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ON-SITE ADVANCED OCCUPANT PROTECTION SYSTEM INVESTIGATION

CASE NUMBER - IN-04-004
LOCATION - OKLAHOMA
VEHICLE - 2004 SATURN ION
CRASH DATE - January 2004

Submitted:

September 18, 2007

Contract Number: DTNH22-01-C-07002

Prepared for:

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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 air bag deployment investigation involving a 2004 Saturn Ion, four-door sedan, with manual safety belts and dual front air bags, which ran-off-road striking multiple fixed objects

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 2004 Saturn Ion (case vehicle) which ran-off-road striking multiple fixed objects. This crash became of special interest because the case vehicle was equipped with multiple **A**dvanced **O**ccupant **P**rotection **S**ystem (**AOPS**) features, as well as an **E**vent **D**ata **R**ecorder (**EDR**) and, the fact that all three of the case vehicle's unrestrained, 17-year-old, male occupants sustained critical injuries, resulting in their deaths. The trafficway on which the case vehicle was traveling was a two-lane, undivided, city roadway, traversing in a north-south direction. The case vehicle was traveling north in the northbound lane at a police-estimated, very high rate of speed. The case vehicle crested a hill and was traveling on a downgrade when the driver lost control and departed the roadway onto the west roadside. The crash sequence began when the front left of the case vehicle impacted a vertical metal fence post. The case vehicle continued through the post and, almost immediately, the left front fender impacted a medium sized tree (2nd event), most likely causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle was redirected slightly to its right but struck another metal fence post (3rd event) before impacting a large tree with its front (4th event). After the collision with the second tree, the back end of the case vehicle elevated, causing damage to the roof (5th event). None of the occupants used their available, active, three-point, lap-and-shoulder, safety belt systems. The driver was seated with his seat track located at its rearmost position, and the position of the tilt steering wheel could not be determined because of the severity of damage. He sustained, according to his non-invasive, post-mortem examination records, rib fractures with a flail chest and fractures of his right medial malleolus and nose. The front passenger was seated with his seat track located in its rearmost position, and he sustained, according to his non-invasive, post-mortem examination records, right rib fractures with bilateral hemothoraces, a fracture and dislocation to his left elbow, and nasal fractures. Furthermore, he sustained lacerations over both eyes and both index (2^{nd}) fingers. The back left passenger was seated but his seat track and seat back were not adjustable. He sustained, according to his hospital records and his non-invasive, post-mortem examination, a nonanatomic brain injury; an unknown thoracic cavity injury with left hemothorax; and fractures to his left femur, right tibial condyle, mid-shaft left tibia, left medial malleolus, and his teeth. In addition, all three occupants sustained multiple soft tissue injuries.

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This investigation was brought to NHTSA's attention on January 28, 2004 by an individual with the Transportation Safety Institute in Oklahoma City. This crash involved a 2004 Saturn Ion (case vehicle) which ran-off-road striking multiple fixed objects. The crash occurred in January 2004, at 5:20 p.m., in Oklahoma and was investigated by the applicable city police department. This crash was initially of special interest because the case vehicle was thought to be equipped with multiple **A**dvanced **O**ccupant **P**rotection **S**ystem (**AOPS**) features**,** including certified advanced 208-compliant air bags**,** as well as an **E**vent **D**ata **R**ecorder (**EDR**). However, it was determined later that the case vehicle was not Certified Advanced 208-Compliant and, therefore, the special interest involves the case vehicle's AOPS features and the fact that all three of the case vehicle's occupants–driver [17-year-old, White (non-Hispanic) male], front right passenger [17-year-old, White (non-Hispanic) male], and back left passenger [17-year-old, Black (non-Hispanic) male] sustained critical injuries in this crash, resulting in their deaths. This contractor inspected the scene and vehicles on 2-3 February 2004 and received from the investigating police agency, a download of the data from the onboard **EDR**. This contractor met the father of the case vehicle's driver on 2 February 2004 during our vehicle inspection and obtained occupant height and weight information. This report is based on the Police Crash Report, a conversation with the father of the case vehicle's driver, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The traffic-way on which the case vehicle was traveling was a two-lane, undivided, city roadway, traversing in a north-south direction. At the time of the crash the light condition was daylight, the atmospheric condition was snowing (i.e., according to the Police Crash Report, it had just began to snow), and the roadway pavement was most likely wet; see **CRASH DIAGRAM** at end.

The case vehicle was traveling north in the northbound lane at a police-estimated, very high rate of speed and intended to continue straight ahead. The case vehicle had just crested a hill and was traveling on a downgrade measured at approximately 4% negative to the north. The case vehicle's driver lost control on the downgrade and crossed the centerline into the southbound lane, depositing curvilinear marks as he traveled toward the west roadside. The case vehicle departed the roadway to its left, onto the west roadside, and continued along the roadside in a north-northwesterly direction. The grade of the roadway had decreased to approximately 1.5% percent negative to the north at the approximate area where the case vehicle departed the roadway. The crash occurred off the roadway on the western roadside.

The crash sequence began when the front left of the case vehicle impacted a vertical metal fence post. The case vehicle continued through the post and, almost immediately, the left front fender impacted a medium sized tree (2nd event), most likely causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Based on the downloaded **EDR** data, only one stage of the multi-stage air bags was activated. The case vehicle was redirected slightly to its right but struck another metal fence post (3rd event) before impacting a large tree with its front (4th event). The impact with the large tree was so severe that, according to the Police

Crash Report, both front wheels were separated from the vehicle and continued forward a substantial distance. After the collision with the second tree, the back end of the case vehicle elevated, but its upward movement was constricted by the top horizontal rail of the fence (5th event), causing damage to the roof.

As a result of the impact sequence, the case vehicle came to rest against the second tree, heading in a north-northwesterly direction. The case vehicle's two front wheels were found in a wooded area, approximately 27-37 meters (30-40 yards) further to the northwest. The engine block was also knocked out of the vehicle.

The 2004 Saturn Ion (level 3) was a front wheel drive, four-door sedan (VIN: 1G8AK52F94Z------) equipped with **ADVANCED OCCUPANT PROTECTION SYSTEM** features. Four-wheel, anti-lock brakes and traction control were options on the case vehicle but, because of the damage, it could not be determined if this vehicle was so equipped. The case vehicle was equipped with dual stage driver and front right passenger air bag inflators and driver and front right passenger seat belt buckle switch sensors. In addition, the case vehicle was equipped with LATCH system features. Furthermore, left and right side impact inflatable occupant protection systems (head curtain air bags) were an option on the case vehicle but it was not so equipped. Finally, the case vehicle was also equipped with an **E**vent **D**ata **R**ecorder (**EDR**). It was thought, initially, that the case vehicle was **CERTIFIED ADVANCED 208-COMPLIANT**; however, it was not.

Based on the vehicle inspection and available photographs, the CDCs for the case vehicle were determined and/or estimated to be–in sequential order: **12-F9EN-99** (**0** degrees–1st event with fence post), **99-LYA9-99** (**999** degrees–2nd event with 1st tree), **12-F9EN-99** (**0** degrees–3rd event with fence post), **12-FYAW-6** (**0** degrees–4th event with 2nd tree), and **00-TPLN-99** (**320** degrees–5th event with fence rail). The WinSMASH reconstruction program, barrier algorithm, was used on the case vehicle's highest severity (4th) impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 112.8 km.p.h. (70.1 m.p.h.), -112.8 km.p.h. (-70.1 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The case vehicle was towed due to damage.

The data downloaded from the case vehicle's **EDR** showed the case vehicle was traveling at a speed in excess of 145 km.p.h. (90 m.p.h.), the driver's seat belt status showed it was not buckled, the second stage of the multi-stage air bags was not activated, and the Delta V reached a value of 36.02 km.p.h. (22.38 m.p.h.) at the 120 millisecond mark of recorded data. These data occurred during the case vehicle's 2nd event (i.e., the impact with the 1st tree).

The driver of the vehicle [17-year-old, White (non-Hispanic) male] was seated with his seat track located at its rearmost position, and the position of the tilt steering wheel could not be determined because of the severity of damage. He was not using his available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to his non-invasive, post-mortem examination records, rib fractures with a flail chest and fractures of his right medial malleolus and nose. In addition, he sustained abrasions and lacerations about his face and neck, a chest abrasion, and multiple soft tissue injuries over his upper and lower extremities.

