

**TRANSPORTATION SCIENCES CENTER
Crash Data Research Center**

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ON-SITE ADVANCED OCCUPANT PROTECTION SYSTEM INVESTIGATION

CASE NO: CA02-037

VEHICLE - 2003 PONTIAC BONNEVILLE

LOCATION - PENNSYLVANIA

CRASH DATE - SEPTEMBER, 2003

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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 be 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 of the involved vehicle(s) or their safety systems.

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CASE NO: CA02-037**

**VEHICLE: 2003 PONTIAC BONNEVILLE
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CRASH DATE: SEPTEMBER, 2002**

BACKGROUND

This investigation focused on the crash severity and the performance of the Advanced Occupant Protection System (AOPS) features in a 2003 Pontiac Bonneville. The AOPS consisted of dual stage frontal air bags for the driver and front right passenger. The crash occurred when the Pontiac departed the right side of road and impacted a 46 cm (18 in) diameter tree with the center aspect of its front plane. The frontal air bags did not deploy as a result of the impact. The unrestrained 23 year old male driver of the Pontiac initiated a forward trajectory in response to the impact induced deceleration. The driver loaded the steering column with his chest causing complete separation of the shear capsules and struck the windshield with his head. He was unconscious at the scene and hospitalized for approximately two days. The Event Data Recorder on-board the Pontiac was downloaded during the course of the SCI investigation. The EDR data indicated the vehicle's maximum delta V was -46.0 km/h (-28.6 mph).

The investigating police officer notified the Crash Investigations Division of the National Highway Traffic Safety Administration (NHTSA) of the crash on September 20, 2002. NHTSA in-turn assigned an on-site investigation of the crash to the Special Crash Investigations team at Veridian Engineering. The vehicle was impounded by the police pending the completion of the criminal proceedings against the driver and was available for SCI inspection. The on-site inspection occurred on September 25, 2002

SUMMARY

Crash Site

This crash occurred during the nighttime hours in September 2002. At the time of the crash, it was dark and the area of the crash was illuminated by overhead street lights. It was raining and the road surface was wet. **Figure 1** is a trajectory view approaching the crash scene. The crash occurred off the right shoulder of a five lane east/west asphalt road in an urban commercial setting. The traffic way was bordered by 15 cm (6 in) barrier curbs and grass shoulders. A row of deciduous trees was planted parallel to the road and was located approximately 2.1 m (7.0 ft) outboard of the curb. This subject roadway intersected a north/south arterial road approximately 66 m (217 ft) east of the point of impact. The speed limit in the area of the crash was 40 km/h (25 mph).



Figure 1: Westbound trajectory view.

Pre-crash

The 2003 Pontiac Bonneville was operated by a 23 year old unrestrained male. The Pontiac was initially northbound on the intersecting roadway and turned left, traveling westbound on the subject road. The driver was operating the Pontiac in the outboard westbound lane and for unknown reasons allowed the vehicle to drift to the right. The vehicle struck and mounted the barrier curb with the right front tire and traveled onto the grassy shoulder. A 31 m (102 ft) rolling tire mark leading to the point of impact was documented during the police investigation. (Reference Figure 1.) The roadside departure angle was an estimated 5 degrees. There was no physical evidence to support any pre-crash avoidance maneuvers by the driver of the vehicle.

The data downloaded from the EDR indicated the Pontiac was traveling 24 mph five seconds prior to Algorithm Enable (AE) and accelerated to 48 km/h (30 mph) two seconds before AE. The data indicated the driver braked immediately prior to impact.

Crash

The crash occurred with the center and left aspects of the Pontiac's front plane impacting a 46 cm (18 in) diameter oak tree. The force of the crash deformed the vehicle's bumper reinforcement rearward into the engine compartment. The maximum crush measured 71.9 cm (28.3 in) and was located 13 cm (5 in) left of the vehicle's centerline. The slight offset of the impact force caused the vehicle to rotate less than 5 degrees counterclockwise during its rebound to final rest. The Pontiac came to rest approximately at the point of impact. **Figure 2** is an on-scene police photograph of the vehicle at final rest. The total delta V calculated by the Barrier algorithm of the WINSMASH model was 37 km/h (23 mph). **Figure 3**, page 3, is a schematic of the crash generated by the police investigation.



