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SCI/NASS COMBINATION CASE REPORT

CASE NUMBER - NASS-99-41-042J

LOCATION - FLORIDA

VEHICLE - 1998 TOYOTA AVALON

CRASH DATE - March 1999

Submitted:

April 21, 2000

Revised:

June 7, 2000



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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| 16. <i>Abstract</i> This report covers a SCI/NASS combination case concerning a side air bag deployment crash that involved a 1998 Toyota Avalon (case vehicle) and a 1989 Mercury Cougar LS (vehicle #2). This crash is of special interest because the case vehicle was equipped with side air bags and the front right passenger's side air bag deployed as a result of collision events. The restrained front right passenger (41-year-old female, race/ethnicity unknown) sustained a fractured left clavicle and loss of consciousness at the scene. The case vehicle was traveling west in the outside westbound lane of a four-lane, two-way, undivided, state highway, approaching a four-leg intersection and intending to continue westbound. Vehicle #2 was traveling south in the outside, southbound through lane of a four-lane (left and right turn lanes and two through lanes) roadway that was part of a six-lane (estimated), divided, state trafficway, approaching the same four-leg intersection. The right side of the case vehicle was impacted by the front of vehicle #2, causing the case vehicle's front right passenger side air bag to deploy; the only air bag to deploy of the four available in the case vehicle. The case vehicle rotated clockwise and rolled two quarter-rolls onto its top. It came to rest atop a guardrail and a traffic sign on the intersection's southwest quadrant, facing southwest. Vehicle #2 rotated clockwise and came to rest in its original travel lane facing northwest. The case vehicle's front right passenger was airlifted from the crash scene and hospitalized for two days. Both the case vehicle's restrained driver and restrained second seat right passenger sustained incapacitating injuries, were transported by ambulance, and admitted to a hospital. | | | | | |
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This combination SCI/NASS crash investigation concerns a 1998 Toyota Avalon (case vehicle) and a 1989 Mercury Cougar LS (vehicle #2). The crash occurred in March 1999, at 2:29 p.m., in Florida, and was investigated by the applicable state highway patrol agency. This case is of special interest because the case vehicle was equipped with seat back-mounted side air bags and the front right passenger's side air bag deployed as a result of collision events. The case vehicle's restrained front right passenger (41-year-old female, race/ethnicity unknown) sustained a fractured left clavicle and a loss of consciousness at the scene. The case vehicle was also equipped with dual redesigned front air bags that did not deploy. The NASS investigator inspected the scene and the case vehicle in April 1999, and interviewed vehicle #2's driver in May. This report is based on the Police Crash Report; the NASS investigator's coded forms, scene photographs, and case vehicle photographs; vehicle #2 driver's interview; scene and the case vehicle inspections; occupant kinematic principles; and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The case vehicle was traveling west in the outside westbound lane of a four-lane, two-way, undivided state highway (i.e., one left-turn lane and one through lane in each direction), approaching an intersection and intending to continue west (**Figure 1**). Vehicle #2 was traveling south in the outside, southbound through lane of a four-lane (i.e., left and right turn lanes and two through lanes), one-way roadway that was part of a six-lane (estimated), divided trafficway, approaching the same four-leg intersection and intending to continue south (**Figure 2**). The case vehicle entered the intersection, into the path of vehicle #2. The crash occurred within the intersection

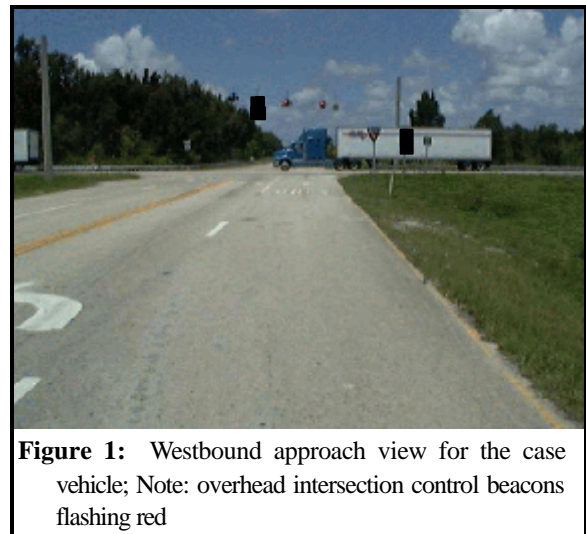


Figure 1: Westbound approach view for the case vehicle; Note: overhead intersection control beacons flashing red

