

**TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION**

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

NASS RABSS CASE NO. 1998-45-803E

RABSS VEHICLE - 1999 CHEVROLET TAHOE SPORT UTILITY

LOCATION - STATE OF TENNESSEE

CRASH DATE - AUGUST, 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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<p>16. <i>Abstract</i> This investigation focused on a single vehicle crash involving a 1999 Chevrolet Tahoe sport utility. The Chevrolet Tahoe was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with a large diameter tree. The driver was operating the vehicle westbound on a 2 lane rural roadway when he crested a hill and observed a westbound non-contact vehicle stopped in the roadway waiting to make a left turn into a private driveway. Upon recognition of the impending harmful event, he steered right/braked in avoidance and departed the right (north) pavement edge. As the Chevrolet exited the north pavement edge the front right area impacted a large diameter tree which resulted in moderate damage. The Chevrolet came to rest in close proximity to the point of impact facing northwest. The 38 year old male driver was properly 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-rear position. At impact, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and redesigned driver air bag. Contact to the deployed air bag resulted in multiple abrasions and contusion to the facial area. He also sustained a contusion to the right knee/shin from loading to the knee bolster. The driver was transported to a local hospital for treatment and released.</p>			
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CRASH DATE - AUGUST, 1998**

BACKGROUND

This investigation focused on a single vehicle crash involving a 1999 Chevrolet Tahoe sport utility. The Chevrolet Tahoe was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with a large diameter tree. The driver was operating the vehicle westbound on a 2 lane rural roadway when he crested a hill and observed a westbound non-contact vehicle stopped in the roadway waiting to make a left turn into a private driveway. Upon recognition of the impending harmful event, he steered right/braked in avoidance and departed the right (north) pavement edge. As the Chevrolet exited the north pavement edge, the front right area impacted a large diameter tree which resulted in moderate damage. The Chevrolet came to rest in close proximity to the point of impact facing northwest. The 38 year old male driver was properly 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-rear position. At impact, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and redesigned driver air bag. Contact to the deployed air bag resulted in multiple abrasions and contusion to the facial area. He also sustained a contusion to the right knee/shin from loading to the knee bolster. The driver was transported to a local hospital for treatment and released.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-45-803E for 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 single vehicle crash occurred during the morning hours of August, 1998. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred off the north pavement edge of a straight, 2 lane east/west asphalt roadway (see **Figure 7 - page 5**). No traffic controls were present at the scene which had a posted speed limit of 48 km/h (30 mph).

Pre-Crash

The 38 year old male driver of the 1999 Chevrolet Tahoe sport utility was operating the vehicle westbound when he crested a hill and observed a westbound non-contact vehicle stopped in the roadway waiting to make a left turn (**Figure 1**). Upon recognition of the impending harmful event, he steered right/braked in avoidance and exited the north pavement edge, traversing a private driveway and lawn area.

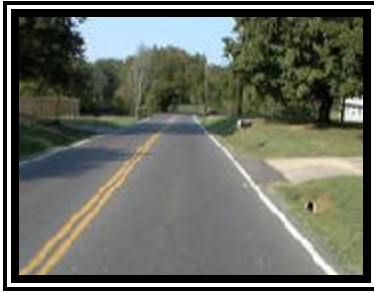


Figure 1. Westbound approach for the 1999 Chevrolet Tahoe sport utility.

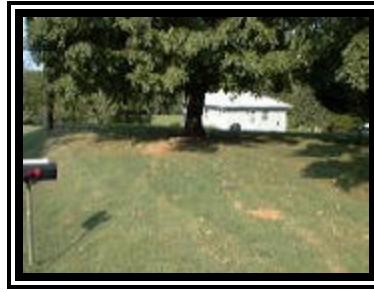


Figure 2. Struck tree.

Crash

As the Chevrolet exited the north pavement edge of the 2 lane roadway, the front right area impacted a 60.0 cm (23.6 in) diameter tree that was located 7.3 meters (24.0 ft) outboard of the north edgeline (**Figure 2**). The impact resulted in moderate damage. The Collision Deformation Classification (CDC) for this impact to the Chevrolet Tahoe was 12-FZEW-3. The impact induced deceleration was sufficient to deploy the Chevrolet's redesigned frontal air bag system. The WinSMASH damage and trajectory algorithm computed an impact speed of 36.5 km/h (22.7 mph) with a computed (barrier equivalent) velocity change of 33.5 km/h (20.8 mph). The respective longitudinal component was -33.0 km/h (-20.5 mph). The Chevrolet rotated clockwise 20 degrees and came to rest in close proximity to the point of impact facing northwest.

