TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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

NASS RABSS CASE NO. 1998-11-812E

RABSS VEHICLE - 1998 SATURN SC1

LOCATION - STATE OF MICHIGAN

CRASH DATE - OCTOBER, 1998

Contract No. DTNH22-94-D-07058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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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

1. *Report No.* 98-11-812E	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* Redesigned Air Bag Special Study (RABSS) RABSS Vehicle - 1998 Saturn SC1 Location - State of Michigan		5. *Report Date*: June, 2000 6. *Performing Organization Code*	
7. *Author(s)* Crash Research Section		8. *Performing Organization Report No.*	
9. *Performing Organization Name and Address* Transportation Sciences Crash Research Section Veridian Engineering P.O. Box 400 Buffalo, New York 14225		10. *Work Unit No.* C01115.0262.(0000-0009) 11. *Contract or Grant No.* DTNH22-94-D-07058	
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		13. *Type of Report and Period Covered* Technical Summary Report Crash Date: October, 1998 14. *Sponsoring Agency Code*	
15. *Supplementary Notes* NASS investigation of a frontal collision that involved a 1998 Saturn SC1 2-door coupe equipped with redesigned frontal air bags.			
16. *Abstract* This investigation focused on a two vehicle crash involving a 1998 Saturn SC1 2-door coupe (subject vehicle) and a 1995 Oldsmobile Achieva S 4-door sedan. The Saturn SC1 was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of a frontal collision with the Oldsmobile Achieva. The driver of the Oldsmobile was operating the vehicle eastbound when he failed to observe the westbound Saturn as he attempted to turn left (north) at a 4-leg intersection. As the Oldsmobile crossed the westbound lanes, the front right area impacted the front left area of the Saturn resulting in moderate damage to each vehicle. Both vehicles came to rest in the northwest sector of the intersection facing northwest. The unrestrained 17 year old female driver of the Saturn SC1 initiated a forward trajectory in response to the 12 o'clock impact force and loaded the deployed redesigned driver air bag and knee bolster. Contact to the deployed driver air bag resulted in superficial lacerations to the lips from her braces. Loading to the knee bolster resulted in multiple soft tissue injuries to the knees. The driver of the Saturn was transported to the emergency room of a local trauma center for treatment and released. The occupants of the Oldsmobile were reported by police as uninjured, however, the driver sought an evaluation for the child occupants later at a medical facility.			
17. *Key Words* Redesigned frontal air bag system Collision Deformation Classification (CDC): 12-FYEW-2 Proper use of the manual belt system Lacerations upper/lower lips		18. *Distribution Statement* General Public	
19. *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 5	22. *Price*

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CRASH DATE - OCTOBER, 1998

BACKGROUND

This investigation focused on a two vehicle crash involving a 1998 Saturn SC1 2-door coupe (subject vehicle) and a 1995 Oldsmobile Achieva S 4-door sedan. The Saturn SC1 was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of a frontal collision with the Oldsmobile Achieva. The driver of the Oldsmobile was operating the vehicle eastbound when he failed to observe the westbound Saturn as he attempted to turn left (north) at a 4-leg intersection. As the Oldsmobile crossed the westbound lanes, the front right area impacted the front left area of the Saturn resulting in moderate damage to each vehicle. Both vehicles came to rest in the northwest sector of the intersection facing northwest. The unrestrained 17 year old female driver of the Saturn SC1 initiated a forward trajectory in response to the 12 o'clock impact force and loaded the deployed redesigned driver air bag and knee bolster. Contact to the deployed driver air bag resulted in superficial lacerations to the lips from her braces. Loading to the knee bolster resulted in multiple soft tissue injuries to the knees. The driver of the Saturn was transported to the emergency room of a local trauma center for treatment and released. The occupants of the Oldsmobile were reported by police as uninjured, however, the driver sought an evaluation for the child occupants later at a medical facility.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-11-812E for 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 two vehicle crash occurred during the evening hours of October, 1998. At the time of the crash, it was dark (street lighted) with no adverse conditions as the roads were dry. The crash occurred in a multi-lane straight (asphalt) 4-leg intersection which was controlled by an overhead signal system **(see Figure 7 - page 5)**. The posted speed limit at the crash site was 72 km/h (45 mph).

