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ON-SITE AIR BAG INVESTIGATION

CASE NUMBER - IN-03-014
LOCATION - Texas
VEHICLE - 2001 BUICK LESABRE
CRASH DATE - March 2003

Submitted:

August 4, 2004
Revised:
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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

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15. *Supplementary Notes*
On-site investigation of an air bag deployment crash involving a 2001 Buick LeSabre, equipped with multiple advanced occupant protection system features, that impacted a parked 1986 Toyota mini-pickup

16. *Abstract*
This report covers an on-site investigation of an air bag deployment crash involving a 2001 Buick LeSabre Custom (case vehicle) that impacted a parked and unoccupied 1986 Toyota long bed/long wheelbase mini-pickup. This crash is of special interest because the case vehicle was equipped with multiple advanced occupant protection system (AOPS) features and an Event Data Recorder (EDR) that was successfully downloaded. The case vehicle's restrained driver (37-year-old male) and unrestrained front right passenger (34-year-old female) were both reported as not sustaining any injuries in the crash. The case vehicle was traveling north in the northbound lane of a two-lane, undivided, residential street and apparently intended to proceed straight ahead. The 1986 Toyota pickup was parked and unoccupied, heading south along the east curb of the same roadway. It was dark but lighted, raining and the asphalt road surface was wet. The police crash report made no mention of any attempted avoidance maneuvers taken by the case vehicle's driver. The EDR indicated that the driver braked a few seconds prior to the impact. The crash occurred in the northbound lane of the roadway. The case vehicle's front right area impacted the front of the parked Toyota, causing the case vehicle's driver and front right passenger air bags to deploy. After the initial impact, the case vehicle pushed the Toyota northwestward before the vehicles separated. The case vehicle came to a final rest in the northbound portion of the roadway heading north. The Toyota was pushed northwestward and came to rest straddling the west curb heading northeast. The case vehicle was towed due to disabling damage. The case vehicle's front right passenger air bag was installed in what the manufacturer calls the " active instrument panel" configuration and the air bag module did not have cover flaps.

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BACKGROUND

This on-site investigation was brought to the NHTSA's attention on March 25, 2003 by NASS/GES sampling activities. This crash involved a 2001 Buick LeSabre Custom (case vehicle) and a 1986 Toyota mini-pickup truck that was parked and unoccupied. The crash occurred in March 2003 at 2:39 a.m., in Texas, and was investigated by the applicable municipal police department. This crash is of special interest because the case vehicle was equipped with multiple advanced occupant protection system (AOPS) features and an Event Data Recorder (EDR) that was successfully downloaded. The case vehicle's restrained driver (37-year-old male, white, unknown if Hispanic) and unrestrained front right passenger (34-year-old female, race/ethnicity unknown) were both reported as not sustaining any injuries in the crash. This contractor inspected the scene and case vehicle on 31 March, 2003. The other vehicle could not be located and was not inspected. The case vehicle occupants declined to participate and were 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 north in the northbound lane of a two-lane, undivided, residential street and apparently intended to proceed straight ahead. The 1986 Toyota pickup was parked and unoccupied, heading south along the east curb of the same roadway. The speed limit was 48 km.p.h. [30 m.p.h.], it was dark but lighted, raining and the asphalt road surface was wet. The police crash report made no mention of any attempted avoidance maneuvers taken by the case vehicle's driver. The EDR indicated that the driver braked a few seconds prior to the impact. The crash occurred in the northbound lane of the roadway.

The case vehicle's front right area impacted the front of the parked Toyota, causing the case vehicle's driver and front right passenger air bags to deploy. After the initial impact, the case vehicle pushed the Toyota northwestward before the vehicles separated. The case vehicle came to a final rest in the northbound portion of the roadway heading north, approximately 22 meters [72.2 feet] from the point of impact. The Toyota was pushed northwestward and came to a rest straddling the west curb heading northeast.

The case vehicle was a 2001 Buick LeSabre Custom front wheel drive, four-door, six-passenger sedan (VIN: 1G4HP54K014------), equipped with a 3.8 liter V6 gasoline engine and an automatic transmission with a column-mounted selector lever. The case vehicle was equipped with anti-lock brakes and its wheelbase was 285 centimeters [112.2 inches]. Traction control was an option for this model, but it is not known if the case vehicle was so equipped. The case vehicle was fitted with multi-stage frontal air bags, seat back-mounted side impact air bags and integrated manual safety belts for the two front outboard seat positions. Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDEW-2 (0)**. The WinSMASH reconstruction program, missing vehicle algorithm based on the case vehicle's crush profile, was used on the single impact. The total, longitudinal, and lateral delta Vs are, respectively: 17.0 km.p.h. [10.6 m.p.h.], -17.0 km.p.h. [-10.6 m.p.h.], and 0 km.p.h. [0 m.p.h.]. These results should be viewed as borderline but reasonable. The crash severity for the case vehicle was low (14 - 23 km.p.h. [9 - 14 m.p.h.]). The case vehicle was towed due to damage.

