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REMOTE AIR BAG DEPLOYMENT REPORT

CASE NUMBER - IN99-016
LOCATION - COLORADO
VEHICLE - 1998 TOYOTA CAMRY LE
CRASH DATE - June 1998

Submitted:

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Contract Number: DTNH22-94-D-17058

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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* Remote air bag deployment investigation involving a 1998 Toyota Camry LE, four-door sedan, with manual safety belts and dual redesigned front air bags, and a 1994 Lexus LS 400, four-door sedan			
16. *Abstract* This report covers a remote investigation of an air bag deployment crash that involved a 1998 Toyota Camry LE (case vehicle, vehicle #2) and a 1994 Toyota Lexus LS400 (vehicle #1). This crash is of special interest because the case vehicle was equipped with redesigned air bags that deployed as a result of collision events, and the case vehicle's restrained driver (54-year-old male) and restrained front right passenger (54-year-old female) were both killed. The case vehicle (vehicle #2) was traveling south in the southbound lane of a two-lane, undivided, U.S. highway. Vehicle #1 was traveling north in the northbound lane of the same U.S. highway. The crash occurred in the southbound lane. The left two-thirds of the case vehicle's frontal plane was impacted by the front of vehicle #1, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle rotated approximately 210 degrees counterclockwise and came to rest off the west roadside heading north-northwest. Vehicle #1 also rotated counterclockwise, then rolled four ¼ turns about its longitudinal axis, before coming to rest straddling the east shoulder heading west. There is no knowledge of the pre-crash posture or seat adjustments of the case vehicle's occupants. The restrained driver contacted his air bag and the steering wheel and sustained both fatal and serious injuries that included: a lacerated heart and pericardial sac, lacerated aorta, bilateral lung contusions, bilateral lung lacerations, bilateral rib fractures, a fractured sternum, fractured thoracic vertebra at T_4, lacerations to his left hemidiaphragm, stomach, liver, spleen, and gallbladder, and many other fractures, lacerations, abrasions, and contusions. No autopsy was performed on the restrained front right passenger; the extent of her injuries is unknown, but she died 3 hours and 55 minutes post-crash.			
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BACKGROUND

IN99-016

This case was brought to the NHTSA's attention by a review of the 1998 Fatality Analysis Reporting System (FARS) in February 1999. The crash involved a 1998 Toyota Camry LE (case vehicle, vehicle #2) and a 1994 Lexus LS 400 (vehicle #1). The crash occurred in June, 1998, at 4:05 p.m., in Colorado, and was investigated by the applicable state patrol. This crash is of special interest because the case vehicle was equipped with redesigned air bags that deployed as a result of collision events, and the case vehicle's restrained driver [54-year-old, White (unknown if Hispanic) male] and restrained front right passenger [54-year-old, (race and Hispanic origin unknown) female] were both killed. The Police Crash Report was received in March, 1999; police photographs were received in May, and a complete autopsy report, for the case vehicle's driver, was received in June. No autopsy was performed on the case vehicle's front right passenger. This report is based on the Police Crash Report, the autopsy report on the driver, the front right passenger's death certificate, police photographs, occupant kinematic principles, and this contractor's evaluation of the evidence. This is FARS-1998-08-0211.

CRASH CIRCUMSTANCES

The case vehicle (vehicle #2) was traveling south in the southbound lane of a two-lane, undivided, U.S. highway **(Figure 1**) and, presumably, intended to continue in her southward path of travel. Vehicle #1 was traveling north in the northbound lane of the same U.S. roadway, most likely intending to continue northward. It was daylight, and there was no adverse weather. The roadway was bituminous, dry, straight, and level. Posted speed limit was 105 km.p.h. (65 m.p.h.), and the travel speed for each involved vehicle was estimated by investigating officers to be the same [i.e., 105 km.p.h. (65 m.p.h.)]. The only traffic control devices present were a single broken yellow centerline and a single solid white edge line on each side of the pavement. All were clearly visible. There were no crash avoidance maneuvers visible in police photographs or reported for either vehicle by investigating officers. The crash occurred in the southbound lane of the roadway.

