

**TRANSPORTATION SCIENCES
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**ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
SCI TECHNICAL SUMMARY REPORT**

VERIDIAN CASE NO. CA01-056

SUBJECT VEHICLE - 2002 FORD TAURUS

LOCATION - STATE OF PENNSYLVANIA

CRASH DATE - DECEMBER 2001

Contract No. DTNH22-01-C-17002

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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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LOCATION - STATE OF PENNSYLVANIA
CRASH DATE - DECEMBER 2001**

BACKGROUND

This on-site investigation focused on the performance of a rear-facing child safety seat (CSS) that was installed without a detachable base in the rear right position of a 2002 Ford Taurus. The Taurus was involved in a low-speed intersection crash with a straight truck transporting logs and was occupied by a 30-year-old unrestrained female driver and a 2-month-old male who was restrained in the rear-facing infant CSS. The front right area of the Taurus impacted the left front bumper corner of the truck (**Figure 1**). The impact resulted in minor damage to both vehicles and was not sufficient to deploy the frontal air bag system or fire the seat



Figure 1. On-scene photograph

belt pretensioners in the Taurus. The driver and infant initiated forward trajectories at impact. The driver loaded the steering wheel rim and the knee bolster. She rebounded rearward and struck her head, possibly on the left B-pillar or door frame. She sustained a contusion on the left aspect of her torso and a driver-reported headache. She refused treatment at the scene. The infant loaded the rear aspect of the CSS and rebounded forward (toward the rear of the vehicle) against the integrated harness straps. The infant was found to be in respiratory arrest following the impact. The driver removed the CSS from the vehicle, and subsequently removed the child from the CSS. The driver delivered a single back blow to the infant and he began spontaneous respirations. The infant was transported by helicopter to a regional trauma center where he was treated and released.

The crash was identified by the Veridian SCI team following an Internet search of potential cases of interest to NHTSA. The notification was forwarded to NHTSA and the case was assigned for on-site investigation on December 18, 2001. Cooperation was established with the investigating officer and the PAR was obtained to locate the involved Taurus. The officer contacted the family of the infant and secured possession of the CSS prior to SCI departure. The on-site field activities were initiated on December 19, 2001.

SUMMARY

Crash Site

This two-vehicle crash occurred during the daylight hours at the intersection of a two-lane state roadway and a two-lane local roadway. At the time of the crash, the asphalt roadway was dry and the weather was clear. The north/south state roadway consisted of two travel lanes that were separated by a double-yellow centerline. The east/west roadway consisted of two travel lanes that were undivided and had a slight negative grade for eastbound traffic approaching the intersection. The roadways were bordered by concrete curbs and sidewalks. A two-story building was located on the southwest corner which reduced westbound visibility for northbound traffic entering the intersection. Traffic flow through the intersection was controlled by stop signs for north/south traffic. Flashing overhead red signals were present for north/south traffic and flashing overhead amber signals were present for east/west traffic. The posted speed limit for the north/south roadway was 56 km/h (35mph). The speed limit increased to 72 km/h (45 mph) on the north leg of the intersection. The speed limit for east/west traffic was 40 km/h (25 mph). The scene schematic is included as **Figure 14**.

Pre-Crash

The 30-year-old female driver was operating the 2002 Ford Taurus eastbound on the two-lane local roadway, on approach to the four-leg intersection (**Figure 2**). The driver estimated her speed to be approximately 40 km/h (25 mph). The driver of the log truck was operating the vehicle northbound on the state roadway (**Figure 3**). The driver of the truck reportedly slowed as the truck approached the intersection, but did not come to a complete stop. The truck rolled into the intersection at a low speed. The driver of the Taurus observed the truck entering the intersection and applied the brakes in full lockup and steered left in an attempt to avoid the collision. The Taurus was not equipped with anti-lock brakes (ABS) and tire marks that measured approximately 6 m (20') in length were documented at the scene. It did not appear that the driver of the truck attempted any avoidance maneuvers.



Figure 2. Eastbound approach for the Ford Taurus



Figure 3. Northbound approach for the truck

Crash

The front right area of the Taurus impacted the left front aspect of the log truck in an “L” configuration. Impact resulted in minor damage to both vehicles. The resultant impact forces were in the 1 o’clock sector for the Taurus and in the 9 o’clock sector for the log truck. The barrier equivalent damage algorithm of the WinSMASH program computed a total delta-V of 10.0 km/h (6.2 mph) for the Taurus which was below the threshold to deploy the frontal air bag system or fire the seat belt pretensioners. The longitudinal and latitudinal components were -9.4 km/h (-5.8 mph) and -3.4 km/h (-2.1 mph), respectively. The Taurus was deflected slightly to the left and the vehicles remained engaged as they came to final rest in the intersection (Figure 4).



