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## REMOTE AIR BAG DEPLOYMENT REPORT

CASE NUMBER - IN99-035

LOCATION - Texas

VEHICLE - 1998 SATURN SL2

CRASH DATE - April 1998

Submitted:

June 22, 1999



Contract Number: DTNH22-94-D-17058

Prepared for:

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

**Technical Report Documentation Page**

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15. <i>Supplementary Notes</i> Remote air bag deployment investigation involving a 1998 Saturn SL2 with manual safety belts and dual redesigned front air bags, and a 1996 Western Star tractor-trailer rig					
16. <i>Abstract</i> This report covers a remote investigation of an air bag deployment crash that involved a 1998 Saturn SL2 (case vehicle, vehicle #2) and a 1996 Western Star tractor-trailer rig (vehicle #1). 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. The unrestrained driver (50-year-old male) and the restrained front right passenger (46-year-old female) were both killed. The case vehicle was traveling south in the southbound lane of a two-lane undivided local rural road, approaching a four-leg intersection. Vehicle #1 was traveling east in the eastbound lane of the intersecting two-lane undivided local rural road. The case vehicle's driver braked with full lockup, steered left and yawed counterclockwise. Vehicle #1's driver braked with full lockup and steered right. The case vehicle's front right corner impacted the left side of vehicle #1's power unit, causing the case vehicle's driver and front right passenger air bags to deploy. The case vehicle rotated counterclockwise and the right side of the case vehicle impacted the left side of vehicle #1. The leading edge of vehicle #1's left tandem drive wheel impacted the right-center area of the back of the case vehicle. The crash severity for the case vehicle was high (greater than 40 km.p.h. [25 m.p.h.]). There is no knowledge of the case vehicle occupants' pre-crash posture or seat adjustments. The driver impacted the steering wheel and instrument panel and sustained fatal injuries that included multiple contusions of the brain with global edema, multiple broken ribs, contusions and lacerations of the lungs, intimal lacerations of the thoracic aorta, a contusion of the epicardium and various integumentary injuries. The front right passenger's head impacted vehicle #1's driver door, which intruded into the case vehicle's passenger compartment, and she sustained fatal massive injuries to the skull and brain.					
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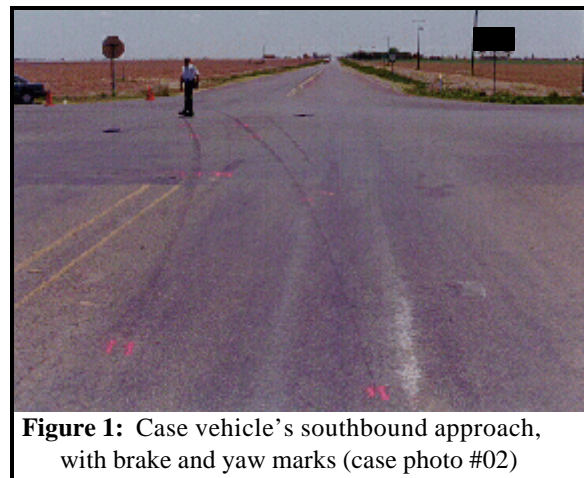
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This case was brought to the NHTSA's attention by a review of the 1998 Fatality Analysis Reporting System (FARS) in February 1999. The crash involved a 1998 Saturn SL2 (case vehicle, vehicle #2) and a 1996 Western Star truck-tractor pulling a semi-trailer (vehicle #1). The crash occurred in April 1998, at 1:03 p.m., in Texas, and was investigated by the applicable state police. This case is of special interest because the case vehicle was equipped with redesigned air bags that deployed as a result of collision events. The unrestrained driver (50-year-old male) and the restrained front right passenger (46-year-old female) were both killed. The Police Crash Report was received in March 1999. Coroner's reports of complete autopsies for the two victims were received in April and police photographs were received in June. This report is based on the Police Crash Report, the autopsy reports, police photographs, occupant kinematic principles, and this contractor's evaluation of the evidence.

