TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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VERIDIAN REMOTE SIDE IMPACT AIR BAG AND SIDE CURTAIN DEPLOYMENT INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

NASS/SCI COMBO CASE NO. 2000-09-004C

VEHICLE - 2000 MERCEDES-BENZ S500

LOCATION - STATE OF MARYLAND

CRASH DATE - JANUARY, 2000

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.

TECHNICAL REPORT STANDARD TITLE PAGE

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16. *Abstract* This remote investigation focused on a two vehicle crash involving a 2000 Mercedes-Benz S500 4-door sedan (subject vehicle) and a 1997 Honda Civic EX 2-door coupe. The Mercedes-Benz was equipped with side impact air bags and side curtains that deployed as a result of a right angle collision with the Honda Civic. The driver of the northbound Honda failed to detect the red traffic signal phase or the westbound Mercedes as she proceeded straight through a 4-leg intersection. As the Honda entered the 4-leg intersection, the front right area impacted the left front side area of the Mercedes resulting in moderate damage to both vehicles. The 25 year old female driver of the Mercedes-Benz S500 was restrained by the available 3-point manual lap and shoulder belt system. At impact, she initiated a lateral and slightly forward trajectory in response to the 10 o'clock impact force and loaded the deployed side impact air bag and side curtain. The sudden lateral movement of the head/torso resulted in a strain of the cervical and lumbar spine (non-contact injury). The deployed side impact air bag and side curtain protected the driver from contact against the left side surface and potential serious injury. She also sustained a contusion to the left knee from contact to the knee bolster. Both drivers was transported to a local hospital for treatment and released.			
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CRASH DATE - JANUARY, 2000

BACKGROUND

This remote investigation focused on a two vehicle crash involving a 2000 Mercedes-Benz S500 4-door sedan (subject vehicle) and a 1997 Honda Civic EX 2-door coupe. The Mercedes-Benz was equipped with side impact air bags and side curtains that deployed as a result of a right angle collision with the Honda Civic. The driver of the northbound Honda failed to detect the red traffic signal phase or the westbound Mercedes as she proceeded straight through a 4-leg intersection. As the Honda entered the 4-leg intersection, the front right area impacted the left front side area of the Mercedes resulting in moderate damage to both vehicles. The 25 year old female driver of the Mercedes-Benz S500 was restrained by the available 3-point manual lap and shoulder belt system. At impact, she initiated a lateral and slightly forward trajectory in response to the 10 o'clock impact force and loaded the deployed side impact air bag and side curtain. The sudden lateral movement of the head/torso resulted in a strain of the cervical and lumbar spine *(non-contact injury)*. The deployed side impact air bag and side curtain protected the driver from contact against the left side surface and potential serious injury. She also sustained a contusion to the left knee from contact to the knee bolster. Both drivers was transported to a local hospital for treatment and released.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 00–09-004C. The Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian/Calspan the task of case review and report preparation.

SUMMARY

Crash Site

This two vehicle crash occurred during the afternoon hours of January, 2000. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the northbound lanes of a level/asphalt 4-leg intersection **(Figure 8 - page 6)** which was controlled by an overhead signal system. The northbound lanes consisted of five lanes with a negative grade to the north. The signal system was in red phase for north/southbound traffic. The posted speed limit at the crash scene was 89 km/h (55 mph).

Pre-Crash

The 25 year old female driver of the 2000 Mercedes-Benz S500 was operating the vehicle westbound at a (driver reported) speed of 16 km/h (10 mph) when she entered the 4-leg intersection **(Figure 1)** and

proceeded to turn left (south). The 1997 Honda Civic EX was driven by a 30 year old female who was operating the vehicle northbound **(Figure 2)** in the outboard lane at a (driver reported) speed of 64 km/h (40 mph) when she failed to detect the red phase of the overhead signal system or the Mercedes as she continued straight through the 4-leg urban intersection. Upon recognition of the impending harmful event, she braked in avoidance remaining in the northbound lanes prior to the collision (no pre-impact brake marks documented at the scene).

