TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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

NASS RABSS CASE NO. 1998-11-805G

RABSS VEHICLE - 1998 FORD ESCORT ZX2

LOCATION - STATE OF MICHIGAN

CRASH DATE - JULY, 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 ZX2 2-door coupe. 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 westbound on a rural two lane roadway when she apparently had fallen asleep and allowed the vehicle to depart the left (south) pavement edge. As the vehicle exited the south pavement edge, the right windshield/header area struck the end section of a W-beam guardrail which penetrated the passenger compartment resulting in moderate damage. The vehicle continued down an embankment where the front left area impacted a large diameter tree resulting in moderate damage. The Ford rotated counterclockwise and came to rest in close proximity to the tree facing southwest. The 23 year old female driver of the Ford Escort was presumed to be seated in an upright posture and was restrained by the available 3-point manual lap and shoulder belt system. At impact with the tree, 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. Loading of the manual restraint resulted in an abrasion to the left shoulder. No other injury was reported. The driver refused treatment.			
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BACKGROUND

This investigation focused on a single vehicle crash involving a 1998 Ford Escort ZX2 2-door coupe. 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 westbound on a rural two lane roadway when she apparently had fallen asleep and allowed the vehicle to depart the left (south) pavement edge. As the vehicle exited the south pavement edge, the right windshield/header area struck the end section of a W-beam guardrail which penetrated the passenger compartment resulting in moderate damage. The vehicle continued down an embankment where the front left area impacted a large diameter tree resulting in moderate damage. The Ford rotated counterclockwise and came to rest in close proximity to the tree facing southwest. The 23 year old female driver of the Ford Escort was presumed to be seated in an upright posture and was restrained by the available 3-point manual lap and shoulder belt system. At impact with the tree, 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. Loading of the manual restraint resulted in an abrasion to the left shoulder. No other injury was reported. The driver refused treatment.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-11-805G 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 early morning 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 off the south pavement edge of a level two lane east/west asphalt roadway **(see Figure 9 - page 5)** which curved right for westbound traffic. No traffic control was present at the scene which had a posted speed limit of 89 km/h (55 mph). The roadside environment featured a W-beam guardrail and a steep embankment to the south.

Pre-Crash

The 23 year old female driver of the 1998 Ford Escort was operating the vehicle westbound and negotiating a right curve **(Figure 1)** when she apparently had fallen asleep and allowed the vehicle to depart the left (south) pavement edge in a forward tracking mode.

Figure 1. Westbound approach for the 1998 Ford Escort ZX2.

Crash

As the Ford exited the south pavement edge of the rural two lane roadway, it encountered a steep embankment which pitched the front end slightly downward. The right windshield/header area struck the end section of a W-beam guardrail **(Figure 2)** resulting in moderate damage. Although coded as unknown in the NASS case file, the Collision Deformation Classification (CDC) for this initial impact to the Ford Escort was 12-FZGW-7. The guardrail penetrated the passenger compartment prior to separation as the vehicle continued down the embankment in a slight clockwise rotation. The Ford traveled approximately 11.0 meters (36.1 feet) into a wooded area as the front left area impacted a large diameter tree **(Figure 3)** resulting in moderate damage. This was the first significant structural contact, therefore, the air bag system probably deployed at this time, late in the crash sequence. 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 33.1 km/h (20.6 mph). The specific longitudinal component was -32.6 km/h (-20.3 mph). The CDC for this second and final impact to the Ford Escort was 12-FYEN-3. At this point, the Ford rotated counterclockwise approximately 20 degrees and came to rest in close proximity to the tree facing southwest.

Figure 2. Guardrail impact area (end section replaced).

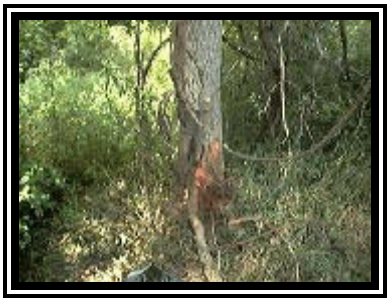

Figure 3. Impacted tree.

