TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

Calspan Corporation
Buffalo, New York 14225

CALSPAN ON-SITE DEPOWERED AIR BAG DEPLOYMENT INVESTIGATION

CALSPAN CASE NO. CA98-012

SUBJECT VEHICLE - 1998 PONTIAC SUNFIRE

LOCATION - STATE OF NEW YORK

CRASH DATE - FEBRUARY, 1998

Contract No. DTNH22-94-D-07058

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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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An on-site investigation of an intersection type crash which involved the frontal plane of a 1998 Pontiac Sunfire and the right side of a 1993 Ford Taurus, 4-door station wagon in a turn across path configuration. The impact resulted in the deployment of the Pontiac's depowered air bag system. The restrained female driver of the Pontiac sustained a nose abrasion (AIS-1), bilateral knee contusions (AIS-1), and lumbar strain (AIS-1) from the crash sequence.

16. *Abstract*

This crash investigation focused on the depowered front driver and front right air bag system of a 1998 Pontiac Sunfire, 4-door sedan, which was involved in a moderate severity intersection-type crash with a 1993 Ford Taurus, 4-door station wagon. The driver of the Taurus initiated a left turn at a four-leg intersection and impacted its right fender with the frontal plane of the Sunfire. This impact initiated the deployment sequence of the Sunfire's depowered air bag system. The vehicles rotated counter-clockwise (CCW) and the front left bumper fascia of the Sunfire contacted the right rear area of the Taurus in a sideslap-type impact which resulted in minor damage to the involved vehicles. The Sunfire was occupied by an unrestrained 64 year old female driver. She sustained minor injuries as a result of the crash which included a nose abrasion (AIS-1), bilateral knee contusions (AIS-1), and lumber strain (AIS-1). She was transported to a local hospital via ambulance for treatment and subsequently released. The Taurus was occupied by a 70 year old restrained female driver who sustained a mid chest contusion (AIS-1) and a fractured sternum (AIS-2) during the crash sequence. She was also transported to a local hospital where she was treated and released.

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Background

This crash investigation focused on the depowered front driver and front right air bag system of a 1998 Pontiac Sunfire, 4-door sedan, which was involved in a moderate severity intersection-type crash with a 1993 Ford Taurus, 4-door station wagon. The driver of the Taurus initiated a left turn at a four-leg intersection and impacted its right fender with the frontal plane of the Sunfire. This impact initiated the deployment sequence of the Sunfire's depowered air bag system. The vehicles rotated counter-clockwise (CCW) and the front left bumper fascia of the Sunfire contacted the right rear area of the Taurus in a sideslap-type impact which resulted in minor damage to the involved vehicles. The Sunfire was occupied by an unrestrained 64 year old female driver. She sustained minor injuries as a result of the crash which included a nose abrasion (AIS-1), bilateral knee contusions (AIS-1), and lumber strain (AIS-1). She was transported to a local hospital via ambulance for treatment and subsequently released. The Taurus was occupied by a 70 year old restrained female driver who sustained a mid chest contusion (AIS-1) and a fractured sternum (AIS-2) during the crash sequence. She was also transported to a local hospital where she was treated and released.

The involved Ford Taurus was a participant vehicle in Calspan's Automated Collision Notification (ACN) program sponsored by the NHTSA. The crash was reported to Calspan on February 18, 1998 via ACN channels and the Special Crash Investigations COTR was notified of the depowered status of the involved Sunfire's air bag system. An on-site investigation was subsequently assigned to Calspan's Special Crash Investigation team on February 19, 1998. The investigation was initiated on February 19, however, inspection of the Sunfire was delayed four months due to litigation.

Summary

This crash occurred during the early afternoon hours in an urban four-leg intersection which was controlled by an overhead signal. The posted speed limit was 48 km/h (30 mph) for north and southbound travel lanes and the asphalt roadway was dry with a three percent grade, negative to the south. Traffic flow at the time of the crash was moderate to heavy. **Figure 1** identifies an overall view of the crash scene.

Figure 1. Overview of the crash scene.

The 1998 Pontiac Sunfire, 4-door sedan, was identified by vehicle identification number (V.I.N.) 1G2JB524XW2 (production sequence omitted) and was placed in a rental fleet after its 10/97 manufacture date. The odometer read 9,290 kilometers (5,773 miles) at the time of inspection. The vehicle

was equipped with a Supplemental Restraint System (SRS) which consisted of a depowered front driver and front right air bag system. Three-point manual lap and shoulder belt systems with height adjusters were available for the front outboard seated positions. The second seat outboard positions were equipped with 3-point manual lap and shoulder belt systems and the second center seat was equipped with a manual lap belt. The Sunfire was also equipped with an anti-lock braking system (ABS).