The front passenger [17-year-old, White (non-Hispanic) male] was seated with his seat track located in its rearmost position and was not using his available, active, three-point, lap-and-shoulder, safety belt system. He sustained, according to his non-invasive, post-mortem examination records, right rib fractures with bilateral hemothoraces, a fracture and dislocation to his left elbow, and nasal fractures. Furthermore, he sustained lacerations over both eyes and near complete amputative lacerations of his right and left index (2nd) fingers. In addition, he had multiple soft tissue injuries to his face, neck, chest, abdomen, right scapular area, and upper and lower extremities.

The back left passenger [17-year-old, Black (non-Hispanic) male] was seated but his seat track and seat back were not adjustable. He also was not using his available, active, three-point, lap-and-shoulder, safety belt system. He sustained, according to his hospital records and his non-invasive, post-mortem examination, a nonanatomic brain injury; an unknown thoracic cavity injury with left hemothorax; and fractures to his left femur, the condylar area of his right tibia, his left tibia mid-shaft, his left medial malleolus, and his teeth. In addition, he sustained multiple soft tissue injuries to his head, face, chest, bilateral distal forearms, and bilateral lower extremities.

Figure 1: Case vehicle's northward path of travel in northbound lane after cresting hill; arrow indicates approximate area of impacts following roadside departure (case photo #03)

Figure 2: Southward view of case vehicle's northward travel path from hill crest across southbound lane and onto western roadside (case photo #11)

CRASH CIRCUMSTANCES

Crash Environment: The traffic-way on which the case vehicle was traveling was a two-lane, undivided, city roadway, traversing in a north-south direction (**Figure 1**). The city roadway was straight and had a 4.0% grade negative to the north (i.e., a downgrade in the case vehicle's direction of travel), near the area of impact (**Figure 2**). The pavement was bituminous, but traveled, and the width of both the northbound and southbound travel lanes was 3.0 meters (10 feet). The shoulders were essentially not improved (i.e., grass), except for an section along the eastern shoulder on the north side of the hill crest with an estimated 15-20 centimeters (6-8 inches) of bituminous surface prior to the grassy area (**Figure 1**). The roadway was not bordered by curbs. Pavement markings consisted of a double solid yellow centerline for both north and southbound traffic. In addition, solid white edge lines were present. The estimated coefficient of friction was 0.40. Traffic controls consisted of a regulatory **SPEED LIMIT** sign (Manual on Uniform Traffic Control Devices, R2-1) which was located just north of the hill crest for

northbound traffic. The posted speed limit was 80 km.p.h. (50 m.p.h.). At the time of the crash the light condition was daylight, the atmospheric condition was snowing (i.e., according to the Police Crash Report, it had just began to snow), and the roadway pavement was most likely wet. Traffic density was light, and the site of the crash was primarily urban undeveloped; see **CRASH DIAGRAM** at end.

Pre-Crash: The case vehicle was traveling north in the northbound lane at a police-estimated, very high rate of speed and intended to continue straight ahead. The case vehicle had just crested a hill and was traveling on a downgrade measured at approximately 4.0% negative to the north (**Figure 2** above). The case vehicle's driver lost control on the downgrade and crossed the centerline into the southbound lane, depositing curvilinear marks as he traveled toward the west roadside (**Figure 3**). The case vehicle departed the roadway to its left, onto the west roadside (**Figure 2** above), and continued along the roadside in a north-northwesterly direction (**Figure 4**). The grade of the roadway had decreased to approximately 1.5% percent negative to the north at the approximate area where the case vehicle departed the roadway. No physical evidence was found at the crash scene to indicate what, if any, action the case vehicle's driver took attempting to avoid the crash, but based on the **EDR** data, the brake switch was briefly activated shortly after the case vehicle traversed the hill crest, and the driver most likely attempted to steer to his right in an effort to regain control of the vehicle. The crash occurred off the roadway on the western roadside.

Crash: Based upon the Police Crash Report and our investigation, the crash sequence began when the front left (**Figure 5**) of the case vehicle impacted a vertical metal fence post (1st event– **Figure 6** below). The case vehicle continued through the post and almost immediately the left front fender impact a medium sized tree (2nd

Figure 3: Curved marks (highlighted) from case vehicle's right side tires as vehicle travels northward in southbound lane heading off road onto west roadside and impact area (arrows) with fence rail and trees (case photo #03b)

Figure 4: Case vehicle's northward travel path on west roadside toward area of impact with fence post and rail and trees (case photo #05)

Figure 5: Case vehicle's left side damage from impact with fence rail and deployment impact with 1st tree (case photo #12)

event–**Figures 6** and **7**), most likely causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Based on the downloaded **EDR** data, only one stage of the multi-stage air bags was activated. The case vehicle was redirected slightly to its right but struck another metal fence post (3rd event–**Figure 6**) before impacting a large tree with its front (4th event–**Figures 6** and **8**). The impact with the large tree was so severe that, according to the Police Crash Report, both front wheels were separated from the vehicle and continued forward a substantial distance. At this point, the case vehicle was still oriented in a north-northwesterly direction. After the collision with the second tree, the back end of the case vehicle elevated, but its upward movement was constricted by the top horizontal rail of the fence (5th event–**Figure 8**), causing damage to the roof (**Figure 9**).

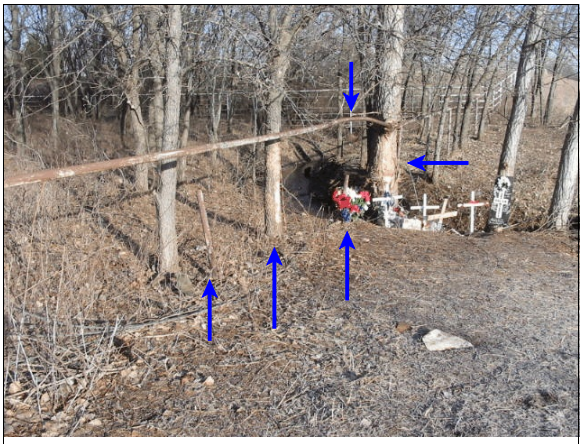


Figure 6: Case vehicle's area of impact with fence post and rail and trees; an arrow marks each of the five identified impacts (case photo #06)

Figure 7: Close-up of 1st tree impacted (2nd event) by case vehicle; this impact was most likely the deployment impact (case photo #07)

Figure 8: Close-up of 2nd tree impacted (4th event) by case vehicle; arrows show impact with fence post, blue arrow–3rd event, and fence rail, red arrow–5th event (case photo #09)

Figure 9: Damage to case vehicle's roof, removed by rescue personnel, showing indentation over driver's seating area from contact with horizontal portion of fence pole; Note: separated engine block in background (case photo #16)

Post-Crash: As a result of the impact sequence, the case vehicle came to rest against the second tree, heading in a north-northwesterly direction. According to the Police Crash Report, the case vehicle's two front wheels were found in a wooded area, approximately 27-37 meters (30-40 yards) further to the northwest. The engine block was also knocked out of the vehicle (**Figure 9**).

The 2004 Saturn Ion (level 3) was a front wheel drive, five-passenger, four-door sedan vehicle (VIN: 1G8AK52F94Z------) equipped with a 2.2L, I-4 engine and a five-speed manual transmission. Braking was achieved by a power-assisted, front disc and rear drum system. Four-wheel, anti-lock brakes and traction control were options on the case vehicle but, because of the damage, it could not be determined if this vehicle was so equipped. The case vehicle's wheelbase was 262 centimeters (103.2 inches), and the odometer reading at inspection was unknown because the case vehicle was equipped with an electronic odometer.

It was thought, initially, that the case vehicle was **CERTIFIED ADVANCED 208-COMPLIANT**; however, it was not. The case vehicle was equipped with **ADVANCED OCCUPANT PROTECTION SYSTEM** features including dual stage driver and front right passenger air bag inflators and driver and front right passenger seat belt buckle switch sensors. In addition, the case vehicle was equipped with height-adjustable front shoulder belts with pretensioners and energy-absorbing retractors and LATCH system features. Furthermore, left and right side impact inflatable occupant protection systems (head curtain air bags) were an option on the case vehicle but it was not so equipped. Finally, the case vehicle was also equipped with an **E**vent **D**ata **R**ecorder (**EDR**).

