

**TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION**

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**REMOTE SIDE IMPACT AIR BAG DEPLOYMENT INVESTIGATION
SCI TECHNICAL SUMMARY REPORT**

NASS CDS CASE NO. 1999-11-117C

VEHICLE - 1998 MERCEDES-BENZ ML320 SPORT UTILITY

LOCATION - STATE OF MICHIGAN

CRASH DATE - JULY, 1999

Contract No. DTNH22-94-D-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 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. <i>Abstract</i> This investigation focused on a two-vehicle crash involving a 1998 Mercedes-Benz ML320 4-door sport utility (subject vehicle) and a 1992 GMC Sierra 2500 series pickup truck. The Mercedes was equipped with side impact air bags that deployed as a result of an obtuse angle collision with the Sierra pickup. The driver of the eastbound Mercedes failed to detect the stop sign or southbound Sierra as she proceeded straight through a 4-leg intersection. As the Mercedes entered the 4-leg intersection, the front right area of the Sierra struck the left passenger area of the Mercedes resulting in moderate damage to both vehicles. At this point, the Mercedes rotated clockwise as the preceding impact initiated a 2 quarter turn right side rollover resulting in moderate top damage. The Mercedes came to rest (on its roof) on the west shoulder facing southeast. The Sierra pickup came to rest in the northbound lane facing southeast. The 30 year old female driver of the Mercedes-Benz ML320 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 manual restraint and deployed side impact air bag. Loading to the manual restraint resulted in a contusion to the mid-chest and abrasion to the left abdomen. Contact to the roof side rail resulted in a scalp contusion and cervical strain. She also sustained abrasions and contusions to the left forearm and lateral aspect of the left leg from the door panel. The driver was transported to a local hospital for treatment and released. The driver of the Sierra pickup truck sought treatment later at a medical facility.			
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BACKGROUND

This investigation focused on a two-vehicle crash involving a 1998 Mercedes-Benz ML320 4-door sport utility (subject vehicle) and a 1992 GMC Sierra 2500 series pickup truck. The Mercedes was equipped with side impact air bags that deployed as a result of an obtuse angle collision with the Sierra pickup. The driver of the eastbound Mercedes failed to detect the stop sign or southbound Sierra as she proceeded straight through a 4-leg intersection. As the Mercedes entered the 4-leg intersection, the front right area of the Sierra struck the left passenger area of the Mercedes resulting in moderate damage to both vehicles. At this point, the Mercedes rotated clockwise as the preceding impact initiated a 2 quarter turn right side rollover resulting in moderate top damage. The Mercedes came to rest (on its roof) on the west shoulder facing southeast. The Sierra pickup came to rest in the northbound lane facing southeast. The 30 year old female driver of the Mercedes-Benz ML320 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 manual restraint and deployed side impact air bag. Loading to the manual restraint resulted in a contusion to the mid-chest and abrasion to the left abdomen. Contact to the roof side rail resulted in a scalp contusion and cervical strain. She also sustained abrasions and contusions to the left forearm and lateral aspect of the left leg from the door panel. The driver was transported to a local hospital for treatment and released. The driver of the Sierra pickup truck sought treatment later at a medical facility.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 99-11-117C. The Field Operations Branch of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian/Calspan the task of case review and final report preparation.

SUMMARY

Crash Site

This two-vehicle crash occurred during the afternoon hours of July, 1999. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the southbound lane of a straight/level 4-leg intersection (**see Figure 9 - page 7**) which was controlled by stop signs for east/westbound traffic. The speed limit at the crash scene was 56 km/h (35 mph).

Pre-Crash

The 30 year old female driver of the 1998 Mercedes-Benz ML320 was operating the vehicle eastbound (**Figure 1**) on approach to a rural 4-leg intersection. Although intending to turn left, she was unfamiliar with the area and failed to detect the stop sign as she proceeded straight through the intersection. The

NASS scene inspection revealed that the stop sign was obstructed by tree limbs. The 1992 GMC Sierra pickup truck was driven by a 46 year old male who was operating the vehicle southbound (**Figure 2**) when he observed the Mercedes cross his path of travel. Upon recognition of the impending harmful event, he steered left and braked in avoidance remaining in the southbound travel lane prior to the collision.



Figure 1. Eastbound approach for the 1998 Mercedes-Benz ML320 sport utility vehicle.



Figure 2. Southbound approach for the 1992 GMC Sierra pickup truck.