Figure 1: Case vehicle's southbound travel path showing absence of pre-impact braking marks; Note: case vehicle off road to right of Trooper, vehicle #1 off road to left (case photo #01)

The left two-thirds of the case vehicle's frontal plane was impacted by the front of vehicle #1 (**Figure 2**), causing the case vehicle's driver and front right passenger air bags to deploy. The case vehicle rotated approximately 210 degrees counterclockwise and its center of gravity traveled south-southwestward off the west pavement edge, across the asphalt shoulder, and down a slight embankment--a distance of nearly 8.5 meters (28 feet). The case vehicle was facing north-northwestward at final rest. Vehicle #1 also began a

Figure 2: Case vehicle's frontal and left side direct damage; Note: post-crash location of left front wheel and upper/lower "A"-pillar (case photo #10)

post-impact counterclockwise rotation as well, traveling 9.2 meters (30.2 feet) before initiating a 360 degree rollover (i.e., four ¼ turns) about its longitudinal axis. Vehicle #1 traveled an additional 10.8 meters (35.5 feet) in a north-northeasterly direction during its rollover and came to rest on its wheels facing west, with its damaged frontal plane on the east edge line and its rear on the east roadside (**Figure 1** above). The crash severity for the case vehicle was high [greater than 40 km.p.h. (25 m.p.h.)].

CASE VEHICLE (VEHICLE #2)

The case vehicle was a front wheel drive, 1998 Toyota Camry LE, five-passenger, four-door sedan (VIN: JT2BG22K1W0------) equipped with a 2.2 liter, I-4, gasoline engine and a four-speed manual transmission; the location of the shift lever is not known. Four-wheel anti-lock brakes were an option for this vehicle, but it is not known if the case vehicle was so equipped. The wheelbase for the case vehicle was 267 centimeters (105.2 inches). No odometer reading was reported. The case vehicle was towed from the scene due to disabling damage.

Figure 3: Case vehicle's frontal damage; Note: right fender shifted to left (case photo #09)

The case vehicle sustained direct contact damage to the left two-thirds of the front (**Figure 3**). Damaged components included: the left two-thirds of the **front fascia** (torn off); the **front bumper** (shoved rearward); **front splash pan** (pushed rearward); **grille**, **engine** compartment front **brackets**, and **radiator** (crushed rearward); **right fender** (pulled leftward); **front headlamp assemblies** (shattered); **hood** (pressed downward onto engine and the rear edge rippled and thrust into the windshield); **left fender** (shoved into the cowl and lower left "A"-pillar); **left front tire and wheel** (crushed rearward into lower "A"-pillar and top of tire tilted inwards at a 30-degree angle); **left "A"-pillar** (lower and upper shoved into a near vertical line); **left side roof** and **roof rail** (buckled at the upper "B"-pillar); **windshield**--in front of the driver's position, holed and extensively cracked (the left rear portion of the hood penetrated it); **left front door** (forward portion of door panel penetrated the driver's compartment; top of the door frame pulled outward at a 45 degree angle); and both **left front and left rear door glazings** [shattered ("kernelized")]. Based on the police photographs, the CDC for the case vehicle was estimated as: **12-FYAW-6 (-10)**. The WinSMASH reconstruction program, CDC-only algorithm, provided a borderline reconstruction, but the results appear reasonable. The case vehicle's estimated Total, Longitudinal, and Lateral Delta Vs are, respectively: 95.5 km.p.h. (59.3 m.p.h.), -94.0 km.p.h. (-58.4 m.p.h.), and 16.6 km.p.h. (10.3 m.p.h.).

Interior damage to the case vehicle was difficult to assess with the available photographs. The driver's seating area was reduced by intrusion of the left side of the instrument panel, steering wheel and column, windshield, left front door panel, and the left roof rail and roof (**Figure 2** above). The driver's seat was also displaced rearward. The steering column and wheel were relocated rearward and downward from their original positions.

