

**TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION**

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

NASS RABSS CASE NO. 1998-09-801E

RABSS VEHICLE - 1998 FORD ESCORT LX

LOCATION - STATE OF MARYLAND

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. <i>Abstract</i> <p>This investigation focused on a two-vehicle crash involving a 1998 Ford Escort LX 4-door sedan (subject vehicle) and a 1983 Cadillac Deville 4-door sedan. The Ford Escort was equipped with redesigned frontal air bags that deployed as a result of a right angle collision with the Cadillac Deville. The Cadillac was southbound and attempted to turn left (east) at a 4-leg intersection when it crossed into the path of the northbound Ford. As the Cadillac turned left and crossed the northbound lanes the front left area of the Ford struck the right front side of the Cadillac. Impact resulted in moderate frontal damage to the Ford Escort. At this point, the Ford rotated clockwise and sideslapped the Cadillac resulting in minor left side damage. The 19 year old female driver of the Ford Escort was properly restrained by the 3-point manual lap and shoulder belt system. At impact, she initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint and deployed air bag which resulted in a cervical strain and abrasion to the face. The 45 year old female front right passenger was properly restrained by the 3-point manual lap and shoulder belt system and initiated a forward trajectory in response to the 11 o'clock impact force. She loaded the manual restraint resulting in abrasions/contusions to the right shoulder and left pelvis. Contact to the deployed air bag resulted in an abrasion to the face. The rear left and center seating positions were occupied by 2 year old and 1 year old females who were restrained by the available manual belt systems used in conjunction with (unspecified make/model) child safety seats and were uninjured in the collision. The rear right seating position was occupied by an 18 year old female who was properly restrained by the available 3-point lap and shoulder belt system and was also uninjured in the collision. The driver and front right passenger of the Ford Escort were transported to a local hospital for treatment and released.</p>			
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SCI TECHNICAL SUMMARY REPORT
NASS RABSS CASE NO. 1998-09-801E
RABSS VEHICLE - 1998 FORD ESCORT LX
CRASH DATE - JULY, 1998**

BACKGROUND

This investigation focused on a two-vehicle crash involving a 1998 Ford Escort LX 4-door sedan (subject vehicle) and a 1983 Cadillac Deville 4-door sedan. The Ford Escort was equipped with redesigned frontal air bags that deployed as a result of a right angle collision with the Cadillac Deville. The Cadillac was southbound and attempted to turn left (east) at a 4-leg intersection when it crossed into the path of the northbound Ford. As the Cadillac turned left and crossed the northbound lanes the front left area of the Ford struck the right front side of the Cadillac. Impact resulted in moderate frontal damage to the Ford Escort. At this point, the Ford rotated clockwise and sideslapped the Cadillac resulting in minor left side damage. The 19 year old female driver of the Ford Escort was properly restrained by the 3-point manual lap and shoulder belt system. At impact, she initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint and deployed air bag which resulted in a cervical strain and abrasion to the face. The 45 year old female front right passenger was properly restrained by the 3-point manual lap and shoulder belt system and initiated a forward trajectory in response to the 11 o'clock impact force. She loaded the manual restraint resulting in abrasions/contusions to the right shoulder and left pelvis. Contact to the deployed air bag resulted in an abrasion to the face. The rear left and center seating positions were occupied by 2 year old and 1 year old females who were restrained by the available manual belt systems used in conjunction with (unspecified make/model) child safety seats and were uninjured in the collision. The rear right seating position was occupied by an 18 year old female who was properly restrained by the available 3-point lap and shoulder belt system and was also uninjured in the collision. The driver and front right passenger of the Ford Escort were 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 98-09-801E 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 two-vehicle crash occurred during the early evening hours of July, 1998. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the northbound lanes of an north/south multi-lane asphalt roadway (see **Figure 8 - page 7**) which is divided by a grass median. Traffic control at the scene included stop signs for east/westbound traffic. The speed limit at the crash scene was 56 km/h (35 mph).

Pre-Crash

The 19 year old female driver of the 1998 Ford Escort LX was operating the vehicle northbound (**Figure 1**) and proceeding straight when she observed the Cadillac Deville turn left (east) across her lane of travel. Upon recognition of the impending harmful event, the driver steered right and braked {5.0 meters (16.4 ft) of pre-impact skid marks documented at the crash site} in avoidance remaining in the northbound travel lanes prior to the collision. The 1983 Cadillac Deville was driven by a 19 year old male who was operating the vehicle southbound when he approached the intersection and proceeded to turn left (east).