Crash

As the Mercedes crossed the southbound lane of the 4-leg intersection, the front right area of the Sierra struck the left passenger area of the Mercedes. The impact induced deceleration was sufficient to deploy the Mercedes' side impact air bag system. The damage algorithm of the WinSMASH program computed velocity changes of 27.0 km/h (16.8 mph) for the subject vehicle and 21.3 km/h (13.2 mph) for the striking Sierra pickup. Respective longitudinal components were -13.5 km/h (-8.4 mph) and -16.3 km/h (-10.1 mph). Respective lateral components were 23.4 km/h (14.5 mph) and -13.7 km/h (8.5 mph). The Collision Deformation Classification (CDC) for this initial impact to the Mercedes was 10-LPEW-3 with a principal direction of force of (+)300 degrees. The CDC for this impact to the Sierra was 81-FZEW-1 (PDOF incremented for lateral end shifting to the left) with a principal direction of force of (+)40 degrees. At this point, the Mercedes rotated clockwise as the preceding impact initiated a 2 quarter turn right side rollover resulting in moderate top damage. The CDC for this secondary impact to the Mercedes was 00-TYDO-2. The Mercedes-Benz ML320 came to rest (on its roof) on the west shoulder of the north/southbound roadway facing southeast. The GMC Sierra pickup truck came to rest in the northbound lane also facing southeast.

Post-Crash

The driver of the Mercedes exited the vehicle through the (disintegrated) left front window and subsequently used her cell phone to call for help. The driver of the Sierra pickup exited the vehicle under his own power. Treatment was rendered at the scene by emergency medical technicians (EMT) and fire department personnel. The driver of the Mercedes was transported to a local hospital for treatment and released. The driver of the Sierra sought treatment later at a medical facility. Both vehicles were towed from the scene.

VEHICLE DATA

The 1998 Mercedes-Benz ML320 was identified by the Vehicle Identification Number (VIN): 4JGAB54E3WA (production sequence deleted). The vehicle was a 4-door sport utility equipped with 4-wheel drive, 4-wheel ABS, traction control and a 3.2 liter, 6 cylinder engine (with a 5-speed automatic overdrive transmission). The vehicle's odometer reading was unknown at the time of the crash. The seating was configured with front bucket seats and a rear split bench (with folding backs). The driver reported no previous crashes or maintenance on the air bag system (original equipment). A cell phone was present but not in use at the time of the collision.

VEHICLE DAMAGE

Exterior Damage

The Mercedes sustained moderate left side damage as a result of the impact with the Sierra pickup truck (**Figure 3**). The direct contact began 102.0 cm (40.2 in) forward of the left rear axle and extended forward 135.0 cm (53.1 in). The combined direct and induced damage length (Field L) began 55.0 cm (21.7 in) forward of the left rear axle and extended forward 228.0 cm (89.8 in). Six crush measurements were documented at the level of the lower door: C1= 4.0 cm (1.6 in), C2= 17.0 cm (6.7 in), C3= 32.0 cm (12.6 in), C4= 27.0 cm (10.6 in), C5= 8.0 cm (3.1 in), C6= 4.0 cm (1.6 in). The direct contact damage restricted the left front door opening. Induced damage was noted to the left front/rear glazing (disintegrated), left fender and quarter panel. The right front wheel/tire was deflated (not restricted). Rollover damage was documented to the top and right side surface of the vehicle with a maximum crush value of 6.0 cm (2.4 in) identified at the right A-pillar area. The windshield was fractured from exterior forces (only).



Figure 3. Left side and top damage to the 1998 Mercedes-Benz ML320 sport utility.



Figure 4. Frontal damage to the 1992 GMC Sierra pickup truck.

The 1992 GMC Sierra pickup truck sustained moderate frontal damage as a result of the impact with the Mercedes (**Figure 4**). The direct contact damage began at the front right bumper corner and extended 110.0 cm (43.3 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 175.0 cm (68.9 in). The end structure was displaced to the left approximately 25.0 cm (9.8 in). The hood was displaced up and to the left from engagement against the side surface of the Mercedes. Induced damage was identified at the left and right fenders which restricted the front wheels/tires (not deflated). The windshield was undamaged.

