

**TRANSPORTATION SCIENCES
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**VERIDIAN ON-SITE CHILD SAFETY SEAT INVESTIAGTION
VERIDIAN CASE NO. CA00-024
VEHICLE: 1990 MERCURY TOPAZ
LOCATION: MARYLAND
CRASH DATE: JULY 2000**

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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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<p>16. <i>Abstract</i> This crash investigation focused on the performance and usage issues of two child safety seats (CSS) that were occupied by child passengers, ages 16 months and 3 years, in a 1990 Mercury Topaz. The Topaz was involved in a severe offset, head-on crash with a Freightliner dump truck. The 21 year old female driver of the Topaz was traveling in an easterly direction on a two lane road in a posted 80 km/h (50 mph) speed zone. She allowed her vehicle to drift across the center line into the path of the dump truck. The front left area of the Topaz impacted the front left area of the dump truck resulting in severe exterior damage to the Topaz with massive intrusion of the driver's compartment. The driver of the Topaz was restrained by the automatic shoulder belt system and expired at the scene of the crash. The 3 year old child passenger was seated in a Fisher Price Safe Embrace belt positioning booster seat in the front right position and restrained by the automatic shoulder belt and manual lap belt. She sustained multiple soft tissue injuries and was transported to a regional trauma center where she was admitted overnight for observation. The 16 month old male was restrained in a forward facing (make/model unknown) convertible safety seat in the right rear position. He sustained soft tissue injuries and was transported to the regional trauma center where he was admitted overnight for observation.</p>			
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BACKGROUND

This crash investigation focused on the performance and usage issues of two child safety seats (CSS) that were occupied by child passengers, ages 16 months and 3 years, in a 1990 Mercury Topaz. The Topaz was involved in a severe offset, head-on crash with a Freightliner dump truck. The 21 year old female driver of the Topaz was traveling in an easterly direction on a two lane road in a posted 80 km/h (50 mph) speed zone. She allowed her vehicle to drift across the center line into the path of the dump truck. The front left area of the Topaz impacted the front left area of the dump truck resulting in severe exterior damage to the Topaz (**Figure 1**) with massive intrusion of the driver's compartment. The driver of the Topaz was restrained by the automatic shoulder belt system and expired at the scene of the crash. The 3 year old child passenger was seated in a Fisher Price Safe Embrace belt positioning booster seat in the front right position and restrained by the automatic shoulder belt and manual lap belt. She sustained multiple soft tissue injuries and was transported to a regional trauma center where she was admitted overnight for observation. The 16 month old male was restrained in a forward facing (make/model unknown) convertible safety seat in the right rear position. He sustained soft tissue injuries and was transported to the regional trauma center where he was admitted overnight for observation.



Figure 1. Overall view of the frontal damage to the Mercury Topaz.

The crash was identified by NHTSA through a media search and assigned to the Veridian SCI team on July 18, 2000 as an on-site investigative effort. Cooperation was established with the investigating police officer and an on-site investigation was conducted on Thursday, July 20.

SUMMARY

Crash Site

The crash occurred in July 2000 on a two lane county road during daylight hours under clear skies and dry environmental surfaces. The roadway consisted of two travel lanes that were bordered by asphalt shoulders. The eastbound travel lane was 3.5 m (11.5') in width while the westbound lane was 3.7 m (12.1') wide with respective paved shoulders of 2.9 m (9.5') and 3.3 m (10.8') in width. The travel lanes and the north shoulder were resurfaced with new asphalt prior to the crash. W-beam guardrail systems bordered both shoulders which protected traffic from negative sloped embankments. The roadway curved to the left with respect to the Topaz's path of travel. The measured radius of curvature was 347.5 m (1140.1'). The posted speed limit was 80 km/h (50 mph).

Vehicle Data

1990 Mercury Topaz

The subject vehicle in this crash was a 1990 Mercury Topaz, 4-door sedan. The vehicle manufactured on 6/90 and identified by vehicle identification number 1MEPM36X1LK (production number deleted). The odometer reading at the time of the crash was 62,284 km (38,703). The Topaz was equipped with a 2.3 liter, 4-cylinder engine linked to a 3-speed automatic transmission with a console mounted transmission selector lever. The front-wheel drive vehicle was equipped with power-assisted front disc/rear drum brakes (no ABS). The steering was power-assisted rack-and-pinion.

The interior of the Topaz was configured with front bucket seats with a common center armrest. The front seats were equipped with adjustable head restraints and manual track and recline adjusters. The rear seat was a 3-passenger bench with a fixed backrest. The four-spoke steering wheel housed the cruise control switches. The Topaz was not air bag equipped. The restraint systems consisted of 2-point motorized shoulder belts with manual lap belts for the front seated positions. The rear seat was equipped with 3-point continuous loop lap and shoulder belts with sliding latchplates in the outboard positions and a center lap belt with a locking latchplate.

