TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

Veridian Engineering
Buffalo, New York 14225

VERIDIAN REMOTE REDESIGNED AIR BAG INJURY INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

NASS CDS CASE NO. 1998-11-102G

VEHICLE - 1998 FORD EXPLORER

LOCATION - STATE OF MICHIGAN

CRASH DATE - JUNE, 1998

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

<table>
<tr><td colspan="2">1. Report No.
98-11-102G</td><td>2. Government Accession No.</td><td colspan="2">3. Recipient's Catalog No.</td></tr>
<tr><td colspan="3" rowspan="2">4. Title and Subtitle
Veridian Remote Redesigned Air Bag Injury Investigation
Vehicle - 1998 Ford Explorer sport utility vehicle
Location - State of Michigan</td><td colspan="2">5. Report Date:
June, 2000</td></tr>
<tr><td colspan="2">6. Performing Organization Code</td></tr>
<tr><td colspan="3">7. Author(s)
Crash Research Section</td><td colspan="2">8. Performing Organization Report No.</td></tr>
<tr><td colspan="3" rowspan="2">9. Performing Organization Name and Address
Transportation Sciences
Crash Research Section
Veridian Engineering
P.O. Box 400
Buffalo, New York 14225</td><td colspan="2">10. Work Unit No.
C01115.0177.(0000-0009)</td></tr>
<tr><td colspan="2">11. Contract or Grant No.
DTNH22-94-D-07058</td></tr>
<tr><td colspan="3" rowspan="2">12. Sponsoring Agency Name and Address
U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590</td><td colspan="2">13. Type of Report and Period Covered
Technical Summary Report
Crash Date: June, 1998</td></tr>
<tr><td colspan="2">14. Sponsoring Agency Code</td></tr>
<tr><td colspan="5">15. Supplementary Notes
NASS investigation of a frontal collision (into a fixed object) that involved a 1998 Ford Explorer sport utility vehicle equipped with redesigned frontal air bags.</td></tr>
<tr><td colspan="5">16. Abstract
This remote investigation focused on a single vehicle crash involving a 1998 Ford Explorer sport utility vehicle involved in off-road impacts with trees and an embankment. The Explorer was equipped with redesigned frontal air bags for the driver and right passenger seated positions. These modules deployed during the crash sequence.</td></tr>
<tr><td colspan="3">17. Key Words
Redesigned frontal air bag system
WinSMASH damage algorithm - overlapping damage (out-of-scope)
Proper use of the manual belt system
Abrasion posterior right hand</td><td colspan="2">18. Distribution Statement
General Public</td></tr>
<tr><td>19. Security Classif. (of this report)
Unclassified</td><td>20. Security Classif. (of this page)
Unclassified</td><td>21. No. of Pages
4</td><td colspan="2">22. Price</td></tr>
</table>

TABLE OF CONTENTS

VERIDIAN REMOTE REDESIGNED AIR BAG INJURY INVESTIGATION
SCI TECHNICAL SUMMARY REPORT
NASS CDS CASE NO. 1998-11-102G
VEHICLE - 1998 FORD EXPLORER SPORT UTILITY
CRASH DATE - JUNE, 1998

BACKGROUND

This remote investigation focused on a single vehicle crash involving a 1998 Ford Explorer sport utility vehicle involved in off-road impacts with trees and an embankment. The Explorer was equipped with redesigned frontal air bags for the driver and right passenger seated positions. These modules deployed during the crash sequence.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 98-11-102G. 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

The Explorer approached the crash site traveling in a northerly direction on a two lane, dirt and gravel-surfaced, rural roadway **(see Figure 5 - page 4)**. In the immediate vicinity of the crash site the roadway was straight with a slight downgrade to the north. Both edges of the roadway were bounded by tall grass berms with trees located outboard of the grassy areas. At the time of the crash, it was daylight and all environmental surfaces were dry. The area speed limit was 89 km/h (55 mph).

