

TRANSPORTATION SCIENCES
Crash Research Section

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CALSPAN ON-SITE REDESIGNED AIR BAG INVESTIGATION
CALSPAN CASE NO. CA97-51
VEHICLE: 1998 FORD TAURUS SE
LOCATION: STATE OF PENNSYLVANIA
CRASH DATE: NOVEMBER 1997

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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. <i>Abstract</i> <p>This investigation focused on the performance of the deployed redesigned frontal air bag system in a 1998 Ford Taurus SE, 4-door sedan. This deployment crash occurred as the driver of the Taurus entered a 4-leg intersection and impacted the left front fender area of a 1995 Mercury Tracer in an "L"-configuration impact sequence. The crash severity was minor with velocity changes estimated in the 16-18 km/h (10-12 mph) range. The L-configuration impact resulted in opposing post-crash deflections of the vehicles which caused a secondary sideslap impact. Both vehicles departed the northwest quadrant of the intersection and struck fixed objects as they came to rest. The latter frontal impacts were minor in severity and were not injury producing events. The driver of the Taurus was not wearing the manual belt system. He initially loaded the deployed redesigned front left air bag which protected the driver from probable contact against the steering assembly. He was not injured as a result of the crash.</p>			
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BACKGROUND

This investigation focused on the performance of the deployed redesigned frontal air bag system in a 1998 Ford Taurus SE (**Figure 1**), 4-door sedan. This deployment crash occurred as the driver of the Taurus entered a 4-leg intersection and impacted the left front fender area of a 1995 Mercury Tracer in an “L”-configuration impact sequence. The crash severity was minor with velocity changes estimated in the 16-18 km/h (10-12 mph) range. The L-configuration impact resulted in opposing post-crash deflections of the vehicles which caused a secondary sideslap impact. Both vehicles departed the northwest quadrant of the intersection and struck fixed objects as they came to rest. The latter frontal impacts were minor in severity and were not injury producing events. The driver of the Taurus was not wearing the manual belt system. He initially loaded the deployed redesigned front left air bag which protected the driver from probable contact against the steering assembly. He was not injured as a result of the crash.



Figure 1. Frontal view of the 1998 Ford Taurus.

NHTSA was initially notified of this redesigned air bag crash by Primary Sampling Unit (PSU) 05 in Philadelphia, Pennsylvania and subsequently assigned the case to the Special Crash Investigation Team at Calspan on Tuesday, December 30, 1997. An on-site investigation was conducted on January 5-6, 1998. Directives from the COTR included an in-depth examination of the 1998 Ford Taurus, an exterior damage profile of the Mercury Tracer, documentation of the crash scene, and interviews with the involved parties.

SUMMARY

Crash Site

The crash occurred during the morning daylight hours at a city 4-leg intersection of two one-way streets that were bordered by 16.5 cm. (6.5 in) concrete barrier curbs and sidewalks. Both streets had designated parking lanes adjacent to the right curblines. An “L”-shaped granite wall adjacent to a building was located on the sidewalk area at the northwest corner of the intersection. In addition, there was a fire hydrant, sign post, and a traffic light pole on the respective corner of the sidewalk (**Figure 1**). Atmospheric conditions were rainy and the level asphalt road surface was wet. The intersection was controlled by overhead signals with a posted speed limit of 40 km/h (25 mph).

Vehicle Data

The 1998 Ford Taurus, 4-door sedan, was manufactured in 11/97 and was identified by vehicle identification number (V.I.N.) 1FAFP52U8WA (production number omitted). The fourth character (F) of the V.I.N. identified the redesigned frontal air bag system. In addition, labels were affixed to the lower rear aspect of the left front and right front door window glazing (**Figure 3**), adjacent to the “B”-pillar, identified that the vehicle was equipped with “SECOND GENERATION AIR BAGS”.