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

Crash

As the Cadillac crossed the northbound lanes of the multi-lane roadway, the front left area of the Ford struck the right front area of the Cadillac. The impact induced deceleration was sufficient to deploy the Ford's redesigned frontal air bag system. The damage algorithm of the WinSMASH (missing vehicle) program computed velocity changes of 20.1 km/h (12.5 mph) for the subject vehicle and 14.3 km/h (8.9 mph) for the struck Cadillac. The specific longitudinal component was -17.4 km/h (-10.8 mph) for the subject vehicle. The Collision Deformation Classification (CDC) for this impact to the Ford Escort was 11-FLEE-1 (Cadillac not inspected by the NASS researcher). During the impact sequence, the Ford rotated clockwise and sideslapped the Cadillac resulting in minor left side damage. The Collision Deformation Classification (CDC) for this secondary impact to the Ford was 09-LBMN-2. The Ford Escort came to rest in the northbound (right turn) lane facing east. At this point, the Cadillac continued on its post-impact trajectory and subsequently struck a 1996 Hyundai Accent and 1996 Dodge Ram pickup truck that were stationary and facing west in the east sector of the intersection. These subsequent impacts resulted in (unknown) frontal damage to the Cadillac and (unknown) side damage to the Hyundai and Dodge. The Cadillac came to rest in the east sector of the intersection facing northeast.

Post-Crash

The driver and front right passenger of the Ford Escort were removed from their vehicle with perceived serious injuries. The rear right occupant exited the vehicle under her own power and assisted the rear left and center occupants from the vehicle. Treatment was rendered at the scene by emergency medical technicians (EMT's). The front occupants of the Ford Escort were transported to a local hospital for treatment and released. The driver and front right passenger of the Cadillac Deville were uninjured in the collision. The Ford Escort and Hyundai Accent were towed from the scene. The Cadillac Deville and Dodge Ram were driven 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. *Second Generation Air Bag* labels were affixed to each front window glazing (**Figure 2**). The vehicle's odometer reading was 2,343 km (1,456 miles) at the time of the crash. The police report listed the driver as the owner of the vehicle. The seating was configured with front bucket seats and a folding (back) rear bench. 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.



Figure 2. Air bag identification label.

VEHICLE DAMAGE

Exterior Damage

The Ford Escort sustained moderate frontal damage as a result of the impact with the Cadillac Deville (**Figure 3**). The direct contact damage began at the front left bumper corner and extended 12.0 cm (4.7 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 132.0 cm (52.0 in). Six (*revised*) crush measurements were documented at the level of the bumper: C1= 23.0 cm (9.1 in), C2= 2.0 cm (0.8 in), C3= 1.0 cm (0.4 in), C4= 0 cm, C5= 0 cm, C6= 0 cm.



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

Damage was noted to the hood which was displaced up and rearward from engagement against the side surface of the Cadillac.

Direct contact damage was noted to the left fender from sustained contact between the vehicles during spinout. Direct damage was also noted to the left quarter panel from the secondary (sideslap) impact. The direct contact damage began 18.8 cm (7.4 in) forward of the left rear bumper corner and extended 10.0 cm (3.9 in) forward. The impact resulted in a combined direct and induced damage length (Field L) of 47.0 cm (18.5 in). Six crush measurements were documented at the level of the sill: C1= 3.0 cm (1.2 in), C2= 5.0 cm (2.0 in), C3= 10.0 cm (3.9 in), C4= 7.0 cm (2.8 in), C5= 5.0 cm (2.0 in), C6= 1.0 cm (0.4 in). Induced buckling was noted to the left rear door panel. The windshield was fractured from exterior forces and the (interior) front right passenger air bag module cover flap. No wheels were restricted or flat.