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable split back bench seat with folding backs and integral head restraints for the back outboard seating positions; and continuous loop, three-point, lap-and-shoulder, safety belt systems at all five front and back positions. The front seat belt systems were equipped with manually operated, upper anchorage adjusters for the "D"-rings. Both the driver and front right passenger had their upper anchorage adjusters located in the upmost positions. The vehicle was equipped with knee bolsters for both the driver and front right passenger. The area of the driver's knee bolster was so damaged from intrusion and deformation that occupant contacts could not be determined. On the passenger side, the glove box door in the front right seating position had been contacted, but it could not be determined if there were occupant contacts to the front right knee bolster. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of an advanced frontal air bag for the driver and front right passenger seating positions. In addition, the vehicle was equipped with side-inflatable curtain air bags which extend from each of the roof side rails. Both frontal air bags deployed as a result of the case vehicle's frontal impact with the medium size tree (2nd event). Neither of the case vehicle's side inflatable curtains deployed as a result of the case vehicle's frontal impacts with the assorted fixed objects.

Figure 10: Frontal view of case vehicle's severely damaged front end; Note: engine was knocked out during impact with 2nd tree (case photo #14)

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's initial contact with 1st fence post most likely involved the front left corner. Because of the magnitude of the crash and damage, it cannot be determined exactly

which components were involved and where damage began (**Figure 10** above). For the sake of this contractor's reconstruction, our focus will be on the impact with the 2nd (large) tree. Crush measurements were taken at the actual metal bumper, which was split in the center from the 2nd tree impact. Direct damage is estimated to have started near the front left bumper corner and extended for 48 centimeters (18.9 inches) along the bumper to the right. Residual maximum crush at the bumper was measured as 159 centimeters (62.6 inches) at C_3. The table below shows the case vehicle's 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	4	48	159	136	94	148	159	139	101	37	-10	0
in		18.9	62.6	53.5	37.0	58.3	62.6	54.7	39.8	14.6	-3.9	0.0

Because of the case vehicle's severe damage, no attempt was made to estimate the crush from the impact with the 1st (small) tree (**Figure 5** above), which is believed to be the deployment event. The wheelbase on the case vehicle's left side was shortened approximately 22 centimeters (8.7 inches) while the right side was shortened approximately 4 centimeters (1.6 inches). The case vehicle's front bumper, bumper fascia, grille, radiator, hood, left and right headlight and turn signal assemblies, and left fender were directly damaged and crushed rearward. There was catastrophic damage to essentially the entire front end of the case vehicle, with few components remaining. Both front wheel assemblies were sheared off with the wheels continuing forward as discussed above. The engine block was separated from the engine compartment (**Figure 9** above). The contact to the fence rail directly damaged the left side of the roof (**Figure 9** above), left roof side rail, left "A"-pillar, and left windshield header (**Figure 5** above). There was induced damage to the hood, right fender, and right front and rear doors (**Figure 11**) as well as both the left front and rear window glazings. The roof also sustained induced damage and the windshield was heavily damaged and only slightly attached to the windshield frame, but this damage was likely because of the extrication and rescue efforts after the crash. The roof was cut off at the "A", "B", and "C"-pillars.

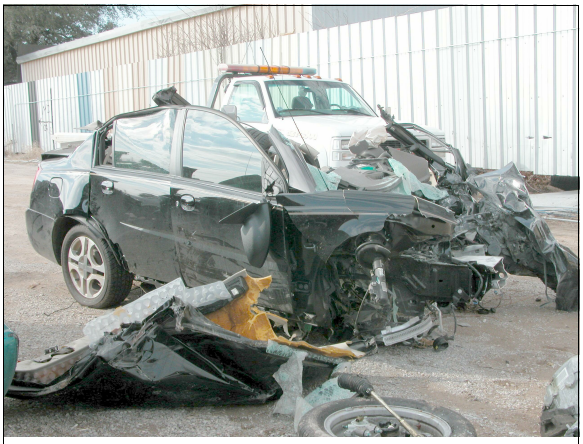


Figure 11: Case vehicle's frontal damaged viewed from right of front; Note: engine missing and roof removed during extrication (case photo #15)

The recommended tire size was: P205/55R16, and the case vehicle tires were the recommended size. The case vehicle's tire data are shown in the table below. In addition, the case vehicle's left rear wheel was rotated 90 degrees inward while the right rear tire was intact.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32nd of an inch			
LF	0	0	207	30	7	9	Large slice on side; detached at scene	No	Yes
RF	152	22	207	30	8	10	None; detached at scene	No	No
LR	Unk	Unk	207	30	8	10	Unseated from rim; distorted from crash	Yes	No
RR	159	23	207	30	8	10	None	No	No

Figure 12: Elevated view from left of case vehicle's front seating area showing damage/intrusion; Note: deformed steering wheel rim and deployed driver air bag (case photo #18)

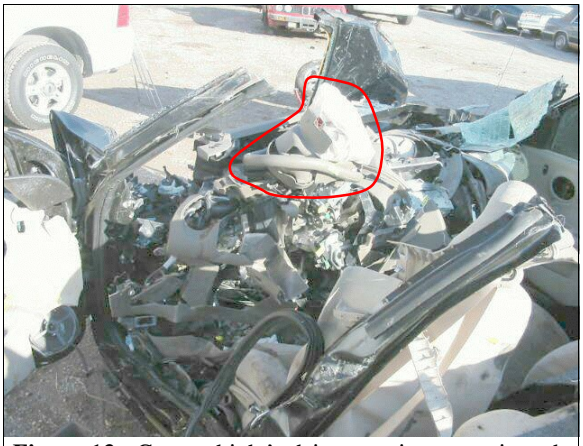


Figure 13: Case vehicle's driver seating area viewed from behind left "B"-pillar showing intrusions and contact evidence; Note: deformed steering wheel and deployed driver air bag (case photo #20)

Figure 14: Interior surface of case vehicle's driver front door showing evidence of occupant contact (case photo #25)

Figure 15: Contact evidence on case vehicle's center instrument panel area; Note: deployed front right passenger air bag (case photo #23)

Interior Damage: Inspection of the case vehicle's interior revealed major interior damage and intrusion because of the severity of the crash (**Figures 12** and **13** above). Numerous occupant contacts were found including the left front door panel, left door armrest (**Figure 14** above), steering wheel rim, steering column, brake pedal, center instrument panel (**Figure 15** above), glove box door (**Figure 16**), left front seat back (**Figure 17**) and driver's adjustable head rest (**Figure 18**).

Figure 16: Case vehicle's front right passenger seating area showing deployed front right passenger air bag, intrusions, and contact evidence; Note: contacts to center instrument panel and "hole" in glove box door (case photo #24)

Figure 17: Back surface of case vehicle's driver seat back showing contact evidence from impact by back left occupant (case photo #27)

Figure 18: Close-up of back surface of adjustable head restraint for case vehicle's driver showing distortion and damage caused by contact from back left occupant; Note: distorted steering wheel rim in background (case photo #48)

There were multiple intrusions to the case vehicle's interior. For the driver's area, the intrusions included: the toe pan, the accelerator pedal, the left "A"-pillar, the left instrument panel, the left floor pan (vertically), the left "B"-pillar (laterally), and the driver's seat back and head restraint (longitudinally forward). The center instrument panel and the driver's seat (laterally) intruded into the front center space, and the right instrument panel and the right toe pan intruded into the front right passenger area. There were most likely intrusions from the roof and windshield header areas as well but, because of the extrication efforts, these could not be measured. The steering wheel rim was totally collapsed, and finally, the steering column compression could not be determined because of the severity of longitudinal intrusions.

Damage Classification: Based on the vehicle inspection and available photographs, the CDCs for the case vehicle were determined and/or estimated to be–in sequential order: **12-F9EN-99** (**0** degrees–1st event with fence post, **Figure 6** above), **99-LYA9-99** (**999** degrees–2nd event with 1st tree, **Figure 7** above), **12-F9EN-99** (**0** degrees–3rd event with fence post, **Figure 8** above), **12-FYAW-6** (**0** degrees–4th event with 2nd tree, **Figure 8** above), and **00-TPLN-99** (5th event with fence rail, **Figure 8** above). The WinSMASH reconstruction program, barrier algorithm, was

used on the case vehicle's highest severity (4th) impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 112.8 km.p.h. (70.1 m.p.h.), -112.8 km.p.h. (-70.1 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). Based on the vehicle inspection and because of the overlapping damage from the three different frontal impacts, this collision reconstruction should be considered borderline, and the results may be high. The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained dual stage frontal air bags at the driver and front right passenger positions. Both frontal air bags deployed as a result of the frontal impact with the 1st (small) tree. Only one stage of the multi-stage air bags was activated.

