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SCI/NASS COMBINATION CASE REPORT

CASE NUMBER - NASS-99-11-082E
LOCATION - Michigan
VEHICLE - 1997 BMW 740IL
CRASH DATE - May, 1999

Submitted:

April 26, 2000
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June 7, 2000

Contract Number: DTNH22-94-D-17058

Prepared for:

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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.

Technical Report Documentation Page

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15. *Supplementary Notes*
Combination SCI/NASS side air bag deployment investigation involving a 1997 BMW 740i with manual safety belts with pretensioners and dual front and side air bags, that impacted a small tree, several signs and a guardrail prior to rolling over.

16. *Abstract*

This report covers a SCI/NASS combination investigation of a side air bag deployment crash that involved a 1997 BMW 740il sedan (case vehicle) that struck several roadside objects and a guardrail prior to rolling over. This crash is of special interest because the case vehicle was equipped with door-mounted side air bags, one of which deployed as a result of the right side impact with the guardrail. The case vehicle's restrained driver [32-year-old, White (non-Hispanic), male] was not injured. The case vehicle was traveling in a westerly direction at high speed in the westbound lane of a two-lane, two-way undivided city roadway entering a left curve. The right rear tire slipped on some loose gravel causing the case vehicle to go off the right side of the roadway in a counterclockwise yaw. The case vehicle's right side struck a small tree and two small road signs prior to impacting a guardrail, causing the case vehicle's front right passenger door-mounted side air bag to deploy. The case vehicle's front right passenger door came open. The case vehicle continued its counterclockwise yaw, rolled over and came to rest with its trunk atop a chain link fence. The case vehicle's driver was seated with his seat track located in its rear-most position and the tilt steering wheel in its center position. He was restrained by his available, active, three-point, lap-and-shoulder safety belt and sustained, according to his interview, just soreness as a result of this crash. The front right passenger in the case vehicle [41-year-old, White (non-Hispanic) male] was seated with his seat track located in its middle position and was restrained by his available, active, three-point, lap-and-shoulder safety belt. He sustained minor injuries and was transported to a hospital where he was treated and released. According to his interview he sustained shoulder and chest injuries from his seat belt and a right scalp contusion as a result of this crash. The case vehicle was towed from the scene due to damage.

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BACKGROUND

NASS-99-11-082E

This combination SCI/NASS crash investigation concerns a 1997 BMW 740il (case vehicle) that impacted a small tree, two small road signs, a guardrail, and rolled over onto its roof. The crash occurred in May, 1999, at 3:14 p.m., in Michigan and was investigated by the applicable police department. This crash is of special interest because the case vehicle was equipped with door-mounted side air bags, one of which deployed as a result of a right side impact, and the restrained front right passenger [41-year-old White (non-Hispanic) male] sustained only minor injuries. Another item of interest is that the case vehicle's front right door came open during the crash as a result of a guardrail impact. The NASS investigator inspected the scene and case vehicle in May 1999. This report is based on the Police Crash Report, the NASS investigator's coded forms and scene photographs, passenger and witness interviews, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The case vehicle was traveling in a westerly direction at high speed in the westbound lane of a two-lane, two-way undivided city roadway and was about to enter a left curve. The case vehicle had just passed another westbound vehicle when its right rear tire lost traction on some loose gravel. The case vehicle went into a counterclockwise yaw and departed the right side of the roadway (**Figure 1**). The case vehicle's driver braked and steered to his left trying to regain control. The crash occurred off the right side of the roadway.

Figure 1: Westerly view of case vehicle's path of travel path while in CCW yaw leaving roadway with right rear tire mark highlighted

Figure 2: Case vehicle's path of travel leading into second struck sign post and guardrail

The right side of the case vehicle impacted a small tree (diameter of trunk 3 centimeters [1.2 inches]), continued its westerly counterclockwise yaw, struck a green road sign post, another 4 centimeter (1.5 inch) road sign post with its right rear prior to striking the end of a guardrail, causing the case vehicle's front right passenger door-mounted side air bag to deploy (**Figure 2**). The case vehicle's impact with the guardrail also resulted in the front right passenger door coming open. The case vehicle continued in a westerly direction, rolling over six quarter turns and coming to rest on its roof with the trunk lid atop a chain link fence. At final rest the case vehicle was heading in a southerly direction. The case vehicle was towed from the scene due to damage.

The concrete roadway was curved left and level at the point of the crash. It was daylight at the time of the crash with the roadways being dry. The posted speed limit is 64 km.p.h. (45 m.p.h.) for the roadway. The two-lane roadway was uncontrolled and divided by a dashed white line and was bordered by a solid white fog line.

