

On-Site Rollover / Child Safety Seat Investigation
Dynamic Science, Inc. (DSI), Case Number (DS08005)
2003 Mercedes-Benz ML500
Oregon
January 2008

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

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16. Abstract This on-site investigation focused on a forward facing child seat that was installed in the second row middle position of a 2003 Mercedes-Benz ML500. The Mercedes was occupied by a 74-year-old restrained female driver and a 5-year-old male second row middle seat passenger who was restrained in a child seat. The driver of the vehicle was the great-grandmother of the child. The child seat was held inside the vehicle by a manual 3-point lap and shoulder belt. The Mercedes was traveling northbound on a straight roadway. The driver reported that she lost control of the vehicle due to ice on the roadway. The vehicle traveled off the roadway, struck a fence and rolled over two quarter turns. The Mercedes came to final rest on its roof in a field adjacent to the roadway. After the crash, the child was able to unbuckle his child seat harness, exit the vehicle and obtain help from a passing motorist. Both occupants were transported by ground ambulance to a local hospital. The driver sustained contusions and abrasions. The child was not injured. The Mercedes was towed from the scene due to damage.					
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Crash Investigation
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BACKGROUND

This on-site investigation focused on a forward facing child seat that was installed in the second row middle position of a 2003 Mercedes-Benz ML500. The Mercedes was occupied by a 74-year-old restrained female driver and a 5-year-old male second row middle seat passenger who was restrained in the child seat. The driver of the vehicle was the great-grandmother of the child. The child seat was held inside the vehicle by a manual 3-point lap and shoulder belt. The Mercedes was traveling northbound on a straight roadway. The driver reported that she lost control of the vehicle due to ice on the roadway. The vehicle traveled off the roadway, struck a fence and rolled over two quarter turns. The Mercedes came to final rest on its roof in a field adjacent to the roadway. After the crash, the child was able to unbuckle his child seat harness, exit the vehicle and obtain help from a passing motorist. Both occupants were transported by ground ambulance to a local hospital. The driver sustained contusions and abrasions. The child was not injured. The Mercedes was towed from the scene due to damage.



Figure 1. 2003 Mercedes-Benz ML500

This on-site rollover/child safety seat investigation was identified by DSI from an on-line news article. On January 9, 2008, DSI was instructed to locate the vehicle and the child safety seat. On February 12, 2008, DSI obtained a copy of the police report. The vehicle was being held at a local tow facility. The child safety seat was located inside the Mercedes. On February 13, 2008, DSI obtained permission to inspect the Mercedes. DSI was assigned the case on February 14, 2008. Field work was completed on February 18, 2008.

SUMMARY

Crash Site

This single vehicle crash occurred on a two-lane roadway at 0847 hours in January 2008. The crash occurred near the intersection of a driveway and the roadway. At the time of the crash, the asphalt roadway surface was reported to be icy. The north/south roadway was configured with single lanes in each direction that were separated by a double-yellow painted centerline. At 30.4 m (100 ft) south of the impact area, the grade was -11%. At the area of impact, the grade was -1.4%. North of the driveway, there is a plastic fence. The fence runs parallel to the north/south roadway and at a 45 degree angle from the driveway entrance. Just north of the driveway, there was an



Figure 2. Approach to area of impact

irregularly shaped sink hole that was perpendicular to the roadway and extended beyond the fence to the east. The sink hole contained running water.

Pre-Crash

The Mercedes was traveling northbound. The driver was transporting the child to his kindergarten class. The child seat had been installed in the Mercedes by the child's father and had been in that position several months. As the Mercedes descended the hill, the vehicle lost traction, went into a clockwise rotation and departed the roadway to the right. The Mercedes traveled through the driveway entrance.

Crash

The Mercedes traversed the driveway and struck the plastic fence with its left side. The Mercedes then tripped with its left side leading and began to overturn. The left side tires likely dropped into the sinkhole which caused the tripping motion. The Mercedes rolled over two quarter turns and came to rest on its roof in the sinkhole in a nose down configuration.

