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ON-SITE AIR BAG NON-DEPLOYMENT INVESTIGATION

CASE NUMBER - IN99-074
LOCATION - MISSISSIPPI
VEHICLE - 1995 CHEVROLET ASTRO MINIVAN
CRASH DATE - January, 1999

Submitted:

January 27, 2003

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* On-site air bag non-deployment investigation involving a 1995 Chevrolet Astro, three-door minivan, with manual safety belts and driver's air bag, and a 1996 Mack CH series incomplete vehicle with logging bed			
16. *Abstract* This report covers an on-site investigation of an air bag non-deployment crash that involved a 1995 Chevrolet Astro Van (case vehicle) and a 1996 Mack CH series incomplete vehicle with logging truck bed (other vehicle). This crash is of special interest because the case vehicle's driver [46-year-old, White (non-Hispanic) male] sustained a serious injury in a high speed, offset frontal crash in which his driver air bag did not deploy. The case vehicle was traveling north, up a grade, in the northbound lane of a two-lane, undivided, U.S. highway. The Mack truck was traveling south, down the grade, in the southbound lane of the same, two-lane, undivided highway. According to the police investigating, the crash occurred in the southbound lane of the roadway. The front left half of the case vehicle impacted the front left (unknown lateral area) of the Mack truck; however, the case vehicle's driver (only) supplemental restraint (air bag) did not deploy. After maximum engagement, based on the police investigation, the case vehicle rotated approximately 225 degrees counterclockwise and came to rest in the northbound lane heading southeastward. The Mack truck continued southward after impact and subsequently drove completely across the northbound lane and off the east side of the roadway. The Mack truck came to rest heading south-southeastward on the east roadside. The case vehicle's driver was seated with his seat track located near its rearmost position, and the tilt steering wheel was located in its middle position. He was restrained by his available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to his interview and his EMT records, serious injuries which included: fractures to his left jaw, left hip, left femur, left wrist, and right ankle; a laceration to the optic nerve of his left eye and a 12.7 centimeter (5 inch) laceration to his left temple; and contusions to his lower abdomen and whole lower extremities. As a result of the crush to this vehicle, the air bag's deployment threshold was surely achieved, and the case vehicle' driver air bag should have deployed.			
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This on-site investigation was brought to NHTSA's attention on June 7, 1999 by the driver of the case vehicle. This crash involved a 1995 Chevrolet Astro Van (case vehicle), and a 1996 Mack CH series incomplete vehicle with logging truck bed (other vehicle). The crash occurred in January, 1999, at 9:38 a.m., in Mississippi and was investigated by the Mississippi Highway Patrol division. This crash is of special interest because the case vehicle's driver [46-year-old, White (non-Hispanic) male] sustained a serious injury in a high speed, offset frontal crash in which his driver air bag did not deploy. This contractor inspected the case vehicle on June 9, 1999. This contractor interviewed the case vehicle's driver on June 8, 1999. This report is based on the Police Crash Report, interviews with the case vehicle's driver and the investigating police officer, inspection of the case vehicle, occupant kinematic principles, emergency medical transport records, and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The case vehicle was traveling north, up a grade (of unknown percent), in the northbound lane of a two-lane, undivided, U.S. highway and intended to continue traveling northbound. The Mack truck was traveling south, down the grade, in the southbound lane of the same, two-lane, undivided highway. Exactly what happened next is uncertain, but two scenarios follow.

According to the case vehicle's driver (scenario 1), the Mack truck had just exited a left-hand curve and was entering a straight section of road when the Mack truck traveled off the right (i.e., west side) of the roadway. The truck's driver steered to the left, back onto the roadway, but overcorrected. The case vehicle's driver observed the truck's maneuver and thought, presumably, that the truck was going to cross over into the northbound lane. As a result, the case vehicle's driver steered left into the southbound lane. However, the case vehicle's driver does not recall attempting any avoidance maneuvers prior to the crash.

Based on the sketch on the Police Crash Report (scenario 2), the case vehicle was left-of-center when the driver of the Mack truck observed the case vehicle and steered rightward, attempting to avoid the crash. The investigating police officer indicated that the driver of the Mack truck attempted to avoid the crash by locking up his brakes.

