-year-old, Black (unknown if Hispanic) female; unknown height and 73 kilograms (160 pounds)] was most likely seated in a nominal upright driving position. She most likely had both hands on the steering wheel. The position of her feet is not known at this time. At the time of the case vehicle inspection, the driver's seat track was adjusted to its middle position, and the seat back was slightly reclined. The tilt steering wheel was located in its center position.

The evidence indicates the case vehicle's driver was restrained by her manual, three-point, lap-and-shoulder, safety belt system. The driver's buckle-mounted pretensioner actuated in the crash (**Figure 12**).

As the case vehicle rotated counterclockwise across the eastbound lane and entered the median, the driver's safety belt retractor most likely locked and she most likely moved to the right within her seat and safety belt. As the case vehicle entered the westbound lane and approached impact, its counterclockwise rotation increased rapidly. The case vehicle's impact with the Saturn caused the driver to move forward and to the left opposite the case vehicle's 300 degree direction of principal force as the case vehicle decelerated longitudinally and accelerated laterally to the right. As a result of the impact, the driver's safety belt pretensioner actuated, she loaded her safety belt and her face and upper chest impacted her deployed air bag causing a closed head injury without lose of conscious. In addition, the driver sustained a cervical strain due to the impact force. The driver rebounded off her air bag and impacted the left side of her head on the left "B"-pillar causing a contusion to her head. The driver remained restrained in her seat as the case vehicle rotated clockwise to final rest. The driver was most likely able to exit the case vehicle under her own power following the crash. The driver's use of her safety belt system and the deployment of advanced air bag mitigated her interaction with the case vehicle's interior components and reduced her injury potential.

CASE VEHICLE DRIVER INJURIES

The police crash report indicated the driver sustained a "C" (possible) injury and was transported by ambulance to a local medical center and treated and released. The table below sows the case vehicle driver's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Closed head injury without loss of consciousness; awake, GCS=15	unknown 115099.7,0	Air bag, driver's	Probable	Emergency room records
2	Contusion {hematoma}, subgaleal, overlying left parietal bone	minor 190402.1,2	Left "B"-pillar	Possible	Emergency room records
3	Strain, acute cervical with tenderness C_2-C_3 and/or right lateral neck	minor 640278.1,6	Noncontact injury: impact forces	Possible	Emergency room records

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's front right passenger [39-year-old, Black (unknown if Hispanic) female; unknown height and weight] was likely seated in an upright position. The position of her hands, arms and feet is not known at this time. At the time of the case vehicle inspection, the front right passenger's seat track was adjusted to between its middle and rear-most position, and the seat back was slightly reclined.

The evidence indicates the case vehicle's front right passenger was restrained by her manual, three-point, lap-and-shoulder, safety belt system. The passenger's buckle-mounted pretensioner actuated in the crash (**Figure 13**).

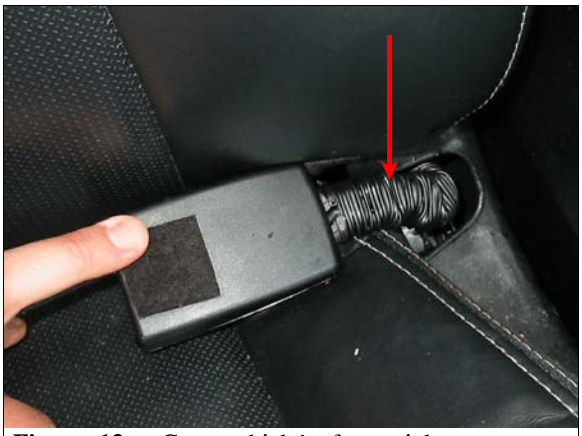


Figure 13: Case vehicle's front right passenger safety belt buckle, arrow shows retracted buckle stalk due to activation of pretensioner

As the case vehicle rotated counterclockwise across the eastbound lane and entered the median, the front right passenger's safety belt retractor most likely locked, and she most likely moved to the right within her seat and safety belt. As the case vehicle entered the westbound lane and approached impact, its counterclockwise rotation increased rapidly. The case vehicle's impact with the Saturn then caused the front right passenger to move forward and to the left opposite the case vehicle's 300 degree direction of principal force as the case vehicle decelerated longitudinally and was accelerated laterally to the right. The passenger's safety belt pretensioner actuated and she loaded her safety belt causing a contusion to her left lower abdomen. In addition, she sustained a cervical strain due to impact force, and her knees impacted the glove box door causing bilateral contusions to her knees and a small laceration to her left knee. The passenger remained restrained in her seat as the case vehicle came to final rest. The front right passenger was most likely able to exit the case vehicle under her own power following the crash. The front right passenger's use of her safety belt system and the deployment of her advanced air bag mitigated her interaction with the case vehicle's interior components and reduced her injury potential.

