



INDIANA UNIVERSITY

TRANSPORTATION RESEARCH CENTER

School of Public and Environmental Affairs

222 West Second Street

Bloomington, Indiana 47403-1501

(812) 855-3908 Fax: (812) 855-3537

REMOTE AIR BAG DEPLOYMENT REPORT

CASE NUMBER - IN99-008

LOCATION - Maryland

VEHICLE - 1998 SATURN SL1

CRASH DATE - February 1998

Submitted:

August 26, 1999

Revised:

September 8, 2000



Contract Number: DTNH22-94-D-17058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
National Center for Statistics and Analysis
Washington, D.C. 20590-0003

DISCLAIMERS

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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

Technical Report Documentation Page

1. <i>Report No.</i> IN99-008		2. <i>Government Accession No.</i>		3. <i>Recipient's Catalog No.</i>	
4. <i>Title and Subtitle</i> Remote Air Bag Deployment Investigation Vehicle - 1998 Saturn SL1 Location - Maryland			5. <i>Report Date:</i> August 26, 1999		
			6. <i>Performing Organization Code</i>		
7. <i>Author(s)</i> Special Crash Investigations Team #2			8. <i>Performing Organization Report No.</i> Task # 0192		
9. <i>Performing Organization Name and Address</i> Transportation Research Center Indiana University 222 West Second Street Bloomington, Indiana 47403-1501			10. <i>Work Unit No. (TRAIS)</i>		
			11. <i>Contract or Grant No.</i> DTNH22-94-D-17058		
12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation (NRD-32) National Highway Traffic Safety Administration National Center for Statistics and Analysis Washington, D.C. 20590-0003			13. <i>Type of Report and Period Covered</i> Technical Report Crash Date: February 1998		
			14. <i>Sponsoring Agency Code</i>		
15. <i>Supplementary Notes</i> Remote air bag deployment investigation involving a 1998 Saturn SL1, 4-door sedan, with manual safety belts and dual redesigned front air bags, and a 1995 Freightliner, 6x4, truck tractor with a semi-trailer					
16. <i>Abstract</i> This report covers a remote investigation of an air bag deployment crash that involved a 1998 Saturn SL1 (case vehicle) and a parked and unoccupied 1995 Freightliner truck-tractor with a semi-trailer (vehicle #2). This crash is of special interest because the case vehicle was equipped with redesigned air bags that deployed as a result of the collision events, and the restrained driver (57-year-old male) sustained fatal head injuries as a result of impacting components intruding into the front seating area. The case vehicle was traveling south in the southbound lane of a two-lane, undivided, city street. Vehicle #2 was unoccupied and legally parked, heading south, on the west shoulder of the road. The case vehicle traveled onto the west (right), asphalt shoulder, and its front impacted the rear underride guard of vehicle #2's semi-trailer (i.e., a channel iron attached to the trailer's undercarriage by inverted triangles of metal designed to retard vehicles from sliding under the bottom of the trailer), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle's driver had a BAC of 0.33%. No pre-impact avoidance maneuvers were reported by two witnesses, and investigating officers found no pre-impact skid marks. The pre-crash posture, seat adjustments, or steering wheel position of the case vehicle's driver (57-year-old male) is unknown. He was restrained by his available, active, three-point, lap and shoulder belt and sustained, according to his autopsy, multiple frontal bone fractures with displacement into the cranial cavity; fractures of his left parietal bone, right temporal bone, nasal bone, maxilla (multiple), and zygoma; a complex basilar skull fracture; extensive brain lacerations involving his right and left frontal and temporal lobes; diffuse subarachnoid hemorrhage involving both cerebral hemispheres; and lacerations to his forehead (deep) and chin					
17. <i>Key Words</i> Redesigned Air Bag Deployment			Motor Vehicle Traffic Crash Injury Severity		
18. <i>Distribution Statement</i> General Public					
19. <i>Security Classif. (of this report)</i> Unclassified		20. <i>Security Classif. (of this page)</i> Unclassified		21. <i>No. of Pages</i> 6	22. <i>Price</i> \$2,500

TABLE OF CONTENTS

	<u>Page No.</u>
BACKGROUND	1
CRASH CIRCUMSTANCES	1
CASE VEHICLE	2
CASE VEHICLE DRIVER	3
CASE VEHICLE DRIVER'S INJURIES	4
VEHICLE #2	6
 SELECTED PHOTOGRAPHS	
Figure 1: Southward view of case vehicle at final rest underneath vehicle #2's semi-trailer	1
Figure 2: Case vehicle's extent of underride	1
Figure 3: Case vehicle's front right corner contact with vehicle #2's right rear tandem tires	2
Figure 4: Case vehicle's underride showing extent almost to "B"-pillars	2
Figure 5: Case vehicle's contact with vehicle #2's undercarriage	3
Figure 6: Case vehicle driver's post-impact position	3