CASE VEHICLE OCCUPANTS

There were two front seat occupants in the case vehicle.

CASE VEHICLE DRIVER

The case vehicle's driver [188 centimeters, 101 kilograms (74 inches, 222 pounds)] was wearing his available, active, three-point, lap and shoulder safety belt system. His pre-crash seat adjustments, steering wheel position, and posture are not known. He was declared dead at the crash scene and was transported, initially, to a funeral home. The following discussion of the driver's injuries is based on a complete autopsy report, on-scene police photographs (i.e., all photographs were exterior vehicle views, with front seat interior details only ancillary and unclearly depicted), and occupant kinematic principles.

The case vehicle's driver was probably seated in a normal driving posture with his back against the seat back, at least one hand on the steering wheel, and his feet on a foot control and the floor. There was no indication from investigating officers or scene photographs that this driver attempted any avoidance maneuvers prior to impact. The vehicle-to-vehicle impact caused the case vehicle's driver and front right passenger air bags to deploy. The driver moved forward and slightly to the left. He contacted his deploying air bag and deflated it as the front windshield, instrument panel, steering column and wheel, toe pan, left upper "A"-pillar, left front door panel, and left roof rail and roof all intruded into the driver's seating area. The case vehicle's driver impacted the air bag in his face and torso causing numerous abrasions and contusions to his forehead, nose, bilateral orbit areas, bilateral upper extremities, and abdomen. As the air bag was deflated by the driver's continued forward movement, he sustained chest and abdominal injuries by loading the steering wheel hub, spokes, and rim. The chest and abdominal injuries included: a lacerated heart and pericardial sac; lacerated aorta; bilateral contused lungs; bilateral lacerated lungs; bilateral rib fractures; a fractured sternum; fractured thoracic vertebra at T_4; lacerations to his left hemidiaphragm, stomach, liver, spleen, and gallbladder; compound fractures to his left humerus, radius, and ulna; a fractured symphysis pubis; and a contused penis. As the left upper "A"-pillar, windshield, hood, instrument panel, and toe pan were crushed rearward and the case vehicle began its counterclockwise rotation, additional injuries to the driver occurred. These included: a basilar hinge fracture, subdural and subarachnoid hemorrhages, a lacerated left parieto-occipital region, multiple fractures to both lower extremities, and a multiplicity of integumentary abrasions, contusions, and small lacerations. Given that the total Delta V for the case vehicle approached 96.6 km.p.h. (60 m.p.h.), this collision is considered virtually nonsurvivable by this contractor.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Laceration/rupture right atrium and ventricle and apex of left ventricle including chordae tendineae	441016.6 untreatable	Steering wheel hub/spoke and/or rim	Probable	Autopsy
2	Lacerations, three, descending aorta; two just distal to origin of left subclavian artery and one at the T_4 area	420210.5 critical	Steering wheel hub/spoke and/or rim	Probable	Autopsy
3	Laceration pericardial sac, not further specified	441602.2 moderate	Steering wheel hub/spoke and/or rim	Probable	Autopsy
4	Contusions bilateral lungs (all five lung lobes) with bilateral hemothoraces	441410.4 severe	Steering wheel hub/spoke and/or rim	Probable	Autopsy
5	Lacerations bilateral lungs including hilar region of left lung and perihilar portion of right lung	441450.4 severe	Steering wheel hub/spoke and/or rim	Probable	Autopsy
6	Laceration {rupture} left hemidiaphragm with fragments of liver and spleen in the left chest cavity	440604.3 serious	Steering wheel hub/spoke and/or rim	Probable	Autopsy
7	Laceration {rupture} stomach, no gastric content is retained	544426.4 severe	Steering wheel hub/spoke and/or rim	Probable	Autopsy
8	Lacerations, deep, liver, involving right and left lobes; there was morcellation[1] of the caudate and quadrate lobes and they were mostly in the left chest cavity	541826.4 severe	Steering wheel hub/spoke and/or rim	Probable	Autopsy
9	Laceration {rupture} gallbladder	541224.3 serious	Steering wheel hub/spoke and/or rim	Probable	Autopsy
10	Lacerations, multiple, spleen, transverse and longitudinal, not further specified	544220.2 moderate	Steering wheel hub/spoke and/or rim	Probable	Autopsy