Pre-Crash

The 22 year old male driver of the 1995 Oldsmobile Achieva was operating the vehicle eastbound **(Figure 1)** when he entered the 4-leg intersection and initiated a left turn to proceed north. The 17 year old female driver of the 1998 Saturn SC1 was operating the vehicle westbound **(Figure 2)** in the outboard lane at a (driver reported) speed of 72 km/h (45 mph) when she observed the eastbound Oldsmobile cross her path of travel. The driver reported no avoidance maneuvers in anticipation of the impending crash.

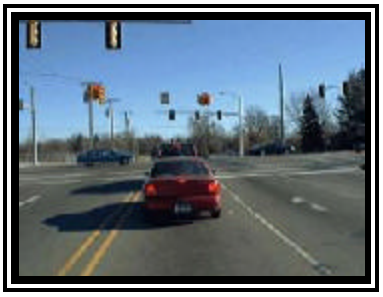

Figure 1. Eastbound approach for the 1995 Oldsmobile Achieva.

Figure 2. Westbound approach for the 1998 Saturn SC1.

Crash

As the Oldsmobile crossed the westbound lanes of the 4-leg intersection, the front right area impacted the front left area of the Saturn resulting in moderate damage to each vehicle. The *(SCI revised)* missing vehicle algorithm of the WinSMASH program computed velocity changes of 32.5 km/h (20.2 mph) for the subject vehicle and 25.9 km/h (16.1 mph) for the struck Oldsmobile. Respective longitudinal components were -32.0 km/h (-19.9 mph) and -23.5 km/h
(-14.6 mph). The impact induced deceleration was sufficient to deploy the Saturn's redesigned frontal air bag system. At this point, both vehicles were re-directed towards the northwest sector of the intersection where they came to rest facing northwest.

Post-Crash

The driver of the Saturn SC1 exited the vehicle with some assistance from a witness. The exit status of the Oldsmobile occupants were unknown. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMTs). The driver of the Saturn was transported by ambulance to the emergency room of a local trauma center for treatment and released. The occupants of the Oldsmobile were reported by police as uninjured, however, the driver sought an evaluation for the child occupants later at a medical facility. Both vehicles were towed from the scene due to disabling damage.

RABSS VEHICLE

The 1998 Saturn SC1 was identified by the Vehicle Identification Number (VIN): 1G8ZF1280WZ (production sequence deleted). The vehicle was a 2-door coupe equipped with front wheel drive and a 1.9 liter, 4 cylinder engine. The vehicle's odometer reading was 16,716 km (10,387 miles) at the time of the crash. The police report did not specify the owner of the vehicle. The seating was configured with a front bucket and rear bench seats (with folding backs). The driver reported one previous crash without deployment of the air bag system (original equipment). No cell phone was present or in-use at the time of the collision.

VEHICLE DAMAGE

Exterior Damage

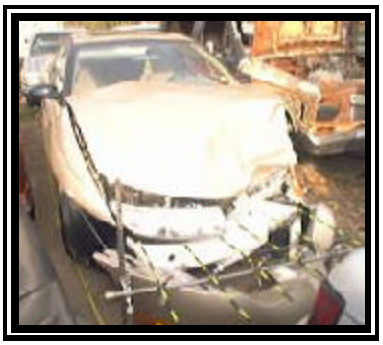

Figure 3. Frontal damage to the 1998 Saturn SC1 2-door coupe.

