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ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-06-022

LOCATION - TEXAS

VEHICLE - 2006 FORD F150

CRASH DATE - June 2006

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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15. <i>Supplementary Notes</i> On-site air bag deployment crash involving a 2006 Ford F-150 equipped with manual safety belts and a manufacturer certified advanced 208-compliant front air bag system.					
16. <i>Abstract</i> This report covers an on-site air bag deployment investigation that involved a 2006 Ford F-150 (case vehicle) and a 1995 Chevrolet Caprice (other vehicle), which were involved in a front to side crash in the intersection of two multi-lane city streets. This crash is of special interest because the supplemental restraint (air bag) system in the Ford F-150 is certified by the manufacturer to be compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Standard (FMVSS) No. 208, and the case vehicle's driver [76-year-old, Black (non-Hispanic) male] sustained a police reported "B" (non-incapacitating) injury as a result of the crash. The case vehicle was traveling northwest in the center right through lane. The Chevrolet was traveling southwest in the outside through lane. The police crash report indicated that the case vehicle's driver entered the intersection on a red light. The front of the case vehicle impacted the left front of the Chevrolet (event 1) causing the case vehicle's driver air bag to deploy. The case vehicle rotated counterclockwise, the Chevrolet rotated clockwise and the right side of the case vehicle impacted the left side of the Chevrolet (event 2). The case vehicle then departed the northwest corner of the intersection and the front right corner impacted a traffic signal pole (event 3) breaking the pole off its base. The front of the case vehicle then impacted the corner of a building (event 4). The case vehicle came to rest on the northwest corner of the intersection with the front against the corner of the building heading northwest. The Chevrolet most likely came to rest in the northwest leg of the intersection heading northwest. The case vehicle driver was restrained by his manual, three-point, lap-and-shoulder safety belt. The driver was transported by ambulance to a hospital and admitted overnight. He sustained three fractured ribs due to loading his shoulder belt.					
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This investigation was brought to NHTSA's attention on or before July 21, 2006 by NASS/GES sampling activities. This crash involved a 2006 Ford F-150 pickup truck (case vehicle) and a 1995 Chevrolet Caprice Classic (other vehicle), which were involved in a front to side crash in the intersection of two multi-lane city streets. The crash occurred in June 2006, at 11:00 a.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the supplemental restraint (air bag) system in the Ford F-150 is certified by the manufacturer to be compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Standard (FMVSS) No. 208, and the case vehicle's driver [76-year-old, Black (non-Hispanic) male] sustained a police reported "B" (non-incapacitating) injury as a result of the crash. This contractor inspected the scene and case vehicle and interviewed the case vehicle's driver on August 15, 2006. The Chevrolet was not inspected. It could not be located. This report is based on the police crash report, scene and vehicle inspections, case vehicle driver interview, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling northwest in the center right through lane. The Chevrolet was traveling southwest in the outside through lane. The police crash report indicated that the case vehicle's driver entered the intersection on a red light. It is unknown if the case vehicle's driver took any actions to avoid the crash. The front of the case vehicle impacted the left front of the Chevrolet (event 1) causing the case vehicle's driver air bag to deploy. The case vehicle rotated counterclockwise, the Chevrolet rotated clockwise and the right side of the case vehicle impacted the left side of the Chevrolet (event 2). The case vehicle then departed the northwest corner of the intersection and the front right corner impacted a traffic signal pole (event 3) breaking the pole off its base. The front of the case vehicle then impacted the corner of a building (event 4). The case vehicle came to rest on the northwest corner of the intersection with the front against the corner of the building heading northwest. The Chevrolet most likely came to rest in the northwest leg of the intersection heading northwest. At the time of the crash the light condition was daylight, the atmospheric condition was clear and the roadway pavement was dry.

