Side Air Bag Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS03027
1999 BMW 328i
Colorado
June, 2003

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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

1. Report No.	2. Government Accession No.	3. Recipient Catalog No.
DS03027		

4. Title and Subtitle	5. Report Date
Side Air Bag Investigation	6. Performing Organization Report No.

7. Author(s)	8. Performing Organization Report No.
Dynamic Science, Inc.	

9. Performing Organization name and Address	10. Work Unit No. (TRAIS)
Dynamic Science, Inc. 530 College Parkway, Ste. K Annapolis, MD 21401	11. Contract or Grant no. DTNH22-01-C-27002

12. Sponsoring Agency Name and Address	13. Type of report and period Covered [Report Month, Year]
U.S. Dept. of Transportation (NRD-32) National Highway Traffic Safety Administration 400 7th Street, SW Washington, DC 20590	14. Sponsoring Agency Code

15. Supplemental Notes

16. Abstract

The focus of this investigation is the deployment of a side air bag in a 1999 BMW 328i. This single vehicle crash occurred in June, 2003 at 0100 hours in a mountainous area of Colorado. The crash occurred off-road. The north/south asphalt roadway approaching the roadway departure is two-way and curved to the left. The roadway was wet. It was dark at the time of the crash and there were no streetlights available. To the right of the roadway is a dirt shoulder followed by a grass/dirt embankment with a 37% downgrade. The speed limit is 64 km/h (40 mph). The case vehicle is a 1999 BMW 328i four-door sedan driven by a restrained 22-year-old male. The case vehicle was equipped with a dual stage driver's air bag, a dual stage front right passenger's air bag, a driver's door mounted side air bag, a front right passenger's door mounted side air bag, Inflatable Tubular Structure (ITS) head protection, and buckle mounted seatbelt pretensioners for both front seats. The front right seat was occupied by a restrained 21-year-old female. The case vehicle was traveling southbound at a police reported speed of 105 km/h (65 mph). As the vehicle entered the curve, the driver lost control. The case vehicle began to yaw in a counterclockwise direction and slid off the roadway onto a grass shoulder. The vehicle continued on and traveled down an embankment. The case vehicle had rotated 30-40 degrees by this time. The case vehicle struck a large boulder with its front right end. The driver and front right passenger air bags deployed and the front seat belt pretensioners fired at this point. The front right passenger side air bag and right side ITS also deployed. The driver sustained multiple minor injuries, including: abrasions to his left upper chest, left forearm, left knee, right elbow, and left ankle. He was able to exit the vehicle on his own. He was transported to a local hospital where he was treated and released. The front right occupant sustained a grade 1 open, comminuted and segmental right humerus fracture, a right fingerfracture, and a concussion with loss of consciousness. She also sustained a variety of contusions and abrasions. She was transported to a local hospital. She was admitted and hospitalized for two days.

17. Key Words	18. Distribution Statement
Air bag, deployment, injury, AOPS, ITS, tubular structure, passenger,	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price

Form DOT F 1700.7 (8_72) Reproduction of this form and completed page is authorized

Dynamic Science, Inc.
Crash Investigation
Case Number: DS03027

TABLE OF CONTENTS

BACKGROUND:

Description:	This Side Air Bag case was initially identified by a NHTSA review of GES police reports. DSI was notified on July 2, 2003. This was an on-site investigation. All field work was completed on July 10, 2003.
Investigation Type:	Side air bag
Crash Location:	Colorado
Crash Date:	June, 2003
Notification Date:	July 2, 2003
Field Work Completed:	July 10, 2003

SUMMARY

Crash Site

This single vehicle crash occurred in June, 2003 at 0100 hours in a mountainous area of Colorado. The crash occurred off-road. The north/south asphalt roadway approaching the roadway departure is two-way, curved to the left, and has a positive 2.5% grade. The curve had a radius of 55.4 m (182.0 ft) and a critical speed of 67.4 km/h (41.9 mph)[1]. The roadway was wet. It was dark at the time of the crash and there were no streetlights available. To the right of the roadway is a dirt shoulder followed by a grass/dirt embankment with a 37% downgrade. The speed limit is 64 km/h (40 mph).