The 1998 Saturn SC1 2-door coupe sustained moderate frontal damage as a result of the impact with the Oldsmobile Achieva **(Figure 3)**. The direct contact damage began at the front left bumper corner and extended 63.0 cm (24.8 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 101.0 cm (39.8 in). Six crush measurements were documented at the level of the reinforcement bar *(bumper fascia separation)*: C1= 16.0 cm (6.3 in), C2= 37.0 cm (14.6 in), C3= 28.0 cm (11.0 in), C4= 19.0 cm (7.5 in), C5= 8.0 cm (3.1 in), C6= 0 cm. The *(revised)* Collision Deformation Classification (CDC) for this impact to the Saturn was 12-FYEW-2 with a principal direction of force of (-)10 degrees. The left fender/hood area was displaced rearward from the impact force. Reduction in the left side wheelbase measured 8.0 cm (3.1 in). All glazing remained intact.

Interior Damage

Figure 4. Scuff marks to the knee bolster and steering column.

Damage to the interior surfaces of the Saturn SC1 were minimal and attributed to occupant contact **(Figure 4)**. Scuff marks were identified on the left side of the knee bolster (rigid plastic type) and right side of the steering column. No intrusions were found in the vehicle.

REDESIGNED AIR BAG SYSTEM

The 1998 Saturn SC1 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). The flaps were symmetrical in shape and measured 13.5 cm (5.3 in) in width and 12.0 cm (4.7 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, small puncture holes measuring approximately 0.5 cm (0.2 in) in diameter were documented to the upper left quadrant of the air bag attributed to the driver's braces. Black vinyl transfers were noted to the right upper quadrant from expansion within the module. The NASS researcher measured the diameter of the driver air bag at 43.0 cm (16.9 in) in its deflated state **(Figure 5)**. The bag was tethered by two internal straps and vented by two ports located at the 11 o'clock and 1 o'clock sectors on the rear aspect of the air bag.

The front right passenger air bag deployed from the right mid-instrument panel area with a single cover flap design hinged at the top aspect. No contact evidence was identified on the air bag or exterior surface of the module cover flap. The cover flap was oval shaped and measured 30.5 cm (12.0 in) in width and 12.0 cm (4.7 in) in height. The NASS researcher measured the passenger air bag at 66.0 cm (26.0 in) in width and 47.0 cm (18.5 in) in height in its deflated state **(Figure 6)**. The bag was tethered by two internal straps. No vent ports or cutoff switch were reported for the front right passenger air bag.

Figure 5. 1998 Saturn SC1 redesigned driver air bag.

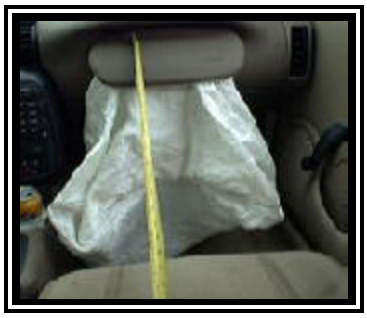

Figure 6. 1998 Saturn SC1 redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	17 year old female
Height:	165 cm (65 in)
Weight:	69 kg (153 lb)
Seat Track Position:	Middle position
Manual Restraint Use:	None
Usage Source:	NASS vehicle inspection, driver interview, medical report
Eyeware:	None
Type of Medical Treatment:	Transported to the emergency room of a local trauma center for treatment and released

Driver Injuries

Injury	***Severity (AIS 90)***	***Injury Mechanism***
Superficial lacerations inside surface upper and lower lips	Minor (290602.1,8)	Front left air bag *(braces)*
Abrasion right knee	Minor (890202.1,1)	Steering column
Contusion left knee	Minor (890402.1,2)	Left knee bolster
Contusion right knee	Minor (890402.1,1)	Steering column
Laceration right knee (multiple/small)	Minor (890602.1,1)	Steering column *(keys?)*

Driver Kinematics

The unrestrained 17 year old female driver of the 1998 Saturn SC1 was seated in an upright posture with the seat track adjusted to the middle position. Her left hand was placed on the door handle as her right hand was placed on the steering wheel rim. The driver stated she was unrestrained, further evidenced by the medical report data. At impact, she initiated a forward trajectory in response to the 12 o'clock impact force and

loaded the deployed redesigned driver air bag and knee bolster/steering column. Contact to the deployed driver air bag resulted in multiple superficial lacerations to the inside surface of the upper and lower lips which resulted from the lip compression against her braces, evidenced by the small puncture holes documented to the upper left quadrant of the air bag face. Loading to the knee bolster resulted in a contusion to the left knee while contact to the steering column resulted in an abrasion/contusion to the right knee as evidenced by the scuff marks documented to these components. She also sustained multiple/small lacerations to the right knee which may have been a result of contact to the car keys **(see Figure 4)**. The redesigned driver air bag provided protection against contact to the steering wheel hub/rim and potential serious injury. The driver was transported by ambulance to the emergency room of a local trauma center for treatment and released.