It is unknown if the case vehicle's driver made any avoidance maneuvers prior to the crash. According to the Police Crash Report, the crash occurred in the southbound lane of the roadway. According to the investigating officer, this impact location was determined by the debris and gouges found in the southbound lane.

According to the Police Crash Report the U.S. highway was straight and had an unknown grade at the area of impact. As stated above, according to the case vehicle's driver, the grade was positive in his northbound direction of travel and the Mack truck had just exited a left-hand curve. According to the Police Crash Report the pavement was bituminous, and the width of the travel lanes for both vehicles is unknown. Presumably the highway was bordered by shoulders but their composition and widths are unknown. Based on the sketch on the Police Crash Report, the pavement markings consisted of a double solid yellow centerline for both the north and southbound

traffic, and presumably solid white edge lines were present. The estimated coefficient of friction is unknown. According to the Police Crash Report, there were no traffic controls present in the immediate area of the crash. The statutory speed limit was 89 km.p.h. (55 m.p.h.). At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the road pavement was dry. According to the case vehicle's driver the traffic density was light, and the site of the crash was rural undeveloped.

The front left half of the case vehicle (**Figure 1**) impacted the front left (unknown lateral area) of the Mack truck; however, the case vehicle's driver (only) supplemental restraint (air bag) did not deploy. After maximum engagement, based on the police investigation, the case vehicle rotated approximately 225 degrees counterclockwise and came to rest in the northbound lane heading southeastward. The Mack truck continued southward after impact and subsequently drove completely across the northbound lane and off the east side of the roadway. The Mack truck came to rest heading south-southeastward on the east roadside.

Figure 1: Case vehicle's frontal deformation from impact with Mack truck; Note: direct contact (yellow tape & arrow) to roof near left "A"-pillar (case photo #02)

CASE VEHICLE

The 1995 Chevrolet Astro was a rear wheel drive, eight-passenger, three-door minivan (VIN: 1GNDM19W0SB------) equipped with a 4.3L, V-6 engine and a four-speed automatic transmission with overdrive. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The case vehicle's wheelbase was 282 centimeters (111.0 inches), and the odometer reading at inspection is unknown of damage to the instrumentation.

Inspection of the vehicle's interior revealed adjustable front bucket seats with integral head restraints; a non-adjustable middle bench seat without head restraints for the seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the front, middle, and back outboard positions; and a two-point, lap belt system at the middle center and back center positions. The middle bench was unsecured, and the back bench seat had been removed. The front seat belt systems were equipped with manually operated, upper anchorage adjusters for the "D"-rings. The driver's upper anchorage adjuster was located 3 centimeters (1.2 inches) upward from its down-most positions. The vehicle was equipped with knee bolsters for both the driver and front right passenger. The case vehicle driver's knee bolster was scuffed and deformed. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for only the driver's seat position. The driver's air bag did not deploy as a result of the case vehicle's frontal impact with the Mack truck.

Figure 2: Extensive deformation to case vehicle's front and left side from impact with Mack truck, viewed from left of front (case photo #06)

Figure 3: Case vehicle's front left damage viewed from right of front (case photo #13)

Figure 4: Reference line view from left of deformation to case vehicle's front left (case photo #05)

The case vehicle's initial contact with the Mack truck involved its front left half (**Figures 2** and **3**). Direct damage began at the front left bumper corner and extended to the right, a measured distance of 71 centimeters (28.0 inches). The case vehicle's front right frame rail was shifted to the left approximately 15 centimeters (5.9 inches). Direct contact damage extended down the case vehicle's left side 185 centimeters (72.8 inches). Furthermore, there was direct contact and deformation to the left "A"-pillar, roof, and windshield. In addition, the direct contact extended laterally 30 centimeters (11.8 inches) inward from the left "A"-pillar. The average residual maximum crush was 83.5 centimeters (32.9 inches) at C_1. The wheelbase on the case vehicle's left side was shortened 73 centimeters (28.7 inches) because of the direct contact to the case vehicle's left front wheel assembly. The wheelbase on the right side was extended 7 centimeters (2.8 inches). The case vehicle's front bumper, bumper fascia, grille, hood, radiator, left "A"-pillar, roof (**Figure 1** above), right and left headlight and turn signal assemblies, left fender, left front door, and left front wheel assembly were directly damaged and crushed rearward. In fact, the case vehicle's left front wheel assembly was pushed rearward into and under the driver's toe pan (**Figures 2** and **4**). As a result, the case vehicle's left front tire was damaged, deflated, and physically restricted. The case vehicle's right front tire was missing at the time of this contractor's inspection. There was induced damage as well to the left side and quarter panels, right fender, and right front door. The windshield and both the left front and left middle side window glazings were broken out as a result of the crash.

