

**TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION**

Veridian Engineering
Buffalo, New York 14225

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

NASS CDS CASE NO. 1998-43-184E

RABSS VEHICLE - 1998 FORD EXPLORER XL

LOCATION - STATE OF NORTH CAROLINA

CRASH DATE - JULY, 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

<p>1. <i>Report No.</i> 98-43-184E</p>	<p>2. <i>Government Accession No.</i></p>	<p>3. <i>Recipient's Catalog No.</i></p>	
<p>4. <i>Title and Subtitle</i> Redesigned Air Bag Special Study (RABSS) RABSS Vehicle - 1998 Ford Explorer XL sport utility vehicle Location - State of North Carolina</p>		<p>5. <i>Report Date:</i> August, 2000</p>	
		<p>6. <i>Performing Organization Code</i></p>	
<p>7. <i>Author(s)</i> Crash Research Section</p>		<p>8. <i>Performing Organization Report No.</i></p>	
<p>9. <i>Performing Organization Name and Address</i> Transportation Sciences Crash Research Section Veridian Engineering P.O. Box 400 Buffalo, New York 14225</p>		<p>10. <i>Work Unit No.</i> C01115.0298.(0000-0009)</p>	
		<p>11. <i>Contract or Grant No.</i> DTNH22-94-D-07058</p>	
<p>12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590</p>		<p>13. <i>Type of Report and Period Covered</i> Technical Summary Report Crash Date: July, 1998</p>	
		<p>14. <i>Sponsoring Agency Code</i></p>	
<p>15. <i>Supplementary Notes</i> NASS investigation of a frontal collision (into a fixed object) that involved a 1998 Ford Explorer XL sport utility vehicle equipped with redesigned frontal air bags.</p>			
<p>16. <i>Abstract</i> This investigation focused on a two vehicle crash involving a 1998 Ford Explorer XL 2-door sport utility (subject vehicle) and a 1989 Lincoln Mark VII 2-door coupe. The Ford Explorer was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of a frontal collision with a concrete barrier. The driver of the Lincoln was operating the vehicle westbound on the inboard lane of a multi-lane divided highway when he failed to observe the westbound Ford as he changed lanes to the right. As the Lincoln entered the center (westbound) lane, the right side surface impacted the left side surface of the Ford resulting in minor damage to both vehicles. At this point, both vehicles rotated counterclockwise and began their respective post-impact trajectories towards the center median divider. As the Ford entered the center median divider, the front left area struck a concrete barrier which resulted in moderate damage. The restrained 16 year old female driver of the Ford Explorer initiated a forward trajectory in response to the 12 o'clock (barrier) impact force and loaded the manual restraint and deployed redesigned driver air bag. She was uninjured in the collision. The restrained 18 year old female front right passenger also initiated a forward trajectory in response to the 12 o'clock (barrier) impact force as the expanding redesigned passenger air bag contacted the anterior aspect of her forearms resulting in bilateral abrasions. She refused subsequent treatment.</p>			
<p>17. <i>Key Words</i> Redesigned frontal air bag system Collision Deformation Classification (CDC): 12-FLEE-2 Proper use of the manual belt system Bilateral forearm abrasions</p>		<p>18. <i>Distribution Statement</i> General Public</p>	
<p>19. <i>Security Classif. (of this report)</i> Unclassified</p>	<p>20. <i>Security Classif. (of this page)</i> Unclassified</p>	<p>21. <i>No. of Pages</i> 6</p>	<p>22. <i>Price</i></p>

TABLE OF CONTENTS

BACKGROUND	1
SUMMARY	
Crash Site	1
Pre-Crash	2
Crash	2
Post-Crash	2
RABSS VEHICLE	2
VEHICLE DAMAGE	
Exterior Damage	3
Interior Damage	4
REDESIGNED AIR BAG SYSTEM	4
DRIVER DEMOGRAPHICS	5
Driver Injuries	5
Driver Kinematics	5
FRONT RIGHT PASSENGER DEMOGRAPHICS	5
Front Right Passenger Injuries	5
Front Right Passenger Kinematics	6
NASS SCENE DIAGRAM	6

**REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
SCI TECHNICAL SUMMARY REPORT
NASS CDS CASE NO. 1998-43-184E
RABSS VEHICLE - 1998 FORD EXPLORER XL
CRASH DATE - JULY, 1998**