Additional photographs are available in SCI EDCS case IN99-008

This case was brought to the NHTSA's attention by a review of the 1998 Fatality Analysis Reporting System (FARS) in February 1999. The crash involved a 1998 Saturn SL1 (case vehicle) and a parked and unoccupied 1995 Freightliner truck tractor with a semi-trailer (vehicle #2). The crash occurred in February, 1998, at 4:53 p.m., in Maryland, and was investigated by the applicable municipal police department. This case is of special interest because the case vehicle was equipped with redesigned air bags that deployed as a result of collision events, and the restrained driver [57-year-old, White (unknown if Hispanic) male] was fatally injured. The Police Crash Report was received in March 1999. A complete Coroner's autopsy report was obtained in May and the police photographs arrived in June. This report is based on the Police Crash Report, the autopsy report, police photographs, occupant kinematic principles, and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The case vehicle was traveling south in the southbound lane of a two-lane, undivided, city street (**Figure 1**). Vehicle #2 was unoccupied and legally parked on the right (west) shoulder, facing south. It was daylight, overcast, no rain at the time of the crash, and no visibility problems. The roadway was bituminous, dry, straight, and had no roadway defects. No assessment of the roadway's vertical alignment was available. Posted speed limit was 64 km.p.h. (40 m.p.h.). The crash occurred on the west (right) shoulder. The only traffic control devices consisted of regulatory SPEED LIMIT signs and pavement markings. Pavement markings included: a single broken yellow centerline with a solid yellow no passing line for southbound traffic and single solid white edge lines on the east and west pavement edges. Each side of the street had 2.8 meter (9.3 foot) asphalt shoulders bordered by concrete curbs of unmeasured height. The absence of pre-impact skid marks from the case vehicle and observations from two witnesses indicate that the case vehicle's driver did not attempt any avoidance maneuvers prior to impact.

The front of the case vehicle impacted the rear of vehicle #2's semi-trailer, contacting the trailer's underride guard (i.e., a channel iron attached to the trailer's undercarriage by inverted triangles of metal designed to retard vehicles from sliding under the bottom of the trailer--**Figure 2**) and causing the case vehicle's driver and front right passenger air bags to deploy. Investigating officers measured the case vehicle's underride distance as 1.7 meters (5.67 feet),

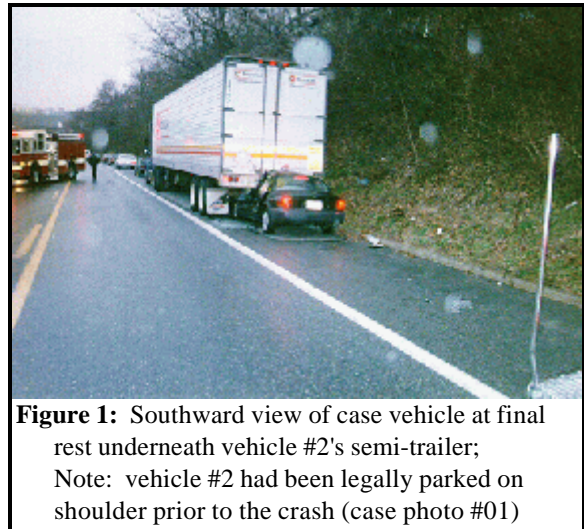


Figure 1: Southward view of case vehicle at final rest underneath vehicle #2's semi-trailer;
Note: vehicle #2 had been legally parked on shoulder prior to the crash (case photo #01)

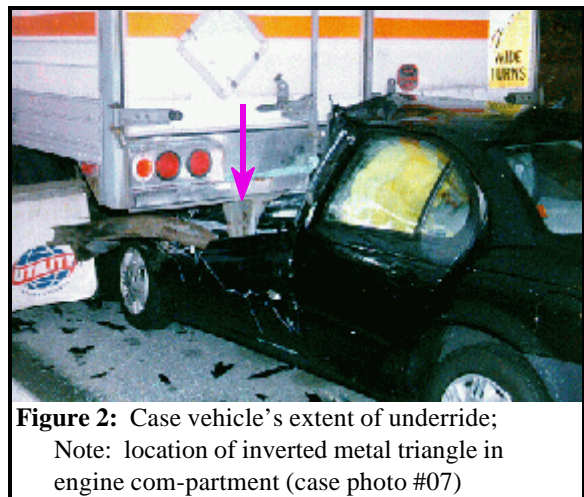


Figure 2: Case vehicle's extent of underride;
Note: location of inverted metal triangle in engine compartment (case photo #07)

in a straight travel path. No contact was made with the left rear tandem wheels of the semi-trailer by the front left corner of the case vehicle. The case vehicle's front right corner contacted vehicle #2's rearmost tandem wheels on the semi-trailer's right side (**Figure 3**). Penetration of the case vehicle underneath the trailer almost reached the "B"-pillars. No post-impact rotation by the case vehicle was discovered.