The case vehicle's contact with Toyota involved the front right bumper, grille and hood. Direct damage began at the front right bumper corner and extended a measured distance of 124 centimeters [48.9 inches] along the front bumper. Maximum crush was measured as 35 centimeters [13.8 inches] at C6. The case vehicle's front right bumper, bumper fascia, right headlamp/turn signal assembly, grille, hood, and radiator were directly damaged and crushed rearward. None of the tires/wheels were damaged or restricted and there was no glazing damage. The left headlight/turn signal assembly was slightly displaced and the left fender was undamaged.

The case vehicle was equipped with driver and front right passenger frontal air bags and seat back mounted side impact air bags at the two front outboard positions, for a total of four air bags. The two frontal air bags deployed and the two side impact air bags did not.

The case vehicle's driver air bag was located in the steering wheel hub. Inspection revealed that the cover flaps opened at the designated tear points and there was no evidence of damage to the air bag or the cover flaps. The driver's air bag was designed with four tether straps, each 7.5 centimeters [3 inches] wide, and had two vent ports, approximately 3.5 centimeters [1.4 inches] in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was round with a diameter of 64 centimeters [25.2 inches]. There was no evidence of contact apparent on the front of the driver's air bag.

The front right passenger's air bag was located in the mid-mount position, on the front of the instrument panel, in a configuration that the manufacturer refers to as an " active instrument panel". There was no module cover flap as such. Rather, as the deploying air bag expands, it forces the top of the instrument panel upward, causing the points of attachment to break away and creating an opening between the horizontal top and the vertical front of the instrument panel. The air bag deploys through this opening. The deployed front right air bag was rectangular, measuring approximately 55 centimeters [21.7 inches] vertically and 35 centimeters [13.8 inches] horizontally. The front right passenger's air bag was designed with one tether, measuring 34 centimeters [13.4 inches], and had two vent ports, each approximately 4.5 centimeters [1.8 inches] in diameter, located at the 9:30 and 2:30 o'clock positions. There was no evidence of contact apparent on the front right passenger's air bag.

The case vehicle's Event Data Recorder (EDR) was successfully downloaded in the field via the diagnostic port. The Sensing and Diagnostic Module (SDM) report is included at the end of this document. The SDM report indicates that the SIR Warning Lamp Status was OFF, the driver's belt was buckled and the deployment event took place during ignition cycle 4,957. The case vehicle was traveling at 64 km.p.h. [40 m.p.h.] with zero throttle five seconds prior to the impact. At approximately four seconds prior to algorithm enable, the driver applied the brakes and the vehicle slowed to 60 km.p.h. [37 m.p.h.] at one second prior to the impact. The case vehicle driver and front right passenger air bags were equipped with multi-stage inflators. The SDM report indicates that the command for first stage deployment for both air bags was issued at 12.5 milliseconds [0.0125 seconds] after algorithm enable, and the criteria for second stage deployment was not met. The SDM report indicates that the maximum recorded longitudinal velocity change was -24.2 km.p.h. [-15.05 m.p.h.], at 107.5 milliseconds [0.1075 seconds] after algorithm enable. The velocity change data show delta V accumulating gradually to the maximum

at approximately 110 milliseconds following algorithm enable, after which recording ceased. The SDM recorded velocity change is 7.2 km.p.h. [4.5 m.p.h.] greater than the WinSMASH missing vehicle calculated deltaV for the case vehicle.

Inspection of the case vehicle's interior indicated no readily apparent evidence of occupant contact on the interior surfaces. The case vehicle was equipped with integrated restraints at the two front seat outboard positions, both with a sewn-on latch plate. The driver's safety belt showed creases in the webbing at the approximate area where the belt passed into the seat back, which indicate that the belt was in use and was loaded by the driver's inertial force. There was no evidence of loading on the front right passenger's belt.

