TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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

NASS RABSS CASE NO. 1998-43-808E

RABSS VEHICLE - 1998 FORD ESCORT LX

LOCATION - STATE OF NORTH CAROLINA

CRASH DATE - SEPTEMBER, 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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16. *Abstract* This investigation focused on a single vehicle crash involving a 1998 Ford Escort LX 4-door sedan. The Ford Escort was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with a large diameter tree. The driver was operating the vehicle southbound on a two lane rural roadway and negotiating a left curve when it departed the left (east) pavement edge and subsequently entered a wooded area. As the vehicle penetrated the wooded area, the frontal area struck a small cluster of brush resulting in superficial damage. At this point, the front left area impacted a large diameter tree resulting in moderate damage. The Ford came to rest in close proximity to the tree impact facing southeast. The 31 year old male driver of the Ford Escort was seated in an upright posture and properly 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 and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in a rib contusion and abrasion to the left hip. He also sustained an avulsion of the scalp tissue as a result of rebound into the left B-pillar. The driver of the Ford Escort was transported to a local hospital for treatment and released.			
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BACKGROUND

This investigation focused on a single vehicle crash involving a 1998 Ford Escort LX 4-door sedan. The Ford Escort was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with a large diameter tree. The driver was operating the vehicle southbound on a two lane rural roadway and negotiating a left curve when it departed the left (east) pavement edge and subsequently entered a wooded area. As the vehicle penetrated the wooded area, the frontal area struck a small cluster of brush resulting in superficial damage. At this point, the front left area impacted a large diameter tree resulting in moderate damage. The Ford came to rest in close proximity to the tree impact facing southeast. The 31 year old male driver of the Ford Escort was seated in an upright posture and properly 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 and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in a rib contusion and abrasion to the left hip. He also sustained an avulsion of the scalp tissue as a result of rebound into the left B-pillar. The driver of the Ford Escort was transported to a local hospital for treatment and released.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-43-808E for 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/Calspan the task of case review and final report preparation.

SUMMARY

Crash Site

This single vehicle crash occurred during the late evening hours of September, 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 off the east pavement edge of a rural (level) two lane north/south asphalt roadway **(see Figure 7 - page 5)** which curved left for southbound traffic. The roadside environment included soft shoulders and a wooded area to the east. No traffic control was present at the scene which had a posted speed limit of 89 km/h (55 mph).

Pre-Crash

The 31 year old male driver of the 1998 Ford Escort LX was operating the vehicle southbound and negotiating a left curve **(Figure 1)** at a police reported speed of 105 km/h (65 mph). As the vehicle rounded the curve it partially exited the right (west) pavement edge. The driver overcorrected with a left steer and braking which redirected the vehicle towards the left (east) pavement edge. The investigating officer noted 60.9 meters (200.0 feet) of pre-impact tire marks, however, the NASS researcher failed to identify the marks at the scene.

Figure 1. Southbound approach for the 1998 Ford Escort LX.

Figure 2. Struck tree.

Crash

As the Ford Escort exited the east pavement edge of the two lane rural roadway, the frontal area struck a small cluster of brush resulting in superficial damage (overlooked in the NASS case file). The Collision Deformation Classification (CDC) for this impact to the Ford Escort was 12-FDEW-1. As the vehicle continued forward, the front left area impacted a large diameter tree **(Figure 2)** resulting in moderate damage. The impact induced deceleration was sufficient to deploy the Ford's redesigned frontal air bag system. The damage algorithm of the WinSMASH program computed a (barrier equivalent) velocity change of 41.5 km/h (25.8 mph) which appears to be high. The specific longitudinal component was -41.5 km/h (-25.8 mph). The CDC for this second impact to the Ford was 12-FYEW-3. The vehicle rotated counterclockwise approximately 20 degrees and came to rest in close proximity to the tree facing southeast.

Post-Crash

The driver was removed from the vehicle with some assistance. Treatment was rendered at the scene by emergency medical technicians (EMT). The driver was transported by ambulance to a local hospital for treatment and released. The vehicle sustained disabling damage and was towed from the scene.

RABSS VEHICLE

The 1998 Ford Escort LX was identified by the Vehicle Identification Number (VIN): 1FAFP10P8WW (production sequence deleted). The vehicle was a 4-door sedan equipped with front wheel drive and a 2.0 liter, 4 cylinder engine. The vehicle's odometer reading was 9,719 km (6,039 miles) at the time of the crash. The police report listed an unspecified relative as the owner of the vehicle. The seating was configured with front bucket and a rear bench (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 Escort LX sustained moderate frontal damage as a result of the impact with the tree **(Figure 3)**. The direct contact damage began 21.0 cm (8.3 in) to the right of the front left bumper corner and extended 41.0 cm (16.1 in) inboard. The impact deformed the full frontal width resulting in a

combined direct and induced damage length (Field L) of 107.0 cm (42.1 in). Six crush measurements were documented at the level of the reinforcement bar (bumper cover separation): C1= 28.0 cm (11.0 in), C2= 50.0 cm (19.7), C3= 61.0 cm (24.0 in), C4= 36.0 cm (14.2 in), C5= 8.0 cm (3.1 in), C6= 0 cm. The hood was displaced up and rearward from engagement against the tree. The left fender was deformed rearward which restricted/deflated the left front wheel/tire. Reduction in the left side wheelbase measured 12.0 cm (4.7 in). The left lower windshield was fractured from exterior impact forces as the right mid-windshield fractured from the (interior) passenger air bag module cover flap.