Figure 3: Case vehicle's front right corner contact with vehicle #2's right rear tandem tires (case photo #12)

It was estimated by two witnesses that the case vehicle was traveling approximately 56 km.p.h. (35 m.p.h.) immediately prior to its frontal impact with the back surface of vehicle #2's semi-trailer. That speed equates to 15.6 meters (51.3 feet) per second. Although the investigating officers measured the case vehicle's underride distance of 1.7 meters (5.67 feet), this contractor, using vehicle specification data, expanded that underride distance to 2.5 meters (8.3 feet). Thus, the case vehicle decelerated from its travel speed to zero in approximately 0.16 seconds. Police photographs indicate that the underride guard was almost vertically aligned with the lower edge of the trailer's back plane.

CASE VEHICLE

The case vehicle was a front wheel drive, 1998 Saturn SL1, five-passenger, four-door sedan (VIN: 1G8ZH5289WZ-----) equipped with a 1.9L, I-4 gasoline engine with an unknown transmission type (five-speed manual or four-speed automatic) and shift lever location. Four-wheel anti-lock brakes were an option for this vehicle, but it is not known if it was so equipped. The wheelbase for the case vehicle was 260 centimeters (102.4 inches). An odometer reading was not reported. The case vehicle was towed due to disabling damage.

The case vehicle sustained direct contact across the entire width of its front end. The front bumper and fascia were shoved rearward and downward. The grille and headlamp assemblies were shattered and broken away. Front radiator and engine compartment brackets were laid over towards the cowl. The front hood was peeled rearward and folded in thirds, with the forward hood edge pointing forward. The left fender was also peeled rearward and the front of the right fender was pushed back and down. Many of the engine compartment components affixed on or around the engine block were shoved rearward and down. The lower edge of the trailer's back plane contacted the top third of the windshield and shoved it and the front header almost to the "B"-pillars (**Figure 4** above and **Figure 5**). The top third of the windshield



Figure 4: Case vehicle's underride of vehicle #2 showing extent of underride extending almost to "B"-pillars and is offset to back right of semi-trailer (case photo #05)

remained attached to the header, but the bottom two-thirds was fractured along its entire width and laid down with the “A”-pillars. The left side roof rail and roof were buckled at the “B”-pillar. Front door window glazing on both sides was shattered (kernelized). All four doors remained closed. The upper right quadrant of the exterior left front door panel was broken and moved rearward.

Based on the police photographs, the CDC for the case vehicle is estimated as: **12-FDAA-8**. This crash is outside the scope for the WinSMASH reconstruction program. The crash severity for the case vehicle was estimated as high [greater than 40 km.p.h. (25 m.p.h.)].

Heavy intrusion occurred into the case vehicle’s passenger compartment, but the intrusion was limited to the greenhouse area (i.e., top third of the windshield, the “A”-pillars, the front header, and the front portion of the roof). These components were pushed rearward almost to the “B”-pillars of the case vehicle by the bottom edge of vehicle #2’s semi-trailer. From available police photographs it appears that the tops of the instrument panel and the steering wheel were not damaged, neither were the window sills of the two front door panels.

CASE VEHICLE DRIVER

The case vehicle’s driver [188 centimeters and 91 kilograms (74 inches, 200 pounds)] was restrained by his available, manual, three-point, lap and shoulder safety belt system. There were no other occupants in the vehicle. The driver’s pre-crash seat adjustments, steering wheel adjustment, and body posture are not known; however, his post-crash body position is known. He was sitting essentially upright with his three-point safety belt still buckled, but his body had been forced backwards into his seat back. His face appears (**Figure 6**) to be in contact with the windshield. Toxicology analysis reported a BAC of 0.33%. Two witnesses indicated that the case vehicle traveled onto the west shoulder and impacted the rear of vehicle #2’s semi-trailer without any detectable avoidance maneuver. No pre-impact skid marks were noted by investigating officers.

The following discussion is based on a full autopsy report, police on-scene photographs, and occupant kinematic principles. As the case vehicle



Figure 5: Case vehicle’s contact with vehicle #2’s undercarriage; Note: sheared underride guard channel iron (case photo #06)



Figure 6: Case vehicle driver’s post-impact position sitting upright but back against his seat back; Note: driver’s face (arrow) is hidden behind the wind-shield which has intruded into front seating area and red spot is blood from the driver’s face which has dripped onto his shirt (case photo #15)

impacted the rear underride guard, the deceleration enabled the driver to continue forward, most likely loading his safety belt and the deploying air bag; although, this contractor cannot be certain of the degree to which the driver loaded his safety belt and/or air bag since there are no available photographs of the air bag’s surface and his medical records do not indicate any safety belt or air bag-related injuries. The lower edge of the semi-trailer’s back plane contacted the top third of the windshield and pushed the glazing into the head and face of the case vehicle’s driver (**Figure 6** above), stopping and reversing his forward momentum. This contact caused the driver’s head and facial injuries.