The case vehicle's driver (37-year-old male, white, unknown if Hispanic, height and weight unknown) was seated in an unknown posture, probably with his left foot on the floor, his right foot on the foot controls and at least one hand on the steering wheel. At the inspection, his seat track was located between the middle and rearmost positions, the seat back was sightly reclined, and the tilt steering wheel was adjusted between its middle and full down positions. The driver was restrained by his available, active, integrated, three-point, lap-and-shoulder safety belt system. Inspection of the driver's seat belt webbing showed evidence of loading.

The driver braked at approximately four seconds prior to the impact. There were no skid marks at the crash scene. The driver probably moved slightly forward in response to this braking deceleration. The case vehicle's impact with the Toyota caused the case vehicle's driver to continue forward, toward the case vehicle's 12 o'clock direction of force. This was in impact of low severity and he did not load the safety belt heavily. He probably encountered the deployed air bag with his face and chest and likely rebounded rearward as the vehicle traveled to final rest.

According to the police crash report, the case vehicle's driver did not sustain any injuries as a result of this crash and was not transported. The driver declined to be interviewed and it is not known if he sought treatment or sustained any specific injuries.

The case vehicle's front right passenger (34-year-old female, race/ethnicity, height and weight unknown) was seated in an unknown posture. At the inspection, her seat track was located between the middle and rearmost positions and the seat back was sightly reclined. The case vehicle's front right passenger was not using her available, active, integrated, three-point, lap-and-shoulder safety belt system. No evidence of usage was found on her safety belt system.

The driver braked at approximately four seconds prior to the impact. The front right passenger probably moved slightly forward in response to the braking deceleration. The impact with the Toyota caused her to move further forward, toward the 12 o'clock direction of force. This was an impact of low severity and she probably encountered the deployed air bag with her face and chest and rebounded rearward as the vehicle traveled to final rest.

According to the police crash report, the front right passenger did not sustain any injuries from this crash and was not transported. It is not known if she sought treatment or sustained any specific injuries.

The other vehicle was a 1986 Toyota rear wheel drive, long bed/long wheelbase, two-door mini-pickup truck (VIN: JT4RN55R2G0------). This vehicle was legally parked and unoccupied (i.e., not in transport). The Toyota could not be located and was not inspected. With no available vehicle photographs, a CDC for the Toyota cannot be estimated. The WinSMASH reconstruction program, missing vehicle algorithm based on the case vehicle's crush profile, was used on the single impact. The total, longitudinal, and lateral delta Vs for the Toyota are, respectively: 26.0 km.p.h. [16.2 m.p.h.], -26.0 km.p.h. [-16.2 m.p.h.], and 0 km.p.h. [0 m.p.h.]. The crash severity for the Toyota was moderate (24 - 40 km.p.h. [15 - 25 m.p.h.]).

CRASH CIRCUMSTANCES

The case vehicle was traveling north in the northbound lane of a two-lane, undivided, residential street and apparently intended to proceed straight ahead. The 1986 Toyota pickup was parked and unoccupied, heading south along the east curb of the same roadway. The speed limit was 48 km.p.h. [30 m.p.h.], it was dark but lighted, raining and the asphalt road surface was wet. The paved road surface was 9.1 meters [29.8 feet] wide, with concrete curbs on both sides. The police crash report made no mention of any attempted avoidance maneuvers taken by the case vehicle's driver. The EDR indicated that the driver braked a few seconds prior to the impact. The crash occurred in the northbound lane of the roadway (**Figure 1**).

The case vehicle's front right area impacted the front of the parked Toyota, causing the case vehicle's driver and front right passenger air bags to deploy. After the initial impact, the case vehicle pushed the Toyota northwestward before the vehicles separated. The case vehicle came to a final rest in the northbound portion of the roadway heading north, approximately 22 meters [72.2 feet] from the point of impact. The Toyota was pushed northwestward and came to a rest straddling the west curb heading northeast.

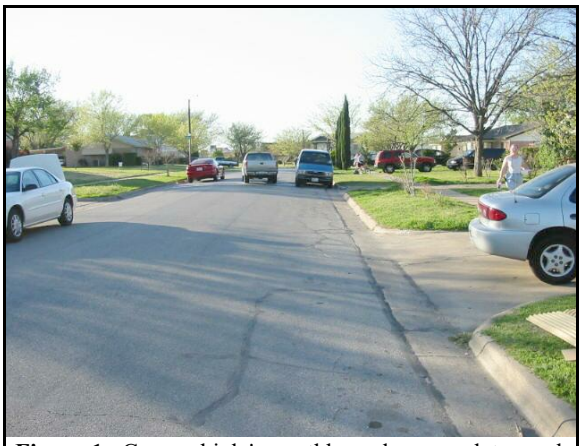


Figure 1: Case vehicle's northbound approach toward impact with Toyota pickup parked heading south along the right (east) curb (case photo #01)

