TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

Veridian/Calspan Operations
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REMOTE SIDE AIR BAG DEPLOYMENT/FATALITY INVESTIGATION

CALSPAN CASE NO. 1998-043-280A

VEHICLE - 1997 MERCEDES BENZ SL320

LOCATION - NORTH CAROLINA

CRASH DATE - NOVEMBER, 1998

Contract No. DTNH22-94-07058

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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 of the involved vehicle(s) or their safety systems.

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17. *Abstract*

The Mercedes was equipped with a Supplemental Restraint System that consisted of dual frontal air bags and door mounted side impact air bags. The driver of the Mercedes was fatally injured in the left side impact crash. The left side impact air bag allegedly failed to properly deploy in the crash. The crash was identified and selected for investigation by a NASS research team on November 23, 1998 and identified by the case number 43-280A. The suspect side impact air bag deployment was identified during the vehicle inspection conducted by the NASS team on December 2, 1998. Subsequent SCI investigation determined that the side impact air bag had deployed as designed during the crash sequence.

This two-vehicle crash occurred during the morning hours in November 1998. At the time of the crash, it was dawn and the police report indicated the weather was fog. Visibility may have been a factor in the crash. The 1987 Toyota pick-up was traveling southbound, driven by a 21 year old male. The 1997 Mercedes-Benz SL320 was eastbound on the local roadway and came to a stop at the intersection. The crash occurred when the driver of the Mercedes accelerated forward and attempted to turn left across the path of the Toyota. It was the intention of the Mercedes's driver to travel north along the state route. Impact occurred with the front plane of the Toyota striking the left side plane of the Mercedes in a 12/9 o'clock impact configuration. The impact was centered approximately on the Mercedes left A-pillar. Analysis of the crash indicated the impact speed of the truck was approximately 80 km/h (50 mph).

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REMOTE SIDE IMPACT AIR BAG DEPLOYMENT/FATALITY INVESTIGATION
NASS/SCI CASE NO: 1998-043-280A
VEHICLE: 1997 MERCEDES SL320 CONVERTIBLE
LOCATION: NORTH CAROLINA
CRASH DATE: NOVEMBER 1998

BACKGROUND

This remote investigation focused on an intersection collision between a 1997 Mercedes-Benz SL320 2dr. convertible and a 1987 Toyota pick-up. The Mercedes was equipped with a Supplemental Restraint System that consisted of dual frontal air bags and door mounted side impact air bags. The driver of the Mercedes was fatally injured in the left side impact crash. The left side impact air bag allegedly failed to properly deploy in the crash.

The crash was identified and selected for investigation by a NASS research team on November 23, 1998 and identified by the case number 43-280A. The suspect side impact air bag deployment was identified during the vehicle inspection conducted by the NASS team on December 2, 1998. The Zone Center subsequently informed the Field Operations Branch of the National Highway Traffic Safety Administration and a remote investigation of the crash was assigned to the Special Crash Investigation team at Veridian/Calspan on December 9, 1998. SCI investigation determined that the side impact air bag had deployed as designed during the crash sequence.

SUMMARY

Crash Site

This two-vehicle crash occurred during the morning hours in November 1998. At the time of the crash, it was dawn and the police report indicated the weather was fog. Visibility may have been a factor in the crash. The crash occurred at the 3-leg intersection of a two lane east/west local roadway and 2 lane north/south state route, located in a rural residential setting. The local road intersected the state route from the west. A stop sign for eastbound traffic on the local roadway controlled the intersection. The speed limit in the area of the crash was 89 km/h (55 mph). **Figure 1** is a southbound approach view of the intersection.

Figure 1: Southbound trajectory view of the Toyota pick-up.

Pre-Crash

The 1987 Toyota pick-up was traveling southbound, driven by a 21 year old male. The Toyota was equipped with a lift kit and oversize tires. The 1997 Mercedes-Benz SL320 was eastbound on the local roadway and came to a stop at the intersection. The Mercedes was driven by a 45 year old female with a reported height/weight of 160 cm (63 in) and 57 kg (125 lb) respectively. The Mercedes driver was en route to her place of employment. The police report indicated the driver lived on the local road, in close proximity to the intersection.

Crash

The crash occurred when the driver of the Mercedes accelerated forward and attempted to turn left across the path of the Toyota. It was the intention of the Mercedes's driver to travel north along the state route. Impact occurred with the front plane of the Toyota striking the left side plane of the Mercedes in a 12/9 o'clock impact configuration. The impact was centered approximately on the Mercedes left A-pillar. The force of the impact caused the Mercedes to slide southeastward and rotate approximately 90 degrees counterclockwise. The Mercedes came to rest in the northbound lane of the state route, facing north. The 9 o'clock direction of the impact force caused the left side impact air bag to deploy and deformed the left side of the Mercedes. The NASS researcher measured approximately 42 cm (16.5 in) of lateral deformation at the left A-pillar. Analysis of the crash indicated the impact speed of the truck was approximately 80 km/h (50 mph).

