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## SCI/NASS COMBINATION CASE REPORT

CASE NUMBER - NASS-2003-48-193C  
LOCATION - Alabama  
VEHICLE - 2001 BMW 525i  
CRASH DATE - September 2003

Submitted:

April 2, 2004

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September 23, 2005



Contract Number: DTNH22-01-C-07002

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U.S. Department of Transportation  
National Highway Traffic Safety Administration  
National Center for Statistics and Analysis  
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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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15. <i>Supplementary Notes</i> SCI/NASS combination investigation of an air bag deployment crash involving a 2001 BMW 525i, equipped with door-mounted side impact air bags and roof rail-mounted head protection air bags, that was impacted by a 1998 Chrysler Cirrus					
16. <i>Abstract</i> The report covers a SCI/NASS combination investigation of a crash involving a 2001 BMW 525i four-door sedan (case vehicle) and a 1998 Chrysler Cirrus four-door sedan (other vehicle). This crash is of special interest because the case vehicle was equipped with door-mounted side impact air bags and roof-rail mounted head protection air bags and the left side air bags deployed. The case vehicle's driver (47-year-old male) sustained minor injuries. There was no other occupant in the case vehicle. The case vehicle was traveling east in the outside eastbound lane of a four-lane city street, approaching a four-leg intersection controlled by automatic signals and intending to continue east. The other vehicle was traveling south in the leftmost southbound through lane on the intersecting five-lane, one-way city street, intending to continue south. The case vehicle entered the intersection across the path of the other vehicle. The left side of the case vehicle was impacted by the front of the other vehicle, causing the case vehicle's front left door-mounted side impact air bag and the roof rail-mounted head protection air bag to deploy. The case vehicle rotated clockwise, the other vehicle rotated counterclockwise and the left rear area of the case vehicle impacted the right center area of the other vehicle. The case vehicle was redirected to the southeast and came to rest on the east side of the north-south roadway, heading south. The other vehicle was redirected to the southeast, ran off the road at the southeast corner of the intersection, impacted a traffic signal support pole and came to rest heading southeast. Both vehicles were towed due to disabling damage. The case vehicle's driver was taken to a hospital by a private vehicle (i.e., he was not transported via ambulance), where he was treated and released. The driver sustained a contusion on the left side of his head, a muscle strain in his neck and bilateral knee contusions.					
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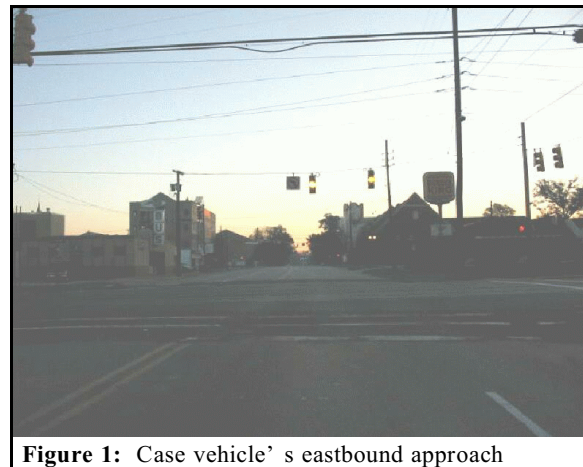
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This SCI/NASS combination investigation was brought to the NHTSA's attention in October 2003 by NASS/CDS sampling activities and was designated for SCI on February 10, 2004. This crash involved a 2001 BMW 525i (case vehicle) and a 1998 Chrysler Cirrus (other vehicle). The crash occurred in September 2003, at 10:05 p.m., in Alabama and was investigated by the applicable municipal police department. This crash is of special interest because the case vehicle was equipped with door-mounted side impact air bags and roof-rail mounted head protection air bags and the left side air bags deployed. The case vehicle's restrained driver (47-year-old male, black, non-Hispanic) sustained minor injuries. There was no other occupant in the case vehicle. The completed NASS case was received on March 26, 2004. This report is based on the coded NASS case, occupant kinematic principles and this contractor's evaluation of the evidence.

