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SCI/NASS COMBINATION CASE REPORT

CASE NUMBER - NASS-98-41-086C
LOCATION - Florida
VEHICLE - 1997 BMW 328i
CRASH DATE - June 1998

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.

Technical Report Documentation Page

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SCI/NASS combination side air bag deployment investigation concerning a 1997 BMW 328i, four-door sedan, equipped with manual belts and dual front and side air bags, and a 1991 Ford Aerostar minivan

16. *Abstract*

This report covers a SCI/NASS combination investigation of a side air bag deployment crash that involved a 1997 BMW 328i (case vehicle) and a 1991 Ford Aerostar (vehicle #2). This case is of special interest because the case vehicle was equipped with door-mounted side air bags and the driver's side air bag deployed as a result of the collision events. The case vehicle had been traveling south in the southbound roadway of a four-lane, divided trafficway and had come to a complete stop. Vehicle #2 was traveling west, with the right-of-way, on a two-lane, undivided, roadway. Both vehicles were approaching a four-leg intersection and intending to pass through and continue straight ahead. The intersection was controlled by stop signs for north-south traffic. The case vehicle entered the intersection, and the case vehicle's driver did not attempt any avoidance actions. The driver of vehicle #2 braked with full lockup. The crash occurred within the intersection of the two trafficways. The front of vehicle #2 impacted the left side of the case vehicle, causing the case vehicle's left front side air bag to deploy. The case vehicle was also equipped with dual frontal air bags and a right front side air bag, none of which deployed. The case vehicle rotated a few degrees clockwise, traveled in a south-southwesterly direction, and came to rest off the roadway at the south-west corner of the intersection. Vehicle #2 rotated approximately 45 degrees counterclockwise and came to rest close to the point of impact. The case vehicle's driver (43-year-old male) was seated with his seat track located in its middle position, and the case vehicle was not equipped with a tilt steering wheel. He was restrained by his available, manual, three-point lap-and-shoulder safety belt system and sustained, according to his interview and his medical records, only minor soft tissue injuries. The front right passenger in the case vehicle (89-year-old female) was seated with her seat track located in its middle position was restrained by her available, manual, three-point lap-and-shoulder safety belt system. She sustained, according to the interview with the case vehicle's driver and her medical records, only minor soft tissue injuries. Neither occupant sustained any air bag-related injuries.

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BACKGROUND

NASS-98-041-086C

This combination SCI/NASS crash investigation was brought to the NHTSA's attention in June, 1998 by NASS/CDS sampling activities. This crash involved a 1997 BMW 328i (case vehicle) and a 1991 Ford Aerostar (vehicle #2). The crash occurred in June, 1998, at 1:44 p.m., in Florida, and was investigated by the applicable municipal police department. This case is of special interest because the case vehicle was equipped with door-mounted side air bags and the driver's side air bag deployed as a result of the collision events. In addition, the driver (43-year-old male) and the front right passenger (89-year-old female) of the case vehicle sustained only minor injuries in the crash, none of which were air bag-related. The NASS/CDS team inspected the scene and the case vehicle and interviewed the two drivers in late June and early July, 1998. Vehicle #2 was not inspected. This report is based on the Police Crash Report, the driver interviews, the NASS/CDS data from the scene and case vehicle inspections, emergency room treatment records for the occupants of the case vehicle, occupant kinematic principles and this contractor's evaluation of the evidence.

SUMMARY

This report covers a combination SCI/NASS investigation of a side air bag deployment crash that involved a 1997 BMW 328i (case vehicle) and a 1991 Ford Aerostar (vehicle #2). This case is of special interest because the case vehicle was equipped with door-mounted side air bags and the driver's side air bag deployed as a result of the collision events. The case vehicle had been traveling south in the southbound roadway of a four-lane, divided trafficway and had come to a complete stop. Vehicle #2 was traveling west, with the right-of-way, on a two-lane, undivided, roadway. Both vehicles were approaching a four-leg intersection and intending to pass through and continue straight ahead. The intersection was controlled by stop signs for north-south traffic. The case vehicle entered the intersection, and the case vehicle's driver did not attempt any avoidance actions. The driver of vehicle #2 braked with full lockup. The crash occurred within the intersection of the two trafficways. The front of vehicle #2 impacted the left side of the case vehicle, causing the case vehicle's left front side air bag to deploy. The case vehicle was also equipped with dual frontal air bags and a right front side air bag, none of which deployed. The case vehicle rotated a few degrees clockwise, traveled in a south-southwesterly direction, and came to rest off the roadway at the south-west corner of the intersection. Vehicle #2 rotated approximately 45 degrees counterclockwise and came to rest close to the point of impact. The case vehicle's driver (43-year-old male) was seated with his seat track located in its middle position, and the case vehicle was not equipped with a tilt steering wheel. He was restrained by his available, manual, three-point lap-and-shoulder safety belt system and sustained, according to his interview and his medical records, only minor soft tissue injuries. The front right passenger in the case vehicle (89-year-old female) was seated with her seat track located in its middle position was restrained by her available, manual, three-point lap-and-shoulder safety belt system. She sustained, according to the interview with the case vehicle's driver and her medical records, only minor soft tissue injuries. Neither occupant sustained any air bag-related injuries.

