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Indiana University
Bloomington, Indiana 47403-1599

ON-SITE AIR BAG INVESTIGATION

CASE NUMBER - IN97-022
LOCATION - MISSISSIPPI
VEHICLE - 1993 FORD TAURUS GL
CRASH DATE - June, 1997

Submitted:

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

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

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16. <i>Abstract</i> This report covers an on-site investigation of an air bag deployment crash that involved a 1993 Ford Taurus GL (case vehicle) that ran off the roadway, striking a curb and a wooden utility pole. This crash is of special interest because the case vehicle's driver (79-year-old female) sustained fatal chest and abdominal injuries from contacting her deploying driver air bag module's cover flaps and air bag. The case vehicle was traveling north in the northbound lane of a two-lane, undivided, city street and intended to continue in its northbound direction of travel. The crash occurred when the northbound case vehicle angled left-of-center into the opposing traffic lane and struck the west curb of the city street and a wooden utility pole. The case vehicle came to rest heading north-northwest. The front of the case vehicle impacted the wooden utility pole, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. According to a witness, the case vehicle's driver was seen slumped over the steering wheel just prior to the impact. Her electronically-adjusted seat was in a forward position, but it is unknown (i.e., battery was damaged in the crash) if the post-crash position was the forward-most position that the seat could be extended. The driver seat back was in a reclined position, such that it is this contractor's opinion that the seat back was reclined post-crash by someone other than the driver. The tilt steering wheel was found in the middle position. She was not wearing her available, active, three-point, lap and shoulder belt and sustained, according to her medical records, fatal injuries which included: lacerations to the anterior surface of both lungs with bilateral hemopneumothoraces, multiple rib fractures (bilateral, most likely), a transverse fracture to the upper third of her sternum, a laceration to the anterior surface of her liver, and a laceration to her spleen at the lower pole. Exsanguination was listed as one of her causes of death. The Medical Examiner's "Narrative Summary" states: "The autopsy could find nothing to explain why (sic) patient was slumped over the steering wheel prior to impact. There were no cerebrovascular accident or myocardial infarction."					
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BACKGROUND

This on-site investigation was brought to NHTSA's attention on July 25, 1997 by a police officer at a city police department. This crash involved a 1993 Ford Taurus GL (case vehicle), that ran off the roadway, striking a curb and a wooden utility pole. The crash occurred in June, 1997, at 8:22 a.m., in Mississippi and was investigated by the applicable city police department's Accident Follow Up Unit. This crash is of special interest because the case vehicle's driver (79-year-old female) sustained fatal chest and abdominal injuries from contacting her deploying driver air bag module's cover flaps and air bag. This contractor inspected the scene and vehicle on July 30, 1997. A relative (i.e., son) of the case vehicle's driver was interviewed in early July, 1998.

SUMMARY

The case vehicle was traveling north in the northbound lane of a two-lane, undivided, city street and intended to continue in its northbound direction of travel. There was no scene evidence that would indicate that the case vehicle's driver attempted any avoidance maneuvers. The crash occurred when the northbound case vehicle angled left-of-center into the opposing traffic lane, struck the west curb of the city street, and impacted a wooden utility pole. The case vehicle came to rest heading north-northwest.

The front of the case vehicle impacted the wooden utility pole, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle's speed prior to the crash is unknown. This impact to the case vehicle was moderate [24-40 km.p.h. (15 to 25 m.p.h.)].

The case vehicle's driver [157 centimeters and 70 kilograms (62 inches, 155 pounds)] was not wearing her available, active, three-point, lap and shoulder belt. In addition, there was no evidence of belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's three-point, continuous loop, seat belt webbing, "D"-ring, and latch plate showed no evidence of loading and, in fact, infrequent use.

