TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

Veridian
Calspan Operations
Buffalo, New York 14225

VERIDIAN ON-SITE FAIL-TO-DEPLOY INVESTIGATION

VERIDIAN CASE NO. CA99-42

VEHICLE - 1999 GMC SIERRA PICKUP TRUCK

LOCATION - STATE OF NEW YORK

CRASH DATE - AUGUST, 1999

Contract No. DTNH22-94-D-07058

Prepared for:

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

DISCLAIMER

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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.* CA99-42	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* Veridian On-Site Fail-To-Deploy Investigation Vehicle - 1999 GMC Sierra Pickup Truck Location - State of New York		5. *Report Date*: December, 1999 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 (Calspan Operations) P.O. Box 400 Buffalo, New York 14225		10. *Work Unit No.* C01115.0246.(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 Report Crash Date - August, 1999 14. *Sponsoring Agency Code*	
15. *Supplementary Notes* On-site investigation of a single vehicle crash involving a 1999 GMC Sierra pickup truck and the non-deployment of the frontal air bag system.			
16. *Abstract* This on-site investigation focused on a single vehicle crash involving a 1999 GMC Sierra 1500 series pickup truck and the non-deployment of the frontal air bag system. The Sierra pickup was equipped with redesigned frontal air bags for the driver and right passenger positions which failed to deploy as a result of a run-off-road collision with a tree cluster. The 33 year old male driver failed to detect a stop sign as he proceeded straight through a Y-intersection and subsequently entered a wooded area. As the eastbound Sierra exited the east pavement edge of the 3-leg intersection, the frontal area impacted some brush, the left side surface sideswiped two trees; then continued into a large diameter tree resulting in moderate damage to the front left area. The pickup rotated counterclockwise as the front left area struck a tree stump, coming to rest against this final impact facing east. The 33 year old male driver was unrestrained. At impact with the third tree, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the upper portion of the steering wheel rim resulting in a contusion to the right upper chest. He continued the kinematic response pattern into the sunvisor which resulted in multiple lacerations to the left face, an abrasion to the nose, a contusion to the left eyelid and a left corneal abrasion. He also sustained a contusion to the left shoulder from contact to the A-pillar. The driver was transported by a friend to a local emergency care facility for treatment and released. The front right position was occupied by a 39 year old female who was properly restrained by the 3-point manual lap and shoulder belt system. At impact with the third tree, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint. She was not reported as injured in the collision but accompanied her husband to the medical facility.			
17. *Key Words* Tree cluster Overlapping damage Collision Deformation Classification (CDC): 12-FLEE-2 Left corneal abrasion		18. *Distribution Statement* General Public	
19. *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 7	22. *Price*

TABLE OF CONTENTS

VERIDIAN ON-SITE FAIL-TO-DEPLOY INVESTIGATION
VERIDIAN CASE NO. CA99-42
VEHICLE - 1999 GMC SIERRA PICKUP TRUCK
LOCATION - STATE OF NEW YORK
CRASH DATE - AUGUST, 1999

BACKGROUND

This on-site investigation focused on a single vehicle crash involving a 1999 GMC Sierra 1500 series pickup truck and the non-deployment of the frontal air bag system. The Sierra pickup was equipped with redesigned frontal air bags for the driver and right passenger positions which failed to deploy as a result of a run-off-road collision with a tree cluster. The 33 year old male driver failed to detect a stop sign as he proceeded straight through a Y-intersection and subsequently entered a wooded area. As the eastbound Sierra exited the east pavement edge of the 3-leg intersection, the frontal area impacted some brush, the left side surface sideswiped two trees; then continued into a large diameter tree resulting in moderate damage to the front left area. The pickup rotated counterclockwise as the front left area struck a tree stump, coming to rest against this final impact facing east. The 33 year old male driver was unrestrained. At impact with the third tree, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the upper portion of the steering wheel rim resulting in a contusion to the right upper chest. He continued the kinematic response pattern into the sunvisor which resulted in multiple lacerations to the left face, an abrasion to the nose, a contusion to the left eyelid and a left corneal abrasion. He also sustained a contusion to the left shoulder from contact to the A-pillar. The driver was transported by a friend to a local emergency care facility for treatment and released. The front right position was occupied by a 39 year old female who was properly restrained by the 3-point manual lap and shoulder belt system. At impact with the third tree, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint. She was not reported as injured in the collision but accompanied her husband to the medical facility.

