CRASH DATA RESEARCH CENTER

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

NASS CDS CASE NO. 1999-45-154C

RABSS VEHICLE - 1999 FORD EXPLORER XLT 4X4

LOCATION - STATE OF TENNESSEE

CRASH DATE - SEPTEMBER, 1999

Contract No. DTNH22-94-D-07058

Prepared for:

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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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16. *Abstract* This investigation focused on a two vehicle crash involving a 1999 Ford Explorer XLT 4x4 sport utility vehicle (subject vehicle) and a 1996 Ford LTL9000 tandem dump truck. The Ford Explorer was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of an offset rear-end collision with the Ford dump truck. The driver of the dump truck was operating the vehicle southbound when he failed to observe the westbound Ford Explorer as he attempted to turn right (west) out of a private driveway. As the dump truck entered the westbound lanes, the rear left area was impacted by the front right area of the Ford Explorer which resulted in minor damage to the dump truck and severe damage to the Ford Explorer. The restrained 46 year old male driver of the 1999 Ford Explorer XLT 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 resulted in multiple facial abrasions. He also sustained a superficial avulsion to the helix of the left ear from contact to the (intruded) A-pillar. He was transported to the emergency room of a local trauma center for treatment and released.			
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BACKGROUND

This investigation focused on a two vehicle crash involving a 1999 Ford Explorer XLT 4x4 sport utility vehicle (subject vehicle) and a 1996 Ford LTL9000 tandem dump truck. The Ford Explorer was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of an offset rear-end collision with the Ford dump truck. The driver of the dump truck was operating the vehicle southbound when he failed to observe the westbound Ford Explorer as he attempted to turn right (west) out of a private driveway. As the dump truck entered the westbound lanes, the rear left area was impacted by the front right area of the Ford Explorer which resulted in minor damage to the dump truck and severe damage to the Ford Explorer. The restrained 46 year old male driver of the 1999 Ford Explorer XLT 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 resulted in multiple facial abrasions. He also sustained a superficial avulsion to the helix of the left ear from contact to the (intruded) A-pillar. He was transported to the emergency room of a local trauma center for treatment and released.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 1999-45-154C 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 morning hours of September, 1999. At the time of the crash, it was daylight (dawn) with no adverse conditions as the roads were dry. The crash occurred in the westbound lanes of a (straight/asphalt) 4-lane east/west state roadway **(see Figure 8 - page 5)** which was divided by a grass median with a positive grade for westbound traffic. The westbound lanes were bordered by a wide paved shoulder and private driveways to the north. No traffic control was present at the scene which had a posted speed limit of 89 km/h (55 mph).

Pre-Crash

The 49 year old male driver of the 1996 Ford LTL9000 tandem dump truck was operating the vehicle southbound **(Figure 1)** and exiting a private driveway when he failed to observe the Ford Explorer as he turned right onto the (outboard) westbound lane.

The 46 year old male driver of the 1999 Ford Explorer XLT was operating the vehicle in the (outboard) westbound lane **(Figure 2)** when he observed the dump truck encroach into his path of travel. Upon recognition of the impending harmful event, the driver steered left and braked in avoidance, partially remaining in the outboard lane prior to impact.

Figure 1. Southbound approach for the 1996 Ford LTL9000 dump truck.

Figure 2. Westbound approach for the 1999 Ford Explorer XLT.

Crash

As the Ford dump truck entered the westbound lanes of the 4-lane divided state roadway, the rear left area was impacted by the front right area of the Ford Explorer resulting in minor damage to the dump truck and severe damage to the Explorer. Although the impact with the dump truck was classified as out-of scope, the WinSMASH reconstruction program computed a barrier equivalent velocity change of 15.6 km/h (9.7 mph) for the subject vehicle with a matching negative longitudinal component. The impact induced deceleration was sufficient to deploy the Ford Explorer's redesigned frontal air bag system. Both vehicles sustained contact to final rest in the outboard (westbound) lane facing northwest.

Post-Crash

The driver of the 1999 Ford Explorer XLT exited the vehicle through the left front door with some assistance from rescue personnel as the driver of the dump truck exited under his own power. The Ford Explorer was towed from the scene with disabling damage as the Ford dump truck was driven from the scene with non-disabling damage.