### CRASH CIRCUMSTANCES

The case vehicle was traveling east in the outside eastbound lane of a four-lane city street, approaching a four-leg intersection controlled by automatic signals and intending to continue east (**Figure 1**). The other vehicle was traveling south in the leftmost southbound through lane on the intersecting five-lane, one-way city street, intending to continue south. It was dark but lighted, the weather was clear, both roads were straight and level, the asphalt surface was dry with no apparent defects and the speed limit on both roadways was 56 km.p.h. [35 m.p.h.]. The case vehicle entered the intersection across the path of the other vehicle.

The crash occurred within the intersection. The left side of the case vehicle was impacted by the front of the other vehicle (event #1), causing the case vehicle's front left door-mounted side impact air bag and the roof rail-mounted head protection air bag to deploy. The case vehicle rotated clockwise, the other vehicle rotated counterclockwise and the left rear area of the case vehicle impacted the right center area of the other vehicle (event #2). The case vehicle was redirected to the southeast and came to rest on the east side of the north-south roadway, heading south. The other vehicle was redirected to the southeast, ran off the road at the southeast corner of the intersection, impacted a traffic signal support pole (event #3) and came to rest heading southeast.



**Figure 1:** Case vehicle's eastbound approach

### CASE VEHICLE

The case vehicle was a 2001 BMW 525i rear wheel drive, four-door, five-passenger sedan (VIN: WBADT43421G-----), equipped with a 2.8 liter I6 gasoline engine and an automatic transmission with a console-mounted selector lever. Four-wheel anti-lock brakes and traction

control were standard for this model. The case vehicle was equipped with dual-stage frontal air bags, door-mounted side impact air bags, roof rail-mounted head protection tubular air bags, and safety belt pretensioners for the two front row outboard seat positions. The odometer reading showed 43,860 kilometers [27,254 miles]. Its wheelbase was 283 centimeters [111.4 inches]. The case vehicle was towed due to disabling damage.

The case vehicle sustained direct contact damage on the left side from event #1, on the driver's door and extending forward of the left A-pillar to the left front wheel well (**Figures 2 and 3**). Direct damage was measured as 165 centimeters [64.9 inches], with maximum crush of 30 centimeters [11.8 inches] located at the leading edge of the driver's door (**Figure 3**). The driver's door window glazing was shattered, the windshield was cracked in the lower left area and there was no other glazing damage. None of the tires were damaged or restricted. The CDC was determined to be **10-LYEW-3 (290)**. This was the most severe impact for both vehicles. The WinSMASH reconstruction program, damage algorithm based on the measured crush profile of the case vehicle and CDC-only for the other vehicle (due to overlapping damage), was used on this impact. The Total, Longitudinal and Lateral delta Vs are, respectively: 31 km.p.h. [19.3 m.p.h.], -11 km.p.h. [-6.8 m.p.h.] and +29 km.p.h. [+18.0 m.p.h.]. These results appear reasonable. The first impact was of moderate severity (24-40 km.p.h. [15-25 m.p.h.]) for the case vehicle.

The case vehicle also sustained side-slap damage on the left rear area (event #2), with direct contact entirely on the rear overhang (**Figure 4**). Direct contact was measured as 61 centimeters [24.0 inches], with maximum crush of 8 centimeters [3.1 inches] located approximately midway from the rear axle to the rear end of the vehicle. The CDC was determined to be **09-LBEW-1 (270)**. The WinSMASH reconstruction program, damage algorithm based on the measured crush profiles of both vehicles, was used on this impact. The Total, Longitudinal and



Figure 2: Case vehicle's front and left side



Figure 3: Close up, case vehicle's left side damage from event #1



Figure 4: Close up, case vehicle's side slap damage



Lateral delta Vs are, respectively: 6 km.p.h. [3.7 m.p.h.], 0 km.p.h. [0 m.p.h.] and + 6 km.p.h. [+ 3.7 m.p.h.]. These results appear reasonable. The second impact was of minor severity (1-13 km.p.h. [1-8 m.p.h.]) for the case vehicle.