The crash notification was provided to NHTSA on Monday, August 30, 1999 and assigned the case to the Veridian/Calspan Special Crash Investigation Team on Tuesday, August 31, 1999 for an on-site investigative effort. The Veridian SCI Team departed the morning of Tuesday, September 7, 1999 to conduct the local on-site investigation.

SUMMARY

Crash Site

The crash occurred during the early morning hours of August, 1999. At the time of the crash, it was dark with no adverse conditions as the roads were dry. The rural roadway consisted of 2 lanes with no lane markings or paved shoulders. The crash occurred off the east pavement edge of a level 3-leg ("Y") intersection **(see Figure 8 - page 7)** which had a posted speed limit of 48 km/h (30 mph). Traffic control at the scene included a stop sign for eastbound traffic.

Pre-Crash

The 33 year old male driver of the 1999 GMC Sierra pickup truck was operating the vehicle eastbound **(Figure 1)** on a 2 lane rural roadway when he failed to detect a stop sign as he proceeded straight through a Y-intersection. As he approached the intersection, he steered right/braked and subsequently departed the east pavement edge.

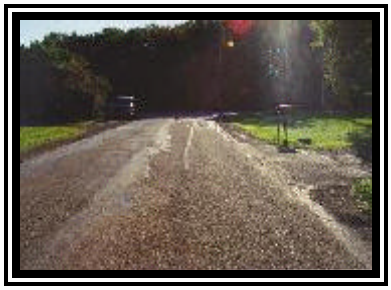

Figure 1. Eastbound approach for the 1999 GMC Sierra pickup truck.

Figure 2. Struck tree (impact #5).

Crash

As the Sierra departed the east pavement edge of the 3-leg intersection, the frontal area struck a patch of vegetation (brush) resulting in superficial damage. The Collision Deformation Classification (CDC) for this initial impact was 12-FDEW-1. The pickup continued 5.0 meters (16.4 feet) into the wooded area as the left side surface sideswiped an 8.0 cm (3.1 in) diameter tree resulting in minor damage. The CDC for this secondary impact was 12-LDES-1. The left side surface subsequently sideswiped an 18.0 cm (7.1 in) diameter tree resulting in moderate damage. The CDC for this third impact was 12-LDAS-1. The Sierra impacted another patch of brush which also resulted in superficial frontal damage. The CDC for this fourth impact was
12-FDEW-1. The pickup traveled 7.0 meters (23.0 feet) where the front left area struck a 22.0 cm (8.7 in) diameter tree **(Figure 2)** which resulted in moderate damage. The CDC for this fifth impact was 12-FLEE-2. At this point, the pickup rotated counterclockwise 29 degrees as the front left area struck a 25.0 cm (9.8 in) diameter tree stump resulting in minor damage. The CDC for this sixth and final impact was 12-FYLN-1. The impact induced deceleration was insufficient to deploy the Sierra's air bag system. Although the impacts were classified as out of scope (overlapping damage), the WinSMASH damage algorithm computed a barrier equivalent velocity change of 20.6 km/h (12.8 mph). The specific longitudinal component was -20.6 km/h
(-12.8 mph). This speed change was below the *"must fire"* threshold of 25.7 km/h (16.0 mph) required for air bag deployment. The Sierra came to rest against the final impact facing east.

Post-Crash

Both occupants of the GMC Sierra pickup exited the vehicle under their own power. The driver called a friend on his cellular phone who transported him (accompanied by his wife) to an emergency care

facility for treatment. Police were notified of the crash later by medical facility personnel. The vehicle was towed from the scene.