Pre-Crash

Prior to the crash, the Explorer was traveling in a northerly direction **(Figure 1)** at an estimated speed of 80-89 km/h (50-55 mph). As the vehicle crested a hill, the driver noted an animal entering the roadway forward of his position. The animal's trajectory was from the driver's left to his right. The driver reported that he initially steered sharply to the right to avoid the animal and then steered sharply back to the left to remain on the roadway. As the Explorer regained the center of the roadway, the driver overcorrected back to the right. The Explorer subsequently exited the right edge of the roadway traveling in a northeasterly direction while in a clockwise yaw.

Figure 1. Northbound approach for the 1998 Ford Explorer.

Crash

The Explorer traveled approximately 4.0 m (13.1') in a north northeasterly direction after exiting the roadway. At that point, the front right area of the vehicle struck a tree that was 29.0 cm (11.4") in

diameter **(Figure 2)**. The resultant direction of force for this impact was in the 12 o'clock sector. This initial impact accentuated the clockwise rotation of the vehicle which continued in a north northeasterly direction. The vehicle then struck and rode up an embankment. The resultant direction of force for this second impact was in the 11 o'clock sector and the impact involved most of the lateral width of the front bumper.

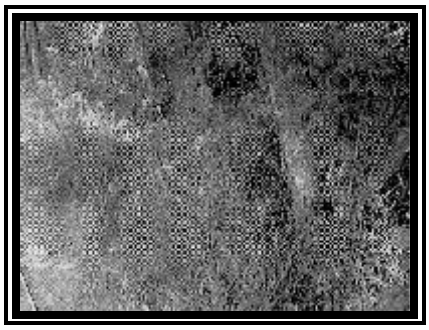

Figure 2. Tree impact area.

Following the second impact, the Explorer struck a second tree with its front left area (11 o'clock direction of force). The Explorer rotated off this third impact, continuing to yaw in a clockwise direction. The vehicle rotated back into the roadway and came to rest straddling both travel lanes, facing in a southeasterly direction.

No delta V levels were computed for this impact sequence due to the overlapping nature of the impacts. The impacts were sufficient, however, to deploy the supplemental restraint system installed in the vehicle.

Post-Crash

The two occupants of the Explorer exited the vehicle under their own power. A resident living near the scene responded to the crash site and backed the Explorer off the roadway to clear the scene. A police unit responded to the scene. The 16 year old male driver of the Explorer, who sustained a minor injury during the crash sequence, declined medical treatment. The 17 year old male front right passenger was uninjured in the collision. The Explorer was towed from the scene after the investigating officer completed the on-site investigation.

VEHICLE DATA

The 1998 Ford Explorer was identified by the Vehicle Identification Number (VIN): 1FMZU34E6W4 (production sequence deleted). The vehicle was a 4-door sport utility vehicle equipped with 4-wheel drive and a 4.0 liter, 6-cylinder engine. The vehicle's odometer reading was 26,195 km (16,277 miles) at the time of the crash. The police report did not specify the owner of the vehicle. The seating was configured with front bucket and rear split bench seats (with folding backs).

Exterior Damage

Exterior damage to the 1998 Ford Explorer was rated as moderately severe **(Figure 3)**. Maximum frontal crush as a result of the initial tree impact was 20.0 cm (7.9") located at the front right corner of the vehicle. Maximum frontal crush as a result of the third impact was 21.0 cm (8.3") located at the front left corner of the vehicle. Crush was distributed across the frontal plane as a result of the second impact with the embankment. The right wheelbase dimension was reduced 3.0 cm (1.2") and the left wheelbase dimension was elongated 12.0 cm (4.7") during the crash sequence.

Figure 3. Frontal damage to the 1998 Ford Explorer.

Interior Damage

Interior damage to the Explorer was minor and was associated with the air bag deployment and occupant contact **(Figure 4)**. The Explorer was equipped with depowered frontal air bags for the driver and right passenger seated positions. Both modules deployed as designed during the crash sequence. No damage or evidence of occupant contact was noted to either of the module cover flaps or air bags. Evidence of driver contact was noted to the left portion of the left sunvisor (deformed) and knee bolster on either side of the steering column (scuff marks). Evidence of passenger contact with interior components was noted to the front right seat back support (deformed rearward).