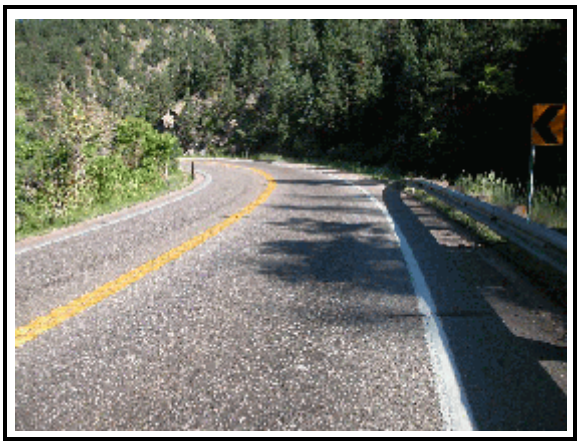

Figure 1. Approach to area of road departure/off road impact (south)

Pre-Crash

The case vehicle is a 1999 BMW 328i four-door sedan driven by a restrained 22-year-old male (83 kg/185 lbs). He was wearing the available type 2 lap and shoulder belt with an Emergency Locking Retractor (ELR). The shoulder belt upper anchorage was adjusted to the mid position. The case vehicle was equipped with a dual stage driver's air bag, a dual stage front right passenger's air bag, a driver's door mounted side air bag, a front right passenger's door mounted side air bag, Inflatable Tubular Structure (ITS) head protection, and buckle mounted seatbelt pretensioners for both front seats.

[1]See Attachment 1

The front right seat was occupied by a restrained 21-year-old female (152 cm/60 in, 48 kg/105 lbs). She was wearing the available type 2 lap and shoulder belt with a switchable retractor in the ELR mode. The shoulder belt upper anchorage was adjusted to the full down position. Both occupants were seated in leather covered bucket seats. The seats were both adjusted to between the middle and rear most track position. Both occupants were intoxicated. The case vehicle was traveling southbound at a police reported speed of 105 km/h (65 mph).

Figure 2. Impact area/final rest

Crash

As the vehicle entered the curve, the driver lost control. The case vehicle began to yaw in a counterclockwise direction and slid off the roadway onto a grass shoulder. The vehicle continued on for 14.2 m (46.5 ft) and traveled down an embankment. The case vehicle had rotated 30-40 degrees by this time. The case vehicle struck a large boulder with its front right end (01FREE6).

Figure 3. Front right, case vehicle

The total velocity change calculated by the barrier algorithm of the WinSmash collision model was 33.0 km/h (20.5 mph)[2]. The longitudinal and lateral delta V components were -25.3 km/h (-15.7 mph) and -21.2 km/h (-13.2 mph), respectively.

The driver and front right passenger air bags deployed and the front seat belt pretensioners fired at this point. The front right passenger door mounted side air bag and right side ITS also deployed.

After the impact with the boulder, the case vehicle rotated counterclockwise and contacted a small tree/bush with its right side (03RPAW2).

Post-Crash

The case vehicle was towed from the scene and was placed on a police hold. The vehicle was declared a total loss by the insurance company.

The driver sustained multiple minor injuries, including: abrasions to his left upper chest, left forearm, left knee, right elbow, and left ankle. He was able to exit the vehicle on his own. He was transported to a

[2]Calculated using pocket extent for C4 measurement.

local hospital by a passerby who had been flagged down by the driver. He arrived at the hospital shortly after the crash and initially refused any treatment. At 0240 hours he indicated that he did want to be seen because of pain to his elbow and left shoulder. He was seen at 0305 hours–a little over two hours post-crash. He had a Glasgow Coma Scale (GCS) of 15. He tested positive for alcohol (BAC=0.077). He was examined and then released at 0430 hours.

The front right occupant sustained a grade 1 open, comminuted and segmental right humerus fracture, a non-displaced fracture of the distal right first proximal phalanx, and a concussion with loss of consciousness. She also sustained a variety of contusions and abrasions. She was transported to the hospital in the same vehicle as the driver. She arrived at the hospital with a GCS of 15, however she suffered from perseveration[3] and had no recollection of the crash. She tested positive for alcohol (BAC=0.17). She was first seen at 0105 hours. She was admitted and underwent surgery to repair the humerus fracture. She was hospitalized for two days.

[3]Perseveration is the persistent repetition of the same verbal or motor response to varied stimuli; continuance of activity after cessation of the causative stimulus.