The case vehicle's restrained driver (178 centimeters and 82 kilograms [70 inches, 181 pounds]) reported no injuries and was not transported. The case vehicle's restrained front right passenger [172 centimeters and 72 kilograms (68 inches, 159 pounds)] was transported to a hospital where he was treated and released with minor injuries.

CASE VEHICLE

The case vehicle was a rear wheel drive 1997 BMW 740il, five-passenger, four-door sedan (VIN: WBAGJ8320VD------) equipped with a 4.4 liter V8 engine, power-assisted rack-and-pinion steering, and 5-speed automatic transmission with console-mounted selector lever. Braking was achieved by a power-assisted, four wheel anti-lock system. The wheelbase was 307 centimeters (120.9 inches). The case vehicle had a reported odometer reading of 50,194 kilometers (31,192 miles).

Figure 3: Front right angle view of deformation to case vehicle; NOTE: front right door open

The front row of the case vehicle was equipped with adjustable bucket seats with adjustable head restraints and three-point lap-and- shoulder safety belts. The vehicle was equipped with padded knee bolsters for the driver and front right passenger seat positions. The steering wheel had both a tilt and telescopic mechanism to allow for vertical and longitudinal adjustment. The rear seat was a bench seat with separate backs and adjustable head restraints for the outboard seat positions. The front safety belt systems were equipped with manually operated height adjusters for the D-rings with both in the middle position. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a front air bags and door-mounted side air bags for the driver and front right seat positions.

Figure 4: Angled view from right rear of right side damage and rollover damage; NOTE: C-pillar damage and back light

The case vehicle's initial contact with the small tree involved the right side but the exact point is unknown. The case vehicle's impact with the green street sign began 136 centimeters (53.5 inches) forward of the right rear axle and was 48 centimeters wide (18.9 inches). The maximum crush could not be measured because of the overlapping rollover damage. The case vehicle's impact with the other road sign involved the right rear quarter panel but the direct damage width and maximum crush could not be measured because of the overlapping rollover damage (**Figures 3-4**, above). The case vehicle's highest severity impact with the guardrail, which deployed the right side door-mounted air bag, was between the right front fender and right front door seam. The direct damage started 32 centimeters (12.6 inches) behind the right front axle and extended 46 centimeters (18.1 inches) rearward. The maximum crush to the case vehicle's right side was a measured 13 centimeters (5.1 inches) and was located between C4 and C5 (**Figure 5**). The case vehicle's rollover damage encompassed the entire length and width of the vehicle (**Figure 6**). The maximum crush was measured at 9 centimeters (3.5 inches) to the top plane. The vehicle's final impact was to the rear trunk lid which resulted when the case vehicle's trunk came to rest atop a chain link fence. Maximum crush was measured at 1 centimeter (0.4 inches). The wheel base on the both sides remained unchanged. Both right tires were restricted and deflated sometime during the case vehicle's CCW yaw and subsequent impacts.

Figure 5: Straight-on view of most severe damage to case vehicle which deployed side air bag and caused latch/striker to fail; NOTE: contour gauge

Figure 6: Overhead view of damage to case vehicle's top plane from rollover

There was several areas of integrity loss to the case vehicle. The case vehicle's front right door came open due to latch/striker failure. The front right window, back light and moon roof were disintegrated from impact forces. The windshield was cracked but remained in place.

Because of the case vehicle's multiple impacts with resulting overlap damage, CDCs could be determined only for events 4 (guardrail impact) and 5 (rollover). The CDCs were determined to be: **03-RYEW-3 (80)** and **00-TYDO-3** for the case vehicle (maximum crush was 13 centimeters [5.1 inches] on the right side). No reconstruction program was used on the case vehicle's left side impact due to the collision conditions (i.e., yielding objects and overlapping damage) being beyond the scope of the WinSMASH reconstruction program; however, this contractor's visually estimated Delta V for the right side impact with the guardrail is between 13 km.p.h. (8 m.p.h.) and 21 km.p.h. (13 m.p.h.).

An examination of the case vehicle's interior showed no visible evidence of contact by the vehicle's occupants primarily because of the crusted over mud strewn throughout the interior. The energy absorbing steering column was not measured for compression. The case vehicle driver and front right passenger's knee bolsters showed no evidence of scuffing or deformation. There was evidence of intrusion by the case vehicle's windshield, windshield header and roof. The most significant being 48 centimeters (18.9 inches) by the windshield into front right passenger seat position. The roof above the front right seat position was intruded 10 centimeters (3.9 inches).