[1] The following term is defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
morcellation (mor"sel-a shen): the division of solid tissue (as a tumor) into pieces, followed by its removal piecemeal.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
11	Contusion penis, gland and shaft	543010.1 minor	Steering wheel rim	Probable	Autopsy
12	Hemorrhage, minimal, subdural, location not specified [Aspect = Unknown]	140652.4 severe	Left "A"-pillar and/or driver's front header	Probable	Autopsy
13	Hemorrhage, minimal, subarachnoid, location not specified [Aspect = Unknown]	140684.3 serious	Left "A"-pillar and/or driver's front header	Probable	Autopsy
14	Fracture, multiple, basilar, including a stellate fracture of the left supraorbital plate and a transverse hinge fracture through the middle cranial fossa involving the sella turcica	150206.4 severe	Left "A"-pillar and/or driver's front header	Probable	Autopsy
15	Fracture, transverse, massive, middle **a** of sternum	450804.2 moderate	Steering wheel hub/spoke and/or rim	Probable	Autopsy
16	Fractured ribs, bilaterally, left: 1-9 in midclavicular line and 3-5 in anterior axillary line; right: 1-10 in midclavicular line, and 2-4 at parasternal position	450240.4 severe	Steering wheel hub/spoke and/or rim	Probable	Autopsy
17	Fracture, transverse, gaping, at T_4, aorta is transected at this level as well	650416.2 moderate	Steering wheel hub/spoke and/or rim	Probable	Autopsy
18	Fracture left clavicle at sternoclavicular junction	752200.2 moderate	Safety belt webbing	Possible	Autopsy
19	Fracture, compound[2], left distal humerus near the elbow	752604.3 serious	Steering wheel rim	Possible	Autopsy
20	Fracture, compound[2], left proximal radius	752804.3 serious	Steering wheel rim	Possible	Autopsy
21	Fracture, compound[3], left middle forearm, radius or ulna not specified	751800.2 moderate	Steering wheel rim	Possible	Autopsy
22	Separation {fracture}, wide, symphysis pubis	853000.3 serious	Steering wheel rim	Probable	Autopsy
23	Fracture {hypermobility} middle **a** of left femur	851814.3 serious	Left instrument panel and below	Probable	Autopsy

[2] There was an 11 x 5 centimeter (4.3 x 2.0 inch) laceration overlying the distal humerus and proximal radial fractures.

[3] Lacerations, 10 x 4 centimeters (3.9 x 1.6 inches) were associated with this fracture.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
24	Fracture, compound[4], right patella in the midline	852400.2 moderate	Left instrument panel and below	Probable	Autopsy
25 26	Fractures proximal right tibia and proximal right fibula, just below knee	853422.3 serious 851610.2 moderate	Left instrument panel and below	Probable	Autopsy
27 28	Fractures, compound[5], proximal left tibia and proximal left fibula	853422.3 serious 851610.2 moderate	Left instrument panel and below	Probable	Autopsy
29 30	Fractures, compound[6], distal right tibia and fibula	853422.3 serious 851610.2 moderate	Foot controls	Possible	Autopsy
31	Laceration, vertically oriented, gaping, right temporoparietal region, 5 x 2 centimeters (2.0 x 0.8 inches)	190602.1 minor	Front header, driver's side	Possible	Autopsy
32	Laceration, gaping, left parieto-occipital region, 7 x 6 centimeters (2.8 x 2.4 inches), with partial avulsion of the scalp	190602.1 minor	Left "A"-pillar	Possible	Autopsy
33	Laceration, transverse, 3.5 x 1.0 centimeters (1.4 x 0.4 inches) left forehead	290602.1 minor	Flying glass	Possible	Autopsy
34	Abrasions forehead, above the left forehead laceration and over the medial right eyebrow	290202.1 minor	Air bag, driver's	Possible	Autopsy
35 36	Abrasions left periorbital region Abrasions lateral right upper and lower eyelids	297202.1 minor 297202.1 minor	Air bag, driver's	Possible	Autopsy
37	Laceration, diagonal, left periorbital, 3.0 x 0.5 centimeters (1.2 x 0.2 inches)	297600.1 minor	Flying glass	Possible	Autopsy

