

**TRANSPORTATION SCIENCES
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GENERAL DYNAMICS ON-SITE CHILD SAFETY SEAT INVESTIGATION

GENERAL DYNAMICS CASE NO: CA03-035

VEHICLE: 1997 MERCURY SABLE

LOCATION: NEW YORK

CRASH DATE: JUNE 2003

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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 on-site investigation focused on the performance of a Cosco Explorer forward-facing shield booster child safety seat (CSS) installed in a 1997 Mercury Sable. The Sable was occupied by a 36-year-old female driver, a 4-year-old female child seated in the CSS that was positioned in the rear center and a 7-year-old female child seated in the rear right position. The Cosco Explorer was manufactured on 8/16/94. The CSS was configured with a plastic shell and a plastic shield that was hinged on the left side. The Mercury was involved in an intersection-type crash with a 1999 Volkswagen Passat. The Passat was occupied by an 18-year-old male driver. The driver of the Passat was traveling in westerly direction on a two-lane state route while talking on a hand-held cellular telephone. He passed a police officer that was on the east roadside conducting police business. The police officer then made a U-turn with the intent to stop the Passat as hand-held cellular telephone use by a driver of a vehicle is illegal in New York State. The driver of the Passat initiated a left turn across the eastbound lane at a four-leg intersection, into the path of the 1997 Mercury Sable. The frontal area of the Passat impacted the left side of the Sable. The impact resulted in moderate damage to the left side of the Sable and moderate frontal damage to the Passat. The driver of the Sable was restrained by the manual 3-point lap and shoulder belt. She was transported by helicopter to a regional trauma center where she was treated and released. The 4-year-old and the 7-year-old passengers were transported by ambulance to a regional children's hospital for evaluation. The 4-year-old child was not injured and was released. The 7-year-old child sustained an arm injury and was treated and released. The driver of the Passat was also transported by ambulance to a hospital with police reported minor injuries.					
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GENERAL DYNAMICS ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
GENERAL DYNAMICS CASE NO: – CA03-035
SUBJECT VEHICLE – 1997 MERCURY SABLE
LOCATION - STATE OF NEW YORK
CRASH DATE – JUNE 2003

BACKGROUND

This on-site investigation focused on the performance of a Cosco Explorer forward-facing shield booster child safety seat (CSS) installed in a 1997 Mercury Sable. The Sable was occupied by a 36-year-old female driver, a 4-year-old female child seated in the CSS that was positioned in the rear center and a 7-year-old female child seated in the rear right position. The Cosco Explorer was manufactured on 8/16/94. The CSS was configured with a plastic shell and a plastic shield that was hinged on the left side. The Mercury was involved in an intersection-type crash with a 1999 Volkswagen Passat. The Passat was occupied by an 18-year-old male driver. The driver



Figure 1. View of damaged Mercury Sable

of the Passat was traveling in westerly direction on a two-lane state route while talking on a hand-held cellular telephone. He passed a police officer that was on the east roadside conducting police business. The police officer then made a U-turn with the intent to stop the Passat as hand-held cellular telephone use by a driver of a vehicle is illegal in New York State. The driver of the Passat initiated a left turn across the eastbound lane at a four-leg intersection, into the path of the 1997 Mercury Sable. The frontal area of the Passat impacted the left side of the Sable. The impact resulted in moderate damage to the left side of the Sable (**Figure 1**) and moderate frontal damage to the Passat. The driver of the Sable was restrained by the manual 3-point lap and shoulder belt. She was transported by helicopter to a regional trauma center where she was treated and released. The 4-year-old and the 7-year-old passengers were transported by ambulance to a regional children's hospital for evaluation. The 4-year-old child was not injured and was released. The 7-year-old child sustained an arm injury and was treated and released. The driver of the Passat was also transported by ambulance to a hospital with police reported minor injuries.

This June 2003 crash was identified by the SCI team through local contacts. The crash information was forwarded to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) due to the presence of the CSS. The case was assigned on June 19, 2003, and an on-site investigation of the crash was initiated immediately.

SUMMARY

Crash Site

This two-vehicle crash occurred during the evening hours of June 2003. At the time of the crash, the weather was clear with no adverse conditions. The crash occurred at a four-leg intersection of two roadways. **Figure 2** is a northwest view of the intersection. The east/west roadway was configured with one travel lane in each direction separated by a double-yellow centerline. The roadway curved left with an uphill grade for the eastbound direction. The north/south roadway was configured with one travel lane in each direction separated by a double-yellow centerline. Asphalt shoulders bordered both roadways. East/west traffic flow through the intersection was not controlled. The posted speed limit for eastbound traffic was 72 km/h (45 mph) and 64 km/h (40 mph) for the westbound traffic. The scene schematic is included as **Figure 15** of this report.



Figure 2. Northwest view of intersection.