The right side of the case vehicle was impacted by the front of vehicle #2, causing the case vehicle's front right passenger side air bag to deploy (dual, redesigned front air bags and the driver's side air bag did not deploy). The case vehicle began a clockwise rotation (**Figure 3** below) that resulted in a two quarter-turn rollover onto its top, and came to rest atop a guardrail and a traffic sign on the intersection's southwest quadrant, facing southwest, with its CG having traveled a conservatively estimated 13.7 meters (45 feet) post-impact. Vehicle #2 also rotated in a clockwise direction that reached approximately 150 degrees and came to rest in its original travel

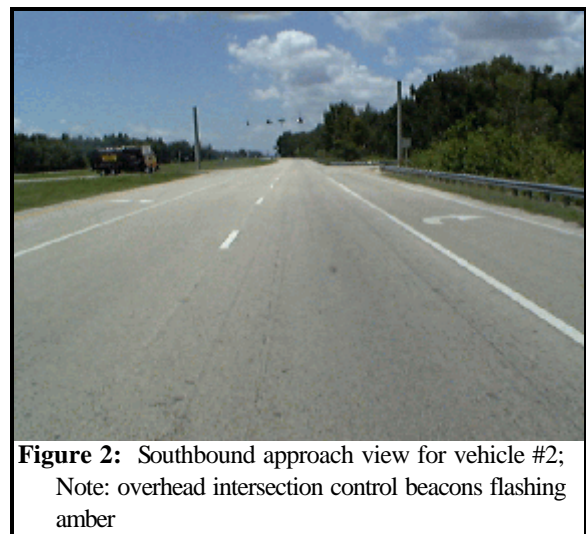


Figure 2: Southbound approach view for vehicle #2; Note: overhead intersection control beacons flashing amber

lane facing northwest, some 10.7 meters (35 feet) south of the first point of impact (see **SCENE DIAGRAM**, at end).

It was daylight, with no adverse weather conditions, no vision obstructions, and no roadway defects being reported. The southbound roadway's surface was bituminous, dry, straight, and level. Lane widths for both the case vehicle and vehicle #2 were measured as 3.7 meters (12 feet). Dry coefficient of friction for the southbound lanes was estimated at 0.70%. Improved shoulders were present on both the east and west pavement edges of the southbound lanes' north leg; their respective widths were conservatively estimated at 0.6 meters (2 feet). The posted speed limit was 72 km.p.h. (45 m.p.h.) for the east-west trafficway and 89 km.p.h. (55 m.p.h.) for the north-south trafficway. Travel speeds of 16-32 k.p.h. (10-20 m.p.h.) for the case vehicle and 80-89 (50-55 m.p.h.) for vehicle #2 were estimated by the investigating officer. Traffic control devices for westbound traffic in the median crossover of the north/south trafficway consisted of two overhead, flashing red intersection control beacons, an overhead right-turn prohibition sign (Manual on Uniform Traffic Control Devices, R3-1), and a YIELD sign (MUTCD, R1-2) with an attached ONE-WAY (south) sign (MUTCD, R6-1). Pavement markings for westbound traffic included a double solid yellow center line, a single solid yellow edge line (north edge), a single broken white lane line, and a solid white stop line across both westbound lanes. Investigating officers did not report any pre-impact avoidance maneuvers by the case vehicle. The crash site was rural and undeveloped.