Inspection of the case vehicle's interior revealed lateral intrusion by left side components, including: the interior surface of the driver's door and the side panel forward of the A-pillar, both approximately 16 centimeters [6.3 inches]; the driver's door sill, measured as 13 centimeters [5.1 inches]; and the left A-pillar, measured as 2 centimeters [0.8 inches]. In addition, the left-most portion of the instrument panel was displaced slightly upward. The steering wheel was not deformed. Contact points were noted where the driver's right knee impacted the knee bolster, leaving a scuff, and on the driver's safety belt webbing, which was stretched.

#### AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with dual stage frontal air bags, door-mounted side impact air bags and roof rail-mounted head protection tubular air bags, for a total of six air bags. The driver's side impact air bag and head protection air bag deployed. None of the other air bags deployed. The case vehicle was also equipped with safety belt buckle pretensioners for the two front seat positions that did not actuate.

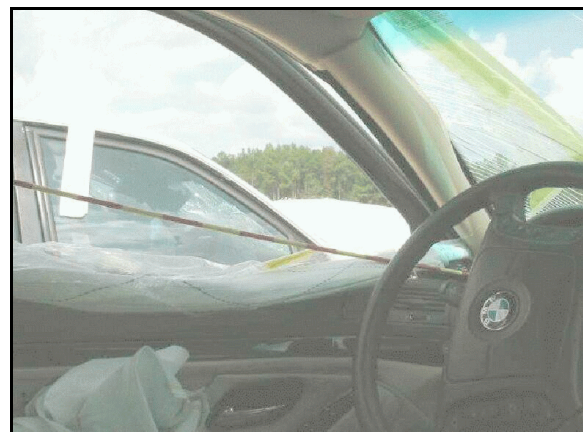
The driver's side impact air bag module was mounted behind a panel of pleated upholstery in the driver's door, immediately above the arm rest (**Figure 5**). The upholstery panel was approximately trapezoidal, measuring 19 centimeters [7.5 inches] horizontally and 12 centimeters [4.7 inches] vertically. The deployed air bag was an elongated oval, measuring 50 centimeters [19.7 inches] horizontally and 24 centimeters [9.4 inches] vertically (**Figure 6**). The air bag had no vent ports. It is not known if the air bag had internal tethers. There was no evidence of damage to the air bag, the upholstery cover flap or the surrounding structures.



**Figure 5:** Deployed driver's door-mounted side air bag tucked away, showing upholstery cover

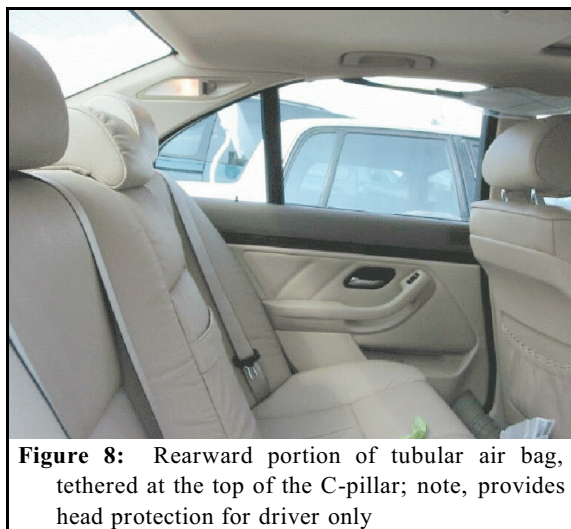


**Figure 6:** Inboard surface of the driver's door-mounted side air bag



**Figure 7:** Forward portion of tubular air bag, tethered to the base of the upper A-pillar

The driver's tubular head protection air bag was mounted in the left roof rail, with a short tether to the base of the upper A-pillar and a long tether to the top of the upper C-pillar (**Figures 7, 8 and 9**). The deploying tubular air bag deploys through a seam along the roof rail and upper A-pillar, and there is no cover flap as such. The deployed air bag was a round tube measuring 113 centimeters [44.5 inches] long and with a diameter of 12 centimeters [4.7 inches]. The tubular air bag did not have any internal tethers or vent ports. There was no evidence of damage to the air bag or the surrounding structures, except the opening of the seam through which the air bag emerged.