The Toyota rotated counterclockwise and rolled two quarter turns to the right, while sliding to the south. The vehicle came to rest on its roof approximately 3 m (10 ft) away from the Mercedes. The force of the impact dislodged the cab from the frame of the pick-up. **Figures 2 and 3** are on-scene photographs of the vehicle's final rest positions taken during the police investigation.

Figure 2: Southward view of the final rest position of the Mercedes.

Figure 3: Northward view of the Toyota's final rest position.

The 45 year old female driver of the Mercedes was fatally injured in the crash. The medical examiner's report indicated the probable cause of death was 1st degree injuries to the head, chest and extremities secondary to a motor vehicle crash. An autopsy was not requested. The ME's external examination identified the following injuries: multiple abrasions and contusions about the lower extremities, fracture of the left forearm and multiple abrasions to the left side of the face. X-rays yielded a skull fracture and blood was identified in both ears indicative of a basilar skull fracture (AIS 3).

The 21 year old male driver of the Toyota was unrestrained at the time of the crash. Upon the arrival of the EMS, he had removed himself from the vehicle and was seated at the roadside. He complained of pain to the left side of his head, above the right eye, and left upper leg. The driver recalled hitting the left side of his head on the windshield. He also complained of blurred vision which resolved within 10 minutes. The driver was secured to a back board and transported to the emergency room of a local hospital. He was examined in the ER and discharged home, with medications for pain, approximately 2 hours and 20 minutes post-crash.

AIR BAG VEHICLE

The 1997 Mercedes-Benz SL320 convertible was identified was a Vehicle Identification Number (VIN): WDBFA63F7VF (production sequence deleted)**.** The vehicle was configured as a 2 door convertible and was equipped with a 3.2 liter, V6 engine linked to a 4-speed automatic transmission. The Mercedes was equipped with a Supplemental Restraint System that consisted of frontal air bags for the driver and right front passenger and door mounted side impact air bags. The vehicle was also equipped with 4-wheel anti-lock brakes and traction control.

Damage

Figure 4 is a left front three-quarter view of the Mercedes. The vehicle sustained left side direct contact damage that began 60 cm (23.6 in) aft of the left front axle and extended rearward 165 cm (65.0 in). The impact involved the full frontal width of the Toyota and was centered approximately on the Mercedes left A-pillar and door. The maximum lateral deformation occurred in the area of the left A pillar and was measured to be approximately 42 cm (16.5 in). The crush profile measured over a damage length of 285 cm (112 in) was as follows: C1=0, C2=11.0 cm (4.3 in), C3=28.0 cm (11.0 in), C4=42.0 cm (16.5 in), C5=17 cm (6.7 in), C6=9.0 cm (3.5 in). The left door, **Figure 5**, intruded into the left front occupant space and was jammed shut by deformation. It was removed by rescue personnel during the extrication of the driver. There was also lateral deformation to the left front seat, foot well and instrument panel.

Figure 5: Left front three-quarter view.

Figure 4: Left door exterior.

The Barrier Model of the WINSMASH program calculated a barrier equivalent delta V of approximately 32 km/h (20 mph). The longitudinal and lateral components were 0 km/h and 32 km/h (20 mph), respectively. This calculated value seemed low given the severity of the damage and dynamics of the collision. An estimated delta V of 40 to 45 km/h (25 to 28 mph) for the Mercedes is more consistent with forensic analysis of the damage and SCI experience. The Collision Deformation Classification of the Mercedes was 09-LYAW-03. The lateral delta V of the crash was above the threshold required for deployment of the left side impact air bag.

Manual Restraint System

The manual 3-point restraint system in the 1997 Mercedes-Benz SL320 was an integrated system. The retractor, D-ring and lower anchor were attached to the outboard aspect of the vehicle's two front seat

structures, refer to **Figure 6.** The restraint consisted of a continuous loop webbing with a sliding latch plate. The driver was properly restrained by the manual belt system at the time of the crash. On-scene photographs taken prior to the extrication of the driver depict the manual restraint in use at the time of the crash. Additionally, blood and body fluids were identified on the webbing during the inspection and are depicted in Figure 6.

Figure 6: View of the left front seat and integrated manual restraint.