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a SRS that consisted of front air bags and door-mounted side air bags at the driver and front right passenger seat positions. The only air bag that deployed was the front right passenger's side air bag (**Figure 7**). The right side air bag deployed as a result of the case vehicle's right side impact with the guardrail. The front right passenger's side air bag deployed from the door panel were it was mounted. The module cover consisted of two trapezoidal cover flaps with overall dimensions of 13 centimeters (5.1 inches) at the top and bottom horizontal creases, 9 centimeters (3.5 inches) at the center horizontal seam and 7 centimeters (2.8 inches) angled horizontal seams. The flap material is an unknown vinyl/rubber material. The side air bag was 43 centimeters (16.9 inches) longitudinally and 28 centimeters (11 inches) vertically and had one tether along the air bag seam. The front right passenger's side air bag had no vent ports.

Figure 7: Close-up of case vehicle's deployed front right door-mounted air bag

An inspection of the front right passenger's side air bag and cover flap revealed no visible evidence of direct contact (i.e., fibers or skin) or damage from the front right passenger.

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's [32-year-old, White (non-Hispanic) male] driver was restrained by his available, active, three-point, lap and shoulder belt. The driver's adjustable shoulder anchorage was in the middle position. Seatbelt usage was based on the police report and the front right passenger's interview since the right side impact would not have caused any significant loading to the system.

Figure 8: View of case vehicle driver's seating area; NOTE: open sunroof

The case vehicle's driver (178 centimeters and

82 kilograms [70 inches, 181 pounds]) was seated in a slightly reclined posture with his back against the seat back, his left foot was on the floor, his right foot on the brake, and both hands were on the steering wheel steering to the left. His seat track was located in its full rearward position, the seat back was slightly reclined, and the tilt steering wheel was in center position. The position of the steering wheel's telescopic adjustment was not documented and is unknown.

The case vehicle's driver braked and steered to the left, attempting to avoid the crash; these actions resulted in him leaning to his left away from his impending impact with the guardrail. The case vehicle's impact with the tree and both sign posts had little effect on the case vehicle driver's pre-impact posture. The case vehicle's impact with the guardrail resulted in the driver moving to his right towards the 3 o'clock direction of principal force. After impacting the guardrail the case vehicle rolled over causing the driver to move upwards towards the roof. The case vehicle's subsequent 6 quarter rolls caused the driver to move within his immediate seating area, (his exact movements within the vehicle are unknown) his three-point restraint kept him from being thrown out of the vehicle during the roll (**Figures 8-9**). The case vehicle came to rest on its roof with the case vehicle driver suspended upside down, hanging by his safety belt.

Figure 9: Interior view of case vehicle; NOTE: anti theft device on SW hub and overhead console hanging down

CASE VEHICLE DRIVER INJURIES

The driver was not transported and was not treated by EMS personnel. No other information is available.

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The case vehicle's front right passenger [41-year-old, White (non-Hispanic) male] was wearing his available, active, three-point, lap-and-shoulder safety belt system. The front right passenger's adjustable shoulder anchorage was in the middle position. Seatbelt usage was based on the police report and this passenger's interview since the right side impact would not have caused any significant loading to the system.

The case vehicle's front right passenger [170 centimeters and 72 kilograms (67 inches,159 pounds)] was seated in a slightly reclined posture with his back

Figure 10: Close-up of case vehicle's front right door panel showing no evidence of contact

against the seat back, both feet on the floor and both hands were on his lap. His seat track was located in its middle position, the seat back was slightly reclined.

The case vehicle's driver braked and steered to the left, attempting to avoid the crash. These actions resulted in the front right passenger leaning to his left away from the impending impact with the guardrail. The case vehicle's impact with the tree and both sign post had little effect on this passenger's pre-impact posture. The case vehicle's impact with the guardrail resulted in the front right passenger moving to his right towards the 3 o'clock direction of principal force. After impacting the guardrail the case vehicle rolled over causing the front right passenger to move upwards towards the roof (**Figures 10-11**). The case vehicle's subsequent 6 quarter rolls caused the passenger to move within his immediate seating area (his exact movements within the vehicle are unknown). His three-point restraint kept him from being thrown out of the vehicle during the roll. According to the front right passenger, at some point during the rollover, while the door was open, his head came out side the vehicle causing his face to contact the muddy ground. The case vehicle came to rest on its roof with the case vehicle's front right passenger suspended upside down, hanging by his safety belt.

Figure 11: Vertical view of case vehicle's front right passenger seating area

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right passenger was transported by an ambulance to the hospital where he was treated and released. According to his interview he sustained minor injuries which included a right shoulder contusion, a contusion to his upper right chest, and a contusion to the right side of his scalp.