The 1993 Ford Taurus, 4-door station wagon, was identified by vehicle identification number (V.I.N.) 1FALP5743PG (production number omitted) and had 121,445 kilometers (75,465 miles) at the time of inspection. The Taurus was equipped with a front driver and front right air bag system which did not deploy as a result of the crash. Three-point manual lap and shoulder belt systems were available for the four outboard seated positions and the front and rear center seated positions were equipped with a lap belt system. The in-vehicle components of the ACN unit consisted of the in-vehicle module (IVM), cellular phone transceiver, cellular phone antenna, cellular phone handset, backup battery, and the Global Positioning System (GPS) antenna. The IVM (alpha numeric identification: 92325ASSY01308102REVBS/N00346), backup battery, and cellular phone transceiver were properly secured to the floor, located under the back bench seat cushion of the Taurus (**Figure 2**). Software version 1.00 was installed for the IVM. The cellular phone handset was mounted in the front center floor position and its antenna was located on the upper left corner of the right rear most window's fixed glazing. The GPS antenna was mounted adjacent to the left rear seat back and behind the C-pillar on the interior beltline of the vehicle. An identification label was adhered to the lower left corner of the left rear most window's glazing which identified the vehicle as equipped with crash instrumentation and noted the identification number of the in-vehicle ACN unit (00346).

Figure 2. View of the installed position of the ACN unit's IVM, backup battery, and cellular phone transceiver.

Crash Events

The Ford Taurus was traveling southbound in the left turn lane of a five lane undivided urban roadway. The Pontiac Sunfire was traveling northbound on the same roadway in the center lane. The overhead signal system which controlled the intersection was in the green phase for north/southbound travel. The driver of the Sunfire indicated that a van was traveling in the northbound left turn lane which obstructed her vision of the southbound lanes and presumably obstructed the Taurus driver's view of the northbound lanes. The driver of the Taurus initiated a left turn onto an intersecting three-lane undivided roadway as the Sunfire entered the intersection with the intent to travel through it. Pre-impact braking marks were not evidenced from the ABS equipped Sunfire and the driver did not recall initiating braking actions pre-impact. Damage sustained by the vehicle, however, indicated that the driver took avoidance action to the crash by swerving left. This maneuver was confirmed by the Sunfire's driver. The frontal plane of the Sunfire impacted the right fender and right front door of the Taurus. This impact initiated the deployment sequence of the Sunfire's air bag system and recognition of the crash by the Taurus' ACN system. The WinSMASH program calculated the total delta V for the Sunfire at 24.2 km/h (15.0 mph) and 17.2 km/h (10.7 mph)

for the Taurus. The ACN crash instrumentation onboard the Taurus calculated the total delta V for the Taurus at 22.5 km/h (14.0 mph).

The vehicles rotated CCW and disengaged. The front left plane of the Sunfire then contacted the right rear quarter panel and wheel cover of the Taurus. The Sunfire and Taurus sustained estimated delta Vs of 4.8 km/h (3.0 mph) and 4.8 km/h (3.0 mph), respectively. The vehicles came to final rest in the northeast quadrant of the intersection and were towed from the crash scene due to police reported disabling damage.

Exterior Vehicle Damage

The Pontiac Sunfire sustained moderate damage to its frontal plane resultant of its initial impact with the Taurus. Direct contact damage began at the front right bumper corner and extended 93.3 cm (36.7 in) to the left. The bumper fascia was separated from the vehicle's reinforcement bar and direct damage was located vertically from the lower bumper fascia to the right aspect of the hood face. Maximum crush was measured at 37 cm (14.6 in) at the bumper reinforcement bar and was located 10.5 cm (4.1 in) right of the vehicle's center. The damage resulted in a 12 o'clock direction of force with a Collision Deformation Classification (CDC) of 12-FZEW-2. The minor secondary impact sequence resulted in direct contact damage that began at the front left bumper corner and extended right approximately 30.0 cm (11.8 in). The damage resulted in an 11 o'clock direction of force with a CDC of 11-FLLW-1. **Figures 3 and 4** identify the damage sustained to the frontal plane of the Sunfire.

Figure 3. Damage to the frontal plane of the Sunfire

Figure 4. Sunfire's bumper fascia direct contact damage.