Post-Crash

The driver of the Chevrolet Tahoe exited the vehicle under his own power. Treatment was rendered at the scene by emergency medical technicians (EMT). The driver was transported to a local hospital for treatment and released. The vehicle was towed from the scene.

RABSS VEHICLE

The 1999 Chevrolet Tahoe sport utility was identified by the Vehicle Identification Number (VIN):1GNEK13R3XR (production sequence deleted). The police report listed the driver as the owner of the vehicle. The vehicle was a 4-door sport utility equipped with four wheel drive, ABS and a 5.7 liter, V-8 engine. The vehicle's odometer reading was 15,332 km (9,527 miles) at the time of the crash. The seating was configured with front bucket seats and a rear split bench (with folding backs). The driver reported no previous crashes or maintenance on the air bag system (original equipment). No cell phone was present or in use at the time of the collision.

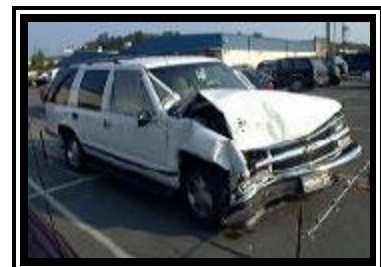


Figure 3. Frontal damage to the 1999 Chevrolet Tahoe sport utility.

VEHICLE DAMAGE

Exterior Damage

The Chevrolet Tahoe sustained moderate frontal damage as a result of the impact with the tree (**Figure 3**). The direct contact damage began 15.0 cm (5.9 in) left of the front right bumper corner and extended 50.0 cm (19.7 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 168.0 cm (66.1 in). Six crush measurements were documented at the level of the bumper: C1= 0 cm, C2= 6.0 cm (2.4 in), C3= 17.0 cm (6.7 in), C4= 34.0 cm (13.4 in), C5= 56.0 cm (22.0 in), C6= 53.0 cm (20.9 in). The hood was displaced up and rearward from engagement against the tree. Induced damage was noted to the right fender which restricted the right front wheel/tire (not deflated). The right wheelbase was displaced 15.0 cm (5.9 in). The windshield was fractured from exterior forces (only).

Interior Damage

Interior damage to the Chevrolet identified through the NASS vehicle inspection was minimal and was attributed to occupant contact (**Figure 4**). Smudge marks were identified on the lower section of the driver air bag. Scuff marks were documented on the left knee bolster. No deformation was noted to the steering wheel rim (tilt column set to the center position). No intrusions were found in the vehicle.



Figure 4. Interior view.

REDESIGNED AIR BAG SYSTEM

The 1999 Chevrolet Tahoe sport utility 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, smudge marks were documented on the lower section of the air bag. The NASS researcher measured the diameter of the driver air bag at 56.0 cm (22.0 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. 1999 Chevrolet Tahoe redesigned driver air bag.



Figure 6. 1999 Chevrolet Tahoe redesigned passenger air bag.

The front right passenger air bag deployed from a mid-mount module in the right instrument panel with a horizontally oriented flap tear seam

(H-configuration). The cover flaps were rectangular and symmetrical in shape which measured 32.0 cm (12.6 in) in width and 6.0 cm (2.4 in) in height. No contact evidence was identified on the air bag or exterior surface of the module cover flaps. The NASS researcher measured the passenger air bag at 60.0 cm (23.6 in) in width and 48.0 cm (18.9 in) in height in its deflated state (**Figure 6**). No internal tether straps were present. The bag

was vented by two ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the air bag. No cutoff switch was reported for the front right air bag.

DRIVER DEMOGRAPHICS

Age/Sex: 38 year old male
 Height: 183 cm (72 in)
 Weight: 120 kg (265 lb)
 Seat Track Position: Mid-to-rear 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 a local hospital and released

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
Abrasion right forehead	Minor (290202.1,7)	Front left air bag
Abrasion right cheek	Minor (290202.1,1)	Front left air bag
Contusion right eyelid ("black eye")	Minor (297402.1,1)	Indirect contact injury (front left air bag/eye glasses)
Abrasion right abdomen	Minor (590202.1,1)	Lap belt webbing
Contusion right knee/shin	Minor (890402.1,1)	Left knee bolster

Driver Kinematics

The 38 year old male driver of the 1999 Chevrolet Tahoe sport utility was properly restrained by the available 3-point lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the mid-to-rear position. Belt usage was confirmed by the lack of significant contact points within the vehicle relative to the injuries sustained. At impact, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual belt and redesigned driver air bag. Contact to the deployed air bag resulted in an abrasion to the right cheek and forehead, evidenced by the location of the injuries in conjunction with the smudge marks identified on the driver air bag. He also sustained a contusion to the right eyelid ("black eye") which was an indirect result of air bag contact to the prescription eyeglasses worn. Loading of the manual restraint resulted in an abrasion to the right abdomen. His lower extremities contacted the knee bolster resulting in a contusion to the right knee/shin as evidenced by the scuff marks documented on the knee bolster. The driver was transported to a local hospital for treatment and released.