Post-Crash

The driver exited the vehicle under her own power. No ambulance was summoned to the crash site. The vehicle was towed from the scene due to disabling damage.

RABSS VEHICLE

The 1998 Ford Escort ZX2 was identified by the Vehicle Identification Number (VIN): 3FAKP1136WR (production sequence deleted). The vehicle was a 2-door coupe equipped with front wheel drive and a 2.0 liter, 4 cylinder engine. The vehicle's odometer reading was 9,379 km (5,828 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 (folding back) bench seats. 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 ZX2 sustained moderate frontal damage as a result of the impact with the tree **(Figures 4 & 5)**. The direct contact damage began 33.0 cm (13.0 in) to the left of the front left bumper corner and extended 33.0 cm (13.0 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 112.0 cm (44.1 in). Six crush measurements were documented at the level of the reinforcement bar (bumper cover separation): C1= 19.0 cm (7.5 in), C2= 42.0 cm (16.5 in), C3= 48.0 cm (18.9 in), C4= 22.0 cm (8.7 in), C5= 9.0 cm (3.5 in), C6= 2.0 cm (0.8 in). The hood and grille assembly separated from the vehicle during the crash sequence. Both fenders were deformed which restricted/deflated the front wheels/tires. The windshield was holed and fractured from the guardrail impact with minimal penetration noted into the passenger compartment. The windshield header and surrounding roof area was deformed with the backlight glazing disintegrated. Reduction in the left side wheelbase measured 10.0 cm (3.9 in).

Figure 4. Frontal damage to the 1998 Ford Escort ZX2.

Figure 5. Crush depth.

Interior Damage

Interior damage to the Ford Escort identified through the NASS vehicle inspection was minimal and was attributed to occupant contact **(Figure 6)**. A scuff mark was documented to the left knee bolster (rigid plastic type). Intrusions into the passenger compartment included 2.0 cm (0.8 in) of vertical header intrusion, 10.0 cm (3.9 in) of longitudinal windshield intrusion and 10.0 cm (3.9 in) of longitudinal exterior object (guardrail) intrusion. No deformation was noted to the steering wheel hub/rim (tilt column placed between the full up and center position).

Figure 6. Interior view.

REDESIGNED AIR BAG SYSTEM

Figure 7. 1998 Ford Escort ZX2 redesigned driver air bag.

The 1998 Ford Escort ZX2 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. The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). No contact evidence was identified on the air bag or exterior surface of the module cover flaps. The flaps were asymmetrical in shape as the upper flap measured 22.0 cm (8.7 in) in width and 11.0 cm (4.3 in) in height while the lower flap measured 22.0 cm (8.7 in) in width along the upper portion, 14.0 cm (5.5 in) along the lower portion and 9.0 cm (3.5 in) in height. The NASS researcher measured the diameter of the driver air bag at 44.0 cm (17.3 in) in its deflated state **(Figure 7)**. 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.

Figure 8. 1998 Ford Escort ZX2 redesigned passenger 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 33.0 cm (13.0 in) in width and 19.0 cm (7.5 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flap, blood spattering was documented to the (rear) upper right quadrant of the air bag. The NASS researcher measured the passenger air bag at 60.0 cm (23.6 in) in width and 70.0 cm (27.6 in) in height in its deflated state **(Figure 8)**. 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.

DRIVER DEMOGRAPHICS

Age/Sex:	23 year old female
Height:	168 cm (66 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, driver interview, police report
Eyeware:	None
Type of Medical Treatment:	None

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Abrasion left shoulder	Minor (790202.1,2)	Shoulder belt webbing

Driver Kinematics

The 23 year old female driver of the 1998 Ford Escort ZX2 was presumed to be seated in an upright posture with the seat track adjusted to the middle position. She was restrained by the available 3-point manual lap and shoulder belt system. Belt usage was confirmed by the type of injury sustained and lack of significant contact points within the vehicle. At impact with the guardrail, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint with no resulting injury reported. At impact with the tree, she again 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 an abrasion to the left shoulder as evidenced by the size and location of the injury. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential injury. The driver refused treatment.