1980 Freightliner Dump Truck

The 1980 Freightliner was a 10-wheeled chassis was a conventional cab and a hydraulic dump body. The straight truck was configured with a front bumper that was bolted to the frame rails and extended full width forward of the front tires. The front steer axle was equipped with Type 20 air brake chambers. The one-piece front hood/cowl was hinged at the forward aspect and opened in a forward direction. The cab of the straight truck was configured with two doors, a split two-piece windshield with a center post, and front suspension bucket-type seats. Both seat positions were equipped with fixed length adjustable manual lap belts. The body of the truck was a welded steel dump body with a top hinged tailgate. The length of the dump body was 4.3 m (14.0') and was empty at the time of the crash. The truck was equipped with two fuel tanks mounted to the sides of the vehicle, below the door areas of the cab. Both aluminum tanks were equipped with two serrated aluminum steps to allow for ingress/egress to the cab. The Freightliner was identified by vehicle identification number CB413HH1(production number deleted). The vehicle's odometer reading at the time of the crash was 374,040 km (232,424 miles).

Crash Sequence

Pre-Crash

The driver of the Mercury Topaz was transporting her two children, ages 3 years and 16 months. Both children were restrained in child safety seats. The driver was restrained by the automatic shoulder belt, however, she did not wear the manual lap belt. She was traveling in a westerly direction on the two lane state route (**Figure 2**) at an estimated speed of 80 km/h (50 mph). While negotiating a gradual left curve, the driver was possibly distracted by the children which resulted in her failure to maintain her travel lane. The Topaz traveled on a near



Figure 2. Pre-crash trajectory of the Topaz.

straight line trajectory as she entered the left curve and crossed the centerline of the two lane county road into the eastbound travel lane into the path of the dump truck.

The 1980 Freightliner dump truck was empty and was traveling in an easterly direction. The driver of the dump truck observed the Topaz as it crossed the center line into his path of travel. The driver of the truck steered right and braked the vehicle in an attempt to avoid the impending crash. Skid marks were present on the newly surfaced asphalt road from the rear tires of the dump truck. The investigating officer documented approximately 9.1 m (30') of pre-crash skid marks. The crash schematic is attached as **Figure 15**, on Page 17 of this summary report.



Figure 3. Trajectory of the Freightliner dump truck.

Crash

The front left area of the Mercury Topaz impacted the front left aspect of the dump truck in the center of the eastbound travel lane. The offset left impact resulted in directions of force of 12 o'clock for both vehicles with a principal direction of force (PDOF) of 350 degrees for the Topaz. As the Topaz crushed to maximum engagement against the frontal structure of the truck, the Topaz was rotated in a counterclockwise (CCW) direction by the offset nature of the crash and the continued straight line trajectory of the dump truck. Although the crash was outside the scope of the WinSMASH program due to the involvement of the large truck, a barrier equivalent velocity change of 47.0 km/h (29.2 mph).

As the Topaz rotated approximately 90 CCW and began to separate from the truck, the left front tire of the truck impacted the leading edge of the right front fender of the Topaz. This impact, located forward of the Topaz's center of gravity, accelerated the CCW rotation to the vehicle. The lateral impact force that resulted from this impact event was within the 3 o'clock sector for the Topaz and 12 o'clock for the truck.

The Topaz was displaced approximately 9.7 m (32.0') laterally to its right and 4.8 m (16.0') longitudinally (west) of its at-impact position with the truck. The vehicle came to rest straddling the outboard edge of the north shoulder, facing in a northwesterly direction. At rest, the Topaz rotated approximately 314 degrees CCW from its initial westbound heading at impact.

The dump truck traveled approximately 20.7 m (68.0') following the impact with the Topaz and impacted the W-beam guardrail system that was located outboard of the south shoulder. The truck's trajectory was evident by front axle tire marks on the asphalt road surface. The front right area of the dump truck initially impacted the guardrail. The continued forward trajectory of the vehicle allowed the truck to penetrate through the downstream end of the guardrail system which resulted in overlapping damage to the left frontal area. The truck traversed the embankment and came to rest in a non-horizontal attitude on the sloped embankment approximately 37.4 m (123.0') east of the initial point of impact with the Topaz.

Post-Crash

A passing motorist and witness to the crash stopped at the crash site to check the status of the occupants of the Topaz. This witness assisted the front seated child passenger from the vehicle and assisted in removing the rear seated child passenger from the vehicle in his CSS. Rescue personnel arrived on-scene within minutes of the crash. The driver was evaluated by rescue personnel and pronounced deceased at the scene. Both child passengers were transported by helicopter to a regional trauma center where they were treated for their injuries and admitted overnight for observation. The driver of the dump truck sustained police reported possible injuries. His medical treatment was unknown.

