TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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

NASS CDS CASE NO. 1998-12-182K

RABSS VEHICLE - 1998 FORD ESCORT LX

LOCATION - STATE OF MICHIGAN

CRASH DATE - SEPTEMBER, 1998

Contract No. DTNH22-94-D-07058

Prepared for:

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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 LX 4-door sedan (subject vehicle) and a 1989 Buick Park Avenue 4-door sedan. 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 the Buick Park Avenue. The driver of the Ford was operating the vehicle eastbound when she failed to observe the westbound Buick as she turned left (north) at a 4-leg intersection. As the Ford crossed the westbound lanes, the front right area impacted the front left area of the Buick resulting in moderate damage to both vehicles. The restrained 16 year old female driver of the Ford Escort initiated a forward trajectory in response to the 1 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in contusions to the left shoulder and chest. She also sustained a cervical strain from the sudden forward head movement as the body loaded the belt system (flexion). The restrained 17 year old male front right passenger initiated a forward trajectory in response to the 1 o'clock impact force and loaded the manual restraint and deployed redesigned passenger air bag. Contact to the deployed air bag resulted in an abrasion to the left cheek. The rear left/right seating positions were occupied by unrestrained 18 and 14 year old males (respectively) who sustained multiple soft tissue injuries to the head/face from contact to the front seat backs. The driver and rear seated occupants of the Ford Escort were transported by ambulance to the emergency room of a local trauma center for treatment and released.			
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BACKGROUND

This investigation focused on a two vehicle crash involving a 1998 Ford Escort LX 4-door sedan (subject vehicle) and a 1989 Buick Park Avenue 4-door sedan. 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 the Buick Park Avenue. The driver of the Ford was operating the vehicle eastbound when she failed to observe the westbound Buick as she turned left (north) at a 4-leg intersection. As the Ford crossed the westbound lanes, the front right area impacted the front left area of the Buick resulting in moderate damage to both vehicles. The restrained 16 year old female driver of the Ford Escort initiated a forward trajectory in response to the 1 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in contusions to the left shoulder and chest. She also sustained a cervical strain from the sudden forward head movement as the body loaded the belt system (flexion). The restrained 17 year old male front right passenger initiated a forward trajectory in response to the 1 o'clock impact force and loaded the manual restraint and deployed redesigned passenger air bag. Contact to the deployed air bag resulted in an abrasion to the left cheek. The rear left/right seating positions were occupied by unrestrained 18 and 14 year old males (respectively) who sustained multiple soft tissue injuries to the head/face from contact to the front seat backs. The driver and rear seated occupants of the Ford Escort were transported by ambulance to the emergency room of a local trauma center for treatment and released.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 98-12-182K and also included in 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 late evening hours of September, 1998. At the time of the crash, it was dark (street lighted) with no adverse conditions as the roads were dry. The crash occurred in the westbound lanes of a five lane (straight/asphalt) 4-leg intersection **(see Figure 7 - page 6)**. Traffic flow through the intersection was controlled by an overhead signal system. The posted speed limit at the crash site was 72 km/h (45 mph).

Pre-Crash

The 16 year old female driver of the 1998 Ford Escort was operating the vehicle eastbound **(Figure 1)** on approach to an urban 4-leg intersection when she attempted to turn left (north) at a (driver reported) speed of 24 km/h (15 mph). The 70 year old male driver of the 1989 Buick Park Avenue was operating the vehicle westbound **(Figure 2)** in the center travel lane at a (passenger reported) speed of 64 km/h (40 mph) when he

observed the eastbound Ford cross his path of travel. Upon recognition of the impending harmful event, he braked in avoidance remaining in the (center) westbound lane prior to the collision. The front right passenger seating position of the Buick was occupied by a 68 year old female.

Figure 1. Eastbound approach trajectory for the 1998 Ford Escort LX.

Figure 2. Westbound approach trajectory for the 1989 Buick Park Avenue (wrong lane photographed by the NASS researcher).

Crash

As the Ford Escort crossed the westbound lanes of the 4-leg intersection, the front right area impacted the front left area of the Buick resulting in moderate damage to both vehicles. The *(SCI revised)* damage algorithm of the WinSMASH program computed velocity changes of 21.7 km/h (13.5 mph) for the subject vehicle and 18.0 km/h (11.2 mph) for the struck Buick. Respective longitudinal components were -20.4 km/h (-12.7 mph) and -17.7 km/h (-11.0 mph). The impact induced deceleration was sufficient to deploy the Ford's redesigned frontal air bag system. Both vehicles came to rest in the northwest sector of the intersection facing northwest.

Post-Crash

The occupants of the Ford Escort exited the vehicle under their own power. The driver of the Buick Park Avenue exited the vehicle with some assistance from rescue personnel as the front right passenger was removed from the vehicle with perceived serious injuries. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMTs). The driver and rear seated occupants of the Ford were transported by ambulance to the emergency room of a local trauma center for treatment and released. The driver and passenger of the Buick were transported by ambulance to the emergency room of a local trauma center for treatment and admitted for one and two days, respectively. Both vehicles were towed from the scene due to disabling damage.