The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of symmetrical "I"-configuration cover flaps made of medium thickness vinyl with overall dimensions of 6.5 centimeters (2.6 inches) at the left and right horizontal seams and 13.5 centimeters (5.3 inches) vertically. An inspection of the air bag module's cover flaps and the air bag's fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two tethers, each approximately 11 centimeters (4.3 inches) in width. The driver's air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was round with a diameter of 57 centimeters (22.4 inches). An inspection of the driver's air bag fabric revealed obvious contact evidence and damage on the front surface of the air bag's fabric (**Figure 19**). There was a large tear in the bag starting from the outside seam at approximately the 11 o'clock position and extending approximately 30 centimeters (11.8 inches) primarily to the right and slightly downward just past the vertical center of the bag's face (**Figure 20**). A smaller tear/hole, 5 centimeters (2.0 inches) was found at the outer edge at approximately the 1 o'clock position and another tear/hole, 7.6 centimeters (3.0 inches), was found also at the outer edge at the 6 o'clock position. A number of small holes, all 0.6 centimeters (0.25 inches) or less, were found in the

Figure 19: Front surface of case vehicle's deployed driver air bag showing contact evidence near center in lower left quadrant and tear in air bag's fabric in upper left quadrant (case photo #30)

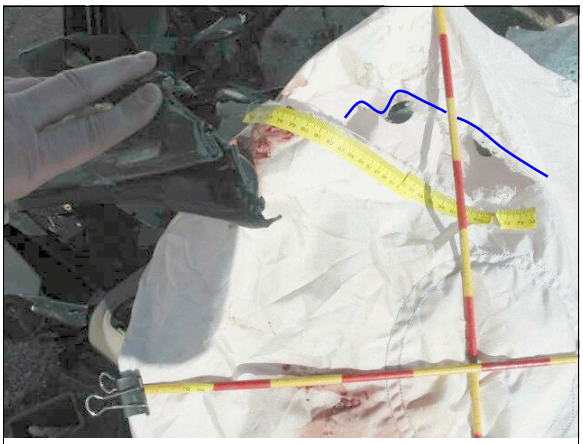


Figure 20: Close-up of obliquely oriented tear (i.e., yellow tape) and blood evidence on front surface of case vehicle's deployed driver air bag; tear exposes vent ports on air bag's back surface (case photo #32)

upper and lower right quadrants of the bag's front surface face and there were sizeable blood and tissue stains in the upper and lower left quadrants of the air bag's face. The back side of the air bag was free of damage except for a pair of 2.5 centimeter (1.0 inch) holes in the lower left and right quadrants near the 6 o'clock position.

The front right passenger's air bag was located in the top of the instrument panel. There was a single, essentially rectangular, modular cover flap. The cover flap was made of thick semi-pliable vinyl, thicker than the vinyl on the driver's module. The flap's dimensions were not recorded nor was the profile of the case vehicle's instrument panel. An inspection of the front right air bag module's cover flap and the air bag's fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flap. The front right passenger's air bag was designed with two tethers, each approximately 11 centimeters (4.3 inches) in width. The front right air bag had two vent ports, approximately 5.5 centimeters (2.2 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 60 centimeters (23.6 inches) and a width of approximately 43 centimeters (16.9 inches). An inspection of the front right passenger's air bag fabric revealed nothing more than dirt and grease scuffs routinely found in most deployments (**Figure 21**).

Figure 21: Front surface of case vehicle's deployed front right passenger air bag showing no obvious evidence of occupant contact (case photo #43)

CRASH DATA RECORDING

The data downloaded from the case vehicle's **EDR** showed the vehicle's SIR warning lamp status, driver's seat belt buckle status, ignition cycles at deployment, time from algorithm enable to deployment (i.e., air bag deployments) for both of the system's first and second stages, and the vehicle's speed and brake switch status for the five recorded sample periods preceding the **ALGORITHM ENABLE**. In addition, the vehicle's velocity change (i.e., Delta V) is reported. Downloaded data of interest indicated the following. The case vehicle was traveling at a speed in excess of 145 km.p.h. (90 m.p.h.), the driver's seat belt status showed it was not buckled, the second stage of the multi-stage air bags was not activated, and the Delta V reached a value of 36.02 km.p.h. (22.38 m.p.h.) at the 120 millisecond mark of recorded data; see **EVENT DATA RECORDER DATA** (**Figures 23** through **25**) below. This contractor believes that the recorded Delta V seems reasonable considering the amount of deformation to the case vehicle's front. It should also be noted that the case vehicle's **EDR** recorded a non-deployment event; however, this event occurred approximately 46 ignition cycles prior to this crash. This near deployment obviously was not part of this crash, but the recorded data are included; see **EVENT DATA RECORDER DATA** (**Figures 26** through **28**) below.

Immediately prior to the crash the exact posture of the case vehicle's driver [17-year-old, White (non-Hispanic) male; 183 centimeters and 69 kilograms (72 inches, 152 pounds)] is unknown, but he was most likely seated with his back near the seat back, his left foot on the floor, his right foot on the accelerator, and most likely both hands on the steering wheel. His seat track was located at its rearmost position and the seat back was near upright (i.e., exact position cannot be determined because it was deformed from contact by the back left passenger). The case vehicle was equipped with a tilt steering wheel, but the position of the wheel could not be determined because of the severity of damage.

Based on this contractor's vehicle inspection and substantiated by the **EDR** data, the case vehicle's driver was not using his available, active, three-point, lap-and-shoulder, safety belt system; the belt system was equipped with a retractor-mounted pretensioner with force load limiters, housed within the "B"-pillar. Furthermore, the inspection of the driver's seat belt webbing, "D"-ring, and latch plate revealed that the pretensioner had actuated and showed no evidence of loading.

Based on the available evidence, which includes the tire mark and the vehicle's converging trajectory to the roadside objects and supported by the **EDR** data, the case vehicle's driver braked briefly (i.e., during the 2nd sample period prior to Algorithm Enable) and most likely steered to his right, attempting to avoid the crash. As a result of these attempted avoidance maneuvers and the nonuse of his available safety belts, he most likely moved slightly forward and to his left just prior to impact. The case vehicle's impact with the 1st fence post had little or no effect upon the driver's posture. The impact that quickly followed with the 1st (small) tree enabled the case vehicle's driver to continue forward and probably, slightly leftward, toward the case vehicle's likely **345** degree Direction of Principal Force as the case vehicle decelerated (i.e., the exact nature of the Direction of Principal Force cannot be determined for this impact). As a result, the driver loaded his deploying driver air bag, most likely on the left side, and the case vehicle was redirected by the small tree to its right. Shortly thereafter the front of the case vehicle impacted the 2nd fence post, followed by 2nd (large) tree. The impact with the 2nd fence post most likely did not significantly alter the driver's posture. On the other hand, the impact with the large tree enabled the case vehicle's driver to move straight forward and most likely upward toward the **0** degree Direction of Principal Force as the case vehicle decelerated rapidly to rest. As a result the driver severely loaded the deploying air bag, the steering wheel and column, the knee bolsters, the left instrument panel, and the toe pan areas, all of which were also intruding backwards toward the driver. As the case vehicle reached maximum engagement, the back end of the vehicle lifted vertically upwards. As a result, the case vehicle's roof, left roof side rail, and possibly the left "A"-pillar and/or windshield header contacted the fence rail deforming the rail upwards and the vehicle's components inward and probably downward. The driver most likely contacted one or more of these aforementioned components with his head. The exact posture of the driver at final rest is unknown, but he was entrapped between his seat back and the intruding front left seating area components. According to the Police Crash Report, the case vehicle's driver was unconscious and unable to exit the case vehicle.