CASE VEHICLE

The case vehicle was a 2001 Buick LeSabre Custom front wheel drive, four-door, six-passenger sedan (VIN: 1G4HP54K014------), equipped with a 3.8 liter V6 gasoline engine and an automatic transmission with a column-mounted selector lever. The case vehicle was equipped with four wheel anti-lock brakes. Traction control was an option for this model, but it is not known if the case vehicle was so equipped. The case vehicle was fitted with multi-stage frontal air bags, seat back-mounted side impact air bags and integrated manual safety belts for the two front outboard seat positions. Its specification wheelbase was 285 centimeters [112.2 inches] and

the odometer reading is not known due to the non-functional electronic instrument panel. The case vehicle was towed due to disabling damage.

The case vehicle's initial contact with Toyota involved the front right bumper, grille and hood (**Figure 2**). Direct damage began at the right front bumper corner and extended a measured distance of 124 centimeters [48.9 inches] along the front bumper. All crush measurements were taken on the steel bumper as there was a significant gap between the bumper and bumper fascia, except C1 was taken on bumper fascia. Maximum crush was measured as 35 centimeters [13.8 inches] at C6. The case vehicle's front right bumper, bumper fascia, right headlamp/turn signal assembly, grille, hood, and radiator were directly damaged and crushed rearward (**Figure 3**). None of the tires/wheels were damaged or restricted and there was no glazing damage. The left headlight/turn signal assembly was slightly displaced and the left fender was undamaged.

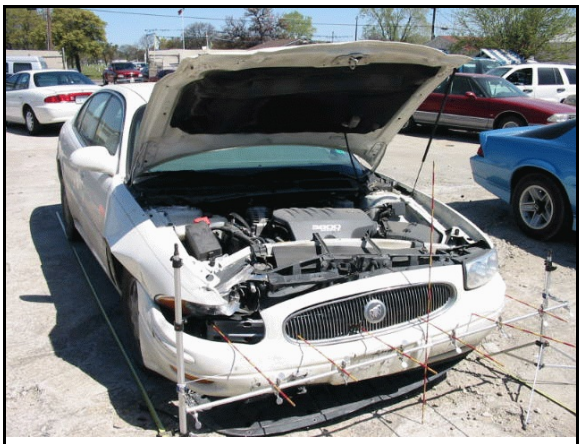


Figure 2: Case vehicle's front right damage area (case photo #25)

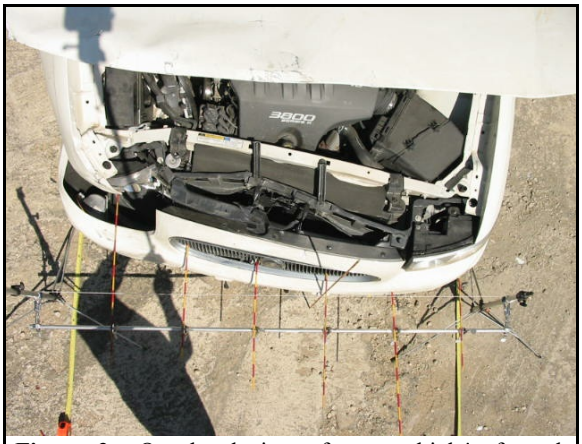


Figure 3: Overhead view of case vehicle's frontal damage (case photo #16)

Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDEW-2 (0)**. The WinSMASH reconstruction program, missing vehicle algorithm based on the case vehicle's crush profile, was used on the case vehicle's single impact. The total, longitudinal, and lateral delta Vs for the case vehicle are, respectively: 17.0 km.p.h. [10.6 m.p.h.], -17.0 km.p.h. [-10.6 m.p.h.], and 0 km.p.h. [0 m.p.h.]. These results should be viewed as borderline but reasonable. The crash severity for the case vehicle was low (14 - 23 km.p.h. [9 - 14 m.p.h.]).

Inspection of the case vehicle's interior indicated no readily apparent evidence of occupant contact on the interior surfaces. The case vehicle was equipped with integral restraints at the two front seat outboard positions, both with a sewn-on latch plate. The driver's safety belt showed creases in the webbing at the approximate area where the belt passed into the seat back, which indicate that the belt was in use and was loaded by the driver's inertial force. There was no evidence of loading on the front right passenger's belt.

