TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

Veridian Engineering
Buffalo, New York 14225

VERIDIAN REMOTE REDESIGNED AIR BAG INJURY INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

NASS CDS CASE NO. 1998-09-053A

VEHICLE - 1998 SATURN SL

LOCATION - STATE OF MARYLAND

CRASH DATE - JUNE, 1998

Contract No. DTNH22-94-D-07058

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 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. *Abstract* This remote investigation focused on a two vehicle crash involving a 1998 Saturn SL 4-door sedan (subject vehicle) and a 1998 GMC Jimmy Typhoon sport utility vehicle. The Saturn was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of an oblique frontal collision with the GMC. The Saturn had been proceeding in an easterly direction on a four lane divided state roadway. The Saturn exited the left edge of the eastbound lanes, crossed a depressed grass median, and was then involved in the frontal impact sequence in the westbound travel lanes.			
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BACKGROUND

This remote investigation focused on a two vehicle crash involving a 1998 Saturn SL 4-door sedan (subject vehicle) and a 1998 GMC Jimmy Typhoon sport utility vehicle. The Saturn was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of an oblique frontal collision with the GMC. The Saturn had been proceeding in an easterly direction on a four lane divided state roadway. The Saturn exited the left edge of the eastbound lanes, crossed a depressed grass median, and was then involved in the frontal impact sequence in the westbound travel lanes.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 98-09-053A. 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

In the immediate vicinity of the crash site the eastbound lanes of the state roadway were asphalt surfaced, straight, and level. The east and westbound travel lanes were delineated by a broken white centerline and solid white edge lines **(see Figure 8 - page 7)**. Both edges of the east and westbound travel lanes were bounded by wide paved shoulders and the travel lanes were separated by an 11.0 m (38.7') wide depressed grass median. At the time of the crash it was dark, the roadway was not lighted, the weather was clear, and all environmental surfaces were dry. Both travel directions were posted with a 80 km/h (50 mph) speed limit.

Pre-Crash

The Saturn approached the crash site traveling in an easterly direction in the second eastbound travel lane at an estimated travel speed of 89-97 km/h (55-60 mph). The Saturn driver was grossly intoxicated (BAC=0.28) and may have either fallen asleep or passed out, relinquishing steering control. The Saturn exited the left edge of the eastbound travel lanes at a shallow departure angle, crossed the depressed grass median, and then entered the westbound travel lanes, the Saturn began arcing to the left, crossing the outboard westbound lane and entered the inboard or first westbound lane **(Figure 1)**.

The GMC Jimmy approached the crash site traveling in the first westbound travel lane **(Figure 2)** at an estimated travel speed of 81-89 km/h (50-55 mph). When the Jimmy driver saw the Saturn entering the

westbound lanes she began steering right/braking in avoidance.

Figure 1. Eastbound approach for the 1998 Saturn SL.

Figure 2. Westbound approach for the 1998 GMC Jimmy Typhoon.

Crash

The two vehicles collided in an oblique frontal impact configuration **(Figure 3)**. The resultant directions of force associated with the crash were 1 o'clock for the Saturn and 11 o'clock for the GMC Jimmy. The velocity changes experienced by each vehicle during the crash were estimated at 60.0 km/h (37.3 mph) for the Saturn and 43.0 km/h (26.7 mph) for the GMC Jimmy using the WinSMASH program.

Figure 3. Northeast view of impact area.

The GMC deflected to its right following the initial impact, rotating in a clockwise direction. This vehicle traveled approximately 2.0 m (6.5') (-CG position to -CG position) and rotated through approximately 95 degrees before coming to rest straddling the north edge of the westbound lanes, facing in a north northeasterly direction. The Saturn traveled through the point of impact, deflecting to its left and rotating in a counterclockwise direction. The vehicle traveled approximately 7.0 m (2.8') and came to rest on the grassy area located outboard of the north shoulder of the westbound lanes, facing in a northwesterly direction.

Post-Crash

Police and rescue units responded to the scene. First aid treatment was provided to the driver of the Saturn and to both occupants of the GMC Jimmy. The Saturn driver was transported to a local hospital where he was pronounced dead on arrival. Both vehicles were towed from the scene due to disabling damage.

VEHICLE DATA

The 1998 Saturn SL was identified by the Vehicle Identification Number (VIN): 1G8ZH5288WZ (production sequence deleted). The vehicle was a 4-door sedan equipped with front wheel drive and a 2.0 liter, 4-cylinder engine. The vehicle's odometer reading was 25,259 km (15,696 miles) at the time of the crash. The police report did not specify the owner of the vehicle. The seating was configured with front bucket and rear bench seats (with folding backs).

Exterior Damage

Figure 4. Frontal damage to the 1998 Saturn SL.