VEHICLE DATA

The 1999 GMC Sierra 1500 series pickup truck was identified by the vehicle identification number (VIN): 2GTEK19T8X1 (production number deleted) and was manufactured on 4/99. The driver was listed on the police report as the owner of the vehicle which was purchased 5/99. The vehicle was a 3-door extended cab pickup truck equipped with 4-wheel ABS, 4-wheel drive and a 5.3 liter, V-8 engine. The vehicle's odometer reading was approximately 10,460 km (6,500 miles) at the time of the crash. The seating was configured with front bucket seats (with folding backs) and a rear bench. The driver reported no previous crashes or maintenance on the Sierra's air bag system. A cell phone was present but not in use at the time of the collision.

VEHICLE DAMAGE

Exterior

Figure 3. Frontal and left side damage to the 1999 GMC Sierra pickup truck.

The Sierra sustained moderate frontal damage as a result of the impact with the tree cluster **(Figure 3)**. The direct contact damage encompassed the full frontal width resulting in a combined direct and induced damage length (Field L) of 154.0 cm (60.6 in). Six crush measurements were taken at the level of the bumper: C1= 39.0 cm (15.4 in), C2= 9.0 cm (3.5 in), C3= 12.0 cm (4.7 in), C4= 5.0 cm (2.0 in), C5= 0 cm, C6= 0 cm. Damage was documented outside the left frame rail from the third tree impact (impact #5). The damage began 4.0 cm (1.6 in) inboard of the front left bumper corner and extended 22.0 cm (8.7 in) to the right. This damage pattern restricted/deflated the left front wheel/tire. Damage was also documented inside the left frame rail from the tree stump impact (impact #6). The damage began 41.0 cm (16.1 in) inboard of the front left bumper corner and extended 24.0 cm (9.4 in) right. Brush transfers were noted which encompassed the full frontal width of the vehicle. Overlapping sideswipe damage was identified to the left side surface which began 13.0 cm (5.1 in) aft of the front left bumper corner and extended 445.0 cm (175.2 in) rearward. The lateral displacement from the sideswipes measured 7.0 cm (2.8 in) between the left B and C-pillars. The windshield was fractured at the lower left A-pillar from exterior impact forces. Minor induced buckling was found on the roof area at the left B-pillar.

Interior

Interior damage to the Sierra pickup identified through the vehicle inspection was minor and was attributed to occupant contact **(Figures 4&5)**. The upper portion of the steering wheel rim was deformed forward 6.0 cm (2.4 in) with the lower portion deformed 1.0 cm (0.4 in). The left sunvisor was displaced and scuffed with the inboard locking clip fractured. No deformation was found on the left or right knee bolsters. A 4.0 cm (1.6 in) longitudinal toepan intrusion was documented to the driver space. A 28.0 cm (11.0 in) fabric transfer was identified to the shoulder portion of the front right

manual restraint along with an 8.0 cm (3.1 in) transfer to the lap portion.

Figure 4. Interior view.

Figure 5. Interior view.

MANUAL RESTRAINT SYSTEMS

Figure 6. Loading transfers to the front right manual restraint.

The interior of the GMC Sierra pickup truck consisted of a five passenger seating configuration with two front bucket seats and three rear seat positions. The front seated positions were equipped with 3-point manual lap and shoulder belt systems which were integrated into the seat backs. The driver restraint consisted of a continuous loop belt webbing with a sliding latchplate and dual mode retractors (inertial lock/belt sensitive). The driver's manual restraint did not yield evidence of loading (webbing in pristine condition) and the lack of significant routine wear marks to the latchplate supported no belt usage. The front right restraint consisted of a continuous loop belt webbing with a sliding latchplate and retractors equipped with inertial and switchable lock mechanisms. A 28.0 cm (11.0 in) loading transfer was identified to the webbing of the front right manual restraint **(Figure 6)** along with an 8.0 cm (3.1 in) transfer to the lap potion. In addition, superficial routine wear marks were noted to the latchplate. The rear outboard seated positions were equipped with 3-point manual lap and shoulder belt systems which consisted of continuous loop belt webbings with sliding latchplates that retracted onto dual mode locking retractors (fixed anchorage adjustments). The rear center position was equipped with a 2-point manual lap belt system.

