

**TRANSPORTATION SCIENCES  
CRASH RESEARCH SECTION**

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

**NASS RABSS CASE NO. 1999-08-801E**

**RABSS VEHICLE - 1999 FORD ESCORT SE**

**LOCATION - STATE OF PENNSYLVANIA**

**CRASH DATE - JULY, 1999**

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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**REDESIGNED AIR BAG SPECIAL STUDY (RABSS)  
SCI TECHNICAL SUMMARY REPORT  
NASS RABSS CASE NO. 1999-08-801E  
RABSS VEHICLE - 1999 FORD ESCORT SE  
CRASH DATE - JULY, 1999**

***BACKGROUND***

This investigation focused on a single vehicle crash involving a 1999 Ford Escort SE 4-door sedan. The Ford Escort was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with a guardrail. The Ford was northbound on a 4-lane divided highway when the driver allegedly fell asleep and allowed the vehicle to depart the left (west) pavement edge of the northbound lanes. As the vehicle departed the west pavement edge, the left side surface sideswiped the median guardrail which resulted in minor damage. The vehicle re-entered the northbound lanes and subsequently exited the right (east) pavement edge where the front right area impacted a second guardrail resulting in minor damage. Contact separation occurred as the right rear area struck the guardrail resulting in minor damage. The vehicle came to rest in the northbound lanes facing west.

The 19 year old male driver of the Ford Escort was unrestrained (3-point manual lap and shoulder belt system available) with the seat track adjusted to the full rearward position. At impact with the second guardrail, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the redesigned driver air bag. The driver was uninjured in the crash but was transported to a local hospital for evaluation and released. Although the police report listed the 27 year old male as the driver of the vehicle, contact evidence within the vehicle and associated injuries suggest that this occupant was in the *front right seating position*. He was also unrestrained and initiated a forward trajectory in response to pre-crash braking prior to the second guardrail impact. His face was positioned against or within a close proximity to the mid-mount front right air bag module cover flap. At impact, the flap struck the passenger in the chin area which resulted in bilateral fractures of the mandible. He was accelerated into the windshield resulting in multiple abrasions/lacerations to the facial area. The front right passenger was transported to a local hospital for treatment and admitted for two days.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 99-08-801E for the Redesigned Air Bag Special Study. The Field Operations Branch 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**

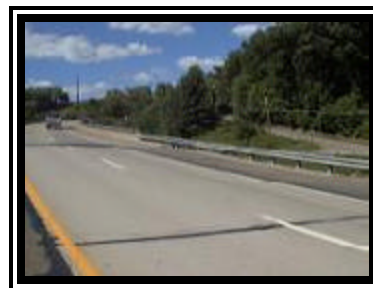
This single vehicle crash occurred during the early morning hours of July, 1999. At the time of the crash, it was dark (street lighted) with no adverse conditions as the roads were dry. The crash occurred off the northbound lanes of a 4-lane north/south asphalt roadway (see **Figure 7 - page 6**) which was divided by a grass median and curved right for northbound traffic. No traffic controls were present at the scene which had a posted speed limit of 105 km/h (65 mph).

## Pre-Crash

The 19 year old male driver of the 1999 Ford Escort was operating the vehicle northbound in the #2 curb lane at a police reported speed of 113 km/h (70 mph) when he apparently fell asleep and allowed the vehicle to exit the left (west) pavement edge.

## Crash

As the Ford exited the west pavement edge of the northbound lanes, the left side surface sideswiped the median (w-beam) guardrail resulting in minor damage. The Collision Deformation Classification (CDC) for this initial impact to the Ford was 12-LDES-1. The Ford re-entered the northbound lanes and subsequently exited the right (east) pavement edge where the front right area impacted the second (w-beam) guardrail resulting in minor damage (**Figure 1**). The impact induced deceleration was sufficient to deploy the Ford's redesigned frontal air bag system. Although the impact was classified as a yielding object (guardrail yielded-out of scope), the damage algorithm of the WinSMASH program computed a (barrier equivalent) velocity change of 12.5 km/h (7.8 mph). The respective longitudinal component was -12.5 km/h (-7.8 mph). The CDC for this impact to the Ford Escort was 12-FREE-4. Contact separation occurred as the right rear area struck the guardrail resulting in minor damage. The CDC for this third and final impact to the Ford was 02-RZEW-1. The Ford Escort came to rest in the northbound lanes facing west.