Interior Damage

Interior damage to the Mercedes identified through the NASS vehicle inspection was minimal and was attributed to occupant contact. Scuff marks were documented to the knee bolster (rigid plastic type) and

upper left door panel area. A small indentation and scuff mark were also identified on the door armrest. Hair strands were found on the left sunvisor with a scuff mark surrounding the transfer. A fabric transfer and scuff mark were documented on the upper portion of the side impact air bag. The front left lower retractor assembly was restricted by the lateral B-pillar intrusion (**Figure 5**) with the belt in the extended/used position. This intrusion also displaced the seat back forward to an upright position. No steering wheel rim deformation was noted (tilt column placed between full up and center position). Lateral intrusions into the driver space included 9.0 cm (3.9 in) of B-pillar intrusion, 14.0 cm (2.3 in) of door panel intrusion, 11.0 cm (3.4 in) of sill intrusion and 6.0 cm (2.2 in) of side panel intrusion. Vertical intrusions into the front right passenger space included 4.0 cm (1.6 in) of A-pillar and windshield header intrusions.



Figure 5. Driver seating area.

SUPPLEMENTAL RESTRAINT SYSTEMS

The 1998 Mercedes-Benz ML320 was equipped with frontal air bags for the driver and front right passenger positions (**Figure 6**). The 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 mid-mount module in the right instrument panel with a single cover flap design hinged at the top aspect. No cutoff switch was reported for the front right air bag. The vehicle was also equipped with restraint pretensioners which did not actuate as a result of the impacts.



Figure 6. Example of the 1998 Mercedes-Benz ML320 Sport Utility Vehicle Supplemental Restraint Systems.

The Mercedes was also equipped with door-mounted side impact air bags for the front left and right



Figure 7. Side impact air bag flaps.



Figure 8. Side impact air bag.

seating positions. The left side air bag deployed as a result of the crash. The left side impact air bag module was identified by the Mercedes part number: *T1RA226K20004* with a lot number of 2010322K. The air bag module was housed in the door panel above the armrest with a horizontally oriented flap tear seam (H-configuration). The flaps were rectangular in shape as the upper flap measured 25.0 cm (9.8 in) in width and 6.0 cm (2.4 in) in height while the lower flap measured 22.0 cm (8.7 in) in width and 6.0 cm (2.4 in) in height (**Figure 7**). Although no contact evidence was identified on the exterior surface of the module cover flaps, a scuff mark and fabric transfer were documented on the upper section of the air bag. The NASS researcher measured the left side impact air bag at 45.0 cm (17.7 in) in width and 15.0 cm (5.9 in) in height in its deflated state (**Figure 8**).

DRIVER DEMOGRAPHICS

Age/Sex: 30 year old female
 Height: 173 cm (68 in)
 Weight: 64 kg (140 lb)
 Seat Track Position: Mid-to-forward position
 Manual Restraint Use: 3-point lap and shoulder belt system
 Usage Source: NASS vehicle inspection, driver interview, medical records
 Eyewear: Prescription glasses
 Type of Medical Treatment: Transported to a local hospital and released

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
Contusion left scalp	Minor (190402.1,2)	Roof side rail (left)
Cervical strain	Minor (640278.1,6)	Roof side rail (indirect contact injury)
Contusion mid-chest	Minor (490402.1,4)	Shoulder belt webbing
Abrasion left posterior forearm	Minor (790202.1,2)	Flying glass
Contusion left lateral forearm	Minor (790402.1,2)	Door panel
Abrasion left abdomen	Minor (590202.1,2)	Lap belt webbing
Contusion right knee	Minor (890402.1,1)	Knee bolster
Contusion right medial thigh	Minor (890402.1,1)	Steering wheel rim (lower)

Laceration right knee (small)	Minor (890602.1,1)	Steering column
Abrasion left lateral thigh/knee	Minor (890202.1,2)	Door armrest
Contusion left lateral thigh	Minor (890402.1,2)	Door armrest
Laceration left medial thigh	Minor (890602.1,2)	Left side window glass (exiting vehicle post-crash)

Driver Kinematics

The 30 year old female driver of the 1998 Mercedes-Benz ML320 was seated in an upright posture with the seat back slightly reclined and the seat track adjusted to the mid-to-forward position. She was properly restrained by the 3-point manual lap and shoulder belt system with the anchorage adjustment placed to the middle position. Belt usage was confirmed by the restricted retractor assembly with the belt in the extended (used) position, further evidenced by the lack of substantial interior contacts and injury.

At impact with the Sierra pickup truck, she initiated a lateral (and slightly forward) trajectory in response to the 10 o'clock impact force and loaded the manual restraint and deployed side impact air bag. Loading to the manual restraint resulted in a contusion to the mid-chest and abrasion to the left abdomen. Contact to the left roof side rail resulted in a contusion to the left scalp and an associated (indirect) cervical strain, evidenced by the type of injury sustained relative to the existing kinematic response pattern. She impacted the door panel/armrest resulting in contusions/abrasions to the left lateral thigh and forearm, evidenced by the indentations and scuff marks documented to this component. She also sustained a minor contusion to the right knee from contact to the knee bolster as evidenced by the scuff mark documented to the right of the steering column.