Interior Damage

Interior damage to the Ford Escort identified through the NASS vehicle inspection was minimal and was attributed to occupant contact. A smudge mark was documented to the left front door glazing. Blood spattering was identified to the lower left quadrant of the driver redesigned air bag. A lipstick transfer was documented to the upper left quadrant of the passenger redesigned air bag. The windshield was fractured from the front right passenger air bag module cover flap. Scuff marks were noted to the glove compartment door and the rear aspect of the front right head restraint. No intrusion of interior components were found in the vehicle. No steering wheel rim deformation was noted (fixed column). No deformation was documented to the left knee bolster (rigid plastic type) or front seat backs from rear occupant loading.

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. The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). The upper flap measured 21.0 cm (8.3 in) in width and 8.0 cm (3.1 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 identified at the lower left quadrant of the air bag. The NASS researcher measured the diameter of the driver air bag at 56.0 cm (22.0 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.



Figure 4. 1998 Ford Escort LX redesigned driver air bag.



Figure 5. 1998 Ford Escort LX redesigned passenger 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 opened in an upward direction toward the windshield (windshield fractured). The cover flap was rectangular in shape and measured 31.0 cm (12.2 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, a lipstick transfer was documented to the upper left quadrant of the air bag. The NASS researcher measured the passenger air bag at 44.0 cm (17.3 in) in width and 72.0 cm (28.3 in) in height in its deflated state (**Figure 5**). No tether straps were present. The bag was vented by two ports located below 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 air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	19 year old female
Height:	152 cm (60 in)
Weight:	47 kg (104 lb)
Seat Track Position:	Mid-to-forward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, passenger interview
Eyeware:	None
Type of Medical Treatment:	Transported to a local hospital and released

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
Cervical strain	Minor (640278.1,6)	Non-contact injury
Abrasion face	Minor (290202.1,8)	Front left air bag
Laceration upper lip	Minor (290600.1,8)	Front left air bag (split/self inflicted?)

Driver Kinematics

The petite 19 year old female driver of the Ford Escort was seated in an upright posture with the seat back slightly reclined and the seat track adjusted to the mid-to-forward position. She was properly restrained by the 3-point manual lap and shoulder belt system with the anchorage adjustment placed to the full down position. At impact, she initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual belt and deployed redesigned driver air bag resulting in a cervical strain and abrasion to the face. She also sustained a minor (vertical) laceration to the upper lip which was probably self-inflicted or split from the air bag, evidenced by the blood transfer documented to the lower left quadrant of the air bag (**Figure 6**). In addition, the air bag provided additional restraint from further contact to the steering wheel hub/rim. The driver was transported to a local hospital for treatment and released.



Figure 6. Blood transfers to the driver air bag.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex:	45 year old female
Height:	160 cm (63 in)
Weight:	76 kg (168 lb)
Seat Track Position:	Mid-to-forward position
Manual Restraint Usage:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, passenger interview
Eyewear:	None
Type of Medical Treatment:	Transported to a local hospital and released

Front Right Passenger Injuries

<i>Injury</i>	<i>Severity</i>	<i>Injury Mechanism</i>
Closed head injury, unspecified (with dizziness or blurred vision reported)	Minor (160402.1,0)	Unknown
Cervical strain	Minor (640278.1,6)	Non-contact injury
Abrasion face	Minor (290202.1,9)	Front right air bag
Mouth injury (not further specified)	Minor (243099.1,8)	Front right air bag (split/self inflicted?)
Abrasion right shoulder	Minor (790202.1,1)	Restraint webbing
Contusion right shoulder	Minor (790402.1,1)	Restraint webbing
Contusion left pelvis	Minor (850602.1,2)	Restraint webbing/buckle
Abrasion left lower extremity (distal to knee)	Minor (890202.1,2)	Glove compartment door
Contusion bilateral lower extremities (distal to knee)	Minor (890402.1,3)	Glove compartment door

Front Right Passenger Kinematics

The 45 year old female passenger was seated in the front right position of the Ford Escort. She was properly restrained by the 3-point manual lap and shoulder belt system (anchorage adjustment placed to the full down position), seated in an upright posture with the seat back slightly reclined and the seat track adjusted to the mid-to-forward position. At impact, she initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint resulting in contusions/abrasions to the right shoulder and left pelvis. Contact to the redesigned passenger air bag resulted in an abrasion to the face as evidenced by the lipstick transfer to the upper left quadrant of the air bag (**Figure 7**). Although no significant trauma

to the head/face was sustained by the passenger, she complained of dizziness and blurred vision for a short period of time following the collision (unspecified closed head injury). The cervical strain was probably a result of the sudden forward head movement as the body loaded the belt system. Her lower extremities contacted the glove compartment door resulting in an abrasion to the left leg and bilateral contusions (distal to the knee) as evidenced by the scuff marks documented to this component. The front right passenger was transported to a local hospital for treatment and released.