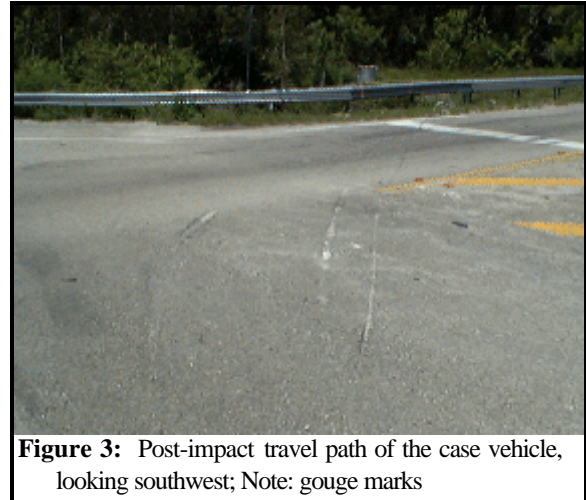


Figure 3: Post-impact travel path of the case vehicle, looking southwest; Note: gouge marks

CASE VEHICLE

The case vehicle was a front wheel drive, 1998 Toyota Avalon, six-passenger, four-door sedan (VIN: 4T1BF18B6WU-----) equipped with a 3.0 liter, V-6, MPFI gasoline engine and a four-speed automatic transmission with a console-mounted shift lever. It was equipped with four-wheel anti-lock brakes. Wheelbase for the case vehicle was 272 centimeters (107.1 inches). No odometer reading was reported. The case vehicle was towed from the scene due to disabling damage.

The interior of the case vehicle had front bucket seats with folding backs and adjustable head restraints. It had manual, three-point, lap-and-shoulder safety belts at the four outboard seating positions. Anchorage adjustments were only available for the front outboard seat locations at their respective B-pillars and both were found to be in the middle position. The second seat was a bench seat, with integral head restraints at the outboard positions. The second seat center position was equipped with a lap belt only and no head restraint. The case vehicle was equipped with dual, redesigned front air bags for the driver and front right passenger, plus the outboard front seat

occupants were protected by a side air bag mounted within their respective seat back's outboard edge. Only the front right passenger side air bag deployed of the four air bags available in the case vehicle (**Figure 4**).

CASE VEHICLE DAMAGE

The first event in this crash sequence was a vehicle-to-vehicle collision. Vehicle #2's front plane impacted the right side of the case vehicle from the right front door's forward seam to near the right rear wheel well (**Figure 5**). Direct damage begins 75 centimeters (29.5 inches) forward of the rear axle and extends forward 209 centimeters (82.3 inches). Maximum penetration was 55 centimeters (21.7 inches) at C3. Both right side door panels were displaced inward, the right rocker panel was pushed in, the glazing in both right side doors was shattered, the right upper and lower B-pillars were shoved in, and the right outside rearview mirror was smashed. Induced damage included: buckling of the rear portion of the right front fender, the front right turn signal assembly dangling from its wire harness, slight rearward pull to the right upper A-pillar, downward pull of the right roof rail over the two right side doors, the outward pull to the upper right rear door frame, and the buckling of the right rear quarterpanel's sheet metal above the right rear wheel well.

The second event in this crash sequence was the case vehicle's two quarter-turn rollover onto the guardrail (**Figure 6**). Direct damage to the case vehicle from this second impact included: the top of the front bumper fascia's left half, the right third of the front roof header, the forward edge of the hood, the top of the left front fender, the left upper A-pillar, camber of left rear wheel changed to top out and bottom in, top of left rear door frame pulled outward, and left rear door glazing disintegrated. Induced damage included: partially disintegrated sunroof glazing, left front door glazing shattered, and backlight glazing missing.