The case vehicle's driver made no avoidance maneuvers prior to the crash. A witness reported seeing the driver slumped over the steering wheel just prior to the first impact. As a result, the case vehicle's driver most likely did not move just prior to impact. The case vehicle's impact with the curb would have caused the driver to move further forward and/or slightly upward on the steering wheel. The case vehicle's primary impact with the wooden utility pole not only deployed the driver and front right air bags but thrust the driver upward and against the steering wheel containing the driver air bag module. As the driver's air bag deployed, the unbelted driver's abdominal and thoracic areas were struck by the deploying driver air bag module's cover flaps as she moved forward towards the zero degree direction of principle force (PDOF). Based on the available evidence, the left knee or leg of the driver struck the left lower side of the instrument panel, bending the brake release handle downward. It is possible that the driver's right hand and arm contacted the interior rearview mirror and the windshield, cracking the mirror and causing a small, chipped spot and slight spidering to the center of the windshield. The unfolding air bag propelled the case vehicle's driver backwards into her seat back. The case vehicle's driver contacted the interior surface of the driver's door causing some skin transfer near the window sill area. This contact coincides with a police officer verbally reporting that the driver was laying partially out of an open left front door at final rest.

The driver was transported by ambulance to a hospital, with CPR performed en route. She sustained fatal injuries and was pronounced dead 12 minutes after arriving at the emergency room (i.e., 37 minutes post-crash). According to her medical records, she sustained: lacerations to the anterior surface of both lungs with bilateral hemopneumothoraces, multiple rib fractures (bilateral, most likely), a transverse fracture to the upper third of her sternum, a laceration to the anterior surface of her liver, and a laceration to her spleen at the lower pole. Exsanguination was listed as one of her causes of death. The Medical Examiner's "Narrative Summary" states: "The autopsy could find nothing to explain why (sic) patient was slumped over the steering wheel prior to impact. There were no cerebrovascular accident or myocardial infarction. Maybe patient blacked out for some unknown reason."

The case vehicle was a 1993 Ford Taurus GL, 4-door sedan (VIN: 1FALP5246PA-----). The case vehicle was not equipped with anti-lock brakes. The case vehicle was towed from the scene due to damage. Based on the vehicle inspection, the CDCs were determined to be: **12-FZEW-2** for the pole impact [maximum crush was 43 centimeters (17 inches)], and **12-FLNW-3** for the curb impact. The WinSMASH reconstruction program, damage only algorithm, was used on the highest severity impact to the case vehicle. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 26 km.p.h. (16 m.p.h.), -26 km.p.h. (-16 m.p.h.), and 0 km.p.h. (0 m.p.h.). The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the driver air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and that there were two light-colored liquid stains in the right lower quadrant (approximately at the 4:30 to 5:30 clock position) and what appeared to be several blood stains on the underneath (reverse) side of the air bag (from 4:30 to 6:00 clock position). There was no cloth or skin transfer found on the upper half of the driver's air bag. An inspection of the air bag module's top cover flap revealed a possible scratch, and the bottom flap contained a small scratch, as well.

Immediately prior to the crash, the case vehicle's driver was slumped over the steering wheel. Her electronically-adjusted seat was in a forward position, but it is unknown (i.e., battery was damaged in the crash) if the post-crash position was the forward-most position that the seat could be extended. The driver seat back was in a reclined position, such that it is this contractor's opinion that the seat back was reclined post-crash by someone other than the driver. The tilt steering wheel was found in the middle position.

CRASH CIRCUMSTANCES

The case vehicle was northbound on a two-lane, undivided, city street and intended to continue its northerly travel path (see **Figure 1** below). It crossed over the single, broken yellow centerline, continued across the southbound lane, struck the west curb [concrete, 10 centimeters (4 inches) high], impacted a wooden utility pole (see **Figure 2** below), and came to rest facing north-northwest. The pavement was new asphalt--0.85 estimated coefficient of friction, perpendicular to the pole impact. The ambient weather conditions at the time of the crash were daylight, cloudy (no precipitation), and a dry pavement. The roadway was undivided, straight, and level (i.e., actual slope was 0.5% negative to the north). There were no view obstructions, traffic controls, or roadway defects. Although two of the witnesses indicated that the case vehicle was moving slowly (i.e., slowly enough to pass), they would not estimate its travel speed. The posted speed limit was 48 km.p.h. (30 m.p.h.).