SCENE DIAGRAM

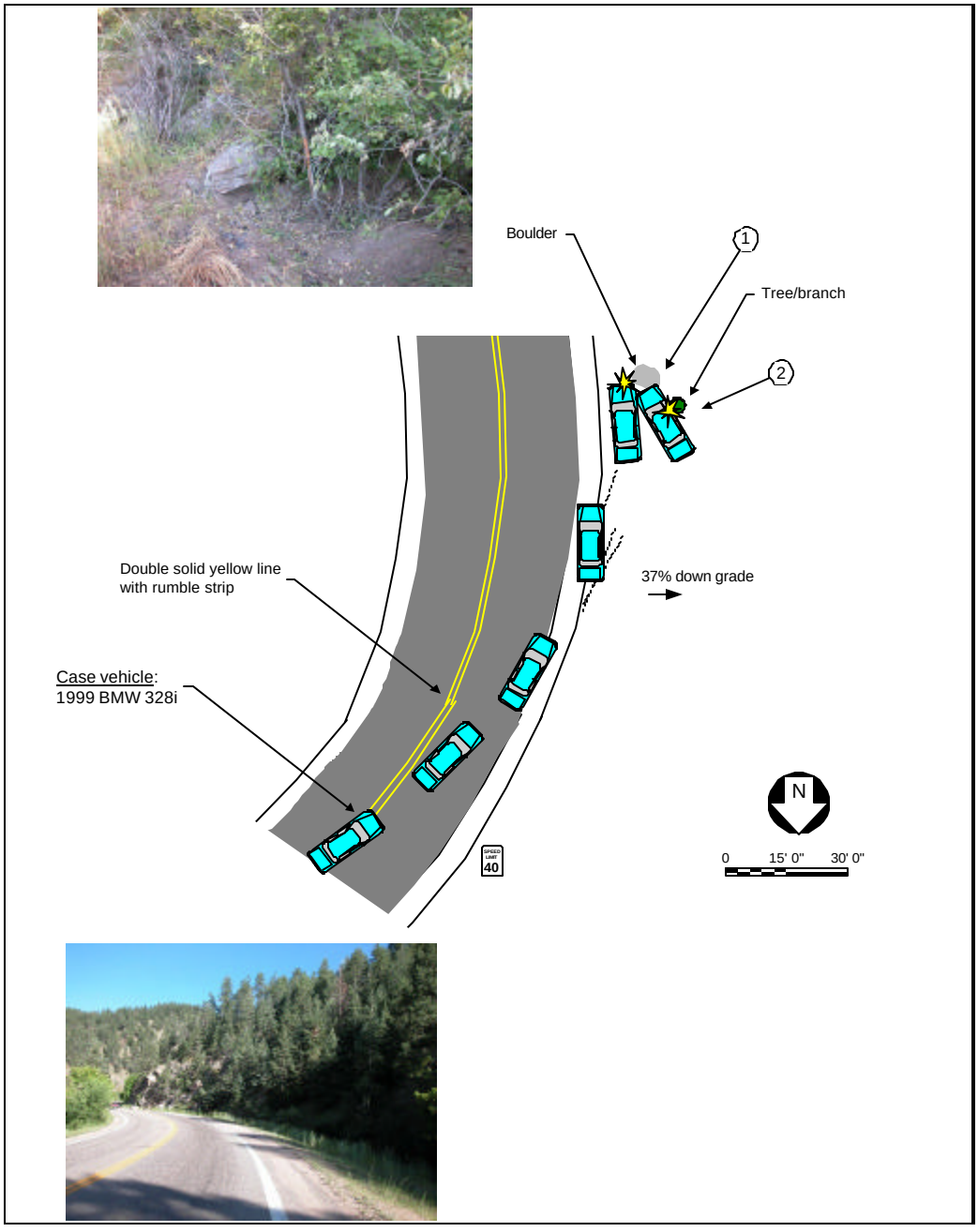

Figure 4. Scene diagram

COLLISION MEASUREMENT TABLE

Crash Data	Vehicle #1			
Surface Type	Asphalt - Roadway			
Surface Condition	Dry			
Grade (pre-impact)	+2.5%			
Grade (impact)	-37%			
Speed Limit	64 km/h (40mph)			