Figure 4. On-scene photograph

Post-Crash

Both drivers exited their vehicles under their own power. The driver of the Taurus determined that the 2-month-old in the CSS had stopped breathing. She ran around the back of the Taurus and attempted to open the right rear door, but it was locked. She returned to the driver’s door and unlocked the doors of the Taurus. She returned to the right rear door and removed the CSS from the vehicle. She determined that the infant was still in respiratory arrest, and observed that his lips had become cyanotic. She removed the infant from the CSS and provided a single back blow with her hand. The infant began breathing and was transported by helicopter to a regional trauma center for evaluation. The Taurus was towed from the scene and the truck was driven from the scene.

VEHICLE DATA - 2002 Ford Taurus

The 2002 Ford Taurus was identified by the Vehicle Identification Number (VIN): 1FAFP53U72A (production sequence omitted). The Taurus was a rental vehicle that was provided through the dealer while the family’s primary vehicle was being serviced. It was a new vehicle, and not driven prior to being rented by the driver. The driver stated that the odometer read approximately 26 km (16 miles) at the time of the crash. The vehicle was a four-door sedan and was equipped with a 3.0 liter, V-6 engine, front wheel-drive, an electronic four-speed automatic transmission, front disc and rear drum brakes without anti-lock (ABS), and alloy wheels. The Taurus was also equipped with power locks, power windows, power mirrors, power driver’s seat, tilt steering wheel, variable assist power steering, air conditioning, and cruise control. At the time of the vehicle inspection, the odometer read 47 km (29 miles). The Taurus was configured with P215/60R16 tires that exhibited excellent tread.

The Taurus was not equipped with the optional adjustable pedals or the side impact air bag system.

The Taurus was equipped with bucket seats with adjustable head restraints for the driver and front right passenger positions. The driver’s seat track was positioned 15.2 cm (6.0") rear of full-forward and 8.9 cm (3.5") forward of full-rear and the seat back was reclined to a 30 degree angle from vertical. The front right

seat was in the full-rear track position. The rear seating was configured with a three-person bench seat with a 60/40 split folding back. The Ford Taurus was also equipped with tether anchors and lower anchor points for the LATCH (Lower Anchors and Tethers for Children) system at each rear seat position. CSS emblems were sewn onto the seat fabric to identify the location of the lower anchors (**Figure 5**).

Supplemental safety equipment in the 2002 Ford Taurus included dual-stage frontal air bags for the driver and front right passenger, front seat belt buckle pretensioners, and a driver's seat track position sensor.



Figure 5. Lower anchor for CSS and identifying emblem

VEHICLE DAMAGE

Exterior Damage - 2002 Ford Taurus

The 2002 Ford Taurus sustained minor damage as a result of the impact with the log truck (**Figure 6**) and was under partial repair at the time of the SCI inspection. The maximum residual crush along the bumper beam was located at the front right corner and measured 5.1 cm (3.0"). The maximum residual crush at the upper radiator support measured 6.4 cm (2.5") and was located on the right corner of the radiator support. The direct contact damage began 43.8 cm (17.3") right of center on the bumper fascia, and extended 29.2 cm (11.5") to the front right corner. The combined direct and induced damage involved the entire frontal width of the Taurus. The bumper fascia was fractured on the right front corner and on the left front aspect. The right front fender was crushed and displaced rearward. The hood was buckled and crushed on the front right aspect, and the head lamp assemblies were removed by the body shop. Longitudinal abrasions were present on the front right corner of the bumper fascia, front right aspect of the hood, and on the right front fender. The right front alloy wheel was also abraded from contact with the truck. The vertical radiator core supports were fractured on both sides from the impact (**Figure 7**), and the upper radiator support was separated from the vehicle. The Collision Deformation Classification (CDC) for the impact with the truck was 01-FREE-5. Six crush measurements were taken along the bumper beam and were as follows: C1 = 0.0 cm, C2 = 0.3 cm (0.1"), C3 = 0.5 cm (0.2") , C4 = 1.0 cm (0.4"), C5 = 2.5 cm (1.0"), C6 = 5.1 cm (3.0").



Figure 6. Damage to 2002 Ford Taurus



Figure 7. Damaged radiator supports

Interior Damage - 2002 Ford Taurus

The 2002 Ford Taurus sustained minor interior damage as a result of occupant contact. The rigid plastic knee bolster was slightly displaced and scuffed from contact with the driver's knees (**Figure 8**). The bottom right aspect of the windshield was fractured from the rearward displacement of the right hood hinge assembly. There was no additional interior damage.



