TRANSPORTATION SCIENCES CENTER
ACCIDENT RESEARCH GROUP

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CALSPAN REMOTE SIDE AIR BAG DEPLOYMENT INVESTIGATION

CALSPAN CASE NO. CA 97-020

SUBJECT VEHICLE - 1996 MERCEDES E32OW
VEHICLE #2 - 1988 ISUZU TROOPER 4X4

LOCATION - STATE OF NORTH CAROLINA

CRASH DATE - MAY, 1996

Contract No. DTNH22-94-D-07058

Prepared for:

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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 are 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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16. *Abstract* This remote investigation focused on the deployment of the right front door-mounted side impact air bag of a 1996 Mercedes-Benz E32OW, 4-door sedan which resulted from a right side impact to the Mercedes from a 1988 Isuzu Trooper, 4-door sport utility multipurpose vehicle. The Mercedes was also equipped with driver and passenger frontal air bags and a left side air bag which did not deploy during the crash sequence. The Mercedes was occupied by a by a 61 year old male driver and a 58 year old female passenger seated in the right front position. The driver did not sustain injury from the crash. The right front passenger sustained a fractured right wrist (AIS-2), right rib contusions (AIS-1), and a right elbow dislocation (AIS-1). These injuries were the result of contact to either the inside of the right front door, the air bag cover flap, the deploying passenger side air bag, or a combination of these components. This passenger was transported from the scene of the crash, via ambulance, to a nearby hospital where her injuries were diagnosed by x-ray. The staff recognized the need for more specialized orthopedic care and prepared her for transport to an upgraded medical facility. This facility performed orthopedic surgery for her right elbow injuries. Follow up treatment for the passenger entailed the repair of the right wrist injury with several orthopedic plates and pins, and over a year of physical therapy to regain right wrist mobility.			
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CALSPAN REMOTE SIDE AIR BAG DEPLOYMENT INVESTIGATION
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VEHICLE: 1996 MERCEDES E32OW
LOCATION: NORTH CAROLINA
CRASH DATE: MAY, 1996

SUMMARY

This remote investigation focused on the deployment of the right front door-mounted side impact air bag of a 1996 Mercedes-Benz E32OW, 4-door sedan which resulted from a right side impact to the Mercedes from a 1988 Isuzu Trooper 4x4, 4-door sport utility vehicle. The Mercedes was also equipped with driver and passenger frontal air bags and a left side air bag which did not deploy during the crash sequence. The Mercedes was occupied by a 61 year old male driver and a 58 year old female passenger seated in the right front position. The driver did not sustain injury from the crash. The right front passenger sustained a fractured right wrist (AIS-2), right rib contusions (AIS-1), and a right elbow dislocation (AIS-1). These injuries were the result of contact to either the inside of the intruded right front door, the air bag cover flap, the deploying passenger side impact air bag, or a combination of these components. This passenger was transported from the scene of the crash, via ambulance, to a nearby hospital where her injuries were diagnosed by x-ray. The staff recognized the need for more specialized orthopedic care and prepared her for transport to an upgraded medical facility. This facility performed orthopedic surgery for her right elbow injuries. Follow-up treatment for the passenger entailed the repair of the right wrist injury with several orthopedic plates and pins, and over a year of physical therapy to regain right wrist mobility.

This special interest case was reported to the NHTSA by a Special Crash Investigator located in California who relayed an Internet article which detailed the events of the crash and highlighted the involvement of a deployed side impact air bag. Calspan's Special Crash Investigation Team was notified of the crash on May 23, 1997, and a remote investigation was subsequently initiated. Cooperation with Mercedes-Benz, who is in possession of the vehicle and all photographic documentation of the damage, was not obtained. They were unable to comply with repeated requests for information due to legal restrictions.

This crash occurred in the four-leg intersection of two undivided two-lane roadways during daylight hours. The asphalt road surface was straight, level, and dry for this crash. The posted speed limit for the Mercedes and Isuzu's paths of travel was 40 km/h (25 mph) and 56 km/h (35 mph) respectively. Police estimated the pre-crash travel speed for the Mercedes at 24 km/h (1 5 mph) and for the Isuzu at 56 km/h (35 mph).

