

**CRASH DATA RESEARCH CENTER**

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**REDESIGNED AIR BAG SPECIAL STUDY (RABSS)  
SCI TECHNICAL SUMMARY REPORT**

**NASS CDS CASE NO. 1999-11-132A**

**RABSS VEHICLE - 1999 PONTIAC SUNFIRE**

**LOCATION - STATE OF MICHIGAN**

**CRASH DATE - AUGUST, 1999**

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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16. <i>Abstract</i> <p>This investigation focused on a single vehicle crash involving a 1999 Pontiac Sunfire 2-door coupe equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of a frontal collision with a large diameter tree. The driver of the Pontiac Sunfire was operating the vehicle eastbound on a 2-lane rural roadway and negotiating a left curve when he allowed the vehicle to depart the right (south) pavement edge in a forward tracking mode. As the vehicle exited the right pavement edge, the front right area made initial contact to a signpost resulting in minor damage. The vehicle continued eastbound as the right side surface sideswiped a telephone junction box which also resulted in minor damage. The front left area subsequently impacted a large diameter tree resulting in moderate damage. At impact with the tree, the restrained 33 year old male driver of the 1999 Pontiac Sunfire initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Loading of the manual restraint resulted in a small "scratch" to the left upper chest while bag expansion against the wrist watch resulted in a small laceration/abrasion to the left posterior wrist. He was transported to a local hospital for treatment and released. The 34 year old female front right passenger was seated out-of-position sitting sideways and leaning to the left. She was improperly restrained by the 3-point manual lap and shoulder belt system with the lap belt riding high over the right hip and shoulder belt across the neck. At impact with the tree, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint resulting in a multitude of soft tissue injuries to the neck and abdomen with associated underlying internal injury to the spleen, liver and right kidney. Improper belt placement also resulted in a cervical spine fracture and unspecified head trauma which produced cerebral brain swelling. The front right passenger was pronounced deceased at the scene.</p>			
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CRASH DATE - AUGUST, 1999**

***BACKGROUND***

This investigation focused on a single vehicle crash involving a 1999 Pontiac Sunfire 2-door coupe equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of a frontal collision with a large diameter tree. The driver of the Pontiac Sunfire was operating the vehicle eastbound on a 2-lane rural roadway and negotiating a left curve when he allowed the vehicle to depart the right (south) pavement edge in a forward tracking mode. As the vehicle exited the right pavement edge, the front right area made initial contact to a signpost resulting in minor damage. The vehicle continued eastbound as the right side surface sideswiped a telephone junction box which also resulted in minor damage. The front left area subsequently impacted a large diameter tree resulting in moderate damage. At impact with the tree, the restrained 33 year old male driver of the 1999 Pontiac Sunfire initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Loading of the manual restraint resulted in a small "scratch" to the left upper chest while bag expansion against the wrist watch resulted in a small laceration/abrasion to the left posterior wrist. He was transported to a local hospital for treatment and released. The 34 year old female front right passenger was seated out-of-position sitting sideways and leaning to the left. She was improperly restrained by the 3-point manual lap and shoulder belt system with the lap belt riding high over the right hip and shoulder belt across the neck. At impact with the tree, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint resulting in a multitude of soft tissue injuries to the neck and abdomen with associated underlying internal injury to the spleen, liver and right kidney. Improper belt placement also resulted in a cervical spine fracture and unspecified head trauma which produced cerebral brain swelling. The front right passenger was pronounced deceased at the scene.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 1999-11-132A and also included in the Redesigned Air Bag Special Study. The Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian the task of case review and final report preparation.

***SUMMARY***

**Crash Site**

This single vehicle crash occurred during the early morning hours of August, 1999. At the time of the crash, it was dark (street not lighted) with a light fog reported as the road was dry. The crash occurred off the south pavement edge of a level 2-lane east/west rural roadway which curved left for eastbound traffic (see **Figure 10 - page 8**). The asphalt pavement changed to a gravel surface 12.7 meters (41.7 feet) west of the crash site. No traffic control was present at the scene which had a posted speed limit of 89 km/h (55 mph).

### Pre-Crash

The 33 year old male driver of the 1999 Pontiac Sunfire was operating the vehicle eastbound (**Figure 1**) and negotiating a left curve when he became distracted by sexual activities with the passenger and allowed the vehicle to depart the right (south) pavement edge in a forward tracking mode (**Figure 2**). The police reported no pre-impact brake marks indicative of driver avoidance maneuvers.



