

**TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION**

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

NASS RABSS CASE NO. 1998-11-808G

RABSS VEHICLE - 1998 FORD ESCORT ZX2

LOCATION - STATE OF MICHIGAN

CRASH DATE - AUGUST, 1998

Contract No. DTNH22-94-D-07058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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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.

TECHNICAL REPORT STANDARD TITLE PAGE

1. <i>Report No.</i> 98-11-808G	2. <i>Government Accession No.</i>	3. <i>Recipient's Catalog No.</i>	
4. <i>Title and Subtitle</i> Redesigned Air Bag Special Study (RABSS) RABSS Vehicle - 1998 Ford Escort ZX2 Location - State of Michigan		5. <i>Report Date:</i> June, 2000	
		6. <i>Performing Organization Code</i>	
7. <i>Author(s)</i> Crash Research Section		8. <i>Performing Organization Report No.</i>	
9. <i>Performing Organization Name and Address</i> Transportation Sciences Crash Research Section Veridian Engineering P.O. Box 400 Buffalo, New York 14225		10. <i>Work Unit No.</i> C01115.0262.(0000-0009)	
		11. <i>Contract or Grant No.</i> DTNH22-94-D-07058	
12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		13. <i>Type of Report and Period Covered</i> Technical Summary Report Crash Date: August, 1998	
		14. <i>Sponsoring Agency Code</i>	
15. <i>Supplementary Notes</i> NASS investigation of a frontal collision (into a fixed object) that involved a 1998 Ford Escort ZX2 equipped with redesigned frontal air bags.			
16. <i>Abstract</i> 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 for the driver and right passenger positions which deployed as a result of a frontal collision with a large diameter tree. The driver of the Ford was operating the vehicle eastbound on a rural two lane roadway and negotiating a right curve when he allowed the vehicle to cross the centerline and depart the left (north) pavement edge into a wooded area. As the Ford entered the wooded area, the front left area impacted a large diameter tree resulting in moderate damage. The vehicle subsequently rotated counterclockwise and continued in a northeasterly direction across a private yard as the right side wheels dug into the soft soil. This initiated a 4-quarter turn right side rollover resulting in moderate top damage. The Ford Escort came to rest upright off the north shoulder facing northwest. The restrained 22 year old male driver of the Ford Escort initiated a forward trajectory in response to the initial 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in a contusion to the left chest. Contact to the deployed driver air bag resulted in a small abrasion to the left cheek. The driver of the Ford Escort refused medical treatment.			
17. <i>Key Words</i> Redesigned frontal air bag system Collision Deformation Classification (CDC): 12-FLEW-3 Proper use of the manual belt system Abrasion left cheek		18. <i>Distribution Statement</i> General Public	
19. <i>Security Classif. (of this report)</i> Unclassified	20. <i>Security Classif. (of this page)</i> Unclassified	21. <i>No. of Pages</i> 5	22. <i>Price</i>

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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 for the driver and right passenger positions which deployed as a result of a frontal collision with a large diameter tree. The driver of the Ford was operating the vehicle eastbound on a rural two lane roadway and negotiating a right curve when he allowed the vehicle to cross the centerline and depart the left (north) pavement edge into a wooded area. As the Ford entered the wooded area, the front left area impacted a large diameter tree resulting in moderate damage. The vehicle subsequently rotated counterclockwise and continued in a northeasterly direction across a private yard as the right side wheels dug into the soft soil. This initiated a 4-quarter turn right side rollover resulting in moderate top damage. The Ford Escort came to rest upright off the north shoulder facing northwest. The restrained 22 year old male driver of the Ford Escort initiated a forward trajectory in response to the initial 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in a contusion to the left chest. Contact to the deployed driver air bag resulted in a small abrasion to the left cheek. The driver of the Ford Escort refused medical treatment.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-11-808G 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 the task of case review and final report preparation.

SUMMARY

Crash Site

This single vehicle crash occurred during the early morning hours of August, 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 a wooded area approximately 4.4 meters (14.4 feet) north of a two lane east/west (asphalt) roadway which curved right for eastbound traffic (see **Figure 11 - page 5**). The rural roadway was bordered by narrow gravel shoulders with a positive grade 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 22 year old male driver of the 1998 Ford Escort was operating the vehicle eastbound and negotiating a right curve (**Figure 1**) at a (driver reported) speed of 121 km/h (75 mph) when he allowed the vehicle to cross the centerline and depart the left (north) pavement edge (**Figure 2**). The driver steered right/braked in an attempt to regain control as the vehicle continued alongside the shoulder in a northeasterly direction approximately 27.0 meters (88.6 feet) prior to the collision.