Reference Point:	**Reference Line:**
paddle marker north of curve	artificial line set along north/south axis

Data Point	**Distance and Direction from RL**			**Distance and Direction from RP**		
	ft	m	d	ft	m	d
ERF	0.7	0.2	W	38.0	11.6	S
BRF	0	0	W	59.0	18	S
ELR	6.5	2	W	52.0	15.8	S
ERR	9.3	2.8	W	35.0	10.7	S
BLR	1.0	0.3	E	71.0	21.6	S
BRR	1.0	0.3	E	71.0	21.6	S
Rock	16.0	4.9	W	19.0	5.8	S
Impacted tree/bushes	20	6.1	W	21.0	6.4	S
Chord - 30.4m (100.0 ft)						
Middle ordinate - 2.1 m (7.0 ft)						

VEHICLE DATA - 1999 BMW 328i four-door sedan

The 1999 BMW 328i was a four-door sedan equipped an automatic transmission, rear wheel drive, front and rear disc brakes, and an anti-lock brake system.

VIN:	WBAAM5337XKGxxxxx
Odometer:	Unknown
Engine:	6 cylinder, 2.8 L (170 CID)
Reported Defects:	NHTSA Recall No. 99V063[4]
Cargo:	None

The BMW 328i was equipped with Bridgestone Potenza S-03 P225/45R17 tires. The specific tire data is as follows:

Tire	Tread	Pressure	Recommended pressure
LF	5.0 mm (0.19 in)	207 kPa (30 psi)	248 kPa (36 psi)
LR	2.0 mm (0.09 in)	262 kPa (38 psi)	248 kPa (36 psi)
RF	4.0 mm (0.13 in)	flat	248 kPa (36 psi)
RR	2.0 mm (0.09 in)	248 kPa (36 psi)	248 kPa (36 psi)

The front seating positions in the 1999 BMW 328i were configured with leather covered bucket seats with adjustable head restraints. Both front seats were slightly reclined prior to the crash and did retain their pre-impact positions. The rear seating positions were configured with a bench seat with adjustable head restraints for the outboard seat positions.

[4]See Attachment 2. This was a recall to reprogram the computer control module to make the system less sensitive and reduce inadvertent side air bag deployments. The control module for this vehicle had undergone the required reprogramming.

VEHICLE DAMAGE

Exterior Damage - 1999 BMW 328i

Damage Description:	Major front end damage beginning at right corner.	
CDC:	Impact 1: 01FREE6 Impact 2: 03RPAW2	
Delta V:	Total	33.0 km/h (20.5 mph)
	Longitudinal	-25.3 km/h (-15.7 mph)
	Latitudinal	-21.2 km/h (-13.2 mph)
	Energy	83,301 joules (61,440 ft-lbs)

The case vehicle sustained direct contact damage from the first impact that began at the front right bumper corner and extended 36.0 cm (14.2 in) along the front. The residual crush measured on the bumper reinforcement bar was as follows: C1=0 cm (0 in), C2=0 cm (0 in), C3=0 cm (0 in), C4=44.0 cm (17.3 in). The maximum crush was into the pocket beyond the end of the bumper corner and measured 118 cm (46.4 in). The right side wheelbase was shortened by 69.0 cm (27.2 in). There was minor contact damage to the right passenger area from contact with a tree/bushes. There was intrusion into the passenger compartment from the initial impact through the right instrument panel, right toe pan, and right A pillar.

Figure 6. Front right, case vehicle (impact 1)

Figure 5. Right side of vehicle (impact 2)

Interior Damage - 1999 BMW 328i

Interior damage to the 1999 BMW 328i was moderate and attributed to occupant contact and passenger compartment intrusion. The windshield was fractured from impact forces. There was longitudinal intrusion into the front right seating area from the toe pan, right instrument panel, and A pillar. The glove compartment door was dislodged. The right door was deformed outward due to occupant contact and the impact along the frame. There were make up contacts to the right side ITS and the B pillar.

MANUAL RESTRAINT SYSTEMS - 1999 BMW 328i

The 1999 BMW 328i was configured with manual 3-point lap and shoulder belts with sliding latch plates for both front positions and rear outboard positions. The front seat restraints were configured with adjustable anchorages; the left was in the mid position, the right in the full up position. A 2-point lap belt with a locking latch plate was present for the rear center position. All the outboard seats were equipped with switchable retractors that were in the emergency locking mode. Buckle mounted pretensioners were available for the front seat positions and did actuate during the crash.