Figure 8. View of displaced and scuffed knee bolster

Exterior Damage - 1995 Freightliner Straight Truck

The 1995 Freightliner straight truck sustained minor damage on the front left aspect of the bumper. There did not appear to be any structural deformation.

MANUAL RESTRAINT SYSTEM - 2002 Ford Taurus

The front seat positions in the 2002 Ford Taurus were equipped with manual 3-point, continuous loop, lap and shoulder belts with sliding latch plates and inertial lock/belt sensitive retractors. The front right lap and shoulder belt was also equipped with a switchable/automatic locking retractor (ALR). Both front manual restraints were configured with buckle pretensioners located on the inboard aspects of the front seat tracks which did not fire in this crash. The driver's adjustable D-ring was in the full-up position and the front right D-ring was 1.9 cm (0.8") below the full-up position at the time of the vehicle inspection. The driver was not restrained by the manual restraint in this crash.



Figure 9. View of creases in the rear right belt webbing

The rear seat positions were equipped with manual 3-point continuous loop lap and shoulder belts with sliding latch plates and inertial lock/belt sensitive retractors. Each rear seat restraint was configured with a switchable/ALR. The rear right manual restraint exhibited four creases in the lap belt portion of the webbing spaced 10.2 cm (4.0") apart and located 19.1 cm (7.5") above the lower anchor (**Figure 9**). These creases did not correlate to any points on the child safety seat, and appear to have been unrelated to this crash.

FRONTAL AIR BAG SYSTEM - 2002 Ford Taurus

The 2002 Ford Taurus was equipped with dual-stage frontal air bags for the driver and front right positions. The driver's air bag was housed in the center of the steering wheel and the front right passenger's air bag was housed in the right upper instrument panel. The frontal air bag system did not deploy in this crash. During the vehicle inspection, the air bag indicator on the instrument panel flashed a code of 42 which corresponded to a front impact severity sensor circuit failure. The front impact severity sensor was reconnected during the vehicle inspection and the flash code was terminated.

CHILD SAFETY SEAT

The Evenflo On My Way Position Right V infant child safety seat (CSS) was installed in the rear right position of the Ford Taurus by the driver. The model number was 4621108P1 and the manufacture date was August 2001. There were no NHTSA recalls associated with this CSS (**Figure 10**). The driver purchased the seat new approximately two months prior to the crash, and stated that the instruction manual was read by her and her husband. At the time of the CSS inspection, the owner's manual and locking clip were present on the rear aspect of the CSS. The infant seat was designed to be used with or without a detachable base. The detachable base was not used to install the CSS in the Taurus, but was installed in the family's other vehicle that was being serviced. The seat was designed for rear-facing use for infants that weighed between 2.3-9.0 kg (5.0-20.0 lb) and were 48.0-66.0 cm (19.0-26.0") in length. The Evenflo infant seat was occupied by 2-month-old male child who weighed 5.0 kg (11.0 lb) and measured 58.4 cm (23.0") in length. The child was within the range of the manufacturer's recommended weight and height limits, outlined in the instruction manual for use of the rear-facing infant seat. The CSS was equipped with a five-point harness system to secure the infant. The CSS was configured with only one set of shoulder harness slots. Original equipment manufacturer (OEM) shoulder pads were present on each shoulder harness and were affixed with velcro closures. The shoulder pads measured 12.7 cm (5.0") in height, 3.8 cm (1.5") in width, and 1.9 cm (0.8") thick around the harness straps.



Figure 10. Evenflo rear facing CSS

There were minor abrasions on the carrying handle and minor abrasions on the plastic shell at the belt path. Scuff marks were also present on the bottom outboard aspects. The harness straps exhibited creases that began 10.2 cm (4.0") and 13.3 cm (5.3") above the bottom aspects on the left and right harness straps, respectively. The creases marks extended upward 26.6 cm (10.5") on the harness system.

The driver had attended an informational CSS event at a local toy store approximately two months before the crash. The event consisted of a demonstration model, literature, and one individual to answer questions, but did not include the inspection or installation of any individual CSS's. This event was not a CSS checkpoint.