The case vehicle was equipped with frontal and seat back mounted side impact air bags at the two front seat outboard positions, for a total of four air bags. The two frontal air bags deployed and the two side impact air bags did not.

The case vehicle's driver air bag was located in the steering wheel hub (**Figure 4**). Inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points and there was no evidence of damage to the air bag or the cover flaps. The driver's air bag had four tether straps, each 7.5 centimeters [3 inches] wide, and two vent ports, 3.5 centimeters [1.4 inches] in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was round with a diameter of 64 centimeters [25.2 inches]. There was no contact evidence apparent on the driver's air bag.

The front right passenger's air bag was located in the mid-mount position, on the front of the instrument panel, in a configuration that the manufacturer refers to as an "active instrument panel". There was no module cover flap as such. Rather, as the deploying air bag expands, it forces the top of the instrument panel upward, causing the points of attachment to break away and creating an opening between the horizontal top and the vertical front of the instrument panel. The air bag deploys through this opening (**Figure 5**). The deployed front right air bag was rectangular, measuring 55 centimeters [21.7 inches] vertically and 35 centimeters [13.8 inches] horizontally. The front right passenger's air bag had one tether, measuring 34 centimeters [13.4 inches], and two vent ports, each 4.5 centimeters [1.8 inches] in diameter, located at the 9:30 and 2:30 o'clock positions. There was no contact evidence apparent on the front right passenger's air bag (**Figure 6**).

Figure 4: Front of driver's air bag (case photo #40)

Figure 5: Deployed front right passenger air bag, showing displaced top of "active instrument panel" (case photo #49)

Figure 6: Front of passenger's air bag (case photo #44)

The case vehicle's Event Data Recorder (EDR) was successfully downloaded in the field via the diagnostic port. The Sensing and Diagnostic Module (SDM) report is included as **Figures 8, 9 and 10**. The SDM report indicates that the SIR Warning Lamp Status was OFF, the driver's belt was buckled and the deployment event took place during ignition cycle 4,957 (**Figure 8**). The case vehicle was traveling at 64 km.p.h. [40 m.p.h.] with zero throttle five seconds prior to the impact. At approximately four seconds prior, the driver applied the brakes and the vehicle slowed to 60 km.p.h. [37 m.p.h.] at one second prior to the impact (**Figures 8** and **9**). The case vehicle driver and front right passenger air bags were equipped with multi-stage inflators. The SDM report indicates that the command for first stage deployment for both air bags was issued at 12.5 milliseconds [0.0125 seconds] after algorithm enable, and the criteria for second stage deployment was not met (**Figure 8**). The SDM report indicates that the maximum recorded velocity change was -24.2 km.p.h. [-15.05 m.p.h.], at 107.5 milliseconds [0.1075 seconds] after algorithm enable (**Figure 8**). The velocity change data show deltaV accumulating gradually to the maximum at approximately 110 milliseconds following algorithm enable, after which recording ceased (**Figures 8** and **10**). The SDM recorded velocity change is 7.2 km.p.h. [4.5 m.p.h.] greater than the WinSMASH missing vehicle calculated deltaV for the case vehicle.

CASE VEHICLE DRIVER'S KINEMATICS

The case vehicle's driver (37-year-old male, white, unknown if Hispanic, height and weight unknown) refused to take a blood alcohol breath test and was cited by the police for driving while intoxicated. He also refused to be interviewed for this research investigation. He was seated in an unknown posture, probably with his left foot on the floor, his right foot on the foot controls and at least one hand on the steering wheel. At the inspection, his seat track was located between the middle and rearmost positions, the seat back was sightly reclined, and the tilt steering wheel was adjusted between its middle and down-most positions. The driver was restrained by his available, active, integrated, three-point, lap-and-shoulder safety belt system. The inspection of the driver's seat belt webbing showed evidence of loading (**Figure 7**).

The case vehicle driver braked at approximately four seconds prior to the impact. There were no skid marks at the crash scene. The driver probably moved slightly forward in response to this braking deceleration. The case vehicle's impact with the Toyota caused the case vehicle's driver to continue forward, toward the case vehicle's 12 o'clock direction of force. This was in impact of low severity and he did not load the safety belt heavily. He probably encountered the deployed air bag with his face and chest and likely rebounded rearward as the vehicle traveled to final rest.

Figure 7: Driver's safety belt webbing and integrated retractor port (case photo #34)

According to the police crash report, the case vehicle's driver did not sustain any injuries as a result of this crash and was not transported. The driver was not interviewed and it is not known if he sought medical treatment or sustained any specific injuries.

