

**TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION**

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

NASS RABSS CASE NO. 1998-43-803E

RABSS VEHICLE - 1998 CHEVROLET SUBURBAN

LOCATION - STATE OF NORTH CAROLINA

CRASH DATE - JULY, 1998

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> This investigation focused on a two vehicle crash involving a 1998 Chevrolet Suburban 4-door sport utility (subject vehicle) and a 1997 Dodge Ram pickup truck. The Chevrolet Suburban was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of a right angle collision with the Dodge Ram pickup truck. The driver of the Chevrolet was operating the vehicle southbound when she failed to observe the eastbound Dodge as she proceeded straight through a rural 4-leg intersection. As the Chevrolet entered the intersection, the frontal area impacted the left passenger area of the Dodge resulting in moderate damage to both vehicles. The restrained 21 year old female driver of the Chevrolet Suburban initiated a forward trajectory in response to the 1 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Loading of the knee bolster resulted in bilateral contusions to the knees. She also sustained a cervical spine strain which was a result of the sudden forward movement of the head as the body loaded the belt system (flexion). The driver sought treatment later at her physician's office. The rear center and right seating positions were occupied by a 5 month old male and 18 month old female (respectively) who were restrained in child safety seats and uninjured in the collision.			
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BACKGROUND

This investigation focused on a two vehicle crash involving a 1998 Chevrolet Suburban 4-door sport utility (subject vehicle) and a 1997 Dodge Ram pickup truck. The Chevrolet Suburban was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of a right angle collision with the Dodge Ram pickup truck. The driver of the Chevrolet was operating the vehicle southbound when she failed to observe the eastbound Dodge as she proceeded straight through a rural 4-leg intersection. As the Chevrolet entered the intersection, the frontal area impacted the left passenger area of the Dodge resulting in moderate damage to both vehicles. The restrained 21 year old female driver of the Chevrolet Suburban initiated a forward trajectory in response to the 1 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Loading of the knee bolster resulted in bilateral contusions to the knees. She also sustained a cervical spine strain which was a result of the sudden forward movement of the head as the body loaded the belt system (flexion). The driver sought treatment later at her physician's office. The rear center and right seating positions were occupied by a 5 month old male and 18 month old female (respectively) who were restrained in child safety seats and uninjured in the collision.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-43-803E 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 morning hours of July, 1998. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in a straight and level 4-leg asphalt intersection (see **Figure 9 - page 6**). Traffic flow through the 2-lane intersection was controlled by stop signs for north/southbound traffic. The posted speed limit at the crash site was 72 km/h (45 mph).

Pre-Crash

The 21 year old female driver of the 1998 Chevrolet Suburban was operating the vehicle southbound (**Figure 1**) on an approach to the 4-leg intersection when she stopped at the stop sign and proceeded straight at a (driver reported) speed of 8 km/h (5 mph). The driver reported no avoidance maneuvers in anticipation of the impending crash. The 41 year old male driver of the 1997 Dodge Ram pickup was operating the vehicle eastbound (**Figure 2**) at a (police reported) speed of 64 km/h (40 mph) when he entered the intersection and observed the southbound Chevrolet cross his path of travel. The NASS researcher reported no skid marks at the scene indicative of driver avoidance maneuvers.

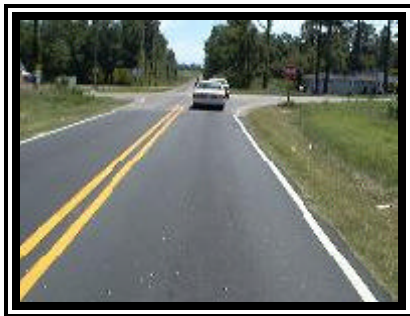


Figure 1. Southbound approach for the 1998 Chevrolet Suburban.



Figure 2. Eastbound approach for the 1997 Dodge Ram pickup truck.

