TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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

NASS CDS CASE NO. 1998-02-095C

RABSS VEHICLE - 1998 CHEVROLET MALIBU LS

LOCATION - STATE OF NEW YORK

CRASH DATE - JULY, 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 investigation focused on a two-vehicle crash involving a 1998 Chevrolet Malibu LS (subject vehicle) and a 1986 GMC G-Series van. The Chevrolet Malibu was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with the left side of the GMC van. The Chevrolet was westbound negotiating a right curve when it crossed the centerline into the path of the van. The driver of the van braked and steered right in avoidance, partially exiting the south shoulder. Impact resulted in moderate front left damage to the Chevrolet Malibu and minor left side damage to the GMC van. The 48 year old male driver of the Chevrolet was sleepy or had fallen asleep prior to collision and was leaning to the right with his left hand at the 10 o'clock position on the steering wheel. He was properly restrained by the 3-point manual lap and shoulder belt system and sustained a minor abrasion/laceration to the anterior aspect of the left forearm from the air bag deployment. The 16 year old male front right passenger (also asleep) was leaning to the right and properly restrained by the 3-point manual lap and shoulder belt system. He complained of numbness to the neck area, but there was no notable trauma to the head nor interior contacts for this occupant. This injury was an indirect result of sudden forward head movement (flexion) during the collision sequence as the body loaded the belt system. All four occupants of the Chevrolet Malibu were transported to a local hospital for treatment and released. The two occupants in the GMC van were uninjured.			
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BACKGROUND

This investigation focused on a two-vehicle crash involving a 1998 Chevrolet Malibu LS (subject vehicle) and a 1986 GMC G-Series van. The Chevrolet Malibu was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with the left side of the GMC van. The Chevrolet was westbound negotiating a right curve when it crossed the centerline into the path of the van. The driver of the van braked and steered right in avoidance, partially exiting the south shoulder. Impact resulted in moderate front left damage to the Chevrolet Malibu and minor left side damage to the GMC van. The 48 year old male driver of the Chevrolet was sleepy or had fallen asleep prior to collision and was leaning to the right with his left hand at the 10 o'clock position on the steering wheel. He was properly restrained by the 3-point manual lap and shoulder belt system and sustained a minor abrasion/laceration to the anterior aspect of the left forearm from the air bag deployment. The 16 year old male front right passenger (also asleep) was leaning to the right and properly restrained by the 3-point manual lap and shoulder belt system. He complained of numbness to the neck area, but there was no notable trauma to the head nor interior contacts for this occupant. This injury was an indirect result of sudden forward head movement (flexion) during the collision sequence as the body loaded the belt system. All four occupants of the Chevrolet Malibu were transported to a local hospital for treatment and released. The two occupants in the GMC van were uninjured.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 98-02-095C and was also included in the Redesigned Air Bag Special Study. The Field Operations Branch of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian/Calspan the task of case review and final report preparation.

SUMMARY

Crash Site

This two-vehicle crash occurred during the early morning hours of July, 1998. At the time of the crash, it was dark (street lighted) with no adverse conditions as the roads were dry. The crash occurred on a slight hillcrest in the eastbound lane of an east/west two lane rural asphalt roadway which curves to the left for eastbound traffic **(see Figure 9 - page 8)**. The speed limit at the crash scene was 89 km/h (55 mph). The Chevrolet Malibu was westbound and negotiating a right curve **(Figure 1)**. The GMC van was eastbound entering a left curve **(Figure 2)**.

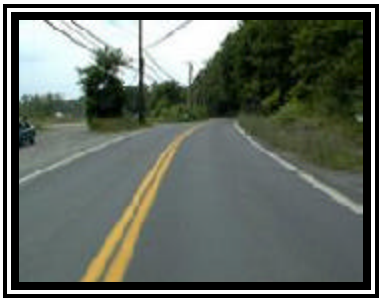

Figure 1. Westbound approach for the 1998 Chevrolet Malibu LS.

Figure 2. Eastbound approach for the 1986 GMC G-Series van.