The Taurus was a rental vehicle and was a short term rental by the out-of-state driver. The Taurus was equipped with a 3.0 liter, V-6 transverse mounted engine linked to a four-speed automatic overdrive transmission, power-assisted rack-and-pinion steering and power-assisted front disc/rear drum brakes without ABS (anti-lock). The interior was configured with front bucket seats with a flip and fold center armrest that converted into a center seat position and a rear bench seat. Power accessories included windows, door locks, and outside rear view mirrors. The four outboard seated positions were equipped with manual 3-point lap and shoulder belt systems with height adjusters for the front positions. The front center position was equipped with a lap belt while the center rear position was equipped with a 4-point system. The odometer reading at the time of the SCI inspection was 6,442 kilometers (4,003 miles).

Crash Sequence

Pre-Crash

The driver of the 1998 Ford Taurus was traveling northbound on a one-lane, one-way street on an approach to a four-leg intersection. His intent was to travel through the 4-leg intersection and continue in a northerly direction. The driver of the Mercury Tracer was operating the vehicle in a westbound direction on a two-lane, one-way street, also with the intent of traveling through the intersection to continue



Figure 2. View from the initial impact location to the northwest quadrant of the intersection.



Figure 3. “SECOND GENERATION AIR BAG” label affixed to the right front door glazing.

SUMMARY (continued)

westbound. It should be noted that traffic flow through the intersection was controlled by an overhead signal system and that both drivers claimed to have a green signal phase. There was no evidence of pre-crash braking (e.g. skid marks) at the scene of the crash to support avoidance actions by either of the involved drivers.

Crash

The Ford Taurus and the Mercury Tracer simultaneously entered the intersection on driver alleged green signal phases. The front right corner area of the Taurus impacted the left front fender area of the Tracer in an L-configuration impact sequence. Resultant directions of force were within the 1 o'clock sector for the Taurus and 10 o'clock for the struck Mercury Tracer. The corner engagement was outside the scope of the WinSMASH reconstruction program, therefore the velocity change was estimated as 16-18 km/h (10-12 mph) for the Taurus. This impact initiated the deployment sequence of the Taurus' redesigned frontal air bag system. The vehicles began to rotate in opposing directions which allowed the right front fender of the Taurus to contact the corner of the Tracer in a continuous engagement, resulting in sheet metal crush.

This impact displaced the Ford Taurus in a counterclockwise direction as the Tracer rotated in a clockwise direction. The vehicles subsequently impacted in a sideslap configuration involving the right rear side area of the Taurus and the left rear side area of the Tracer. Resultant directions of force were 3 and 9 o'clock for the Taurus and Tracer respectively. Velocity changes were computed by the damage algorithm of the WinSMASH program at 10.1 km/h (6.3 mph) for the Taurus with a lateral component of -9.9 km/h (6.2 mph) and 13.8 km/h (8.6 mph) for the Mercury Tracer.

The vehicles separated from the sideslap sequence and departed the northwest quadrant of the intersection, mounting the barrier curbs. The front left bumper area of the Ford Taurus impacted a traffic light pole resulting in minor contact damage to the vehicle. The Tracer impacted the corner of a barrier wall with the front left area. Both vehicles came to rest against the struck objects.

Post-Crash

The Taurus came to rest facing in a northwesterly direction with the front of the vehicle resting on the sidewalk and its center of gravity straddling the north curbline. The driver of the Taurus exited the vehicle unassisted and waited for police assistance. He was not injured and refused medical attention.

The Tracer came to rest in a similar attitude to the Taurus, completely blocking the sidewalk at the apex of the northwest quadrant of the intersection. All occupants of the Tracer exited the vehicle unassisted and were transported to a local hospital where they were treated for minor injuries and released. Both vehicles were towed from the scene due to damage.