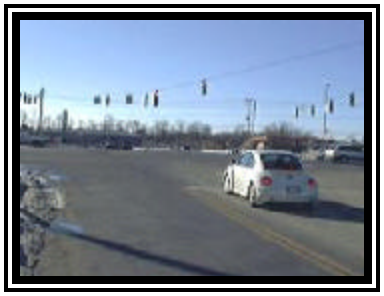

Figure 1. Westbound approach for the 2000 Mercedes-Benz S500.

Figure 2. Northbound approach for the 1997 Honda Civic EX.

Crash

As the Honda entered the 4-leg intersection, the front right area impacted the left front side area of the Mercedes-Benz resulting in moderate damage to both vehicles. The impact induced deceleration was sufficient to deploy the air bag systems in each vehicle. The damage algorithm of the WinSMASH program computed velocity changes of 13.3 km/h (8.3 mph) for the subject vehicle and 22.9 km/h (14.2 mph) for the striking Honda. Respective longitudinal components were -4.5 km/h (2.8 mph) and -21.5 km/h (13.4 mph). Respective lateral components were 12.5 km/h (7.8 mph) and -7.8 km/h (4.8 mph). The Collision Deformation Classification (CDC) for this impact to the Mercedes-Benz was 10-LFEW-3 with a principal direction of force of (-)70 degrees. The CDC for this impact to the Honda Civic EX was 01-FREW-2 with a principal direction of force of (+) 20 degrees. At this point, both vehicles rotated clockwise and came to rest in the northbound lanes of the intersection facing northeast.

Post-Crash

The driver of the Mercedes-Benz exited the vehicle with some assistance while the driver of the Honda Civic exited the vehicle under her own power. Treatment was rendered at the scene by emergency medical technicians (EMTs) and fire department personnel. Both drivers were transported to a local hospital for treatment and released. Both vehicles were towed from the scene with disabling damage.

VEHICLE DATA

The 2000 Mercedes-Benz S500 was identified by the Vehicle Identification Number (VIN): WDBNG75J4YA (production sequence deleted). The vehicle was a 4-door sedan equipped with rear wheel drive, anti-lock braking system and a 5.0 liter, V-8 engine. The vehicle's odometer reading was

7,725 km (4,800 miles) at the time of the crash. The seating was configured with front bucket seats and a rear bench. The driver reported no previous crashes or maintenance on the air bag system (original equipment). No cell phone was present or in-use at the time of the collision.

VEHICLE DAMAGE

Exterior Damage

The Mercedes-Benz sustained moderate left side damage as a result of the impact with the Honda Civic **(Figure 3)**. The direct damage began at the front left bumper corner and extended 63.0 cm (24.8 in) rearward. The combined direct and induced damage length (Field L) began at the front left bumper corner and extended 138.0 cm (54.3 in) rearward. Six crush measurements were documented at the level of the mid-door: C1= 0 cm, C2= 3.0 cm (1.2 in), C3= 8.0 cm (3.1 in), C4= 20.0 cm (7.9 in), C5= 31.0 cm (12.2 in), C6= 46.0 cm (18.1 in). The left front wheel was restricted (not deflated). Minor hood displacement was noted along with lateral bumper shift to the right. The windshield was undamaged.

Figure 3. Left side damage to the 2000 Mercedes-Benz S500.

Figure 4. Frontal damage to the 1997 Honda Civic EX.

The 1997 Honda Civic EX sustained moderate frontal damage as a result of the impact with the Mercedes-Benz **(Figure 4)**. The direct contact damage began at the front right bumper corner and extended 50.0 cm (19.7 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 103.0 cm (40.6 in). The bumper fascia separated from the reinforcement bar with an indentation noted from the left front wheel of the Mercedes-Benz. Direct contact damage was also noted along the right side surface of the vehicle from sustained contact prior to spinout. The right front wheel was deflated (not restricted). Reduction in the right side wheelbase measured 14.0 cm (5.5 in).