REDESIGNED AIR BAG SYSTEM

The Sierra pickup was equipped with front air bags for the driver and right passenger positions which did not deploy as a result of the crash. The air bag system consisted of the interior mounted sensing and diagnostic module (SDM), the air bag modules and the interior air bag warning lamp. There was no power available to the vehicle at the time of inspection, therefore, the status of the air bag indicator lamp could not be checked. The driver air bag was housed in the center of the steering wheel with a vertically oriented flap tear seam (I-configuration). No contact evidence was identified to the exterior surface of the air bag module cover flaps.

The front right passenger air bag module was located at the right mid-instrument panel area with a single cover flap design hinged at the top aspect. There was no contact evidence noted to the exterior surface

of the module cover flap which was rectangular in shape and measured 38.0 cm (15.0 in) in width and 14.0 cm (5.5 in) in height. The vehicle was equipped with a cutoff switch for the front right air bag which was set to the "on" position.

DRIVER DEMOGRAPHICS

Age/Sex:	33 year old male
Height:	188 cm (74 in)
Weight:	79 kg (175 lb)
Seat Track Position:	17.0 cm (6.7 in) aft of the full forward position, 7.0 cm (2.8 in) forward of the full rearward position.
Manual Restraint Use:	None
Usage Source:	Vehicle inspection, driver interview, police report
Eyeware:	None
Type of Medical Treatment:	Transported to a local emergency care facility and released

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Abrasion left cornea	Minor (240602.1,2)	Sunvisor
Contusion left eyelid	Minor (297402.1,2)	Sunvisor
Laceration left face (multiple-superficial)	Minor (290602.1,2)	Sunvisor (inboard locking clip)
Abrasion nose	Minor (290202.1,4)	Sunvisor (inboard locking clip)
Contusion left neck	Minor (390402.1,2)	Sunvisor
Contusion left shoulder	Minor (790402.1,2)	A-pillar
Contusion right upper chest	Minor (490402.1,1)	Steering wheel rim

Driver Kinematics

The 33 year old male driver of the 1999 GMC Sierra pickup truck was seated in an upright posture with the seat track adjusted 17.0 cm (6.7 in) aft of the full forward position/7.0 cm (2.8 in) forward of the full rearward position. Lack of belt usage was confirmed by the injuries

Figure 7. Steering wheel deformation.

sustained and contact points within the driver space.

At impact with the brush and first two trees (sideswiped), the driver probably remained in his pre-impact posture as these impacts offered no significant resistance to the vehicle or produce any resulting kinematic response from the occupant. At impact with the third tree (impact #5), he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the steering wheel rim which resulted in a contusion to the right upper chest, evidenced by the 6.0 cm (2.4 in) of deformation noted to the upper portion of the steering wheel rim **(Figure 7)**. He continued the kinematic response pattern into the sunvisor resulting in multiple (superficial) lacerations to the left face, an abrasion to the nose, a contusion to the left neck, a contusion to the left eyelid and a left corneal abrasion. This trajectory was evidenced by the displaced/scuffed sunvisor and fracture of the inboard locking clip. He also sustained a contusion to the left shoulder from contact to the A-pillar. Following the collision, the driver exited the vehicle under his own power and was transported by a friend to a local emergency care facility for treatment and released.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex:	39 year old female
Height:	168 cm (66 in)
Weight:	59 kg (130 lb)
Seat Track Position:	19.0 cm (7.5 in) aft of the full forward position, 4.0 cm (1.6 in) forward of the full rearward position.
Manual Restraint Use:	3-point lap and shoulder restraint
Usage Source:	Vehicle inspection, driver interview, police report
Eyeware:	None
Type of Medical Treatment:	None

Front Right Passenger Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
None	N/A	N/A

Front Right Passenger Kinematics

The 39 year old female front right passenger of the 1999 GMC Sierra pickup truck was properly restrained by the available 3-point lap and shoulder belt system, seated in an upright posture with the seat track adjusted 19.0 cm (7.5 in) aft of the full forward position/4.0 cm (1.6 in) forward from the full rearward position. Belt usage was confirmed by the loading marks documented to the webbing of the manual restraint in conjunction with the lack of interior contact points within the passenger space.

