

CRASH DATA RESEARCH CENTER

Calspan Corporation
Buffalo, NY 14225

**CALSPAN ADULT DRIVER AIR BAG RELATED FATALITY
INVESTIGATION**

CASE NO: CA03-023

VEHICLE: 1999 FORD TAURUS SE

LOCATION: MICHIGAN

CRASH DATE: APRIL 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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BACKGROUND

This remote investigation focused on the severity of the crash and the injury sources that caused the death of a 62-year old male driver of a 1999 Ford Taurus (**Figure 1**). The Taurus was equipped with redesigned frontal air bags for the driver and front right passenger positions that deployed as a result of a frontal crash with the trunk of a large shrub. The unrestrained driver sustained multiple internal injuries of the chest from the deploying air bag. The expanding air bag displaced the driver rearward into the left B-pillar. He sustained multiple head injuries from the B-pillar contact. The driver was removed from the Taurus by emergency medical personnel and transported by ambulance to a local hospital where he expired. The Taurus sustained minor severity frontal and right side damage from impact with the shrub and was towed from the crash site.



Figure 1. 1999 Ford Taurus.

The crash was identified and researched by a University based project. Due to the severity of the driver's injuries and the deployment of the redesigned frontal air bag system, the case was assigned by NHTSA to the Calspan Special Crash Investigations (SCI) team on April 15, 2003 as a remote level investigation. Components of the original investigation were provided to the Calspan SCI team and served as the basis for this report.

SUMMARY

Crash Site

The crash occurred off-road of a three-leg T-intersection on a lawn area of a private residence (**Figure 2**). The Taurus departed the right side of an east/westbound roadway that consisted of four lanes in the area of the intersection. The asphalt road surface was straight and level with a posted speed limit of 72 km/h (45 mph). The crash occurred during daylight hours on dry environmental surfaces. The travel lanes were bordered by concrete curbs with lawn areas extending outboard of the curb lines. The intersecting roadway was surfaced with concrete. There were no active traffic controls for east/westbound traffic flow. A stone driveway intersected the eastbound travel lane,



Figure 2. Eastbound view of the crash site.

east of the intersecting roadway. A large overgrown shrub with multiple trunks and limbs was located east of the driveway. An overgrown hedgerow of various shrubs and small diameter trees extended east of the large shrub and paralleled the roadway.

Vehicle Data

This single vehicle crash involved a 1999 Ford Taurus SE, 4-door sedan. The Taurus was identified by Vehicle Identification Number: 1FAFP53S1XG (production number deleted). The Ford was equipped with a 3.0 liter, transverse mounted V-6 gasoline engine linked to a four-speed automatic transmission with a console mounted shifter. The service brakes were power-assisted front disc/rear drum. The Taurus was equipped with OEM alloy wheels and all-season radial tires.

The interior of the Ford Taurus was equipped with front bucket seats with recline and adjustable head restraints, a fixed center console, and a three-passenger rear bench seat with forward folding seatbacks. The driver's head restraint was adjusted to the full-down position. The seat belt systems consisted of manual 3-point lap and shoulder belts with continuous loop webbing and sliding latch plates for all five seated positions. The front belt systems were equipped with adjustable D-rings. The driver's side D-ring was adjusted to a lower position. Supplemental restraints were provided by the redesigned frontal air bags for the driver and front right passenger positions. Both air bags deployed as a result of the frontal crash with a trunk of the large shrub.

Crash Sequence

Pre-Crash

The 62-year old male driver of the Ford Taurus departed his residence to pick-up a pizza. While returning to his residence, he was traveling in an easterly direction. Reportedly, he stopped the Taurus behind several vehicles for a non-contact vehicle that was initiating a left turn at an intersection located west of the crash site. As traffic started to accelerate, the driver of the Taurus accelerated in an easterly direction on the four lane segment of the roadway. For an unknown reason, the driver of the Taurus allowed the vehicle to drift to the right as it departed the roadway in a tracking mode at the three-leg T-intersection. The Taurus overrode the barrier curb at an area of a storm receiver. At this location, the concrete road surface was tapered to the receiver which exposed a higher curb face. There was no evidence of undercarriage contact to the curb or storm receiver. The Taurus mounted the curb and departed the southeast quadrant of the intersection and traversed the lawn area in a slight, but tracking counterclockwise arc. The vehicle's trajectory was evidenced by rotating tire prints across the lawn area (**Figure 3**). The Taurus traversed a sidewalk and the stone driveway on a departure angle that was approximately 10 degrees from the south road edge. There was no scene evidence to support avoidance maneuvers. The Scene Schematic is included as **Figure 15** at the end of this narrative report.