VEHICLE DAMAGE

Ford Taurus - Exterior

The initial frontal impact sequence resulted in direct contact damage to the front bumper fascia of the Taurus which began 45 cm (18 in) right of the center and extended 23 cm (9 in) to the right (**Figure 4**). Maximum crush was located at the front right bumper corner which yielded 7.5 cm (3.0 in) of residual crush. As the vehicle's began to rotate, the right front fender of the Taurus engaged against the corner aspect of the Tracer resulting in contact damage to the fender. This contact damage extended 43 cm (17 in) rearward of the corner with 7.6 cm (3.0") of sheet metal crush. The damage resulted in a 1 o'clock direction of force with a Collision Deformation Classification (CDC) of 01-FREE-2.



Figure 4. Initial front right corner impact damage to the Ford Taurus.

The initial impact induced a counterclockwise rotation to the Taurus and clockwise rotation to the Tracer which resulted in a sideslap impact involving the right rear passenger compartment and quarter panel of the Taurus (**Figure 5**) against the left rear quarter panel of the Tracer. The secondary impact to the Taurus generated direct contact damage that began 42.0 cm (16.5 in) forward of the right rear axle and extended forward 159.0 cm (62.6 in). Maximum crush was 22.0 cm (8.7 in) located 89.6 cm forward of the right rear bumper. This impact resulted in a 3 o'clock direction of force with a CDC of 03-RZEW-2.



Figure 5. Sideslap damage to the right rear side of the Taurus.

The Taurus' impact with the base of a traffic light pole involved the lower aspect of the front left bumper. The direct contact damage began 12.0 cm (5.7 in) inboard of the corner and extended 29.0 cm (11.4 in) to the right. There was no residual crush from this third impact event. This impact resulted in a 12 o'clock direction of force with a CDC of 12-FYLN-1.

Ford Taurus - Interior

The interior of the Ford Taurus sustained damage that was associated with air bag deployment and driver contact with interior components. There was no intrusion of the passenger compartment. The deployment of the front right passenger air bag resulted in extensive damage to the windshield. The module cover flap impacted and fractured the laminate glazing, displacing the glazing in an outward direction. This damage was normal during this deployment.

The driver was unrestrained during this multiple event crash sequence. He initially contacted the center flip and fold armrest which abraded the padded component. His right hand/arm contacted and displaced the rearview mirror to the right. There was no damage to the mirror glass. His continued lateral trajectory resulted in a tissue transfer to the face of the front right air bag. Although not injury producing, the transfer did track his trajectory during the crash event.

VEHICLE DAMAGE (continued)

Mercury Tracer - Exterior

The left front damage that resulted from the initial impact with the Taurus produced approximately 27.0 cm (10.6 in) of lateral crush. The direct contact damage began 277 cm (109 in) forward of the left rear axle and extended an additional 31 cm (12 in) forward to the front bumper corner. The damage resulted in an 10 o'clock direction of force with a CDC of 10-LFEE-2 (**Figure 7**). The estimated delta V for this impact was 12-16 kph (8-10 mph).

The secondary sideslap impact to the Tracer generated direct contact damage that began at the left rear bumper corner and extended forward 96 cm (38 in). Maximum crush was located 60 cm (24 in) forward of the left rear bumper corner and yielded 12 cm (5 in) of residual crush. This impact resulted in a 9 o'clock direction of force with a CDC of 09-LBEW-2.

The front left bumper area of the Tracer impacted the barrier wall as the vehicle came to rest off-road. The CDC for this impact was 12-FLEN-1.



Figure 6. Initial impact damage to the left front side area of the Mercury Tracer.



Figure 7. Sideslap damage to the left rear of the Tracer.

AUTOMATIC RESTRAINT SYSTEM

Ford Taurus

The 1998 Ford Taurus was equipped with a Supplemental Restraint System (SRS) that consisted of redesigned frontal air bags for the driver and right passenger positions. In addition to the air bag modules, the SRS included two front mounted crash sensors, a safing sensor, and electronic control module, and a instrument panel mounted indicator lamp.