Crash Sequence

Pre-Crash

The 36-year-old female driver of the Mercury Sable was operating the vehicle eastbound on the two-lane roadway approaching the four-leg intersection (**Figure 3**). The 18-year-old male driver of the Passat was traveling westbound while talking on a hand-held cellular telephone (**Figure 4**). He passed a police officer that was on the east roadside conducting police business. The police officer then made a U-turn with the intent to stop the Passat as hand-held cellular telephone use by a driver of a vehicle is illegal in New York State. The driver of the Passat disregarded eastbound traffic and proceeded to turn left at the intersection across the path of the Sable. The lack of pre-impact evidence indicated that no avoidance maneuvers were attempted by either driver.



Figure 3. Eastbound approach for the Sable.



Figure 4. Westbound approach for the Passat.

Crash

The frontal aspect of the Volkswagen Passat impacted the left side of the Mercury Sable in a 11 o'clock and 01 o'clock impact configuration. The impact resulted in moderate damage to the left side of the Sable and moderate damage to the front of the Passat. The damage algorithm of the WinSMASH program computed a total delta-V of 22 km/h (13.7 mph) for the Sable. The longitudinal and lateral components for the Sable were -21 km/h (-13 mph) and 8 km/h (5 mph), respectively. The total delta-V for the Passat was 26 km/h (18.0 mph) and the longitudinal and lateral components for the Passat were -27.3 km/h (-16.2 mph) and -9 km/h (-5.6 mph), respectively. The Sable was equipped with frontal air bags that deployed as a result of the vehicle-to-vehicle crash. The Passat was also equipped with frontal air bags that deployed during the crash. The impact redirected both vehicles into the southeast quadrant of the intersection. The Sable traveled southeast approximately 19.3 m (63.3') off the road onto an embankment. The lower front right aspect of the Sable's bumper fascia impacted the embankment before coming to final rest. The Passat rotated approximately 50 degrees and came to rest near the area of impact facing south.

Post-Crash

Rescue personnel arrived on-scene and pried open the left front door of the Sable to facilitate the extrication of the driver. Rescue personnel removed the 4-year-old child from the CSS in the rear center and the 7-year-old rear right child. The driver was transported by helicopter to a trauma center where she was treated and released. The two children were transported by ambulance to a children's hospital for evaluation. They were treated and released. The driver of the Passat was transported by ambulance to a hospital where he was treated and released.

VEHICLE DATA – 1997 Mercury Sable

The 1997 Mercury Sable was identified by the Vehicle Identification Number (VIN): 1MELM50U0VA (production sequence omitted). At the time of the vehicle inspection, the Sable's odometer read 144,753 km (89,948 miles). The vehicle was a four-door sedan that was equipped with a 3.0-liter, V6 engine, 4-speed automatic transmission, power-front and rear disc brakes with anti-lock, OEM alloy wheels, power-steering, and a tilt steering wheel. The Sable was configured with UniRoyal American Gold P205/65R15 tires. The specific tire data is as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0 kpa (0 psi)	7 mm (9/32)	Yes	De-beaded
LR	221 kpa (32 psi)	7 mm (9/32)	No	None
RF	228 kpa (33 psi)	6 mm (8/32)	No	None
RR	234 kpa (34 psi)	5 mm (6/32)	No	None

The seating positions in the Mercury Sable were configured with front bucket seats with adjustable head restraints and a flip and fold front center seat/console. The front seat head restraints were both adjusted to the full-down positions at the time of the vehicle inspection. The rear seat was configured with a bench seat with a 60/40 split folding rear seat back. The vehicle was not equipped with Lower Anchorages and Tethers for Children (LATCH).

VEHICLE DATA – 1999 Volkswagen Passat

The 1999 Volkswagen Passat was identified by the VIN: WVWMA63B4XE (production sequence omitted). The Passat's battery was discharged at the time of the inspection, therefore the odometer reading could not be obtained. The vehicle was a four-door sedan that was equipped with a 1.8-liter, 4-cylinder turbo-charged gasoline engine, a 5-speed manual transmission, and power-front/rear disc brakes with anti-lock, OEM alloy wheels and power steering. The Passat was also equipped with redesigned frontal air bags that deployed as a result of the crash.