Vehicle Damage

Exterior - 1990 Mercury Topaz

The Mercury Topaz sustained severe damage as a result of its initial offset, head-on crash with the Freightliner dump truck. The impact grossly deformed the frontal structure of the vehicle and resulted in separation of the front bumper fascia, the left third of the bumper beam, upper radiator support, left inner fender structure, hood, left front fender, and the left front wheel, brake, and suspension assembly. The direct contact damage was estimated as originating approximately 20.3 cm (8.0") left of center and extending 53.3 cm (21.0") to the left bumper corner. It should be noted that this value was derived from comparison between the crash vehicle and an exemplar Mercury Topaz. The Collision Deformation Classification (CDC) was 12-FYEW-4 (**Figure 4**). The impact deformed the entire width of the frontal structure resulting in a combined induced and direct contact damage length (Field L) of 77.5 cm (30.5"). A crush profile (**Figure 5**) was documented at the level of the lower radiator support panel and was as follows: C1 = 78.7 cm (31.0"), C2 = 50.8 cm (20.0"), C3 = 34.0 cm (13.4"), and C4 = 21.0 cm (8.25").



Figure 4. Frontal damage to the Topaz.

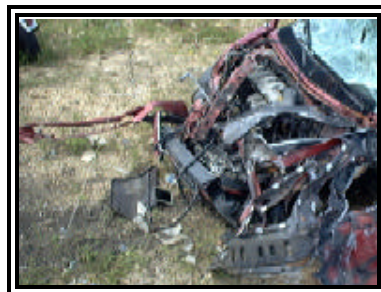


Figure 5. Lateral view documenting the crush profile.

As the Topaz rotated in a CCW direction, the left front tire of the truck engaged the side surface of the vehicle at the leading edge of the right front fender. This subsequent engagement resulted in crush to the right front fender and altered the above documented crush profile by further displacing the fender and its sub-components laterally left. A black tire lug pattern began at the leading edge of the front fender and

extended 38.1 cm (15.0") rearward. Displacement of the fender resulted in an induced damage length of 66.0 cm (26.0") which involved the full damaged length of the fender. The crush profile at this plane was as follows: C1 = 11.7 cm (4.6"), C2 = 24.8 cm (9.75"), C3 = 48.3 cm (19.0"), and C4 = 85.3 cm (33.6") located at the front corner. The CDC for this secondary impact (**Figure 6**) was 03-RFEN-9* (*The side extent of 9 represents an unknown value due to the lateral displacement that resulted from the initial offset configuration. The crush profile presents the overall profile and could not be used for a delta V computation). The left front door latch released during the crash due to the displacement of the left A-pillar. The door was subsequently cut from the vehicle at the hinges by rescue personnel to aid in the extrication of the driver's body. The left rear door was jammed closed while both right side doors remained closed during the crash and were operational post-crash.



Figure 6. Lateral displacement of the right front fender.

Interior - 1990 Mercury Topaz

The interior of the Mercury Topaz sustained severe damage that was associated with exterior deformation and passenger compartment intrusion (**Figure 7**). In addition, the driver contacted several interior components that resulted in additional, but minor damage. The interior intrusions are identified in the following table:



Figure 7. Compression of the frontal structure into the driver's compartment.

Seat Position	Intruding Component	Direction	Magnitude
Driver (11)	Left upper A-pillar at juncture with header	Longitudinal	16.5 cm (6.5")
Driver (11)	Mid left A-pillar at beltline	Longitudinal	36.8 cm (16.5")
Driver (11)	Lower left A-pillar	Longitudinal	44.4 cm (17.5")
Driver (11)	Steering wheel	Longitudinal	10.2 cm [(4.0") inclusive of column compression]
Driver (11)	Left corner of mid instrument panel	Longitudinal	33.0 cm (13.0")

Seat Position	Intruding Component	Direction	Magnitude
Driver (11)	Left toe pan	Longitudinal	30.5 cm (12.0")
Driver (11)	Lower left A-pillar and sill	Lateral	17.8 cm (7.0")
Front right (13)	Center mid instrument panel	Longitudinal	5.1 cm (2.0")
Front right (13)	Heater box/toe pan	Longitudinal	10.2 cm (4.0")
Rear left (23)	Left rear door panel	Lateral	7.6 cm (3.0")

The driver was restrained by the automatic 2-point motorized shoulder belt webbing, however, she was not restrained by the manual lap belt. Her loading of the shoulder belt resulted in longitudinally oriented abrasions, stretching, and fabric transfers of the webbing in the area of her torso. Rescue personnel subsequently cut the belt webbing during the extrication of the driver's body.

Her left hand impacted the top left aspect of the instrument panel (IP). A 1.9 cm (0.75") diameter scuff mark with a 1.3 cm (0.5") deep gouge was noted to the panel 38.1-40.0 cm (15.0-15.75") left of the vehicle's center line at the top brow of the IP. Her torso loaded the intruding steering wheel as evidenced by edge loading 1.9 cm (0.75") of deflection of the right spokes. Additionally, the steering column was compressed with complete separation of the shear brackets.

The driver's knees contacted the intruding knee bolster. The left knee scuffed the bolster 38.1-44.4 cm (15.0-17.5") left of center and 36.8-41.9 cm (14.5-16.5") below the top of the IP. The right knee scuff was located 7.6-12.7 cm (3.0-5.0") left of center and 38.1-44.4 cm (15.0-17.5") below the referenced IP.