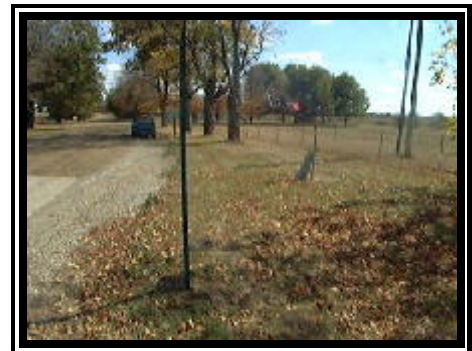
**Figure 1.** Eastbound approach for the 1999 Pontiac Sunfire.



**Figure 2.** Pre-impact trajectory off the south pavement edge.

### Crash

As the Pontiac Sunfire departed the right (south) pavement edge, the vehicle traveled 19.7 meters (64.6 feet) as the front right area made initial contact to a small diameter signpost (**Figure 3**) resulting in minor damage. The vehicle continued 7.2 meters (23.6 feet) in an easterly direction as the right rear side surface sideswiped a telephone junction box resulting in minor damage. At this point, the vehicle continued 12.0 meters (39.4 feet) as the front left area impacted a large diameter tree which resulted in moderate damage. The WinSMASH reconstruction program computed a barrier equivalent velocity change of 48.4 km/h (30.1 mph) with a respective longitudinal component of -47.7 km/h (-29.6 km/h), which seemed high. The impact induced deceleration was sufficient to deploy the Pontiac's redesigned frontal air bag system. At this point, the vehicle rotated approximately 30 degrees counterclockwise and came to rest in close proximity to the final point of impact facing southeast.



**Figure 3.** Impacts #1-3 (signpost-foreground, telephone junction box, and large diameter tree-background).

### Post-Crash

The driver exited the vehicle under his own power and fled the scene on foot. He was later found by police wandering the area asking local residents for a ride home. He was subsequently transported by police vehicle to the emergency room of a local hospital and released into police custody. Police arrived on-scene approximately 2.5 hours following the crash to find the passenger (deceased) still in the vehicle. She was officially pronounced deceased on-scene approximately 6 hours post-crash, and was

removed from the vehicle and transported to the local morgue 6.5 hours post-crash. No fire department personnel were summoned to the crash site. The vehicle was towed from the crash site due to disabling damage.

### ***RABSS VEHICLE***

The 1999 Pontiac Sunfire was identified by the vehicle identification number (VIN): 1G2JB1249X7 (production number deleted). The rental vehicle was a 2-door coupe equipped with front-wheel drive and a 2.2 liter, 4 cylinder engine. The odometer reading at the time of the crash was unknown. The seating was configured with front bucket and rear bench seats (with folding backs). Previous crashes or maintenance on the Pontiac's frontal air bag system were unknown. Cell phone presence/usage at the time of the collision was also unknown.

### ***VEHICLE DAMAGE***

#### **Exterior**

The 1999 Pontiac Sunfire sustained moderate frontal damage as a result of the impact with the tree (**Figure 4**). The direct contact damage began 5.0 cm (2.0 in) right of the front left bumper corner and extended 54.0 cm (21.3 in) inboard. The impact deformed the entire front end width resulting in a combined direct and induced damage length (Field L) of 90.0 cm (35.4 in). Six crush measurements were documented at the level of the bumper: C1= 64.0 cm (25.2 in), C2= 73.0 cm (28.7 in), C3= 69.0 cm (27.2 in), C4= 61.0 cm (24.0 in), C5= 22.0 cm (8.7 in), C6= 12.0 cm (4.7 in). The crush profile seemed overstated, however, inadequate field documentation prohibited further SCI analysis for correctional purposes. The *SCI revised* Collision Deformation Classification (CDC) for this impact to the Pontiac was 12-FYEW-3 with a principal direction of force of 0 degrees. The hood was displaced up and rearward from engagement against the tree. Rearward displacement of the left fender restricted the left front wheel/tire (not deflated) and jammed the left door. Induced rearward displacement of the left A-pillar buckled the roof and side rail areas. The windshield was fractured from exterior impact forces and the interior passenger air bag module cover flap. The right rear tire was deflated (not restricted). Reduction in the left side wheelbase measured 22.0 cm (8.7 in).