During the rollover, the medial aspect of her right thigh contacted the lower portion of the steering wheel rim resulting in a small contusion, evidenced by the location of the injury relative to the seat track position. Following the collision, she exited the vehicle through the (disintegrated) left front window and probably lacerated the medial aspect of her left thigh on a piece of glazing still embedded in the window frame. The driver called for help on her cell phone and was subsequently transported to a local hospital for treatment and released.

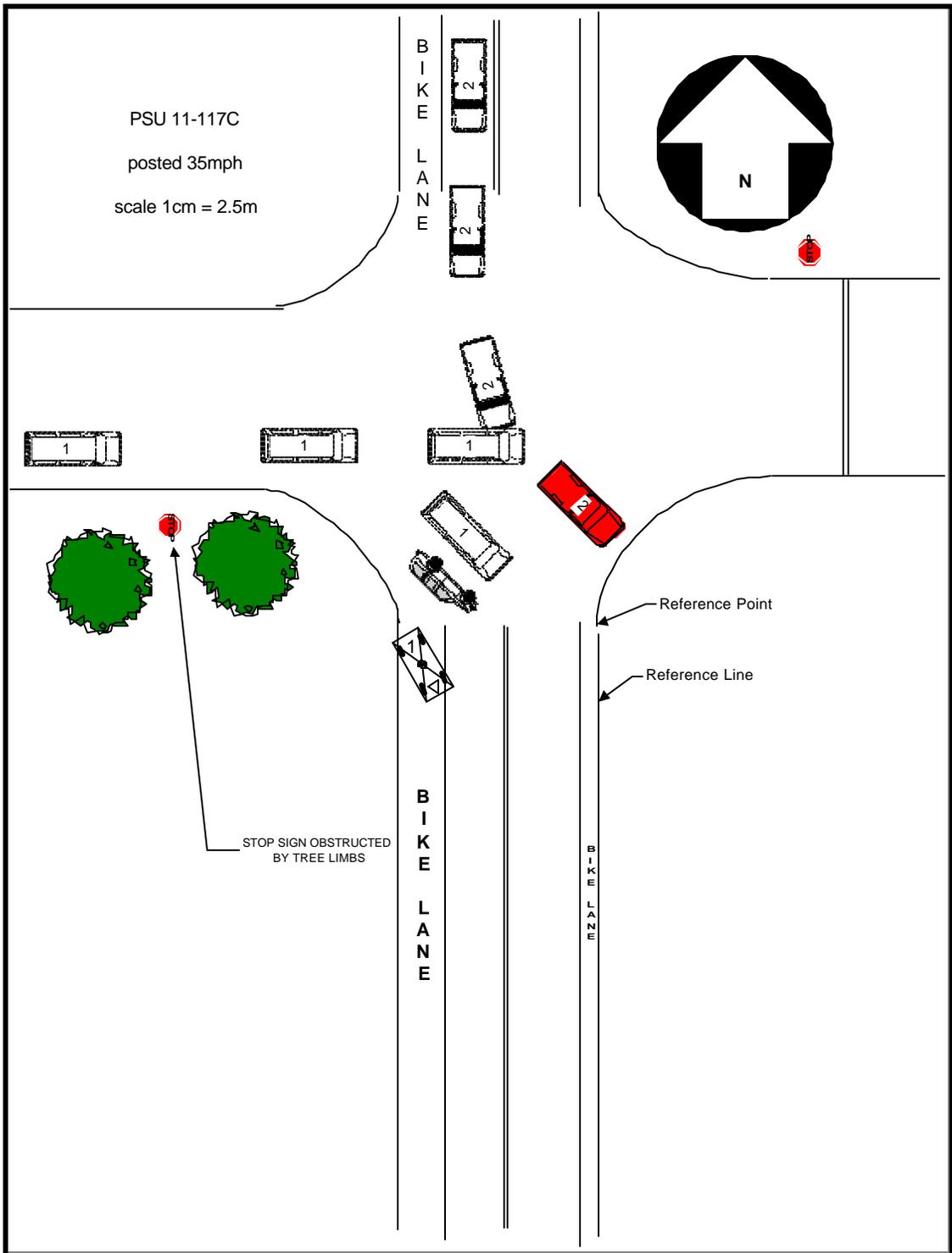


Figure 9. NASS Scene Diagram