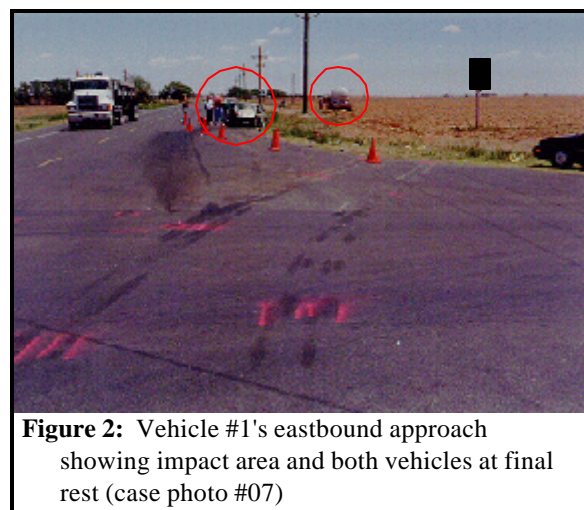
### CRASH CIRCUMSTANCES

The case vehicle (vehicle #2) was traveling south in the southbound lane of a two-lane undivided local rural road, approaching a four-leg intersection and apparently intending to pass through the intersection and continue south. Vehicle #1 was traveling east in the eastbound lane of the intersecting two-lane undivided local rural road, intending to pass through the intersection and continue east. It was daylight, the weather was clear, the bituminous surface was dry and there were no roadway defects. The speed limit was 113 km.p.h. (70 m.p.h.) for the case vehicle and 97 km.p.h. (60 m.p.h.) for vehicle #1. The intersection was controlled by stop signs for north-south traffic with an overhead beacon flashing red for north-south and amber for east-west traffic. The control devices were functioning correctly. The case vehicle approached the intersection at high speed. The case vehicle's driver braked with full lockup, steered left and yawed counterclockwise (**Figure 1**). Vehicle #1's driver braked with full lockup and steered right.

The crash occurred within the intersection (**Figure 2**). The case vehicle's front right corner impacted the left side of vehicle #1's power unit, causing the case vehicle's driver and front right passenger air bags to deploy. Initial contact with vehicle #1 included the trailing edge of the left front fender and the leading edge of the fuel tank beneath the driver's door. The case vehicle rotated counterclockwise and the right side of the case vehicle impacted the left side of vehicle #1 (side slap-type impact), contacting the steps attached to the fuel tank, the door sill and the lower edge of the door plus the



**Figure 1:** Case vehicle's southbound approach, with brake and yaw marks (case photo #02)



**Figure 2:** Vehicle #1's eastbound approach showing impact area and both vehicles at final rest (case photo #07)

tool boxes and apparatus mounted immediately behind the cab. The leading edge of vehicle #1's left tandem drive wheel impacted the right-center area of the back of the case vehicle, causing the case vehicle to rotate counterclockwise, away from vehicle #1. The case vehicle rotated approximately 180 degrees counterclockwise and came to rest headed west on the right (south) shoulder of the east-west roadway, approximately 25 meters (80 feet) east of the initial impact location. Vehicle #1 departed the roadway at the southeast corner of the intersection and entered a plowed farm field. The driver brought vehicle #1 to a controlled stop in the field, approximately 90 meters (300 feet) east of the initial impact location.

**CASE VEHICLE**

The case vehicle was a front wheel drive 1998 Saturn SL2 five-passenger four-door sedan (VIN: 1G8ZK5276WZ-----) equipped with a 1.9 liter I4 engine. The transmission selector lever was part of the center console; it is not known if the transmission was automatic or manual. Four-wheel anti-lock brakes were an option for this vehicle, but it is not known if the case vehicle was so equipped. The case vehicle's wheelbase was 260 centimeters (102.4 inches). The odometer reading is not known. The case vehicle was towed due to disabling damage.

The case vehicle sustained direct contact damage at the front right corner, the entire right side and the back (**Figures 3, 4 and 5**). The front bumper cover was torn off with the right end of the front bumper crushed rearward and downward and the left end levered forward. The grille and headlight assemblies were shattered and broken away. The hood was buckled, bent down in the front, crushed inward on the right and the entire hood was displaced to the left. The left front fender was broken off and hanging loose. The right front wheel's suspension was broken, with the wheel and tire pushed rearward and the top edge tilted slightly inward. The windshield was fractured across the entire width and separated from its mounting at the left and right A-pillars. The right front fender and the outer panel of the right front door were torn away but the right front door remained closed. There was direct contact to the upper right A-, B- and C-pillars; the right front and rear door glazing and backlight were shattered (kernalized); and the right roof rail and roof were crushed down and inward. The



Figure 3: Front of case vehicle (case photo #13)



Figure 4: Right side of case vehicle (case photo #16)



Figure 5: Back of case vehicle (case photo #15)

right rear door was distorted and came open. The right rear axle was broken with the top edge of the wheel tilted inward at approximately a 45 degree angle. There was direct contact at the right rear corner area, with the quarter panel crushed inward, the rear bumper cover torn loose and the trunk lid distorted and shifted to the right. The back bumper cover had a heavy black tire scrub just to the right of center. There was substantial intrusion along the entire right side, but the available photographs do not show specific intruding components. The CDCs for the case vehicle's three impacts with vehicle #1 (estimated from photographs) are: first **02-FREE-3**; second **03-RDAW-3**; third **06-BCLN-1**. This crash is out of scope for the WinSMASH reconstruction program. The crash severity for the case vehicle was high (greater than 40 km.p.h. [25 m.p.h.]).