The front right child passenger was restrained in a belt positioning booster seat. The windshield was fractured and at the time of the SCI inspection, had sagged into the front right passenger compartment. Strands of blond hair were snagged by the glazing fractures forward of the child passenger's position. These hair strands were located 24.1-36.8 cm (9.5-14.5") right of center and approximately 12.7 cm (5.0") above the top of the IP. Hair was also noted at the right corner of the upper instrument panel.

The child passenger's right foot scuffed the glove box door 30.4-32.4 cm (12.0-12.75") right of center and 27.9-31.8 cm (11.0-12.5") below the upper instrument panel. A scuff on the right mid IP was noted 7.6-9.5 cm (3.0-3.75") right of center and 20.3-21.6 cm (8.0-8.5") below the IP.

A cake was transported in the center rear seat area of the vehicle. At impact, the cake was displaced forward which splattered onto the front seat backs.

Exterior - 1980 Freightliner

The exterior of the 1980 Freightliner straight (dump) truck sustained severe damage (**Figure 8**) as a result of the initial frontal impact with Mercury Topaz and subsequent frontal impact with the W-beam guardrail. The initial impact with the Mercury Topaz involved the front left and center areas of the truck's front bumper (**Figure 9**). Rubber transfers from the Mercury's left front tire were present on the chrome bumper. The transfers began at the corner and extended 47.0 cm (18.5") inboard. The extent of frontal crush to the bumper was unknown due to the subsequent impacts. The Truck Deformation Classification (TDC) was 12-FLEW-9* with the 9 reflecting an unknown extent zone value.

The left front tire was cut from engagement against the right front fender of the Topaz during the secondary impact phase of the crash event. The wheel rim was deformed and abraded circumferentially from both the initial impact and the subsequent events. The TDC for the secondary impact with the Topaz was 12-FLWN-2.



Figure 8. Front and left side damage to the dump truck.



Figure 9. Deflected left corner of the front bumper.

The third impact event with the W-beam guardrail resulted in rearward displacement of the full width left front bumper with subsequent snagging damage to the left fuel tank and the leading outboard drive axle tire and wheel (**Figure 10**). The latter damage resulted from the penetration of the guardrail system. The bumper was deformed 90 degrees and folded between the left front brake chamber and the outer tie rod arm. A abrasive-type mark was present on the leading edge of the aluminum fuel tank and the left outer tire of the forward drive axle was separated from the wheel rim. The wheel rim was dented to a maximum depth of 18.4 cm (7.25").



Figure 10. Fuel tank and tire/wheel damage.

The impact with the earth embankment involved the frontal undercarriage components. The front axle was embedded with dirt and grass, however, no residual damage occurred to the undercarriage.

Seat Belt Systems - 1990 Mercury Topaz

The front outboard seated positions of the Mercury Topaz were equipped with automatic 2-point motorized shoulder belts and manual lap belt systems. The automatic shoulder belts retracted onto emergency locking retractors (ELR) that were mounted at the inboard aspect of the front seats. The belt was fastened to a mouse (carriage assembly) that motored fore and aft in a track along the side rails and upper A- and B-pillars. Due to the severe damage to the vehicle and the obliteration of the vehicle's battery and frontal electrical system, both motorized seat belt carriage assemblies remained in the fully extended positions at the B-pillars. The manual lap belts for the front positions retracted to the outboard aspects of the seats with emergency locking retractors affixed to the sill of the Topaz.

The outboard rear seat positions were equipped with 3-point lap and shoulder belts for the outboard positions and a lap belt for the center seated position. The 3-point belts consisted of continuous loop webbings and sliding latch plates that retracted onto emergency locking retractors. The center lap belt was a fixed length adjustable with a cinch bar locking latch plate.

The driver was restrained by the automatic shoulder belt, however, she was not wearing the manual lap belt. Belt usage was supported by observations of the first responders, loading evidence to the shoulder belt webbing, and a cut of the shoulder belt webbing by rescue personnel during the extrication of the driver. The lap belt was found post-crash retracted into the outboard mounted retractor and was not damaged. An investigating police officer examined the belt by extending the belt webbing from the retractor. Due to the severe crash related structural damage to the vehicle in the area of the sill, the retractor would not spool-up the webbing, therefore the driver's lap belt was extended at the time of the SCI inspection.

The shoulder belt webbing was cut 5.7 cm (2.25") below the level of the mouse. Vertically oriented abrasions that were consistent with occupant loading were noted to the inside surface of the webbing (side against the driver's torso), located 26.7-78.7 cm (10.5-31.0") below the level of the cut line. Several faint fabric transfers were visible within this area of the webbing.