Because of the severity of the crash, both "A"-pillars were cut and the windshield was folded onto what remained of the hood. The intrusion to the driver's seating area was catastrophic, not only from the crash, but also because of the extrication process. The extrication process eradicated most of the contact evidence. With that said, the inspection of the case vehicle's

interior revealed contact evidence on the driver's knee bolster, both left and right of the steering column. Also, the steering wheel rim was deformed both above and below the hub with a 16 centimeters (6.3 inches) of deformation to the top half of the rim (**Figure 5**). Finally, there was a deposit of skin and hair on the driver's front windshield header (**Figures 6** and **7**), and the driver's sun visor was completely torn off.

Based on the vehicle inspection the CDC for the case vehicle was determined to be: **12-FYAW-7 (350)**. The WinSMASH reconstruction program, barrier algorithm, was used on the case vehicle's highest severity impact because the Mack truck is out-of-scope. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 61.4 km.p.h. (38.2 m.p.h.), -60.5 km.p.h. (-37.6 m.p.h.), and +10.7 km.p.h. (+6.6 m.p.h.). In this contractor's opinion the actual Delta V is closer to 40-48 km.p.h.(25-30 m.p.h.). Regardless of the actual Delta V, the air bag's deployment threshold was surely achieved, and the case vehicle' driver air bag should have deployed. The case vehicle was towed due to damage.

Figure 5: Close-up looking along case vehicle's left side showing steering column which was rotated perpendicular to the vehicle's left side and distortion to steering wheel's rim (case photo #19)

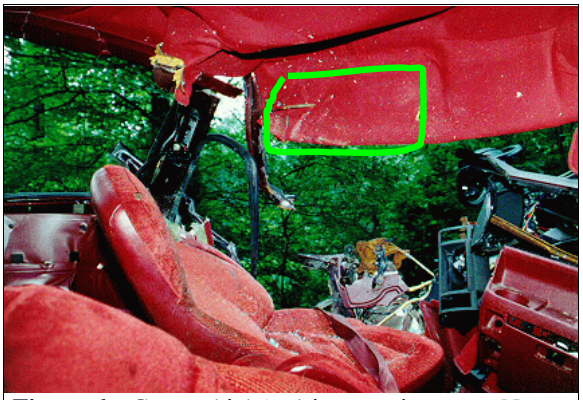

Figure 6: Case vehicle's driver seating area; Note: intrusion and deformation to seating area and direct contact to roof/front header (highlighted) from driver's head/face (case photo #21)

Figure 7: Close-up of skin and hair on case vehicle's roof/front header from contact by driver's head and face; Note: driver's sun visor has been completely torn away from its pivot bar (case photo #22)

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained a frontal air bag at the driver position. The driver/owner reports that this was the original

manufacturer installed air bag. The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module confirmed that the air bag did not deploy (**Figure 8**). Because of the intrusion of the steering column and the collapse of the steering wheel rim due to loading, the module's cover flaps were directly contacted but showed no evidence of scratching or cloth transfers.

Figure 8: Case vehicle's non-deployed driver air bag (case photo #18)

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [178 centimeters and 132 kilograms (70 inches, 290 pounds)] was seated in an upright posture with his back against the seat back, his left foot on the floor, his right foot reaching for the brake, and both hands on the steering wheel. His seat track was located near its rearmost position, the seat back was upright, and the tilt steering wheel was located in its middle position.

Figure 9: Case vehicle's driver seating area viewed through what once was the driver's door; Note: cut seat belts and twisted steering wheel with non-deployed driver's air bag (case photo #15)

The case vehicle's driver was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed extensive evidence of loading. In addition, and it is visibly apparent that the belt was cut off the driver by rescue personnel at the scene (**Figure 9**).