Post-Crash

Both occupants came to rest in the vehicle upside down. The water was running through the vehicle and across the roof. The water level rose to the level of the driver's head. The rear seated occupant was positioned above the water. The driver was initially unable to unbuckle her safety belt. The rear seat occupant also was not able to initially unbuckle the child seat harness. After approximately 10 minutes, the 5-year-old was able to unbuckle the child seat harness. He crawled forward towards the driver. The driver's arms were free, and she helped him float/swim out the driver's side window. The 5-year-old climbed up out of the sink hole and proceeded to the roadway. He was able to signal a passerby. The passerby called 911 and went to the edge of the sink hole, but did not go down into the sink hole. Shortly after her arrival, the driver of the Mercedes was able to free herself from the safety belt, but she was unable to get out of the vehicle due to the slippery conditions. A second passerby attempted to help, but was unable to pull the driver of the Mercedes out due to the slippery conditions. Emergency personnel arrived a short time later and were able to extricate the driver of the Mercedes.



Figure 3. Area of impact with fence and rollover



Figure 4. Side view of sink hole (east)

Both occupants were transported by ground ambulance to a local hospital. The driver sustained contusions to her left leg and minor lacerations to her left hand. The driver also reported soreness to her left hip. The hip was x-rayed and no fracture was found. The 5-year-old child was examined but was not injured. The Mercedes was towed from the scene due to damage. It was being held prior to sale at a local tow facility

VEHICLE DATA - 2003 Mercedes-Benz ML500

The 2003 Mercedes-Benz ML500 was identified by the Vehicle Identification Number (VIN): 4JGAB75E13Axxxxxx. The vehicle's odometer could not be read, as there was no power to the instrument panel. The Mercedes was a four-door sport utility vehicle that was equipped with a 5.0 liter, eight-cylinder engine, an automatic five-speed transmission, all wheel drive, four wheel ABS, traction control, and a tilt steering wheel. The Mercedes was configured with Michelin Cross Terrain 275/55R17 tires. The tire manufacturer's maximum pressure was 352 kPa (51 psi). The vehicle manufacturer recommended cold pressure was 221 kPa (32 psi) for the front and 269 kPa (39 psi) for the rear. The specific tire information is as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	207 kPa (30 psi)	6 mm (7/32 in)	No	None
LR	Flat	4 mm (5/32 in)	No	Tire de-beaded
RR	179 kPa (26 psi)	4 mm (5/32 in)	No	None
RF	221 kPa (32 psi)	6 mm (7/32 in)	No	None

The seating in the Mercedes was configured with cloth covered front bucket seats with adjustable head restraints and a second row split-bench seat with adjustable head restraints for all three positions. The driver's seat was in the middle track position. The driver's seat bottom was at a 13 degree angle from horizontal and the seat back was at a 20 degree angle from the vertical. The second row middle seat bottom was at 16 degree angle from horizontal and the seat back was at a 25 degree angle from the vertical. The head restraint for the second row middle seat position was not present during the vehicle inspection.

Vehicle Damage

Exterior Damage -2003 Mercedes-Benz ML500

The 2003 Mercedes-Benz ML500 sustained minor left side damage from the impact with the fence and the rollover. There was 420.0 cm (165.3 in) of direct contact to the left side of the vehicle. The maximum crush to the side was located at the driver's door and measured 3.0 cm (1.2 in). The contact evidence from the fence impact was largely masked by the rollover damage. There were three patches of white transfer evidence located on the left side of the vehicle (at the left rear door panel, left front door panel, and left lower corner of the front bumper). There were also white transfers found on the left upper portion of the tailgate and along the left front bumper. The rear bumper fascia was torn from the vehicle. A Collision Deformation Classification (CDC) for the impact with the fence was 11LDEW1. There was caked mud found on both left side tires. The left rear tire was de-beaded. The damage to the top of the vehicle measured 152.0 cm (59.8 in) laterally. The maximum crush was located at the left A pillar and measured 2.0 cm (0.8 in). There was light contact along the left edge of the hood, along the right edge of the hood, along the right A pillar, and along the right roof rail. The left upper portion of the windshield was cracked. The CDC for the top damage was 00TDYO2.

