TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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

NASS RABSS CASE NO. 1998-11-807G

RABSS VEHICLE - 1998 FORD ESCORT SE

LOCATION - STATE OF MICHIGAN

CRASH DATE - AUGUST, 1998

Contract No. DTNH22-94-D-07058

Prepared for:

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National Highway Traffic Safety Administration
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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 two vehicle crash involving a 1998 Ford Escort SE 4-door sedan (subject vehicle) and a 1993 Chevrolet C-1500 extended cab pickup truck. The Ford Escort was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of a head-on collision with the Chevrolet pickup. The Ford was southbound on a 2-lane rural roadway when the driver observed a small animal in the roadway. The Ford driver steered left/braked in avoidance as the vehicle subsequently entered the northbound lane into the path of the Chevrolet. As the Ford Escort entered the northbound lane, the front right area impacted the front right area of the Chevrolet pickup truck resulting in moderate damage to both vehicles. The restrained 29 year old male driver of the Ford Escort initiated a forward trajectory in response to the 12 o'clock impact force as the expanding air bag contacted the anterior aspect of his right forearm resulting in an abrasion. Loading of the manual restraint resulted in a contusion to the right lower chest. The driver of the Ford Escort sought treatment later at a medical facility.			
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BACKGROUND

This investigation focused on a two vehicle crash involving a 1998 Ford Escort SE 4-door sedan (subject vehicle) and a 1993 Chevrolet C-1500 extended cab pickup truck. The Ford Escort was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of a head-on collision with the Chevrolet pickup. The Ford was southbound on a 2-lane rural roadway when the driver observed a small animal in the roadway. The Ford driver steered left/braked in avoidance as the vehicle subsequently entered the northbound lane into the path of the Chevrolet. As the Ford Escort entered the northbound lane, the front right area impacted the front right area of the Chevrolet pickup truck resulting in moderate damage to both vehicles. The restrained 29 year old male driver of the Ford Escort initiated a forward trajectory in response to the 12 o'clock impact force as the expanding air bag contacted the anterior aspect of his right forearm resulting in an abrasion. Loading of the manual restraint resulted in a contusion to the right lower chest. The driver of the Ford Escort sought treatment later at a medical facility.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-11-807G 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 two vehicle crash occurred during the afternoon hours of August, 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 lane of a 2-lane (level/asphalt) rural roadway **(see Figure 6 - page 5)** which curved right for southbound traffic. No traffic control was present at the scene which had a posted speed limit of 80 km/h (50 mph).

Pre-Crash

The 29 year old male driver of the 1998 Ford Escort SE was operating the vehicle southbound **(Figure 1)** at a (driver reported) speed of 64 km/h (40 mph) when he observed a cat enter the roadway from the west. The Ford driver initially steered left/braked in avoidance of the animal and entered the northbound lane. He subsequently steered right/braked in avoidance of the northbound Chevrolet. The 75 year old male driver of the 1993 Chevrolet C-1500 pickup truck was operating the vehicle northbound **(Figure 2)** and negotiating a left curve when he observed the southbound Ford cross his path of travel. The NASS researcher reported no brake marks at the scene indicative of driver avoidance maneuvers.

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

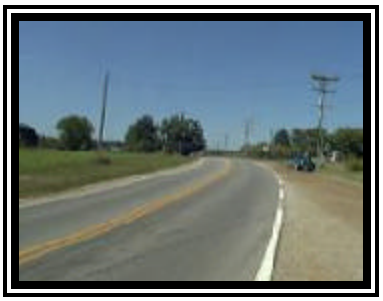

Figure 2. Northbound approach for the 1993 Chevrolet C-1500 pickup truck.

Crash

As the Ford Escort entered the northbound lane of the two lane rural roadway, the front right area impacted the front right area of the Chevrolet in an offset head-on configuration resulting in moderate damage to both vehicles. Modifications to the WinSMASH program were made at the SCI level resulting in improved velocity changes of 28.9 km/h (18.0 mph) for the subject vehicle and 18.4 km/h (11.4 mph) for the struck Chevrolet. Respective longitudinal components were -27.1 km/h (-16.8 mph) and -15.9 km/h (-9.9 mph). The impact induced deceleration was sufficient to deploy the Ford's redesigned frontal air bag system. At this point, both vehicles rotated clockwise as the Ford Escort came to rest on the east shoulder facing northwest while the Chevrolet came to rest perpendicular to the center divider line facing northeast.

Post-Crash

The driver of the Ford Escort exited the vehicle under his own power. The exit status of the Chevrolet driver was unknown. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMTs), however, neither driver was transported directly from the scene to a local hospital for treatment. The Ford driver sought treatment later at a medical facility. Both vehicles were towed from the scene due to disabling damage.

RABSS VEHICLE

The 1998 Ford Escort SE was identified by the Vehicle Identification Number (VIN): 1FAFP13P6WW (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 25,259 km (15,696 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 bench seats (with folding backs). The vehicle was used for driving instruction with post-manufacturer additions (brake/gas pedal) to the front right floor area. 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

Figure 3. Front right damage to the 1998 Ford Escort SE (image washed out).

The 1998 Ford Escort SE sustained moderate frontal damage as a result of the impact with the Chevrolet pickup **(Figure 3)**. The direct contact damage began at the front right bumper corner and extended 90.0 cm (35.4 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 125.0 cm (49.2 in). Six crush measurements were documented at the level of the reinforcement bar *(bumper fascia separation)*: C1= 0 cm, C2= 11.0 cm (4.3 in), C3= 24.0 cm (9.4 in), C4= 38.0 cm (15.0 in), C5= 40.0 cm (15.7 in), C6= 45.0 cm (17.7 in). The Collision Deformation Classification (CDC) for this impact to the Ford was 01-FDEW-2 with a principal direction of force of (+)20 degrees. The grille and right headlight assembly fractured and separated from the vehicle during the collision sequence. The right fender was displaced rearward which restricted/deflated the right front wheel/tire. The hood was displaced up and rearward from the impact force. Induced buckling was noted to the roof area at the right B-pillar. Reduction in the right side wheelbase measured 7.0 cm (2.8 in). The windshield was fractured from (exterior) impact forces and the (interior) front right air bag module cover flap .

