

**TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER**

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**REMOTE REDESIGNED AIR BAG DEPLOYMENT INVESTIGATION
SCI TECHNICAL SUMMARY REPORT**

VERIDIAN CASE NO. CA99-029

RABSS VEHICLE -1998 CHEVROLET 1500 SERIES PICKUP TRUCK

LOCATION - STATE OF MARYLAND

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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<p>16. <i>Abstract</i> This remote investigation focused on a single vehicle crash that involved a 1998 Chevrolet 1500 series extended cab pickup truck. The Chevrolet pickup truck was equipped with redesigned frontal air bags that deployed as result of a frontal collision with a tree. The pickup truck was occupied by a 24-year-old female driver, a 24-year-old male front right passenger, a 23-year-old female rear center passenger, and a 21-year-old male rear right passenger. All occupants were unrestrained except the rear right passenger who was wearing the 3-point manual lap and shoulder belt system. The Chevrolet pickup truck departed the top aspect of a T-intersection and impacted a tree. The occupants initiated a forward trajectory in response to the 12 o'clock impact force. The driver loaded the air bag and steering wheel and sustained arm and facial injuries. The front right passenger loaded through the front right passenger's air bag and struck the windshield header, upper and lower instrument panel and A-pillar. He sustained a cerebral subarachnoid hemorrhage, multiple rib fractures, internal bleeding, and open fracture of the left tibia. The rear center passenger struck the rear aspect of the driver's seat and was ejected through the windshield. She sustained police-reported serious injuries. The rear right passenger loaded the manual restraint and contacted the rear aspect of the front passenger seat and the right B-pillar. He sustained police-reported non-incapacitating injuries. The pickup truck rotated in a counterclockwise (CCW) direction and came to rest wedged between two trees with the rear aspect elevated approximately 3.1 m (10.0') above ground level. The driver and rear right passenger were transported by ambulance to a regional medical center and admitted. The front right passenger and rear center passenger were transported by helicopter to a regional medical center. The front right passenger expired 5.5 hours after the crash.</p>			
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SCI TECHNICAL SUMMARY REPORT
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RABSS VEHICLE -1998 CHEVROLET 1500 SERIES PICKUP TRUCK
CRASH DATE - JULY 1998**

BACKGROUND

This remote investigation focused on a single vehicle crash that involved a 1998 Chevrolet 1500 series extended cab pickup truck. The Chevrolet pickup truck was equipped with redesigned frontal air bags that deployed as result of a frontal collision with a tree. The pickup truck was occupied by a 24-year-old female driver, a 24-year-old male front right passenger, a 23-year-old female rear center passenger, and a 21-year-old male rear right passenger. All occupants were unrestrained except the rear right passenger who was wearing the manual 3-point lap and shoulder belt system. The Chevrolet pickup truck departed the top aspect of a T-intersection and impacted a tree. The occupants initiated a forward trajectory in response to the 12 o'clock impact force. The driver loaded the air bag and steering wheel and sustained arm and facial injuries. The front right passenger loaded through the front right passenger's air bag and struck the windshield header, upper and lower instrument panel and A-pillar. He sustained a cerebral subarachnoid hemorrhage, multiple rib fractures, internal bleeding, and open fracture of the left tibia. The rear center passenger struck the rear aspect of the driver's seat and was ejected through the windshield. She sustained police reported serious injuries. The rear right passenger loaded the manual restraint and contacted the rear aspect of the front passenger seat and the right B-pillar. He sustained police reported non-incapacitating injuries. The pickup truck rotated in a counterclockwise (CCW) direction and came to rest wedged between two trees with the rear aspect elevated approximately 3.1 m (10.0') above ground level. The driver and rear right passenger were transported by ambulance to a regional medical center and admitted. The front right passenger and rear center passenger were transported by helicopter to a regional medical center. The front right passenger expired 5.5 hours after the crash.

This crash was identified through a search of the Fatality Analysis Reporting System (FARS) for fatalities that occurred in vehicles equipped with redesigned air bags. The crash occurred in July 1998 and was assigned to the Veridian Special Crash Investigation Team on September 2, 1999, as a remote investigation effort. Police photographs and medical data were obtained which provided the basis for this narrative report.