Figure 2: On-scene photograph of the vehicle at final rest.

Post-Crash

The police and ambulance personnel responded to the crash. The driver was found unconscious in the driver seat and unresponsive. During the crash, the unrestrained driver had initiated a forward trajectory in response to the 12 o'clock direction of the impact and contacted the steering column and windshield. He was transported to the emergency room of a local hospital and was placed in a drug induced coma for approximately two days. The reasons for the drug induced coma were unknown. The driver reportedly regained consciousness two days post-crash and was diagnosed with a forehead contusion. He was released to police custody pending criminal charges related to the crash.

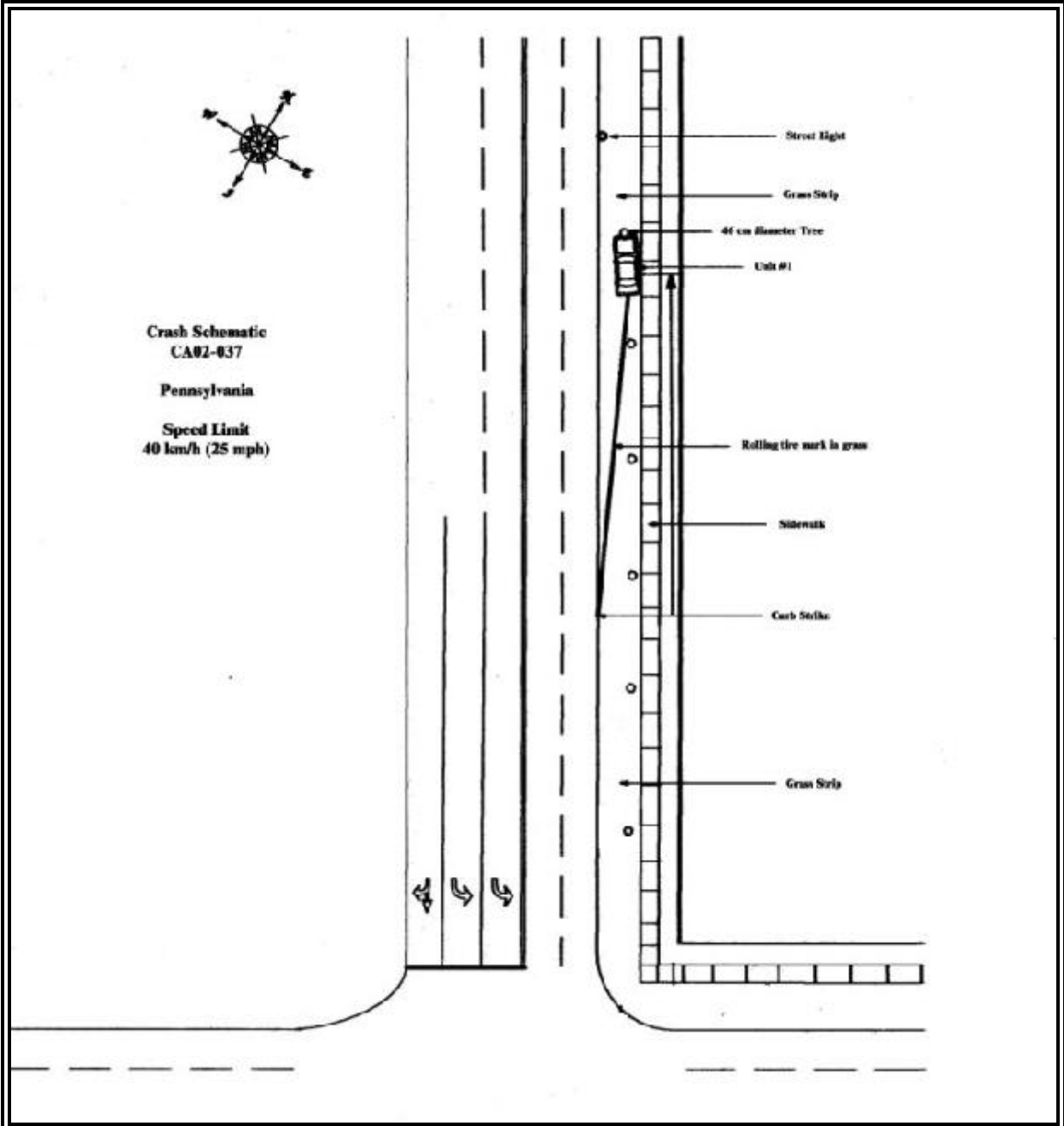


Figure 3: Crash schematic.

2003 PONTIAC BONNEVILLE

The 2003 Pontiac Bonneville, **Figure 4**, was identified by the Vehicle Identification Number (VIN): 1G2HX52KX34 (production sequence deleted). The vehicle's date of manufacture was 08/02. The odometer had recorded 2,660 km (1,653 miles). The Pontiac was owned by a rental car agency and was being operated under a rental agreement at the time of the crash. The SE model, 4-door sedan was equipped with a 3.8 liter, V6 engine linked to a four-speed automatic transmission. The vehicle was also equipped with ABS power brakes, power steering and an interior package to include power windows and locks and a 6-way adjustable driver seat. The manual restraint system consisted of 3-point lap and shoulder belts in all five seat positions. The Supplemental Restraint System was an advanced system (AOPS) consisting of dual stage frontal air bags for the driver and front right passenger. The air bags did not deploy during the frontal crash. The vehicle was capable of recording pre-crash and crash event data related to the impact. This data was downloaded during the SCI inspection as a supplement to the investigation.



Figure 4: Pontiac front view.

Exterior Damage