Two northbound witnesses had followed and passed the case vehicle. Both witnesses said that for some unknown reason (i.e., specifically, one

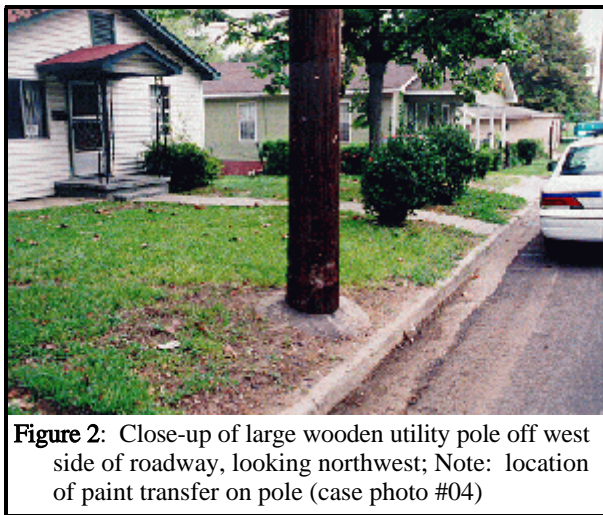


Figure 2: Close-up of large wooden utility pole off west side of roadway, looking northwest; Note: location of paint transfer on pole (case photo #04)

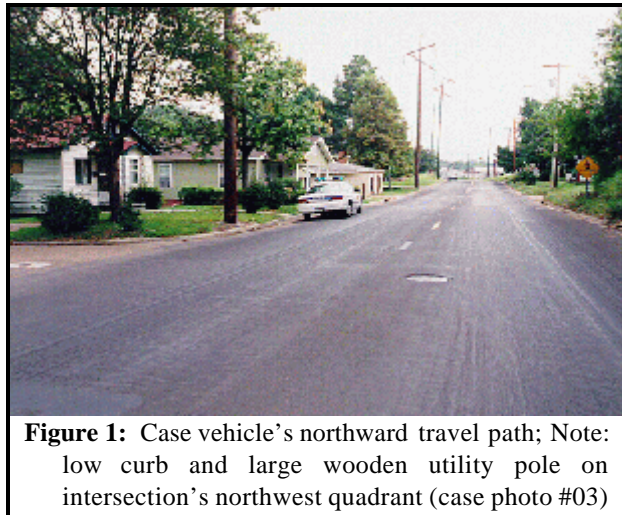


Figure 1: Case vehicle's northward travel path; Note: low curb and large wooden utility pole on intersection's northwest quadrant (case photo #03)

said that something made her think the case vehicle driver was not alright) they kept an eye (behind them) on the elderly case vehicle's driver. Both witnesses saw the case vehicle cross the southbound lane and impact the utility pole. They both turned around and drove to the crash scene to see if the case vehicle's driver needed help. A third witness, who was southbound in the opposing lane, saw the case vehicle cross into his travel lane and noticed its driver slumped over her steering wheel prior to impact. None of the three witnesses noticed any avoidance maneuvers by the case vehicle's driver.

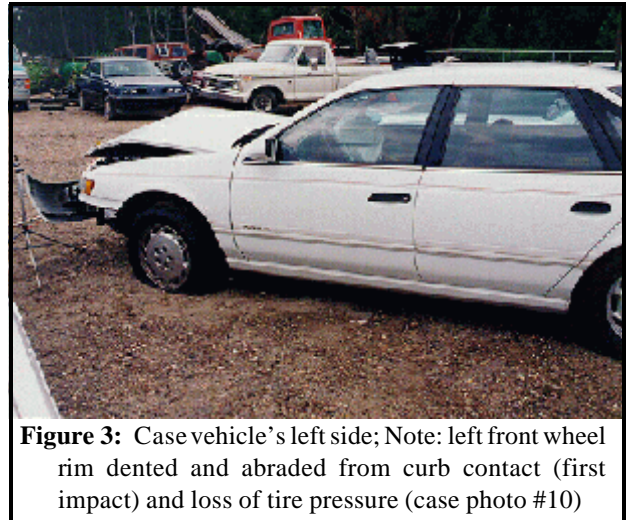
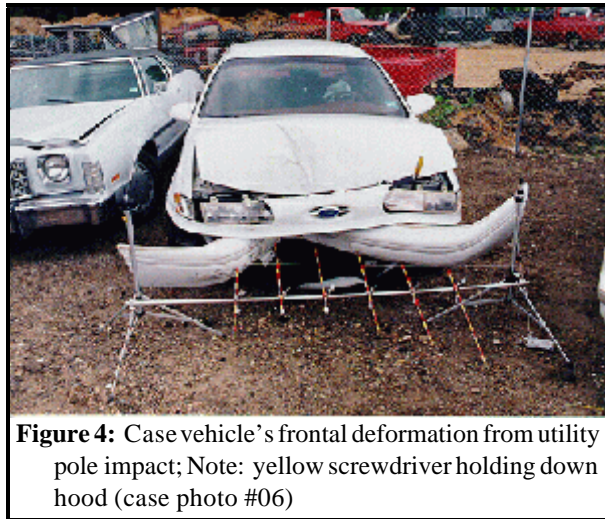
The case vehicle's left front tire struck the west curb. This first impact did not deploy the air bags. After striking the curb, the case vehicle continued northwestward and impacted a wooden utility pole, deploying the case vehicle's dual front air bags.. The case vehicle came to rest heading north-northwest.