FRONTAL AIR BAG SYSTEM - 1999 BMW 328i

The case vehicle was equipped with a dual stage driver's air bag, a dual stage front right passenger air bag, a driver's door mounted side air bag, a front right passenger side air bag, and the Inflatable Tubular Structure (ITS) head protection for both front seats. Both front seat manual restraints were also configured with buckle pretensioners. The front air bags include a "smart" dual-threshold deployment system. The system will automatically assess the severity of an impact and choose between two inflation rates for the front air bags. The front right seat cushion contains a sensor mat that detects seat occupancy. The sensor recognizes if the seat is occupied or not. If the seat is not occupied, the air bag won't go off in the event of a collision. The ITS is entirely concealed above the front doors and within the A-pillar and roof cladding or upholstery. The ITS is a hollow, flexible, essentially airtight tube. At one end, this tube is anchored inside the vehicle's A-pillar, near the bottom of the pillar. At the other end, it is anchored in the roof just above the rear door. Upon side impact, the inflator, mounted on one end of the tube, inflates the tube with an inert gas. A relatively airtight inner tube of silicon material manages the inflation; a woven nylon outertube manages the tube's shape. The diameter increase forced by inflation causes the length to decrease. In turn, the tube no longer fits inside the area where it is stored; it pulls out of the headliner and forms a soft, straight tube and stretched in a straight line from the lower windshield pillar to the roof. According to BMW literature on the ITS, the tube is designed to stay inflated for approximately six seconds after deploying. The ITS is described in BMW's literature as the Head Protection System (HPS).


98-1

Fig. 98-1: Identifying Air Bag Components (M3 & 3 Series)

M3 & 3 Series: Convertible models are equipped with Rollover Protection System (RPS), located at the rear of the passenger compartment. Roll bars will pop up when deployed.

Table 98-1: Component Locations (M3 & 3 Series)

Component	[1] Location
Control Module	Under Rear Seat
Driver Air Bag Module	On Steering Wheel
Passenger Air Bag Module	Passenger-Side Instrument Panel
Seat Belt Pretensioners	Driver & Passenger-Side Inner Front Seat Belt Buckles
Side Impact Air Bag Module	Inside Driver & Passenger-Side Front & Rear Doors
Side Impact Air Bag Sensors	Under Driver & Passenger-Side Front Seats Near B-Pillars

[1] - Refer to Fig. 98-1 for component locations.

Figure 7. Air bag component locations

Figure 8. Driver's air bag

The driver's air bag module had a roughly triangular configuration and was located in the center hub of the steering wheel rim and had a single cover flap. There was no contact evidence on the cover flap. The diameter of the air bag measured 45.0 cm (17.7 in) in its deflated state. There was a single vent port located at the 12 o'clock position. There were no tethers. There were four vertical and three horizontal folds on the air bag face. There were no indications of any occupant contacts.

Figure 9. Front right passenger air bag

The front right passenger air bag was a top mount design located in the right aspect of the instrument panel. The rectangular module cover measured 44.0 cm (17.3 in) wide by 19.0 cm (7.5 in) high. It was held in place by two 13.0 cm (5.1 in) long nylon straps on the back side and two 15.0 cm (5.9 in) long nylon straps on the front side. The deflated rectangular air bag measured 52.0 cm (20.5 in) wide by 60.0 cm (23.6 in) high. There were two vent ports and two tethers. The ports were at the 3 and 9 o'clock positions.