CASE VEHICLE DRIVER INJURIES

He was pronounced dead at the scene of the crash and was transported directly to the morgue. According to his autopsy, the injuries sustained by the case vehicle’s driver included: a frontal bone fracture, at multiple sites, with displacement into the cranial cavity; a fractured left parietal bone; a fractured right temporal bone; a complex basilar skull fracture; extensive brain lacerations involving the inferior surfaces of the right and left frontal and temporal lobes; diffuse subarachnoid hemorrhage involving both cerebral hemispheres; fractured nasal bones; multiple maxillary fractures; a fractured zygoma; a deep forehead laceration; and a chin laceration. These injuries resulted from contacting the windshield which had been pushed rearward and reinforced by the back of vehicle #2's semi-trailer. Multiple lacerations of the right hand resulted from contact with the lower two-thirds of the windshield. A lacerated left knee and bilateral contusions to the lower extremities followed contact with the left lower instrument panel.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture frontal bone, multiple sites, with displacement into cranial cavity; a linear fracture ran through the parietal bone (unspecified aspect) along the sagittal suture and reached the lambdoid suture	150404.3 serious	Windshield reinforced by exterior object (i.e., rear surface of other motor vehicle)	Certain	Autopsy
2	Fracture left parietal bone	150402.2 moderate	Windshield reinforced by exterior object (i.e., rear surface of other motor vehicle)	Certain	Autopsy
3	Fracture right temporal bone along its lateral aspect	150402.2 moderate	Windshield reinforced by exterior object (i.e., rear surface of other motor vehicle)	Certain	Autopsy

Case Vehicle Driver Injuries (Continued)

IN99-008

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
4	Fracture, complex, basilar skull including fractures of the right and left anterior cranial fossa with displacement of the right eye into the cranial cavity, left middle cranial fossa along the lesser wing of the sphenoid bone, and a hinge fracture across the posterior cranial fossa transecting the clivus	150206.4 severe	Windshield reinforced by exterior object (i.e., rear surface of other motor vehicle)	Certain	Autopsy
5 6	Lacerations, extensive, of inferior surfaces of right and left frontal and temporal lobes by multiple bone fragments	140688.4 140688.4 severe	Windshield reinforced by exterior object (i.e., rear surface of other motor vehicle)	Certain	Autopsy
7 8	Hemorrhage, subarachnoid, diffuse, in frontal, parietal, and occipital lobes, bilaterally	140684.3 140684.3 serious	Windshield reinforced by exterior object (i.e., rear surface of other motor vehicle)	Certain	Autopsy
9	Fracture nasal bones with leftward displacement	251004.2 moderate	Windshield reinforced by exterior object (i.e., rear surface of other motor vehicle)	Certain	Autopsy
10 11	Fractures maxilla, multiple sites, both laterally and midline with displacement of both 1 ST teeth	250800.2 250200.2 moderate	Windshield reinforced by exterior object (i.e., rear surface of other motor vehicle)	Certain	Autopsy
12	Fracture zygoma (most likely right)	251800.2 moderate	Windshield reinforced by exterior object (i.e., rear surface of other motor vehicle)	Certain	Autopsy
13	Laceration, deep, forehead 8.9 x 7.6 centimeters (3.5 x 3 inches)	290602.1 minor	Windshield glazing	Certain	Autopsy
14	Laceration chin, 3.8 centimeters (1.5 inches)	290602.1 minor	Windshield glazing	Certain	Autopsy

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
15	Lacerations (3) dorsum of right hand at base right thumb, base of 2 ND and 3 RD fingers, and along medial edge right hand	790602.1 minor	Windshield glazing	Probable	Autopsy
16	Laceration above and at left knee, not further specified	890600.1 minor	Knee bolster, driver's	Possible	Autopsy
17	Contusions {hematomas} left and right lower extremities	890402.1 minor	Left lower instrument panel	Possible	Autopsy

VEHICLE #2

Vehicle #2 was a 1995 Freightliner, 6x4, medium conventional truck-tractor, with an aluminum cab and a Cummins M11 diesel engine. Attached to the truck-tractor was a 1991 Utility van semi-trailer with two axles. The semi-trailer was 14.6 meters (48 feet) in length. The truck-tractor was equipped with air brakes and had a wheelbase of 391 centimeters (154 inches). An odometer reading was not reported. Vehicle #2 was unoccupied and legally parked on the roadway's west shoulder. An estimated TDC for vehicle #2 is **06-BZLR-A**.