The front right shoulder belt webbing was found extended across the seat back of the Topaz and was intact. The shoulder belt webbing was twisted with one complete twist noted approximately 20.3 cm (8.0") below the carriage assembly. The shoulder belt webbing was dark in color due to dirt that had accumulated on the webbing. A blood stain was noted to the shoulder belt webbing at the inboard aspect of the webbing adjacent to the seat cushion. The lap belt was retracted into the outboard mounted retractor. A longitudinally oriented 5.1 cm (2.0") black transfer was noted to the lap belt webbing and was located 26.7 cm (10.5") above the latch plate.

The left rear 3-point lap and shoulder belt system exhibited minimal routine wear marks for the age and mileage of the vehicle. The ELR system with a sliding latch plate required the use of a locking clip to secure a child safety seat (CSS). This was the position occupied by the 16 month old male who was restrained in a forward facing convertible child safety seat. There was no locking clip on the belt webbing, therefore

the CSS was not properly secured to the vehicle. The crossbar of the latch plate was abraded from frictional interaction against the belt webbing. The black plastic from the latch plate was transferred onto the webbing at a point that was located 85.1-90.2 cm (33.5-35.5") above the bight of the seat cushion/seat back. The latch plate was found positioned 86.4 cm (34.0") above the seat bight. The child was removed from the vehicle in the CSS, therefore the buckle was released and the webbing was routed back through the belt path to free the CSS from the left rear position.

The center rear lap belt was not used in this crash. The locking latch plate was positioned 40.6 cm (16.0") from the seat bight with an additional 69.9 cm (27.5") of webbing extended from the latch plate. There was no damage or loading evidence to the lap belt.

The right rear 3-point lap and shoulder belt system exhibited minimal routine usage indicators for the mileage and year of the Topaz. There was no damage or loading evidence to the right rear belt system.

Child Safety Seats

The Mercury Topaz was occupied by two child passengers who were restrained in child safety seats (CSS). The 3 year old female was positioned in the front right of the vehicle and was seated on a Fisher Price Safe Embrace belt positioning booster seat (Figure 11). The investigating officer had removed the CSS from the vehicle and retained the seat in the evidence locker for preservation. The CSS was made available to the SCI investigator and was returned to the vehicle for inspection and placement purposes. Although the CSS appeared to be in new condition, the labels that identified the model number and date of manufacturer were not present on the CSS. This CSS was designed exclusively as a belt positioning booster with the vehicle's belt system serving as the primary restraint for the child passenger. The booster seat was not physically damaged as a result of the crash, however, blood stains were present on the fabric of the seat cushion and seat back areas of the CSS. A warning label located on the outer fabric at the bight of the booster seat stated the following:

WARNING - Use only with a lap and shoulder belt combination.

The 3 year old child passenger was assisted from the vehicle by a passing motorist. The lap belt was unbuckled and the child slid out from under the motorized shoulder belt and exited the vehicle from the front right door. A family member stated to the investigating officer that the 3 year old child passenger always rode in the front right position of the vehicle.

The 16 month old child passenger was restrained in the left rear position of the Topaz in a forward facing convertible CSS. The child was removed from the vehicle in the CSS and transported by helicopter to a regional trauma center. The child safety seat was not inspected and could not be located during this on-site SCI investigation. A member of the flight crew noted the CSS during the transport, however, he could not



Figure 11. Fisher Price Safe Embrace.

identify the make and/or model of the CSS. Hospital personnel were contacted by the investigating officer and again, the location of the CSS was not known. The flight crew member did not observe damage to the forward facing CSS.

Driver Demographics

Age/Sex: 22 year old female
 Height: 170 cm (67")
 Weight: 47.6 kg (105.0 lb)
 Seat Belt Usage: Motorized 2-point shoulder belt, manual lap belt not worn
 Usage Source: Vehicle inspection, observations of the first responders
 Seat Track Position: Mid track
 Medical Treatment: None, pronounced deceased at the scene of the crash

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Multiple deep lacerations of the right lobe of the liver	Severe (541826.4,1)	Automatic 2-point shoulder belt webbing
Fracture of the right 1-4 ribs	Serious (450230.3,1)	Steering wheel rim
Upper middle lobes of the right lung was severely lacerated	Serious (441430.3,1)	Steering wheel rim
Fracture of the distal left femur	Serious (851814.3,2)	Intruding knee bolster
Proximal left tibia fracture	Moderate (853420.2,2)	Intruding knee bolster
Distal left tibia fracture	Moderate (853420.2,2)	Intruding left toe pan
Several subcapsular lacerations of the spleen at its hilum	Moderate (544222.2,2)	Compression of the abdominal wall against the steering wheel rim
Inferior aspect of the right diaphragm was hemorrhagic	Moderate (440699.2,8)	Steering wheel rim
Faint contusion of the right forehead, 3.8x2.5 cm	Minor (290402.1,7)	Steering wheel rim