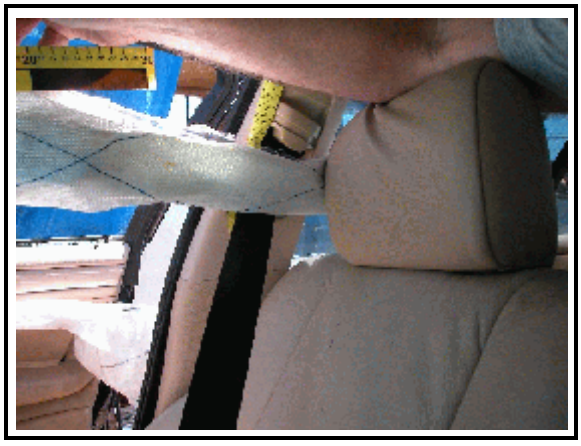

Figure 10. Right ITS (contact evidence to structure and B pillar)

The side air bag was door mounted. The trapezoid shaped cover measured 23.0 cm (9.0 in) wide by 11 cm (4.3 in) high. The air bag measured 43.0 cm (16.9 in) wide at the top, 25.0 cm (9.8 in) wide at the bottom, and 19.0 cm (7.5 in) high. There was no contact evidence on the cover flap or air bag.

The ITS was roof rail mounted. The ITS was 94.0 cm (37.0 in) in length. It was connected to the vehicle by a 16.0 cm (6.3 in) tether on the front and a 21.0 cm (8.3 in) in the rear. There was make-up contact evidence found 49.0 cm (19.3 in) from the front end.

OCCUPANT DEMOGRAPHICS - 1999 BMW 328i

	Occupant 1	Occupant 2
Age/Sex:	22/Male	21/Female
Seated Position:	Front left	Front right
Seat Type:	Leather covered bucket seat. Seat adjusted to between the middle and rear most track position.	Leather covered bucket seat. Seat adjusted to between the middle and rear most track position.
Height:	Unknown	152 cm (60 in)
Weight:	84 kg (185 lbs)	48 kg (105 lbs)
Occupation:	Car salesman	Student
Pre-existing Medical Condition:	None noted	Two surgeries for Tetralogy of Fallot[5], including one as an infant as well as a later valve replacement.
Alcohol/Drug Involvement:	BAC=0.077 @ 0420 hours. Breathalyzer.	BAC=0.170 @ 0105 hours. Blood test.
Driving Experience:	Unknown	NA
Body Posture:	Upright, pitching to right	Upright, pitching to right
Hand Position:	Steering to the left. Right hand likely above left.	Unknown
Foot Position:	Right foot on brake, left on floorboard	Both feet presumed to be on floor.

[5]Tetralogy of Fallot is a type of heart problem which consists of four different heart defects. The first defect is called a ventricular septal defect (VSD). This is a hole between the two bottom chambers (ventricles) of the heart. The second defect is called Pulmonary Stenosis. This is a narrowing at or just below the pulmonary valve. The third part of Tetralogy of Fallot involves the aorta being positioned over the ventricular septal defect instead of in the left ventricle. Finally, the right ventricle in infants born with Tetralogy of Fallot is more muscular than normal.

Restraint Usage:	Using available type 2 lap and shoulder belt with an Emergency Locking Retractor (ELR). The shoulder belt upper anchorage was adjusted to the mid position. Buckle mounted pretensioners available, fired.	Using the available type 2 lap and shoulder belt with a switchable retractor in the ELR mode. The shoulder belt upper anchorage was adjusted to the full down position. Buckle mounted pretensioners available, fired.
Air bag:	Steering wheel mounted air bag available, deployed. ITS available, did not deploy. Side air bag available, did not deploy.	Top instrument panel mounted front right passenger air bag available, deployed. ITS available, deployed. Seat mounted side air bag available, deployed.

OCCUPANT INJURIES -1999 BMW 328i

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Left upper chest abrasion	490202.1,2	911.0	Shoulder belt
	Left forearm abrasion	790202.1,2	913.0	Air bag
	Left knee abrasion	890202.1,2	916.0	Left lower instrument panel
	Left ankle abrasion	890202.1,2	916.0	Clutch pedal
	Right elbow abrasion	790202.1,1	913.0	Unknown
RF Occupant:	Grade 1 open, comminuted and segmental right humerus fracture	752604.3,1	812.31	Door side panel
	Non-displaced fracture of the distal right first proximal phalanx	853602.1,1	816.02	Unknown
	Anterior frontal parietal scalp hematoma, left forehead	290402.1,7	920.0	Air bag
	Concussion, loss of conscious (time unknown)	160406.2,0	850.5	ITS
	Small laceration in the oral mucosa of lower lip	290602.1,8	873.43	ITS
	Contusion, right medial malleolus	890402.1,1	924.21	Door side panel