The CSS was installed without the base in the rear right position of the Ford Taurus (**Figure 11**). The owner's manual for the rented Taurus was in the glove box, however, it was not consulted by the driver regarding the CSS installation. The driver stated that she installed the seat on the morning of the crash, and noticed that it appeared to be rocking as she backed the vehicle out of the driveway. She stopped the Taurus and evaluated the installation of the CSS. She determined that the manual 3-point lap and shoulder belt was not routed properly through the belt path on the CSS,



Figure 11. Left side view of installed CSS

and corrected the installation based on the labeling present on the CSS. The driver stated that she engaged the automatic locking retractor (ALR) by extending the seat belt webbing all the way out and pulled the webbing tight to secure the CSS. She described the attachment of the CSS to the vehicle as tight. She checked the recline angle and determined that the level indicator on the CSS was in the green area. It should be noted that this CSS was not equipped with a level indicator. The lower left aspect of the CSS exhibited a sticker with a horizontal arrow that pointed to the rear of the vehicle that read: "Place child restraint on vehicle seat so that Position Right line is parallel to the ground." There were no additional objects used to ensure a 45 degree recline angle (**Figure 12**).



Figure 12. Right side view of installed CSS showing sticker with horizontal arrow

The SCI Investigator obtained the CSS during the vehicle inspection and performed repeated installations in the Ford Taurus based on the known crash information at the time. Repeated installation attempts were unsuccessful in obtaining the NHTSA recommended 45 degree recline angle without the use of styrofoam pool noodles or a firmly rolled towel. Without additional objects placed under the CSS, the lowest recline angle obtained by the SCI Investigator was 60 degrees from horizontal (**Figure 13**).



Figure 13. View of inclinometer showing recline angle

OCCUPANT DEMOGRAPHICS - 2002 Ford Taurus

Driver

Age/Sex:	30-year-old female
Height:	163 cm (64")
Weight:	72.6 kg (160 lb)
Seat Track Position:	Between mid-track and full-rear
Manual Restraint Use:	Unrestrained
Usage Source:	Driver interview, police report
Eyewear:	Sunglasses
Type of Medical Treatment:	Did not receive medical treatment

Driver Kinematics

The 30-year-old female driver of the 2002 Ford Taurus was seated in an upright posture with the seat track adjusted between the mid-track and full-rear positions. She was not restrained by the available manual 3-point lap and shoulder belt. She stated that her hands were positioned at approximately the 10 and 2 o'clock positions on the steering wheel rim. At impact, she initiated a forward and slightly lateral trajectory in response to the 1 o'clock direction of force. She contacted the steering wheel rim with her torso which

resulted in a driver-reported left side torso contusion and struck the knee bolster with her knees, evidenced by displacement and scuff marks on the bolster. She rebounded rearward and most likely struck her head on the left door frame or left B-pillar which resulted in a driver-reported headache. She stated that her sunglasses were knocked off her face as a result of the crash.

After the Taurus came to rest, the driver exited the vehicle through the driver's door and attempted to remove the infant from the right rear seat. Due to the fact that the vehicle was a rental, she did not realize that the doors automatically locked upon movement of the vehicle. She attempted to open the right rear door, but it was locked. She noticed that the infant was not breathing, and went back to the driver's door to electronically unlock all of the doors. The driver returned to the right rear door and removed the CSS with the infant still restrained, and observed that the infant was still in respiratory arrest and his lips had become cyanotic. She removed the infant from the CSS and provided a single back blow to him, which resulted in spontaneous respirations.

The driver had a cellular telephone with her and used it to call for help after the crash. The cellular phone was not in use prior to the crash. She refused medical treatment at the scene and accompanied the infant to the regional trauma center.

Rear Right Child Passenger

Age/Sex:	2-month-old male
Height:	58 cm (23")
Weight:	5 kg (11 lb)
Seat Track Position:	Fixed
Restraint Use:	Rear-facing Evenflo infant CSS
Usage Source:	Vehicle inspection, CSS inspection
Eyewear:	None
Type of Medical Treatment:	Transported by helicopter to a regional trauma center

Rear Right Child Passenger

The 2-month-old male right rear passenger was restrained in the Evenflo On My Way Position Right V infant CSS. The rear-facing CSS was installed in the rear right position of the Taurus. Based on the contour of the rear seat cushion, the contour of the CSS, driver interview, and repeated installations by the SCI investigator, it appeared that the CSS recline angle was approximately 60 degrees when it was installed in the Taurus.

The infant was wearing an undershirt, a one-piece fleece garment, a sweater, socks, and a hat. The driver stated that the harness system was holding the infant securely in the seat, and that she could put no more than two fingers between the harness straps and the infant. The harness slots were located below the infant's shoulders and the harness retainer clip was positioned about armpit level.

Pre-crash braking displaced the CSS and infant forward. At impact, the infant and CSS initiated forward

trajectories. The CSS loaded the manual restraint and the infant loaded the rear aspect of the CSS. The infant rebounded forward (toward the rear of the vehicle) and loaded the integrated harness system. Due to the CSS's probable recline angle of 60 degrees, his head flexed forward of his body while seated in the rear-facing CSS. As a result of the young age of the infant and lack of developed neck muscles, he may not have been able to lift his head from the forward position. The position of his head may have occluded his airway which resulted in respiratory arrest.