Pre-Crash

The 48 year old male driver of the 1998 Chevrolet Malibu LS was operating the vehicle westbound and was on his way home from a trip to his son's college. He reportedly fell asleep at the wheel and allowed the vehicle to drift across the centerline into eastbound traffic, tracking throughout its pre-crash trajectory. There were no brake marks within the vehicle's trajectory indicative of driver avoidance maneuvers. The 1986 GMC G-Series van was driven eastbound by a 53 year old male with a 50 year old female passenger in the front right position. As the driver of the van entered the left curve he noticed the Chevrolet Malibu encroaching into his path of travel and attempted to brake and steer right in avoidance. This maneuver placed the van partially off the south (right) road edge prior to collision.

Crash

As the Chevrolet crossed the centerline of the two lane roadway, the front left corner area of the Chevrolet Malibu struck the left side of the GMC van. The impact induced deceleration was sufficient to deploy the Malibu's redesigned frontal air bag system. The crash, however, could not be reconstructed by WinSMASH due to the corner engagement against the side of the van (out of scope). The Collision Deformation Classification (CDC) for this impact to the Chevrolet Malibu was 12-FLEE-7 (despite above beltline direct damage to the side mirror, vertical code "E" chosen so as not to overstate damage pattern) and 12-LDES-1 for the GMC van. During the impact sequence, engagement occurred between the left front wheel of the Chevrolet Malibu and the left rear wheel of the GMC van which initiated a counterclockwise rotation of both vehicles as they began their respective post-impact trajectories to final rest. The Chevrolet Malibu came to rest 10 meters (33 ft) west of the point of impact (in the roadway) facing southeast. The GMC van came to rest 38 meters (125 ft) from the point of impact partially off the north road edge facing southwest.

Post-Crash

All four occupants of the Chevrolet Malibu exited the vehicle under their own power. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMT's). All four occupants of the Chevrolet Malibu were transported by ambulance to a local hospital for treatment and released. Both vehicles were towed from the scene.

RABSS VEHICLE

The 1998 Chevrolet Malibu LS was identified by the Vehicle Identification Number (VIN): 1G1NE52M5WY (production sequence deleted). The vehicle was a 4-door sedan equipped with front wheel drive and a 3.1 liter, 6 cylinder engine. The vehicle's odometer reading was 15,852 km (9,850 miles) at the time of the crash. The police report listed the rear center occupant as the owner of the vehicle. The seating was configured with front bucket seats and a folding (back) rear bench. The NASS interview revealed a portable cellular phone was present in the vehicle but not in use at the time of the collision. The driver reported no previous crashes or maintenance on the air bag system (original equipment).

VEHICLE DAMAGE

Exterior Damage

The direct contact damage to the Chevrolet Malibu began at the front left bumper corner and extended inboard 15 cm (6 in). The damage profile measured across the frontal plane exhibited no residual longitudinal displacement at any of the six crush measurements. The contact damage extended longitudinally down the side plane with the left fender deformed rearward to the A-pillar and minimal lateral displacement to the left front door. The left front tire deflated and the wheel/tire rotated counterclockwise 45 degrees from engagement against the left rear wheel of the GMC van during the impact sequence. This damage pattern jammed the left front door and shattered the side window glazing **(Figure 3)**. The direct contact damage to the GMC van began 72 cm (28 in) forward of the left front axle and extended 464 cm (183 in) rearward **(Figure 4)**. Moderate left rear wheel damage was noted to the van associated to the left front wheel damage of the Chevrolet Malibu.

Figure 3. Narrow end engagement damage to the Chevrolet Malibu.

Figure 4. Sideswipe damage to the left side of the GMC van.

Interior Damage

Interior damage to the Chevrolet Malibu identified through the NASS vehicle inspection was minimal and was attributed to occupant contact. A scuff mark was noted on the steering wheel rim along with blood spattering on the upper portion of the driver air bag and door panel (above the armrest). This damage was attributed to the driver's left forearm injury. No remarkable contacts were found on the passenger side air bag. Additional contacts included scuff marks on the driver seat back from the rear occupants and minor fabric transfers to the front left and rear left shoulder belts. No intrusion of interior components were found to the driver seating area. No deformation was noted to the knee bolsters (padded type) or steering wheel rim (tilt column set to the full up position).

Figure 5. Chevrolet Malibu redesigned driver air bag.

Figure 6. Chevrolet Malibu redesigned passenger air bag.