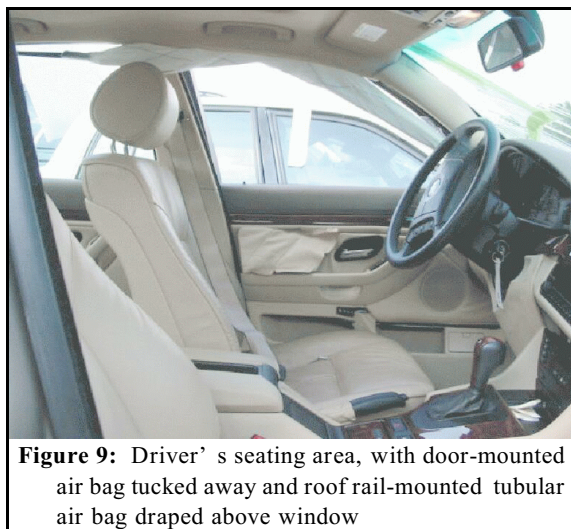


**Figure 8:** Rearward portion of tubular air bag, tethered at the top of the C-pillar; note, provides head protection for driver only

#### CASE VEHICLE DRIVER KINEMATICS

The case vehicle driver (47-year-old male, black, non-Hispanic, 178 centimeters, 94 kilograms [70 inches, 207 pounds]) was restrained by the available, manual, three-point lap-and-shoulder safety belt system. He was seated in a normal, upright driving posture, with the bucket seat back slightly reclined, the seat track adjusted between the middle and rear most positions and the tilt steering wheel adjusted at the full up position (**Figure 9**).

The driver did not attempt any pre-crash avoidance actions and his posture did not change immediately prior to the first impact. The case vehicle's left front door, A-pillar and fender were impacted by the front of the other vehicle, causing the driver to move leftward and forward, toward the 290 degree direction of force, and causing the case vehicle's door-mounted side impact air bag and roof rail-mounted tubular head protection air bag to deploy. The left side of his head contacted the tubular air bag, causing a contusion on his scalp, and his knees impacted the knee bolster, causing bilateral knee contusions. The case vehicle rotated clockwise in response to the first impact and sustained a second side slap-type impact. The vehicle's rapid rotation and, perhaps, rebound motion from his head contact with the tubular air bag caused the driver's head/neck to flex and he sustained a cervical strain injury. At final rest, the driver remained in his seat in an approximately normal upright position.



**Figure 9:** Driver's seating area, with door-mounted air bag tucked away and roof rail-mounted tubular air bag draped above window



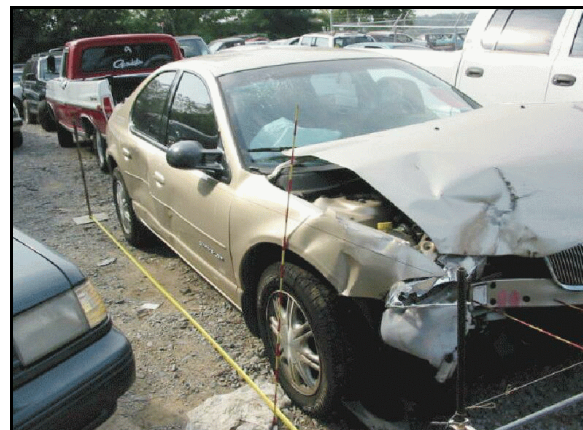
The driver was taken directly to a hospital by a private vehicle (i.e., not transported via ambulance), where he was treated and released.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Cervical spine strain	minor 640278.1,6	Belt restraint system (indirect)	Certain	Emergency Room
2	Knee contusions, bilateral	minor 890402.1,3	Knee bolster	Certain	Emergency Room
3	Scalp contusion	minor 190402.1,2	Roof rail-mounted tubular air bag	Certain	Emergency Room