The infant was removed from the vehicle by the driver, and subsequently removed from the CSS. The driver delivered a single back blow to the infant to stimulate spontaneous respirations. The infant did not have any visible injuries, but was transported by helicopter to a regional trauma center to be evaluated. The child was treated and released. The driver consented to a telephone interview but subsequently failed to provide a medical release for the child's medical records. Despite repeated attempts, official medical records could not be obtained due to loss of cooperation with the family.

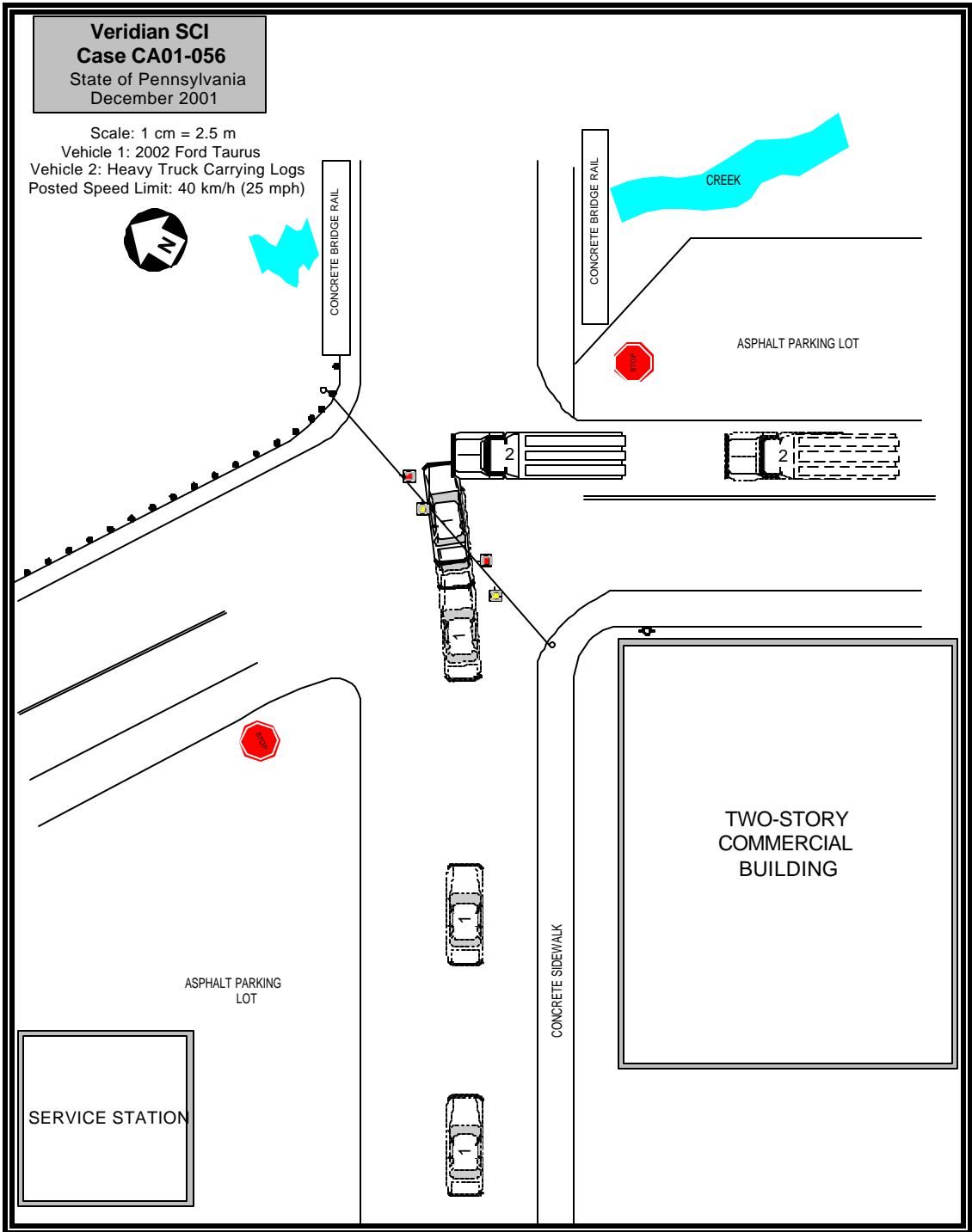


Figure 14. Scene schematic