The Ford Taurus sustained moderate damage to its right side plane resultant of impact with the Sunfire. The initial impact to the right fender and right front door generated direct contact damage which consisted of red paint transfers and began 102 cm (40 in) forward of the right rear axle and extended 243 cm (96 in) forward. Maximum crush was measured at 14.5 cm (5.7 in) and was located 247.8 cm (97.6 in)

Figure 5. Right fender damage sustained by the ACN equipped Ford Taurus.

forward of the right rear axle on the right front fender. The damage resulted in a 2 o'clock direction of force with a Collision Deformation Classification (CDC) of 02-RYEW-2. **Figure 5** identifies the right fender damage sustained by the Taurus. The secondary impact sequence generated direct contact damage which began 44.5 cm (17.5 in) forward of the right rear axle and extended 147 cm (58 in) rearward. Residual crush was not present from this impact, however, a CDC of 03-RZEW-1 resulted.

Interior Vehicle Damage

The moderate severity impact did not cause intrusion damage to the Sunfire, however, interior damage was present and resulted from occupant contact and air bag deployment. Two light abrasion patterns to the knee bolster were exhibited in the front left passenger compartment area which resulted from contact with the driver's knees at impact. The center of the first abrasion pattern was located 3.0 cm (1.2 in) left of the center knee bolster and 38 cm (15 in) above the floor. The abrasion was 3.5 cm (1.4 in) in diameter. The second abrasion pattern was located 7.0 cm (2.8 in) right of the center knee bolster and 35 cm (13.8 in) above the floor. It had a measured diameter of 3.0 cm (1.2 in). The steering wheel rim was not deformed and there was no movement of the steering column's shear capsules during the impact sequence.

A fracture was evident on the right side of the windshield which resulted from contact with the front right air bag module cover flap as it opened to deploy the air bag. The center of the fracture was located 34.0 cm (13.4 in) right of the vehicle's center and 86.0 cm (33.9 in) above the floor of the Sunfire. The fracture had a measured width of 52 cm (20.5 in) and height of 24 cm (9.4 in). **Figure 6** identifies the fractured windshield and the front right air bag module cover flap.

Figure 6. Right side windshield fracture and front right air bag module cover flap.

Automatic Restraint System

The Sunfire was equipped with a Supplemental Restraint System (SRS) which included front driver and front right depowered air bags. The membranes of the air bag system had been removed from the vehicle and were not available for inspection, however, the air bag modules and module cover flaps were still in place. The vehicle (manufactured 10/97) was not equipped with identifiers which indicated "Next Generation Air Bags" or noted the depowered status of the vehicle's air bag system. Adhesive-type labels were located on the windshield aspect of the driver and passenger side sun visors which warned of the potential danger related to air bag deployment. These labels were identified by WLC 15001737. The labels and their identification were identical to post-manufactured labels which were mailed to the owners of air bag equipped vehicles due to safety issues related to air bag deployment. The labels were intended for adhesion and display on the air bag module cover flaps and were referenced in Special Crash Investigation case CA97-43. **Figure 7** identifies the

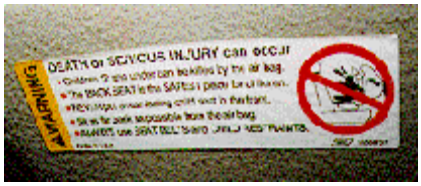
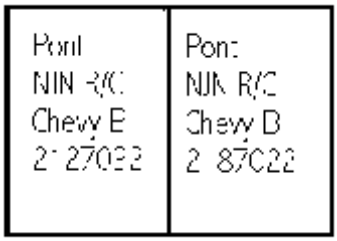


Figure 7. Adhesive air bag warning label.

Sunfire's adhesive air bag warning label. The front left and front right belt webbings displayed additional air bag warning labels.

The front driver air bag deployed from an I-configuration module cover flap and was incorporated within the steering wheel hub. The module cover flap measured 10.5 cm (4.1 in) in height and 16.5 cm (6.5 in) in total width. The left and right side flaps were symmetrical and they did not sustain damage from the impact sequence. The flap was manufactured of a pliable plastic and concealed laminated horn touch pads. The touch pads were identified as follows:



The horn touch pads were reinforced by a white plastic module encasement which was identified by Part No. 1657337, Lot # 26271A1. **Figure 8** identifies the air bag module. The front driver air bag was not available for inspection and insurance photographs which captured the air bag were not useful for identification purposes.

Figure 8. Front driver air bag module.