CASE VEHICLE FRONT RIGHT PASSENGER'S KINEMATICS

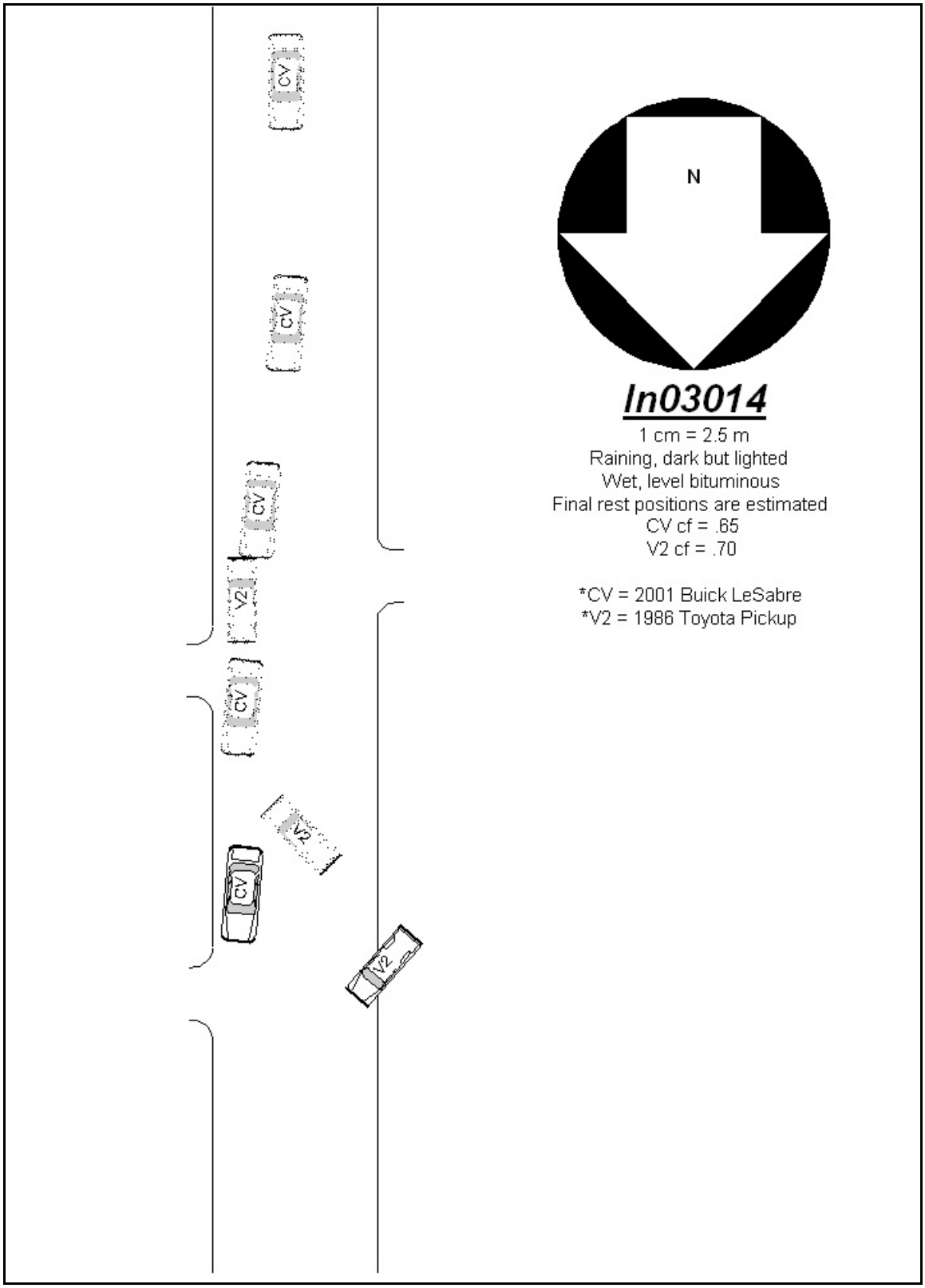
The case vehicle's front right passenger (34-year-old, female, race, ethnicity, height and weight unknown at this time) was seated in an unknown posture and her feet/hands in unknown positions. At the inspection, her seat track was located between the middle and rearmost positions and the seat back was sightly reclined. The case vehicle's front right passenger was not using her available, active, integrated, three-point, lap-and-shoulder safety belt system. No evidence of usage was found on her safety belt system.