At impact with the brush and first two trees (sideswiped), the passenger probably remained in her pre-impact posture as these impacts offered no significant resistance to the vehicle or produce any resulting kinematic response from the occupant. At impact with the third tree (impact #5), she initiated a forward

trajectory in response to the 12 o'clock impact force and loaded the manual restraint with no resulting injury reported. Following the collision, she exited the vehicle under her own power and accompanied her husband to the medical facility.

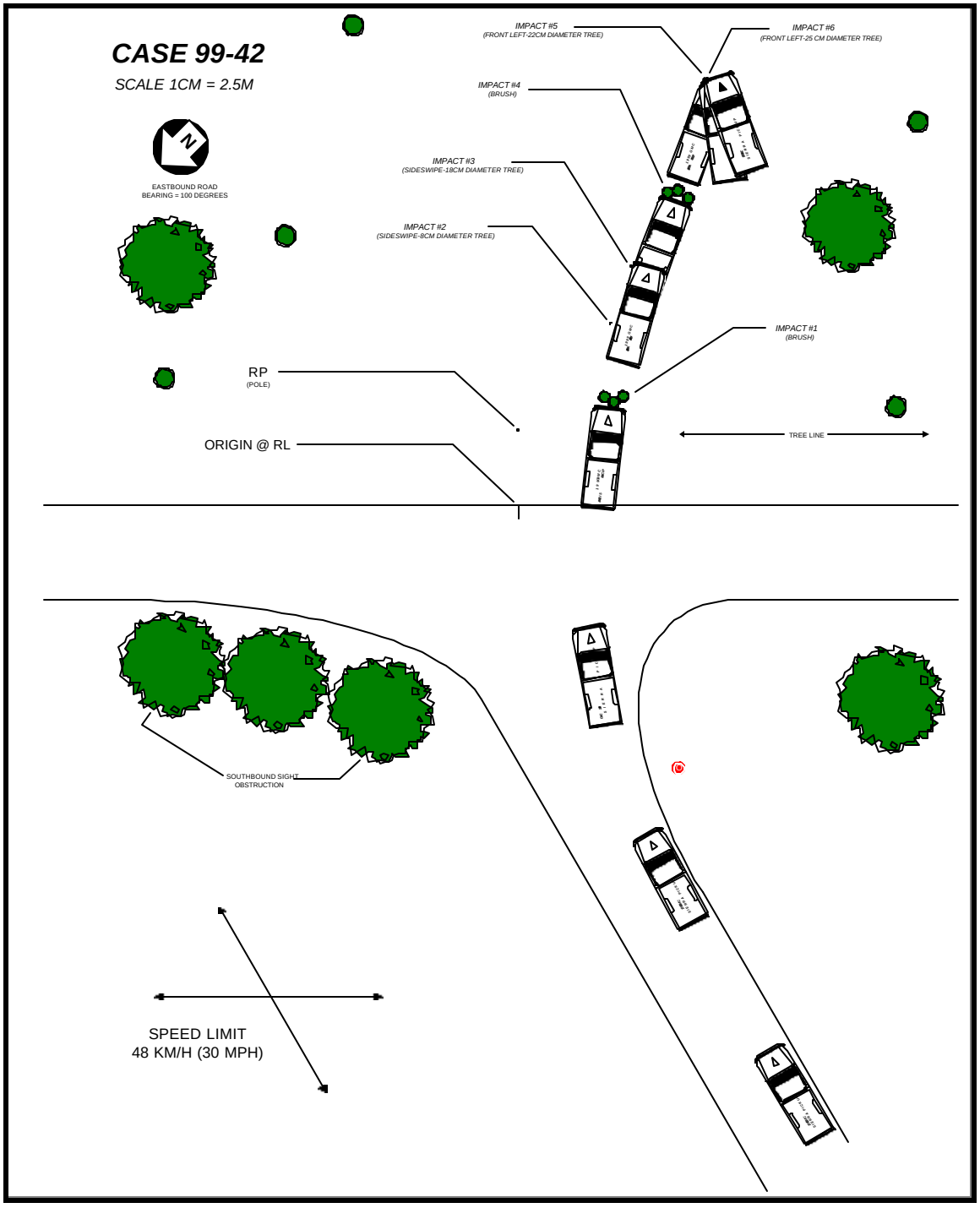

Figure 8. Scene Diagram