**Figure 1. Northeast approach into the second guardrail impact.**

## Post-Crash

Both occupants of the Ford Escort exited the vehicle under their own power. Treatment was rendered at the scene by emergency medical technicians (EMT). The driver was transported to a local hospital for evaluation and released. The front right passenger was transported to a local hospital for treatment and admitted for two days. The vehicle was towed from the scene.

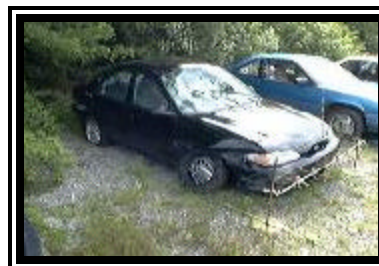
## ***RABSS VEHICLE***

The 1999 Ford Escort SE was identified by the Vehicle Identification Number (VIN): 1FAFP13P9XW (production sequence deleted). The police report listed the passenger as the owner of the vehicle. 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 5,432 km (3,375 miles) at the time of the crash. The seating was configured with front bucket seats and a rear bench (with folding backs). The owner 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 Ford Escort sustained minor frontal damage as a result of the impact with the second guardrail (**Figure 2**). The direct contact

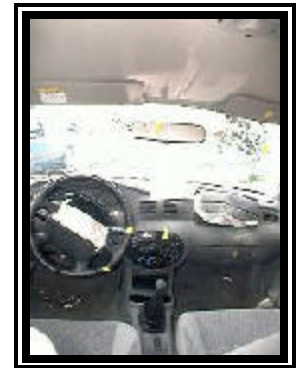


**Figure 2. Front and right side damage to the 1999 Ford Escort SE.**

damage began at the front right bumper corner and extended 36.0 cm (14.2 in) inboard. The impact resulted in a combined direct and induced damage length (Field L) of 139.0 cm (54.7 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= 2.0 cm (0.8 in), C6= 4.0 cm (1.6 in). The direct contact damage extended rearward to the right front wheel which restricted and deflated the tire. Separation in the contact damage was noted between the right A and C-pillars. This damage to the right rear area was attributed to the third guardrail impact which began 30.0 cm (11.8 in) forward of the right rear axle and extended 87.0 cm (34.3 in) rearward. Superficial scratching was identified on the left side of the vehicle attributed to the first guardrail impact. The direct contact damage began 62.0 cm (24.4 in) forward of the left front axle and extended 310.0 cm (122.0 in) rearward. The windshield was fractured from exterior forces and the (interior) front right air bag module cover flap.

### **Interior Damage**

Interior damage to the Ford Escort identified through the NASS vehicle inspection was moderate and was attributed to occupant contact (**Figure 3**). Blood spattering was noted to the (right) upper and lower sections of the driver air bag. The upper portion of the steering wheel rim was deformed forward 2.0 cm (0.8 in) with the tilt column set to the full down position. A scuff mark was documented on the left knee bolster (padded type) and glove compartment door. The rear view mirror was displaced and fractured. Spider-web type fractures were identified to the right mid/lower windshield area from passenger contact and the air bag module cover flap. A large indentation was documented on the passenger air bag module cover flap which was attributed to the passenger's mandible fracture. Blood spattering was also noted to the (rear) upper section of the passenger air bag. No loading evidence was found on the webbing of the front manual lap and shoulder belt systems.



**Figure 3. Interior view of the 1999 Ford Escort SE.**

### **REDESIGNED AIR BAG SYSTEM**

The 1999 Ford Escort SE 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 asymmetrical in shape as the upper flap measured 21.0 cm (8.3 in) in width and 11.0 cm (4.3 in) in height while the lower flap measured 21.0 cm (8.3 in) in width and 10.0 cm (3.9 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, blood spattering was found on the (right) upper and lower sections of the air bag.