The 1996 Mercedes E32OW 4-door sedan (3.2 L, 6 cylinder, DOHC) was equipped with a Supplemental Restraint System (SRS) that consisted of driver and passenger front air bags, doormounted side impact air bags, knee bolsters, and seat belt Emergency Tensioning Retractors (ETR) with belt-force limiters. Occupancy sensors were also available which prevent the front passenger air bags and ETR from deploying if the seat is unoccupied. The vehicle was identified by vehicle

identification number WDBJF55F9TJ (production number omitted). Three-point manual seat belts with height adjusters were available for the four outboard seated positions for this ABS equipped vehicle. The driver of the vehicle was a journalist who frequently published automotive articles. Mercedes-Benz provided the vehicle to the driver as a test vehicle.

The 1988 Isuzu Trooper 4x4, 4-door sport utility vehicle (4ZE1, 2.6 L) was identified by vehicle identification number JACCH58EIJ7 (production number omitted).

This crash occurred as the driver of the Mercedes accelerated from a stopped position at a stop sign that was controlling westbound travel through the four-way intersection. The Isuzu was traveling south on the intersecting roadway which was not regulated by a traffic control. The frontal plane of the Isuzu impacted the right side passenger compartment area of the Mercedes, aft of the right front door as both vehicles entered the intersection. The Mercedes traveled approximately 6.4 meters (21.0 feet) post-crash in a clockwise yaw and came to final rest facing north in the eastbound travel lane. The Isuzu Trooper came to rest approximately 1.2 meters (4.0 feet) from the point of impact facing southwest in the intersection. Both vehicles were towed from the scene of the crash due to disabling damage. The drivers of the involved vehicles indicated that they did not take evasive maneuvers to the crash. This was confirmed by the investigating police officer who indicated that there were no pre-crash braking maneuvers evidenced at the scene of the crash.

Damage sustained by the involved vehicles was reported on the North Carolina Police Crash Report (PCR) by using the TAD scale. Other information was not available to confirm this. Damage to the Mercedes was documented to be RD-7 which equates to a Collision Deformation Classification (CDC) of approximately RDEW-4. A TAD scale rating of FC-4 was assigned to the Isuzu which equates to an estimated CDC of FDEW-2. Directions of force for the Mercedes and Isuzu were estimated at 2 o'clock and 1 0 o'clock respectively. This estimate was based on police reported travel speeds, vehicle weights, and intersection and impact configurations. Intrusion to the right passenger compartment was reported to be approximately 30.5 cm (12.0 in).

The restrained driver of the Mercedes was a 61 year old male who reported no injury as a result of the crash. The right front passenger, a 58 year old female with a reported (husband) height of 155 cm (61 in) and weight of 64 kg (140 lbs), was restrained in the 3-point manual lap and shoulder belt system which was cut from her during EMS intervention. The right front seat was slightly reclined and the track position was reported to be adjusted between the center and rear positions. She was seated in an upright position with her hands reportedly in her lap prior to impact. At impact, the right front passenger responded to the PDOF and initiated movement towards the right front door as it intruded and the side impact air bag deployed. This passenger sustained a right wrist fracture (AIS-2), right elbow dislocation (AIS-1), and right rib contusions (AIS-1). There are several scenarios for the mechanisms that caused the injuries sustained by the passenger.

The first scenario focuses on the deploying air bag module cover flap as the source of the fractured wrist

and the dislocated elbow. The side impact air bag module cover was located on the rear aspect of the right front door panel immediately superior to the right arm rest. The cover flap could have contacted the right elbow and wrist as it opened to deploy the air bag. In this scenario, the right rib contusions could have been the result of the deployed air bag, the passenger's right arm displaced into the right thoracic area of the passenger, or the intruded right front door panel.

The second scenario focuses on the deployed side impact air bag as the source of the injuries sustained to the right wrist and elbow of the female passenger. In this scenario, the passenger would have responded to the direction of force and moved toward the deployed side impact air bag which contacted her right wrist and elbow, causing the sustained injuries. The side impact air bag, the rebound of the arm, or intrusion of the right front door panel could be the source of the contused right ribs.

The third scenario focuses on the intrusion of the right front door as the source of the sustained injuries. The passenger was displaced towards the 2 o'clock direction of force into the right front door panel as it intruded from the right side passenger compartment impact from the front of the Isuzu. The combination of the movement towards the door panel and its intrusion may have caused the right elbow and wrist injuries in addition to the contused right ribs. As previously noted, there were no photographs available to support injury mechanism identification.