[4] There was a 9 x 10 centimeter (3.5 x 3.9 inch) transverse laceration to the right knee, with the knee joint hypermobile.

[5] There is 30 x 11 centimeter (11.8 x 4.3 inch), longitudinally oriented, gaping laceration over the medial aspect of the left lower extremity.

[6] There is a 12 x 6 centimeter (4.7 x 2.4 inch) transverse laceration to the right ankle with the distal portion of the right tibia and fibula projecting through the laceration.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
38	Contusion left bridge of nose	290402.1 minor	Air bag, driver's	Possible	Autopsy
39	Laceration left bridge of nose, 1.5 x 0.8 centimeters	290602.1 minor	Flying glass	Possible	Autopsy
40	Contusions beneath left nipple	490402.1 minor	Steering wheel hub/spoke and/or rim	Probable	Autopsy
41	Abrasions right upper quadrant of abdomen	590202.1 minor	Air bag, driver's	Probable	Autopsy
42	Contusions right lower quadrant of abdomen	590402.1 minor	Steering wheel hub/spoke and/or rim	Probable	Autopsy
43	Abrasions above left clavicle	790202.1 minor	Safety belt webbing, driver's	Probable	Autopsy
44	Abrasion, 11 x 6 centimeters (4.3 x 2.4 inches) lateral left upper arm at supra axillary level	790202.1 minor	Air bag, driver's	Possible	Autopsy
45	Contusions, 6 x 4 centimeters (2.4 x 1.6 inches) overlying left biceps muscle (left upper arm) and 11 x 4 centimeters (4.3 x 1.6 inches) over medial right lower **a** upper arm and antecubital fossa [Aspect = bilateral]	790402.1 minor	Steering wheel rim	Probable	Autopsy
46	Contusions lateral left wrist and dorsum left hand and left little and ring (5TH & 4TH) fingers at base	790402.1 minor	Left instrument panel and below	Probable	Autopsy
47	Abrasions over right lower **a** upper arm and antecubital fossa	790202.1 minor	Air bag, driver's	Probable	Autopsy
48	Abrasions right forearm, dorsolateral for the lower **b**s and medial for upper **a**--15 x 2 centimeters (5.9 x 0.8 inches)	790202.1 minor	Air bag, driver's	Probable	Autopsy
49	Contusions right forearm, dorsolateral for the lower **b**s and medial for upper **a**--15 x 2 centimeters (5.9 x 0.8 inches)	790402.1 minor	Air bag, driver's	Probable	Autopsy
50	Contusions, posterior (dorsum) right wrist and hand	790402.1 minor	Left instrument panel and below	Possible	Autopsy