The case vehicle driver braked at approximately four seconds prior to the impact. The front right passenger probably moved forward slightly in response to the braking deceleration. The impact with the Toyota caused her to move further forward, toward the 12 o'clock direction of force. This was an impact of low severity and, although she was not restrained, she probably encountered the deployed air bag with her face and chest and rebounded rearward as the vehicle traveled to final rest.

According to the police crash report, the front right passenger did not sustain any injuries from this crash and was not transported. It is not known if she sought treatment or sustained any specific injuries.

OTHER VEHICLE

The other vehicle was a 1986 Toyota rear wheel drive, long bed/long wheelbase, two-door mini-pickup truck (VIN: JT4RN55R2G0------). This vehicle was legally parked and unoccupied (i.e., not in transport). The Toyota could not be located and was not inspected. With no available vehicle photographs, a CDC for the Toyota cannot be estimated. The WinSMASH reconstruction program, missing vehicle algorithm based on the case vehicle's crush profile, was used on the Toyota's impact. The total, longitudinal, and lateral delta Vs for the Toyota are, respectively: 26.0 km.p.h. [16.2 m.p.h.], -26.0 km.p.h. [-16.2 m.p.h.], and 0 km.p.h. [0 m.p.h.]. The crash severity for the Toyota was moderate (24 - 40 km.p.h. [15 - 25 m.p.h.]).


CV
CV
CV
V2
CV
CV
V2
V2
N
In03014
1 cm = 2.5 m
Raining, dark but lighted
Wet, level bituminous
Final rest positions are estimated
CV cf = .65
V2 cf = .70
*CV = 2001 Buick LeSabre
*V2 = 1986 Toyota Pickup

1G4HP54K014[redacted] System Status At Deployment	
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Deployment	4957
Ignition Cycles At Investigation	4961
Maximum SDM Recorded Velocity Change (MPH)	-15.05
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	107.5
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	12.5
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	12.5
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Time Between Non-Deployment And Deployment Events (sec)	N/A
Frontal Deployment Level Event Counter	1
Event Recording Complete	Yes
Multiple Events Associated With This Record	No
One Or More Associated Events Not Recorded	No

Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.62	-1.55	-3.10	-5.27	-6.51	-8.99	-10.85	-12.71	-13.95	-14.57	-14.88	N/A	N/A	N/A	N/A

PRE-CRASH DATA				
Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	40	1536	0	OFF
-4	40	1536	0	ON
-3	39	1408	0	ON
-2	38	1024	0	ON
-1	37	832	0	ON