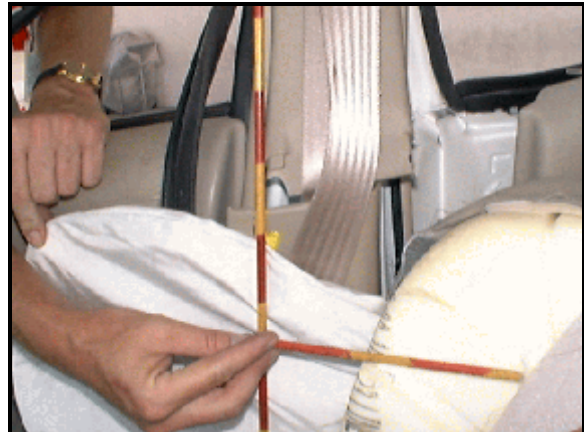


Figure 4: View of case vehicle's deployed side air bag at front right passenger's seat position



Figure 5: Case vehicle's right side damage from contact with vehicle #2



Figure 6: Case vehicle's damage from rollover; Note: front header and sunroof distortion

There were significant areas of intrusion resulting from the vehicle-to-vehicle collision, mostly to the right side of the case vehicle. There were lateral intrusions of 45 centimeters (17.7 inches) at the right rear door panel, 33 centimeters (13.0 inches) at the right upper and lower B-pillars, 32 centimeters (12.6 inches) at the right front door panel, 26 centimeters (10.2 inches) at the second seat right floor pan and sill, 24 centimeters (9.4 inches) at the front right seat floor pan and sill, 25 centimeters (9.8 inches) at the roof rail over both right side doors, and 4 centimeters (1.6 inches) at the C-pillar at the second seat right position. A longitudinal intrusion of 5 centimeters (2.0 inches) was measured at the windshield header forward of the front right seat position



Figure 7: Right oblique view of damage to the case vehicle; Note: depth of intrusion at the right B-pillar

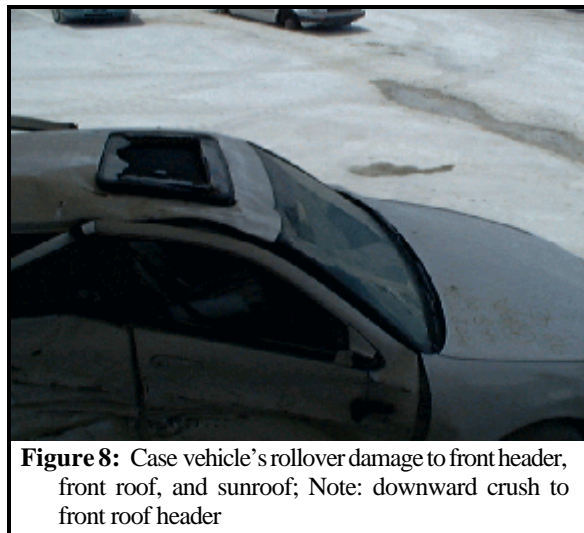


Figure 8: Case vehicle's rollover damage to front header, front roof, and sunroof; Note: downward crush to front roof header

Based on the vehicle inspection, a CDC for the vehicle-to-vehicle impact for the case vehicle (**Figure 5** and **Figure 7**) was determined to be: **03-RYEW-04 (+080)**. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 46 km.p.h. (28.6 m.p.h.), 0.0 km.p.h. (0.0 m.p.h.), and -46 km.p.h. (-28.6 m.p.h.). Thus, the crash severity for the case vehicle was high [greater than 40 km.p.h. (25 m.p.h.)]. A CDC for the case vehicle rollover (**Figure 6** and **Figure 8**), the second event of this crash sequence, was also determined: **00-TDDO-03**. This rollover is outside the scope for the WinSMASH reconstruction program

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a SRS system that included dual, redesigned front air bags at the driver and front right passenger positions. Those two modules did not deploy in this crash. The case vehicle was also equipped with side air bags at the driver and front right passenger positions. While the driver's side air bag did not deploy, the front right passenger's air bag did deploy (**Figure 9**). It was located at the outboard side of the passenger's seat back. The passenger's side air bag deployed through the seat back's right-side cloth seam. The air bag was characterized as oblong in shape, with a height of 27 centimeters (10.6 inches) and a width of 35 centimeters (13.8 inches). There were no tethers or vent ports. No damage to the module or air bag fabric was noted. The NASS investigator did not identify any occupant contact points to the deployed front right passenger's side air bag.