OCCUPANT KINEMATICS - 1999 BMW 328i

The 22-year-old male driver of the case vehicle was seated in a forward facing fashion. He was seated in a leather covered bucket seat; the seat had been adjusted to the mid track position. He was using the available type 2 lap and shoulder belt with an emergency locking retractor (ELR). Loading evidence was found on the seat belt. The shoulder belt upper anchorage was adjusted to the mid position. His right foot was on the brake, the left was on the floor board. He was actively steering the vehicle to the left. His right hand was likely above the left. The vehicle was in a counterclockwise yaw and both occupants were pitched somewhat to the right due to rotation and the 37% embankment down grade. At impact, the driver's air bag deployed and the seat belt pretensioner fired. The driver pitched forward and to the right in response to the 40 degree direction of force–loading the locked lap and shoulder belt and causing an abrasion to the upper left chest. His left knee engaged the lower instrument panel–causing a minor abrasion. The driver engaged the deployed air bag with his face and torso but did not sustain any injuries. The air bag did, however, contact his left forearm–causing an abrasion. His left foot was initially on the floor but moved sharply to the right at impact and struck the clutch pedal. He sustained minor ankle abrasion from this contact. The vehicle rotated counterclockwise after the initial impact and engaged a bush/tree. This contact did not have a significant effect on this occupant. He was able to exit the vehicle on his own. He was transported to a local hospital. He arrived shortly after the crash and initially refused any treatment, but was later treated and released.

Figure 11. Driver's seated position

Figure 12. Loading evidence on front left seat belt

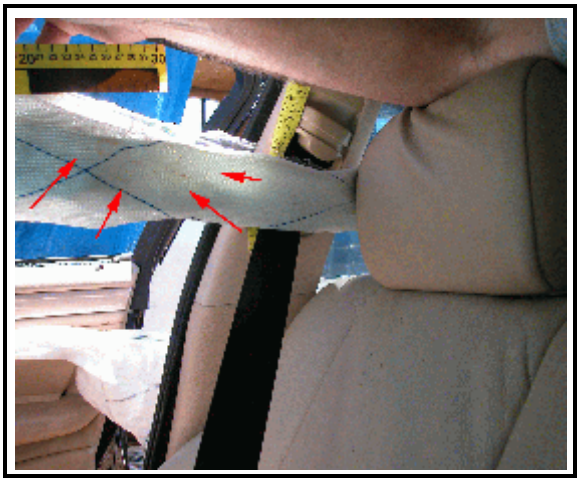

Figure 13. Make-up contacts to ITS and B pillar

The 21-year-old female front right occupant was seated in a forward facing fashion. She was seated in a leather covered bucket seat; the seat had been adjusted to the mid track position. She was using the available type 2 lap and shoulder belt with a switchable retractor that was in ELR mode. The shoulder belt upper anchorage was adjusted to the full down position. Both feet were presumed to be on the floor. The driver was actively steering the

vehicle to the left. The vehicle was in a counterclockwise yaw and this occupant was likely pitched somewhat to the right due to rotation and the 37% embankment down grade. The right front window was in the down position at the time of the crash. At impact, the front right passenger air bag deployed and the seat belt pretensioner fired. It is this contractor's opinion that the right side door mounted side air bag and the right side ITS also deployed during the initial impact due to the lateral impact forces. This occupant pitched forward and to the right in response to the 40 degree direction of force–loading the locked lap and shoulder belt. The case vehicle rotated sharply counterclockwise during this impact. This occupant's right upper arm contacted the door panel–resulting in a comminuted humerus fracture. Her torso engaged the door mounted side air bag, but there were no indications of contact or injury. Her head pitched to the right and engaged the deployed ITS–causing the concussion and minor soft tissue injuries. As vehicle rotation continued, and the vehicle continued its pitch to the right, it appears that this occupant by-passed the top of the ITS and engaged the B pillar with the right side of her face. This contact appears to more of a vertical contact–traveling up the B pillar. Her mouth injury may have come from this contact. After the crash she was able to exit the vehicle on her own. She was transported to a local hospital. She was admitted and underwent surgery to repair the humerus fracture. She was hospitalized for two days.