Figure 3. Frontal damage to the 1998 Ford Escort LX.

Interior Damage

Interior damage to the Ford Escort identified through the NASS vehicle inspection was minimal and was attributed to occupant contact **(Figure 4)**. The left B-pillar panel was fractured. The brake pedal was deformed against the longitudinally intruded [20.0 cm (7.9 in)] toepan. No deformation was identified on the knee bolster (padded type) or steering wheel hub/rim.

Figure 4. Interior view.

REDESIGNED AIR BAG SYSTEM

The 1998 Ford Escort LX 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 crash. Air bag warning labels were affixed to each sun visor. 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 20.0 cm (7.9 in) in width and 8.0 cm (3.1 in) in height while the lower flap measured 20.0 cm (7.9 in) in width and 9.0 cm (3.5 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, vinyl transfers were documented on the upper/lower sections of the air bag from expansion within the module. The NASS researcher measured the diameter of the driver air bag at 48.0 cm (18.9 in) in its deflated state **(Figure 5)**. 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. The cover flap was rectangular in shape and measured 34.0 cm (13.4 in) in width and 18.0 cm (7.1 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flap, a vinyl transfer was documented on the left lower quadrant of the air bag from expansion within the module. The NASS researcher measured the passenger air bag at 42.0 cm (16.5 in) in width and 68.0 cm (26.8 in) in height in its deflated state **(Figure 6)**. No internal tether straps were present. 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 cutoff switch was reported for the front right redesigned passenger air bag.

Figure 5. 1998 Ford Escort LX redesigned driver air bag.

Figure 6. 1998 Ford Escort LX redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	31 year old male
Height:	175 cm (69 in)
Weight:	91 kg (200 lb)
Seat Track Position:	Full rearward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, driver interview, medical report
Eyeware:	Prescription eyeglasses
Type of Medical Treatment:	Transported to a local hospital and released

Driver Injuries

Injury	***Severity (AIS 90)***	***Injury Mechanism***
Avulsion (superficial-4 cm) posterior scalp	Minor (190802.1,6)	Left B-pillar
Laceration below right ear (small)	Minor (190602.1,1)	Head restraint
Contusion ribs (not further specified)	Minor (450202.1,1)	Shoulder belt webbing
Abrasion left hip	Minor (890202.1,2)	Lap belt webbing
Sprained right ankle	Minor (850206.1,1)	Brake pedal (indirect contact injury)

Driver Kinematics

The 31 year old male driver of the 1998 Ford Escort LX was seated in an upright posture with the seat track adjusted to the full rearward position. He was properly restrained by the available 3-point manual lap and shoulder belt system. Belt usage was confirmed by the type of injuries sustained and lack of significant contact points within the vehicle.

At impact with the bush, the driver probably remained in his pre-impact posture as this minor impact offered no significant resistance to the vehicle or produce any resulting kinematic response from the occupant. At impact with the tree, 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. Loading of the manual restraint resulted in a rib contusion (injury source identified as the air bag in the NASS case file) and left pelvic abrasion. The redesigned driver air bag provided additional restraint against further contact to the steering wheel hub/rim. He also sustained a sprained right ankle from loading to the brake pedal, evidenced by the nature of the injury relative to the deformed brake pedal. At this point, the driver rebounded into the seat back as the posterior aspect of the head struck the left B-pillar, resulting in a 4.0 cm avulsion of the soft tissue. This mechanism was evidenced by the location of the injury in conjunction with the fractured B-pillar panel. During this trajectory, the area below the right ear possibly contacted the head restraint which resulted in the minor laceration. The driver was transported to a local hospital for treatment and released.

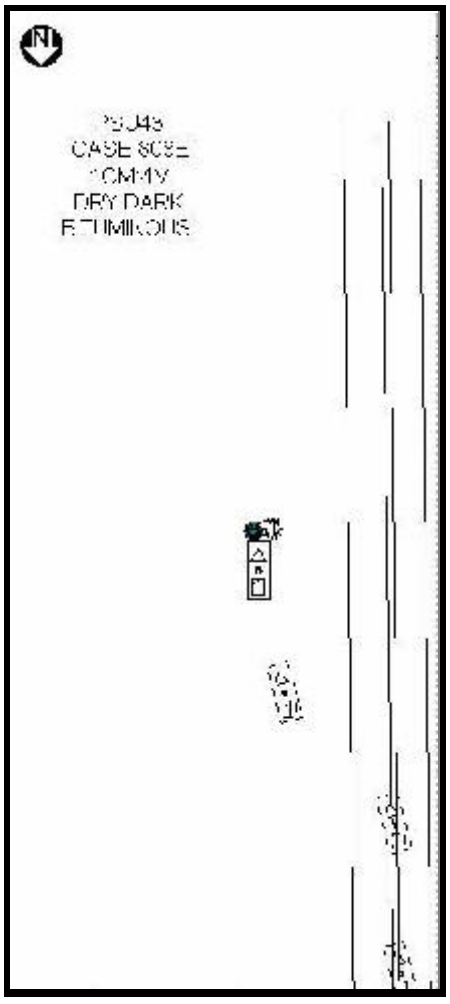

Figure 7. NASS Scene Diagram.