The CDC for the impact with the Chevrolet (event 1) was determined to be: **01-FZEW-1 (30 degrees)**. The CDC for the case vehicle's right side-slap impact to the left side of the Chevrolet (event 2) was determined to be: **03-RBEW-2 (90 degrees)**. The CDC for the impact with the street lamp post (event 3) was determined to be: **12-FREE-2 (0 degrees)**. The CDC for the impact with the corner of the building (event 4) was determined to be: **12-FZEW-3 (0 degrees)**. The WinSMASH reconstruction program could not be used on the case vehicle's front impacts due to overlapping damage. The crash severity for the case vehicle's deployment impact (i.e., event 1) was estimated to be in a range of 16 to 24 km.p.h. (10 to 15 m.p.h.). The damage to the case vehicle indicated its most severe impact was to the corner of the building. The crash severity for this impact was estimated to be in a range of 24 to 32 km.p.h. (15 to 20 m.p.h.). The case vehicle was towed due to damage.

The case vehicle's driver was restrained by his manual, three-point, lap-and-shoulder safety belt system. He sustained three fractured ribs due to loading his safety belt, most likely due to the impact with the corner of the building. He was transported by ambulance to a hospital and admitted overnight. The driver's use of his safety belt system and the deployment of his advanced air bag prevented him from impacting the steering wheel and instrument panel and reduced his injury potential.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle was traveling was a four-lane, undivided, one-way city street, traversing in a northwesterly and southeasterly direction. The case vehicle was approaching a four-leg intersection. The trafficway on which the Chevrolet was traveling was a five-lane, undivided, city street, traversing in a northeasterly and southwesterly direction. The Chevrolet was approaching the same four-leg intersection. Both the northwest and southeast legs of the intersection had four through lanes. The average travel lane width was 3.6 meters (11.8 feet) and the roadway was bordered by barrier curbs. The roadway pavement markings consisted of faded broken white lane lines and faded solid white pedestrian crossing edge lines. The northeast leg of the intersection had two northeastbound lanes, two southwestbound lanes and an opposing left turn lane in the center of the roadway. The roadway was bordered by barrier curbs. Each through lane was approximately 3.5 meters (11.5 feet) in width. The opposing left turn lane was 3.2 meters (10.5) in width. Roadway pavement markings consisted of broken white lane lines, solid yellow opposing left turn lane lines and faded solid white pedestrian crossing edge lines. The southwest leg of the intersection had two northeastbound through lanes, a left turn lane and two southwestbound through lanes. The roadway was bordered by barrier curbs. Each lane was approximately 3.5 meters (11.5 feet) in width. Roadway pavement markings consisted of broken white lane lines, solid yellow left turn lane lines and faded solid white pedestrian crossing edge lines. The intersection was controlled by three-phase traffic signals. The speed limit for both trafficways was 48 km.p.h. (30 m.p.h.). At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry, level bituminous with an estimated coefficient of friction of 0.65. Traffic density was moderate, and the site of the crash was urban commercial. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was traveling northwest in the center right through lane (**Figure 1**). According to the police crash report, the driver had just left a dialysis treatment center and had been involved in a minor crash several blocks prior to this crash. The police crash report indicated the driver may have been having a diabetic episode. The driver did not stop following the previous crash and continued northwestbound and was intending to continue straight ahead through the intersection. The Chevrolet was traveling southwest in the outside



Figure 1: Approach of case vehicle to intersection, northwestbound in center right through lane

through lane (**Figure 2**). Its unlicensed driver was intending to continue southwestbound through the intersection. The police crash report indicated that the case vehicle's driver entered the intersection on a red light. It is unknown if the case vehicle's driver took any actions to avoid the crash. The crash occurred in the intersection of the two trafficways (**Figure 2**).