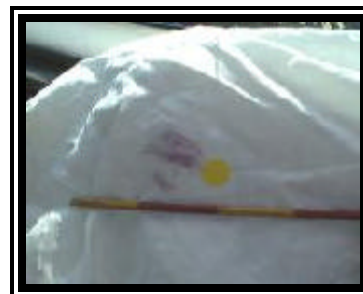


Figure 7. Lipstick transfers to the passenger air bag.

REAR OCCUPANT DEMOGRAPHICS

The 2 year old female passenger was seated in the rear left position in a (unspecified make/model) child safety seat used in conjunction with the available 3-point lap and shoulder belt system. The police report noted that the passenger was belted, further evidenced by the lack of substantial interior contacts and injury. At impact, she initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint. The passenger was not injured in the collision nor transported to a local hospital for evaluation.

The 1 year old female passenger was seated in the rear center position in a (unspecified make/model) child safety seat used in conjunction with the available 2-point lap belt system. The police report noted that the passenger was belted, further evidenced by the lack of substantial interior contacts and injury. At impact, she initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint. The passenger was not injured in the collision nor transported to a local hospital for evaluation.

The 18 year old female was seated in the rear right position in an upright posture and properly restrained by the 3-point manual lap and shoulder belt system. The police report noted that the passenger was belted, further evidenced by the lack of interior contacts and injury. At impact, she initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint. Her hand probably contacted the rear aspect of the front right head restraint as evidenced by the scuff mark documented to this component, but no injury was reported as a result. The passenger was not transported to a local hospital for treatment.

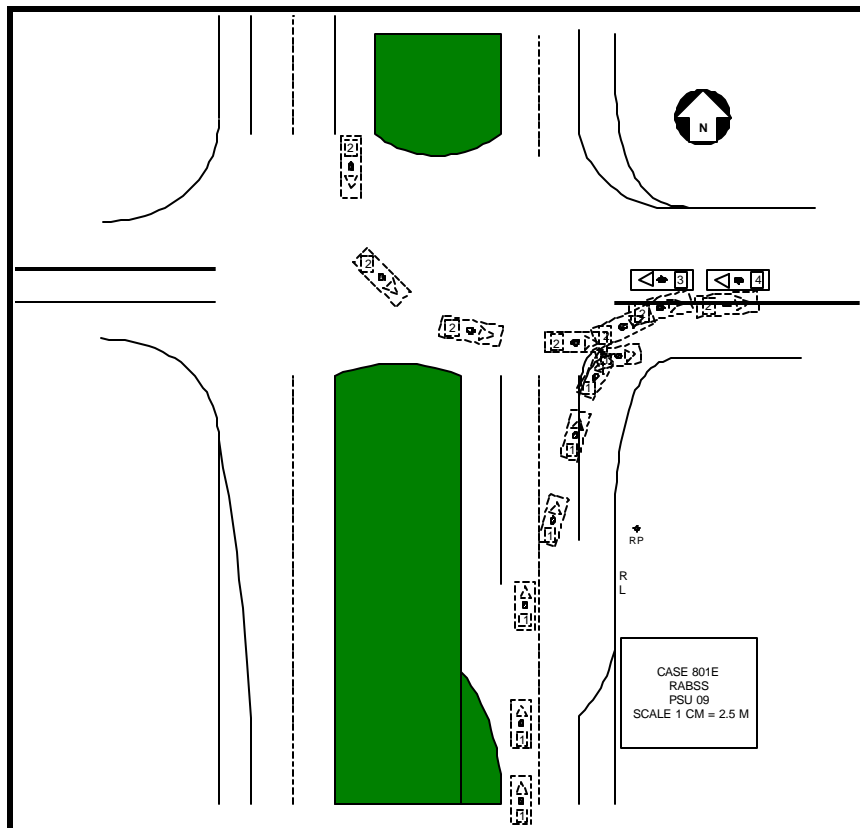


Figure 8. NASS Scene Diagram