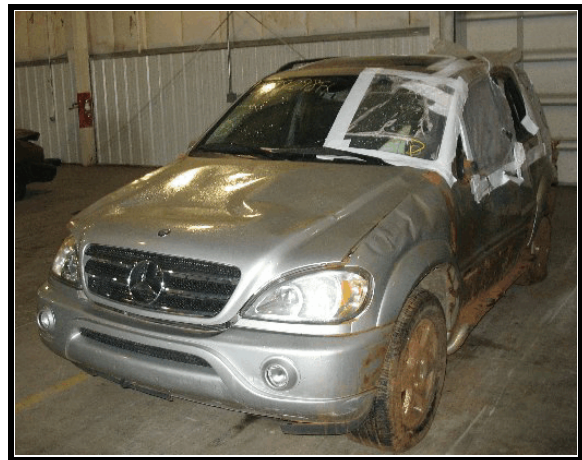


Figure 5. Front left side damage



Figure 6. Right front/top damage

Interior Damage -2003 Mercedes-Benz ML500

The 2003 Mercedes-Benz ML500 sustained moderate interior damage from the water and mud. All the doors remained closed and operational. All the glazing on the left side was disintegrated with the exception of the rear most glazing. The tailgate glazing was also disintegrated. There was 4.0 cm (1.6 in) of intrusion at the sill level on the left side.



Figure 7. Overview of water/mud damage



Figure 8. Windshield damage

Manual Restraints - 2003 Mercedes-Benz ML500

The 2003 Mercedes-Benz ML500 was configured with manual 3-point lap and shoulder belts for each seating position. The driver's safety belt was equipped with an anchorage adjustment that was in the full up position. The front right safety belt was equipped with an anchorage adjustment that was in the full down position. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). The remaining safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR). The second row middle safety belt was found in the switched out ALR mode and was used to secure the child safety seat.

Supplemental Restraint Systems -2003 Mercedes-Benz ML500

The 2003 Mercedes-Benz ML500 was equipped with frontal air bags and safety belt pretensioners for the driver and front right passenger positions. The driver's air bag was located in the steering wheel hub. The front right passenger air bag was located in the mid instrument panel. The Mercedes was equipped with door mounted side air bags and roof side rail mounted head impact air bags for the front and rear outboard seating positions. The air bags did not deploy and the pretensioners did not actuate during the crash. The impact with the fence was of insufficient force to deploy the side air bags.

Child Safety Seat

A Century Next Step Forward Facing only/booster seat was positioned in the second row middle seat of the Mercedes. The model number was 44910SAF and the date of manufacture was September 28, 2000. The booster seat was configured with a five-point harness system and a two-piece, locking retainer clip. The seat was designed with three sets of harness height slots, adjustable arm rests, and adjustable recline positions.

The CSS was designed to be used with or without the internal harness. With the harness, the seat was recommended for children who can sit upright, who weigh between 14-18 kg (30-40 lbs), and whose height is between 69-109 cm (27-43 in). Without the harness, the seat was recommended for children who weigh between 14-36 kg (30-80 lbs) and whose height is between 89-132 cm (35-52 in).

The harness was being used during this crash. The involved child's height was 91 cm (36 in) and his weight was 19 kg (41 lbs). The child's height was within the manufacturer's recommended height guideline and slightly over the recommended weight guideline.

At the time of the child seat inspection, the harness straps were routed through the top set of harness slots. The straps were twisted and doubled over in several locations.

The child seat was installed in a forward facing configuration and anchored to the vehicle using the Mercedes' 3-point manual lap and shoulder belt. The father of the child had installed the CSS several months earlier. The safety belt was found to be in the ALR mode and the seat was secured inside the vehicle. There was approximately 5.0 cm (1.9 in) movement in the forward direction and approximately 7.0 cm (2.8 in) movement laterally.