Figure 5 is an overhead view of the frontal damage. The frontal plane of the Pontiac sustained 71.1 cm (28.0 in) of direct contact damage. The direct contact began 22.9 cm (9.0 in) right of center and ended 48.3 cm (19.0 in) left of center. The combined width of the direct and induced damage extended across the vehicle's entire 137 cm (54 in) frontal end width. The impact deformed and collapsed the bumper reinforcement bar rearward into the engine compartment. The maximum crush measured 71.9 cm (28.3 in) and was located 13 cm (5 in) left of the vehicle's centerline. The residual crush profile was as follows: C1 = 5.0 cm (2.0 in), C2 = 22.0 cm (8.7 in), C3 = 62.0 cm (24.4 in), C4 = 47.0 cm (18.5 in), C5 = 21.0 cm (8.3 in), C6 = 1 cm (2.5 in). The longitudinal length of the direct contact on the hood measured 46 cm (18 in). The impact force shifted the left and right fenders rearward into their respective A-pillars. The operation of the left front door was restricted. The left and right wheelbases were reduced 8.6 cm (3.4 in) and 3.0 cm (1.2 in), respectively. The Collision Deformation Classification was 12-FYEW-3. The curb impact punctured the sidewall of the right front tire and abraded the exterior surface of the rim. The CDC of the curb impact was 12-FRWN-3. The total delta V calculated by the Barrier Algorithm of



Figure 5: Overhead view of the frontal damage.

the WINSMASH model was 32.3 km/h (20.1 mph). The longitudinal and lateral components were -32.3 km/h (-20.1 mph) and 0 km/h (0 mph), respectively. The WINSMASH calculation appears to have underestimated the severity of the crash in the opinion of this investigator.

Interior Damage

Figure 6 is a view of the driver's interior. There was no interior damage or intrusion attributed to the exterior forces of the crash. The only interior damage was directly associated to the unrestrained driver's interior contacts.

The driver seat was adjusted in a mid-to-rear track position consistent with the driver's stature. The seat back was reclined 35 degrees aft of vertical measured 30 cm (12 in) above the seat cushion. The head restraint was in the full up position. The horizontal distance from the center of the steering wheel to the driver seat back measured 81 cm (32 in).

