

**TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION**

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**CALSPAN ON-SITE DEPOWERED AIR BAG
DEPLOYMENT INVESTIGATION**

CALSPAN CASE NO. CA 97-030

SUBJECT VEHICLE - 1998 PONTIAC FIREBIRD

LOCATION - STATE OF MICHIGAN

CRASH DATE - SEPTEMBER, 1997

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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<p>16. <i>Abstract</i> This on-site investigation focused on the deployment of the depowered front left and front right air bag system of a 1998 Pontiac Firebird. The crash occurred as the 36 year old male driver was exiting a left curve in an active construction zone and attempted to avoid a construction barrel that was displaced in his lane. He subsequently lost control of his vehicle, rotated clockwise, and departed the right road side where the Firebird's frontal plane impacted with a guardrail bordering the right shoulder of the roadway. This impact was sufficient to deploy the depowered Supplemental Restraint System (SRS) that consisted of front left and front right air bags. The Barrier Equivalent run of WinSMASH calculated the total change in velocity at 23.2 km/h (14.4 mph). The vehicle continued to rotate clockwise and side-swiped its left side with the guardrail. The restrained driver sustained a sore/tender nose (not AIS codeable) resulting from this crash.</p>			
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Background

This on-site investigation focused on the deployment of the depowered front left and front right air bag system of a 1998 Pontiac Firebird. The crash occurred as the 36 year old male driver was exiting a left curve in an active construction zone and attempted to avoid a construction barrel that was displaced in his lane. He subsequently lost control of his vehicle, rotated clockwise, and departed the right road side where the Firebird's frontal plane impacted with a guardrail bordering the right shoulder of the roadway. **Figure 1** identifies the frontal plane damage sustained by the Firebird. This impact was sufficient to deploy the depowered Supplemental Restraint System (SRS). The vehicle continued to rotate clockwise and side-swiped its left side with the guardrail. The driver sustained a sore/tender nose (not AIS codeable) resultant of the crash.



Figure 1. View of the damaged frontal plane of the 1998 Pontiac Firebird

This investigation was assigned to Calspan's Special Crash Investigation team on Wednesday, September 24, at the SCI training seminar at TSI. The local NASS team (PSU-11) located the police crash report (PCR) during sampling and faxed it to NHTSA headquarters on September 22nd. An on-site investigation was initiated on October 22nd after cooperation was obtained from the owner of the vehicle, General Motors, who had been storing the vehicle. This is the first SCI crash investigation assigned for a crash that involved a 1998 vehicle equipped with a depowered air bag system. Air bag development and data litigation representatives from General Motors were present at the vehicle inspection.

Summary

The police crash reported scene was initially investigated by the Calspan SCI investigators. Scene inspection revealed lack of tire impressions and a new guardrail system. This site was later ruled out as the actual crash scene due to conflicting scene location information provided by the driver of the Firebird. The local NASS

team (PSU-11) was subsequently recruited to inspect the driver indicated crash site. Physical evidence documented at this crash site was not consistent with the damage sustained by the Firebird during the crash sequence. The NASS inspected crash site, however, was reconfirmed with the Firebird's driver and is reported in this summary.

The crash reportedly occurred at the merge point of a south and eastbound interstate roadway. The southbound roadway consisted of two travel lanes which merged with one eastbound travel lane. The travel lanes merged for eastbound travel. The inboard lane was closed due to construction during this crash and the modified posted speed limit was 89 km/h (55 mph). The crash occurred during the daylight hours on a dry asphalt road surface with a left curve and a negative grade to the east. The inboard travel lane was obstructed by construction barrels standing approximately 0.9 meter (3.0 feet). The roadway was bordered by an asphalt shoulder with a measured width of 3.6 meters (9.1 feet) and a thri-beam guardrail. **Figures 2 and 3** identify the crash scene.



Figure 2. Approach of the Pontiac Firebird



Figure 3. View of the impacted thri-beam guardrail

The Pontiac Firebird 2-door hatchback (3.8 L, V-6) was equipped with manual 3-point belt systems for the four outboard seated positions, in addition to a Supplemental Restraint System (SRS) that consisted of depowered front left and front right air bags. The Firebird was also equipped with a 4-wheel Anti-lock Braking System (ABS) and 4-wheel power disc brakes. The vehicle was identified by vehicle identification number (V.I.N.) 2G2FS22K2W2 (production number omitted) and was manufactured in March, 1997. The electronic odometer indicated that the vehicle had been driven 3,632 km (2,257 miles). Visible identifiers (i.e., window stickers) were not present on the Firebird to indicate that it was equipped with a depowered air bag system.