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Faint curvilinear imprint over the left anterior chest at the mid clavicular line	Minor (490402.1,2)	Steering wheel rim
1.2x0.6 cm abrasion with contusion over the right anterior chest wall under the right breast	Minor (490202.1,1; 490402.1,1)	Automatic 2-point shoulder belt webbing
Two curvilinear contused abrasions over the right abdominal wall, 17.8x4.4 cm	Minor (590202.1,1; 590402.1,1)	Automatic 2-point shoulder belt webbing
Three linear abrasions of the left upper quadrant of the abdomen	Minor (590202.1,2)	Steering wheel rim
7 cm gaping laceration of the intercostal muscle between ribs 7 and 8	Minor (490602.1,4)	Automatic 2-point shoulder belt webbing
4.1 cm gaping laceration between ribs 6 and 7	Minor (490602.1,4)	Automatic 2-point shoulder belt webbing
1.9x0.8 cm contused abrasion on the ventral surface of the left upper arm	Minor (790402.1,2; 790202.1,2)	Left door panel
2.5x1.0cm abrasion on the posterior surface of the right forearm below the elbow	Minor (790202.1,1)	Mid instrument panel (possible)
Two oblique abrasions on the anterior and anterio-lateral aspects of the left thigh	Minor (890202.1,2)	Left door panel/mid instrument panel (possible)
Three lacerations on the anterior and proximal aspect of the left leg	Minor (890602.1,2)	Intruding left lower instrument panel/knee bolster

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
5.7 cm curvilinear abrasion over the medial aspect of the left knee	Minor (890202.1,2)	Intruding knee bolster/lower left instrument panel
Contusion with abrasion over the back of the left foot	Minor (890202.1,2; 890402.1,2)	Intruding toe pan/foot controls
Contusion with abrasion over the posterior aspect of the left leg	Minor (890402.1,2; 890202.1,2)	Leading edge of the front left seat cushion
Three contused abrasions of the medial aspect of the right knee	Minor (890202.1,1; 890402.1,1)	Intruding knee bolster
Two linear contused abrasions over the medial, distal aspect of the right lower leg	Minor (890402.1,1; 890202.1,1)	Intruding knee bolster/lower left instrument panel

Source of Injury Data - Autopsy Report

Driver Kinematics

The 22 year old female driver of the Mercury Topaz was seated in a presumed upright driving posture with the seat track adjusted to a mid-to-rear track position and the seat back slightly reclined. The adjustable head restraint was adjusted 1.3 cm (0.5") above the top of the seat back. The driver was reportedly dressed in a bikini and was restrained by the automatic two-point shoulder belt system. She was not restrained by the manual lap belt. Belt usage was supported by loading evidence on the shoulder belt webbing and the post-crash cutting of the belt webbing by rescue personnel. The lap belt was stowed in the outboard retractor and was not damaged by the crash. **Figure 12** is a lateral view of the driver's seated position with respect to the intruding components.



Figure 12. Lateral view of the driver's seated position.

At impact, the driver initiated a forward trajectory and loaded the automatic shoulder belt webbing. Her loading force against the belt webbing resulted in longitudinal striations/stretch marks to the webbing. Due to the lack of use of the manual lap belt, the driver probably partially submarined the automatic shoulder belt webbing as she initiated her forward motion, rotating slightly in a counterclockwise direction. The driver's loading of the belt webbing resulted in an abrasions with contusions of the right anterior chest and

right abdominal wall with underlying lacerations of the intercostal muscle between ribs 6-7 and 7-8. She also sustained multiple deep lacerations of the right lobe of the liver.

Due to the severe intrusion of the frontal components at maximum engagement, the driver subsequently loaded the steering wheel rim as evidenced by rim and spoke deformation and shear bracket separation. The driver's involvement with the steering wheel rim resulted in fractures of the right 1-4 ribs, laceration of the upper lobes of the right lung, hemorrhage of the diaphragm, and subcapsular spleen lacerations.

The driver's knees and lower legs loaded the intruding knee bolster as evidenced by the scuff marks on the rigid plastic panel. As a result of the lower extremity contacts, the driver sustained soft tissue injuries that included three lacerations of the left leg, an abrasion over the left knee, contused abrasions over the right knee, and contused abrasions over the right lower leg. She also sustained fractures of the left tibia. The energy from the left knee contact was transmitted through the knee and into the femur which resulted in a fracture of the distal left femur.

The driver sustained additional upper extremity soft tissue injuries from possible contact with the left door panel, mid instrument panel. Her left foot was contused from involvement with the displaced foot controls that resulted from toe pan intrusion. She also sustained a contusion with abrasion of the posterior aspect of her left leg from compression against the leading aspect of the front seat cushion.

The driver rebounded from her forward trajectory and slumped to her right where she came to rest. She was pronounced deceased at the scene of the crash. Rescue personnel cut the automatic shoulder belt webbing during the extrication of the body. The body was transported to the medical examiner's office for autopsy.