Figure 3. Rotating tire prints across the lawn area.



Figure 4. Struck shrub and continued trajectory of the Taurus.

Crash

The front right area of the Taurus impacted a large overgrown shrub. The front bumper and hood edge impacted and fractured the trunk as the leading edge of the right front fender simultaneously impacted a second, diagonally oriented limb (**Figure 5**). The resultant directions of force were 12 o'clock for both impacts. This trunk impact resulted in 11 cm (4.3") of crush to the bumper, located approximately 33 cm (13") right of center (**Figure 6**). The bumper impact fractured the trunk from the shrub cluster. The Taurus continued forward as the right side of the vehicle remained engaged with the limb resulting in sideswipe-type damage to the entire length of the right side of the vehicle.



Figure 3. Frontal and right side damage to the Taurus.



Figure 4. Lateral view depicting the depth of frontal crush.

The Taurus continued forward and traveled into a hedgerow. The left aspect of the windshield and the left outside side view mirror were fractured from contact with branches within the hedgerow.

The Taurus came to rest in the hedgerow, approximately 8 m (25') east of the initial point of impact. Glass fragments from the shattered left front door glazing evidenced the final rest position. The Ford Taurus was not equipped with an Event Data Recorder (EDR) to support impact events. The initial bumper engagement against the trunk of the shrub probably resulted in a sufficient longitudinal deceleration to deploy the Taurus' redesigned frontal air bag system. The barrier-only algorithm of the WinSMASH program computed a total velocity change of 13 km/h (8.1mph).

Post-Crash

The driver of the Taurus was critically injured by the deploying driver's air bag and subsequent contact with the interior of the vehicle. Passing motorists alerted emergency personnel of the crash. Police and ambulance personnel responded to the crash scene. The driver was removed from the Taurus and transported by ambulance to a local hospital where he expired. The Taurus sustained minor severity damage and was towed from the crash scene.

Vehicle Damage

Exterior – 1999 Ford Taurus

The Ford Taurus sustained minor severity damage to the front and right side areas from the simultaneous impacts with the shrub cluster. Additionally, the right front alloy wheel was fractured with a cut of the tire's sidewall that was associated with the run-off-road crash.

The initial impact with the trunk of the shrub resulted in damage to the front right bumper system. The area of deformation began approximately 13 cm (5") right of center and extended 38 cm (15") to the right turn signal assembly. The maximum crush from this impact was 11 cm (4.3"). The damage involved the fascia, bumper beam, and the hood edge (**Figure 7**). The crush profile at bumper level was as follows: C1 = 0 cm, C2 = 0 cm, C3 = 1 cm (0.4"), C4 = 5 cm (2"), C5 = 7 cm (3"), C6 = 1 cm (0.4"). This event was assigned a Collision Deformation Classification (CDC) of 12-FZEN-1.



Figure 7. Overhead view of the frontal crush depth.



Figure 8. Right front fender sideswipe damage.

The Taurus' continuous engagement with the limb of the large shrub involved the right side area as the Taurus continued on a forward trajectory. This contact produced a series of dents to the top aspect of the fender with abrasions. The contact damage extended rearward and involved the upper right A-pillar, B-pillar, and the right side rear view mirror. The mirror was fractured from its mount. Abrasions and isolated dents were also noted to the right side surface of the Taurus that extended the full length of the vehicle (**Figure 8**). This continuous impact was assigned a CDC of 12-RDAS-9.

The left outside side view mirror was fractured as the vehicle entered the hedge row. In addition, the left aspect of the windshield was fractured from contact with branches within the hedge row. Debris from this engagement was present along the wiper tray of the Taurus. The CDC for this event was 12-FLHE-6.

Interior – 1999 Ford Taurus

The interior of the Ford Taurus sustained minor severity interior damage that was associated with air bag deployment and driver contact. There was no intrusion of the passenger compartment.