### **CASE VEHICLE DRIVER**

The case vehicle's driver (50-year-old male, White (unknown if Hispanic), 177 centimeters, 103 kilograms [69.5 inches, 227.8 pounds]) was not restrained by his available manual three-point lap-and-shoulder safety belt system. His pre-crash posture, seat adjustments and steering wheel adjustments are not known. He was declared dead at the scene of the crash and was transported directly to a morgue. The following discussion of the driver's injuries is based on the report of a full autopsy, on-scene photographs of the vehicle exterior only and occupant kinematic principles.

The case vehicle's driver was probably seated in a normal driving posture, with his back against the seat back, both hands on the steering wheel and feet on the foot controls and floor. The driver braked with full lockup and steered left, causing the case vehicle to go into a counterclockwise yaw. As a result of his non-use of the available safety belt system, he moved forward in response to the braking deceleration and to the right as a result of the counterclockwise yaw. The first impact caused the driver and front right passenger air bags to deploy and caused the driver to move further forward and right, toward the two o'clock direction of principal force. He encountered the deploying driver's air bag with his face and upper torso, causing abrasions to his right face and right chest. The driver continued moving forward and to the right, deflating the air bag. The driver's chest impacted the steering wheel causing blunt force compression of his chest resulting in: anterior fractures of left ribs 2, 3 and 4; posterior fractures of left ribs 1, 2 and 4 and right ribs 2 through 9; four areas of laceration on the right lung with 180 ml right hemothorax; two intimal lacerations of the thoracic aorta; a contusion of the epicardium over the right atrium; and bilateral lung contusions. The case vehicle's second impact broke out the right front door window glazing, spraying the interior of the case vehicle with kernalized glass shards and causing multiple dicing lacerations to the full length of the driver's right arm. The driver's face and head impacted the center instrument panel, causing: an abrasion to his forehead; contusions around both eyes; bilateral fractures of the maxillary bones; and brain injuries consisting of fine midbrain contusions and moderate global edema of the entire brain including both hemispheres of the cerebrum and cerebellum, and the brain stem. His right lower back contacted the center console, causing abrasions.

**CASE VEHICLE DRIVER INJURIES**

IN99-035

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Midbrain, fine contusions NFS	140204.5 critical	Center instrument panel	Possible	Autopsy
2	Moderate global edema, bilateral cerebral hemispheres	140672.4 severe	Center instrument panel	Possible	Autopsy
3	Moderate global edema, brainstem and cerebelli	140454.3 serious	Center instrument panel	Possible	Autopsy
4	Bilateral lung contusions	441410.4 severe	Steering wheel rim, hub and/or spokes	Possible	Autopsy
5	Multiple bilateral rib fractures: right 2-9 posterior; left 2, 3, 4 anterior; left 1, 2, 4 posterior	450240.4 severe	Steering wheel rim, hub and/or spokes	Possible	Autopsy
6	Thoracic aorta, two intimal lacerations	420202.4 severe	Steering wheel rim, hub and/or spokes	Possible	Autopsy
7	Right lung lacerated in four places with 180 ml right hemothorax	441430.3 serious	Steering wheel rim, hub and or spokes	Possible	Autopsy
8	Contusion, epicardium, over right atrium of heart	441004.3 serious	Steering wheel rim, hub and/or spokes	Possible	Autopsy
9	Fracture of maxillary bones, bilateral	250802.2 moderate	Center instrument panel	Possible	Autopsy
10	Abrasion, forehead	290202.1 minor	Center instrument panel	Possible	Autopsy
11	Abrasions, right face	290202.1 minor	Driver's air bag	Probable	Autopsy
12	Contusions, bilateral eyelids	297402.1 minor	Center instrument panel	Possible	Autopsy
13	Multiple abrasions, right chest	490202.1 minor	Driver's air bag	Probable	Autopsy
14	Multiple abrasions, right lower back	690202.1 minor	Center console	Possible	Autopsy
15	Multiple small lacerations, right arm from shoulder to dorsum of right hand	790602.1 minor	Flying glass shards	Certain	Autopsy

**CASE VEHICLE FRONT RIGHT PASSENGER**

The case vehicle's front right passenger (46-year-old female, White (unknown if Hispanic), 165 centimeters, 73 kilograms [65 inches, 162 pounds]) was restrained by her available manual three-point lap-



and-shoulder safety belt system. Her pre-crash posture and seat adjustments are not known. She was declared dead at the scene of the crash and was transported directly to a morgue. The following discussion of the front right passenger’s injuries is based on the report of a full autopsy, on-scene photographs of the vehicle exterior only and occupant kinematic principles.