CASE VEHICLE

The case vehicle was a front wheel drive 1993 Ford Taurus GL, four-door sedan (VIN: 1FALP5246PA-----). It was towed from the scene due to disabling damage. There was no positive indication it was equipped with optional, anti-lock brakes. The engine was a 3.8 liter, EFI, V-6, coupled to a four-speed, automatic transmission with its shift lever mounted to the steering column. Braking was achieved by power-assisted front disks and rear drums. During the vehicle inspection, the odometer showed 71,607 kilometers (44,496 miles).

Inspection of the case vehicle's interior revealed electric windows and door locks; electronic adjustable front bucket seats; three-point lap and shoulder belts at the front and rear outboard seat positions, and a two-point lap belt at the center rear seat position. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a driver air bag and a front right passenger air bag. Both front air bags deployed as a result of the wooden utility pole impact (i.e., the second impact of the crash sequence).

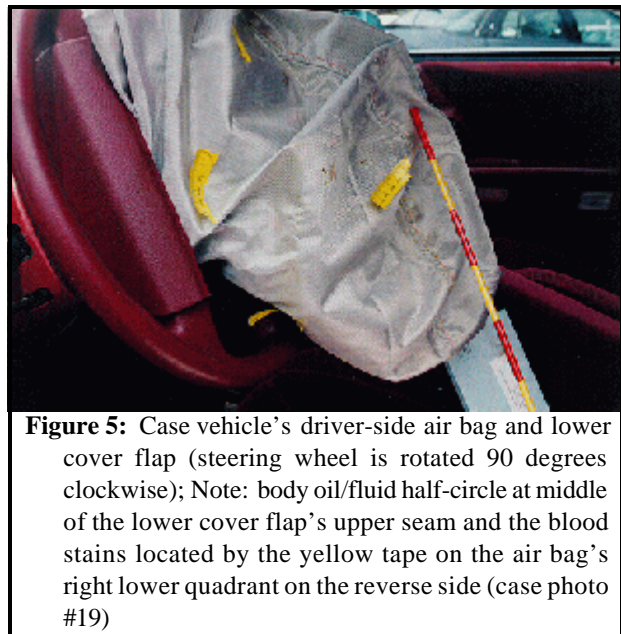
Contact with the 10 centimeter (4 inch), concrete barrier curb (first impact) dented and



(second impact) caused direct damage to the case vehicle's forward frame member, front splash guard, front bumper, front plastic grille, front right radiator and grille brackets, and the front right hood (see **Figure 4**). Direct damage width began at the front right bumper corner and extended 70.1 centimeters (27.6 inches) towards the front center of the vehicle. Impact with the wooden utility pole caused the case vehicle's driver and front right passenger air bags to deploy.

AUTOMATIC RESTRAINT SYSTEM

The 1993 Ford Taurus GL (case vehicle) was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. The air bags deployed as a result of the case vehicle's impact with a wooden utility pole (i.e., the second impact in the crash sequence). The driver air bag was located in the steering wheel hub (see **Figure 5**). The module's seams were in an asymmetrical, "H" configuration, with the larger, top cover flap measuring 20.5 centimeters (8.1 inches) along the horizontal seam and 5.5 centimeters (2.2 inches) along the vertical seam. The smaller, lower cover flap's dimensions were 20.5 centimeters (8.1 inches) horizontally and 2.0 centimeters (0.8 inches)



vertically. During the vehicle inspection, the steering wheel was found to be rotated 90 degrees clockwise. The air bag fabric was measured as an oblong shape, 63 centimeters (24.8 inches) high and 52 centimeters (20.5 inches) wide. This air bag was tethered by two cloth straps 6 centimeters (2.4 inches) wide and vented by two exhaust ports 2 centimeters (0.8 inches) in diameter. The exhaust ports were located at the 11 and 1 o'clock positions. The driver air bag module's cover flaps opened along the designated tear seams.

