TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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

NASS RABSS CASE NO. 1998-06-803E

RABSS VEHICLE - 1998 FORD WINDSTAR

LOCATION - STATE OF PENNSYLVANIA

CRASH DATE - OCTOBER, 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. *Abstract* This investigation focused on a two vehicle crash involving a 1998 Ford Windstar minivan (subject vehicle) and a 1988 Oldsmobile Delta 88 Royale 4-door sedan. The Ford Windstar was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of an oblique angle collision with the Oldsmobile Delta 88. The driver of the Oldsmobile was operating the vehicle northbound when he failed to observe the red traffic signal or eastbound Ford as he proceeded straight through an urban 6-leg intersection. As the Oldsmobile entered the intersection, the left front side surface was struck by the frontal area of the Ford resulting in moderate damage to both vehicles. The restrained 50 year old male driver of the Ford Windstar 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 central chest and abdominal areas with no other injury reported. He was transported by police vehicle 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 Windstar minivan (subject vehicle) and a 1988 Oldsmobile Delta 88 Royale 4-door sedan. The Ford Windstar was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of an oblique angle collision with the Oldsmobile Delta 88. The driver of the Oldsmobile was operating the vehicle northbound when he failed to observe the red traffic signal or eastbound Ford as he proceeded straight through an urban 6-leg intersection. As the Oldsmobile entered the intersection, the left front side surface was struck by the frontal area of the Ford resulting in moderate damage to both vehicles. The restrained 50 year old male driver of the Ford Windstar 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 central chest and abdominal areas with no other injury reported. He was transported by police vehicle 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 case number 98-06-803E 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 early morning hours of October, 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 straight and level 6-leg asphalt intersection **(see Figure 7 - page 5)**. Traffic flow through the 2-lane urban intersection was controlled by an overhead signal system in green phase for eastbound traffic. The posted speed limit at the crash site was 40 km/h (25 mph).

Pre-Crash

The 54 year old male driver of the 1988 Oldsmobile Delta 88 was operating the vehicle northbound **(Figure 1)** when he failed to observe the red traffic signal or eastbound Ford as he proceeded straight through the 6-leg intersection. The 50 year old male driver of the 1998 Ford Windstar was operating the vehicle eastbound **(Figure 2)** at a (driver reported) speed of 48 km/h (30 mph) when he entered the intersection and observed the northbound Oldsmobile cross his path of travel. The Ford driver reported no avoidance maneuvers in anticipation of the impending crash.

Figure 1. Northbound approach for the 1988 Oldsmobile Delta 88 Royale.

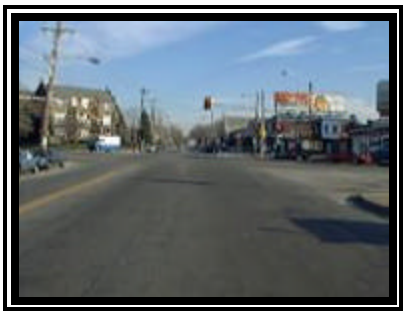

Figure 2. Eastbound approach for the 1998 Ford Windstar.

Crash

As the Oldsmobile entered the urban intersection, the left front side surface was struck by the frontal area of the Ford resulting in moderate damage to both vehicles. The *(SCI revised)* damage algorithm of the WinSMASH program computed velocity changes of 18.2 km/h (11.3 mph) for the subject vehicle and 21.6 km/h (13.4 mph) for the struck Oldsmobile. Respective longitudinal components were -15.7 km/h (-9.8 mph) and -7.4 km/h (-4.6 mph). The impact induced deceleration was sufficient to deploy the Ford's redesigned frontal air bag system. At this point, the Oldsmobile rotated clockwise as the left rear side surface impacted (sideslapped) the right passenger area of the Ford which resulted in minor damage to both vehicles. The *(SCI revised)* damage algorithm of the WinSMASH program computed velocity changes of 5.6 km/h (3.5 mph) for the subject vehicle and 6.7 km/h (4.2 mph) for the striking Oldsmobile. Respective latitudinal components were -5.6 km/h (-3.5 mph) and 6.7 km/h (4.2 mph). Both vehicles came to rest in the northeast sector of the intersection facing northeast.