CRASH CIRCUMSTANCES

The case vehicle had been traveling south in the outside, southbound lane of a two-lane roadway that was part of a four-lane, divided trafficway (two southbound lanes and two northbound lanes separated by

a grass median), and was approaching a four leg intersection intending to pass through the intersection and continue its southbound travel (**Figure 1**). Vehicle #2 was traveling west in the westbound lane of an intersecting, two-lane, undivided roadway, and was approaching the intersection intending to pass through and continue in its westbound travel. The intersection was controlled by stop signs for north-south traffic. The speed limit for both vehicles was 48 km.p.h. (30 m.p.h.). The bituminous road surface was dry and without defects for both vehicles. It was daylight, and there were no adverse atmospheric driving conditions. The case vehicle came to a complete stop and then entered the intersection. The case vehicle's driver did not attempt any avoidance actions while the driver of vehicle #2 braked with full lockup. The crash occurred within the intersection.

Figure 1: Case vehicle's southbound approach

The left side (**Figure 2**) of the case vehicle was impacted by the front of vehicle #2, causing the case vehicle driver's side air bag to deploy. The case vehicle was also equipped with dual frontal air bags and a right front side air bag, none of which deployed. The case vehicle rotated a few degrees clockwise, traveled in a south-southwesterly direction and came to rest off the roadway at the south-west corner of the intersection. Vehicle #2 rotated approximately 45 degrees counterclockwise and came to rest close to the point of impact.

Figure 2: Case vehicle's left side damage

CASE VEHICLE

The case vehicle was a rear wheel drive 1997 BMW 328i five-passenger, four-door sedan (VIN: WBACD4322VA------), equipped with a 2.8 liter, I-6 engine and a five-speed automatic transmission, with a floor-mounted selector lever. Four wheel anti-lock brakes and traction control were standard features for this model. The case vehicle's wheelbase was 270 centimeters (106.3 inches), and the driver estimated that there were 20,921 kilometers (13,000 miles) on the vehicle. The case vehicle was towed from the scene due to disabling damage.

Damage to the case vehicle consisted of direct contact along the left side from slightly forward of the "A"-pillar to the rearward edge of the left rear door, with maximum crush 38 centimeters (15 inches) at the middle of the left front door (**Figure 2** above). The driver's door glazing was disintegrated, and the windshield was cracked along the left "A"-pillar, with no other glazing damage. The wheelbase was shortened by 8 centimeters (3.1 inches) on the left. The CDC for the case vehicle is: **10-LYEW-3**, with principal direction of force 310 (-50) degrees. The WinSMASH reconstruction program, ROLDMIS

algorithm, was used on the case vehicle's highest severity impact because data for vehicle #2 were not available. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 25 km.p.h. (15 m.p.h.), -16 km.p.h. (-10 m.p.h.), and +19 km.p.h. (+12 m.p.h.). The case vehicle sustained intrusion into the left side seating positions in the first and second seat rows, with maximum intrusion 17 centimeters (6.7 inches) at the left "B"-pillar. The driver's seat cushion and seat back were slightly deformed by the intruding door panel and "B"-pillar, but there were no seat performance failures.

Figure 3: Case vehicle's driver seating area, with deployed side air bag folded away and side module cover flap set in place

The case vehicle was fitted with bucket seats in the front seat row and a bench seat in the second seat row, with manual three-point lap-and-shoulder safety belts in the four outboard seating positions and a lap-only manual safety belt in the second seat center position. The two front seat positions also had front and side air bags, for a total of four air bags in the vehicle. The two side air bag modules were mounted behind single-panel cover flaps above the arm rests in the doors (**Figures 3** and **4**, and **Figure 5**, below). The driver's front air bag was in the steering wheel hub and the front right passenger's front air bag was in the top of the instrument panel. The driver's side air bag was the only air bag that deployed.

Figure 4: Case vehicle's deployed left front (driver) side air bag

The deployed driver's side air bag was a rounded rectangle, approximately 25 centimeters (9.8 inches) high and 40 centimeters (15.7 inches) wide, with one tether and no vent ports (**Figure 4**). The module cover flap opened along the perforations, with no evidence of damage to the air bag, the cover flap, or the adjacent structures (**Figure 3**). There were two small areas of blood stain on the inboard surface of the air bag. The driver sustained several small lacerations due to flying glass (see discussion of injuries, below), and these blood stains do not indicate air bag-induced injuries.