Figure 9. Century Next Step child seat as located in the vehicle



Figure 10. Side to side movement of booster seat



Figure 11. Twisted harness straps



Figure 12. Century Next Step CSS, side view showing armrest adjustments

Rollover Discussion

The 2003 Mercedes-Benz ML500 was equipped with Electronic Stability Control (ESC), four-wheel ABS, and traction control. The vehicle rollover resistance rating is not known. The ESC for the Mercedes is referenced to as an Electronic Stability Program (ESP). ESP compares the driver's intended course, via steering and braking inputs, to the vehicle's response, via lateral acceleration, rotation (yaw) and individual wheel speeds. ESP then applies the brakes to individual front or rear wheels and/or reduces excess engine power as needed to help correct understeer (plowing) or oversteer (fishtailing). As the Mercedes descended the ice covered hill, the driver lost control of the vehicle. She reported that she was actively steering and braking, but could not regain control of the vehicle. The Mercedes began a clockwise rotation. As the Mercedes left the roadway, the left side of the vehicle struck the plastic fence. This was a negligible impact that had little effect on the driver due to the yielding nature of the fence. The Mercedes remained upright until engaging the sink hole with its left side. The left side tires dropped into the sinkhole which caused the left side leading tripping motion. The Mercedes rolled over two quarter turns and came on its roof in the sinkhole in a nose down configuration. Both occupants remained in place during the rollover and came to rest upside within the vehicle.

OCCUPANT DEMOGRAPHICS - 2003 Mercedes-Benz ML500

	Driver	Occupant 2
Age/Sex:	74/Female	5/Male
Seated Position:	Front left	Second row middle
Seat Type:	Bucket	Split bench
Height:	173 cm (68 in)	91 cm (36 in)
Weight:	64 kg (141 lbs)	19 kg (41 lbs)
Occupation:	Retired	N/A
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	N/A
Driving Experience:	>30 years	N/A
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Both hands on steering wheel, actively steering	N/A
Foot Position:	Left on floor, right on brake	N/A
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used with child seat
Air bag:	Frontal air bag, side air bag, and side air curtain available, did not deploy.	N/A

OCCUPANT INJURIES - 2003 Mercedes-Benz ML500

Driver: Injuries obtained from driver interview. The driver also reported soreness to her left hip. The hip was x-rayed and no fracture was found.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Contusions, left leg	890402.1,2	Door panel	Probable
Minor lacerations, left hand	790602.1,2	Flying glass	Possible

Second row middle occupant: Not injured.

OCCUPANT KINEMATICS - 2003 Mercedes-Benz ML500

Driver Kinematics

The 74-year-old female driver was seated in an upright posture and was restrained by the manual 3-point lap and shoulder belt. The seat was adjusted to the mid track position and the seat back was slightly reclined. As the Mercedes descended the hill, the driver lost control of the vehicle. She was actively steering and braking in an attempt to regain control. The Mercedes began a clockwise rotation. As the Mercedes left the roadway, the left side of the vehicle struck the plastic fence. This was a negligible impact that had little effect on the driver or the trajectory of the vehicle. As the Mercedes engaged the sink hole with its left side, the vehicle tripped and began a left side leading rollover. As the Mercedes contacted the ground with its left side, the left hip and left leg of the driver contacted the door side panel. There was no resultant hip injury, but the driver did report pain in that area. As the rollover continued, the Mercedes came to rest within the sink hole on its top. The driver came to rest upside down in the vehicle and was held in place by the lap and shoulder belt. The driver was eventually able to unlatch the lap and shoulder belt, but was unable to extricate herself from the vehicle without assistance from EMS personnel. The driver sustained contusions to her left leg and minor lacerations to her left hand. The driver also reported soreness to her left hip. She was transported from the scene by ground ambulance to a local hospital where she was treated and released.



Figure 13. Interior, driver's door

Second Row Middle Occupant Kinematics

The 5-year-old male second row middle passenger was seated in an upright posture and was restrained in the child seat by the five-point harness. The 5-year-old was held in place by the belt system throughout the rollover event. He was initially unable to get out of the child seat. After a few minutes, he was able to free himself and was then helped out of the vehicle by the driver. He was transported from the scene by ground ambulance to a local hospital where he was examined and released. He did not sustain any injuries.

Attachment 1. Scene Diagram