Crash: The front of the case vehicle (**Figure 3**) impacted the left front of the Chevrolet (event 1) causing the case vehicle's driver air bag to deploy. It is unknown if the deployment was stage one or stage two. Following the initial impact, the case vehicle rotated counterclockwise, the Chevrolet rotated clockwise and the right side of the case vehicle truck bed (**Figure 4**) impacted the left side of the Chevrolet (event 2). The case vehicle departed the northwest corner of the intersection (**Figure 5** below) and the front right corner and right front wheel impacted a traffic signal pole (event 3) breaking the pole off its base and fracturing the case vehicle's right front axle. The front of the case vehicle then impacted the corner of a building (event 4, **Figure 6** below). The impact was at an angle to the building. The hood struck an overhanging section of the building, which caused a lateral offset between the damage to the case vehicle's hood and bumper (**Figure 3** and **Figure 6** below).

Post-Crash: The case vehicle came to rest on the northwest corner of the intersection with the front against the corner of a building heading northwest. The Chevrolet most likely came to rest in the northwest leg of the intersection heading northwest.

CASE VEHICLE

The 2006 Ford F-150 was a rear wheel drive, four-door pickup truck (VIN: 1FTRX12W76N-----), and the vehicle's manufacturer has certified that it meets the advanced air bag requirements of Federal Motor



Figure 2: Approach of Chevrolet to intersection, southwestbound in inside through lane, red arrow shows area of first impact, green arrow shows struck corner of building



Figure 3: Damage to front of case vehicle from impact with the Chevrolet as well as the traffic signal pole (red arrow) and building (green arrows)



Figure 4: Damage to right side of case vehicle's truck bed from sideslap impact with left side of Chevrolet

Vehicle Safety Standard (FMVSS) No. 208. The case vehicle was equipped with a 4.6L, V8 engine; four speed automatic transmission; power assisted, four wheel anti-lock disc brakes and a tilt steering column. The front seating row was equipped with bucket seats with adjustable head restraints and integrated, three-point, lap-and-shoulder safety belt systems with pretensioners, energy management retractors, safety belt usage sensors, driver's seat position sensor and a front right passenger occupant classification sensor. The center front seat position was also equipped with a two-point lap belt. The second seating row was equipped with a bench seat with folding backs, adjustable head restraints in the outboard seat positions; three-point, lap-and-shoulder safety belts and a LATCH system for securing child safety seats. The case vehicle's specification wheelbase was 367 centimeters (144.5 inches). The case vehicle's odometer reading at the time of the vehicle inspection was unknown because the case vehicle was equipped with an electronic odometer.

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

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle sustained three impacts through the front plane as follows: The impact with the Chevrolet (event 1) involved approximately the right third of the front end. The front bumper, grille and hood were directly damaged and crushed rearward and the front bumper was shifted to the left. The case vehicle's front impact with the traffic signal pole (event 3) involved the right fender and right front wheel. The fender and wheel were directly damaged and crushed rearward and the wheel was broken off its axle. The case vehicle's impact with the corner of the building (event 4) involved the front bumper, grille and hood. The impact produced a "V"-shaped deformation to the case vehicle's front bumper and crushed the grille and hood.



Figure 5: Approach of case vehicle to impact with traffic signal pole (orange cone shows location of pole) and corner of building

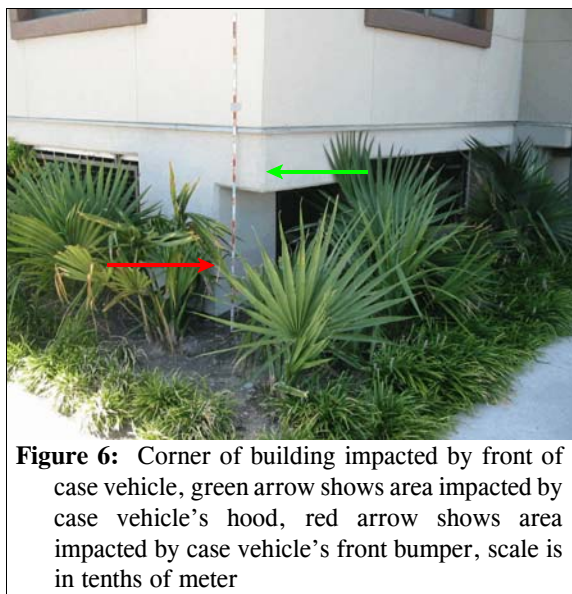


Figure 6: Corner of building impacted by front of case vehicle, green arrow shows area impacted by case vehicle's hood, red arrow shows area impacted by case vehicle's front bumper, scale is in tenths of meter