**Figure 4. Front left damage to the 1999 Pontiac Sunfire.**

A U-beam signpost imprint was documented to the front right area attributed to the (initial) signpost impact; with no subsequent (hood/roof) wrap contact identified. The direct contact damage began 25.0 cm (9.8 in) to the left of the front right bumper corner and extended 10.0 cm (3.9 in) inboard. Although classified as overlapping damage, the vehicle bumper probably sustained no crush from this yielding object, and thus, would not invalidate any WinSMASH outputs for the highest Delta-V event. The estimated CDC for this impact was 12-FREN-1. Surface scratching (*sideswipe damage*) was also noted to the right rear side surface attributed to the telephone junction box impact. The estimated CDC for this impact was 12-RPLS-1.

## Interior

Interior damage to the Pontiac Sunfire identified through the vehicle inspection was moderate and attributed to occupant contact and component intrusion (**Figures 5 & 6**). Scuff marks and indentations were documented on the left knee bolster and glove compartment door. Additional scuff marks were identified on the left (mid) and center (lower) instrument panel areas. The (floor mounted) gearshift knob was displaced slightly to the left. Loading marks and possible tissue transfers were documented on the front left and right shoulder belt webbings. Deformation to the upper portion of the steering wheel rim measured 6.5 cm (2.6 in). Longitudinal intrusions into the front occupant space involved 12.0 cm (4.7 in) of left toepan and 10.0 cm (3.9 in) of center floor intrusion.



**Figure 5. Deformation to the steering wheel rim.**



**Figure 6. Scuff marks and indentations to the driver knee bolster.**

## ***REDESIGNED AIR BAG SYSTEM***

The 1999 Pontiac Sunfire was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags deployed as a result of the crash. The driver air bag was housed in the center of the steering wheel with a vertically oriented flap tear seam (I-configuration). No contact evidence was identified on the air bag or exterior surface of the module cover flaps. The flaps were symmetrical in shape and measured 7.0 cm (2.8 in) in width and 10.0 cm (3.9 in) in height. The NASS researcher measured the diameter of the driver air bag at 54.0 cm (21.3 in) in its deflated state (**Figure 7**). The bag was vented by two ports located at the 9 o'clock and 3 o'clock sectors on the rear aspect of the air bag. No internal tether straps were present.

The front right passenger air bag deployed from the right top instrument panel area with a single cover flap design hinged at the forward aspect. No contact evidence was identified on the air bag or exterior surface of the module cover flap. The cover flap was rectangular in shape and measured 33.0 cm (13.0 in) in width and 17.0 cm (6.7 in) in height. The NASS researcher measured the passenger air bag at 44.0 cm (17.3 in) in width and 60.0 cm (23.6 in) in height in its deflated state (**Figure 8**). The bag was tethered by two internal straps. No vent ports were reported for the front right passenger air bag.





**Figure 7. 1999 Pontiac Sunfire deployed redesigned driver air bag.**



**Figure 8. 1999 Pontiac Sunfire deployed redesigned passenger air bag.**

### ***DRIVER DEMOGRAPHICS***

Age/Sex:	33 year old male
Height:	170 cm (67 in)
Weight:	70 kg (155 lb)
Seat Track Position:	Mid-to-forward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, police report
Eyewear:	None
Type of Medical Treatment:	Transported to the emergency room of a local hospital for treatment and released

### **Driver Injuries**

<b><i>Injury</i></b>	<b><i>Severity (AIS 90)</i></b>	<b><i>Injury Mechanism</i></b>
*Laceration left collar bone area (scratch)	Minor (790602.1,2)	Shoulder belt webbing
*Laceration left posterior wrist (NFS)	Minor (790600.1,2)	Jewelry-watch (air bag related injury)
*Abrasion left posterior wrist	Minor (790202.1,2)	Jewelry-watch (air bag related injury)

*source - police report\**

### **Driver Kinematics**

The 33 year old male driver of the 1999 Pontiac Sunfire was restrained by the available 3-point manual lap and shoulder belt system, presumed to be seated in a reclined posture with the seat track adjusted to the mid-to-forward position. Belt usage was evidenced by the loading marks documented to the webbing of the front left restraint and associated soft tissue injury sustained to the upper left chest area.

At impact with the signpost and telephone junction box, the driver probably remained in his pre-impact posture as these minor impacts offered little or no resistance to the vehicle, nor produce an occupant kinematic response. At impact with the tree, he initiated a forward trajectory in response to the 12

o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Contact to the knee bolster was confirmed by the scuff marks and indentations documented to this component. In addition, the pre-impact seat back recline position *may have* allowed the driver to submerge the restraint and load the upper portion of the steering wheel rim which rotated 180 degrees counterclockwise at maximum engagement against the tree. Deformation to the steering wheel rim confirmed occupant interaction, however, limited injury information prohibited further analysis of any potential injury mechanisms. Bag expansion against the left forearm compressed the driver's watch into the soft tissue, resulting in a small abrasion/laceration to the posterior wrist. Although data suggested this may be an air bag "fling" type injury, a pre-impact hand placement at the 8 o'clock position on the steering wheel rim is a more probable scenario for this injury mechanism, given the lack of associated soft tissue injury to the *anterior* forearm and contact evidence to the left A-pillar. The driver exited the vehicle under his own power and fled the scene on foot. He was found approximately 3 hours later by police wandering the area asking local residents for a ride home. He was subsequently transported by police vehicle to a local hospital for treatment and released into custody.