Crash

As the Chevrolet Suburban entered the rural 4-leg intersection, the frontal area impacted the left passenger area of the Dodge pickup resulting in moderate damage to both vehicles. The damage algorithm of the WinSMASH program computed velocity changes of 20.9 km/h (13.0 mph) for the subject vehicle and 24.1 km/h (15.0 mph) for the struck Dodge pickup. Respective longitudinal components were -18.1 km/h (-11.2 mph) and -12.1 km/h (-7.5 mph). The impact induced deceleration was sufficient to deploy the Chevrolet's redesigned frontal air bag system. At this point, both vehicles began their respective post-impact trajectories towards the southeast sector as the Dodge began to rotate counterclockwise and exited the south pavement edge into the soft soil. The combined initial impact force and subsequent (right side wheels) furrowing into the soft soil initiated a 4-quarter turn right side rollover which resulted in moderate top surface damage. The Dodge pickup came to rest (upright) off the south pavement edge faced northeast as the Chevrolet Suburban continued in an easterly direction approximately 45.7 meters (150.0 feet) coming to rest in the eastbound lane faced southeast.

Post-Crash

The driver of the Chevrolet exited the vehicle under her own power as the passengers subsequently exited with some assistance from the driver. The exit status of the Dodge driver was unknown. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMTs). The Chevrolet driver sought treatment later at her physician's office as the rear seated passengers were uninjured (taken later to a private physician for evaluation). The Dodge driver was transported by ambulance to a local hospital for an unknown level of treatment. Both vehicles were towed from the scene due to disabling damage.

RABSS VEHICLE

The 1998 Chevrolet Suburban was identified by the Vehicle Identification Number (VIN): 1GNGK26J8WJ (production sequence deleted). The vehicle was a 4-door sport utility equipped with four-wheel drive and a 7.4 liter, V-8 engine. The vehicle's odometer reading was 23,297 km (14,476 miles) at the time of the crash. The police report listed the driver as the owner of the vehicle. The seating was configured with front and rear (split) bench seats with folding backs. The driver reported no previous crashes or maintenance on the air bag system (original equipment). A cellular phone was present at the time of the collision (usage unknown).

VEHICLE DAMAGE

Exterior Damage

The 1998 Chevrolet Suburban sustained moderate frontal damage as a result of the impact with the Dodge Ram pickup (**Figure 3**). The direct contact damage began at the front right bumper corner and extended 144.0 cm (56.7 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 176.0 cm (69.3 in). Six crush measurements were documented at the level of the bumper: C1= 20.0 cm (7.9 in), C2= 16.0 cm (6.3 in), C3= 19.0 cm (7.5 in), C4= 21.0 cm (8.3 in), C5= 21.0 cm (8.3 in), C6= 30.0 cm (11.8 in). The Collision Deformation Classification (CDC) for this impact to the Chevrolet was 81-FDEW-2 with a principal direction of force of (+)30 degrees (principal direction of force incremented to reflect shifting of end structure to the left). The grille and headlight assemblies fractured and separated from the vehicle during the collision sequence. The hood was deformed up and rearward from engagement against the side surface of the Dodge. No reduction in the vehicle's wheelbase was sustained. The windshield was fractured by exterior impact forces while all tempered glazing remained undamaged.



Figure 3. Frontal damage to the 1998 Chevrolet Suburban.



Figure 4. Top and left side surface damage to the 1997 Dodge Ram pickup truck.

The 1997 Dodge Ram pickup sustained moderate left side surface damage as a result of the impact with the Chevrolet Suburban (**Figure 4**). The direct contact damage began 42.0 cm (16.5 in) forward of the left rear axle and extended 356.0 cm (140.2 in) forward. A maximum crush value of 23.0 cm (9.1 in) was identified just forward of the B-pillar. The CDC for this initial impact to the Dodge was 10-LDEW-2 with a principal direction of force of (-)60 degrees. Additional contact damage was documented to the top surface attributed to the rollover impact. The CDC for this second and final impact to the Dodge was 00-TDDO-2. A maximum crush value of 5.0 cm (2.0 in) was identified along the left windshield header area. Mud deposits were noted in the right side wheels as all four tires were deflated (not restricted). The windshield was fractured as the left door window glazing was disintegrated by exterior impact forces (only).