Front Right Child Passenger Demographics

Age/Sex:	3 year old female
Height:	Not reported
Weight:	Not reported
Manual Restraint	
Use:	Restrained in a high back belt positioning booster seat, Fisher Price Safe Embrace
Usage Source:	Vehicle inspection, observations of witnesses and first responders to the crash scene
Mode of Transport	
From Scene:	Helicopter to a regional children's trauma center
Type of Medical	
Treatment:	Treated and admitted overnight for observation

Front Right Child Passenger Injuries

Injury	Injury Severity AIS 90/Update 98	Injury Source
10 cm full thickness laceration of the right elbow	Minor (790604.2,1)	Unknown, possible internal loose object
3 cm stellate/gaping laceration of the right lower lip	Minor (290602.1,8)	Unknown, possible internal loose object
Superficial laceration of the face, NFS	Minor 290602.1,0	Flying glass
Contusion of the left arm	Minor (790402.1,2)	Possible mid instrument panel, occupant-to-occupant interaction
Contusion of the left knee	Minor (890402.1,2)	Glove box door

Source of Injury Data - Hospital emergency room report

Front Right Child Passenger Kinematics

The front right child passenger was seated on a Fisher Price Safe Embrace high-back belt positioning booster seat, restrained by the vehicle’s automatic shoulder belt and the manual lap belt. Both belt systems were equipped with emergency locking retractors. The front right seat track was adjusted to a rear track position with the seat back reclined approximately eight degrees aft of vertical. In this position, the horizontal distance between the forward edge of the booster seat back and the mid instrument panel was 59.1 cm (23.25") as depicted in **Figure 13**.

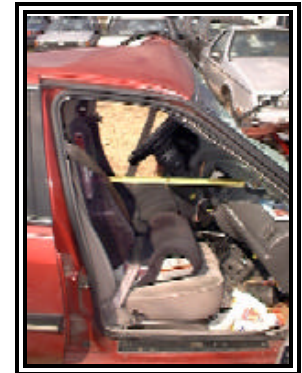


Figure 13. Front right position with the CSS.

At impact, the front right child passenger initiated a forward trajectory and loaded the automatic and manual belt systems. The combination of belt systems provided sufficient restraint to the child as evidenced by the lack of significant occupant contact points and injury. The child did sustain a 10 cm full thickness laceration of the right elbow and a 3 cm stellate/gaping laceration of the right lower lip from unknown sources. It was possible the child passenger was struck by an internal loose object(s) that produced the lacerations.

In addition, the child passenger’s lower extremities contacted the glove box door and the mid instrument panel which resulted in a contusion of the left knee. She also sustained a contusion of the left arm from

possible contact to the center mid instrument panel, or from contact with the driver. The child passenger sustained superficial lacerations of the face that were attributed to flying glass.

The child passenger was removed from the vehicle by a witness and was ambulatory at the scene of the crash. She was transported by helicopter to a regional trauma center where she was treated for her injuries and admitted overnight for observation.

Left Rear Child Passenger Demographics

Age/Sex: 16 month old male
 Height: Not reported
 Weight: Not reported
 Manual Restraint
 Usage: Restrained in a forward facing convertible seat, make/model unknown
 Usage Source: Investigating police officer, helicopter medical personnel
 Mode of Transport
 From Scene: Helicopter to a regional children’s trauma center
 Type of Medical
 Treatment: Treated and admitted overnight for observation

Left Rear Child Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Severity
Anterior forehead abrasion	Minor (290402.1,7)	Probable contact with the front left seat back
Anterior forehead hematoma	Minor (290202.1,7)	Probable contact with the front left seat back
Multiple small abrasions of the chin	Minor (290202.1,8)	Flying glass
Multiple small abrasions of the right elbow	Minor (790202.1,1)	Flying glass
Contusion of the left face	Minor (290402.1,2)	Intruding left rear door panel

Source of Injury Data - Hospital emergency room report

Left Rear Child Passenger Kinematics

The 16 month old male child passenger was restrained in a forward facing convertible child safety seat (CSS) in the left rear position of the Mercury Topaz. The child was transported to the regional hospital in the CSS, therefore it was not available at the time of the vehicle inspection. Follow-up with the hospital,

police, helicopter personnel, was unsuccessful in attempting to locate the CSS. Therefore, the manufacturer and the specifics pertaining to this CSS are unknown.

The CSS was restrained by the continuous loop 3-point lap and shoulder belt of the Mercury Topaz. The specific routing of the belt system through the CSS was also unknown. This belt system consisted of a sliding latch plate with an emergency locking retractor (ELR). A locking clip was required to properly secure the CSS with the vehicle's belt system. There was no locking clip on the belt webbing at the time of inspection and no evidence was present on the webbing to support the use of a clip at the time of the crash. Load induced abrasions were present on the belt webbing at a point that was 85.1-90.2 cm (33.5-35.5") above the seat cushion/seat back juncture (bight). Additional load induced abrasions were present on the crossbar of the latchplate from frictional interaction against the belt webbing (**Figure 14**).



Figure 14. Left rear seated position and the belt loading evidence.