SUMMARY

Crash Site

This single-vehicle crash occurred during the nighttime hours of July 1998. At the time of the crash, it was dark with no adverse conditions as the asphalt roadway was dry. The crash occurred on the north side of a 3-leg (T) intersection of two state roadways. The north/south roadway was straight and consisted of two travel lanes, the northbound lane having a right turn lane that originated prior to the intersection leading to a merge lane with the eastbound lane of the east/west roadway. The other northbound lane of the north/south roadway was designated for left-turn only onto the east/west roadway. The east/west roadway was straight and consisted of two travel lanes with no physical division. There was a left turn lane for

westbound traffic to use when turning onto the southbound lane of the intersecting roadway. The roadside environment of the north/south roadway consisted of grassy shoulders with a shallow ditch on the outboard sides. The outboard shoulder areas were each bordered by cornfields. The east/west roadway was bordered by asphalt shoulders. The north side consisted of a grassy area populated with numerous hardwood trees. Traffic control included an overhead 3-phase traffic signal system in all directions, painted markings on the northbound lanes indicating turn lanes, and a yellow double-arrow warning sign indicating that a right or left turn must be made from the northbound lane. The posted speed limit for the north/south roadway was 80 km/h (50mph).

Pre-Crash

The 24-year-old female driver of the 1998 Chevrolet pickup was operating the vehicle northbound on approach to the 3-leg intersection (**Figure 1**). As the pickup truck approached the intersection, the driver became inattentive while probing with her hand around the driver's seat and floor area for a misplaced object, and failed to detect the intersection and traffic control devices (**Figure 2**). According to a witness, the overhead traffic signal system was in the red phase for the northbound pickup truck. The vehicle traveled through the intersection and departed the roadway at the top side of the T-intersection. The vehicle was reported by police as traveling approximately 56 km/h (35mph) as it traveled through the intersection. There were no identifying marks within the vehicle's trajectory to indicate any driver avoidance maneuvers.



Figure 1. Northbound approach for the Chevrolet pickup truck



Figure 2. 3-leg intersection and traffic controls

Crash

As the Chevrolet pickup traversed the grassy area on the north side of the intersection, the front left area of the vehicle impacted a tree that was approximately 1.0 m (3.0') in diameter. The 12 o'clock direction of force impact induced deceleration was sufficient to deploy the frontal air bag system. The damage algorithm of the WinSMASH program computed velocity changes of 50.8 km/h (32 mph) for the Chevrolet pickup truck based on an estimated crush profile. The specific longitudinal component was -50.0 km/h (-31 mph). At the point of maximum engagement with the tree, the rear of the Chevrolet pickup truck lifted upward approximately 3.0 m (10') while it



Figure 3. Final rest position of the Chevrolet pickup truck

simultaneously rotated approximately 30 degrees in a counterclockwise (CCW) direction. The pickup truck came to final rest with the front aspect near the base of the impacted tree and the rear bumper wedged against the other tree (**Figure 3**). At rest, the vehicle was at an angle of 30 degrees to the ground.

Post-Crash

The driver of the Chevrolet pickup was removed from the vehicle by rescue personnel and transported to a regional medical center with facial and arm injuries. The front right passenger of the pickup was removed by rescue personnel and transported by helicopter to a regional medical center with head, thoracic, and leg trauma. He expired 5.5 hours later from his injuries. The rear center passenger was ejected through the center of the windshield and came to rest on the ground in front of the vehicle. She was transported by rescue personnel to a regional medical center with serious injuries where she later recovered. The rear right passenger had been restrained by the 3-point manual lap and shoulder belt system, and exited the vehicle under his own power through the rear sliding window of the extended cab pickup truck. He was found lying near the roadway and transported by rescue personnel to a regional medical center where he was treated for his injuries and later released. The Chevrolet pickup truck was towed from the scene.

RABSS VEHICLE - 1998 CHEVROLET 1500 SERIES PICKUP TRUCK

The 1998 Chevrolet 1500 series extended cab pickup truck was identified by the Vehicle Identification Number (VIN)1GCEK19R4WE (production sequence omitted). The vehicle was a 2-door pickup truck equipped with four wheel drive and a 5.7 liter, V-8 engine. The police report listed the front right passenger as the owner of the vehicle. The seating was configured with front bucket seats (with folding backs) with adjustable head restraints in the front left and right positions, and a rear bench seat (with folding back) with adjustable head restraints in the rear outboard positions.