REDESIGNED AIR BAG SYSTEM

The 1998 Chevrolet Malibu LS was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags deployed as a result of inertial deceleration from the wheel engagement between the two vehicles just prior to impact spin out, evidenced by the damage pattern(s) to the vehicles and physical evidence found at the scene. 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 and measured 7 cm (3 in) in width and 14 cm (6 in) in height. There was no contact evidence to the exterior surface of the module cover flaps but light blood spattering was identified on the upper portion of the air bag. The driver's forearm injury was a result of contact by the expanding air bag during deployment. The NASS researcher measured the diameter of the driver air bag at 60 cm (24 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 a top mount module in the right instrument panel with a single cover flap design hinged at the forward aspect. The cover flap opened in an upward direction toward the windshield. The cover flap was rectangular in shape and measured 33 cm (13 in) in width and 15 cm (6 in) in height. The NASS researcher measured the passenger air bag at 60 cm (24 in) in width and 72 cm (28 in) in height in its deflated state **(Figure 6)**. There was no contact evidence noted to the module cover flap or front right air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	48 year old male
Height:	178 cm (70 in)
Weight:	77 kg (170 lb)
Seat Track Position:	Mid-to-rear position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, medical reports, passenger interview
Eyeware:	Prescription glasses
Type of Medical Treatment:	Transported to a local hospital and released

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Abrasion left anterior forearm	Minor (790202.1,2)	Front left air bag
Laceration left anterior forearm	Minor (790600.1,2)	Front left air bag

Driver Kinematics

The 48 year old male driver of the Chevrolet Malibu was sleepy or had fallen asleep prior to the collision. The seat back was slightly reclined and the seat track was adjusted to the mid-to-rear position. The NASS researcher interview revealed all occupants were asleep prior to the collision and further information on occupant postures were unavailable. His posture was presumed to be upright and leaning slightly to the right with the left hand at the 10 o'clock position on the steering wheel.

The driver was properly restrained by the 3-point manual lap and shoulder belt system. Belt usage was confirmed by loading marks as he initiated a forward trajectory in response to the 12 o'clock impact force. As the air bag deployed, the expanding air bag contacted the anterior aspect of his left forearm which resulted in abrasions and a minor laceration. This was evidenced by the scuff mark found on the steering wheel rim in conjunction with the location of the blood spattering on the upper portion of the air bag and door panel **(Figure 7)**. The driver was transported to a local hospital for treatment and released.

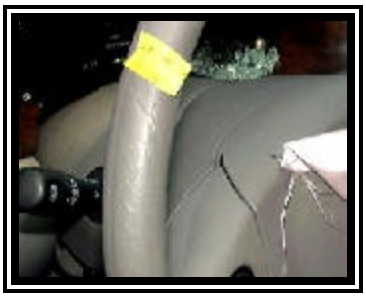

Figure 7. Scuff mark to the steering wheel rim.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex:	16 year old male
Height:	180 cm (71 in)
Weight:	66 kg (145 lb)
Seat Track Position:	Full rearward position
Manual Restraint Usage:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, medical reports, passenger interview
Eyeware:	Contact lenses
Type of Medical Treatment:	Transported to a local hospital and released

Front Right Passenger Injuries

Injury	*Severity*	*Injury Mechanism*
Not injured	N/A	N/A

Front Right Passenger Kinematics

The 16 year old male passenger was seated in the front right position of the Chevrolet Malibu. He was asleep and leaning to the right against the front right door panel, evidenced by the scuff marks on the door panel just below the armrest **(Figure 8)**. The seat back was slightly reclined and the seat track was adjusted to the full rearward position. He was properly restrained by the 3-point manual lap and shoulder belt system.

At impact, the passenger initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint with no notable contacts to the passenger air bag. He complained of numbness with minor pain to the neck (not further specified) with no associated head trauma. This complaint of pain was an indirect result of sudden forward head movement (flexion) during the impact sequence as the body loaded the belt system. The passenger was transported to a local hospital for treatment and released.

Figure 8. Scuff mark to the front right interior door panel.

