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Veridian Engineering
Buffalo, NY 14225

VERIDIAN REMOTE ADVANCED OCCUPANT PROTECTION SYSTEM CRASH INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

NASS/SCI COMBO CASE NO. 02-45-039A

VEHICLE – 2001 PONTIAC BONNEVILLE

LOCATION - STATE OF TENNESSEE

CRASH DATE – MARCH 2002

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.

TECHNICAL REPORT STANDARD TITLE PAGE

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16. Abstract This remote investigation focused on the performance of the Advanced Occupant Protection System (AOPS) in a 2001 Pontiac Bonneville. The vehicle was equipped with side impact air bags, dual-stage frontal air bags, seat belt sensors, integrated manual 3-point lap and shoulder belts, and an Event Data Recorder (EDR). The Bonneville was involved in a run-off-road crash and sideswiped a number of trees, which resulted in the driver's side impact air bag deployment. The Bonneville subsequently sustained a frontal impact with two additional trees, which resulted in the deployment of the frontal air bag system. The vehicle was occupied by a 32-year-old female driver who was restrained by the 3-point lap and shoulder belt. She was probably out of position left due to the negative roadside slope. She initiated a forward trajectory in response to the multiple impacts, and loaded the manual restraint and intruded frontal components. She sustained forehead lacerations and a probable closed head injury from possible contact with the intruded with trees during the sideswipe event. The combination of her forward loading and frontal component intrusion resulted in a left humerus fracture, a left femur fracture, a right lower leg fracture and bilateral lower leg contusions and abrasions. She was pronounced dead at the scene prior to being removed from the vehicle.			
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BACKGROUND

Figure 1. Damaged Pontiac Bonneville

This remote investigation focused on the performance of the Advanced Occupant Protection System (AOPS) in a 2001 Pontiac Bonneville **(Figure 1)**. The vehicle was equipped with side impact air bags, dual-stage frontal air bags, seat belt sensors, integrated manual 3-point lap and shoulder belts, and an Event Data Recorder (EDR). The Bonneville was involved in a run-off-road crash and sideswiped a number of trees, which resulted in the driver's side impact air bag deployment. The Bonneville subsequently sustained a frontal impact with two additional trees, which resulted in the deployment of the frontal air bag system. The vehicle was occupied by a 32-year-old female driver who was restrained by the 3-point lap and shoulder belt. She was probably out of position left due to the negative roadside slope. She initiated a forward trajectory in response to the multiple impacts, and loaded the manual restraint and intruded frontal components. She sustained forehead lacerations and a probable closed head injury from possible contact with the intruded with trees during the sideswipe event. The combination of her forward loading and frontal component intrusion resulted in a left humerus fracture, a left femur fracture, a right lower leg fracture and bilateral lower leg contusions and abrasions. She was pronounced dead at the scene prior to being removed from the vehicle.

This crash was selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 02-45-039A. The crash occurred in March 2002. Initial notification of this crash was made following a NASS CDS case review. The NASS PSU performed the vehicle inspection and scene inspection. Due to the presence of the Advanced Occupant Protection System, NHTSA assigned the tasks of case review and report preparation to the Veridian Special Crash Investigation (SCI) team.

SUMMARY

Crash Site

This single vehicle crash occurred on a three-lane roadway during the nighttime hours of March 2002. The roadway curved gradually to the right at the crash scene and had a six percent eastbound grade. At the time of the crash, the weather was clear and the asphalt road surface was dry. The east/west roadway was configured with two eastbound lanes and one westbound lane, separated by a double-yellow centerline and bordered by white fog lines and asphalt shoulders. The rural roadside environment consisted of trees on the north roadside and fields on the south

roadside. The north roadside exhibited a negative slope from the north road edge. There were no traffic controls present at the crash site and the posted speed limit was 80 km/h (50 mph). The NASS scene schematic is included as **Figure 12**, Page 9 of this report.

Figure 2. Eastbound approach for the Bonneville

Pre-Crash

The 32-year-old female driver was operating the 2001 Pontiac Bonneville in an eastbound direction on the east/west roadway on approach to the gradual right curve **(Figure 2)**. As the vehicle entered the curve and positive grade, the driver relinquished control for unknown reasons. The Bonneville drifted across the centerline and departed the left sloped roadside in a tracking mode. Due to the slope of the north roadside, the Bonneville was leaning to the left relative to the vehicle's longitudinal axis. The vehicle's EDR recorded the pre-crash vehicle speed five seconds prior to Algorithm Enable was 98 km/h (61 mph).