Based on the Police Crash Report, the driver was not transported by ambulance to the hospital. He sustained fatal injuries and was pronounced dead at the scene upon arrival of the emergency medical personnel (7 minutes post-crash). According to his non-invasive, post-mortem examination, the injuries sustained by the case vehicle's driver included: unspecified rib fractures with an unspecified (as to aspect) flail chest, an open fracture of his right medial malleolus, and a nasal fracture. In addition, he sustained abrasions and lacerations about his face and neck, a chest abrasion, and multiple soft tissue injuries over his upper and lower extremities.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture, open with laceration, distal right medial malleolus	moderate 853414.2,1	Floor, foot controls	Certain	Post-mortem examination
2	Fracture ribs, not further specified with flail chest, aspect not specified	severe 450260.4,9	Steering wheel hub and/or spokes and rim	Certain	Post-mortem examination
3	Fracture nasal bone(s), not further specified, with blood present in nose, mouth, and ears	minor 251000.1,4	Steering wheel rim	Probable	Post-mortem examination
4	Abrasion left face near left eye, not further specified	minor 290202.1,2	Air bag, driver's	Probable	Post-mortem examination
5	Laceration, curvilinear, across forehead, not further specified	minor 290600.1,7	Steering wheel rim	Probable	Post-mortem examination
6	Abrasions over neck, not further specified	minor 390202.1,5	Air bag, driver's	Probable	Post-mortem examination
7	Lacerations over neck, not further specified	minor 390600.1,5	Steering wheel hub and/or spokes	Probable	Post-mortem examination
8	Abrasion left chest near armpit	minor 490202.1,2	Air bag, driver's	Probable	Post-mortem examination
9	Contusion penis, not further specified	minor 543010.1,8	Steering wheel rim	Probable	Post-mortem examination
10	Abrasion left upper arm, anterior surface near armpit	minor 790202.1,2	Air bag, driver's	Probable	Post-mortem examination
11	Abrasion posterior, distal, left upper arm near elbow	minor 790202.1,2	Noncontact injury: flying glass, left front glazing	Possible	Post-mortem examination
12	Laceration posterior, proximal, left lower arm near elbow	minor 790600.1,2	Noncontact injury: flying glass, left front glazing	Possible	Post-mortem examination
13	Abrasions, scattered, dorsal surface left hand	minor 790202.1,2	Left instrument panel and below	Possible	Post-mortem examination
14	Contusion dorsal surface left hand, not further specified	minor 790402.1,2	Left instrument panel and below	Possible	Post-mortem examination

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
15	Abrasions anterior right proximal upper arm and anterior, distal, lateral right upper arm near antecubital fossa	minor 790202.1,1	Air bag, driver's	Possible	Post-mortem examination
16	Abrasion posterior, lateral, proximal right lower arm	minor 790202.1,1	Center instrument panel and below	Possible	Post-mortem examination
17	Abrasions, puncture-type, angulated, dorsal surface right hand	minor 790202.1,1	Center instrument panel and below	Possible	Post-mortem examination
18	Laceration right 5th digit, not further specified	minor 790600.1,1	Center instrument panel and below	Possible	Post-mortem examination
19	Abrasion right anterior, lateral pelvis, not further specified	minor 890202.1,1	Floor, center console	Possible	Post-mortem examination
20	Abrasions right anterior leg from above knee to mid-shin	minor 890202.1,1	Knee bolster, driver's, right of steering column	Probable	Post-mortem examination
21	Abrasions left anterior, lateral, distal thigh and around left knee	minor 890202.1,2	Knee bolster, driver's, left of steering column	Probable	Post-mortem examination
22	Abrasion left medial distal leg over medial malleolus	minor 890202.1,2	Floor, including toe pan	Probable	Post-mortem examination
23	Laceration right lower buttock, not further specified	minor 890600.1,1	Floor, center console	Possible	Post-mortem examination

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The exact posture of the case vehicle's front passenger [17-year-old, White (non-Hispanic) male; 183 centimeters and 69 kilograms (72 inches, 152 pounds)] immediately prior to the crash is unknown, but he was most likely seated with both of his feet on the floor. It is unknown whether his back was against the seat or in some other configuration. The exact position of his hands is also unknown. His seat track was located in its rearmost position and the seat back was essentially upright.

The case vehicle's front right passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system; the belt system was equipped with a retractor-mounted pretensioner with force load limiters, housed within the "B"-pillar. Furthermore, the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate revealed that the pretensioner had actuated and showed no evidence of loading.

Based on the available evidence, the case vehicle's driver braked briefly and most likely steered to his right, attempting to avoid the crash. As a result of these attempted avoidance

maneuvers and the nonuse of his available safety belts, the front right passenger most likely moved slightly forward and to his left just prior to impact. The case vehicle's initial impact with the 1st fence post had little or no effect upon the front right passenger's posture. The impact that quickly followed with the 1st (small) tree enabled the case vehicle's front right passenger to continue forward and probably, slightly leftward, toward the case vehicle's likely **345** degree Direction of Principal Force as the case vehicle decelerated (i.e., the exact nature of the Direction of Principal Force cannot be determined for this impact). As a result, the front right passenger loaded his deploying front right air bag, most likely on the left side, and the case vehicle was redirected by the small tree to its right. Shortly thereafter the front of the case vehicle impacted the 2nd fence post, followed by 2nd (large) tree. The impact with the 2nd fence post most likely did not significantly alter the front right passenger's posture. On the other hand, the impact with the large tree enabled the case vehicle's front right passenger to move straight forward and most likely upward toward the **0** degree Direction of Principal Force as the case vehicle decelerated rapidly to rest. As a result the front right passenger severely loaded the deploying air bag, the glove compartment door, the front right knee bolster, the right instrument panel, the right side of the windshield's glazing, the right toe pan area, and possibly the windshield's header and/or right sun visor, all of which were also intruding backwards toward the front right passenger. As the case vehicle reached maximum engagement, the back end of the vehicle lifted vertically upwards. As a result, the case vehicle's roof, left roof side rail, and possible the left "A"-pillar and/or windshield header contacted the fence rail deforming the rail upwards and the vehicle's components inward and probably downward. The front right passenger may have contacted the roof over his seating position with his head. The exact posture of the front right passenger at final rest is unknown, but he was entrapped between his seat back and the intruding front right seating area components. According to the Police Crash Report, the case vehicle's front right passenger was unconscious and unable to exit the case vehicle.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right passenger was not transported by ambulance to the hospital. He sustained fatal injuries and was pronounced dead at the scene upon arrival of the emergency medical personnel (7 minutes post-crash). According to his non-invasive, post-mortem examination, the injuries sustained by the case vehicle's front right passenger included: unspecified fractures to his right ribs with bilateral hemothoraces, a fracture and dislocation to his left elbow, and nasal fractures. Furthermore, he sustained lacerations over both eyes and near complete amputative lacerations of his right and left index (2nd) fingers. In addition, he had multiple soft tissue injuries to his face, neck, chest, abdomen, right scapular area, and upper and lower extremities.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture right ribs with bilateral hemothoraces, not further specified	serious 450222.3,1	Right instrument panel and below	Probable	Post-mortem examination
2	Fracture left elbow, not further specified	moderate 753200.2,2	Right instrument panel and below	Probable	Post-mortem examination

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
3	Dislocation left elbow, not further specified	minor 750630.1,2	Right instrument panel and below	Probable	Post-mortem examination
4	Fracture nasal bone(s), not further specified with blood present in nose and mouth	minor 251000.1,4	Right instrument panel and below	Probable	Post-mortem examination
5	Lacerations on forehead over left and right eyes, not further specified	minor 290600.1,7	Front right windshield's glazing	Probable	Post-mortem examination
6	Abrasion scattered over face, not further specified	minor 290202.1,0	Air bag, front right passenger's	Probable	Post-mortem examination
7	Abrasions, puncture-type scattered over face, not further specified	minor 290202.1,0	Noncontact injury: flying glass, windshield glazing	Probable	Post-mortem examination
8	Abrasions anterior neck, not further specified	minor 390202.1,5	Air bag, front right passenger's	Probable	Post-mortem examination
9	Abrasions chest bilaterally, not further specified	minor 490202.1,3	Air bag, front right passenger's	Probable	Post-mortem examination
10	Abrasions central abdomen, not further specified	minor 590202.1,4	Air bag, front right passenger's	Probable	Post-mortem examination
11	Abrasion over left anterior shoulder, not further specified	minor 790202.1,2	Air bag, front right passenger's	Probable	Post-mortem examination
12	Abrasion over right scapular area, not further specified	minor 790202.1,1	Right front window sill	Possible	Post-mortem examination
13	Contusion over right scapular area, not further specified	minor 790402.1,1	Right front window sill	Possible	Post-mortem examination
14	Abrasions on right and left hands involving both palmar and dorsal surfaces	minor 790202.1,3	Noncontact injury: flying glass, unknown source	Probable	Post-mortem examination
15 16	Laceration, nearly complete amputation, of right and left index (2nd) fingers	moderate 752402.2,1 752402.2,2	Front right windshield's glazing	Possible	Post-mortem examination
17	Abrasions over left and right knees, not further specified	minor 890202.1,3	Glove compartment door	Certain	Post-mortem examination
18	Abrasions anteriorly over right shin and right and left medial malleolar areas, not further specified	minor 890202.1,3	Right instrument panel and below	Probable	Post-mortem examination
19	Abrasions posteriorly over left and right ankles, not further specified	minor 890202.1,3	Seat cushion, front right passenger's	Possible	Post-mortem examination

The exact posture of the case vehicle's back left passenger [17-year-old, Black (non-Hispanic) male; 183 centimeters and 64 kilograms (72 inches and 140 pounds)] immediately prior to the crash is unknown, but he was most likely seated with both of his feet on the floor. It is also unknown whether his back was against the seat or in some other configuration. The exact position of his hands is also unknown. There was no seat track, and the seat back was not adjustable.