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The front right passenger (41-year-old female; race/ethnicity, height, and weight unknown) was wearing her available, manual, three-point, lap-and-shoulder, safety belt system. Although there was no interview with any case vehicle occupant, it is likely that the front right passenger was seated upright with her back against the seat back, her feet in the floor pan, and her hands in unknown positions. The seat track of her bucket seat was adjusted between its middle and rearmost positions and her seat back was slightly reclined.



Figure 9: Case vehicle’s deployed front right passenger side air bag; Note: deformation to B-pillar’s vinyl cover

With no indication that the case vehicle’s driver attempted any evasive action, the front right passenger likely did not change posture until vehicle #2 struck the case vehicle’s right side. This impact would have caused her to move right and slightly forward. Her lap-and-shoulder safety belt, coupled with the deployment of her side air bag, restricted her body’s movement (**Figure 9** above). The NASS investigator identified five potential contact points from the front right passenger: a cracked B-pillar vinyl cover; blood on the seat back support near the right hip area; a dent and body oil smear on the right front door’s interior surface; dents, scuffs, and body oil smear on the right front door’s hardware and armrest; and a scuff on the passenger’s front air bag module cover flap located on the right instrument panel. As the case vehicle began to rotate clockwise, she continued to lean right. A two quarter-turn rollover by the case vehicle would have caused her to move further toward the right. No information is available as to the front right passenger’s posture at final rest.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

She was transported from the scene to a medical facility where she was hospitalized for two days. Only one transport method was mentioned in the Police Crash Report: “air transport.” She sustained a fractured left clavicle and a loss of consciousness at the scene. She probably sustained the loss of consciousness from striking the right B-pillar during the rollover. It is not known how she sustained the left clavicle fracture.

| Injury Number | Injury Description (including Aspect) | NASS Injury Code & AIS 90 | Injury Source (Mechanism) | Source Confidence | Source of Injury Data |
|---------------|---------------------------------------|---------------------------|---------------------------|-------------------|-----------------------|
| 1. | Fracture, left clavicle | 752200.2 moderate | Unknown | Unknown | Discharge Summary |

| Injury Number | Injury Description (including Aspect) | NASS Injury Code & AIS 90 | Injury Source (Mechanism) | Source Confidence | Source of Injury Data |
|---------------|---------------------------------------|---------------------------|---------------------------|-------------------|-----------------------|
| 2. | Loss of consciousness | 160499.1 minor | Right B-pillar | Probable | Emergency Room |

CASE VEHICLE DRIVER KINEMATICS

The case vehicle’s driver [76-year-old male, White (unknown if Hispanic)] was likely seated with his back against the seat back, his left foot on the floor, his right foot on the accelerator pedal, and at least one of his hands on the steering wheel. His seat track was located at its middle position and his seat back was slightly reclined post-crash. He (height and weight unknown) was wearing the available, manual, three-point, lap-and-shoulder, safety belt system. The driver’s body movements during the vehicle-to-vehicle crash and the rollover likely mirrored those of the front right passenger; that is, he likely did not change posture until vehicle #2 struck the case vehicle’s right side. This impact would have caused him to move right and slightly forward. His body movements were restricted by his use of the available safety belts. The NASS investigator identified two potential contact points from the case vehicle’s driver: blood and a body oil smear on the windshield and a body oil deposit and a dent on the inboard armrest. As the case vehicle began to rotate clockwise, he continued to lean right. A two quarter-turn rollover by the case vehicle would have continued his leaning to the right. No information is available as to the driver’s posture at final rest.

CASE VEHICLE DRIVER INJURIES

The Police Crash Report indicated the driver sustained “incapacitating” injuries; however, no specific injuries were detailed by the NASS investigator. The driver was transported from the scene by air (as were the other five crash-involved occupants) to a medical facility. He was hospitalized, but the length of time is not known. His specific injuries are not known.