VEHICLE DAMAGE

Exterior Damage

The 1998 Chevrolet pickup truck sustained severe frontal damage as a result of the impact with the tree (**Figure 4**). The Collision Deformation Classification (CDC) for the impact to the Chevrolet pickup was 12-FYEW-3. The direct contact damage began approximately 20.0 cm (8.0") to the right of the centerline of the vehicle, and extended approximately 80.0 cm (31.5") across the front plane to the left bumper corner. The combined direct and induced damage length (Field L) involved the entire frontal width of the pickup truck. A crush profile was estimated from the police photographs and used to compute a WINSMASH delta-v. The profile was as follows:



Figure 4. Overhead view of the frontal damage

C1= 46.0 cm (18.0"), C2= 66.0 cm (26.0"), C3= 69.0 cm (27.0") C4= 55.0 cm (22.0") C5= 35.0 cm (14.0"), C6= 6.0 cm (2.0").

Both front tires were restricted and the left front deflated from the rearward displacement against the frame. There was a significant reduction in both left and right wheelbases. The windshield was holed in the middle due to the ejection of the rear center passenger. The tempered glass in the left door and left rear window was shattered due to the displacement of the left A-pillar. The center of the windshield header had buckled, and was displaced upward approximately 15.0 cm (6.0") (Figure 5).



Figure 5. Frontal damage to Chevrolet pickup truck

Interior Damage

Interior damage to the Chevrolet pickup truck was moderate, and was attributed to occupant contact and passenger compartment intrusion (Figure 6). Intrusions were estimated from police photographs. Major longitudinal intrusions to the passenger compartment included (estimates) the left A-Pillar [13.0 cm (5.0")], left instrument panel [15.0 cm (6.0")], left toepan [20.0 cm (8.0")], center instrument panel [10.0 cm (4.0")], and center toepan [15.0 cm (6.0")]. The steering column was deformed vertically approximately 30 degrees, with no deformation observed to the steering wheel rim. Deformation was noted on the knee bolster and glove box door. The driver's seat was displaced slightly forward and to the left from impact forces. The front right passenger seat and center arm rest were both displaced forward and to the left due to impact forces and contact from the passengers seated in the rear of the vehicle.



Figure 6. Interior view of Chevrolet pickup truck

REDESIGNED AIR BAG SYSTEM

The 1998 Chevrolet pickup truck 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 impact with the tree (Figure 7). Air bag warning labels were affixed to each sun visor. The driver airbag was housed in the center of the steering wheel with a vertically oriented tear seam (I-configuration). The flaps were symmetrical in shape. Based on inspection of an exemplar vehicle, each measured approximately 9.0 cm (4.0") in width and 9.0 cm (4.0") in height. Vent ports were visible on the rear aspect of the air bag. The air bag was tethered by internal straps. No contact evidence was visible on the air bag or module cover flaps.



Figure 7. Deployed frontal air bag system

The front right passenger air bag deployed from the right mid instrument panel area with a horizontally oriented flap tear seam (H-configuration). The cover flaps were rectangular and symmetrical in shape. Based on inspection of an exemplar vehicle, each flap measured approximately 30.0 cm (12.0") in width and 6.0 cm (2.0") in height. There was no contact evidence visible on the surface of the cover flaps, but a large amount of pooled blood was observed on the left aspect of the air bag. A cutoff switch was visible on the mid instrument panel to the right of the steering column and was set to the "on" position (**Figure 8**).



Figure 8. Front right passenger's air bag cutoff switch

OCCUPANT DEMOGRAPHICS

Driver

Age/Sex: 24-year-old female
 Height: Not reported
 Weight: Not reported
 Seat Track Position: Mid-track (based on police photographs)
 Manual Restraint Use: None
 Usage Source: Police report
 Eyewear: Not reported
 Type of Medical Treatment: Transported to a regional medical center and admitted

Driver Injuries

Injury	Injury Severity (AIS 90)	Injury Mechanisms
Unspecified facial injury	Minor (290099.1,9)	Air bag
Fractured right arm (NFS)	Moderate (751800.2,1)	Instrument panel

*Injury source: Police accident report

Driver Kinematics

The 24-year-old driver of the 1998 Chevrolet pickup was reportedly out of position prior to the impact with the tree. According to police reports and her own witness statement, she was bent forward while probing with her hand around the driver's seat and floor area for a misplaced object. Based on police photos, the seat track position was approximately at the mid-track position. She was not restrained by the available 3-point manual lap and shoulder belt system. Belt non-usage was reported by the police.