CASE FRONT RIGHT PASSENGER INJURIES

The police crash report indicated the case vehicle's front right passenger sustained a "C" (possible) injury and was transported from the scene to a local medical center. The table below shows the front right passenger's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Strain, acute cervical with mild tenderness right lateral neck	minor 640278.1,6	Noncontact injury: impact forces	Possible	Emergency room records
2	Contusion abdomen, left lower quadrant	minor 590402.1,8	Lap portion of safety belt system	Certain	Emergency room records
3	Contusions bilateral knees, anterior surface	minor 890402.1,3	Glove compartment door	Probable	Emergency room records
4	Laceration {scratch} left knee, not further specified	minor 890602.1,2	Glove compartment door	Probable	Emergency room records

The 2005 Saturn Vue was a front wheel drive, four-door sport utility vehicle (VIN: 5GZCZ53445S------) equipped with a 3.5L, V6 engine. The front seating row was equipped with driver and front right passenger advanced air bags, bucket seats and manual, three-point, lap-and-shoulder safety belts

Exterior Damage: The Saturn's impact with the case vehicle involved the front right corner of the vehicle. The right portion of the front bumper fascia, right headlamp/turn signal assembly, fog lamp, grille, hood and right fender were directly contacted and crushed rearward. In addition, the plastic right fender was broken. Due to the length of the front bumper bar, it was minimally engaged. The primary engagement occurred to the right front wheel (**Figure 14**), which was crushed rearward 13 centimeters (5.1 inches). The direct damage began at the front right bumper corner and extended 29 centimeters (11.4 inches) across the front bumper. Crush measurements were taken at the bumper level and the radiator frame level. The maximum residual crush at the bumper level was measured as 2 centimeters (0.8 inches) occurring at C_1. The maximum residual crush at the radiator frame level was measured as 9 centimeters (3.5 inches), also occurring at C_1. The table below shows the case vehicle's crush at the bumper level. The above bumper crush was not averaged with the bumper crush because the extent of the above bumper crush did not meet the crush averaging requirement.

Figure 14: Right side view of damage to Saturn's front bumper, right fender and right front wheel due to impact with front of case vehicle

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	29	2	138	0	0	1	1	1	2	55	0
in		11.4	0.8	54.3	0.0	0.0	0.4	0.4	0.4	0.8	21.7	0.0

The Saturn's right side wheelbase was reduced 13 centimeters (5.1 inches). The left side wheelbase was reduced 2 centimeters (0.8 inch). Induced damage involved the bumper, grille and hood.

Damage Classification: Based on the vehicle inspection, the CDC for the Saturn was determined to be **12-FREE-3** (**350** degrees). The WinSMASH reconstruction program, damage algorithm, was initially used to reconstruct the Saturn's Delta Vs. However, the results were unreasonably low. This was due to the small amount of bumper crush the Saturn sustained due to the impact occurring to its front right corner. During the impact, the right front wheel was primarily engaged

with little engagement of the front bumper bar. Therefore, the WinSMASH, missing vehicle algorithm, was used and the Saturn was treated as the missing vehicle. The missing vehicle run improved the results, but the reconstruction was borderline and the results still appeared low. The Saturn's Total, Longitudinal, and Lateral Delta Vs from the missing vehicle run are, respectively: 20.0 km.p.h. (12.4 m.p.h.), -19.7 km.p.h. (-12.2 m.p.h.), and 3.5 km.p.h. (2.2 m.p.h.). The Saturn's EDR recorded a maximum longitudinal Delta V of -27.29 km.p.h. (-16.96 m.p.h.). The Saturn was towed due to damage.

Crash Data Recording: The Saturn's EDR recorded a deployment event and a non-deployment event. The non-deployment event was recorded 168 ignition cycles prior to the deployment event and was therefore not related to this crash. The EDR reports for the deployment event are presented at the end of this report (**Figures 15-18**). The system status report shows the SIR warning lamp was recorded as off, and the driver's seat belt switch circuit was recorded as buckled. The maximum SDM recorded longitudinal velocity change was -27.29 km.p.h. (-16.96 m.p.h.) occurring 137.5 milliseconds after algorithm enable (AE). In addition, the system status report shows that the first and second stage deployment criteria for the driver's and front right passenger's air bags were met respectively at 37.5 and 47.5 milliseconds after AE. The data indicated the deployment command was issued between approximately 40 and 50 milliseconds after AE.