***FRONT RIGHT PASSENGER DEMOGRAPHICS***

Age/Sex: 34 year old female  
 Height: 163 cm (64 in)  
 Weight: 60 kg (133 lb)  
 Seat Track Position: Middle position  
 Manual Restraint Use: 3-point lap and shoulder belt system (*improper usage*)  
 Usage Source: Vehicle inspection, surrogate interview, police report  
 Eyewear: None  
 Type of Medical Treatment: None (*pronounced deceased at the scene*)

**Front Right Passenger Injuries**

<b><i>Injury</i></b>	<b><i>Severity (AIS 90)</i></b>	<b><i>Injury Mechanism</i></b>
*Laceration liver (2 major-large) (right oblique superior capsular and left lobar parenchymal)	Severe (541826.4,1)	Shoulder belt webbing
*Cerebral brain swelling (mild)	Serious (140662.3,9)	Shoulder belt webbing
*Contusion left lung (lower lobe)	Serious (441406.3,2)	Shoulder belt webbing
*Laceration spleen (2 deep-moderate)	Serious (544224.3,2)	Shoulder belt webbing
*Fracture cervical spine (at C2/C3 with dislocation)	Moderate (650216.2,6)	Shoulder belt webbing
*Laceration right kidney (NFS)	Moderate (541620.2,1)	Shoulder belt webbing
*Abrasion right anterior/lateral neck (cloth weave/linear patterned)	Minor (390202.1,1)	Shoulder belt webbing
*Abrasion right posterior flank (long/curve patterned)	Minor (690202.1,1)	Shoulder belt webbing

## Front Right Passenger Injuries (con't.)

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
*Abrasion superior abdomen (extending from right back)	Minor (590202.1,7)	Shoulder belt webbing
*Laceration right dorsolateral forearm (2cm-minor/sharp)	Minor (790602.1,1)	Flying glass (non-contact injury)
*Laceration left posterior index finger (0.6cm-minor)	Minor (790602.1,2)	Flying glass (non-contact injury)
*Abrasion right lateral thigh, knee, shin	Minor (890202.1,1)	Glove compartment door
*Abrasion left anterior knee	Minor (890202.1,2)	Center instrument panel
*Laceration right lateral shin	Minor (890602.1,1)	Glove compartment door

source - autopsy report\*

## Front Right Passenger Kinematics

The 34 year old female front right passenger of the 1999 Pontiac Sunfire was out-of-position sitting sideways and leaning to the left. Her left hip was against the seat back with her upper torso in the prone position across the center console and arm(s) extended into the driver's lap. She was improperly restrained by the available 3-point manual lap and shoulder belt system with the lap portion riding high over the right hip and shoulder portion across the right neck. Belt usage was evidenced by the nature and extent of the injuries sustained relative to the loading marks documented on the front right shoulder belt webbing (**Figure 9**). Furthermore, the police found the deceased still in the vehicle "*slouched down and tangled in the restraint*". The seat track was adjusted to the middle position with the seat back slightly reclined.

At impact with the signpost and telephone junction box, the passenger probably remained in her pre-impact posture as these minor impacts offered little or no resistance to the vehicle, nor produce an occupant kinematic response. At impact with the tree, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and lower (right/center) instrument panel area. Improper placement of the lap restraint high over the right hip resulted in multiple soft tissue injuries across the abdomen and right flank area. This injury mechanism also produced extensive internal injury to include lacerations of the spleen, liver, and right kidney. Improper pre-crash posture and placement of the shoulder portion across the neck resulted in abrasions to the right lateral neck and flank areas with an underlying left lung contusion. In addition, the lateral load concentrated to the neck region resulted in a cervical fracture at the C2/C3 position. She also sustained cerebral brain swelling which *may have been* a result of contact to the upper portion of the steering wheel rim as it rotated counterclockwise at maximum engagement against the tree, however, the lack of official soft