BACKGROUND

This investigation focused on a two vehicle crash involving a 1998 Ford Explorer XL 2-door sport utility (subject vehicle) and a 1989 Lincoln Mark VII 2-door coupe. The Ford Explorer was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of a frontal collision with a concrete barrier. The driver of the Lincoln was operating the vehicle westbound on the inboard lane of a multi-lane divided highway when he failed to observe the westbound Ford as he changed lanes to the right. As the Lincoln entered the center (westbound) lane, the right side surface impacted the left side surface of the Ford resulting in minor damage to both vehicles. At this point, both vehicles rotated counterclockwise and began their respective post-impact trajectories towards the center median divider. As the Ford entered the center median divider, the front left area struck a concrete barrier which resulted in moderate damage. The restrained 16 year old female driver of the Ford Explorer initiated a forward trajectory in response to the 12 o'clock (barrier) impact force and loaded the manual restraint and deployed redesigned driver air bag. She was uninjured in the collision. The restrained 18 year old female front right passenger also initiated a forward trajectory in response to the 12 o'clock (barrier) impact force as the expanding redesigned passenger air bag contacted the anterior aspect of her forearms resulting in bilateral abrasions. She refused subsequent treatment.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 98-43-184E and also included in the Redesigned Air Bag Special Study. 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

This two vehicle crash occurred during the evening hours of July, 1998. At the time of the crash, it was dark (street not lighted) with no adverse conditions as the roads were dry. The crash occurred in the westbound lanes of a straight and level 6-lane highway (see **Figure 6 - page 6**) which was divided by a raised concrete (jersey) barrier. The asphalt roadway was bordered by wide paved shoulders with on/off-ramp junctions just east of the crash site. No traffic control was present at the scene which had a posted speed limit of 97 km/h (60 mph).

Pre-Crash

The 18 year old male driver of the 1989 Lincoln Mark VII was operating the vehicle westbound on the inboard lane at a (driver reported) speed of 89 km/h (55 mph) when he failed to observe the westbound Ford as he changed lanes to the right. He reported to police that the Ford “was in his blind spot”. The 16 year old female driver of the 1998 Ford Explorer was operating the vehicle westbound in the center lane (**Figure 1**) at a (surrogate reported) speed of 89 km/h (55 mph) when she observed the westbound Lincoln enter her lane of travel. Upon recognition of the impending harmful event, the Ford driver braked in avoidance remaining in the center (westbound) lane prior to the collision.



Figure 1. Westbound approach view of the crash site.

Crash

As the Lincoln entered the center westbound lane of the multi-lane divided highway, the right side surface impacted the left side surface of the Ford resulting in minor damage to both vehicles. The damage algorithm of the WinSMASH program computed velocity changes of 11.8 km/h (7.3 mph) for the subject vehicle and 11.5 km/h (7.1 mph) for the striking Lincoln. Respective latitudinal components were 11.8 km/h (7.3 mph) and -11.5 km/h (-7.1 mph). At this point, both vehicles rotated counterclockwise and began their respective post-impact trajectories towards the center median divider. As the Ford Explorer entered the center median divider, the front left area struck the concrete barrier which resulted in moderate damage. The (*SCI revised*) damage algorithm of the WinSMASH program computed a velocity change of 16.1 km/h (10.0 mph) with a longitudinal component of -15.9 km/h (-9.9 mph) for the subject vehicle. The impact induced deceleration was sufficient to deploy the Ford’s redesigned frontal air bag system. The Lincoln Mark VII subsequently entered the center median divider as the front left area struck the concrete barrier resulting in moderate damage. Both vehicles came to rest in close proximity to the secondary point of impact perpendicular to the concrete barrier faced southeast.

Post-Crash

All occupants exited their respective vehicles under their own power. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMTs). The Ford driver was uninjured in the collision as the passenger refused treatment. The Lincoln occupants were transported by ambulance to a local hospital for treatment and released. Both vehicles were towed from the scene due to disabling damage.

RABSS VEHICLE

The 1998 Ford Explorer XL was identified by the Vehicle Identification Number (VIN): 1FMYU22X5WU (production sequence deleted). The vehicle was a 2-door sport utility vehicle equipped with rear wheel drive and a 4.0 liter, V-6 engine. The vehicle’s odometer reading was 1,761 km (1,094 miles) at the time of the crash. The police report listed the driver’s father as the owner of the vehicle. The seating was configured with front bucket and rear bench seats (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.

VEHICLE DAMAGE

Exterior Damage

The 1998 Ford Explorer XL sustained minor left side surface damage as a result of the initial impact with the Lincoln (**Figure 2**). The direct contact damage began 90.0 cm (35.4 in) aft of the left rear axle and extended 309.0 cm (121.7 in) forward. Six crush measurements were documented at the level of the mid-door: C1= 2.0 cm (1.6 in), C2= 1.0 cm (4.7 in), C3= 4.0 cm (7.1 in), C4= 8.0 cm (8.7 in), C5= 3.0 cm (9.4 in), C6= 0 cm.