The case vehicle's back left passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system; the belt system was not equipped with a pretensioner. Furthermore, the inspection of the back left passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading. In addition, the vehicle inspection indicates that the back left passenger contacted the back surface of the driver's seat back (**Figure 17** above) and deformed the driver's adjustable head restraint (**Figure 18** above and **Figure 22**).

Figure 22: Elevated view of case vehicle's driver seating area showing distorted steering wheel rim, deployed driver air bag, contact evidence on interior surface of driver's door, and distortion to driver's adjustable head restraint from contact by back left passenger (case photo #28)

Based on the available evidence, the case vehicle's driver braked briefly and most likely steered to his right, attempting to avoid the crash. As a result of these attempted avoidance maneuvers and the nonuse of his available safety belts, the back left passenger most likely moved slightly forward and to his left just prior to impact. The case vehicle's initial impact with the 1st fence post had little or no effect upon the back left passenger's posture. The impact that quickly followed with the 1st (small) tree enabled the case vehicle's back left passenger to continue forward and probably, slightly leftward, toward the case vehicle's likely **345** degree Direction of Principal Force as the case vehicle decelerated (i.e., the exact nature of the Direction of Principal Force cannot be determined for this impact). As a result, the back left passenger moved forward toward the back surface of the driver's seat back, most likely on the left side, and the case vehicle was redirected by the small tree to its right. Shortly thereafter the front of the case vehicle impacted the 2nd fence post, followed by 2nd (large) tree. The impact with the 2nd fence post most likely did not significantly alter the back left passenger's posture. On the other hand, the impact with the large tree enabled the case vehicle's back left passenger to move straight forward and most likely upward toward the **0** degree Direction of Principal Force as the case vehicle decelerated rapidly to rest. As a result the back left passenger severely loaded the driver's seat back and adjustable head restraint, intruding the seat forwards and into the case vehicle's driver. As the case vehicle reached maximum engagement, the back end of the vehicle lifted vertically upwards. As a result, the case vehicle's roof, left roof side rail, and possible the left "A"-pillar and/or windshield header contacted the fence rail deforming the rail upwards and the vehicle's components inward and probably downward. The back left passenger may have contacted the roof over the driver's seating position, left "B"-pillar, and/or left roof side rail with his head. The exact posture of the back left passenger at final rest is unknown, but he was entrapped between his seat back and the

driver's seat back. According to the Police Crash Report, the case vehicle's back left passenger was unconscious and unable to exit the case vehicle.

CASE VEHICLE BACK LEFT PASSENGER INJURIES

According to the Police Crash Report, this occupant was transported by ambulance to the hospital. He sustained critical injuries and was pronounced dead 70 minutes post-crash. According to the investigating officer, he expired en route. According to his hospital records and his non-invasive, post-mortem examination, the injuries sustained by the case vehicle's back left passenger included: a nonanatomic brain injury; an unknown thoracic cavity injury with left hemothorax; and fractures to his left femur, the condylar area of his right tibia, his left tibia mid-shaft, his left medial malleolus, and his teeth. In addition, he sustained multiple soft tissue injuries to his head, face, chest, bilateral distal forearms, and bilateral lower extremities.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury with loss of consciousness; unresponsive; pupils fixed, dilated, and non-reactive; GCS=3; no rectal tone or corneal reflexes	critical 160824.5,0	Seat back, driver's head restraint	Probable	Emergency room records
2	Thoracic cavity injury, not further specified, with left hemothorax	serious 442202.3,2	Seat back, driver's	Certain	Post-mortem examination
3	Fracture mid-shaft left femur, not further specified	serious 851814.3,2	Seat back, driver's	Certain	Post-mortem examination
4	Fracture proximal right tibia, most likely involving condyle	moderate 853406.2,1	Seat back, driver's	Certain	Post-mortem examination
5	Fracture mid-shaft left tibia, not further specified	moderate 853420.2,2	Seat back, driver's	Certain	Post-mortem examination
6	Fracture left medial malleolus, not further specified	moderate 853412.2,2	Seat back, driver's	Certain	Post-mortem examination
7	Fractures, multiple, teeth, not further specified	minor 251404.1,8	Seat back, driver's head restraint	Certain	Emergency room records
8	Abrasions, multiple, head, not further specified	minor 190202.1,9	Seat back, driver's head restraint	Probable	Emergency room records
9	Contusions, multiple, head, not further specified	minor 190402.1,9	Seat back, driver's head restraint	Probable	Emergency room records
10	Laceration left posterior parietal-occipital scalp, not further specified	minor 190600.1,6	Roof, left front side rail	Possible	Post-mortem examination
11	Laceration right forehead, not further specified	minor 290600.1,7	Seat back, driver's head restraint	Probable	Post-mortem examination

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
12	Abrasions face, including right forehead, chin, and most likely nose, lips, and left cheek, not further specified	minor 290202.1,0	Seat back, driver's head restraint	Probable	Post-mortem examination
13	Contusions face, including chin and most likely nose, lips, and left face, not further specified	minor 290402.1,0	Seat back, driver's head restraint	Probable	Post-mortem examination
14	Lacerations, multiple, face, not further specified	minor 290600.1,0	Seat back, driver's head restraint	Probable	Emergency room records
15	Abrasions, multiple, chest, not further specified	minor 490202.1,0	Seat back, driver's	Certain	Emergency room records
16	Contusions {ecchymoses}, multiple, chest, not further specified	minor 490402.1,0	Seat back, driver's	Certain	Emergency room records
17	Abrasions distal forearms bilaterally, not further specified	minor 790202.1,3	Noncontact injury: flying glass, unknown source	Possible	Post-mortem examination
18	Laceration left distal thigh, not further specified with deformity noted to pelvis and upper thigh	minor 890600.1,2	Seat back, driver's	Certain	Post-mortem examination
19	Laceration right proximal shin, not further specified	minor 890600.1,1	Seat back, driver's	Certain	Post-mortem examination
20	Lacerations, multiple, bilaterally, over tibia-fibula, not further specified with deformities noted	minor 890600.1,3	Seat back, driver's	Certain	Emergency room records

1G8AK52F94Z [redacted] System Status At Deployment	
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Ignition Cycles At Deployment	169
Ignition Cycles At Investigation	170
Maximum SDM Recorded Velocity Change (MPH)	-22.45
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	117.5
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	20
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)	20
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Time Between Non-Deployment And Deployment Events (sec)	.4
Event Recording Complete	Yes

Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	-0.44	-1.76	-2.63	-3.07	-3.51	-4.39	-5.70	-5.70	-7.46	-10.53	-16.67	-22.38	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	91	4736	100	OFF
-4	94	4864	100	OFF
-3	94	4928	100	OFF
-2	91	4480	1	ON
-1	88	3520	1	OFF

Figure 23: Case vehicle's at deployment data including: pre-crash speed, brake switch status, restraint system status, and activation data for vehicle's dual inflation air bags, and the case vehicle's change in velocity (Delta V) over the first 120 milliseconds post deployment