Crash

As the 2001 Pontiac Bonneville departed the roadside in a tracking mode, the left side aspect impacted five trees in a sideswipe configuration **(Figure 3)**. The direction of force was in the 12 o'clock sector and the impact produced moderate left side damage. Although the force direction did not have a significant lateral component, the tree contact to the lower left B-pillar resulted in the deployment of the driver's side impact air bag. The vehicle's EDR recorded a "Near Deployment" event as a result of the sideswipe impact. The EDR recorded a 1.50 km/h (0.93 mph) velocity change for the left side impact with the trees. The Bonneville continued in a forward direction and impacted two additional trees with the front aspect. Impact resulted in moderate/severe damage to the Bonneville. The direction of force was in the 12 o'clock sector and the impact was sufficient to deploy the frontal air bag system in the vehicle. The maximum EDR recorded velocity change for the frontal impact was 38.8 km/h (24.1 mph). Due to the multiple impacts and masking damage, the WinSMASH program was not used to compute delta-V's for the impacts. The Bonneville rotated in a counterclockwise (CCW) direction around the trees and came to rest on the north shoulder and straddling the fog line.

Figure 3. View of crash site and struck trees

Post-Crash

The 32-year-old female driver was trapped in the vehicle due to intruded frontal components, which included the left floor pan, left instrument panel, and the steering wheel. Based on the vehicle damage, it appeared that rescue personnel used hydraulic equipment to free the driver from the vehicle. Rescue personnel described the driver as "pinned from chest down in vehicle"

and reported that the driver's chest could not be accessed. Rescue personnel noted that the driver was unresponsive and had no life signs upon arrival. Due to the lack of life signs and the inability to access the driver, the efforts to revive the driver were terminated upon orders received from a hospital physician. The driver was pronounced dead at the scene and removed from the vehicle. The extrication of the driver was reported to be lengthy.

VEHICLE DATA – 2001 Pontiac Bonneville

The 2001 Pontiac Bonneville was identified by the Vehicle Identification Number (VIN): 1G2HX54K914 (production sequence omitted). At the time of the vehicle inspection, the electronic odometer reading was unknown. The vehicle was a four-door sedan equipped with a 3.8 liter V-6 engine, front-wheel drive, a four-speed automatic transmission, four-wheel power-assisted anti-lock brakes, a tilt steering wheel, and automatic on/off headlights with daytime running lights. The Bonneville was equipped with Firestone Affinity P225/60R16 tires that had a stated maximum pressure of 303.4 kpa (44 psi). The vehicle manufacturer recommended tire pressure was unknown as the vehicle placard was damaged and illegible. The specific tire data is summarized as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0.0 kpa	7.1 mm (9/32")	Yes	Sidewall damage
LR	268.9 kpa (39.0 psi)	7.9 mm (10/32")	No	None
RF	255.1 kpa (37.0 psi)	7.9 mm (10/32")	No	None
RR	268.9 kpa (39.0 psi)	6.4 mm (8/32")`	No	None

The front seating positions in the Pontiac Bonneville were configured with a split bench seat with separate backs. Both outboard front seat backs were equipped with adjustable open head restraints and integrated manual 3-point lap and shoulder belts. The center position was configured with a forward folding arm rest and a lap belt. The retractors for the shoulder belts were located on the top outboard aspects of the driver and front right passenger seat backs. The rear seating positions in the Bonneville were configured with a rear bench seat that was equipped with a center forward folding arm rest. The rear outboard positions were configured with adjustable head restraints.

VEHICLE DAMAGE

Exterior Damage – *2001 Pontiac Bonneville*

The 2001 Pontiac Bonneville sustained moderate damage as a result of the five left side sideswipe impacts with the trees **(Figure 4)**. The second of the five impacts involved a tree less than 10.0 cm (3.9") in diameter and was assigned as the impact for Collision Deformation Classification (CDC) and crush measurements, as the remaining left side impacts resulted in overlapping damage. The left side combined direct and induced damage began 68.0 cm (26.8") aft of the rear axle and extended forward 415.0 cm (163.4")

Figure 4. Left side damage to the Bonneville

along the left side plane. Both left side doors had been removed by rescue personnel, and the left front door was deformed as a result of extrication efforts. The left front fender was fractured and separated from the vehicle. The left front alloy/aluminum wheel was fractured and the left front tire was deflated. Longitudinal abrasions were present along the entire left side plane. The left front wheel was rotated CCW. One CDC was assigned to the second left side impact and was 12-LDAW-2. The remaining left side impacts were assigned CDC's of 12-L999-9.