The front right passenger was probably seated in a normal posture, with her back against the seat back and her feet on the floor. The driver braked with full lockup and steered left, causing the case vehicle to go into a counterclockwise yaw. The front right passenger moved forward in response to the braking deceleration and to the right as a result of the counterclockwise yaw. Because she was wearing her safety belt, her forward motion was restricted and she was probably leaning slightly forward and against the right interior surface at the moment of the first impact. The first impact caused the driver and front right air bags to deploy and caused her to move further forward and to the right, toward the 2 o’clock direction of principal force, loading the safety belt system and pressing against the right door surface. She encountered the deploying front right passenger’s air bag off center to the right with her face and torso. The second impact caused her to move further to the right as the case vehicle’s right side interacted with vehicle #1’s left side. The right front door window glazing broke out, the right side of the case vehicle collapsed inward and the lower edge of vehicle #1’s driver’s door intruded into the case vehicle’s passenger compartment. The right side of the front right passenger’s head contacted vehicle #1’s driver door (**Figure 6**, below) causing massive damage to her head, described as a gaping wound to the anterior and superior head, with flaps of bone, skin and muscle reflected to the left, most of the brain missing (with some pieces found separately) and parts of the skull also missing. She sustained numerous bruises to her upper arms and shoulders and numerous contusions to the superficial surface of the lung parenchyma from the case vehicle’s intruding right side components. The inner surfaces of both thighs show bruising, possibly due to her legs being slapped against each other as she was sandwiched between the intruding right side components and the center console. The lateral surface of the left thigh shows an area of excoriation of the skin due to contact with the center console.

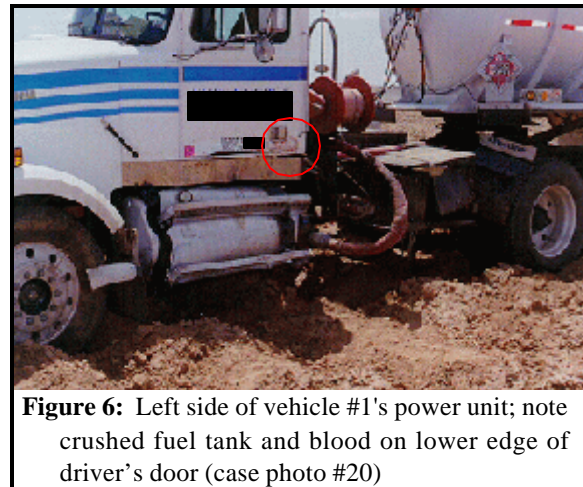
**CASE VEHICLE FRONT RIGHT PASSENGER INJURIES**

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Crushed skull: gaping wound to right anterior and superior head, with flaps of bone, skin and muscle reflected to the left; most of the brain is missing, with some parts found separately; parts of the skull also missing	113000.6 untreatable	Driver’s door of other vehicle	Certain	Autopsy
2	Numerous bruises, upper arms and shoulders, bilateral	790402.1 minor	Intruding right side components	Probable	Autopsy

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
3	Dark bruises on inner thighs, bilateral	890402.1 minor	Non-contact injury, thighs slapped together	Possible	Autopsy
4	Excoriation of skin on left lateral thigh	890202.1 minor	Center console	Probable	Autopsy
6	Numerous contusions of the superficial surface of the lung parenchyma	441402.3 serious	Intruding right side components	Probable	Autopsy

**VEHICLE #1**

Vehicle #1 was a 1996 Western Star 4900-series cab-behind-engine 6-by-4 truck-tractor (VIN: 2WKPDCXH6TK-----) towing a tank semi-trailer. The tank semi-trailer had hazardous materials cargo placarding with commodity code number 1267 (petroleum crude oil). There was no damage to the trailer or its cargo. Damage to the truck-tractor consisted of: the trailing edge of the left front fender had minor damage; the left fuel tank (immediately beneath the driver’s door) was dented along its entire length, but the tank retained its integrity and there was no fuel leakage; the steps to climb up into the cab (fastened to the fuel tank) had minor crush damage and were slightly displaced; the bottom edge of the driver’s door and the door sill were dented, with blood and other tissue on the lower edge of the driver’s door, indicating direct contact with the case vehicle’s front right passenger; various components attached to the frame behind the cab were damaged; and the splash guard for the left forward tandem wheels was displaced. Vehicle #1’s TDCs for the three impacts are estimated as: first **08-LYEW-2**; second **09-LKEW-2**; third **12-FLWN-9**.



**Figure 6:** Left side of vehicle #1's power unit; note crushed fuel tank and blood on lower edge of driver's door (case photo #20)