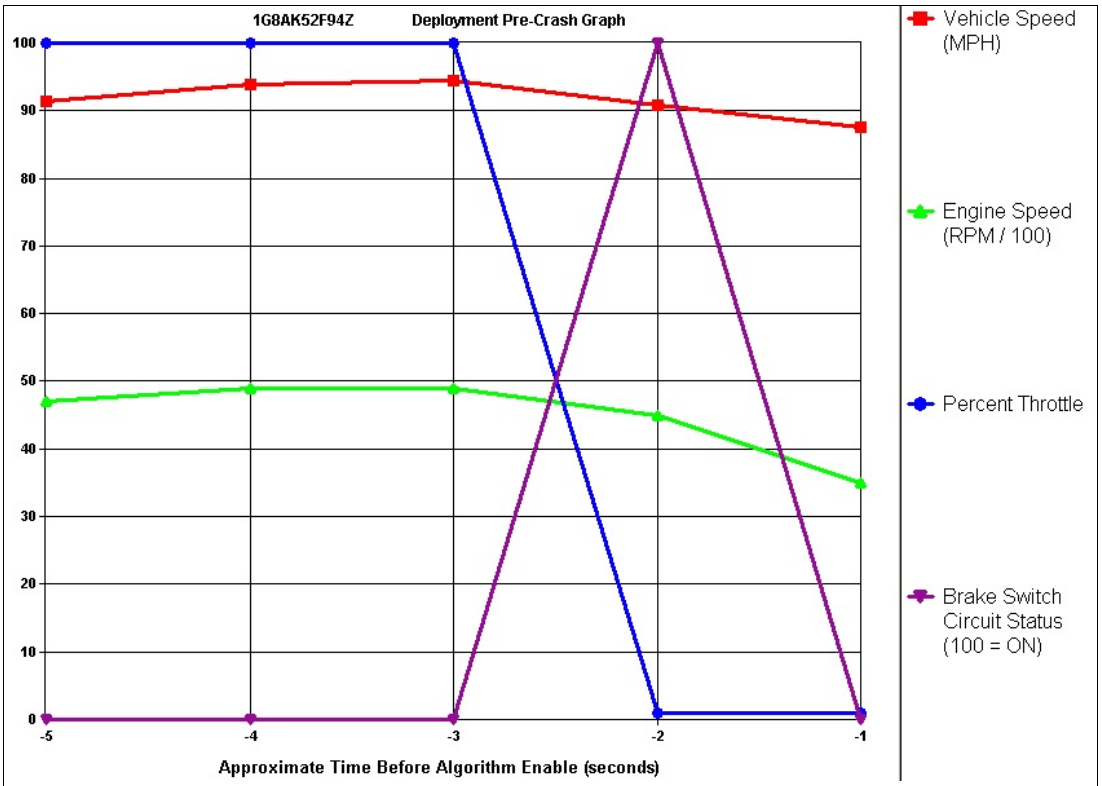


Figure 24: Case vehicle's pre-crash speed and brake switch circuit status showing that the vehicle's speed was recorded at 146 km.p.h. (91 m.p.h.), with the brake activated, at approximately 2 seconds prior to algorithm enable and that the brake switch had been deactivated between the 5th and 2nd recorded sample periods **and** during the last record sample prior to algorithm enable

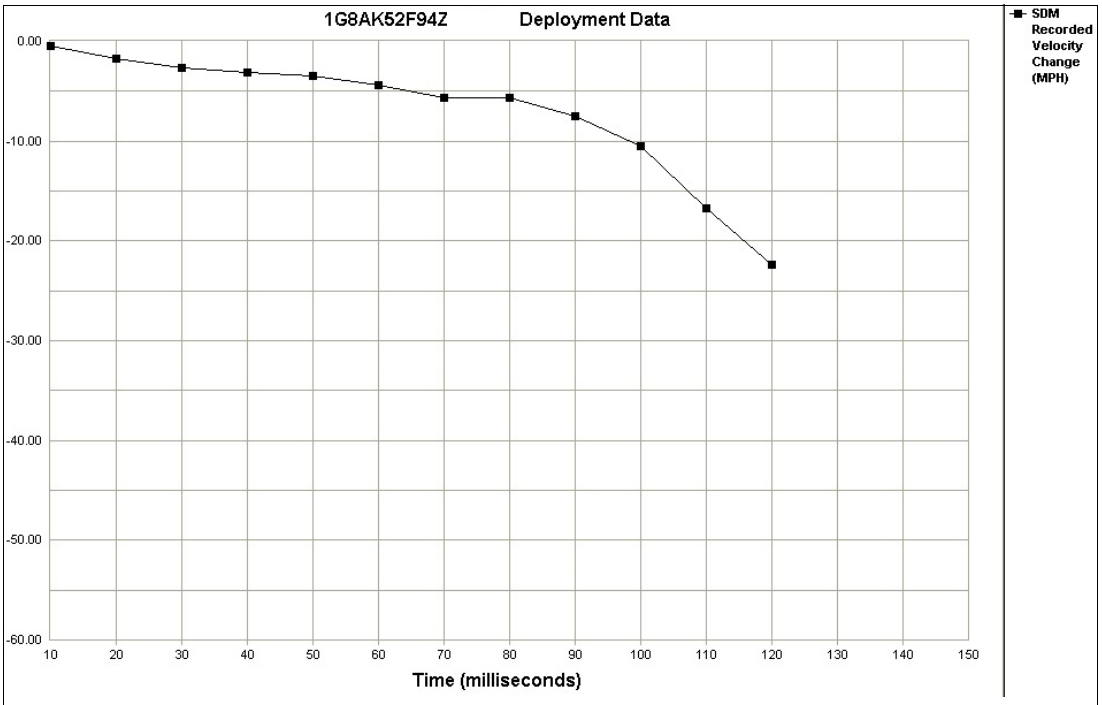


Figure 25: The case vehicle sustained a velocity change of approximately 36.0 km.p.h. (22.4 m.p.h.) during the first 120 milliseconds after the algorithm was enabled; maximum velocity change was recorded as 36.13 km.p.h. (22.45 m.p.h.) at 117.5 milliseconds

1G8AK52F94Z	System Status At Non-Deployment
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Ignition Cycles At Non-Deployment	123
Ignition Cycles At Investigation	170
Maximum SDM Recorded Velocity Change (MPH)	-0.23
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	50
A Deployment was Commanded Prior to this Evert	No

Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	0.00	0.00	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	71	16320	1	ON
-4	66	1088	1	ON
-3	61	1088	1	ON
-2	56	1088	1	ON
-1	47	1088	1	ON

Figure 26: Case vehicle's non-deployment data including: pre-crash speed, brake switch status, restraint system status, time (in milliseconds) from algorithm enable to maximum SDM recorded velocity, and the case vehicle's change in velocity (Delta V) over the first 30 milliseconds post algorithm enablement

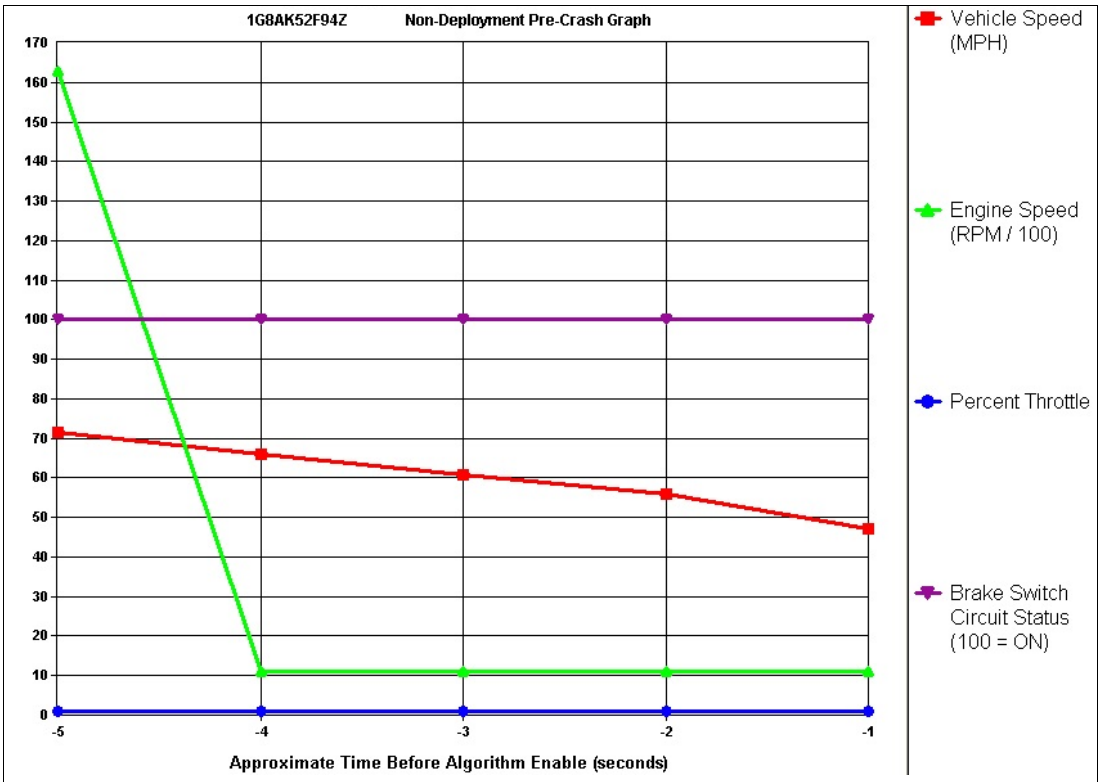


Figure 27: Case vehicle's pre-crash speed and brake switch circuit status showing that the vehicle's recorded speed decreased from 114 km.p.h. (71 m.p.h.) to 76 km.p.h. (47 m.p.h.) during the five recorded sample prior to algorithm enable and that the brake switch had been activated throughout the five recorded sample periods