Crash Events

The Firebird was traveling in the outboard lane of the southbound roadway for which an eastbound lane merged approximately 25 meters (82 feet) ahead. The driver of the Firebird noticed that a construction barrel had been displaced into his lane and took evasive action by steering to the left to successfully avoid an impact with the construction barrel. The driver then swerved to the right to return to his original travel lane and began to rotate clockwise approximately 30 degrees, traversing the merging eastbound travel lane, before the vehicle departed the right side of the road. The Firebird impacted its frontal plane with a guardrail bordering the

southbound shoulder of the roadway. The Barrier Equivalent application of WinSMASH calculated the total change in velocity at 23.2 km/h (14.4 mph). Longitudinal delta V was calculated at -19.0 km/h (-11.8 mph) and lateral delta V at 13.3 km/h (8.3 mph). Total energy dissipated was 54,031 joules (163,713 pounds) This impact initiated the deployment sequence of the depowered front left and front right air bag system. The vehicle continued to rotate clockwise and side-swiped its left side with the guardrail. Estimated total delta V for this impact was 6.4 km/h (4.0 mph). The Firebird came to final rest facing westbound on the south shoulder of the roadway. The driver of the vehicle reported that the driver side door was adjacent to and in contact with the thrie beam guardrail at final rest. He waited over an hour for a tow-truck, then replaced the restricted right front tire with the temporary spare tire. He began to exit the shoulder of the road and swiped the forward aspect of the left side mirror cover with the thrie beam guardrail. The driver traveled approximately 1.6 kilometers (1.0 mile) to a parking lot where he waited for towing assistance.

Exterior Vehicle Damage

The initial impact with the guardrail resulted in moderate frontal damage to the Firebird which extended across the entire bumper fascia. Maximum crush was located 87.6 cm (34.5 in) right of the left front bumper corner and measured 33.1 cm (13.0 in). The resultant direction of force was within the 11 o’clock sector and yielded a Collision Deformation Classification (CDC) of 11-FDEW-1. **Figures 4, 5 and 6** identify the damage sustained by the initial impact to the Firebird.



Figure 4. View of the damaged front bumper of the Firebird



Figure 5. Right side view of the crush damage sustained by the Firebird



Figure 6. View of the damaged frontal plane of the Firebird

Table 1. Front Bumper Crush

C1	C2	C3	C4	C5	C6
No residual crush	14.0 cm (5.5 in)	24.6 cm (9.7 in)	33.1 cm (13.0 in)	32.0 cm (12.6 in)	22.6 cm (8.9 in)

The second impact with the guardrail produced side-swiping type damage to the Firebird that began 52.1 cm (20.5 in) forward of the left front axle and extended rearward 305 cm (120 in). The damage was sustained by the protruding profiles of the left side vehicle plane. There was no residual crush for this impact. The CDC for this impact was 09-LYES-1.

Automatic Restraint System

The depowered front left and front right air bag system consisted of a single point sensing system which was located under the rear most portion of the center console. The deployment threshold of the depowered system was 14.5 - 22.5 km/h (9.0 - 14.0 mph). GM personnel present at the inspection indicated that the air bags for this vehicle's model year deployed with 15-20 percent less force than previous production years. At inspection, the air bag lamp flashed six times and was followed by a constant light which indicated a deployment of the SRS. Labels were not located on the driver or passenger side window glazing identifying that the vehicle was equipped with "NEXT GENERATION AIR BAGS". Warning labels, however, were present on the windshield side of the left and right sunvisors which warned of the dangers associated with air bag deployment.

The front left module cover flap opened in the typical I-configuration and deployed the non-tethered air bag. The right and left flaps were symmetrical and measured 10.2 cm (4.0 in) in height and 9.7 cm (3.8 in) in width. The air bag had two vent ports located at the 2 and 10 o'clock positions and was folded in an accordion style with exception for the center face sector which was flush against the inside of the module cover flap. The front left bag measured 71 cm (28 in) in diameter in its deflated state and displayed the identification tag:

**TWR
000938327**

A vinyl transfer was noted on the center face of the air bag (refer to **Figure 7**) which resulted from contact to the inside of the module cover flap. It measured 25 cm (10 in) below the top most seam of the air bag and 38 cm (15 in) from the air bag's right seam. The transfer measured 14 cm (5.5 in) right of the location point. Shear capsule compression or steering wheel rim deformation was not present as identified in **Figures 8 and 9**.