The left upper aspect of the windshield exhibited a fracture pattern consistent with a head contact. The center of the fracture was located 20.3 cm (8.0 in) below the windshield header and (4.8 in) inboard (right) of the left A-pillar. Several strands of black hair were noted within the fracture. A skin oil smear was located directly above the fracture site. The gross overall dimensions of the smear measured 6.4 cm x 30.5 cm (2.5 in x 12.0 in). The trim panel covering the left A-pillar was displaced from its designed position from probable left hand contact. The contact pattern measured 15 cm (6 in) in length and began on the trim panel's upper aspect. There was no deformation to the sheet metal underlying the left A-pillar trim.



Figure 6: Left interior view.

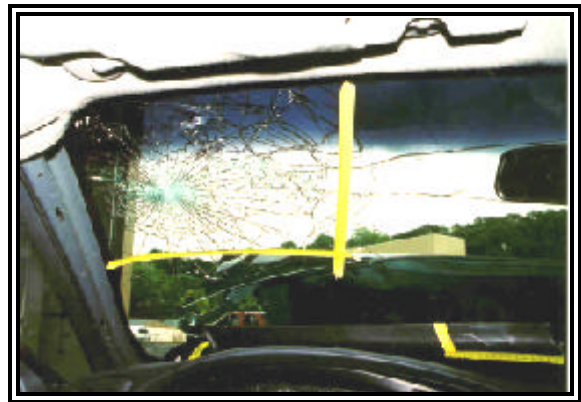


Figure 7: Windshield and left A-pillar contact.

The 4-spoke tilt steering wheel was adjusted to the full up position. The steering wheel was rotated approximately 90 degrees clockwise. There was no steering wheel rim deformation, **Figure 8**. During the crash sequence, the unrestrained driver loaded the plane of the rim and completely separated the steering column from the shear capsules. The column had dropped down and was not attached to the instrument panel, **Figure 9**. The horizontal distance from the top sector of the steering wheel rim to the brow of the instrument panel measured 5 cm (2 in).



Figure 8: Left lateral view of the steering wheel rim.

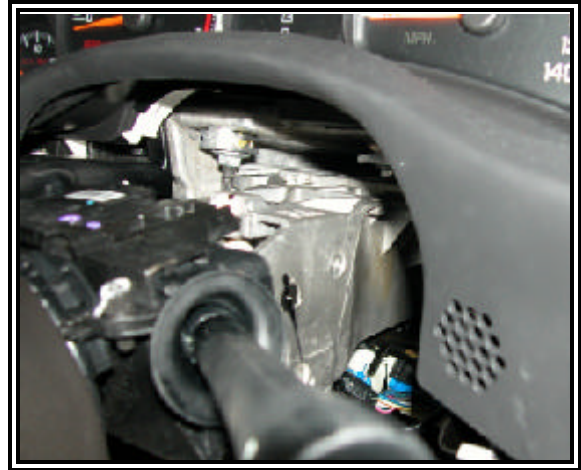


Figure 9: View of the shear capsule separation.

The exterior panel to the driver's knee bolster was found on the rear seat. It may have been separated during the crash sequence. However, there was no evidence of direct contact or deformation to the plastic bolster panel or to the bolster's metal backer.

Manual Restraint System

The driver's manual 3-point lap and shoulder belt was an integrated restraint designed into the seat. The latch plate was sewn to two separate belt webbings for the lap and shoulder, respectively. The belts were housed in two separate webbing sensitive/emergency locking retractors (ELR) attached to the outboard aspect of the seat. Examination of the latch plate identified minimal historical use consistent with the age of the vehicle. There was no evidence on either webbing consistent with use during the crash. All the evidence gathered during the course of the SCI investigation indicated the driver was unrestrained in this crash. This determination was consistent with the data recorded by the EDR.

Advanced Occupant Protection System

The Advanced Occupant Protection System (AOPS) features in the 2003 Pontiac Bonneville consisted of dual stage driver and front right passenger air bags. The air bags did not deploy in the crash. The AOPS was controlled by a Sensing and Diagnostic module (SDM) located under the center console. A single forward satellite sensor was incorporated into the design of the sensing system and augmented the crash, and safing sensors within the SDM. The satellite sensor was located on the vehicle's centerline attached to the lower radiator support. This sensor was located within the region of direct contact.