**Figure 4. 1999 Ford Escort SE redesigned driver air bag.**

The NASS researcher measured the diameter of the driver air bag at 50.0 cm (19.7 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 a mid-mount module in the right instrument panel with a single cover flap design hinged at the top aspect. The cover flap was rectangular in shape which opened in an upward direction toward the windshield and measured 31.0 cm (12.2 in) in width and 19.0 cm (7.5 in) in height. A large indentation was identified to the center portion of the module cover flap which was attributed

to the passenger's mandible fracture. The lower right portion of the cover flap was also deformed from contact to the windshield (fractured). Blood spattering was documented to the back of the air bag (upper section) which was attributed to the passenger's facial injury. The NASS researcher measured the passenger air bag at 40.0 cm (15.7 in) in width and 50.0 cm (19.7 in) in height in its deflated state (**Figure 5**). No tether straps were present. The bag was vented by two ports located at the 3 o'clock and 9 o'clock sectors on the side aspect of the air bag. No cutoff switch was reported for the front right air bag.



**Figure 5. 1999 Ford Escort SE redesigned passenger air bag.**

**DRIVER DEMOGRAPHICS**

Age/Sex: 19 year old male  
 Height: 175 cm (69 in)  
 Weight: 68 kg (150 lb)  
 Seat Track Position: Full rearward position  
 Manual Restraint Use: None  
 Usage Source: NASS vehicle inspection, passenger interview, police report  
 Eyeware: None  
 Type of Medical Treatment: Transported to a local hospital for evaluation and released.

**Driver Injuries**

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

**Driver Kinematics**

The 19 year old male driver of the 1999 Ford Escort SE was unrestrained (3-point lap and shoulder belt available) and presumed to be seated in an upright position with the seat track adjusted to the full rearward position. The police report noted that he was not belted, further evidenced by the lack of loading marks to the manual belt webbing and contact points within the vehicle. At impact with the first guardrail, the driver remained in his pre-impact posture as this swiping impact offered no significant resistance to the vehicle or produce any resulting kinematic response from the occupant. At impact with the second guardrail, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the redesigned driver air bag and knee bolster. The redesigned driver air bag provided restraint against further contact to the steering wheel hub/rim and windshield. Although the driver was not reported as injured, he was transported to a local hospital for evaluation and released.



**FRONT RIGHT PASSENGER DEMOGRAPHICS**

Age/Sex: 27 year old male  
Height: 180 cm (71 in)  
Weight: 73 kg (160 lb)  
Seat Track Position: Full rearward position  
Manual Restraint Use: None  
Usage Source: NASS vehicle inspection, passenger interview, police report  
Eyeware: None  
Type of Medical Treatment: Transported to a local hospital and admitted (2 days)

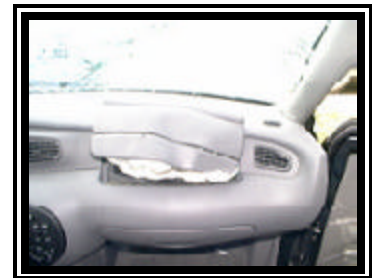
**Front Right Passenger Injuries**

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
Fracture mandible (bilateral: right-angle, left-subcondylar)	Moderate (250608.2,3)	Front right air bag module cover flap
Laceration left ear (posterior- 4 cm)	Minor (190602.1,7)	Windshield
Laceration face (multiple-unspecified)	Minor (290600.1,9)	Windshield
Abrasion face (multiple-unspecified)	Minor (290202.1,9)	Windshield
Abrasion left posterior forearm	Minor (790202.1,2)	Windshield/mirror

**Front Right Passenger Kinematics**

The 27 year old male front right passenger of the 1999 Ford Escort SE was listed on the police report as the driver of the vehicle, but given the low severity of the crash, contact evidence within the vehicle (relative to the kinematic response pattern) and the nature of the injuries sustained, it is the SCI investigator’s opinion that this occupant was seated in the *front right position*.

The front right passenger was unrestrained (3-point lap and shoulder belt available) and presumed to be seated out of position forward due to pre-crash braking actions by the driver prior to the second guardrail impact. His face was positioned against or within a close proximity to the mid-mount front right air bag module cover flap. Lack of belt usage was confirmed by the nature of the injuries sustained and contact points within the vehicle. At impact with the second guardrail, the flap struck the passenger in the chin area which resulted in bilateral fractures of the mandible, evidenced by the indentation documented to this component (**Figure 6**). It should be noted that the redesigned air bag system deployed with less force, therefore, preventing this out-of-position occupant from serious injury or death. He was accelerated into the windshield resulting in multiple abrasions/lacerations to the facial area as evidenced



**Figure 6. Passenger contact to the air bag module cover flap.**

by the spider-web type fracture identified on the right mid-windshield. In addition, the medical report stated that glass was embedded into the hair and face. He also sustained an abrasion to the left posterior forearm from contact to the rear-view mirror/windshield, evidenced by the displacement and fracture of this component. The front right passenger was transported to a local hospital for treatment and admitted for two days.