The 1998 Saturn SL sustained severe frontal damage as a result of the impact with the GMC Jimmy **(Figure 4)**. The direct contact damage began at the front right bumper corner and extended 57.0 cm (22.4") inboard. The impact deformed the full frontal end width resulting in a direct and induced contact length (Field L) of 110.0 cm (43.3"). Six crush measurements were documented at the level of the reinforcement bar *(bumper fascia separation)*: C1= 0 cm, C2= 23.0 cm (9.1"), C3= 41.0 cm (16.1"), C4= 59.0 cm (23.2"), C5= 78.0 cm (30.7"), C6= 96.0 cm (37.8"). Damaged components included the front bumper, both headlight assemblies, the grille and surrounding area, hood and both fenders, windshield, roof panel, right doors, and rear quarter panel. The right wheelbase dimension was reduced 74.0 cm (29.1") and the left wheelbase dimension was elongated 42.0 cm (16.5"). The Collision Deformation Classification (CDC) for this impact to the Saturn was 81-FZEW-4 (1 o'clock direction of force incremented by 80 to indicate end shifting). The delta V associated with this impact damage was estimated at 60.0 km/h (37.3 mph) using the WinSMASH program.

Figure 5. Frontal damage to the 1998 GMC Jimmy Typhoon.

Exterior damage to the 1998 GMC Jimmy Typhoon was also rated as severe **(Figure 5)**. The direct contact damage encompassed the full frontal end width resulting in a direct and induced damage length (Field L) of 141.0 cm (55.5"). Six crush measurements were documented at the level of the bumper: C1= 37.0 cm (14.6"), C2= 28.0 cm (11.0"), C3= 39.0 cm (15.4"), C4= 56.0 cm (22.0"), C5= 57.0 cm (22.4"), C6= 60.0 cm (23.6"). The CDC for this impact to the GMC was 11-FDEW-3.

Interior Damage

Interior damage to the Saturn was also rated as severe and was associated primarily with intrusion of frontal components into the passenger compartment. Intruded components included the right A-pillar, windshield, instrument panel, toepan, and the steering assembly.

Component	**Intrusion Extent**	**Direction**
Right instrument panel	121.0 cm (47.6")	Longitudinal
Right A-pillar	28.0 cm (11.0")	Lateral
Right toepan	47.0 cm (18.5")	Longitudinal
Center instrument panel	28.0 cm (11.0")	Longitudinal
Center instrument panel	19.0 cm (7.5")	Lateral
Steering wheel	15.0 cm (5.9")	Lateral

The driver of the Saturn was the sole occupant of the vehicle. He wore the available 3-point manual lap and shoulder belt and during the initial stages of the crash sequence moved forward and to the right. He subsequently rebounded rearward and to the left. He loaded the restraint system during the forward movement with two separate areas of waffling and stretching noted to the shoulder belt webbing. Areas of scuffing and stretching were noted to the inside aspect of the lap belt. In addition, a 40.0 cm (15.8") blood stain was noted to the outer aspect of the lap belt. Other evidence of driver contact with interior components was noted as follows:

Component	**Contact Evidence**
Right portion of left sunvisor	Scuffed
Windshield top molding beneath visor	Abraded
Left upper A-pillar	Scuff mark and black transfer
Center upper and mid-instrument panel	Tissue and blood transfers
Instrument panel to right of steering column	Blood transfer
Knee bolster to right of steering column	Blood transfer
Knee bolster below/left of steering column	Scuff mark
Instrument panel left of steering column	Vent broken
Upper left door panel	Scuffed and abraded
Left door armrest	Abraded
Left B-pillar	Reddish colored scuff mark below D-ring
Front left air bag	Large blood stain
Front right air bag	Multiple blood stains

MANUAL RESTRAINT SYSTEMS

The Saturn was equipped with 3-point manual lap and shoulder belt systems for the four outboard seated positions. The front belt systems consisted of a continuous loop belt webbing that was retracted into an inertia activated locking retractor. The upper anchorages (D-rings) were adjustable as the driver belt was placed to the mid-position.

The Saturn driver was the sole occupant of the vehicle. He wore the available lap and shoulder belt, heavily loading the system during the crash sequence. Two separate areas of waffling/stretching were noted to the shoulder belt. Areas of scuffing and stretching were noted to the inner aspect of the lap belt. A 40.0 cm (15.8") blood stain was also noted to the outer aspect of the lap belt.

SUPPLEMENTAL RESTRAINT SYSTEMS

The 1998 Saturn SL was equipped with Supplemental Restraint Systems (SRS) for the driver and right passenger positions **(Figure 6)**. The air bags had deployed as a result of the crash. The driver air bag module was mounted in the steering wheel and concealed behind H-configuration module cover flaps. The cover flaps opened as designed with no damage or driver contact noted to the flaps. The driver air bag was a 4-tether design sewn into the front surface of the air bag. Driver contact was noted to the front bag surface in the form of a blood transfer. This transfer was 30.0 cm (11.8") by 31.0 cm (12.2") and was distributed over the upper right and lower quadrants of the bag.

Figure 6. 1998 Saturn SL redesigned frontal air bag systems.

The front right passenger air bag was concealed behind a single cover flap which was hinged at the rear and opened upward. No damage was noted to the module flap. Driver contact was noted to the passenger air bag in the form of blood transfers and splatters. These transfers were distributed over the left front and side surface of the bag.