The pre-crash data indicates the Saturn was traveling 106 km.p.h. (66 m.p.h.) and accelerating at 26% throttle 5 seconds prior to AE. The brake switch is recorded on at 3 seconds prior to AE and remains on to one second prior to AE, at which point the case vehicle's speed is recorded as 61 km.p.h. (38 m.p.h.). The speed recorded during braking can vary and is not precise. It can fluctuate under braking because it is determined from the Saturn's speed sensor.

Saturn's Driver: According to the police crash report, the Saturn's driver [28-year-old, Black (unknown if Hispanic) female] was restrained by her manual, three-point, lap-and-shoulder, safety belt system. The police crash report indicated the driver sustained a "C" (possible) injury and was transported by ambulance to a local medical center.

Saturn's Front Right Passenger: According to the police crash report, the Saturn's front right passenger [10-year-old, Black (unknown if Hispanic) female] was restrained by her manual, three-point, lap-and-shoulder safety belt system. The police crash report indicated the front right passenger sustained a "C" (possible) injury and was transported by ambulance to a local medical center.

CDR File Information

Vehicle Identification Number	5GZCZ53445S******
Investigator	
Case Number	
Investigation Date	
Crash Date	
Filename	IN06013.CDR
Saved on	Tuesday, June 20 2006 at 12:51:10 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 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 100 milliseconds of data after deployment criteria is met and up to 50 milliseconds before deployment criteria is met. For Non-Deployment Events, the SDM will record the first 150 milliseconds of data after algorithm enable.
-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 Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit. If the vehicle's electrical system is compromised during a crash, the state of the Driver's Belt Switch Circuit may be reported other than the actual state.
-The Time between Non-Deployment and 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 power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
SDM Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Speed, Engine Speed, and Percent Throttle data are transmitted once a second by the Powertrain Control Module (PCM), via the vehicle's communication network, to the SDM.
-Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the vehicle's communication network, to the SDM. Depending on vehicle option content, the Brake Switch Circuit Status data may

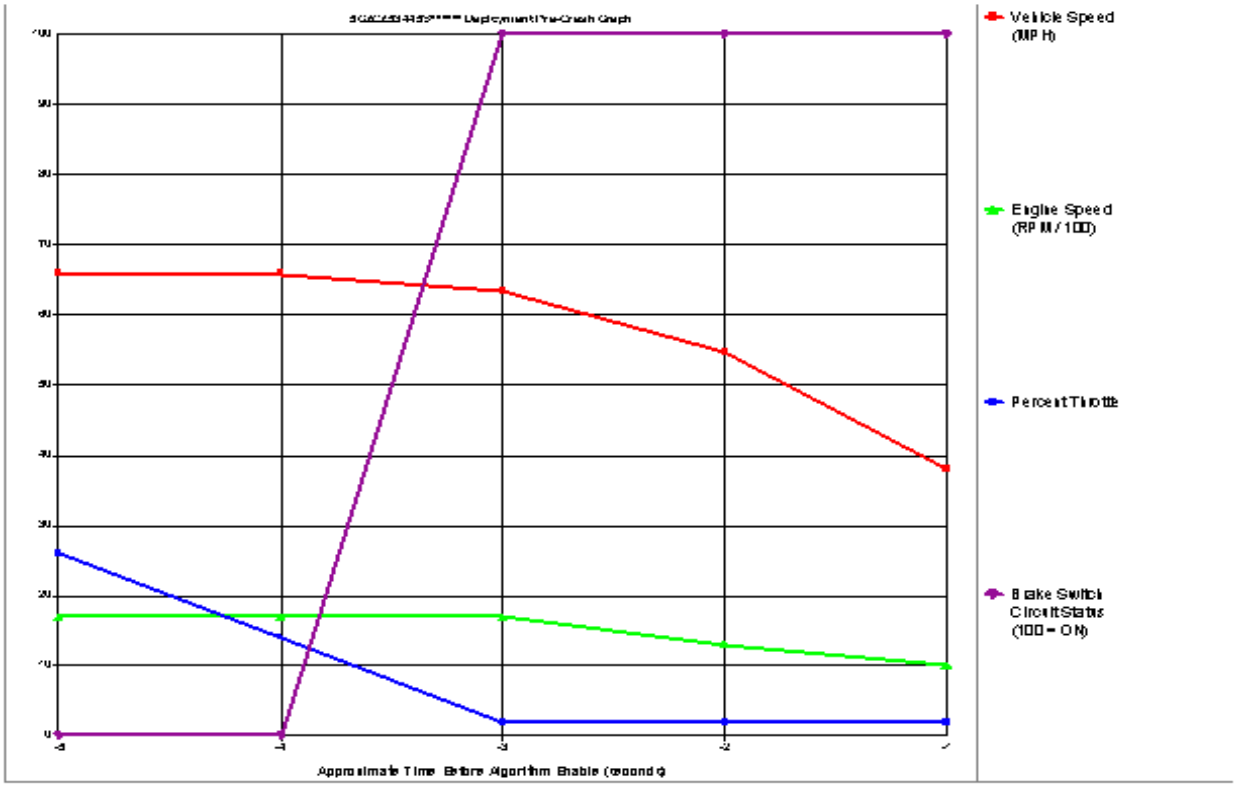
Figure 15: Saturn's CDR File Information and SDM Data Limitations