Figure 5. Frontal damage to the Bonneville

The Bonneville sustained moderate/severe frontal damage as a result of the frontal impact with the trees **(Figure 5)**. The direct contact damage began 31.0 cm (12.2") to the right of the centerline and extended 73.0 cm (28.7") across the frontal plane. The combined direct and induced damage measured 95.0 cm (37.4") across the frontal plane. The bumper fascia was fractured, abraded, and partially separated on the left aspect. The hood sustained abrasions from the tree impact, and was buckled and displaced to the left. The front axle was crushed on the left aspect and displaced rearward and slightly CCW. The front axle displacement resulted in the shortening of the left wheelbase by 32.0 cm (12.6") and the elongation of the right wheelbase by 12.0 cm (4.7"). The left A-pillar was deformed rearward and the left roof side rail was deformed upward from induced buckling. Six crush measurements were taken along the frontal plane and were as follows: C1 = 50.0 cm (19.7"), C2 = 73.0 cm (28.7"), C3 = 85.0 cm (33.5"), C4 = 76.0 cm (29.9"), C5 = 60.0 cm (23.6"), C6 = 29.0 cm (11.4"). The maximum frontal crush was located between C2 and C3 and measured 91.0 cm (35.8"). The CDC for the frontal impact was 12-FDEW-4.

Interior Damage – *2001 Pontiac Bonneville*

Interior damage to the 2001 Pontiac Bonneville was moderate and attributed to passenger compartment intrusion **(Figure 6)**. The windshield laminate was fractured and holed vertically along the left A-pillar as a result of impact forces. The opening in the windshield laminate measured 50.0 cm (19.7") in height and 7.0 cm (2.8") in width **(Figure 7)**. All left side glazing and the backlight were disintegrated from impact forces.

Figure 6. View of driver's seat area and intruded components

Figure 7. View of holed windshield

Intruded components included the following:

Position	Intruded Component	Magnitude of Intrusion	Direction
11	Left instrument panel	53.0 cm (20.9”)	Longitudinal
11	Left A-pillar	45.0 cm (17.7”)	Longitudinal
11	Windshield	40.0 cm (15.7”)	Longitudinal
11	Windshield header	42.0 cm (16.5”)	Longitudinal
11	Left floor pan	24.0 cm (9.4”)	Longitudinal
12	Windshield header	8.0 cm (3.1”)	Longitudinal
12	Center instrument panel	4.0 cm (1.6”)	Longitudinal
21	Roof	28.0 cm (11.0”)	Vertical
21	Left B-pillar	19.0 cm (7.5”)	Longitudinal

MANUAL RESTRAINT SYSTEMS – 2001 Pontiac Bonneville

The driver and front right positions of the Pontiac Bonneville were configured with integrated manual 3-point lap and shoulder belts with sewn latch plates and Emergency Locking Retractors (ELR’s). The shoulder belt retractors were located on the outboard upper aspects of the front seat backs **(Figure 8)** and the lap belt retractors were located on the outboard aspects near the lower B-pillars. The integrated shoulder belts did not have height adjustments. The driver’s and front right passenger’s manual restraints exhibited signs of historical usage. The driver’s seat belt webbing was cut by rescue personnel to facilitate extrication of the driver, and loading evidence was present on the seat belt webbing in the NASS photographs. The EDR summary report indicated the driver’s belt switch circuit status as “buckled.” The front center position was configured with a lap belt that did not show any signs of historical usage.

Figure 8. View of the rear aspect of the integrated shoulder belt retractor

The rear seating positions in the Pontiac Bonneville were configured with manual 3-point lap and shoulder belts for each seating position. Each restraint was equipped with a cinching latch plate and an Emergency Locking Retractor (ELR).