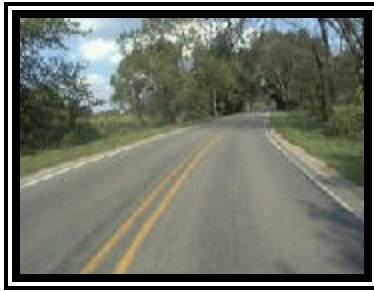


Figure 1. Eastbound approach for the 1998 Ford Escort ZX2.



Figure 2. Eastbound approach off the north pavement edge.

Crash

As the Ford Escort entered the wooded area alongside the north shoulder, the front left area impacted a 45.0 cm (17.7 in) diameter tree (**Figure 3**) resulting in moderate damage. The WinSMASH damage algorithm computed a (barrier equivalent) velocity change of 34.4 km/h (21.4 mph) with a longitudinal component of -33.9 km/h (-21.1 mph). The impact induced deceleration was sufficient to deploy the Ford's redesigned frontal air bag system. At this point, the vehicle rotated counterclockwise and continued its post-impact trajectory in a northeasterly direction approximately 55.0 meters (180.5 feet) across a private yard (**Figures 4 & 5**) as the right side wheels dug into the soft soil. This tripping mechanism initiated a 4-quarter turn right side rollover resulting in moderate top damage. The Ford came to rest (upright) facing northwest.



Figure 3. North view of impacted tree.



Figure 4. Post-impact trajectory northeast into rollover area.



Figure 5. Lookback view from final rest (southwest) showing rollover furrowing to the soft soil.

Post-Crash

The driver of the Ford Escort exited the vehicle under his own power. Treatment was rendered at the scene by emergency medical technicians (EMTs), however, the driver refused transport to a local hospital. 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): 3FAKP1135WR (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 7,422 km (4,612 miles) at the time of the crash. The police report did not specify the owner of the vehicle. The seating was configured with a front bucket and rear bench seats (with folding backs). The surrogate interview reported no previous crashes or maintenance on the air bag system (original equipment). It is unknown if a 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 (**Figure 6**). The direct contact damage began 4.0 cm (1.6 in) to the right of 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 130.0 cm (51.2 in). Six crush measurements were documented at the level of the reinforcement bar (*bumper fascia separation*): C1= 36.0 cm (14.2 in), C2= 53.0 cm (20.9 in), C3= 33.0 cm (13.0 in), C4= 17.0 cm (6.7 in), C5= 6.0 cm (2.4 in), C6= 3.0 cm (1.2 in). The Collision Deformation Classification (CDC) for this initial impact to the Ford was 12-FLEW-3 with a principal direction of force of (-)10 degrees. The left fender was displaced rearward which restricted the left front wheel/tire (not deflated) and jammed the left door. The hood was displaced up and rearward from engagement against the tree. Reduction in the left side wheelbase measured 2.0 cm (0.8 in). The windshield was fractured along with disintegrated left front/rear tempered glazing.

Direct contact damage was also identified to the top and side surfaces of the Ford attributed to the rollover (**Figure 7**). The tripping mechanism deformed the right front wheel and deflated the right rear tire (not restricted). Mud/dirt was also embedded in the right side wheels/rims and forward door seam. A maximum crush value of 6.0 cm (2.4 in) was approximated along the left windshield header/roof side rail area. *Although assigned to the left side surface in the NASS case file, the correct CDC for this non-horizontal impact is 00-TDDO-3 (non-horizontal impacts are assigned based on plane of greatest crush, not greatest contact).*



Figure 6. Front left damage to the 1998 Ford Escort ZX2.



Figure 7. Left side and top rollover damage.

Interior Damage

Interior damage to the Ford Escort was minimal and was attributed to occupant contact and component intrusion. A scuff mark was documented on the left B-pillar panel which was also fractured. *Although omitted in the NASS case file, vertical intrusions into the front occupant space involved 3.0 cm (1.2 in) of left/center windshield header intrusion and 4.0 cm (1.6 in) of left/center roof intrusion* (**Figure 8**).