Interior Damage

Interior damage to the Mercedes-Benz identified through the NASS vehicle inspection was minimal and attributed to occupant contact. Scuff marks were documented on the left knee bolster (padded type) and door surface. No intrusions were found in the vehicle. The windshield was undamaged.

SUPPLEMENTAL RESTRAINT SYSTEMS

The 2000 Mercedes-Benz S500 was equipped with redesigned frontal air bags for the driver and front right passenger positions. The frontal air bags did not deploy as a result of the crash. The driver air bag was housed in the center of the steering wheel with a dual cover flap design. The front right passenger air bag was housed in a top mount module in the right instrument panel with a single cover flap design hinged at the forward aspect. A cutoff switch was found on the floor/console mounted transmission lever and was

set to the "on" position.

The Mercedes-Benz was also equipped with door-mounted side impact air bags for the outboard seating positions. The left side air bags deployed as a result of the crash. The air bags were housed in the door panel above the armrest with a horizontally oriented flap tear seam (H-configuration). The leather flaps were rectangular/symmetrical in shape and measured 35.0 cm (13.8 in) in width and 6.0 cm (2.4 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, blood spattering was found on the upper section of the air bag. The NASS researcher measured the left side impact air bag at 55.0 cm (21.7 in) in width and 40.0 cm (15.7 in) in height in its deflated state **(Figure 5)**. The bag was tethered by one internal strap (no vent ports).

Figure 5. 2000 Mercedes-Benz S500 side impact air bag.

The Mercedes-Benz was also equipped with side curtains for the outboard seating positions **(Figures 6 & 7)**. The left side curtain deployed as a result of the crash. The side curtain was housed between the interior roof headliner and structural roof side rail with a horizontal seam measuring 155.0 cm (61.0 in) in length *(separation of headliner versus an actual flap)*. Hair strands were documented on the curtain just forward of the B-pillar area. The NASS researcher measured the left curtain at 165.0 cm (65.0 in) in width and 30.0 cm (11.8 in) in height in its deflated state. The curtain was tethered by an external strap connected to the left A-pillar.

Figure 6. Interior view of the 2000 Mercedes-Benz side impact curtain.

Figure 7. Secondary view of the Mercedes-Benz side impact curtain.

DRIVER DEMOGRAPHICS

Age/Sex:	25 year old female
Height:	165 cm (65 in)
Weight:	73 kg (160 lb)
Seat Track Position:	Middle position
Manual Restraint Use:	3-point lap and shoulder belt system

Usage Source:	NASS vehicle inspection, driver interview, police report
Eyeware:	None
Type of Medical Treatment:	Transported to a local hospital and released

Driver Injuries *Injury*	*Severity (AIS 90)*	*Injury Mechanism*
*Contusion left knee (anterior-2.0 in)	Minor (890402.1,2)	Knee bolster
+Cervical strain	Minor (640278.1,6)	Non-contact injury
+Lumbar strain	Minor (640678.1,8)	Non-contact injury
+Left knee strain	Minor (850826.2,2)	Knee bolster
+Right knee strain	Minor (850826.2,1)	Knee bolster

sources - driver / medical record+*

Driver Kinematics

The 25 year old female driver of the 2000 Mercedes-Benz S500 was properly restrained by the available 3-point manual lap and shoulder belt system. She was seated in an upright posture with the seat back slightly reclined and the seat track adjusted to the middle position. The NASS interview stated she was restrained, further evidenced by the lack of substantial interior contacts and injury.

At impact, she initiated a lateral and slightly forward trajectory in response to the 10 o'clock impact force as the head/torso loaded the side impact air bag and curtain. Interaction with the side air bag/curtain was confirmed by the hair strands documented to the side curtain membrane. The side impact air bags (both curtain and bag) protected the driver against the left side interior surface, however, the impact force and sudden lateral movement of the head/torso resulted in a strain of the cervical and lumbar spine *(non-contact injury)*. She also sustained a contusion to the left knee from contact to the knee bolster, evidenced by the scuff mark documented to this component. The driver was transported by ambulance to a local hospital for treatment and released.