RABSS VEHICLE

The 1999 Ford Explorer XLT was identified by the vehicle identification number (VIN): 1FMZU34X5XU (production number deleted). The vehicle was a 4-door sport utility equipped with four-wheel drive and a 4.0 liter, V-6 engine. At the time of the crash, the odometer had recorded 16,871 km (10,483 miles). The seating was configured with front bucket and a rear split bench seat (with folding backs). Knowledge of the company-rented vehicle's history was somewhat limited, therefore, previous crashes or maintenance on the Ford's frontal air bag system were unknown. It was also unknown if a cell phone was present or in-use at the time of the collision.

VEHICLE DAMAGE

Exterior

The 1999 Ford Explorer XLT sustained severe frontal damage as a result of the impact with the Ford dump truck **(Figures 3 & 4)**. The direct contact damage *(narrow end engagement)* began at the front right bumper corner and extended 37.0 cm (14.6 in) inboard. The combined direct and induced damage length (Field L) measured 140.0 cm (55.1 in). Six crush measurements were documented at the level of the bumper: C1= 0 cm, C2= 0 cm, C3= 0 cm, C4= 0 cm, C5= 0 cm, C6= 28.0 cm (11.0

in). The Collision Deformation Classification (CDC) for this impact to the Ford Explorer was 12-FRAE-9 with a principal direction of force of 0 degrees. The direct contact damage extended rearward to the right B-pillar which sheared off the right fender, right front wheel/tire, and right side doors. Engagement along these areas displaced *("pulled")* the left roof side rail laterally into the passenger compartment, resulting in separation of the left upper A-pillar from the roof structure. The windshield was fractured and out-of-place as all right side tempered glazings were disintegrated. Pry marks were noted to the left front door, attributed to occupant extrication activities by rescue personnel post-crash. Reduction in the right side wheelbase measured 5.0 cm (2.0 in).

Figure 3. Front right damage (narrow end engagement) to the 1999 Ford Explorer XLT.

Figure 4. Left side surface view of the 1996 Ford LTL9000 dump truck.

Interior

Interior damage to the Ford Explorer identified through the vehicle inspection was severe and was attributed to component intrusion and structure failure for the right side doors **(Figure 5)**. Scuff marks were documented on the left knee bolster along with blood spattering to the left sunvisor. Loading marks were noted on the outboard aspect of the driver seat back along with blood on the shoulder belt webbing. The front/rear right seats were deformed by multiple component intrusions. Lateral intrusion of the left roof side rail slightly deformed the front left head restraint. Lateral intrusion of the left A-pillar measured approximately 37.0 cm (14.6 in). Longitudinal intrusions into the front occupant space involved 50.0 cm (19.7 in) of right windshield header, 26.0 cm (10.2 in) of left header, 25.0 cm (9.8 in) of right instrument panel, and 22.0 cm (8.7 in) of front seat back intrusion into the rear left space. Vertical intrusions into the front occupant space involved 14.0 cm (5.5 in) of right roof, and 8.0 cm (3.1 in) of left roof intrusion.

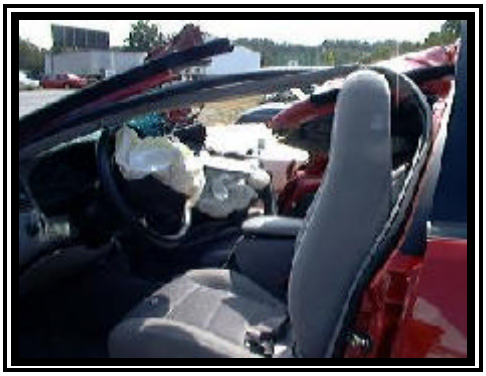

Figure 5. Interior view.

REDESIGNED AIR BAG SYSTEM

The 1999 Ford Explorer XLT was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags deployed as a result of the crash. 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 rectangular in shape as the upper flap measured 20.0 cm (7.9 in) in width and 12.0 cm (4.7

in) in height while the lower flap measured 20.0 cm (7.9 in) in width and 6.0 cm (2.4 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, a small 4.0 cm (1.6 in) tear was documented to the lower right quadrant (source unknown) along with scuff marks to the upper right quadrant of the air bag face. The NASS researcher measured the diameter of the driver air bag at 54.0 cm (21.3 in) in its deflated state **(Figure 6)**. 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, however, a 14.0 cm (5.5 in) tear was documented to the upper right quadrant of the air bag face attributed to intruded components. The cover flap was rectangular in shape and measured 38.0 cm (15.0 in) in width and 18.0 cm (7.1 in) in height. The NASS researcher measured the passenger air bag at 70.0 cm (27.6 in) in width and 55.0 cm (21.7 in) in height in its deflated state **(Figure 7)**. 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 internal tether straps were present.