The front left air bag module was concealed within a four-spoke steering wheel rim that deployed from symmetrical H-configuration module cover flaps. The upper portion of the air bag cover flap displayed the word "FORD" and the lower portion of the flap displayed the acronym "SRS". The deployed front left air bag was 66 cm (26 in) in diameter in its deflated state. The bag was tethered by two wide-band internal tether straps located at the 3 and 9 o'clock positions. Two 2.0 cm (0.8 in) diameter vent ports were located at the 11 and 1 o'clock positions. Maximum rearward excursion of the front left air bag was 33

AUTOMATIC RESTRAINT SYSTEM (continued)

cm (13 in) from the spoke face of the steering wheel. There was no contact evidence on the air bag, however, bilateral gray vinyl transfers were noted on the face of the air bag at the 3 and 9 o'clock positions. These transfers were the result of air bag expansion against the interior of the air bag module cover flap during the initial deployment sequence of the air bag.

The front right air bag deployed from a top-mounted module assembly that was incorporated within the upper right instrument panel. The single cover flap was hinged at the forward edge (with respect to the vehicle) and opened in an upward direction toward the windshield to deploy the air bag. The cover flap was vinyl skinned and reinforced with sheet metal backer panel. The air bag module cover flap was irregular in shape and measured 29.0 cm (11.4 in) in width and 43 cm (17 in) in length at the widest aspect. The top of the flap was abraded from contact against the windshield (fractured) that resulted from the deployment sequence. The flap was tethered by two fabric tethers affixed to the inside aspect of the air bag module. The air bag membrane was tethered by a single wide-band internal tether strap located at the top aspect of the face of the air bag. Two vent ports were located at the 3 and 9 o'clock positions and measured 5.0 cm (2.5 in) in diameter. Overall dimensions of the bag were 58 cm (21 in) in width and 57.0 cm (22.4 in) in height. Maximum rearward excursion of the front right air bag was 45 cm (18 in) from the mid instrument panel.

Contact evidence on the front right air bag consisted of a tissue transfer to the face of the bag which resulted from driver contact as he was displaced laterally by the initial and subsequent sideslap. The top aspect of the air bag, nearest to the air bag module, exhibited gray transfers that resulted from the expansion of the air bag against the interior of the air bag module cover flap during the deployment sequence of the air bag. There was no damage to the bag (e.g. tears, perforations).

DRIVER DEMOGRAPHICS

Ford Taurus

Age/Sex: 36 year old male
Height/Weight: Unknown
Manual Restraint
Use: None
Usage Source: Vehicle inspection
Medical Treatment: None

DRIVER INJURIES

Injury	Injury Severity (AIS 90)	Injury Mechanisms
Not injured	N/A	N/A

DRIVER KINEMATICS

The driver of the Ford Taurus was seated in a mid track position with the seat back reclined to an angle of 17 degrees. He was not wearing the manual 3-point lap and shoulder belt system. The initial frontal impact sequence deployed the redesigned frontal air bag system. The driver responded to the 1 o'clock direction of force by moving forward and laterally to his right. He initially contacted the deployed redesigned front left air bag with his face and chest. The air bag protected the driver from contact against the steering assembly and possible injury (**Figure 8**).



Figure 8. Profile view of the driver's trajectory and the deployed front left air bag.

The lateral component of his trajectory was amplified by the counterclockwise rotation of the vehicle and the subsequent sideslap.

The driver contacted the folding center armrest with the lateral aspect of his right thigh that was evidenced by abrasions to the hinged component. His right hand/forearm probably contacted the rear view mirror which displaced the mirror to the right. A tissue transfer was noted to the face of the front right air bag that resulted from contact with the driver's face or arm as he continued laterally to the right in response to the sideslap impact.

The driver was displaced in a forward direction as the vehicle impacted the pole at the northwest quadrant of the intersection. Although no additional contact points were visible from this event, he may have loaded a partially deflated front left air bag which offered minimal protection against the low severity crash forces.