FRONTAL AIR BAG SYSTEM – 2001 Pontiac Bonneville

The 2001 Pontiac Bonneville was equipped with dual-stage frontal air bags for the driver and front right passenger positions that deployed as a result of the frontal impact with the trees. The EDR summary report indicated that only the first stage deployed in this crash. The driver's air bag **(Figure 9)** was housed in the center of the steering wheel hub with symmetrical I-configuration module cover flaps. Each cover flap measured 7.5 cm (3.0") in width and 11.0 cm (4.3") in height. The driver's air bag measured 55.9 cm (22.0") in diameter in its deflated state. The air bag was tethered by four internal straps and vented by two circular ports located on the rear aspect of the air bag at the 10 and 2 o'clock positions. Body fluid (blood) was present on the front and rear surfaces of the air bag from the driver.

Figure 9. Deployed driver's air bag

The front right passenger's air bag deployed from a top-mount module **(Figure 10)**. The front right passenger's air bag measured 50.0 cm (19.7") in width and 50.0 cm (19.7") in height in its deflated state. The air bag was tethered by four internal straps and was vented internally through the instrument panel. There was no contact evidence present on the front right passenger's air bag.

Figure 10. Deployed front right passenger's air bag

SIDE IMPACT AIR BAG SYSTEM – 2001 Pontiac Bonneville

The 2001 Pontiac Bonneville was equipped with side impact air bags for the driver and front right passenger positions. The side impact air bags were located in the outboard aspects of the front seat backs. The driver's left side impact air bag **(Figure 11)** deployed as a result of the direct left side contact of the vehicle with the trees during the sideswipe event. The left side air bag impact sensor was located on the lower aspect of the left B-pillar. The driver's side impact air bag deployed forward from the outboard aspect of the driver's seat back. The plastic cover flap measured 8.0 cm (3.1") in width and 21.0 cm (8.3") in height and was hinged at the rear aspect. The driver's side impact air bag measured 37.0 cm (14.6") in height and deployed forward from the seat back approximately 38.0 cm (15.0"). A scuff was noted on the forward outboard aspect approximately 5.0 cm (2.0") aft of the forward seam. Body fluid (blood) was present on the inboard aspect of the driver's side impact air bag.

Figure 11. Left side view of driver's side impact air bag

OCCUPANT DEMOGRAPHICS – 2001 Pontiac Bonneville

Driver

Age/Sex:	32-year-old female
Height:	173 cm (68”)
Weight:	66 kg (145 lb)
Seat Track Position:	Between mid-track and full-rear positions
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Expired at the scene and not transported to any medical facility

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Left femur fracture, NFS	Serious (851800.3,2)	Left instrument panel and below
Left humerus fracture, NFS	Moderate (752600.2,2)	Left side interior door surface
Right lower leg fracture, NFS	Moderate (852002.2,1)	Left instrument panel and below
Facial fractures, NFS	Minor (250400.1,9)	Partial ejection and contact with trees
Forehead lacerations, NFS	Minor (290600.1,7)	Partial ejection and contact with trees
Bilateral lower leg abrasions	Minor (890202.1,3)	Left instrument panel and below
Bilateral lower leg contusions	Minor (890402.1,3)	Left instrument panel and below

Injury source: Medical Examiner’s report

Driver Kinematics

The 32-year-old female driver was presumed to have been seated in an upright posture with the seat track adjusted between the mid-track and full-rear positions. She was restrained by the integrated manual 3-point lap and shoulder belt.

The female driver was operating the vehicle eastbound on the three-lane roadway and relinquished control of the vehicle for unknown reasons. As the Pontiac Bonneville departed the left roadside in a tracking mode, the vehicle was tilted to its left due to the slope of the roadside. The driver initiated a lateral trajectory to the left as a result of the vehicle pitch, although the manual restraint usage mitigated significant lateral displacement.

As the vehicle struck multiple trees with the left side aspect, the left side glazing disintegrated from impact forces and the left side aspect of the vehicle sustained direct contact damage from the trees. The left side impact resulted in the deployment of the driver’s side air bag. The driver initiated a slight forward and lateral trajectory to the left and loaded the deployed side impact air

bag with her torso. Due to the vehicle's pitch, her head was probably partially ejected and may have struck one or more of the trees as the vehicle impacted them. The head contact with the trees resulted in facial lacerations and facial fractures. The Bonneville continued in a tracking mode and struck two additional trees with the front left aspect. The impact resulted in the single-stage deployment of the frontal air bag system. The driver initiated a forward trajectory in response to the frontal impact and loaded the manual restraint and the deployed driver's air bag. The frontal impact resulted in moderate passenger compartment intrusion. The driver loaded the intruded left instrument panel, left floor pan, and the steering wheel assembly which resulted in bilateral lower leg contusions and abrasions, a left humerus fracture, a left femur fracture, and a right lower leg fracture. The driver was pinned in the vehicle due to the frontal intruded components and expired at the scene. Rescue personnel reported that the driver was removed from the vehicle after a lengthy extrication and was not transported to any medical facility.