The (*SCI revised*) Collision Deformation Classification (CDC) for this initial impact to the Ford was 09-LDEW-1 with a principal direction of force of (-)90 degrees.

Direct contact damage was also identified at the front left area attributed to the secondary (concrete barrier) impact. The direct contact damage began at the front left bumper corner and extended 45.0 cm (17.7 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 128.0 cm (50.4 in). Six crush measurements were documented at the level of the bumper: C1= 28.0 cm (11.0 in), C2= 6.0 cm (2.4 in), C3= 3.0 cm (1.2 in), C4= 1.0 cm (0.4 in), C5= 0 cm, C6= 0 cm. The Collision Deformation Classification (CDC) for this second and final impact to the Ford was 12-FLEW-2 with a principal direction of force of (-)10 degrees. The left headlight assembly fractured and partially separated from the vehicle during the collision sequence. The left fender was displaced rearward and to the right which restricted/deflated the left front wheel/tire and jammed the left door. All glazing remained intact.



Figure 2. Frontal and left side surface damage to the 1998 Ford Explorer XL.



Figure 3. Frontal and right side surface damage to the 1989 Lincoln Mark VII.

The 1989 Lincoln Mark VII 2-door coupe sustained minor right side surface damage as a result of the initial impact with the Ford Explorer (**Figure 3**). The direct contact damage began 25.0 cm (9.8 in) forward of the right rear axle and extended 342.0 cm (134.6 in) forward. A maximum crush value of 4.0 cm (1.6 in) was identified just forward of the right front axle. The CDC for this initial impact to the Lincoln was 03-RYEW-1 with a principal direction of force of (+)90 degrees. Direct contact damage was also documented to the front left area attributed to the secondary (concrete barrier) impact. The direct contact damage began at the front left bumper corner and extended 75.0 cm (29.5 in) inboard.

The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 121.0 cm (47.6 in). A maximum crush value of 44.0 cm (17.3 in) was identified at the front left bumper corner area. The (*SCI revised*) CDC for this second and final impact to the Lincoln was 11-FYEW-2 with a principal direction of force of (-)20 degrees. The grille and headlight assemblies fractured and separated from the vehicle during the collision sequence. The left fender was deformed rearward which deflated the left front wheel/tire (not restricted).

Interior Damage

There was no damage to the interior surfaces of the Ford Explorer from intrusions or occupant contact.

REDESIGNED AIR BAG SYSTEM

The 1998 Ford Explorer XL 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 concrete barrier impact. The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). The flaps were asymmetrical in shape as the upper flap measured 25.0 cm (9.8 in) in width along the top portion, 17.0 cm (6.7 in) in width along the lower portion and 10.0 cm (3.9 in) in height while the lower flap measured 17.0 cm (6.7 in) in width and 5.0 cm (2.0 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, makeup transfers were documented along the center of the air bag face. The NASS researcher measured the diameter of the driver air bag at 60.0 cm (23.6 in) in its deflated state (**Figure 4**). 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 the right mid-instrument panel area with a single cover flap design hinged at the top aspect. No contact evidence was identified on the air bag or exterior surface of the module cover flap. The cover flap was rectangular in shape and measured 37.0 cm (14.6 in) in width and 17.0 cm (6.7 in) in height. The NASS researcher measured the passenger air bag at 66.0 cm (26.0 in) in width and 50.0 cm (19.7 in) in height in its deflated state (**Figure 5**). No internal tether straps were present. The bag was vented by two ports located at the 9 o'clock and 3 o'clock sectors on the side aspect of the air bag. No cutoff switch was found for the front right air bag.



Figure 4. 1998 Ford Explorer XL redesigned driver air bag.



Figure 5. 1998 Ford Explorer redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex: 16 year old female
Height: 178 cm (70 in)
Weight: 66 kg (145 lb)
Seat Track Position: Middle position
Manual Restraint Use: 3-point lap and shoulder belt system
Usage Source: NASS vehicle inspection, surrogate interview, police report
Eyeware: None
Type of Medical Treatment: None

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
None reported	N/A	N/A

Driver Kinematics

The 16 year old female driver of the 1998 Ford Explorer XL was restrained by the available 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the middle position. Belt usage was confirmed by the lack of significant interior contacts and injury. At impact with the concrete barrier, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Contact to the deployed driver air bag was confirmed by the makeup transfers documented along the center of the air bag face. She was uninjured in the collision. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential serious injury.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex: 18 year old female
Height: 173 cm (68 in)
Weight: 64 kg (140 lb)
Seat Track Position: Middle position
Manual Restraint Use: 3-point lap and shoulder belt system
Usage Source: NASS vehicle inspection, surrogate interview, police report
Eyeware: None
Type of Medical Treatment: Refused treatment