Presumably the case vehicle's driver made no pre-crash avoidance maneuvers. As a result and independent of the use of his available safety belts, his pre-impact body position did not change just prior to impact. The case vehicle's impact with the Mack truck enabled the case vehicle's driver to continue forward and leftward towards the **350** degree Direction of Principle Force as the case vehicle decelerated. The case vehicle's heavyset [113 kilograms (290 pounds)] driver loaded and stretched the webbing of his three-point safety belt. In addition, the driver loaded the steering wheel, but the steering wheel was also beginning to intrude into his seat position. The Mack truck's fiberglass hood directly contacted the left "A"-pillar, roof, and windshield. The intruding windshield's header and driver side sun visor directly contacted the driver's head and face, lacerating the left side of the driver's temple and his left optic nerve and fracturing his jaw

(**Figures 6** and **7** above). The case vehicle driver didn't rebounded off the steering wheel but instead was pushed back against his seat back along with the intruding components of the vehicle (e.g., steering wheel, left instrument panel). At final rest the driver was pinned in his seat by the intruding steering column, left instrument panel, and toe pan area. According to the case vehicle's driver, during the massive longitudinal intrusion his left leg was fractured by the intruding instrument panel and his right ankle was "crushed" between the gas pedal and the intruding toe pan. In this contractor's opinion, regardless of the non-deployment of the driver's air bag, the severe magnitude of the crash and resulting intrusion into the driver's seating area would still have caused serious injuries to the driver. Although the driver did not report any chest or abdominal injuries, the EMTs who treated him suspected their possibility.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital. He sustained serious injuries and was hospitalized for 33 days post-crash. According to his interview and medical records, the injuries sustained by the case vehicle's driver included: fractures to his left jaw, left hip, left femur, left wrist, and right ankle; a laceration to the optic nerve of his left eye and a 12.7 centimeter (5 inch) laceration to his left temple; and contusions to his lower abdomen and whole lower extremities.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury: lethargic on initial observation but responsive to verbal and painful stimuli and unknown if loss of consciousness	160699.2 moderate	Windshield roof header, driver's	Certain	EMS treatment record
2	Fracture, multiple, long bones left leg[1], not further specified	852002.2 moderate	Left instrument panel and below	Certain	EMS treatment record
3	Laceration optic nerve in left eye	230204.2 moderate	Windshield roof header, driver's	Certain	Interviewee (same person)
4	Laceration, 12.7 cm (5 in), left temporal area[2] with profuse bleeding	190604.2 moderate	Front roof header, driver's	Certain	EMS treatment record
5	Fracture (left) mandible {jaw} with collapse of left side of face	250600.1 minor	Windshield roof header, driver's	Probable	Interviewee (same person)
6	Fracture left wrist, not further specified	751800.2 moderate	Left instrument panel and below	Possible	Interviewee (same person)

[1] Because it is unclear which "long" bones the EMTs were referring to, this lesion is coded in addition to the fractures cited by this occupant.

[2] The emergency medical technicians (EMTs) indicated that there was a possible left skull fracture. In addition, they suspected a chest injury as well.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
7	Fracture left hip, not further specified	852600.2 moderate	Knee bolster, driver's, left of steering column	Probable	Interviewee (same person)
8	Fracture left femur[3], not further specified	851800.3 serious	Knee bolster, driver's, left of steering column	Probable	Interviewee (same person)
9	Fracture {crush} right ankle, not further specified	852002.2 moderate	Toe pan including foot controls	Certain	Interviewee (same person)
10	Contusion {bruise} across lower abdomen	590402.1 minor	Lap portion of safety belt system	Probable	Interviewee (same person)
11	Contusions {black and blue} below waist, not further specified	890402.1 minor	Left instrument panel and below	Probable	Interviewee (same person)

OTHER VEHICLE

The 1996 Mack CH series incomplete vehicle is a rear wheel drive truck with a logging trailer bed (VIN: 1M2AA18Y3TW------). Based on the vehicle specifications, the truck was equipped with a 11.9L, 6-cylinder turbo diesel engine and a nine-speed manual transmission. With no available vehicle photographs, the TDC for the Mack truck is unknown. The Mack truck was towed due to damage.

[3] According to the case vehicle's driver there were pins and rods placed in his left knee, but it is unknown if these items were placed because the femur fractured was distally or because there was another lesion to the left knee itself.