The frontal air bag system deployed as designed from the respective module assemblies. The driver air bag deployed from a steering wheel mounted module that was concealed by H-configuration cover flaps. There was no contact evidence or damage to the cover flaps. A vertically oriented stain was located on the both flaps left of center and was considered to be related to a previous event since it involved both flaps. The cruise control buttons were positioned adjacent to the cover flaps and were not damaged by the deployment. The expanding air bag membrane displaced the driver's left hand into the windshield. This fling contact fractured the laminated glazing in the upper left corner. Two apparent contacts occurred to this area of the glazing; one from exterior contact and the second from the fling contact.

The driver was impacted by the expanding air bag membrane. Although he was presumed to be in close proximity to the air bag module at deployment, there was no apparent deflection of the upper steering wheel rim and no visible compression of the energy absorbing steering column (**Figure 9**).



Figure 9. Profile view of the undeformed steering system.

The driver rebounded into the left B-pillar at the juncture of the roof side rail. A body fluid transfer evidenced the contact point; however, there was no damage to the plastic trim panel of the pillar. Also noted in the supplied images of the Taurus was a small disruption of the headliner fabric at the inboard edge of the left sun visor.

The front right passenger air bag deployed from a top mounted air bag module. The single tethered cover flap impacted the windshield, fracturing the glass in the area above the flap. The leading edge of the flap was abraded from glazing contact. The expanding front right air bag probably contacted the rear view mirror and displaced the mirror to the left. The left side of the mirror housing impacted and fractured the glazing.

Manual Restraint Systems

The Taurus was equipped with 3-point lap and shoulder belt systems for the five seated positions. The four outboard systems utilized continuous loop webbing with sliding latch plates. The driver's belt system utilized an Emergency Locking Retractor (ELR) while

the remaining retractors were equipped with ELR/Automatic Locking Retractor feature for use with child safety seats. The front belt systems were equipped with adjustable D-rings. Based on the supplied images, the driver's D-ring was adjusted to a lower position. There was no evidence visible on the belt system to support usage in this crash.

Frontal Air Bag System

The Taurus was equipped with a redesigned frontal air bag system for the driver and front right positions. The air bag system deployed as a result of the impact sequence with the large shrub. The system consisted of a single point sensing and diagnostic module that was mounted to the floor within the passenger compartment under the center instrument panel.

The driver air bag was concealed by asymmetrical H-configuration module cover flaps (**Figure 10**). The upper flap was approximately 8 cm (3") in height by 15 cm (6") in width at the horizontal tear seam. The deployed air bag membrane was tethered internally and was vented by two ports located at the 12 o'clock sector of the bag, forward of the peripheral seam. There was no damage to the air bag; however, several body fluid (blood) transfers were present on the face of the bag (**Figure 11**).



Figure 10. Driver air bag module cover flaps.



Figure 11. Deployed driver's redesigned frontal air bag.

The front right passenger air bag was concealed by a single cover flap on the top of the right instrument panel. The cover flap opened in a forward direction and completely disengaged from the instrument panel. The flap was tethered to the module assembly by two straps. This design results in flap contact to the windshield. As a result of windshield contact, the glazing was fractured above the area of the passenger air bag module. The leading edge of the cover flap was abraded from the windshield contact. The cover flap measured approximately 40 cm (16") in width and 25 cm (10") in depth.

The front right passenger air bag membrane was not tethered internally; however, the bag was vented by two large diameter vent ports that were located laterally at the 3 and 9 o'clock sectors of the bag. In its deflated state, the air bag measured approximately 43 cm (17") vertically by 53 cm (21") laterally. The front right air bag membrane was not damaged and did not yield evidence of occupant contact.

Driver Demographics

Age/Sex: 62-year old/Male
 Height: 173 cm (68")
 Weight: 110 kg (241 lb)
 Manual Restraint
 Use: None:
 Usage Source: Observations of first responders, vehicle inspection
 Seat Track Position: Rear track
 Mode of Transport
 from Scene: Ambulance
 Type of Medical
 Treatment: Transported to a local hospital where he expired on arrival