RABSS VEHICLE

The 1998 Ford Escort LX was manufactured on 3/98 and identified by the Vehicle Identification Number (VIN): 1FAFP10P2WW (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 19,681 km (12,230 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 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

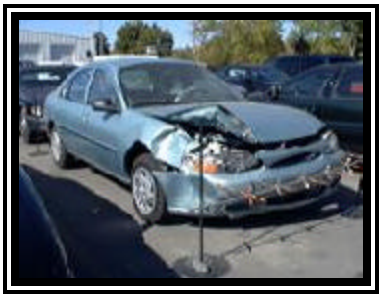

Figure 3. Front right damage to the 1998 Ford Escort LX.

The 1998 Ford Escort LX sustained moderate frontal damage as a result of the impact with the Buick Park Avenue **(Figure 3)**. *Although coded as a full frontal impact in the NASS case file*, the *(SCI revised)* direct contact damage began at the front right bumper corner and extended 32.0 cm (12.6 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 crush measurements were documented at the level of the bumper: C1= 0 cm, C2= 0 cm, C3= 0 cm, C4= 2.0 cm (0.8 in), C5= 6.0 cm (2.4 in), C6= 10.0 cm (3.9 in). The Collision Deformation Classification (CDC) for this impact to the Ford was 01-FREE-2 with a principal direction of force of (+)20 degrees. The right hood area was deformed with direct contact damage noted to the right fender from sustained contact between the vehicle during spinout. The windshield was fractured from exterior impact forces and the (interior) front right passenger air bag.

Figure 4. Front left damage to the 1989 Buick Park Avenue.

The 1989 Buick Park Avenue sustained moderate frontal damage as a result of the impact with the Ford Escort **(Figure 4)**. The *(SCI revised)* direct contact damage began at the front left bumper corner and extended 60.0 cm (23.6 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 150.0 cm (59.1 in). The CDC for this impact to the Buick was 12-FYEW-2 with a principal direction of force of (-)10 degrees. The left fender was deformed rearward which restricted the left front wheel/tire (not deflated). Minor displacement of the hood was also noted. Reduction in the left side wheelbase measured 5.0 cm (2.0 in).

Interior Damage

Damage to the interior surfaces of the Ford Escort were minimal and attributed to occupant contact. Scuff marks were documented on the left knee bolster (rigid plastic type) and rear right headliner. Scratch marks were identified on the left front door surface and rear left headliner. A longitudinal toepan intrusion of 7.0 cm (2.8 in) was documented to the front right passenger space.

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 flaps were asymmetrical in shape as the upper flap measured 22.0 cm (8.7 in) in width and 6.0 cm (2.4 in) in height while the lower flap measured 22.0 cm (8.7 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, red nail polish was documented to the upper left quadrant of the air bag. The NASS researcher measured the diameter of the driver air bag at

40.0 cm (15.7 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.

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 exterior surface of the module cover flap. The cover flap was rectangular in shape and measured 32.0 cm (12.6 in) in width and 25.0 cm (9.8 in) in height. A small scuff mark was documented to the upper right quadrant of the air bag. The NASS researcher measured the passenger air bag at 40.0 cm (15.7 in) in width and 80.0 cm (31.5 in) in height in its deflated state **(Figure 6)**. The bag was tethered by two internal tether straps and 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 documented for the front right passenger air bag.

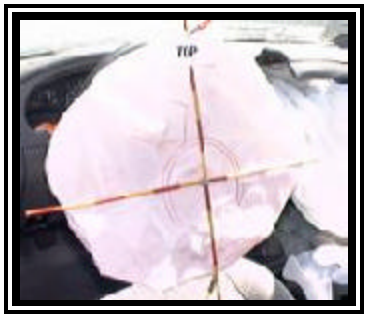

Figure 5. 1998 Ford Escort LX redesigned driver air bag.

Figure 6. 1998 Ford Escort LX redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	16 year old female
Height:	178 cm (70 in)
Weight:	64 kg (140 lb)
Seat Track Position:	Mid-to-rear position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, passenger interview, police report
Eyeware:	Contact lenses
Type of Medical Treatment:	Transported to the emergency room of a local trauma center and released

Driver Injuries

Injury	***Severity (AIS 90)***	***Injury Mechanism***
Mild closed head injury (loss of consciousness-length unknown)	Minor (160406.2,0)	Front left air bag (?)
Acute cervical spine strain	Minor (640278.1,6)	Non-contact injury (flexion)
Contusion left shoulder	Minor (790402.1,2)	Shoulder belt webbing
Abrasion left chest	Minor (490202.1,2)	Shoulder belt webbing

Driver Kinematics

The 16 year old female driver of the 1998 Ford Escort LX was 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. Her left hand was placed on the steering wheel rim as the right hand was placed on the (floor mounted) transmission gearshift. 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 and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in contusions to the left shoulder and chest. The belt system restrained her body as the head flexed forward resulting in the cervical strain. Although no head trauma was sustained, she reported a temporary loss of consciousness which was sourced to the driver air bag in the NASS case file. The loss of consciousness probably resulted from the flexion of the head which resulted in a rapid acceleration of the brain. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential serious injury. The driver was transported by ambulance to the emergency room of a local trauma center for treatment and released.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex:	17 year old male
Height:	180 cm (71 in)
Weight:	68 kg (150 lb)
Seat Track Position:	Mid-to-rear position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, passenger interview, police report
Eyeware:	None
Type of Medical Treatment:	None