These impacts produced overlapping damage that could not be separated for the purpose of documenting individual crush profiles for each impact, so the totality of the damage to the front of the case vehicle was measured using one set of crush measurements. The direct damage began at the front right bumper corner and extended 116 centimeters (45.7 inches) across the front end. The residual maximum crush was measured as 60 centimeters (23.6 inches) occurring 34 centimeters (13.4 inches) left of C₅ (**Figure 7**). The shape of the damage in this area indicated that it was due to the impact with the corner of the building. The table below shows the totality of the case vehicle's front crush due to these overlapping impacts.



Figure 7: Top view of crush to front of case vehicle, baseline was set 10 cm (4 inches) beyond the vehicle's overall length to clear the displaced left bumper corner, each increment on rods is 5 cm (2 in)

Units	Event	Direct Damage		Field L	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1, 3	116	60	144	0	0	17	50	34	3	29	0
in	and 4	45.7	23.6	56.7	0.0	0.0	6.7	19.7	13.4	1.2	11.4	0.0

The case vehicle's second impact with the Chevrolet (event 2) involved the right side of the truck bed. The direct damage began 46 centimeters (18.1 inches) forward of the right rear axle and extended 158 centimeters (62.2 inches) along the side of the truck bed. The residual maximum crush was measured as 10 centimeters (3.9 inches) occurring at C₂. The table below shows the case vehicle's right side 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	2	158	10	225	0	10	9	7	2	0	-218	-188
in		62.2	3.9	88.6	0.0	3.9	3.5	2.8	0.8	0.0	-85.8	-74.0

The case vehicle's left side wheelbase was extended 1 centimeter (0.4 inch). The right side wheelbase measurement indicated it was extended 6 centimeters (2.4 inches); however, the right front wheel was broken off its axle in the crash indicating the wheel was free to move anytime the vehicle was moved and the measurement is, therefore, not indicative of the displacement of the right front wheel due to the traffic signal pole impact. The totality of the induced damage involved the hood, left portion of the front bumper, rear portion of the right fender and right side

of the truck bed. Lastly, there was damage to the bottom edge of the left front and rear doors that was most likely related to the crash this vehicle was involved in just prior to this crash.

The case vehicle’s recommended tire size was: P255/65R17, and the vehicle was equipped with tires of this size. The case vehicle’s tire data are shown in the table below.

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kpa	psi	kpa	psi	milli-meters	32 nd of an inch			
LF	255	37	241	35	9	11	None	No	No
RF	Flat	Flat	241	35	9	11	None	No	Yes
LR	262	38	241	35	9	11	None	No	No
RR	269	39	241	35	9	11	Piece of rubber torn off sidewall	No	No

Vehicle Interior: Inspection of the case vehicle’s interior (**Figures 8 and 9**) revealed no evidence of occupant contact to any of the interior surfaces or components. The vehicle sustained no passenger compartment intrusion. Finally, there appeared to be no compression of the energy absorbing steering column, but the column housing was displaced. There was no deformation of the steering wheel (**Figure 10** below).

Damage Classification: There was overlapping damage to the front of the case vehicle from the impacts with the Chevrolet, the traffic signal pole and the corner of the building. This contractor believed the impacts could be separated sufficiently to assign a complete CDC for each one. The CDC for the impact with the Chevrolet (event 1) was determined to be: **01-FZEW-1 (30 degrees)**. The CDC for the impact with the street lamp post (event 3) was determined to be: **12-FREE-2 (0 degrees)**. The CDC for the impact with the corner of the building (event 4) was determined to be: **12-FZEW-3 (0 degrees)**. The CDC for the case vehicle’s right side-slap impact to the left side of the Chevrolet was determined to be: **03-RBEW-2 (90 degrees)**. The WinSMASH