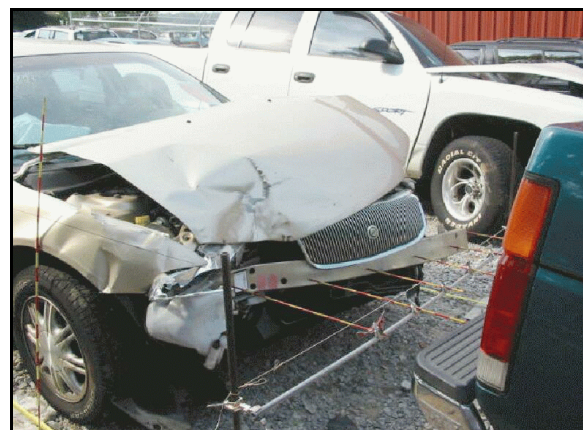
**OTHER VEHICLE**

The other vehicle was a 1998 Chrysler Cirrus front wheel drive, four-door, five-passenger sedan (VIN: 1C3EJ56H4WN-----), equipped with a 2.5 liter V6 gasoline engine. Four-wheel anti-lock brakes were standard for this model. Its wheelbase was 274 centimeters [108.0 inches]. The Cirrus was also equipped with frontal redesigned air bags that deployed as a result of the collision event. The Cirrus was towed due to disabling damage.

The Cirrus sustained direct contact damage across the full width of its front plane (**Figures 10 and 11**) due to its first impact with the case vehicle (event #1). The CDC for event #1 was determined to be **01-FDEW-2 (20)**. The Cirrus also sustained a second impact on the front plane from its impact with the traffic signal pole (event #3), causing overlapping damage near the front right corner. The CDC for event #3 was determined to be **12-FREN-? (0)** with the extent zone unknown due to the overlapping damage configuration. The WinSMASH reconstruction program, damage algorithm based on the measured crush profile of the case vehicle and CDC-only for the Cirrus, was used on event #1, which was the Cirrus’ most severe impact. The



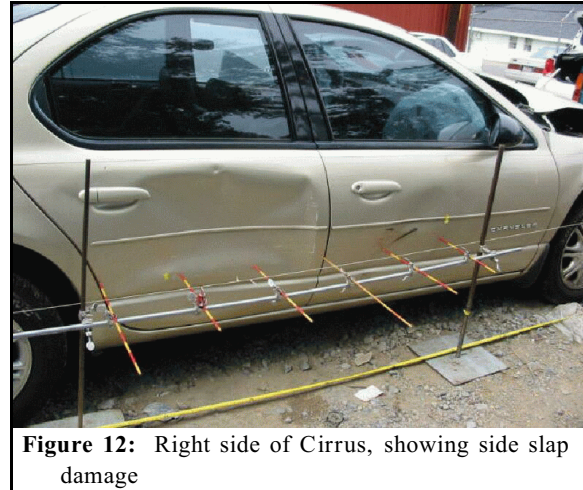
**Figure 10:** Front right corner and right side of the Cirrus



**Figure 11:** Front of Cirrus, showing overlapping damage from two impacts

Total, Longitudinal and Lateral Delta Vs are, respectively: 35 km.p.h. [21.7 m.p.h.], -33 km.p.h. [-20.5 m.p.h.] and -12 km.p.h. [-7.5 m.p.h.]. This is a borderline reconstruction for the Cirrus, but the results appear reasonable. This was an impact of moderate severity (24-40 km.p.h. [15-25 m.p.h.]) for the Cirrus.

The Cirrus also sustained minor damage on the right side (**Figure 12**), primarily on the back door, from the side slap impact (event #2). The length of direct contact was measured as 106 centimeters [41.7 inches], centered approximately on the B-pillar door, with maximum crush 3 centimeters [1.2 inches]. The CDC for the side slap was determined to be **03-RPEW-1 (90)**. The WinSMASH reconstruction program, damage algorithm based on the measured crush profile of both vehicles, was used on event #2. The Total, Longitudinal and Lateral Delta Vs are, respectively: 7 km.p.h. [4.3 m.p.h.], 0 km.p.h. [0 m.p.h.] and -7 km.p.h. [-4.3 m.p.h.]. These results appear reasonable. This was an impact of minor severity (1-13 km.p.h. [1-8 m.p.h.]) for the Cirrus.



**Figure 12:** Right side of Cirrus, showing side slap damage

The other vehicle's driver (20-year-old female) sustained police-reported "A" (evident) injuries and was transported via ambulance to a hospital, where she was treated and released. There was no other occupant in the Cirrus.