not be available.
-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.

Figure 16: Saturn's SDM Data Limitations, continued

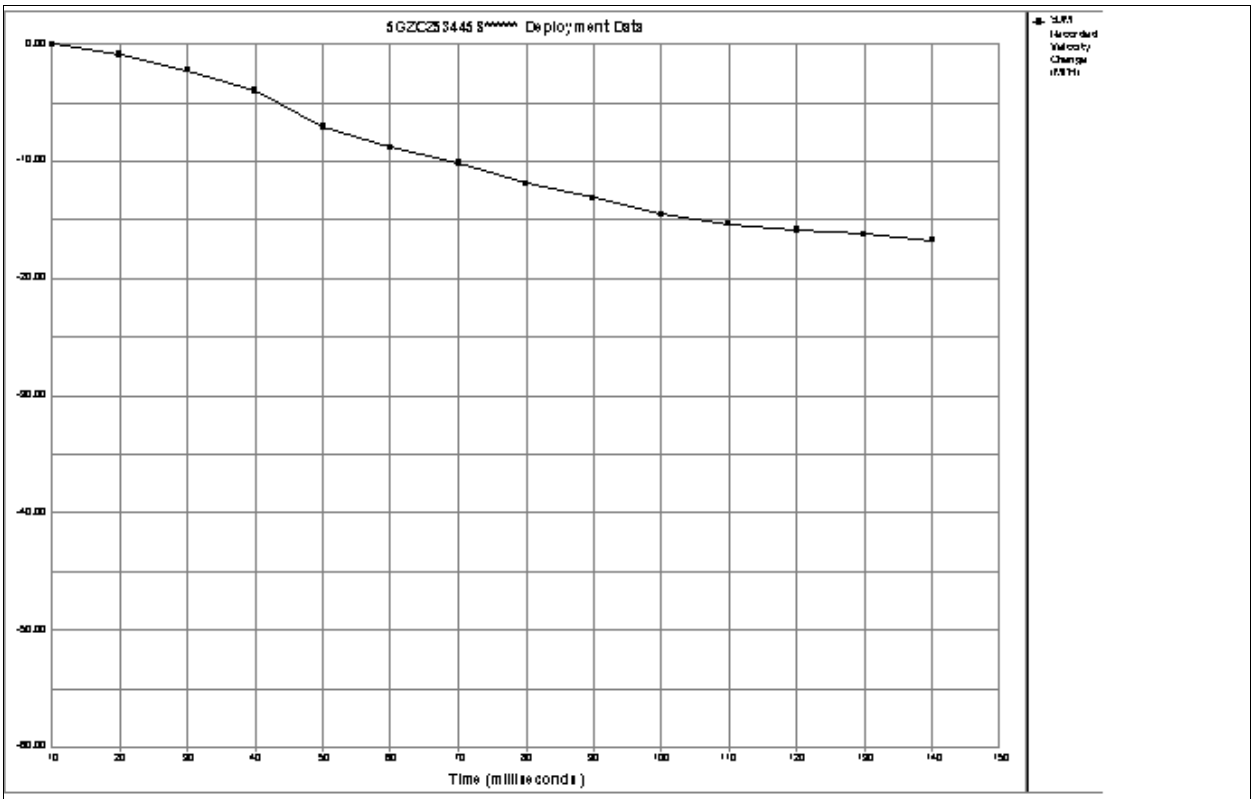
System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Deployment	2403
Ignition Cycles At Investigation	2405
Maximum SDM Algorithm Forward Velocity Change (MPH)	-16.96
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	137.5
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	37.5
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	47.5
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	37.5
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	47.5
Time Between Non-Deployment And Deployment Events (sec)	N/A
Event Recording Complete	Yes