VEHICLE DAMAGE

Exterior Damage – 1997 Mercury Sable

The 1997 Mercury Sable sustained moderate left side damage as a result of the impact with the Volkswagen Passat (**Figure 5**). The direct contact damage began at the left front bumper corner and extended 323.8 cm (127.5") rearward, where it terminated 36.2 cm (14.25") forward of the left rear axle. Both left side doors were crushed laterally and sustained contact abrasions from the bumper of the Passat. The rear aspect of the left front door was deformed rearward as a result of the longitudinal crush. The windshield was fractured with scattered stress fractures at the lower A-pillar area from contact with hood edge. The left front wheel was separated from the suspension components and restricted against the rear of the left front fender. The side and rear glazing were not damaged. The left front door was jammed closed by damage and pried open for extrication of the driver. The damage from rescue personnel's attempts to extricate the driver consisted of pry marks to the latch and striker area of the left front door. The left rear and both right side doors remained closed during the crash and were operational post-crash. The Collision Deformation Classification for the impact with the Passat was 11-LYEW-2. Six crush measurements were documented at the mid-door level: C1 = 0.0 cm, C2 = 11.4 cm (4.5"), C3 = 20.3 cm (8.0"), C4 = 22.8 cm (9.0"), C5 = 21.9 cm (8.6"), C6 = 14.0 cm (5.6"). Maximum crush was located 7.6 cm (3.0") forward of the rear edge of left front fender and measured 22.8 cm (9.0").

The front right area of the bumper fascia had sustained damage from the impact to the embankment. The damage consisted of dirt scuffs and a dent to the lower fascia below the air dam. There was no structural involvement; however, the bumper fascia was deformed to a depth of 2.5 cm (1.0") (**Figure 6**). The Collision Deformation Classification for the impact with the embankment is 12-FRLW-1.



Figure 5. Front left damage to Sable.



Figure 6. Damage to Sable from Embankment.

Exterior Damage – 1999 Volkswagen Passat

The 1999 Volkswagen Passat sustained moderate frontal damage as a result of the impact with the Sable (**Figure 7**). The direct contact damage on the bumper fascia, which separated from the vehicle, began 8.0 cm (3.1”) left of center and extended 72.0 cm (28.3”) to the left front corner. The leading edge of the hood was abraded from direct contact and buckled rearward. The left headlamp and grille trim were disintegrated. The left end of the bumper beam was crushed rearward. The left front fender was buckled rearward. The bumper and front structure sustained left lateral end shifting as a result of the Sable’s forward momentum during the crash. The left corner of the upper radiator support was displaced rearward 42.3 cm (16.6”). Six crush measurements were documented along the front bumper beam and were as follows: C1 = 29.0 cm (11.4”), C2 = 25.5 cm (10.0”), C3 = 17.0 cm (6.8”), C4 = 11.0 cm (4.2”), C5 = 5.5 cm (1.9”), C6 = 0.0 cm (0.0”). The CDC for the frontal impact with the Sable was 01-FYEW-1.



Figure 7. Front damage to the Passat.

Interior Damage –1997 Mercury Sable

Interior damage to the 1997 Mercury Sable was minor and attributed to passenger compartment intrusion and occupant contact (**Figure 8**). The left side panel forward of the A-pillar was intruded laterally 5.0 cm (2.0”). A cluster of the driver’s hair was located on the front left seat cushion and a possible contact was found to the upper B-pillar where strands of hair were adhered to the B-pillar (**Figure 9**). At impact, the driver initiated a forward and left trajectory into the path of the deploying air bag. The driver loaded the air bag and compressed the steering column and displaced the shear capsules. The left shear bracket was displaced 0.6 cm (0.25”) (**Figure 10**) and the right shear bracket was displaced 0.3 cm (0.125”) (**Figure 11**).



Figure 8. View of intrusion to the Sable's side panel forward of A-pillar.



Figure 9. Driver contact to left B-pillar of the Sable. Note* D-ring cover



Figure 10. Left shear bracket displacement of the Sable.



Figure 11. Right shear bracket displacement of the Sable.

MANUAL RESTRAINT SYSTEMS – 1997 Mercury Sable

The 1997 Mercury Sable was equipped with 3-point manual lap and shoulder safety belts for the four outboard seating positions and a lap belt for the front center position. The driver's safety belt (**Figure 12**) was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). Adjustable D-rings were present on the B-pillars for the front left and right safety belts. The front left D-ring height adjustment was 3.8 cm (1.5") above the lowest position and the front right was in the full-down position at the time of the inspection. Inspection of the front left latch plate showed evidence of historical use. The driver's safety belt showed evidence of usage in the crash. In the extended position, the torso section of the webbing had blood spatter that would not be present if the safety belt was not used. The front center safety belt was configured with a locking latch plate. The front right and rear outboard safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR). The center rear safety belt was a lap and shoulder belt with detachable shoulder belt and was configured with an ELR retractor and a locking/cinching latch plate.



Figure 12 - Driver's safety belt in Sable.

Frontal Air Bags- 1997 Mercury Sable

The 1997 Mercury Sable was equipped dual frontal air bags that deployed as a result of the crash. The driver's frontal air bag was concealed by two non-symmetrical cover flaps. The top flap measured 15.2 cm (6.0") width and 7.6 cm (3.0") in height. The lower flap measured 13.9 cm (5.5") in width and 7.6 cm (3.0") in height. The driver's air bag was 60.9 cm (24.0") in diameter and was tethered by two straps at the 3 and 9 o'clock positions. The air bag was internally vented. An expansion transfer was noted to the left peripheral seam. Also noted was blood spatter and minor lacerations to the face of the air bag.