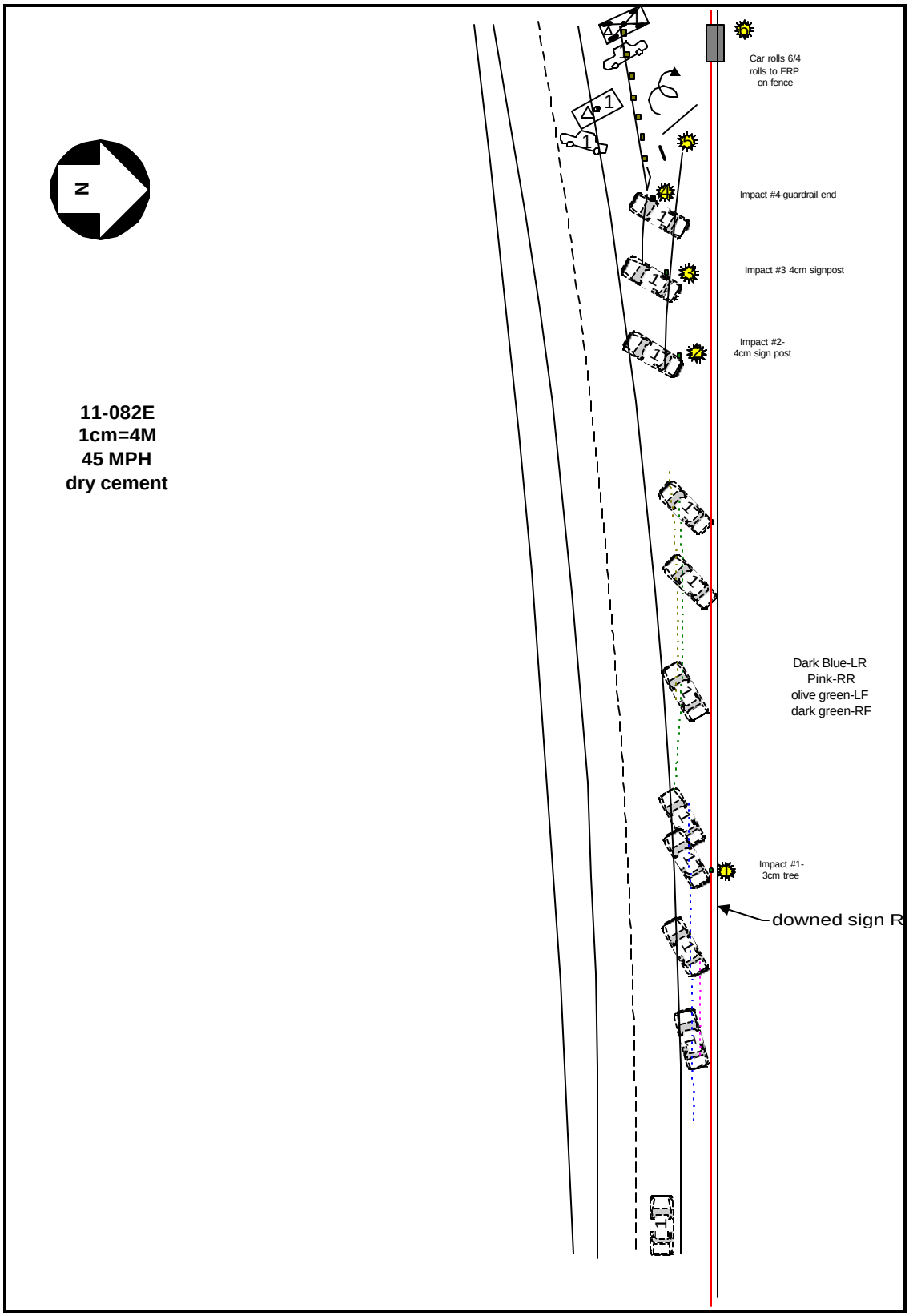
Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Right scalp contusion	190402.1 minor	B-pillar	Possible	Emergency room
2.	Right shoulder contusion	790402.1 minor	Seat belt harness	Certain	Interviewee
3.	Right upper chest contusion	490402.1 minor	Seat belt harness	Certain	Interviewee

The case vehicle's most severe impact occurred when the right side struck the end portion of a W-beam guardrail which caused the case vehicle's right door-mounted side air bag to deploy. This impact also resulted in the failure of the latch/striker of case vehicle's right front passenger door, allowing it to open. The case vehicle's guardrail impact precipitated the case vehicle's rollover event.

The impact to the end portion of the W-beam guardrail fractured the wooden 4 X 4 post to which it was anchored and caused the guardrail to fold back accordion style **(Figures 12-13)**.

Figure 12: Close-up of W-beam guardrail end

Figure 13: View of guardrail end and fractured wooden post; NOTE: highlighted front right tire mark leading into guardrail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rolls to FRP
on fence
Impact #4-guardrail end
Impact #3 4cm signpost
Impact #2-
4cm sign post
Dark Blue-LR
Pink-RR
olive green-LF
dark green-RF
Impact #1-
3cm tree
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