CASE VEHICLE DRIVER

Immediately prior to the crash the case vehicle's driver [43-year-old male, 170 centimeters and 68 kilograms (67 inches, 150 pounds)] was restrained by his available, manual, three-point lap-and-shoulder safety belt system with the upper anchorage adjustment in the full-up position. He was seated in an upright posture with his back against the seat back, his left foot on the floor, his right foot on the accelerator and both hands on the steering wheel. His seat track was located in its middle position, the seat back was sightly reclined, and the vehicle was not equipped with a tilt steering wheel.

Figure 5: Case vehicle's front right passenger seating area and non-deployed front right side air bag

The driver did not make any avoidance actions prior to the crash and remained in his pre-crash posture. The impact with vehicle #2 caused the left front side air bag to deploy and caused the driver to move forward and to the left, toward the 10 o'clock direction of principal force. The slight clockwise rotation caused him to move slightly further to the left. The glazing in the driver's door window shattered, spraying the interior with kernalized glass shards, and the door panel and left "B"-pillar were crushed inward. The deployed side air bag cushioned his abdomen and thorax and he did not sustain any injuries in these areas. His forward and leftward motion was restricted because he was using the manual belt system. He rebounded rearward, and the back of his head struck the now-intruded "B"-pillar, causing a contusion on his posterior scalp in the area of the occiput and a cervical strain. His left arm flailed to the left, contacting the door panel, and he sustained an abrasion on his left elbow. He also sustained several small lacerations on both thighs and both lower legs from the flying glass.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to a hospital, where he was treated in the emergency department and released. The following injuries are based on the emergency department treatment records and the interviewee (driver).

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion, occiput	190402.1 minor	Left "B"-pillar	Probable	Emergency room records
2	Strain, cervical	640278.1 minor	Left "B"-pillar	Probable	Emergency room records
3	Abrasion, left elbow	790202.1 minor	Left side door hardware	Probable	Interviewee (same person)
4	Lacerations, bilateral legs	890602.1 minor	Flying glass	Probable	Interviewee (same person)

The front right passenger [89-year-old female, 147 centimeters and 45 kilograms (58 inches, 100 pounds)] was restrained by her available manual three-point lap-and-shoulder safety belt system with the upper anchorage adjustment in the full-up position. She was seated with her back against the seat back, her feet on the floor, and both hands in her lap. Her seat track was located in its middle position, and the seat back was sightly reclined.

Because the driver did not make any avoidance actions prior to the crash, the front right passenger remained in her pre-crash posture. The impact with vehicle #2 caused her to move forward and to the left, toward the 10 o'clock direction of principal force. Because she was restrained her forward motion was restricted. She was sprayed with flying glass shards from the shattered driver's door window glazing, which caused an abrasion on her right forearm, a small laceration on her right fifth finger and several small lacerations on both knees. She rebounded back into her seat. Her left upper arm struck the seat back, causing a contusion, and her left hip struck her purse which was laying next to her in the seat, causing a contusion on her left hip. Her right arm struck the right door, causing a contusion in the right upper arm and shoulder area.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right occupant was transported by ambulance to a hospital, where she was treated in the emergency department and released. The following injuries are based on the emergency department treatment records and the interviewee (driver).

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Abrasion, right forearm	790202.1 minor	Flying glass	Probable	Emergency room records
2	Lacerations, right 5th finger	790602.1 minor	Flying glass	Probable	Emergency room records
3	Lacerations, bilateral knees	890600.1 minor	Flying glass	Probable	Emergency room records
4	Contusion, right upper arm/shoulder	790402.1 minor	Right side interior door surface	Probable	Emergency room records
5	Contusion, left hip	890402.1 minor	Other interior object (purse)	Possible	Interviewee (driver)
6	Contusion, left upper arm	790402.1 minor	Seat, back support	Probable	Interviewee (driver)

VEHICLE #2

Vehicle #2 was a 1991 Ford Aerostar minivan (VIN: 1FMDA31X6MZ------). Vehicle #2 was

not inspected and the CDC is not known. The ROLDMIS reconstruction program was used to calculate delta v because vehicle #2's damage is not known. The reconstruction results for vehicle #2, based on known damage for the case vehicle, indicate total delta v 23 km.p.h. (15 m.p.h.), longitudinal -17 km.p.h. (11 m.p.h.) and lateral -15 km.p.h. (-9 m.p.h.).

SCENE DIAGRAM