Possible driver contacts were detected on both cover flaps: a "dot" scratch was noted near the center of the upper flap (see **Figure 5** above) and a half-circle of body oil/fluid was detected at the center of the horizontal tear seam of the lower flap (see **Figure 6**). Buttons on the driver's blouse are suspected of causing the top mark and body contact causing the lower mark. As the driver air bag deployed, the close proximity of the driver's body to the steering wheel likely directed the air

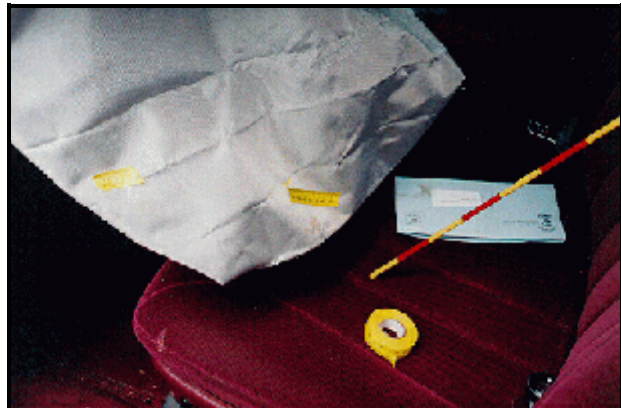


Figure 6: Case vehicle's driver-side air bag (steering wheel is rotated 90 degrees clockwise); Note: yellow tape locates areas of body oil/fluid on the lower right quadrant of the air bag's front surface (case photo #22)



Figure 7: Lower cover flap of case vehicle's driver side air bag module (steering wheel rotated 90 degrees clockwise); Note: yellow tape indicates suspected occupant contact points (case photo #23)

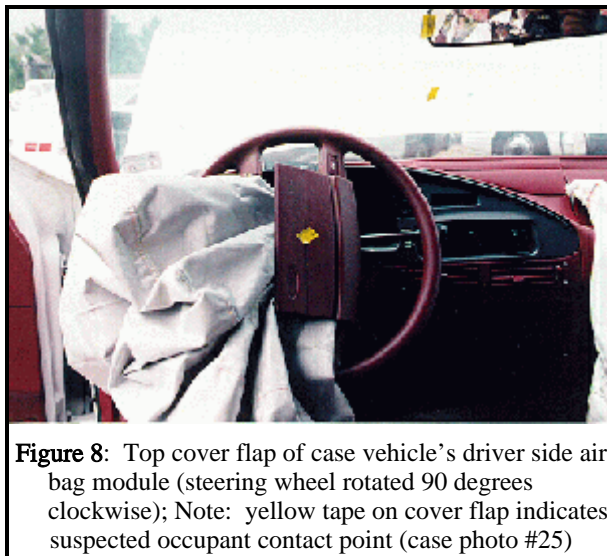


Figure 8: Top cover flap of case vehicle's driver side air bag module (steering wheel rotated 90 degrees clockwise); Note: yellow tape on cover flap indicates suspected occupant contact point (case photo #25)

bag upwards, allowing the driver to contact the lower right quadrant of the air bag's reverse side (see **Figure 7**). Blood stains on the lower reverse side were the major indication that the driver's body may have rerouted the deployment path of the air bag. Two blood stains were detected on the reverse side: one located 8.5 centimeters (3.3 inches) right of the longitudinal axis of the air bag and 4.5 centimeters (1.8 inches) down from the lateral axis; the other blood stain was located 4 centimeters (1.6 inches) right of the longitudinal axis and 10 centimeters (3.9 inches) down from the lateral axis. On the front surface of the driver air bag's lower right quadrant, three light-colored liquid stains were detected (see **Figure 6**). One was located 2.5 centimeters (1.0 inch) right of the longitudinal axis and 5.5 centimeters (2.2 inches) down from the lateral axis. The second was located 8

centimeters (3.1 inches) right of the longitudinal axis and 5.5 centimeters (2.2 inches) down from the lateral axis, and the third was located 5.5 centimeters (2.2 inches) right from the longitudinal axis and 1.5 centimeters (0.6 inches) up from the air bag's bottom seam. Two black transfer marks from the air bag's expansion against the module's interior surfaces were noted on the front, lower right quadrant of the air bag. The first black mark was centered 2.5 centimeters (1.0 inch) right of the longitudinal axis and 4.0 centimeters (1.6 inches) down from the lateral axis, and the second black mark was centered 5.5 centimeters (2.2 inches) right of the longitudinal axis and immediately above the bottom stitched seam.