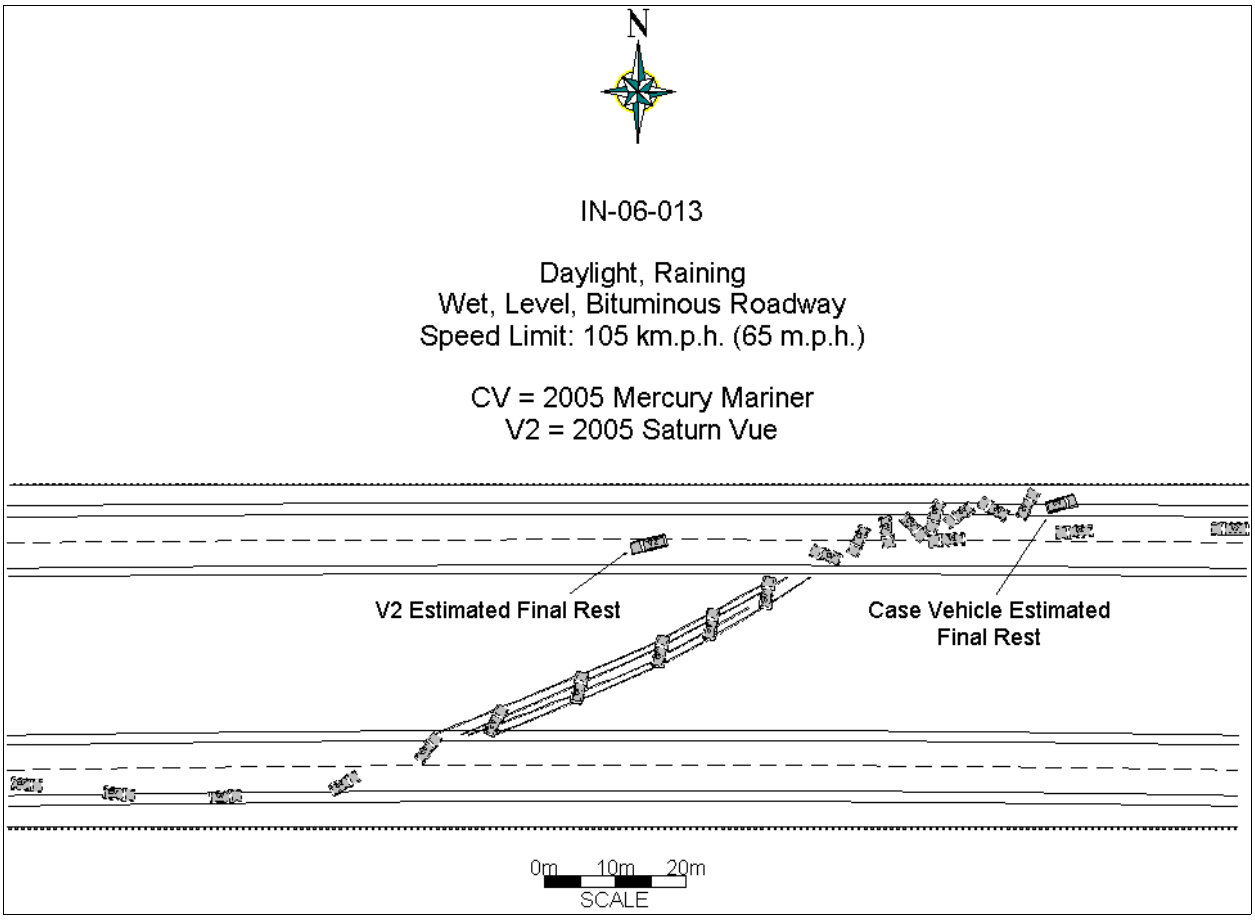
Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	66	1728	26	OFF
-4	66	1728	14	OFF
-3	63	1664	2	ON
-2	55	1344	2	ON
-1	38	1024	2	ON

Figure 17: Saturn's System Status at Deployment report and pre-crash data



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	0.00	-0.88	-2.19	-3.95	-7.02	-8.78	-10.09	-11.85	-13.16	-14.48	-15.36	-15.80	-16.24	-16.67	N/A

Figure 18: Saturn's SDM recorded velocity change data


N
IN-06-013
Daylight, Raining
Wet, Level, Bituminous Roadway
Speed Limit: 105 km.p.h. (65 m.p.h.)
CV = 2005 Mercury Mariner
V2 = 2005 Saturn Vue
V2 Estimated Final Rest
Case Vehicle Estimated Final Rest
0m 10m 20m
SCALE