**Figure 9. Loading marks to the front right shoulder belt webbing.**

tissue injury to the scalp makes this only a plausible scenario. It should be noted that the scuff marks and indentations identified to the left knee bolster accurately places the location of the driver's lower extremities at impact, and thus, may rule him out as a source of the rim deformation. At this point, the front right passenger struck the glove compartment door and (lower) center instrument panel area which resulted in abrasions/lacerations to the right lateral thigh and left anterior knee. These injury mechanisms were evidenced by the scuff marks and indentations documented to these components, and further indicates an abnormal pre-impact posture by the passenger. She also sustained lacerations to the right lateral forearm and posterior left hand from flying glass (non-contact injury). The deceased passenger was found by police 2.5 hours following the crash still in the vehicle and lying across the front seats partially in the prone position "*tangled in the restraint*". She was officially pronounced deceased at the scene approximately 6 hours following the crash and was subsequently removed from the vehicle for transport to the local morgue. Given the improper pre-impact posture and belt placement, the passenger redesigned air bag offered no protection to the occupant nor mitigate any of the fatal injuries sustained.

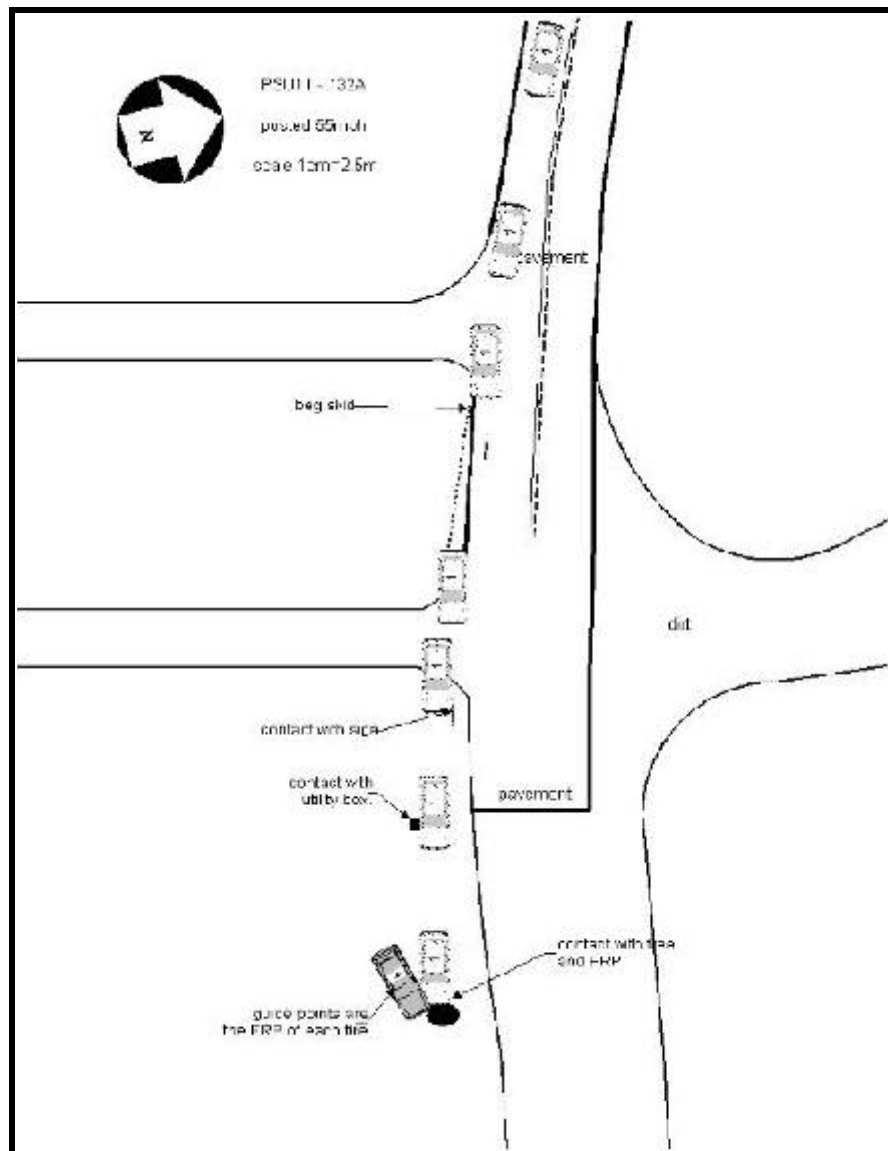


Figure 10. NASS Scene Diagram (impact #1 plotted incorrectly by researcher).