Figure 7. Front left air bag of the Firebird with highlighted grey vinyl transfer



Figure 8. Left side shear capsule showing no movement



Figure 9. Right side shear capsule showing no movement

The front right air bag module was encased in the right side instrument panel and deployed the depowered air bag from a mid-mount position. The module cover flap measured 22.3 cm (8.8 in) in height and 34.3 cm (13.5 in) in width and displayed the acronym “SRS” in the lower right corner of the flap. The module cover flap was secured to the module by a fabric mesh tether that measured 18.5 cm (7.3 in) in height and 19.0 cm (7.5 in) in length. The top aspect of the cover flap sustained abrasions resultant of contact with the right side windshield as it opened to deploy the air bag. GM personnel present at the inspection indicated that the air bag was designed to initially deploy longitudinally until restricted by the available tethers which resulted in subsequent vertical deployment of the front right air bag. The air bag was tethered by two straps which were located at the 6 and 12 o’clock positions and extended the width of the air bag. Two vent ports were located at the 3 and 9 o’clock positions, adjacent to the instrument panel. An identification tag on the front left air bag displayed the identification: **Figure 10** identifies the deployed front right air bag and its cover flap extended to the damaged windshield.

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F-car assemb
TRAF 70071492



Figure 10. View of the passenger compartment with deployed air bag and air bag module cover flap extended to the damaged windshield



Figure 11. Right aspect of the left side knee bolster showing abrasions which resulted from driver knee contact

Interior Vehicle Damage

Intrusion or integrity damage to the interior of the Firebird was not present. Damage to the passenger compartment was resultant of occupant contact and the deployed air bags. An abrasion was located on the left side knee bolster and was positioned 5 cm (2 in) from the bolster’s right perimeter and 3.0 cm (1.2 in) below its top aspect (refer to **Figure 11**). The abrasion measured 3.0 cm (1.2 in) vertically and resulted from contact with the driver’s right knee. Damage to the right side windshield resulted from contact with the front right air bag module cover flap as it opened to deploy the air bag and consisted of a oval shaped spiderweb-type fracture.

Driver Demographics

The driver of the Firebird was a 36 year old male with a stated height of 185 cm (73 inches) and weight of 79 kg (175 lbs). He was properly restrained by the 3-point manual lap and shoulder belt system as indicated by the PAR, interview, and belt webbing damage sustained from the sliding buckle. Evident belt loading was located 52.0 cm (20.5 in) from the floor anchorage position of the belt webbing as identified in **Figure 12**. The stitching of the belt's energy management loop was intact at inspection. In addition, a portion of the plastic binding for the latchplate was disjoined (refer to **Figure 13**). The latch plate had abrasions consistent with regular usage for a vehicle with low mileage. The interview with the driver of the vehicle indicated that the seat track position was two notches forward of the full rear track position and that the steering column was adjusted to the mid-position. At inspection, the seat track was adjusted to the full back position and the seat back was reclined one notch from full upright. The steering column was adjusted to the full up position at inspection. The driver did not receive medical treatment, but indicated that his nose felt tender for two days following the crash.

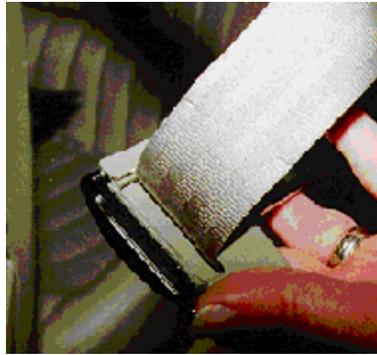


Figure 12. Belt webbing loading for the left front 3-point belt system



Figure 13. Disjoined plastic binding on the left front latchplate

Driver Kinematics

At impact, the driver responded to the 11 o'clock direction of force and initiated a slight forward movement, but was restricted from further displacement due to the utilized 3-point manual lap and shoulder belt. The driver contacted his right knee with the left side knee bolster which resulted in an abrasion which was located 5 cm (2 in) from the bolster's right perimeter and 3.0 cm (1.2 in) below its top aspect. The abrasion measured 3 cm (1.2 in) vertically. The front left and front right air bags initiated their deployment sequence as a result of the Firebird's impact to the guardrail. The deployment forces of the front left air bag may have displaced the driver's hand from the steering wheel to his nose which resulted in a sore/tender nose. The nasal injury, however, may also have resulted from contact to the deployed air bag although abrasions to the nose were not present to support this scenario. The driver did not receive medical treatment.