Figure 8: Overview of case vehicle’s steering wheel, instrument panel and windshield



Figure 9: Overview of case vehicle driver’s seating area and steering assembly

reconstruction program could not be used on the case vehicle's front impact due to overlapping damage. The crash severity for the case vehicle's deployment impact (i.e., event 1) was estimated to be in a range of 16 to 24 km.p.h. (10 to 15 m.p.h.). The damage to the case vehicle indicated its most severe impact was to the corner of the building. The crash severity for this impact was estimated to be in a range of 24 to 32 km.p.h. (15 to 20 m.p.h.). The WinSMASH reconstruction program, missing vehicle algorithm, was used to reconstruct the side-slap impact with the left side of the Chevrolet (i.e., event 2). The Total, Longitudinal and Lateral Delta Vs were, respectively: 6.0 km.p.h. (3.7 m.p.h.), 0.0 km.p.h. (0.0 m.p.h.) and -6.0 km.p.h. (3.7 m.p.h.). The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with manufacturer certified advanced 208-compliant driver and front right passenger air bags. The driver's air bag deployed in this crash due to the front impact with the Chevrolet. The front right passenger air bag did not deploy.

The case vehicle's driver air bag was located in the steering wheel hub. The air bag module cover consisted of approximate "H"-configuration cover flaps made of thick vinyl. There was a semi-oval contour at the horizontal tear seam in the center of the upper cover flap to accommodate the manufacturer's logo. A corresponding semi-oval cut-out was present at the horizontal tear seam on the lower cover flap. The upper cover flap was 11 centimeters (4.3 inches) in width and 6 centimeters (2.4 inches) in height. The lower cover flap was 11 centimeters in width (4.3 inches) and 12 centimeters (4.7 inches) in height. An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points (**Figure 11**). There was no evidence of damage during the



Figure 10: Left side view of case vehicle's steering assembly showing displacement of column cover



Figure 11: Case vehicle driver's air bag module cover flaps



Figure 12: Case vehicle driver's air bag

deployment to the air bag or the air bag module cover flaps. The deployed driver's air bag (**Figure 12** above) was round with a diameter of approximately 61 centimeters (24 inches). The air bag was designed with two tethers, each approximately 14 centimeters (5.5 inches) in width and had two vent ports, each approximately 2.5 centimeters (1 inch) in diameter, located at the 11 and 1 o'clock positions. The distance between the mid-center of the driver's seat back, as positioned as the time of the vehicle inspection (i.e., seat at the rear-most track position, seat back slightly reclined), and the front surface of the air bag's fabric at approximate full excursion was 38 centimeters (15 inches). An inspection of the air bag revealed a few light yellow/orange spots on the upper right quadrant of unknown origin. Otherwise, the air bag was remarkable.

The front right passenger's air bag was located in the middle of the instrument panel. The deployment of the front right passenger's air bag was suppressed by the weight sensor in case vehicle's front right seat cushion because there was no front right passenger in the case vehicle at the time of the crash.

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [75-year-old, Black (non-Hispanic) male; 168 centimeters and 106 kilograms (66 inches, 234 pounds)] was seated in an upright position. He most likely had his left foot on the floor, his right foot on the accelerator and both hands on the steering wheel. His seat track was adjusted to its middle position, his seat back was upright and the tilt steering column was adjusted to its center position. The driver was wearing glasses at the time of the crash.

Based on the vehicle inspection, the case vehicle's driver was restrained by his manual three-point, lap-and-shoulder, safety belt system. There were blood stains on the shoulder belt in a location that was consistent with the safety belt extended out of the retractor (**Figure 13**) and used in the crash.