Front Right Passenger Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Abrasion left cheek	Minor (290202.1,2)	Front right air bag

Front Right Passenger Kinematics

The 17 year old male front right passenger of the 1998 Ford Escort LX 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. Belt usage was confirmed by the lack of significant interior contacts and injury. At impact, the passenger initiated a forward trajectory in response to the 1 o'clock impact force and loaded the manual restraint and deployed redesigned passenger air bag. Contact to the deployed air bag resulted in an abrasion to the left cheek as evidenced by the scuff mark documented to the upper right quadrant of the air bag face. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential serious injury. The front right passenger was not transported to a local hospital for treatment.

REAR OCCUPANT DEMOGRAPHICS / INJURIES

The rear left seating position was occupied by an unrestrained 18 year old male who initiated a forward trajectory in response to the 1 o'clock impact force and loaded the front left seat back with no resulting injury reported. During the vehicle's post-impact rotational trajectory to final rest, he struck the rear right occupant which resulted in a contusion to the right scalp. He rebounded to the left and struck the clothes hook resulting in a small (2 in) laceration to the left temporal area. The passenger was transported by ambulance to the emergency room of a local trauma center for treatment and released.

The rear right seating position was occupied by an unrestrained 14 year old male who initiated a forward trajectory in response to the 1 o'clock impact force and loaded the front right seat back resulting in multiple soft tissue injuries to the forehead and right eyelid. He rebounded into the rear left occupant which resulted in a contusion to the left scalp (and mild closed head injury). The passenger was also transported by ambulance to the emergency room of a local trauma center for treatment and released.

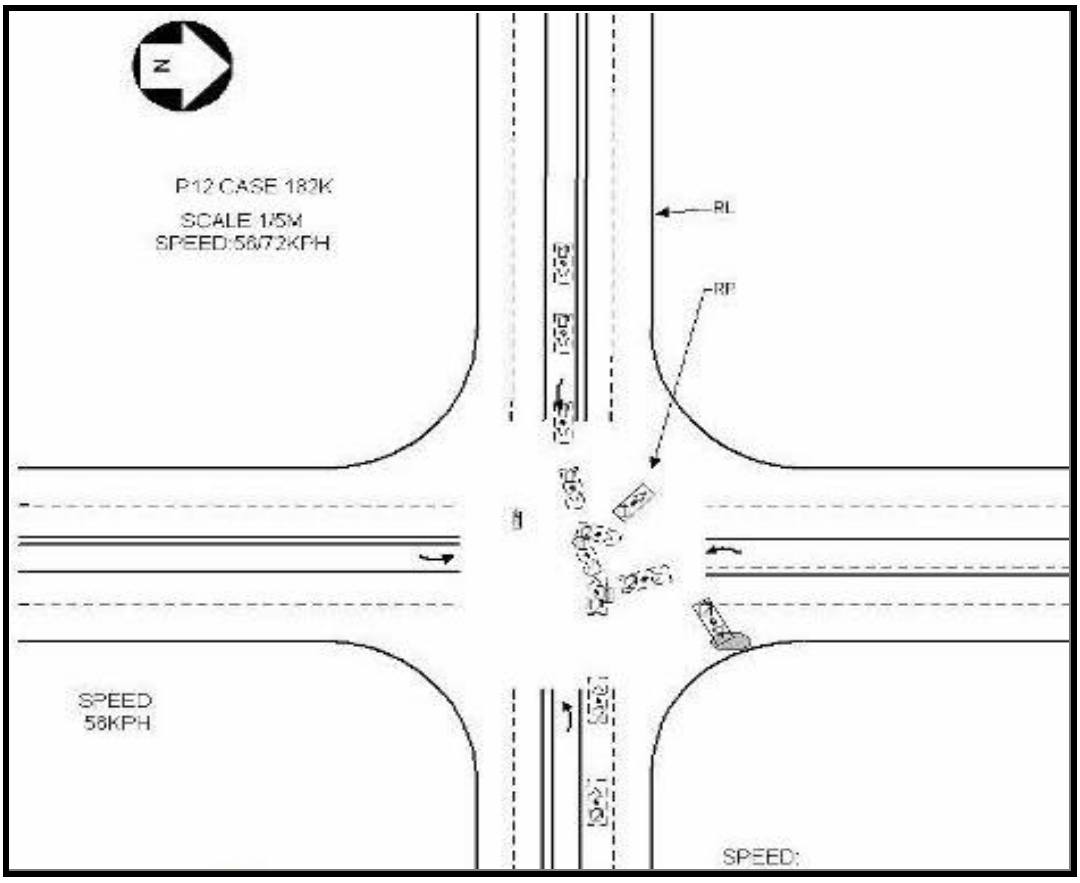

Figure 7. NASS Scene Diagram.