At impact with the tree, the driver initiated a forward trajectory in response to the 12 o'clock impact force and loaded the driver's air bag and underside of the steering column. The steering column was compressed and displaced vertically from occupant loading. There was no visible deformation to the steering wheel rim. She subsequently loaded the knee bolster with her lower extremities, but there were no injuries reported

with that contact. She sustained unspecified facial injuries from probable contact with the driver's air bag. She also sustained a fractured right arm from probable deflection against the instrument panel. Rescue personnel removed the door to aid in removal of the driver from the vehicle. She was transported to a regional medical center where she was admitted for her injuries.

Front right Passenger

Age/Sex: 24-year-old male
 Height: Not reported
 Weight: Not reported
 Seat Track Position: Not reported
 Manual Restraint Use: None
 Usage Source: Police Report, Death Investigation Report
 Eyewear: Not reported
 Type of Medical Treatment: Transported to regional medical center and pronounced dead 5.5 hours later

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90)	Injury Mechanisms
Multiple bilateral inter-orbital lacerations	Severe (140688.4,9)	Windshield header
Flail chest with multiple left rib fractures	Severe (450260.4,2)	Instrument panel
Cerebral subarachnoid hemorrhage	Serious (140684.3,9)	Windshield header
Open fracture anterior left tibia	Serious (853405.3,2)	Glove box door
Abrasion facial (NFS)	Minor (290202.1,9)	Windshield glazing
Abrasion right elbow	Minor (790202.1,1)	Right door interior surface
Nasal bridge compression	N/A (not coded under AIS 90)	Windshield header
Crepitus - left axilla	N/A (not coded under AIS 90)	Instrument panel
Internal abdominal hemorrhage	N/A (not coded under AIS 90)	Instrument panel

*Injury source: Medical Examiner's report

Front right Passenger Kinematics

The 24-year-old front right passenger was presumed to be seated in a reclined position prior to the impact with the tree, based on witness statements. He was not restrained by the available 3-point manual lap and shoulder belt system. Belt non-usage was reported by the police.

At impact with the tree, the passenger initiated a forward trajectory in response to the 12 o'clock impact force. He loaded through the deployed redesigned front right passenger's air bag, compressed the air bag against the instrument panel and deflected it through the open windshield. His head struck the windshield header and sun visor resulting in facial abrasions, inter-orbital lacerations, nasal bridge compression, and sub-arachnoid hemorrhage. He loaded the upper instrument panel and right A-pillar with his thoracic region, resulting in a left flail chest with rib fractures, crepitus in the left axilla, and internal abdominal hemorrhage. He struck the glove box with his lower extremities resulting in an open fracture of the left tibia. He rebounded rearward evidenced by the blood streak on the head liner (**Figure 9**),



Figure 9. Interior of Chevrolet pickup truck showing blood streak on the headliner

and came to rest slumped forward with his face positioned on the left side of the passenger air bag due to the elevated final rest position of the pickup truck. He was removed from the vehicle by rescue personnel and transported by helicopter to a regional medical center where he expired 5.5 hours later from his injuries.

Rear Center Passenger Kinematics

The 23-year-old rear center passenger was out of position with her legs across the rear right passenger's legs, and her head resting against the rear right passenger's chest. She was not restrained by the available manual lap belt system. Belt usage and seat positions were reported by passenger witness statements and police report.

At impact with the tree, she initiated a forward trajectory in response to the 12 o'clock impact force. Her witness statement indicated that just before the impact, she moved to semi-upright attitude. At impact, she was thrown forward and struck the rear aspect of the front left seat. She continued in a forward motion and was fully ejected through the center of the windshield. She came to rest in front of the vehicle and was found seated in dense shrubbery. She was transported by helicopter to a regional medical center with unspecified non-incapacitating injuries. She was admitted for her injuries and underwent surgery for spleen removal.

Rear Right Passenger Kinematics

The 21-year-old male rear right passenger was in a semi-seated position in the extended cab of the Chevrolet pickup truck. He was restrained by the available 3-point manual lap and shoulder belt system. At impact with the tree, he initiated a forward trajectory in response to the 12 o'clock impact force. He loaded the manual restraint system (**Figure 10**) and struck the rear aspect of the front right seat with his head, and was redirected into the right B-pillar. He was reported to have exited the vehicle through the rear sliding window under his own power. He was found lying near the roadway, and was transported to a regional medical center and admitted with unspecified non-incapacitating injuries.



Figure 10. Rear seat with evidence of loading to the rear right 3-point seat belt