CASE VEHICLE SECOND SEAT RIGHT PASSENGER KINEMATICS

The case vehicle’s second seat right passenger (12-year-old male, race/ethnicity unknown) was likely seated with his back against the seat back, his feet near or in the foot pan (depending on his stature), and his hands in unknown positions. Both his seat track and seat back were not adjustable. He (height and weight unknown) was wearing the available, manual, three-point, lap-and-shoulder, safety belt system. This occupant’s body movements during the vehicle-to-vehicle crash and the rollover likely mirrored those of the front right passenger; that is, he likely did not change posture until vehicle #2 struck the case vehicle’s right side. This impact would have caused him to move right and slightly forward. As the case vehicle began to rotate clockwise, he continued to lean right. A two quarter-turn rollover by the case vehicle would have continued his leaning to the right. His body movements were restricted by his use of the available safety belts.

The NASS investigator identified two potential contact points from the case vehicle’s second seat right passenger: blood on the right roof rail and a dent and skin oil transfer to the right rear door interior panel. No information is available as to the driver’s posture at final rest. The NASS investigator assigned a large blood smear and splattering, centered at the B-pillar on the right interior roof rail, to a contact of this occupant’s hand (Figure 10).

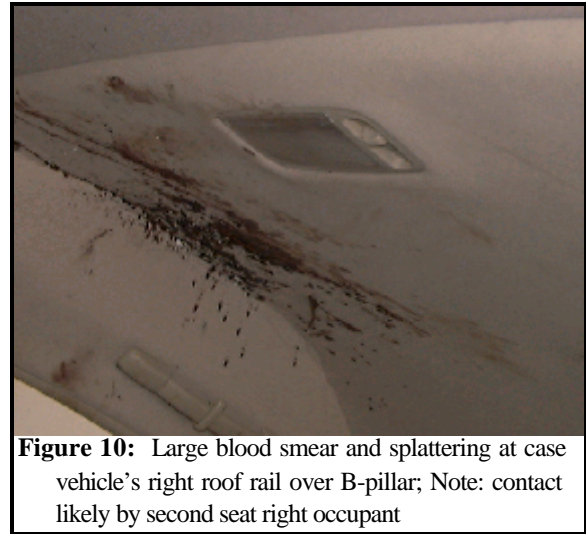


Figure 10: Large blood smear and splattering at case vehicle’s right roof rail over B-pillar; Note: contact likely by second seat right occupant

CASE VEHICLE SECOND SEAT RIGHT PASSENGER INJURIES

The case vehicle’s second seat right passenger sustained the following injuries: a fractured left radius, a fractured left ulna, a fractured right fibula, an upper right extremity abrasion, and loss of consciousness at the scene. He was transported from the scene by air to a medical facility where he was hospitalized for five days.

| Injury Number | Injury Description (including Aspect) | NASS Injury Code & AIS 90 | Injury Source (Mechanism) | Source Confidence | Source of Injury Data |
|---------------|---------------------------------------|---------------------------|----------------------------------|-------------------|-----------------------|
| 1. | Fracture, left radius | 752804.3 serious | Front right seat back | Possible | Discharge Summary |
| 2. | Fracture, left ulna | 753204.3 serious | Front right seat back | Possible | Discharge Summary |
| 3. | Abrasion, right upper extremity | 7902021 minor | Right rear door interior surface | Possible | Emergency Room |
| 4. | Fracture, right fibula | 851606.2 moderate | Right rear door interior surface | Possible | Discharge Summary |
| 5. | Loss of consciousness | 160699.1 minor | Right roof rail | Possible | Discharge Summary |

VEHICLE #2

NASS-99-41-042J

Vehicle #2 was a rear wheel drive, 1989 Mercury Cougar LS, five-passenger, two-door sedan (VIN: 1MEPM6047KH-----) equipped with a 3.8 liter, V-6, SEFI, gasoline engine and a four-speed automatic transmission with overdrive. Vehicle #2 had a wheelbase of 287 centimeters (113.0 inches). No odometer reading was reported. It was towed from the scene due to disabling damage. It was not inspected and there were no photographs provided in the NASS case materials. The Police Crash Report indicates extensive damage involving the entire front plane.