Post-Crash

The driver of the Ford Windstar exited the vehicle under his own power. The exit status of the Oldsmobile driver was unknown. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMTs). The Ford driver was transported by police vehicle as the Oldsmobile driver was transported by rescue vehicle to the emergency room of a local trauma center for treatment and released. Both vehicles were towed from the scene due to disabling damage.

RABSS VEHICLE

The 1998 Ford Windstar was identified by the Vehicle Identification Number (VIN): 2FMZA5149WB (production sequence deleted). The vehicle was a 4-door minivan equipped with front wheel drive and a 3.8 liter, V-6 engine. The vehicle's odometer reading was 2,797 km (1,738 miles) at the time of the crash. The police listed the driver as the owner of the vehicle. The seating was configured with front box-mounted (i.e., van type) bucket seats and (2^{nd}/3^{rd} row) 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 and right side surface damage to the 1998 Ford Windstar.

The 1998 Ford Windstar sustained moderate frontal damage as a result of the initial impact with the Oldsmobile Delta 88 **(Figure 3)**. The direct contact damage began at the front right bumper corner and extended 120.0 cm (47.2 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 158.0 cm (62.2 in). Six crush measurements were documented at the level of the reinforcement bar *(partial bumper fascia separation)*: C1= 4.0 cm (1.6 in), C2= 12.0 cm (4.7 in), C3= 18.0 cm (7.1 in), C4= 22.0 cm (8.7 in), C5= 24.0 cm (9.4 in), C6= 25.0 cm (9.8 in). The *(SCI revised)* Collision Deformation Classification (CDC) for this impact to the Ford was 81-FDEW-2 with a principal direction of force of (+)30 degrees (principal direction of force incremented to reflect shifting of end structure to the left). The grille and headlight assemblies fractured and separated from the vehicle during the collision sequence. The fenders were displaced rearward and to the left which restricted the right front wheel/tire (not deflated). The hood was deformed up and rearward from engagement against the side surface of the Oldsmobile. Reduction in the left side wheelbase measured 6.0 cm (2.4 in). The right side wheelbase was elongated 3.0 cm (1.2 in). All glazing remained undamaged.

Direct contact damage was also documented to the right passenger area attributed to the secondary (sideslap) impact. The damage pattern was concentrated mainly at the right rear door area with slight outward bowing of the upper window frame noted. This direct (and induced) contact damage began 132.0 cm (52.0 in) forward of the rear right bumper corner and extended 118.0 cm (46.5 in) forward. Six crush measurements were documented at the level of the mid-door: C1= 1.0 cm (0.4 in), C2= 10.0 cm (3.9 in), C3= 12.0 cm (4.7 in), C4= 9.0 cm (3.5 in), C5= 6.0 cm (2.4 in), C6= 1.0 cm (0.4 in). The *(SCI revised)* CDC for this second and final impact to the Ford was 03-RPEW-2 with a principal direction of force of (+)90 degrees.

Figure 4. Left side surface damage to the 1988 Oldsmobile Delta 88 Royale.

The 1988 Oldsmobile Delta 88 Royale 4-door sedan sustained moderate left front side surface damage as a result of the initial impact with the Ford Windstar **(Figure 4)**. The direct contact damage began at the front left bumper corner and extended 142.0 cm (55.9 in) rearward. The combined direct and induced damage length (Field L) began at the front left bumper corner and extended 145.0 cm (57.1 in) rearward. A maximum crush value of 29.0 cm (11.4 in) was documented just forward of the front axle. The *(SCI revised)* CDC for this initial impact to the Oldsmobile was 10-LYEW-3 with a principal direction of force of (-)70 degrees. The left fender was deformed laterally to the right which restricted/deflated the left front wheel/tire. All glazing remained undamaged.