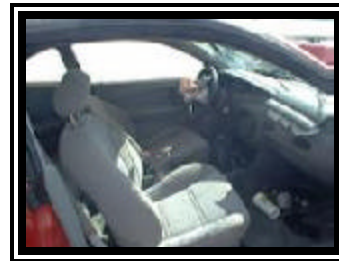


Figure 8. Interior view.

REDESIGNED AIR BAG SYSTEM

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). The flaps were nearly symmetrical in shape as the upper flap measured 22.0 cm (8.7 in) in width and 9.0 cm (3.5 in) in height while the lower flap measured 22.0 cm (8.7 in) in width and 11.0 cm (4.3 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, blood spattering was noted to the upper left quadrant of the air bag.

The NASS researcher measured the diameter of the driver air bag at 46.0 cm (18.1 in) in its deflated state (**Figure 9**). 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 9. 1998 Ford Escort ZX2 redesigned driver air bag.

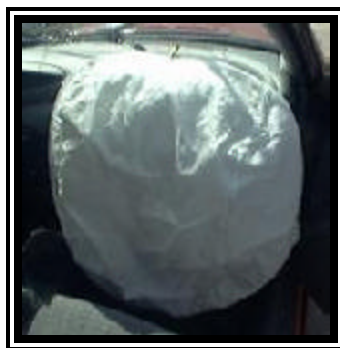


Figure 10. 1998 Ford Escort ZX2 redesigned passenger air bag.

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. 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 33.0 cm (13.0 in) in width and 21.0 cm (8.3 in) in height. The NASS researcher measured the passenger air bag at 70.0 cm (27.6 in) in width and 65.0 cm (25.6 in) in height in its deflated state (**Figure 10**). 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. Black vinyl transfers were noted to the lower (centered) section of the air bag from expansion within the module. No cutoff switch was reported for the front right air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	22 year old male
Height:	183 cm (72 in)
Weight:	73 kg (160 lb)
Seat Track Position:	Mid-to-rear position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, surrogate interview, police report
Eyewear:	None
Type of Medical Treatment:	Refused treatment

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
Contusion above left eyebrow	Minor (290402.1,7)	Left B-pillar
Abrasion left cheek (1.5in x .5in)	Minor (290202.1,2)	Front left air bag
Contusion left chest (2in x 2in)	Minor (490402.1,2)	Shoulder belt webbing

Driver Kinematics

The 22 year old male driver of the 1998 Ford Escort ZX2 was properly restrained by the available 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the mid-to-rear position. The NASS interview stated the driver was belted, further evidenced by the lack of significant interior contacts and injury. 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 small contusion to the left chest. Contact to the deployed redesigned driver air bag resulted in a small abrasion to the left cheek. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential serious injury. During the rollover, he struck the left B-pillar which resulted in a contusion over the left eyebrow, evidenced by the fractured panel and scuff mark on this component. Although an ambulance was summoned to the crash site, the driver refused medical treatment.

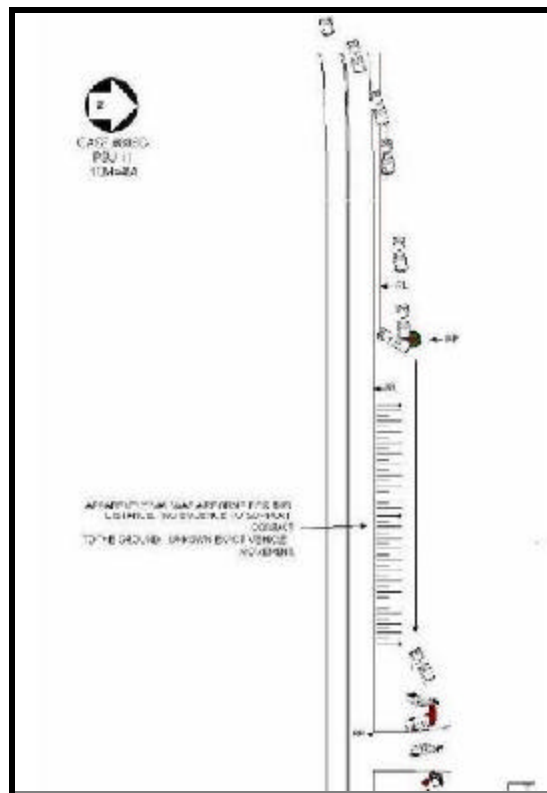


Figure 11. NASS Scene Diagram.