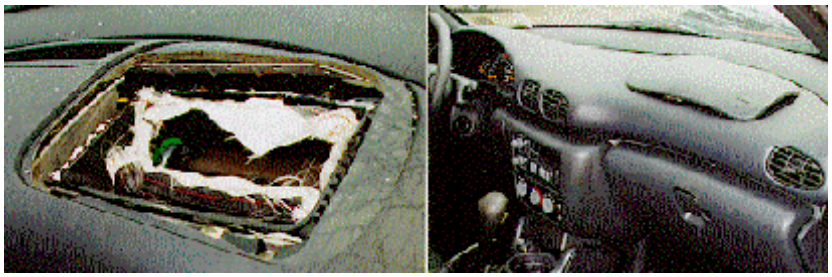


Figure 9. Front right air bag module and its cover flap of the Sunfire.

The front right air bag deployed from a top mounted module assembly that was incorporated within the upper right instrument panel. The single flap was hinged at the forward edge and opened in an upward direction toward the windshield. The flap had a measured maximum width of 33 cm (13 in) and maximum height of 27 cm (10.6 in) and it was identified by 22603255 05 97. The leading edge of the cover flap sustained abrasions resultant of windshield contact as it opened to deploy the air bag. The front right air bag was not available for inspection and insurance photographs which captured the air bag were not useful for identification purposes. **Figure 9** identifies the front right air bag module and its cover flap.

Driver Demographics

The Sunfire was occupied by a 64 year old female driver with a self reported height of 158.8 cm (62.5 in) and weight of 65.7 kgs (145.0 lbs). The police crash report and the driver indicated that the available

3-point manual lap and shoulder belt was in use during the crash. At the time of inspection, the belt webbing was stowed and there was no conclusive evidence on the webbing that would suggest it was in use at the time of crash. It was not stretched, did not exhibit fiber transfers, and there was no evidence of D-ring transfers for the moderate severity crash. The lack of supportive belt evidence in combination with bilateral knee contusions sustained by the driver indicated that the driver was not restrained during the crash sequence. At inspection, the adjustable front left D-ring was located in the full up position. The seat back was reclined to 17 degrees and the seat track was located 5 cm (2 in) forward of the rear most position and 14.5 cm (5.7 in) rearward of the forward most position. The driver indicated that the seat track was probably located closer to the steering wheel, an estimated 16.5 cm (6.5 in) from the steering wheel hub to her chest in a seated position. The driver's recollection is consistent with the seat track position for a female of her height.

Driver Injuries

Injury	Injury Severity (AIS-90)	Injury Mechanism
Nose abrasion	Minor (290202.1,4)	Front driver air bag
Bilateral knee contusions	Minor (890402.1,3)	Left knee bolster
Lumbar strain	Minor (640678.1,8)	Impact forces

Driver Kinematics

Pre-impact the driver was displaced slightly to the right of the vehicle due to the probable left turning maneuver which was initiated to avoid the impending impact with the Taurus. At impact, the unrestrained driver was displaced forward, in response to the 12 o'clock direction of force, and contacted her knees with the left knee bolster area. This resulted in abrasions to the knee bolster and bilateral knee contusions (AIS-1) to the driver. The front driver air bag deployed and contacted the forward positioned driver which resulted in a nose abrasion (AIS-1). Forces of the moderate severity impact resulted in lumbar strain (AIS-1) to the driver.

Medical Treatment

A paramedic unit in close proximity to the crash was flagged down by a pedestrian to respond to the scene. Medical personnel from this primary on-scene ambulance assessed the condition of the drivers of the Taurus and Sunfire and requested a basic ambulance to assist at the crash scene. The basic ambulance transported the female driver of the Sunfire to a local hospital where she was treated and released. The paramedic ambulance transported the driver of the Taurus to the same hospital for treatment of a mid chest contusion (AIS-1) and a sternum fracture (AIS-2). She was subsequently released from the emergency room.

Automated Collision Notification System

At crash, the in-vehicle components of the ACN system detected the crash, then assembled, initiated, and successfully delivered an emergency message to the local Sheriff's Department and Medical Emergency Response System (MERS). The driver of the Taurus (ACN equipped vehicle) indicated that post-crash, she immediately attempted to use the in-vehicle ACN cellular phone to notify 911 of the crash, however she was blocked out due to successful connection between the Sheriff's Department, MERS, and the vehicle. The Sheriff's Department received the emergency call within one minute of the crash, then verified the location of the crash and the injury status of the involved occupants. The emergency call was transferred to the appropriate police jurisdiction and police units were dispatched approximately 16 minutes post-crash. Emergency medical personnel and police were on scene three and twenty-six minutes post-crash, respectively.