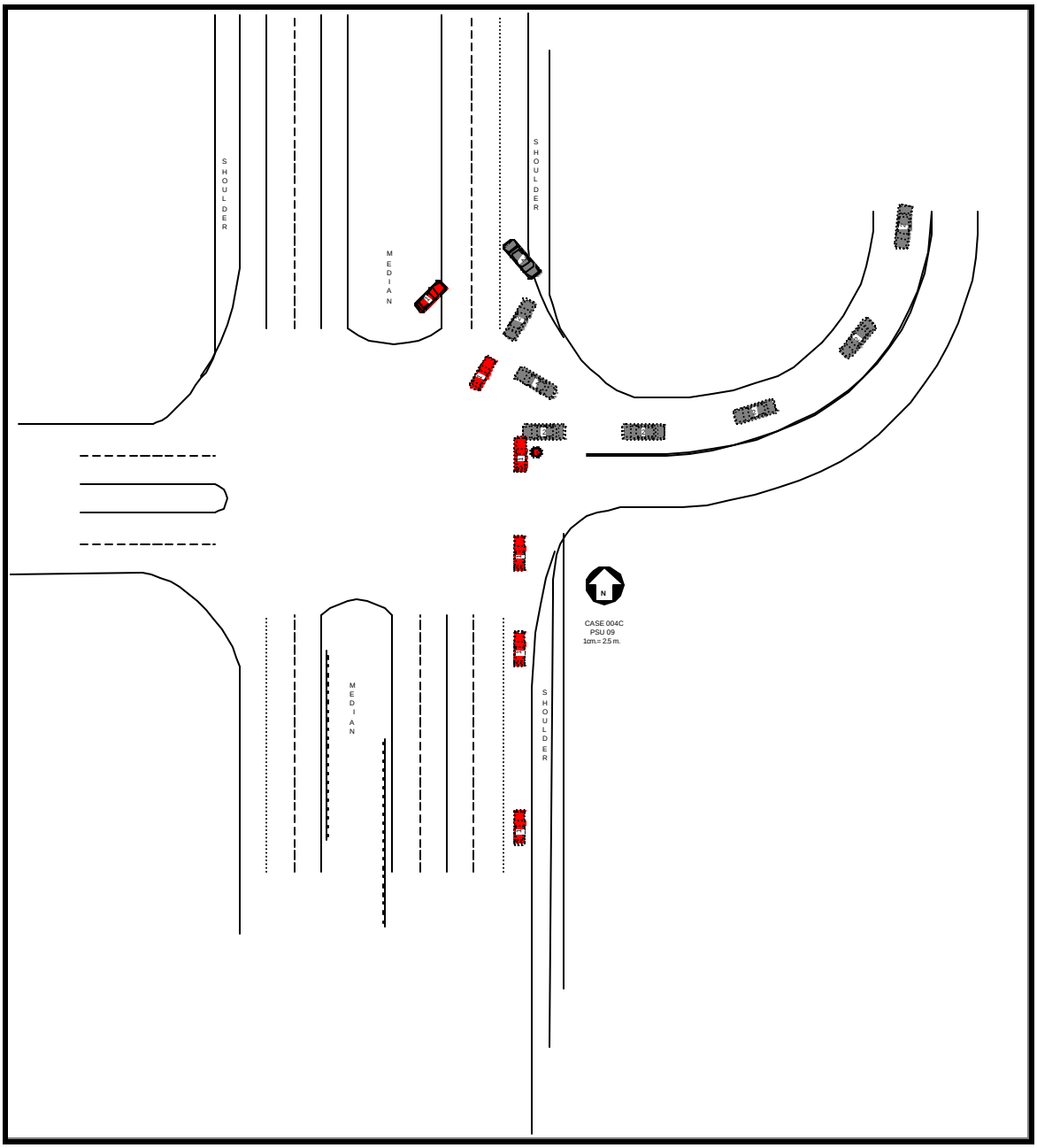

Figure 8. NASS Scene Diagram.