It is unknown if the case vehicle's driver took any avoidance actions just prior to the crash. Regardless of any actions he may have taken, it is likely that his pre-crash position did not change significantly just prior to the impact. The case vehicle's impact with the Chevrolet caused the driver to continue forward and to the right along a path opposite the case vehicle's 30 degree direction of principal force as the case vehicle decelerated longitudinally and accelerated laterally to the left. The impact caused his safety belt retractor to lock and his pretensioner most likely



Figure 13: Case vehicle driver's safety belt, arrow shows blood stains on shoulder belt, location of blood indicates belt usage in crash because that portion of belt would be inside retractor if belt was not worn in crash

actuated. He loaded his safety belt and his face and upper chest impacted his deployed air bag. The driver then moved to the right within his safety belt along a path opposite the case vehicle's 90 degree direction of principal force as the right rear side of the case vehicle impacted the left side of the Chevrolet. The case vehicle then departed the roadway and the front right corner impact with the traffic signal pole caused the driver to move forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated and he again loaded his safety belt. The case vehicle's impact with the corner of the building then caused the driver to continue forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated to a stop. The driver again loaded his safety belt fracturing three left ribs. The driver rebounded back into his seat and remained in the case vehicle until removed by medical personnel. The driver's use of his safety belt system and the deployment of his advanced air bag prevented him from impacting the steering wheel and instrument panel and reduced his injury potential.

CASE VEHICLE DRIVER INJURIES

The police crash report indicated the driver sustained a "B" (non-incapacitating-evident) injury and was transported by ambulance to a local hospital. The driver's medical records indicated he was admitted overnight for chest pain. The table below shows the case vehicle driver's interviewee reported injury and injury mechanism.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture three left ribs near sternum, not further specified	moderate 450220.2,2	Torso portion of safety belt system	Certain	Interviewee (same person) ¹

OTHER VEHICLE

The 1995 Chevrolet Caprice was a rear wheel drive, four-door sedan (VIN: 1G1BL52W4SR-----) equipped with a 4.3L, V8 engine; automatic transmission and driver and front right passenger air bags, which deployed as a result of the crash.

Exterior Damage: The Chevrolet was not inspected. CDCs could not be estimated because there were no available photographs of the damaged vehicle. Due to overlapping damage to the front of the case vehicle, there was insufficient information to use the WinSMASH reconstruction program, missing vehicle algorithm, to reconstruct the Delta Vs for the impact between the front of the case vehicle and the left side of the Chevrolet (i.e., event 1). However, the WinSMASH reconstruction program, missing vehicle algorithm, was used to reconstruct the side-slap impact

¹ This contractor did not receive any medical records that were directly related to the treatment this patient received as a result of his crash. Instead, this contractor received this patient's medical records from his admission following a gastrointestinal bleed that occurred two days post-crash and were related to a colonoscopy that had occurred seven days pre-crash. The available records document acute chest pain that was related to the motor vehicle crash. Plain film X-rays found no fractures nor explanation for this patient's chest pain.

between the right side of the case vehicle and the left side of the Chevrolet (i.e., event 2). The Chevrolet's Total, Longitudinal and Lateral Delta Vs for this impact were, respectively: 7.0 km.p.h (4.3 m.p.h.), 1.2 km.p.h. (0.7 m.p.h.) and 6.9 km.p.h. (4.3 m.p.h.). The Chevrolet was towed due to damage.

Chevrolet's Driver: According to the police crash report, the unlicensed driver of the Chevrolet [15-year-old, unknown race (Hispanic) male] was restrained by his manual, three-point, lap-and-shoulder safety belt system. The police crash report indicated the driver sustained no injury in the crash and was not transported to a medical facility.

Chevrolet's Front Right Passenger: According to the police crash report, the Chevrolet's front right passenger [15-year-old, unknown race (Hispanic) male] was restrained by his manual, three-point, lap-and-shoulder safety belt system. The police crash report indicated the front right passenger sustained no injury in the crash and was not transported to a medical facility.

Chevrolet's Back Right Passenger: According to the police crash report, the Chevrolet's back right passenger [14-year-old, unknown race (Hispanic) male] was restrained by his manual, three-point, lap-and-shoulder safety belt system. The police crash report indicated the back right passenger sustained no injury in the crash and was not transported to a medical facility.