DRIVER DEMOGRAPHICS

Age/Sex:	30 year old male
Height:	173 cm (68")
Weight:	68 kg (150 lb)
Seat Track Position:	Full rearward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, police report
Eyeware:	None
Type of Medical Treatment:	Transported to a local hospital and pronounced dead on arrival

Driver Injuries

Injury	***Injury Severity (AIS 90)***	***Injury Mechanism***
Brain stem laceration involving hypothalamus, medulla, midbrain and pons	Fatal (140212.6,8)	Left B-pillar
Complete basilar skull fracture open with loss of brain tissue; comminuted; ring; hinge	Severe (150206.4,8)	Left B-pillar
Left posterior scalp contusion	Minor (190402.1,6)	Left B-pillar
Chin laceration	Minor (290602.1,8)	Center instrument panel
Tongue laceration	Minor (243402.1,8)	Center instrument panel
Abrasion of chest extending from left pectoral area to right chest	Minor (490202.1,4)	Shoulder belt webbing
Contusion left chest	Minor (490402.1,2)	Shoulder belt webbing
Laceration liver	Moderate (541820.2,1)	Shoulder belt webbing
Laceration right lung	Serious (441430.3,1)	Shoulder belt webbing
Bilateral rib fractures, 3-7 on left and 6-7 on right	Serious (450230.3,3)	Shoulder belt webbing
Contusion left elbow	Minor (790402.1,2)	Left door panel
Abrasions left posterior distal forearm	Minor (790202.1,2)	Left door panel
Multiple lacerations left posterior hand	Minor (790602.1,2)	Left instrument panel
Abrasion of left pelvic area	Minor (890202.1,2)	Lap belt webbing
Contusion left superior medial thigh	Minor (890402.1,2)	Steering wheel rim
Bilateral knee lacerations	Minor (890602.1,3)	Knee bolster
Laceration right anterior lower leg	Minor (890602.1,1)	Knee bolster
Laceration left posterior lower leg	Minor (890602.1,2)	Knee bolster
Fracture left fibula/tibia 5" superior to ankle	Moderate (851605.2,2) Moderate (853404.2,2)	Left toepan Left toepan
Contusion left medial ankle	Minor (800402.1,2)	Left toepan

Driver Kinematics

The exact pre-crash seated posture of the 30 year old male Saturn driver was unknown. He apparently fell asleep or passed out and may have slumped forward or to either side. He was wearing the available 3-point manual lap and shoulder belt with the seat track adjusted to the rear most position.

Figure 7. 1998 Saturn SL driver space.

At impact, the driver moved forward and to the right with respect to the vehicle interior. He loaded the lap and shoulder belt and redesigned driver air bag. He then apparently continued to the right, sliding off the air bag and contacting the center instrument panel with the facial area **(Figure 7)**. While he was moving forward, he loaded the knee bolster and mid-instrument panel on both sides of the steering column with his knees and lower legs.

The driver subsequently rebounded rearward and to the left. He contacted the front left seat back support and left door panel with the left side of his upper torso, and the left B-pillar with his head (source of fatal injury), He then slumped forward into the deployed air bag module. He was transported to a local hospital following the crash sequence where he was pronounced dead on arrival.

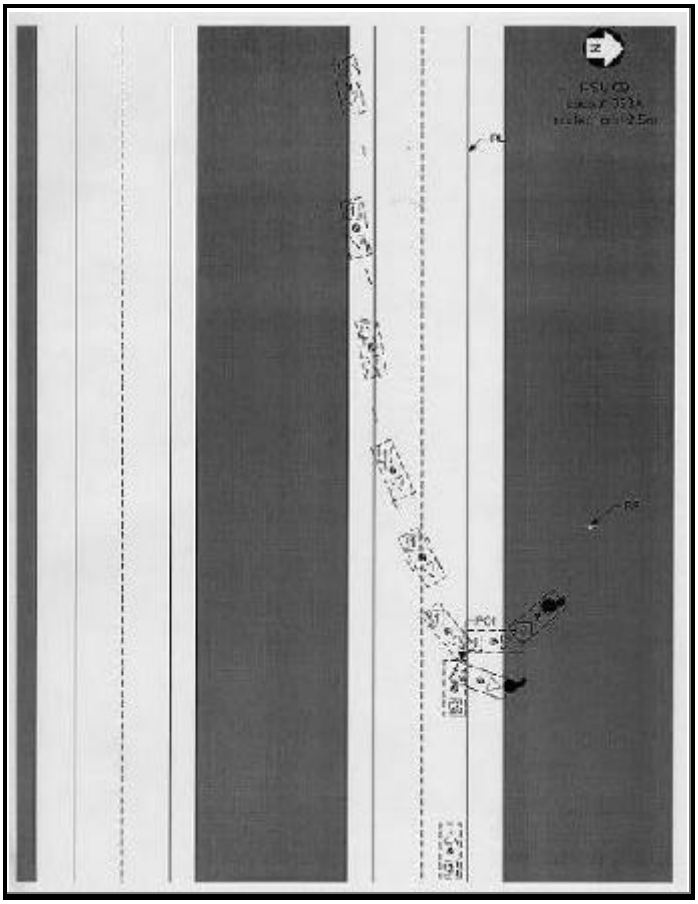

Figure 8. NASS Scene Diagram.