The front right passenger air bag also deployed when the case vehicle impacted the wooden utility pole. The front right passenger air bag module's assembly was mounted at the top of the instrument panel's right side. The tear seams of the front right module were in a symmetrical "H" configuration, with both the upper and lower cover flaps measuring 31 centimeters (12.2 inches) horizontally and 3 centimeters (1.2 inches) vertically. The front right air bag opened along the designated tear seams. The front right air bag fabric was rectangular in shape, measuring 30 centimeters (11.8 inches) high and 89 centimeters (35.0 inches) wide. No tether straps were detected, but two vent ports, 2.5 centimeters (1.0 inch) in diameter, were located at the 6 and 8 clock positions. The leading edge of the lower cover flap was 6 centimeters (2.4 inches) forward of the front of the instrument panel. There was no evidence of occupant contact to the front right passenger air bag. This module's top cover flap did not contact the windshield.

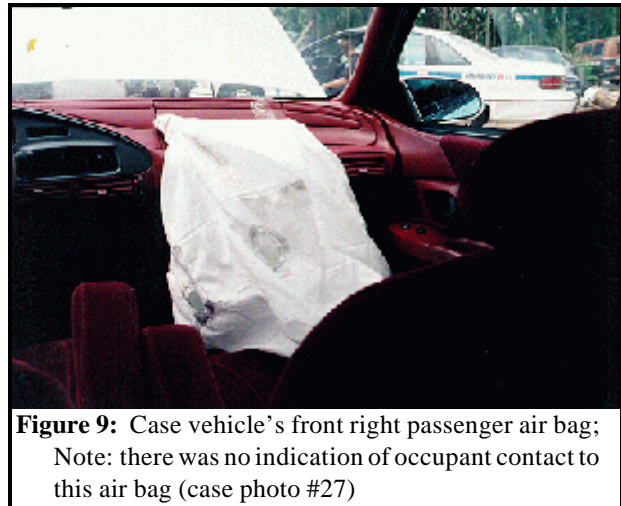


Figure 9: Case vehicle's front right passenger air bag; Note: there was no indication of occupant contact to this air bag (case photo #27)

CASE VEHICLE OCCUPANT

The driver of the case vehicle [79-year-old female, 155 centimeters and 70 kilograms (61 inches and 155 pounds)] was not wearing her available, active, three-point, lap and shoulder belt. In addition, there was no evidence of belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's three-point, continuous loop, seat belt webbing, "D"-ring, and latch plate showed no evidence of loading and, in fact, infrequent use. The driver was transported by ambulance to a medical facility, with CPR performed en route. The driver was pronounced dead 12 minutes after arriving at the emergency room (37 minutes post-crash).

CASE VEHICLE DRIVER KINEMATICS

A relative of the case vehicle's driver indicated during an interview that the driver characteristically sat upright in her seat, with her left foot on the floor and her right foot either on the accelerator or the brake pedal. Further, she drove with her back against the seat back and both hands on the steering wheel. Given the driver's short stature, her seat track was usually in the forward-most position. The relative was unsure as to the normal angle of the driver's seat back. The vehicle inspection indicated that her electronically-adjusted seat was in a forward position, but it is unknown (i.e., battery was damaged in the crash) if the post-crash position was the forward-most position that the seat could be extended. The driver seat back was in a reclined position, such that it is this contractor's opinion that the seat back was reclined post-crash by someone other than the driver. The tilt steering wheel was found in the middle position.

A witness reported the case vehicle's driver was slumped over the steering wheel as the vehicle angled across the opposing traffic lane prior to impacting the curb and wooden utility pole. As a result, the case vehicle's driver most likely did not move just prior to impact. The case vehicle's impact with the curb would have caused the driver to move further forward and/or slightly upward on the steering wheel [i.e., the driver's body may have slightly straightened from the slumped position over the steering wheel (forward motion) and raised upwards a small amount from this barrier curb impact]. From contact with the curb to the utility pole impact, the front of the case vehicle traveled less than 2 meters (6.6 feet), with the driver's body moving very little.