The driver of the Taurus was injured as a result of the crash and refused medical attention at the scene. The investigating police officer transported the driver to his destination following the on-scene investigation.

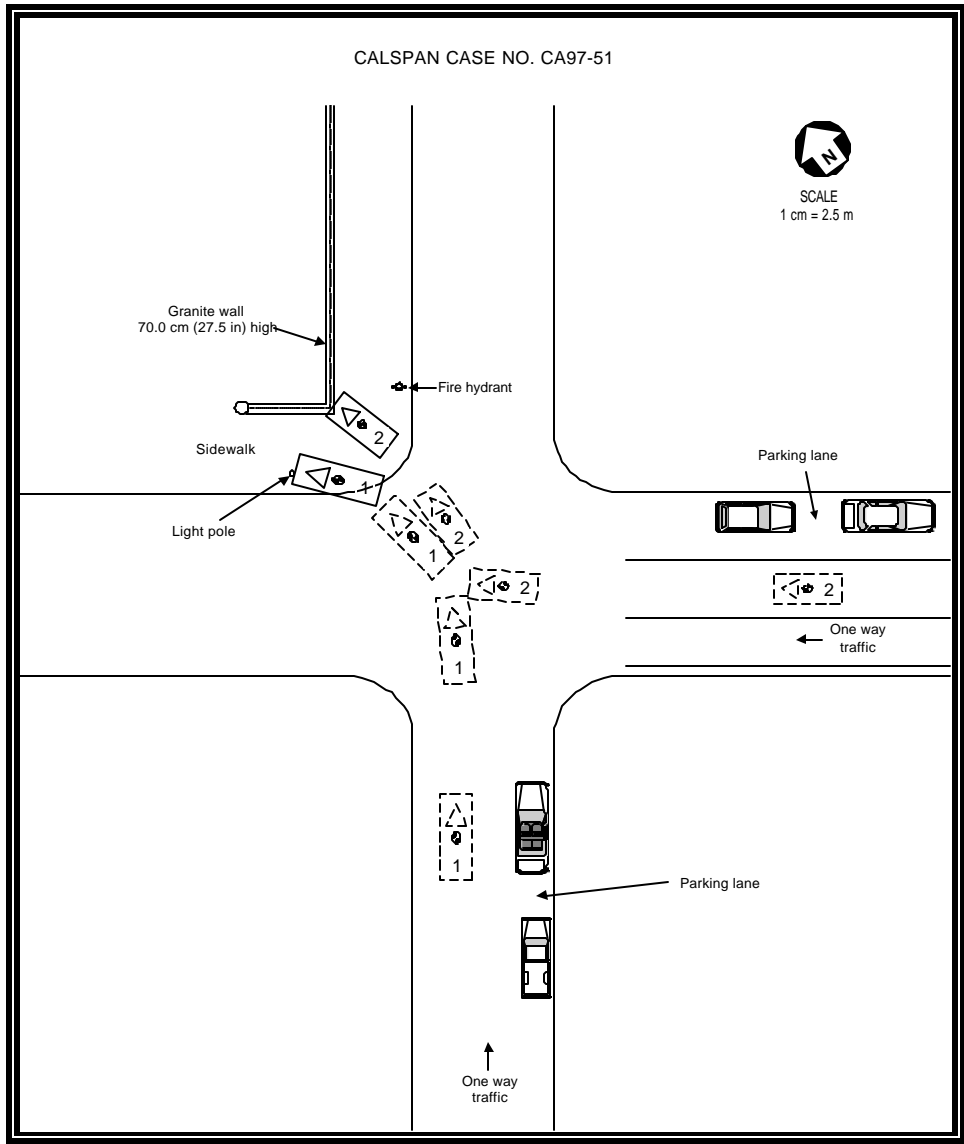


Figure 9. Crash Schematic.