Driver Injuries

Injury	Injury Severity (AIS 90 Update 98)	Injury Source
Uncal and tonsillar herniations	Critical (140202.5,8)	Left B-pillar
Massive cerebral edema	Severe (140608.4,9)	Left B-pillar
Horseshoe shaped depressed skull fracture of the left frontal area (1) that extends inferiorly to the base of the skull across the left and right sphenoid ridges (2)	1-Severe (150406.4,6) 2-Serious (150200.3,8)	Left B-pillar
Cerebral lacerations of the left temporal and frontal lobes	Severe (140688.4,2)	Left B-pillar
Severe cerebral contusions of the left temporal and frontal lobes, and right temporal lobe	Severe (140624.4,3)	Left B-pillar
Subarachnoid hemorrhage	Serious (140684.3,9)	Left B-pillar
Left and right intraventricular hemorrhage	Severe (140629.4,1; 140629.4,2)	Left B-pillar
Fracture of left ribs 4,5,9-11 w/pneumothorax	Severe (450232.4,2)	Expanding front left air bag
Extensive left side subgaleal hematoma	Minor (190402.1,2)	Left B-pillar
Contusions of the mid chest	Minor (490402.1,4)	Expanding front left air bag
Abrasion right forearm	Minor (790202.1,1)	Expanding front left air bag
Abrasions of the left lateral flank	Minor (590202.1,2)	Left B-pillar

Injury	Injury Severity (AIS 90 Update 98)	Injury Source
Contusion of the left forearm	Minor (790402.1,2)	Expanding front left air bag
Abrasion of the left dorsal hand	Minor (790202.1,2)	Windshield

Source – Autopsy Report

Driver Kinematics

The 62-year old male driver of the 1999 Ford Taurus was seated in a rear track position and was not restrained by the manual 3-point lap and shoulder belt system. The lack of belt usage was supported by the vehicle inspection and from observations of the first responders to the crash site. Prior to impact, the driver possibly experienced a medical episode which could have resulted in his loss of directional control of the vehicle and the subsequent lateral drift off the right road edge. Additionally, the driver was out of position forward, within the deployment path of the expanding redesigned front left air bag (**Figure 12**). Based on injury data, the driver had both hands positioned on the steering wheel rim.



Figure 12. Initial trajectory of the unrestrained driver.

The initial impact with the large shrub resulted in deployment of the redesigned frontal air bag system. The driver's air bag membrane expanded from the asymmetrical module cover flaps and impacted the driver's chest resulting in a mid chest contusion and fractures of the left ribs with pneumothorax.

The continued expansion of the air bag engaged the anterior aspect of the driver's forearms. His left arm flung in an upward direction which resulted in his left hand impacting the windshield forward and left of his position. This contact fractured the laminated glass and resulted in an abrasion of the dorsal left hand. The driver also sustained a contusion of the left forearm from either air bag expansion or contact with the upper left A-pillar. There was no contact evidence to support the A-pillar contact. The driver sustained a right forearm abrasion from the air bag expansion.

The driver's head and upper body was displaced upward and to the left with respect to the vehicle by the expanding air bag. A contact point attributed to the driver's head was noted at the upper aspect of the left B-pillar at its juncture with the roof side rail. This was evidenced by a bloody transfer; although, there was no associative damage to the plastic panel (**Figures 13 and 14**). The adjustable D-ring hardware that was located below plastic panel was free of contact evidence and damage as well.



Figure 13. Left B-pillar of the Ford Taurus.



Figure 14. Head strike to the upper left B-pillar.

The driver sustained a horseshoe-shaped fracture of skull that involved a depressed left frontal skull fracture with a 3 cm basilar skull fracture, extending across the left and right sphenoid ridges. A fracture line was noted to originate in the left frontal region and extend anteriorly and inferiorly. These fractures resulted from the driver's head contact with the left B-pillar as he was displaced by the expanding air bag. Underlying injuries of the brain included uncal and tonsilar herniations, massive cerebral edema generalized subarachnoid hemorrhage, bilateral contusions, left and right intraventricular hemorrhage, and lacerations of the left temporal and frontal lobes.

Additionally, the driver sustained an abrasion of the left flank that resulted from probable contact with the left B-pillar during his rearward trajectory that was induced by the deployment sequence.

Medical Treatment

The driver was removed from the Taurus by rescue personnel and transported by ambulance to a local hospital where he expired. An autopsy was performed on the body which provided the detail of his injuries. The driver's multiple severe level injuries were the direct result of the expanding front left air bag.

Figure 15 – Scene Schematic