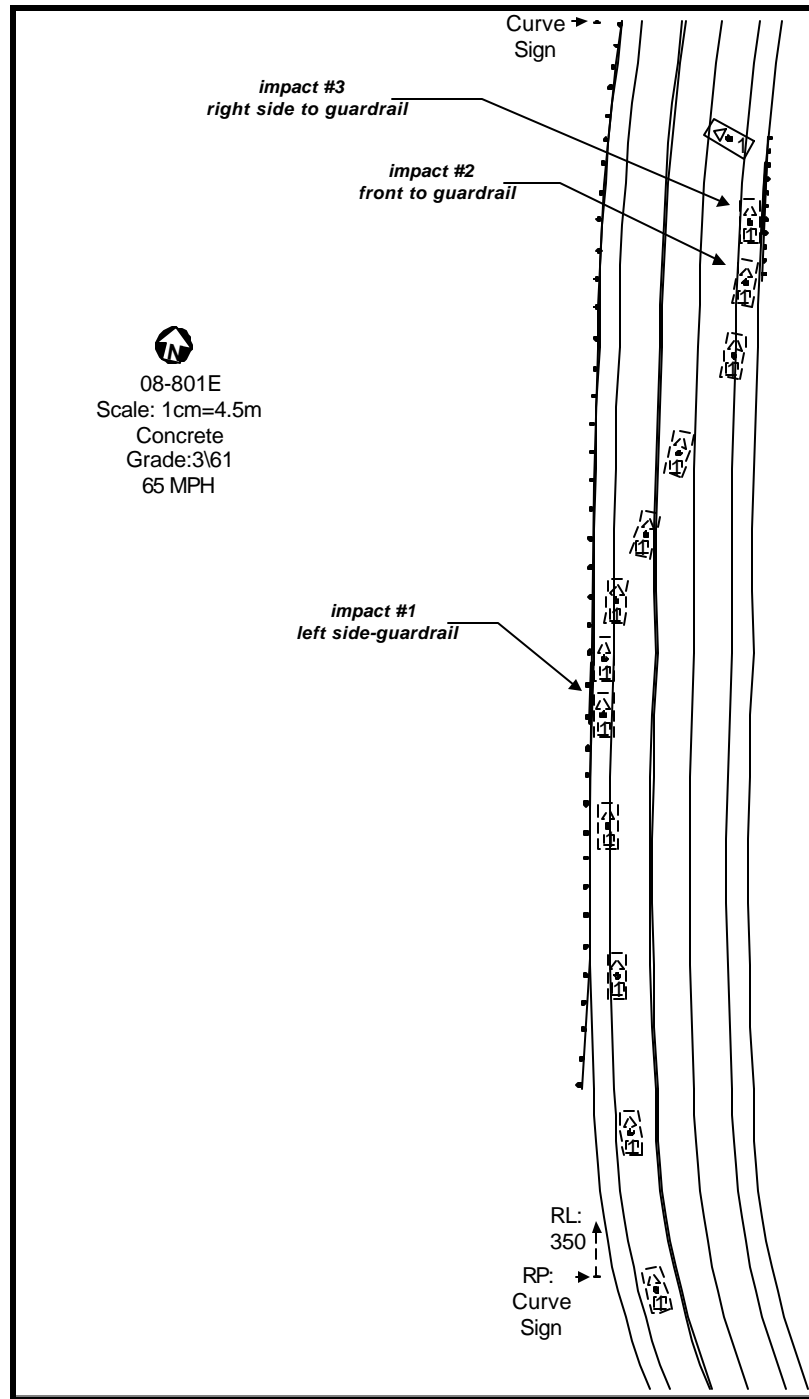


Figure 7. NASS Scene Diagram