Figure 6. 1999 Ford Explorer XLT deployed redesigned driver air bag.

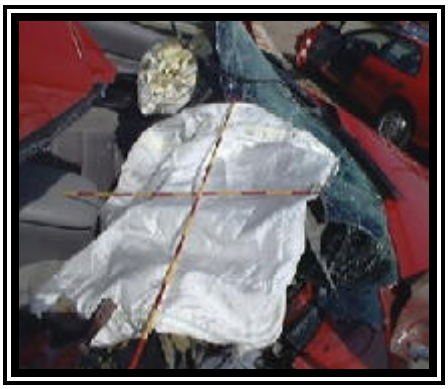

Figure 7. 1999 Ford Explorer XLT deployed redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	46 year old male
Height:	178 cm (70 in)
Weight:	109 kg (240 lb)
Seat Track Position:	Mid-to-rear position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, police report, medical report
Eyeware:	Unknown
Type of Medical Treatment:	Transported to the emergency room of a local trauma center for treatment and released.

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
*Abrasion left face	Minor (290202.1,2)	Driver air bag
*Abrasion nose	Minor (290202.1,4)	Driver air bag
*Avulsion left ear (superficial - ½ of helix)	Minor (290802.1,2)	Left A-pillar

*source-ER report**

Driver Kinematics

The 46 year old male driver of the 1999 Ford Explorer XLT was restrained by the available 3-point manual lap and shoulder belt system and presumed to be seated in an upright posture with the seat track adjusted to the mid-to-rear position. Belt usage was evidenced by the lack of significant interior contacts and injury in conjunction with the blood pattern noted on the shoulder belt webbing, which was consistent with usage. At impact, he 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 resulted in multiple facial abrasions as evidenced by the scuff marks documented to the upper right quadrant of the air bag face. At this point, the driver struck the left A-pillar which avulsed the helix of the left ear (upper ear). Although contrary to the NASS case file which sourced the injury to the driver air bag, this mechanism was evidenced by the specific aspect of the injury relative to the lateral intrusion of this component into the driver's kinematic response path. Following the crash, The driver exited the vehicle with some assistance from rescue personnel and was subsequently transported by ambulance to the emergency room of a local trauma center for treatment and released. The redesigned air bag provided additional protection against further contact to the steering wheel hub/rim, and potential serious injury.

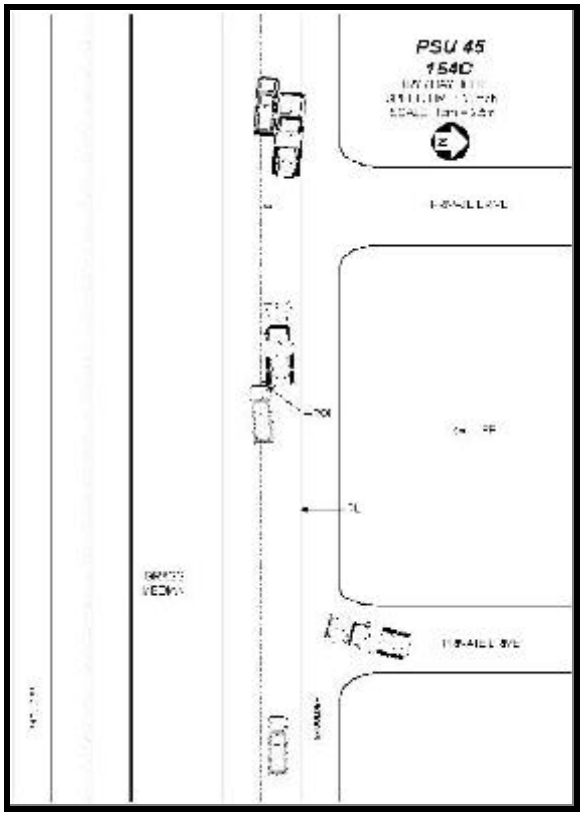

Figure 8. NASS Scene Diagram.