The SDM had Event Data Recording (EDR) capabilities. The EDR recorded five seconds of pre-crash vehicle system data, and crash pulse data regarding the severity of the impact. A deployment level event

was recorded during this crash. This data was downloaded during the SCI investigation. The EDR data is attached to the end of this report. The pre-crash data indicated the vehicle was traveling at a speed of 39 km/h (24 mph) five seconds prior to AE (T-5) and accelerated to 48 km/h (30 mph) at (T-2). The data indicated the driver applied the brakes immediately prior to the impact (T-1) with a reduction of speed to 47 km/h (29 mph). The maximum longitudinal delta V recorded by the SDM was -46.0 km/h (-28.6 mph). The delta V recorded by the SDM was consistent with the recorded pre-crash vehicle speeds and the reconstructed crash dynamics.

The downloaded data indicated Stage 1 deployments of the driver and front right passenger air bags were commanded 25 milliseconds after the Algorithm Enable (AE). However, the frontal air bags did not deploy. Technical representatives of General Motors have determined that the sensor safing criteria was not met during the crash and prevented the deployment of the frontal air bags.

The driver air bag module was attached to the center hub of the steering wheel. The front right passenger air bag was a top-mount design located in the right aspect of the instrument panel. During the SCI inspection, the driver air bag module was disassembled from the steering wheel hub, **Figures 10 and 11**. All the mechanical and electrical connections on the back side of the module appeared to be intact. There were no obvious assembly problems. The following nomenclature identified the driver air bag module: AB2237Q3UCNSD.



Figure 10: Non-deployed driver air bag.

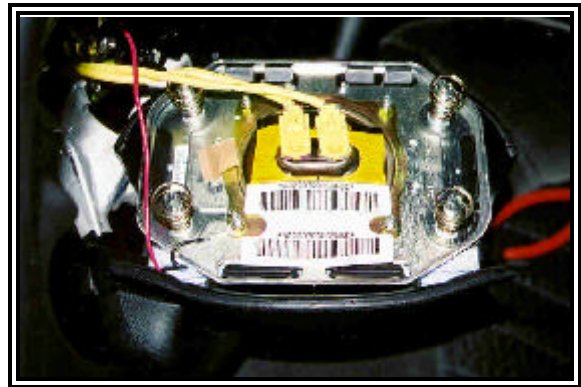


Figure 11: View of the driver air bag disassembly.

DRIVER DEMOGRAPHICS

Age/Sex:	23 year old/Male
Height:	175 cm (69 in) estimated
Weight:	72 kg (160 lb) estimated
Manual Restraint Use:	Unrestrained
Usage Source:	Observations of the first responders/Occupant kinematics/SCI inspection
Medical Treatment:	Transported and hospitalized for two days

DRIVER INJURY

<i>Injury</i>	<i>Injury Severity (AIS update 98)</i>	<i>Injury Source</i>
Forehead contusion	Minor (290402.1,7)	Unrestrained windshield contact
Closed head injury, unconscious at the scene, details unknown	Unknown (115099.7,0)	Unrestrained windshield contact

DRIVER KINEMATICS

The 23 year old unrestrained male driver of the Pontiac was seated in a mid-to-rear track position with a presumed upright posture. The driver became distracted for unknown reasons, lost directional control, and allowed the vehicle to drift to the right. The right front tire impacted and mounted the barrier curb and the vehicle departed the road. The driver responded to the roadside departure by applying the brake immediately prior to impact.

Upon impact, the driver initiated a forward trajectory in response to the 12 o'clock direction of the impact. The driver's chest contacted plane of the steering wheel rim and loaded the steering wheel/column. The driver's inertial loading caused a complete shear capsule separation. The driver's forehead contacted and fractured the left upper aspect of the windshield. This contact resulted in a forehead contusion and the driver was rendered unconscious. His left hand probably contacted the trim panel covering the left A-pillar in a bracing effort. This contact displaced the trim panel. He then rebounded back into his seat where he was found.