Figure #10: Case vehicle's left lower instrument panel; Note: indications of occupant contact and the down-ward displacement of the parking brake release handle (case photo #18)



Figure 11: Interior view of case vehicle's left front door; Note: yellow tape defines area of skin transfer and body oil deposits; also note the absence of heavy im-pact to the door panel and door latch (case photo #14)

The case vehicle's primary impact with the wooden utility pole not only deployed the driver and front right air bags, but thrust the driver upward and against the steering wheel containing the driver air bag module as she moved forward towards the zero degree direction of principle force (PDOF). As the driver's air bag deployed, the unbelted driver's abdominal and thoracic areas were struck by the deploying driver air bag module's cover flaps. The cover flaps caused injury to her lungs, sternum, ribs, liver, and spleen. Based on the available evidence, the left knee or leg of the driver stuck the left lower side of the instrument panel, bending the brake release handle downward (see **Figure 10**); however, no lower extremity injuries were cited.

Because the driver was so close to the steering wheel hub at the time of the air bag's deployment, it is believed that the driver's body redirected the air bag from its intended path to a more vertical track. It is thought that the redirected air bag helped carry the driver's right arm and hand into contact with the interior rearview mirror and the windshield (left of center). The interior rearview mirror was cracked, and the windshield had a small, chipped spot and slight spidering to the center of the windshield. Once again, no upper extremity injuries were noted in her available medical records. On the other hand, it is also possible that the rearview mirror contact resulted from the deploying front right air bag.

The unfolding air bag propelled the case vehicle's driver backwards into her seat back. The case vehicle's driver contacted the interior surface of the driver's door (see **Figure 11** above and **Figure 12**) causing some skin transfer near the window sill area. This contact coincides with the investigating police officer verbally reporting that the driver was laying partially out of an open left front door at final rest.



Figure 12: Close-up of case vehicle's left front door panel; Note: yellow tape indicates beginning (on towards the front) of skin transfer and body oil deposits on the window sill; note also the absence of heavy contact to the door panel(case photo #15)

CASE VEHICLE DRIVER INJURIES¹

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Lacerated {minute perforations} lungs ² bilateral anterior surfaces with bilateral hemopneumothoraces	441450.4 severe	Air bag top cover flap, driver's side	Certain ³	Autopsy
2	Fractured (greenstick type) ribs, multiple--specific ribs not specified, but most likely bilateral ⁴	450220.2 moderate	Air bag top cover flap, driver's side	Certain ³	Autopsy

¹ According to the Report of Investigation by the County Medical Examiner one of the listed causes of death was **exsanguination**. According to DORLAND'S ILLUSTRATED MEDICAL DICTIONARY this term is defined as follows: *exsanguination (ek-sang''wī-na-shen)*: extensive loss of blood due to internal or external hemorrhage. Although both hemoperitoneum and bilateral hemothorax were cited in the autopsy, no quantification of the "blood loss" was reported.

² Both lungs were also collapsed.

³ Although the autopsy indicated thoracic and abdominal cavity injuries, there was no mention made of any integumentary injuries which could have helped to support the Injury Source Confidence levels.

⁴ The only specific fracture location cited in the autopsy was at the left hemiclavicular (i.e., mid-clavicular) line, anteriorly; however, because the autopsy indicated that the anterior surface of both lungs were perforated by the fractured ribs, it logically follows that the ribs were fractured bilaterally.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
3	Fracture, transverse, upper third of sternum	450804.2 moderate	Air bag top cover flap, driver's side	Certain ³	Autopsy
4	Laceration anterior surface of liver, close to anterior edge	541820.2 moderate	Air bag bottom cover flap, driver's side	Probable ³	Autopsy
5	Laceration spleen at lower pole	544220.2 moderate	Air bag bottom cover flap, driver's side	Probable ³	Autopsy

SELECTED PHOTOGRAPHS



Figure 13: Case vehicle's undamaged back and right side (case photo #12)

SELECTED PHOTOGRAPHS (Continued)



Figure 14: Reference line view of case vehicle's frontal damage from right (case photo #13)