The front right air bag module was located on top of the right instrument panel. The cover flap was reinforced with a sheet metal backer panel and was shaped in a tri-oval design. The maximum width of the flap was 43.8 cm (17.25") with a height of 29.2 cm (11.5"). The flap was tethered to the instrument panel by two 2.9 cm (1.125") wide tether straps that were 24.8 cm (9.75") in length. The rear edge of the cover flap contained several minor lacerations from contact with the windshield. The front right passenger air bag was tethered internally by a wide band tether that was sewn to the bag face with a 62.2 cm (24.5") horizontally oriented seam. The air bag was 62.2 cm (24.5") in width and 54.6 cm (21.5") in height. The front right air bag was internally vented.

CHILD SAFETY SEAT

A Cosco Explorer shield booster seat was positioned in the rear center of the Sable. At the time of the inspection, the CSS was found in the rear left position (**Figure 14**). However, the driver stated to the SCI investigator that the CSS was installed in the rear center position and was restrained by the lap belt portion of the safety belt system. The CSS displayed a Manufacture Date of 08/16/94 and a Model Number of 022399EMF. The CSS was constructed of plastic with a plastic abdominal shield that hinged on the left side. The abdominal shield padding was not present at the time of inspection. The instructions and informational labels were not present on the CSS. The lap portion of the safety belt was positioned across the designated belt path on the face of the shield. The shoulder belt was not used with the CSS. The CSS displayed no evidence of failure or damage associated with the crash.



Figure 14. CSS found in rear left position at inspection.

OCCUPANT DEMOGRAPHICS – 1997 Mercury Sable

Driver

Age/Sex:	36-year-old female
Height:	170.0 cm (67.0")
Weight:	72.0 kg (159.0 lbs)
Seat Track Position:	Rear, track was adjusted 7.0 cm (2.8") forward of full rear [track travel = 22.9 cm (9.0")]
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection

Eyewear: Unknown
Type of Medical Treatment: Transported by helicopter to a regional trauma center

Driver's Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Left parietal scalp laceration	Minor (190600.1,2)	Left B-pillar
Minor laceration to right side of upper lip	Minor (290602.1,8)	Flying glass

Injury source= Emergency Records

Driver Kinematics

The 36-year-old female driver of the 1997 Sable was seated in an upright posture. She was restrained by the manual 3-point lap and shoulder belt. At impact, she initiated a forward and left trajectory and loaded the safety belt and the deployed air bag. Her loading force compressed the energy absorbing steering column. The driver then rebounded into the left B-pillar contacting it with her head resulting in the left parietal scalp laceration. The driver was contacted by flying glass that resulted in the minor right side upper lip laceration. She was transported by helicopter to a regional trauma center where she was treated and released.

Rear Center Child Passenger Demographics

Age/Sex: 4-year-old female
Height: 91.0 cm (36.0")
Weight: 15.0 kg (33.0 lbs)
Restraint Use: Forward-facing shield booster seat restrained by the lap belt of the 3-point lap and shoulder belt system
Usage Source: Vehicle inspection
Eyewear: Unknown
Type of Medical Treatment: Transported by ambulance to a regional children's hospital

Rear Center Child Passenger Kinematics

The 4-year-old child passenger was restrained in the forward-facing shield booster seat that was positioned in the rear center. At impact, the child initiated a forward and left trajectory and loaded the shield of the booster seat. No loading evidence was found on the safety belt. The child was removed from the CSS and the vehicle and was transported by ambulance to a regional children's hospital for evaluation. The child was examined at the hospital; however, no injuries were present and the child was released.

Rear Right Child Passenger Demographics

Age/Sex: 7-year-old female
Height: 127.0 cm (50.0’’)
Weight: 39.9 kg (88.0 lbs)
Manual Restraint Use: 3-point safety belt
Usage Source: Police Report, No evidence of usage
Eyewear: Unknown
Type of Medical Treatment: Transported by ambulance to a regional children’s hospital

Rear Right Child Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Left forearm contusion	Minor (790402.1, 2)	Child safety seat

Injury source= Emergency records

Rear Right Child Passenger Kinematics

The 7-year-old child passenger was seated in the rear right seating position. She was restrained by the vehicles lap and shoulder safety belt. There was no loading evidence on the safety belt system. At impact, the child initiated a forward and left trajectory. The child’s left forearm contacted the CSS that was installed in the rear center position that resulted in the left forearm contusion. The child was transported to a regional children’s hospital for evaluation. She was treated and released.

Figure 15. Scene schematic