Although unconfirmed, the child passenger was probably restrained in the CSS by the integral harness system. It should be noted that rescue personnel could not recall if the CSS was equipped with a tray or T-shield. At impact, the child responded to the frontal crash forces by initiating a forward trajectory. He probably loaded the integral harness system which restricted his forward excursion from the CSS. Due to the lack of a locking clip on the vehicle's belt system, the ELR locked as the CSS moved forward against the presumed slack in the belt system. This allowed the child's forehead to impact the back aspect of the front left seat back. His probable contact with the seat back resulted in an anterior forehead contusion with abrasion. The left aspect of his face probably contacted the intruding left rear door panel which resulted in a contusion of the left face. There was no contact evidence to support occupant involvement with the seat back or door panel.

The child passenger sustained multiple small abrasions of the chin and right eyebrow from contact with flying glass. The tempered left side glazing was shattered due to the exterior deformation. Glass fragments were scattered throughout the interior of the vehicle.

The child was removed from the vehicle in his CSS by rescue personnel. The CSS was secured to a cot and the child was transported via helicopter to a regional trauma center where he was treated for his injuries and admitted overnight for observation.

**Crash Schematic
Case No. CA00-024**

Scale: 1" = 40'

Vehicles: #1 - 1990 Mercury Topaz
#2 - 1980 Freightliner Truck

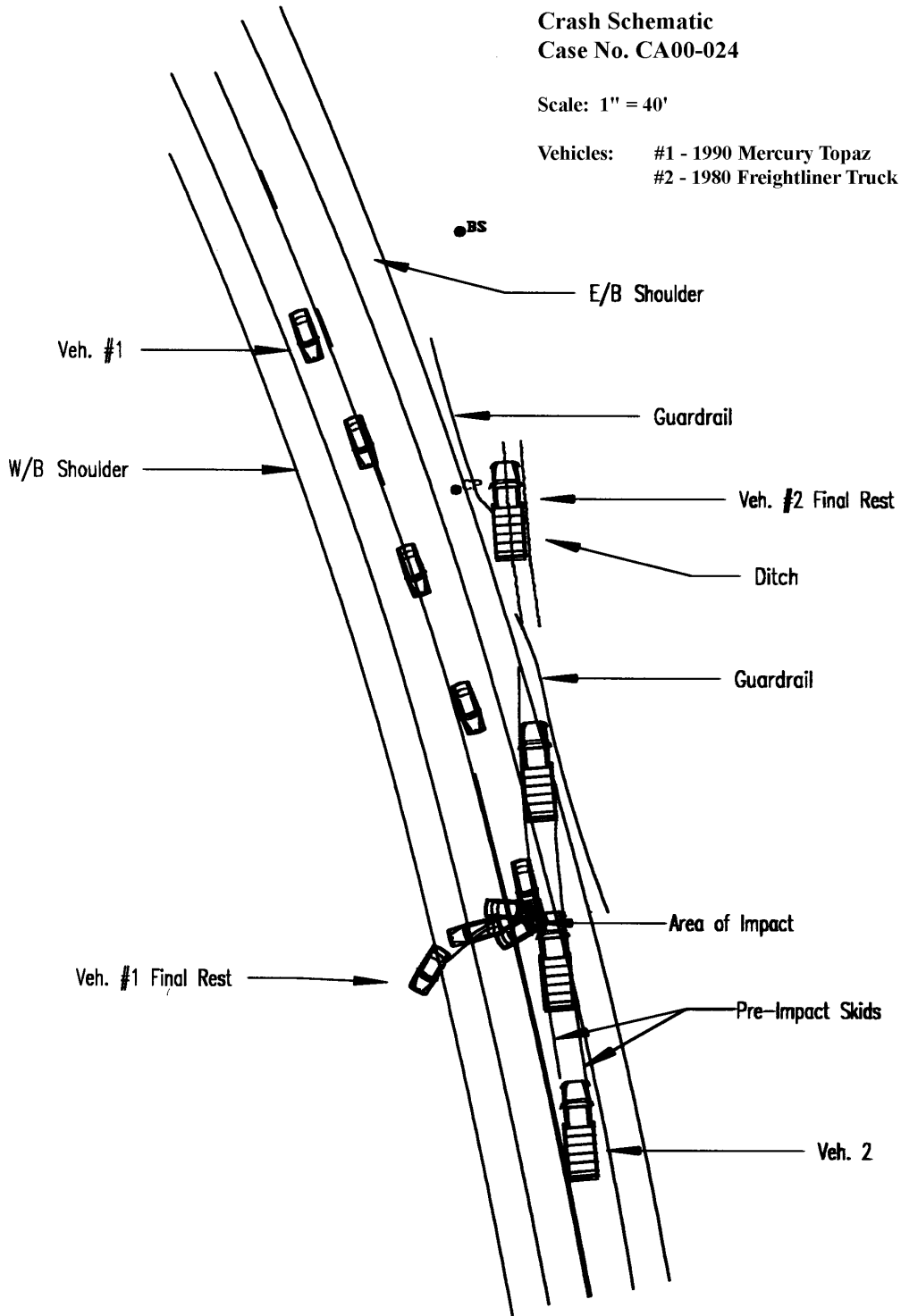


Figure 15. Crash Schematic