Emergency medical personnel responded to the scene of the crash and initiated action to extricate the right front passenger from the Mercedes. This included cutting the 3 -point lap and shoulder belt webbing and removing the roof of the vehicle to remove her from the vehicle through the windshield area. She was transported from the scene of the crash to a nearby medical facility where it was determined that transport to a Virginia hospital was necessary for further evaluation and treatment. Follow-up treatment for the passenger entailed the repair of the right wrist injury with several orthopedic plates and pins, and over a year of physical therapy to regain right wrist movement.

The left and right side impact air bags of the Mercedes E32OW were installed in the rear sector of their respective doors and were designed to work independently of one another. Statements from safety engineering personnel at Mercedes-Benz revealed that the side impact air bag inflated above the armrest to provide a rounded cushion approximately 43 cm (17 in) long, 28 cm (11 in) high, and 8 cm (3 in) thick (refer to figure 1). One satellite sensor was located under each front seat and relay information to a main control unit, or brain box, which decides in ten milliseconds whether to deploy the air bag. Deployment requires a force equivalent to a 1360 kg (3000 lbs) weight impacting at approximately 25 to 27 km/h (16 to 17 mph).

Figure 1. Exemplar photograph of a Mercedes-Benz's deployed door-mounted side impact air bag

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CRASH DATA

Location:	Four-leg Intersection
State:	North Carolina
Area/Type:	Urban/ Commercial
Crash Date/Time:	May, 1996, daylight hours
Investigating Police Agency:	Local Police Department
Crash Type:	Car/Sport Utility Vehicle, front-to-side impact configuration
Driver Injury Severity:	None
Right Front Passenger Injury Severity:	Moderate (AIS-2)

AMBIENCE

Viewing Conditions:	Daylight
Weather:	Clear
Precipitation:	None
Road Surface:	Dry

HIGHWAY

Type:	State route
Number of Lanes:	Two, undivided
Surface:	Smooth asphalt

HIGHWAY (CONT'D.)

Vertical Alignment:	Level
Traffic Density:	Moderate to heavy

VEHICLES

	Air Bag Vehicle	**Vehicle #2**
Description	1996 Mercedes-Benz E32OW, 4-door sedan	1988 Isuzu Trooper 4x4, 4-door sport utility vehicle
V.I.N.:	WDBJF55F9TJ (Production number omitted)	JACCH58E17 (Production number omitted)
Engine:	3.2 liter, V-6 DOHC	2.6 liter, L-4
Transmission:	4-speed automatic	unknown
Steering:	Power-assisted rack and pinion	
Brakes:	4-wheel power disc with anti-lock (ABS)	
Manual Restraints:	3-point lap and shoulder belts for all five seated positions. Height adjusters available for the four outboard seated positions.	
Automatic Restraints:	Supplemental Restraint System (SRS) which consisted of driver and right front passenger front air bags and door mounted side air bags, and seat belt Emergency Tensioning Retractors (ETR) with belt-force limiters	
Tow Status:	Towed due to damage	Towed due to damage

HUMAN DEMOGRAPHICS/ OCCUPANT DATA

Mercedes-Benz E32OW

Driver:	61 year old male
Height:	180 cm (71 in)
Weight:	88 kg (195 lbs)
Manual Restraint Usage:	3-point lap and shoulder belt with height adjusters
Automatic Restraint Usage:	None
Usage Source:	Police Crash Report (PCR) and interview.
Right Front Passenger:	58 year old female
Height:	155 cm (61 in)
Weight:	64 kg (140 lbs)
Manual Restraint Usage:	3-point manual lap and shoulder belt with height adjusters
Automatic Restraint Usage:	Door-mounted side impact air bag.
Usage Source:	Police Crash Report (PCR) and interview
Medical Treatment:	Transported to a local hospital via ambulance from the crash scene for evaluation, then transferred to another medical facility for further treatment. Follow-up treatment entailed over a year of physical therapy to regain right wrist mobility.

PASSENGER INJURIES

Injury	Injury Severity (AIS-90 scale)	Injury Mechanism
Right wrist fracture	(Moderate) 751800.2,1	Side impact air bag, air bag cover flap, or intruding right front door panel
Right elbow dislocation	(Minor) 750630.1,1	Side impact air bag, air bag cover flap, or intruding right front door panel
Right rib contusions	(Minor) 450202.1, l	Side impact air bag, air bag cover flap, or intruding right front door panel