Figure 4. Front right damage to the 1993 Chevrolet C-1500 pickup truck.

The 1993 Chevrolet C-1500 pickup truck sustained moderate frontal damage as a result of the impact with the Ford Escort **(Figure 4)**. The direct contact damage began at the front right bumper corner and extended 52.0 cm (20.5 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 128.0 cm (50.4 in). The CDC for this impact to the Chevrolet was 01-FREW-4 with a principal direction of force of (+)30 degrees. The hood was deformed up and rearward from the impact force. The right fender was deformed rearward which restricted/deflated the right front wheel/tire. Induced buckling was noted to the roof area at the right B-pillar along with outward bowing of the right door frame. Reduction in the right side wheelbase measured 34.0 cm (13.4 in).

Interior Damage

There was no damage to the interior surfaces of the Ford Escort from occupant contact. A longitudinal toepan intrusion of 5.0 cm (2.0 in) was documented to the driver space.

REDESIGNED AIR BAG SYSTEM

The 1998 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). 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 20.0 cm (7.9 in) in width and 7.0 cm (2.8 in) in height while the lower flap measured 20.0 cm (7.9 in) in width and 10.0 cm (3.9 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 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.

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

The front right passenger air bag deployed from the right top instrument panel area with a single cover flap design hinged at the forward aspect ***(no photo available)***. 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 31.0 cm (12.2 in) in width and 13.0 cm (5.1 in) in height. The NASS researcher measured the passenger air bag at 40.0 cm (15.7 in) in width and 60.0 cm (23.6 in) in height in its deflated state. No internal tether straps were present. The bag was vented by two ports located at the 9 o'clock and 3 o'clock sectors on the side aspect of the air bag. No cutoff switch was found for the front right air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	29 year old male
Height:	175 cm (69 in)
Weight:	86 kg (190 lb)
Seat Track Position:	Full rearward 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:	Treatment later at a medical facility

Driver Injuries

Injury	***Severity (AIS 90)***	***Injury Mechanism***
Abrasion right anterior forearm	Minor (790202.1,1)	Expanding front left air bag
Contusion right lower chest	Minor (490402.1,1)	Shoulder belt webbing
Left ankle strain	Minor (850206.1,2)	Left toepan
Left foot strain	Minor (850404.1,2)	Left toepan
Contusion bottom of right foot	Minor (890402.1,1)	Brake pedal/toepan

Driver Kinematics

The 29 year old male driver of the 1998 Ford Escort SE 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 full rearward position. His hands were placed at the 9 o'clock and 3 o'clock sectors on the steering wheel rim. Belt usage was confirmed by the lack of significant interior contacts and injury. At impact, the driver initiated a forward trajectory in response to the 1 o'clock impact force as the expanding air bag contacted the anterior aspect of his right forearm resulting in an abrasion. Loading of the manual restraint resulted in a contusion to the right lower chest. He also sustained a left ankle/foot strain from contact to the (intruded) toepan along with a contusion to the bottom of the right foot from loading to the brake pedal. This contact sequence was evidenced by the location of the injury relative to the driver's placement of the right foot on the brake pedal during pre-crash avoidance maneuvers. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential serious injury. The driver sought treatment later at a medical facility.

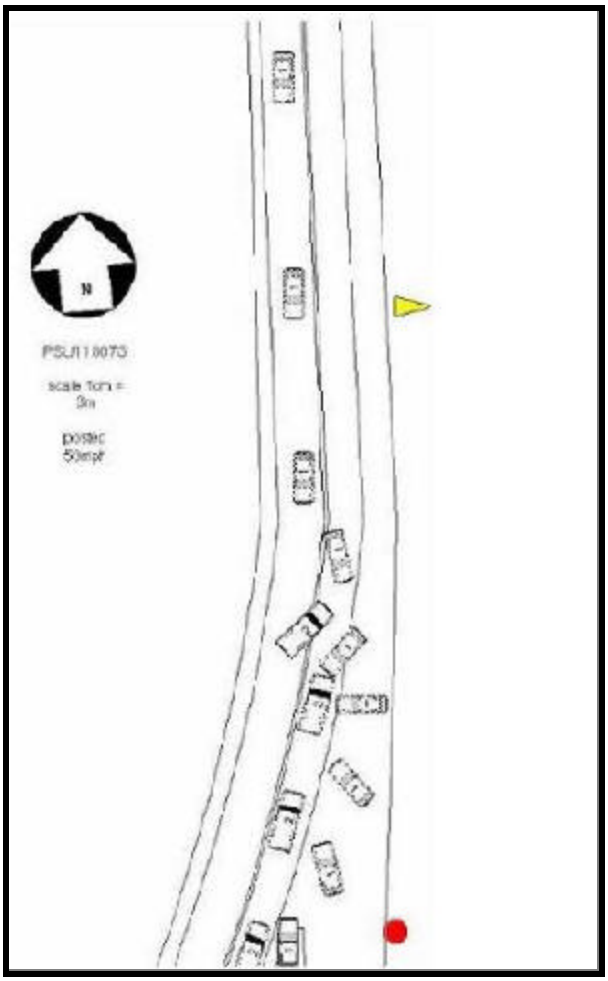

Figure 6. NASS Scene Diagram (physical plant and impact configuration plotted incorrectly by researcher).