Supplemental Restraint System

The Supplemental Restraint System in the 1997 Mercedes-Benz SL320 consisted of a frontal air bag system for the driver and right front passenger and door mounted side impact air bags. The frontal air bag modules were located in the typical manner in the center hub of the steering wheel and in the right aspect of the instrument panel, respectively. The side impact air bags were located in the upper aft aspect of the vehicle's doors.

Figures 7-9 are views of the interior aspect of the left front door taken during the NASS inspection. The longitudinal seam of the interior trim panel tore open during deployment sequence, however the seam appeared to have opened in greater length than required (in consideration of the module's cover flaps). Further, the air bag did not deploy through the trim panel but remained partially folded and captured behind the door's interior trim panel post-crash. There was no contact evidence on the air bag. The police investigator, paramedics and driver's husband, responding to the crash, indicated the air bag did not properly deploy. In the crash, the Mercedes left side impact air bag did deploy. However, the normal deployment path of the air bag was impeded resulting in an altered deployment. The deployment is confirmed by several factors. First and most obvious is the condition of the trim panel, air bag and air bag module. The air bag is out of the module and the cover flaps and trim panel tore open during the deployment sequence. This condition can only occur through a deployment. Additionally, technical representatives from Mercedes-Benz USA inspected the vehicle subsequent to the NASS inspection and confirmed the deployment via electrical resistance tests of the SRS circuitry.

Figure 7: View of the left door's side impact air bag.

Figure 8: View of the side impact air bag through the cover flaps.

Figure 9: View of the side impact air bag.

The altered deployment sequence occurred as a result of an interference between the seat back of the left front seat and side air bag cover flaps of the intruding door. The left front seat was adjusted in a mid-to-forward track position consistent with the short stature of the driver. This forward track adjustment placed the seat back laterally adjacent to the mounted position of the side impact air bag. Although the side impact air bag typically inflates in approximately 20 milliseconds, the door probably began intruding into the occupant space within this time frame, considering the magnitude of the impact speed. As the air bag deployed, the cover flap on the interior trim contacted the outboard aspect of the seat. This contact impeded the rotation of the cover flaps and probably caused the vertical tear in the upper cover flap (**Figure 8** above) and the extended tear in the center trim panel seam, as the inflating bag attempted to "search" for a path out of the module. The rapidly expanding bag inflated behind the trim panel (in the hollow door's interior). The air bag probably deflated faster than normal due to the compression (squeezing) of the bag between the intruding door and seat back. The driver probably received some benefit from the air bag, however the collision forces were probably not survivable with or with out a side impact air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	45 years old/female
Height:	160 cm (63 in)
Weight:	57 kg (125 lb)
Manual Restraint Usage:	Integrated 3-point lap and shoulder belt
Usage Source:	On-scene photographs, Vehicle inspection
Eyewear:	None

DRIVER INJURIES

Injury	Severity (AIS 90)	Injury Mechanism
Basilar skull fracture - blood noted in both ears	Serious (150200.3,8)	Contact with the hood face of impacting truck
Blunt chest trauma	Unknown (415099.7,0)	Contact with the intruding door
Left arm forearm fracture not further specified	Moderate (751800.2,2)	Contact with the intruding door
Multiple facial abrasions	Minor (290202.1,2)	Contact with the hood face of impacting truck
Bilateral multiple abrasions - lower extremities	Minor (890202.1,3)	Contact with the intruding door
Bilateral multiple contusions - lower extremities	Minor (890402.1,3)	Contact with the intruding door

Note: these injuries were identified in the Medical Examiner's Report.

DRIVER KINEMATICS

At impact, the 45 year old female driver of the 1997 Mercedes-Benz SL320 was seated in a presumed normal posture, with her seat adjusted to a mid-to-forward track position consistent with her posture. She responded to the 9 o'clock direction of the impact force by initiating a leftward and slightly forward trajectory. The manual 3-point restraint system in the vehicle locked and she probably began loading the restraint.

The force of the impact caused the left side impact air bag to deploy. The center seam of the trim panel opened and the cover flaps attempted to rotate open. However, the air bag deployment sequence was altered due to the forward position of the left front seat back relative to the door mounted air bag. The expansion of the air bag in conjunction with the impeded deployment path resulted in the bag expanding behind the interior trim panel of the door. At this same time, the force of the impact caused the door structure to intrude into the occupant space.

The driver contacted the inflated air bag and door with the left side of her body. The left forearm was fractured at this time. The sudden deceleration of her body caused her head/neck to flex laterally to the left. The head traveled outside the plane of the fractured side glazing and probably contacted the hood to the impacting truck. Several large dents were noted on the truck's hood face. The contact of the driver's head to the hood face resulted in a basilar skull fracture and abrasions to the driver's face. The blunt chest trauma was resultant to contact with the intruding driver's door. The driver then rebounded to the right where she was found.