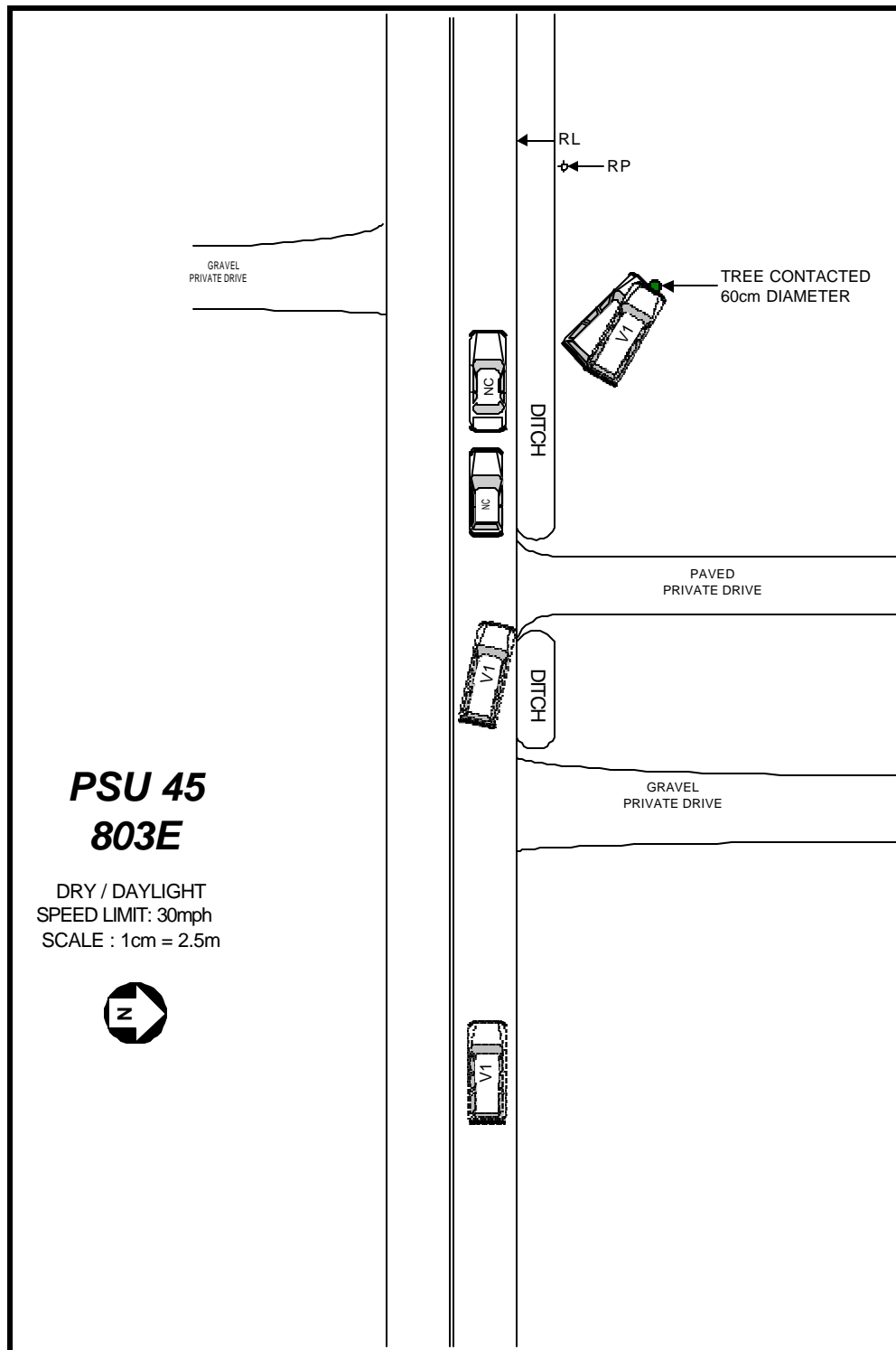


Figure 7. NASS Scene Diagram