REAR OCCUPANT DEMOGRAPHICS / INJURIES

Rear Left Passenger Demographics

Age/Sex:	14 year old male
Height:	188 cm (74 in)
Weight:	66 kg (145 lb)
Seat Track Position:	Fixed
Manual Restraint Usage:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, medical reports, passenger interview
Eyeware:	Contact lenses
Type of Medical Treatment:	Transported to a local hospital and released

Rear Left Passenger Injuries

Injury	*Severity*	*Injury Mechanism*
Abrasion left lower extremity (distal to the knee)	Minor (890202.1,2)	Left side interior surface
Laceration left lower extremity (distal to the knee)	Minor (890602.1,2)	Left side interior surface

Rear Center Passenger Demographics

Age/Sex:	48 year old female
Height:	168 cm (66 in)
Weight:	75 kg (165 lb)
Seat Track Position:	Fixed
Manual Restraint Usage:	Lap belt
Usage Source:	NASS inspection, medical reports, passenger interview
Eyeware:	Prescription glasses
Type of Medical Treatment:	Transported to a local hospital and released

Rear Center Passenger Injuries

Injury	*Severity*	*Injury Mechanism*
Not injured	N/A	N/A

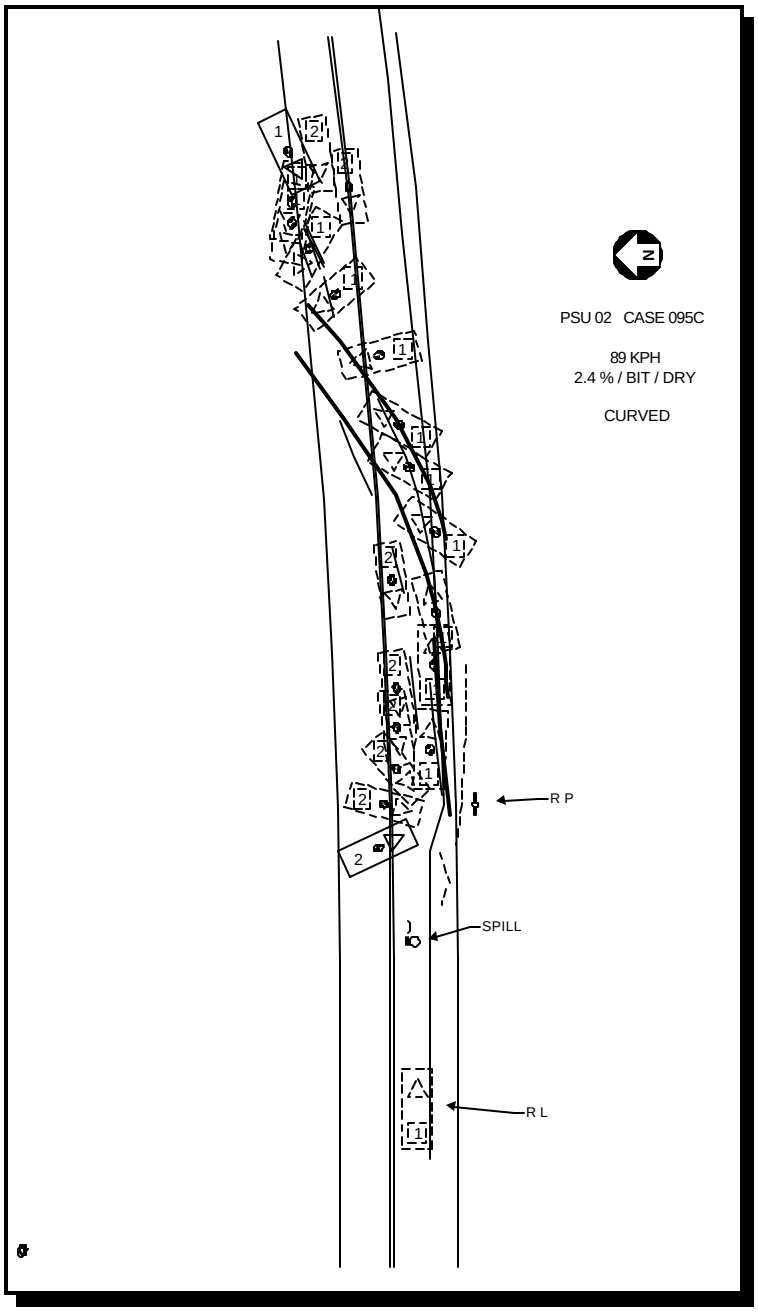

Figure 9. NASS Scene Diagram