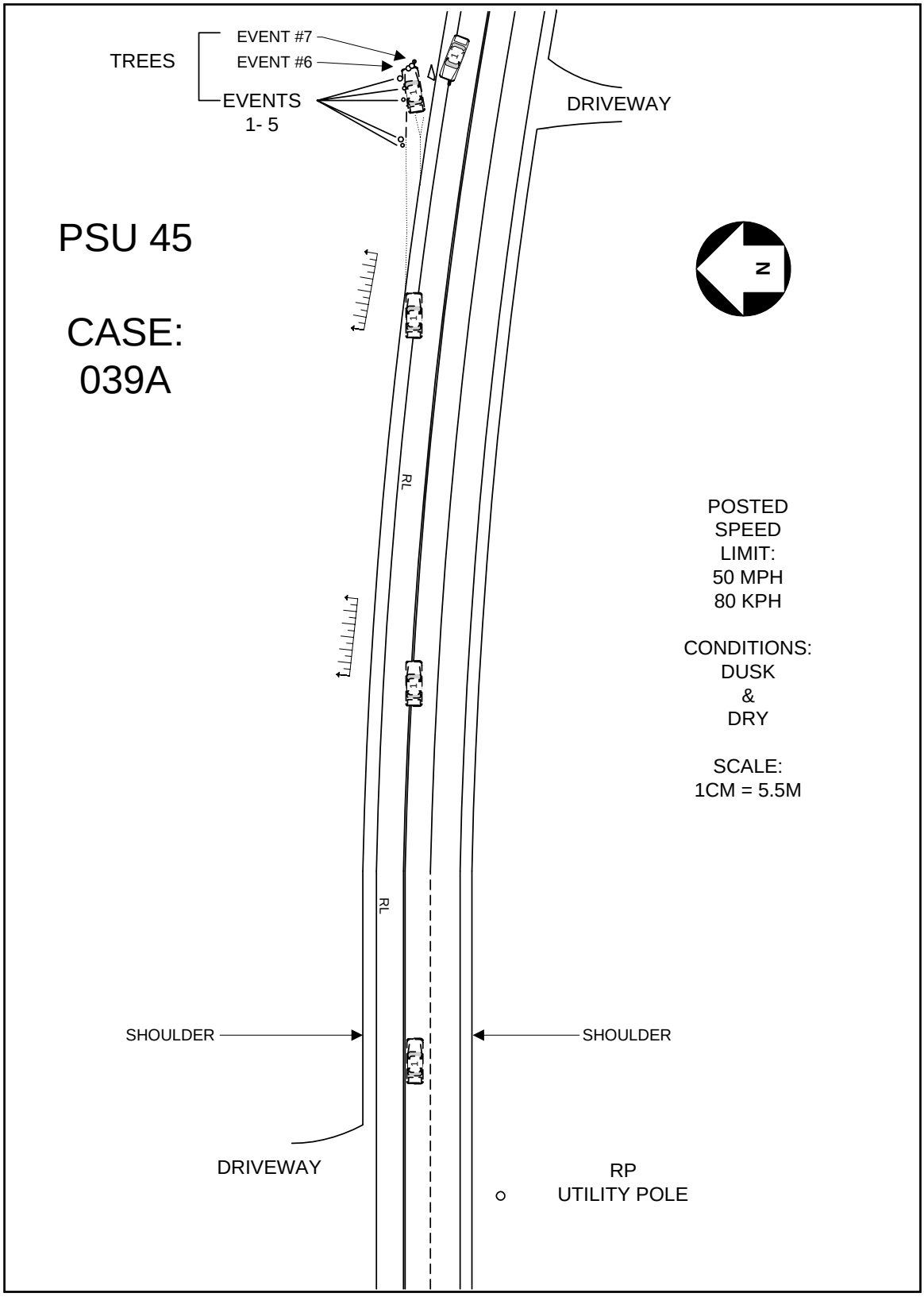

Figure 12. NASS scene schematic