Interior Damage

Damage to the interior surfaces of the Chevrolet Suburban were minimal and attributed to occupant contact. Indentations and scuff marks were documented on the left knee bolster (rigid plastic type). Stretched webbing was identified to the front left manual restraint along with fabric transfers embedded into the fabric. Stretched webbing was also identified on the rear center and right manual restraints attributed to child safety seat loading. No intrusions were found in the vehicle.

REDESIGNED AIR BAG SYSTEM

The 1998 Chevrolet Suburban was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags had 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 7.0 cm (2.8 in) in width and 11.0 cm (4.3 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, skin oil and makeup transfers were documented to the upper right quadrant of the air bag face (**Figure 6**). Multiple black vinyl transfers were also found on the rear aspect of the air bag from expansion within the module. The NASS researcher measured the diameter of the driver air bag at 58.0 cm (22.8 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.

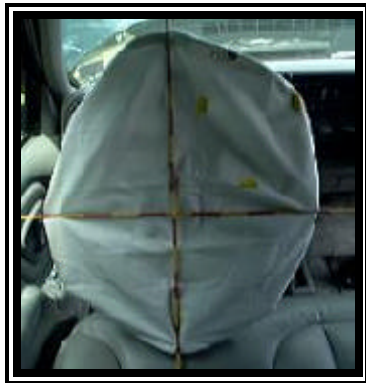


Figure 5. 1998 Chevrolet Suburban redesigned driver air bag.



Figure 6. Skin oil and makeup transfers to the driver air bag.

The front right passenger air bag deployed from the right mid-instrument panel area with a horizontally oriented flap tear seam (H-configuration). No contact evidence was identified on the air bag or exterior surface of the module cover flap. The cover flaps were nearly symmetrical in shape as the upper flap measured 32.5 cm (12.8 in) in width and 7.0 cm (2.8 in) in height while the lower flap measured 32.5 cm (12.8 in) in width and 6.0 cm (2.4 in) in height. The NASS researcher measured the passenger air bag at 54.0 cm (21.3 in) in width and 65.0 cm (25.6 in) in height in its deflated state (**Figure 7**). The bag was tethered by two internal straps and vented by two ports located at the 10 o'clock and 2 o'clock sectors on the rear aspect of the air bag. No cutoff switch was found for the front right air bag.



Figure 7. 1998 Chevrolet Suburban redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	21 year old female
Height:	160 cm (63 in)
Weight:	54 kg (120 lb)
Seat Track Position:	Mid-to-forward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, driver interview, police report
Eyewear:	Prescription glasses
Type of Medical Treatment:	Transported to the emergency room of a local trauma center and released

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
Cervical spine strain	Minor (640278.1,6)	Non-contact injury (flexion)
Bilateral knee contusions	Minor (890402.1,3)	Left knee bolster

Driver Kinematics

The 21 year old female driver of the 1998 Chevrolet Suburban was restrained by the available 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the mid-to-forward position. Belt usage was confirmed by the stretched webbing in conjunction with the lack of significant interior contacts and injury. At impact, she initiated a forward trajectory in response to the 1 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Loading of the knee bolster resulted in bilateral contusions to the knees as evidenced by the indentations and scuff marks documented to this component (*sourced to the steering column in the NASS case file*). Contact to the driver air bag was confirmed by the skin oil and makeup transfers documented to the upper right quadrant of the air bag face. She also sustained a cervical spine strain which was a result of the sudden forward movement of the head as the body loaded the belt system (flexion). The driver sought treatment later at her physician's office. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential serious injury.

REAR OCCUPANT DEMOGRAPHICS / INJURIES

The rear center seating position was occupied by a 5 month old male. He was restrained by the available 2-point manual lap belt system used in conjunction with a Century Smart Move XT child safety seat (**Figure 8**) equipped with a 5-point restraint harness. Although uninjured in the collision, the infant passenger was taken later to a private physician for evaluation.



Figure 8. Century Smart Move XT child safety seats.

The rear right seating position was occupied by an 18 month old female. She was restrained by the available 3-point manual lap and shoulder belt system used in conjunction with a Century Smart Move XT child safety seat (**Figure 8**)