Figure 14. Make up contacts to B pillar

Figure 15. Close up of contact to middle of B pillar

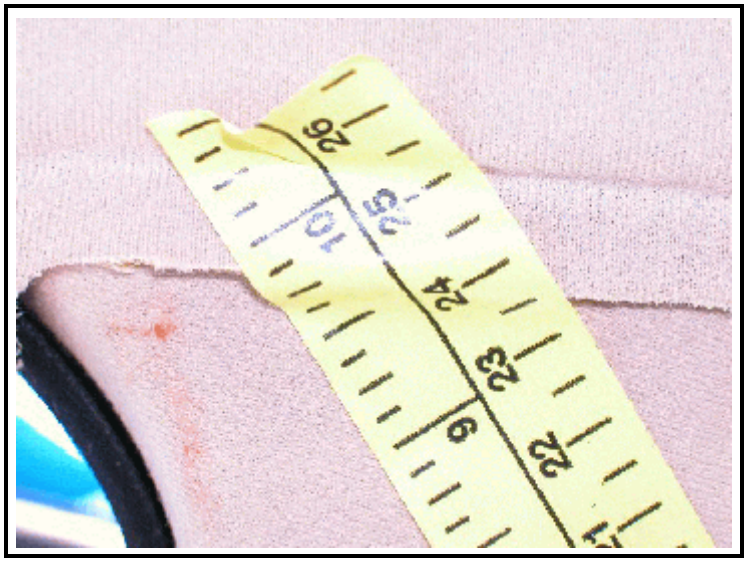

Figure 16. Close up of contact to top of B pillar

Attachment 1. Calculations

CASE NUMBER: DS03027

Comments: Radius of curve

*** * RADIUS FORMULA * ***

$$R = \frac{C^2}{8 \times M} + \frac{M}{2}$$

R = The Radius in Feet.
C = The Chord in Feet.
M = The Middle Ordinate in Feet.
8 = A Constant.
2 = A Constant.

$$R = \frac{100.00^2}{8 \times 7.00} + \frac{7.00}{2}$$

$$R = \frac{10000.00}{56.00} + \frac{7.00}{2}$$

R = 178.57 + 3.50

R = 182.07

AR = (R ± Cntr of Mass Adjustment)
AR = 182.07 + 0.00
AR = 182.07

AR = The Adjusted Radius in Feet.
R = The Radius in Feet.

INPUTS:	
The Chord in Feet is:	100.00
The Middle Ordinate in Feet is:	7.00

RESULTS:	
The Radius in Feet is:	182.07
The Adjusted Radius in Feet is:	182.07

CASE NUMBER: DS03027

Comments: Critical curve speed

*** * CRITICAL SPEED W/ COEFF. OF FRICTION AND RADIUS * ***

$S = 3.86 \times \sqrt{R \times (\mu \pm e)}$

$S = 3.86 \times \sqrt{182.07 \times (0.65 - 0.00)}$

$S = 3.86 \times \sqrt{182.07 \times 0.65}$

$S = 3.86 \times \sqrt{118.34}$

$S = 3.86 \times 10.87$

$S = 41.95$

S = The Speed in MPH.
3.86 = A Constant.
R = The Radius in Feet.
μ = The Coeff. of Friction, Level Surface.
e = The Superelevation.

INPUTS:	
The Level Surface Coeff. of Friction is	0.65
The Radius in Feet is:	182.07
The Percentage of Superelevation is	0.00

RESULTS:	
The Speed in MPH is:	41.95
The Velocity in FPS is:	61.49

Attachment 2. NHTSA Recall No. 99V063 recall notification

Models:
BMW 323i Year: 1999
BMW 328i Year: 1999
Number Involved: 32,500
Dates of Manufacture: June 1998 - March 1999
Defect: These vehicles are built with a side air bag system consisting of door-mounted thorax air bags (rear door air bags are optional), a head protection system (HPS) for front occupants, a central electronic sensor and diagnostic system, left and right satellite impact sensors, and associated wiring. This system is unduly sensitive to certain non-crash impacts, such as contacting large potholes or curbs at substantial speed. This could cause the side air bag and HPS to deploy without an actual side crash.

Remedy: Dealers will reprogram the central computer control module that regulates the performance of all of the vehicle's occupant protection systems. Owner notification was to begin during April 1999. Owners who do not receive the free remedy within a reasonable time should contact BMW at 1-800-831-1117.

[NHTSA Recall No. 99V063]