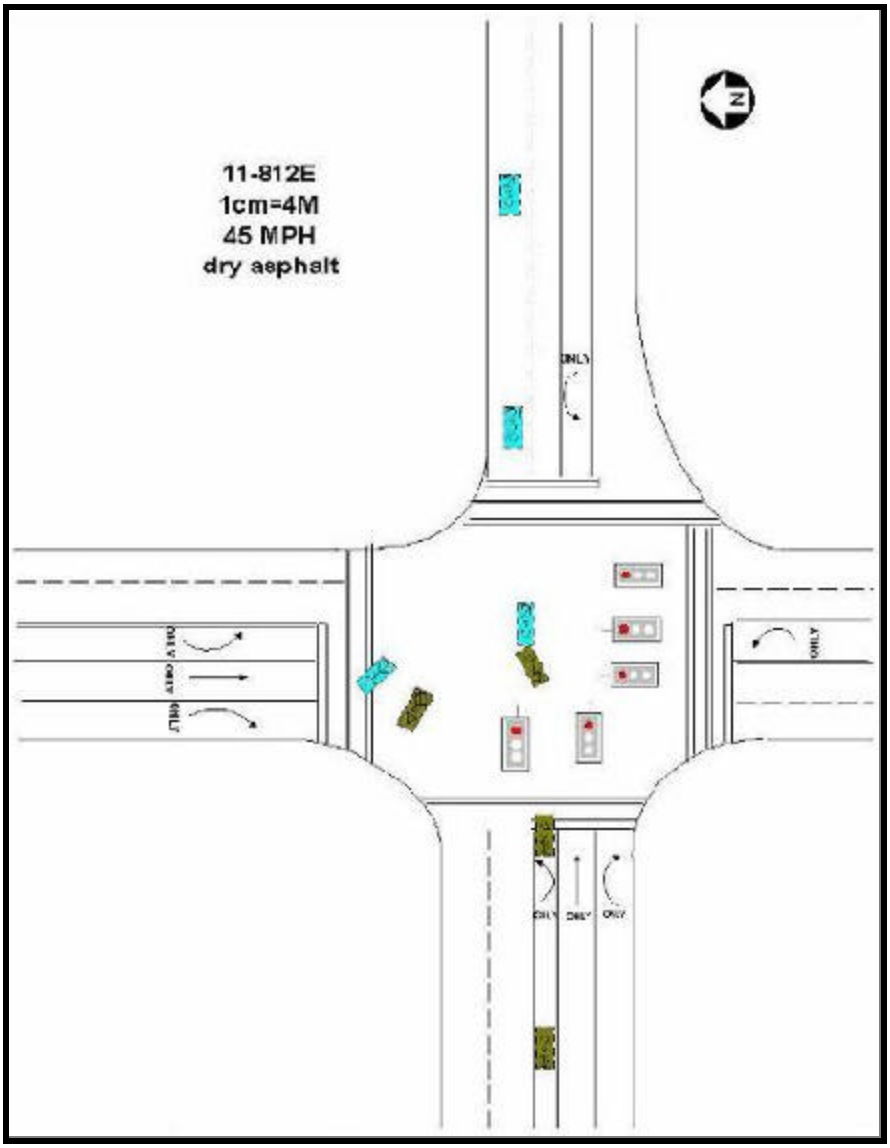

Figure 7. NASS Scene Diagram (physical plant and vehicle numbering incorrectly plotted by researcher).