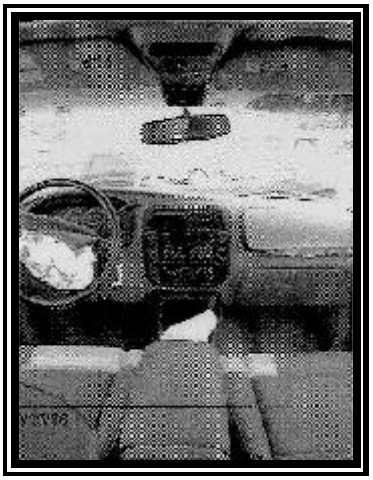

Figure 4. Interior view.

MANUAL RESTRAINT SYSTEMS

The Explorer was equipped with manual 3-point lap and shoulder belts for the outboard seated positions. The front belt systems consisted of a continuous loop belt webbing that was retracted into a inertia activated locking retractor. The upper anchorages (D-rings) were adjustable on both front belts. At the time of the NASS vehicle inspection, the left D-ring was adjusted to the full up position on the left B-pillar and the right D-ring was adjusted to a mid-position on the right B-pillar. Neither of the front belt systems exhibited evidence of occupant loading as a result of the crash sequence.

SUPPLEMENTAL RESTRAINT SYSTEMS

The Explorer was equipped with redesigned frontal air bags for the driver and right passenger positions [Supplemental Restraint System (SRS)]. The air bag system probably deployed as a result of the initial front right impact with the first tree.

The driver depowered air bag deployed from a module that was mounted within the 4-spoke steering wheel. The steering wheel spokes were located at the 9/7:30 and 3/4:30 o'clock positions. The air bag was concealed behind an H-configuration cover assembly with asymmetrical cover flaps. There was no damage or evidence of occupant contact to the cover flaps or deployed air bag.

The front right passenger depowered air bag was mounted in the right instrument panel as a mid-mount configuration. The module cover consisted of a single flap that was hinged at the rear to allow the cover flap to rotate upward toward the windshield. There was no damage or evidence of occupant contact to the cover flap or depowered air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	16 year old male
Height:	183 cm (72")
Weight:	70 kg (154 lb)
Seat Track Position:	Full rearward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, driver interview, police report
Eyeware:	None
Type of Medical Treatment:	None

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Abrasion posterior right hand	Minor (790202.1,1)	Front left air bag

Driver Kinematics

Following the initial impact with the first tree, the driver moved forward and to the left with respect to the vehicle interior. He contacted the knee bolster on either side of the steering column with his knees as the upper torso contacted the deployed redesigned air bag. It is likely that his hands were forced off the steering wheel rim by the deploying air bag. He sustained an abrasion of the posterior surface of the right hand as a result of contact with the air bag. His left hand was forced upward by the deployment sequence and it subsequently contacted and deformed the left portion of the left sunvisor. No other evidence of contact with interior components was noted for this occupant and he did not sustain any other injuries. Following the crash sequence, he declined medical treatment.

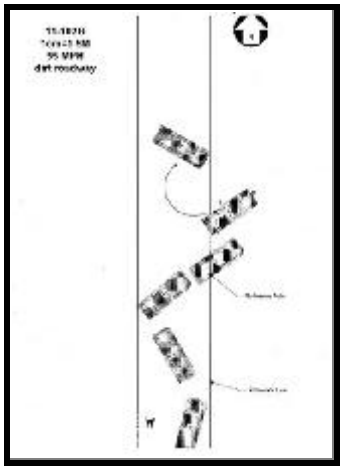

Figure 5. NASS Scene Diagram.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex:	17 year old male
Height:	175 cm (69")
Weight:	58 kg (128 lb)
Seat Track Position:	Full rearward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, interview
Eyeware:	Unknown
Type of Medical Treatment:	None

Front Right Passenger Kinematics

During the crash sequence, the front right passenger moved forward and to the left. Although he was involved with the redesigned passenger air bag, there was no evidence of contact noted to the air bag or to other interior components. The passenger was not injured as a result of crash events.