Figure 8: Sensing and Diagnostic Module (SDM) System Status at Deployment Report

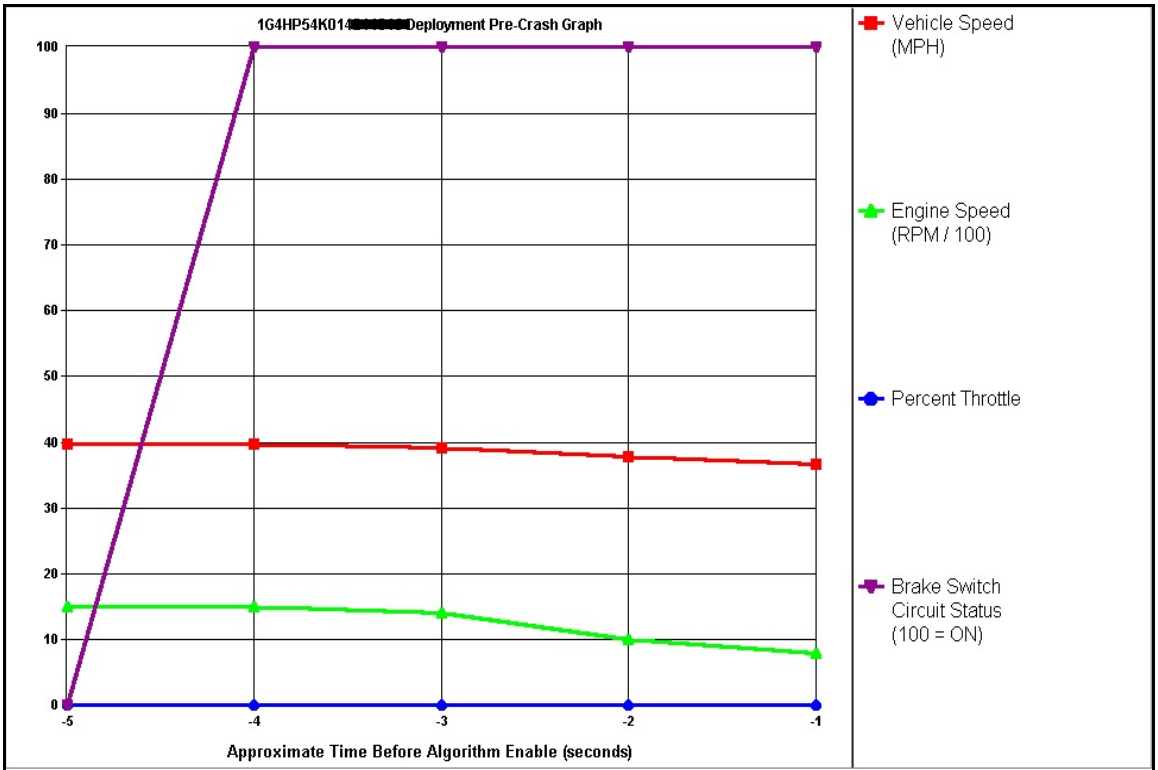


Figure 9: SDM Deployment Pre-Crash Graph, depicting pre-crash data presented in Figure 8

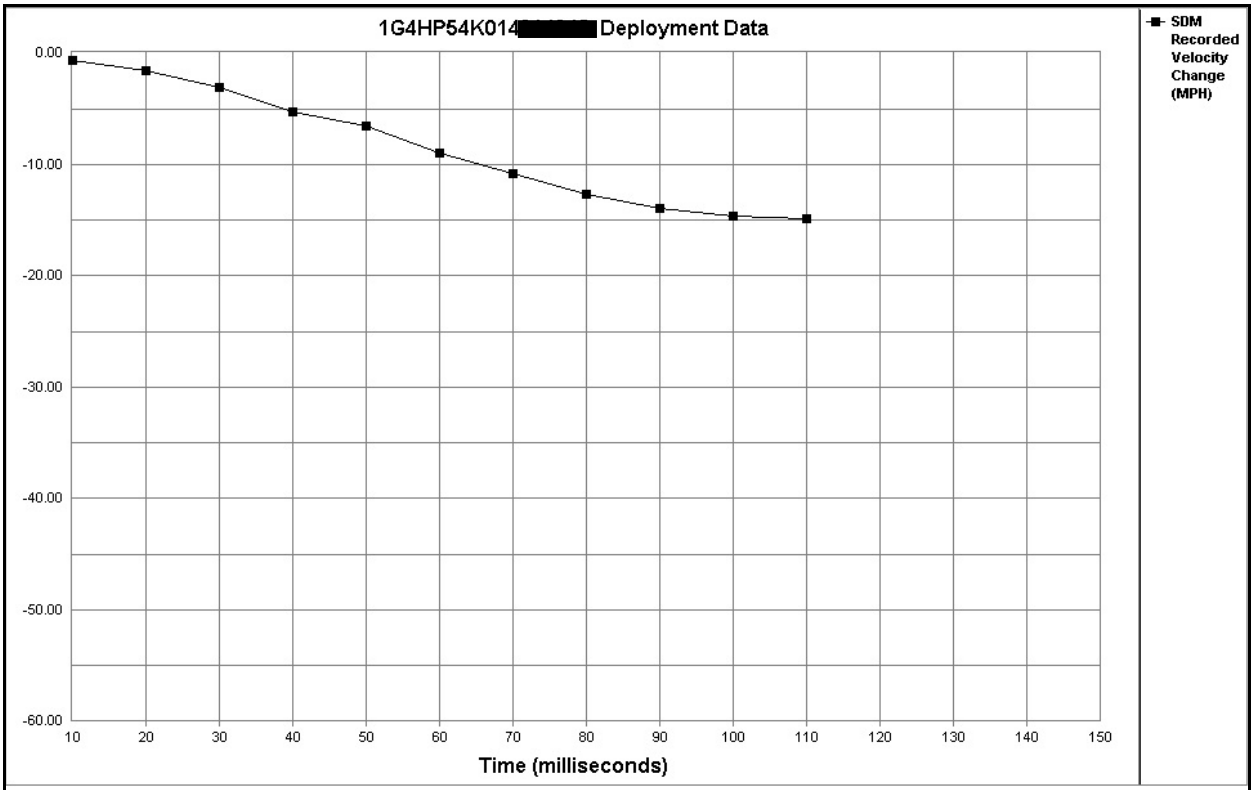


Figure 10: SDM Deployment Data Graph, depicting velocity change data presented in Figure 8