Front Right Passenger Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
Bilateral anterior forearm abrasions	Minor (790202.1,3)	Expanding front right air bag

Front Right Passenger Kinematics

The 18 year old female front right passenger of the 1998 Ford Explorer XL was restrained by the available 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the middle position. The arms were presumed to be extended forward in a bracing position. Belt usage was confirmed by the lack of significant interior contacts and injury. At impact with the concrete barrier, she initiated a forward trajectory in response to the 12 o'clock impact force as the expanding air bag contacted the anterior aspect of both forearms resulting in bilateral abrasions. This injury mechanism was evidenced by the size and location of the injury relative to the kinematic response pattern. The passenger refused treatment. The combination of restraint options provided protection against further contact to the instrument panel and potential serious injury.

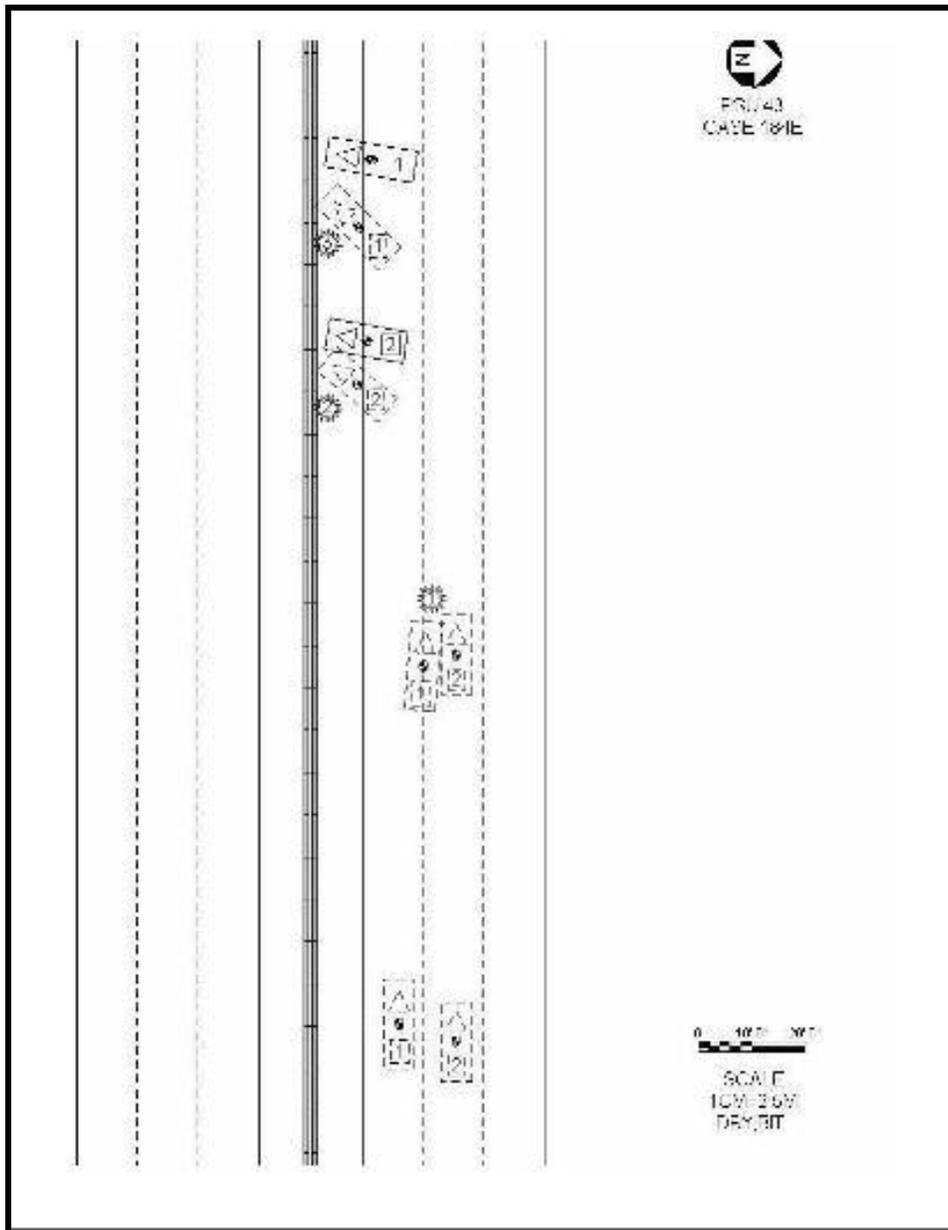


Figure 6. NASS Scene Diagram.