Additional direct contact damage was documented to the left rear side surface attributed to the secondary (sideslap) impact. This *(SCI revised)* damage pattern began at the rear left bumper corner and extended 92.0 cm (36.2 in) forward. Although no crush measurements were obtained by the NASS researcher, the damage was concentrated mainly above the level of the frame and was minor in nature. The CDC for this second and final impact to the Oldsmobile was 09-LBMW-1 with a principal direction of force of (-)90 degrees.

Interior Damage

There was no damage to the interior surfaces of the Ford Windstar from occupant contact. Although omitted in the NASS case file, intrusions into the rear right passenger space involved 10.0 cm (3.9 in) of approximated door panel intrusion and 2.0 cm (0.8 in) of (lower) window frame intrusion.

REDESIGNED AIR BAG SYSTEM

The 1998 Ford Windstar 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 19.0 cm (7.5 in) in width and 12.0 cm (4.7 in) in height while the lower flap measured 19.0 cm (7.5 in) in width and 6.0 cm (2.4 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, a scuff mark was documented at the upper right quadrant of the air bag. The NASS researcher measured the diameter of the driver air bag at 48.0 cm (18.9 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 (centered) sectors on the rear aspect of the air bag.

Figure 5. 1998 Ford Windstar redesigned driver air bag.

Figure 6. 1998 Ford Windstar 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 **(Figure 6)**. 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 13.0 cm (5.1 in) in height. The NASS researcher measured the passenger air bag at 44.0 cm (17.3 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 one port located at the 10 o'clock sector on the side aspect of the air bag. No cutoff switch was found for the front right air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	50 year old male
Height:	180 cm (71 in)
Weight:	118 kg (260 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:	Transported to the emergency room of a local trauma center and released

Driver Injuries

Injury	***Severity (AIS 90)***	***Injury Mechanism***
Central chest contusion	Minor (490402.1,4)	Shoulder belt webbing
Abdominal contusion	Minor (590402.1,9)	Lap belt webbing

Driver Kinematics

The 50 year old male driver of the 1998 Ford Windstar 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 full rearward position. 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 central chest and abdominal areas as evidenced by the location of the injuries in conjunction with the driver's stated placement of the shoulder and lap harness. Contact to the driver air bag was confirmed by the scuff mark documented to the upper right quadrant of the air bag face. No other injury was reported. The driver was transported by police vehicle to the emergency room of a local trauma center for treatment and released. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential serious injury.

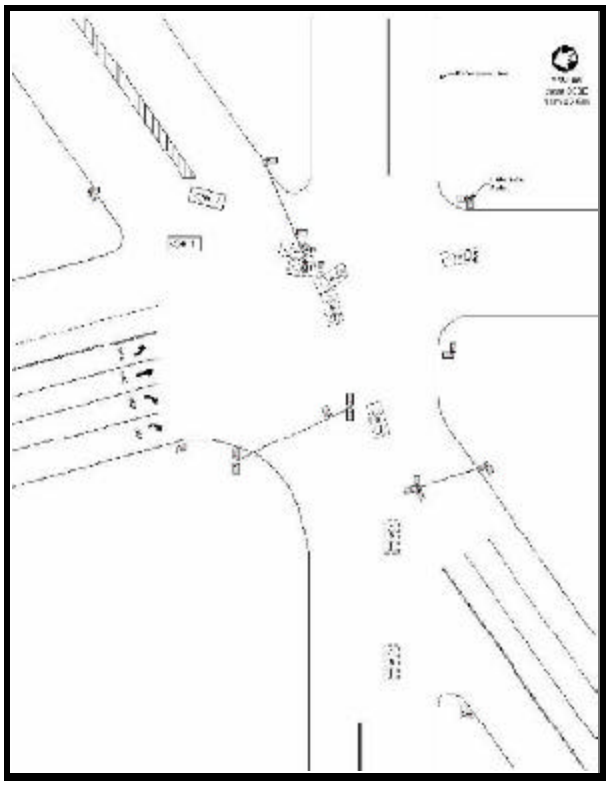

Figure 7. NASS Scene Diagram.