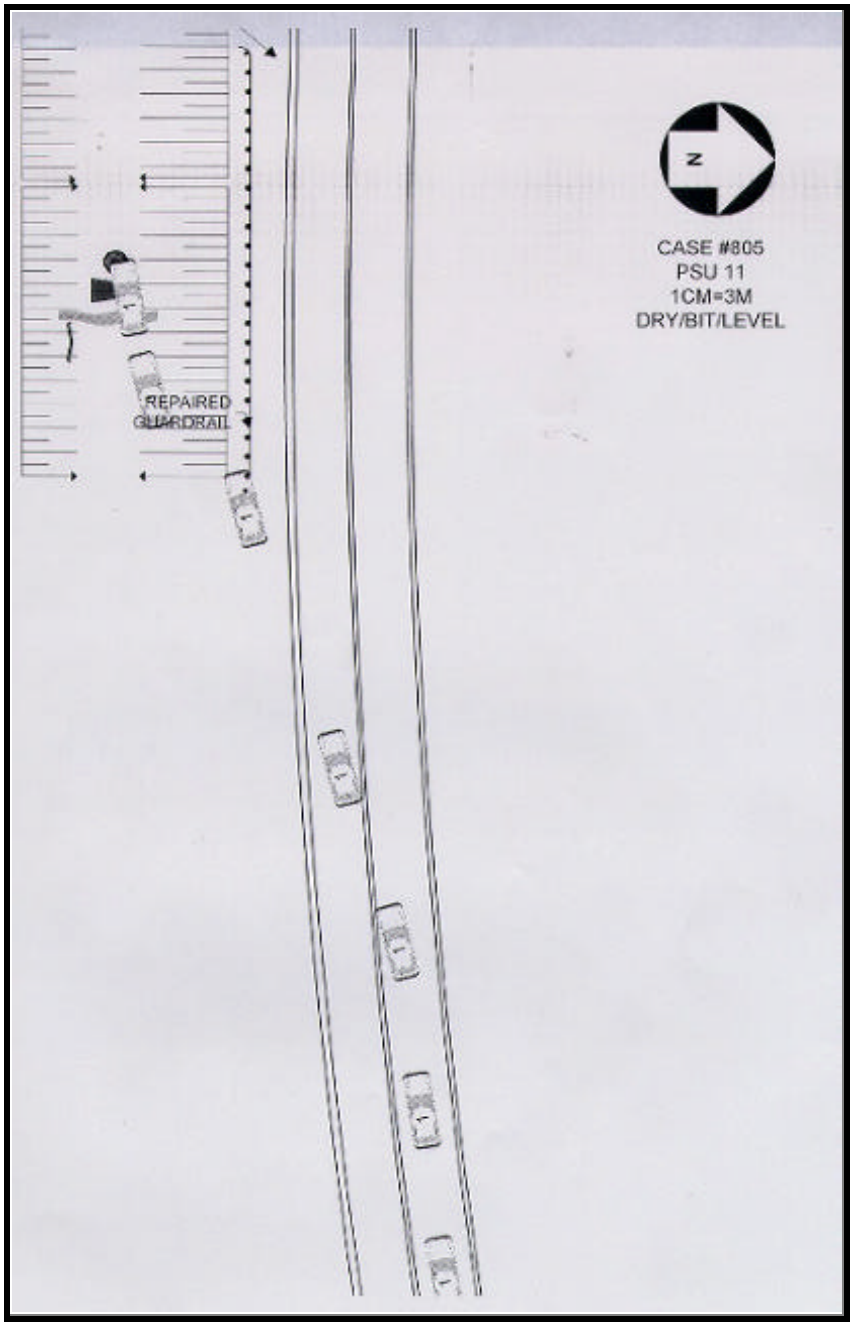

Figure 9. NASS Scene Diagram.