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
51	Avulsion, partial, right little fingernail	790602.1 minor	Left instrument panel and below	Possible	Autopsy
52	Abrasions, 15 x 7 centimeters (5.9 x 2.8 inches), posterior left upper thigh	890202.1 minor	Seat, driver's	Probable	Autopsy
53	Contusion, 15 x 7 centimeters (5.9 x 2.8 inches), posterior left upper thigh	890402.1 minor	Seat, driver's	Probable	Autopsy
54	Lacerations, 8 x 4 centimeters (3.1 x 1.6 inches), parallel, over medial right lower leg	890602.1 minor	Left instrument panel and below	Probable	Autopsy
55	Contusion, lateromedial right foot	890402.1 minor	Toe pan and/or foot controls	Possible	Autopsy
56	Abrasions left thigh: diagonal, 15 x 2 centimeters (5.9 x 0.4 inches,) left upper anterior thigh; parallel, 9 x 2 centi-meters (3.5 x 0.4 inches) mid-dle anterior thigh; and rectan-gular anteromedial middle thigh	890202.1 minor	Steering wheel rim	Possible	Autopsy
57	Abrasions above and below left knee	890202.1 minor	Left instrument panel and below	Probable	Autopsy
58	Lacerations x 2, midline left knee	890602.1 minor	Left instrument panel and below	Probable	Autopsy
59	Laceration, 6 x 3 centimeters (2.4 x 1.2 inches) lateral middle **a** left lower leg	890602.1 minor	Left side interior surface excluding, hardware/armrest	Probable	Autopsy
60	Contusions left ankle and left distal foot	890402.1 minor	Left side interior surface excluding, hardware/armrest	Possible	Autopsy
61	Contusion left great toe	890402.1 minor	Toe pan	Possible	Autopsy
62	Lacerations, transverse, left great toe (1ST) and left little toe (5TH)	890602.1 minor	Toe pan	Possible	Autopsy

CASE VEHICLE FRONT RIGHT PASSENGER

The case vehicle's front right passenger (height and weight unknown) was wearing her available, active, three-point, lap and shoulder safety belt system. Her pre-crash seat adjustments and posture are

not known. She was transported from the scene to a medical facility by ambulance and was pronounced dead 3 hours and 55 minutes post-crash. No autopsy was performed, but her Death Certificate indicated that she died of massive trauma to her head and chest. The only other observations for this occupant are that the right front door was most likely sprung open by the severe shift of the right fender to the left, and her air bag seemed embedded atop the right instrument panel and against the windshield's interior. Her kinematics are assumed to be a mirror of the driver's movements (i.e, she would have moved forward and slightly to the left at-impact and, as the case vehicle began its post-impact, counterclockwise rotation, she would have moved further to the left). No photographs are available to detail possible interior contact points by this passenger.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Traumatic brain injury, not further specified *{massive trauma to head}*	115299.7 unknown	Unknown contact mechanism	Unknown	Other: Death Certificate
2	Thoracic cavity injury, not further specified *{massive trauma to chest}*	442299.7 unknown	Unknown contact mechanism	Unknown	Other: Death Certificate

VEHICLE #1

Vehicle #1 was a rear wheel drive, 1994 Lexus LS 400, five-passenger, four-door sedan (VIN: JT8UF11E7R0------), equipped with 4.0 liter, V-8, gasoline engine and a four-speed automatic transmission. Vehicle #1 was equipped with four-wheel anti-lock brakes. The wheelbase was 281 centimeters (110.8 inches), but no odometer reading was reported. Vehicle #1 was towed from the scene due to disabling damage. From the collision with the case vehicle, direct contact damage (**Figure 4**) to vehicle #1 included: the **front bumper fascia** (torn off and the bumper's left end crushed rearward and slightly upwards), **grille and headlamp assemblies** (shattered), **hood** (pushed rearward and buckled, with its front edge bent downward), **front engine** compartment **brackets** (crushed rearward), **left fender and left front tire and wheel** (pushed rearward), lower **left "A"-pillar** (crushed rearward),

Figure 4: Vehicle #1's damaged frontal plane; Note: vertical bumper shift from impact with case vehicle (case photo #14)

Figure 5: Vehicle #1's post-impact travel path; Note: right front and right rear tire trip points for vehicle's rollover (case photo #07)

engine (pushed into the cowl), and **cowl** (shoved into the passenger compartment). Based on the available police photographs, the CDCs for vehicle #1's two impacts were: **12-FYEW-5** and **00-TDDO-3** (**Figures 4** and **5**). Vehicle #1's driver [70-year-old female--race, Hispanic origin, height, and weight unknown] was wearing her available, active, three-point, lap and shoulder safety belt system. She was the only occupant in vehicle #1. Her pre-crash seat adjustments, steering wheel position, and posture are not known. She was pronounced dead at the scene and transported to a funeral home.