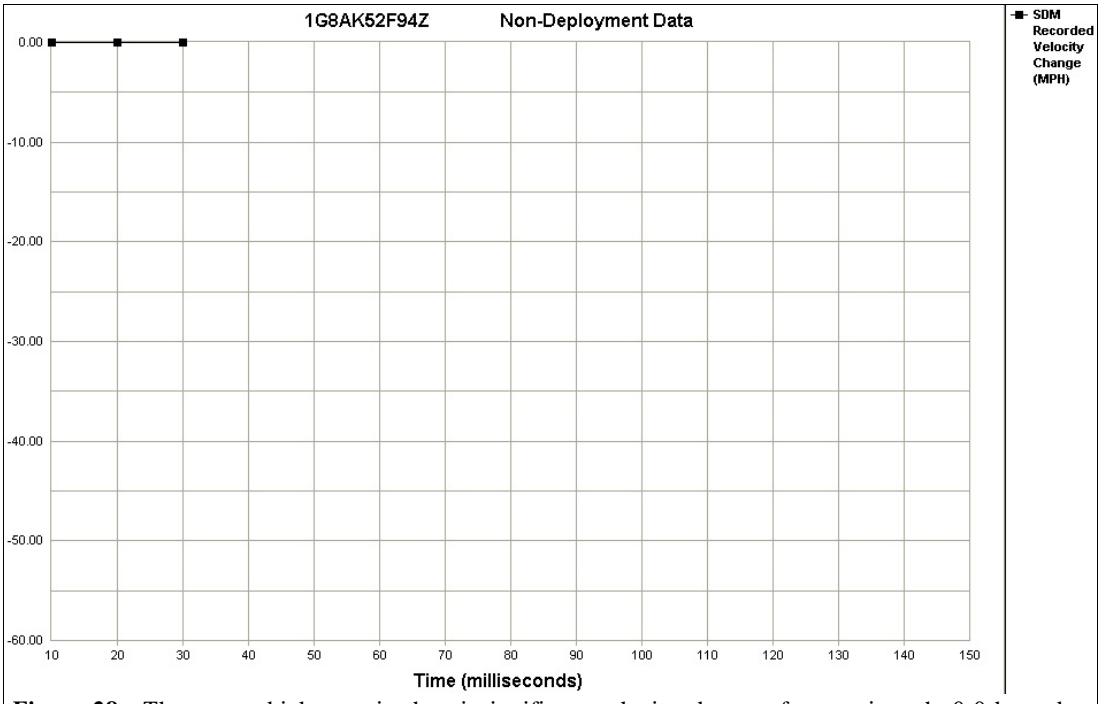
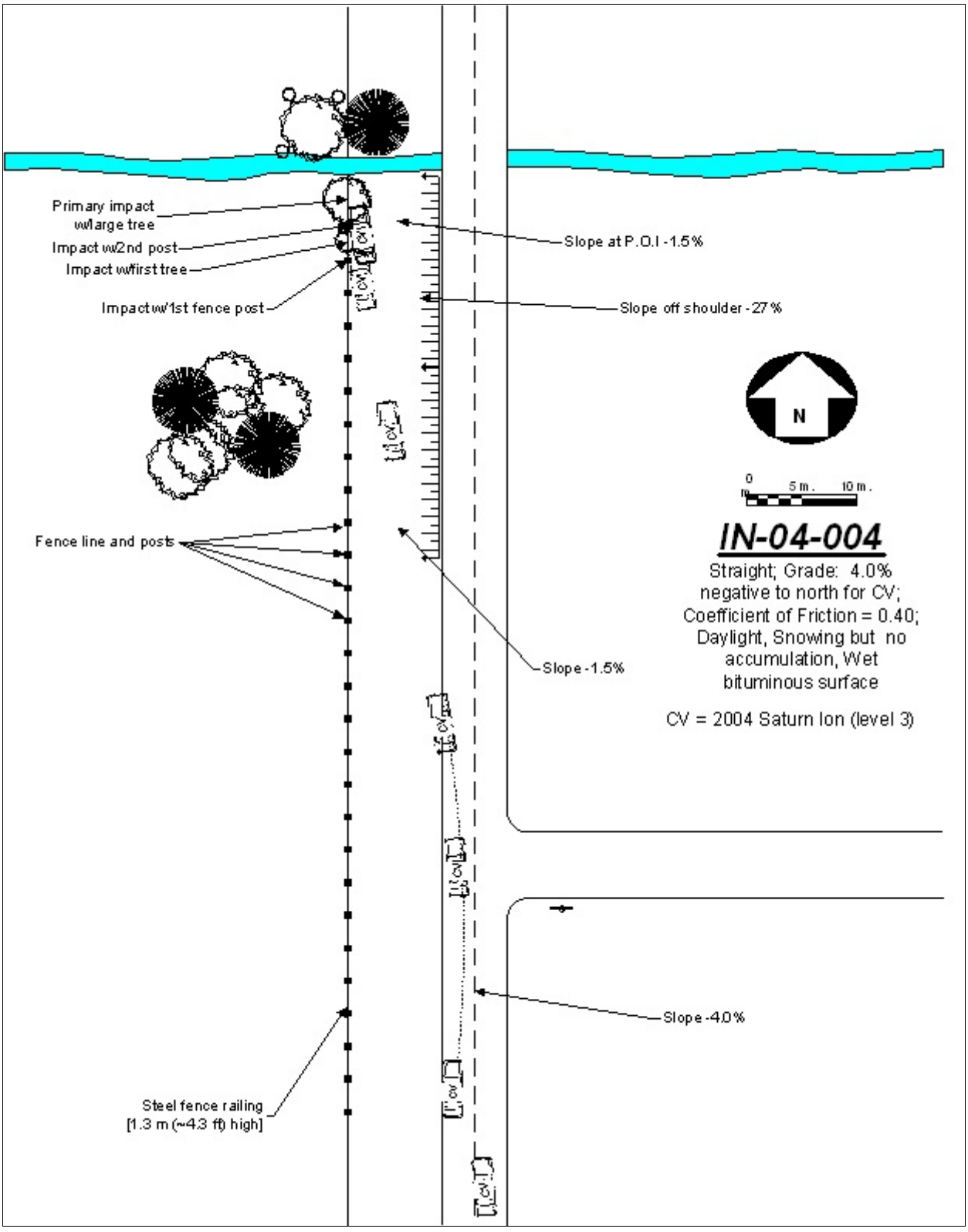


Figure 28: The case vehicle sustained an insignificant velocity change of approximately 0.0 km.p.h. (0.0 m.p.h.) during the first 30 milliseconds after the algorithm was enabled; maximum velocity change was recorded as 0.37 km.p.h. (0.23 m.p.h.) at 50 milliseconds


Primary impact w/large tree
Impact w/2nd post
Impact w/first tree
Impact w/1st fence post
Slope at P.O.I -1.5%
Slope off shoulder -27%
N
0
5 m.
10 m.
IN-04-004
Straight; Grade: 4.0% negative to north for CV; Coefficient of Friction = 0.40; Daylight, Snowing but no accumulation, Wet bituminous surface
CV = 2004 Saturn Ion (level 3)
Fence line and posts
Slope -1.5%
Slope -4.0%
Steel fence railing [1.3 m (~4.3 ft) high]