CRASH DATA RESEARCH CENTER

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

NASS CDS CASE NO. 1999-06-029A

RABSS VEHICLE - 1998 FORD WINDSTAR

LOCATION - STATE OF PENNSYLVANIA

CRASH DATE - MARCH, 1999

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 Windstar (subject vehicle) and a 1997 Honda Accord LX 4-door sedan. The Ford Windstar was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of an offset frontal collision with the Honda Accord. The 19 year old male driver of the Honda Accord was operating the vehicle southbound when he allowed the vehicle to cross the centerline and into the path of the northbound Ford Windstar. As the Honda entered the northbound lane, the frontal area impacted the front left area of the Ford resulting in severe damage to both vehicles. The unrestrained 43 year old male driver of the 1998 Ford Windstar initiated a forward trajectory in response to the 12 o'clock impact force and loaded the knee bolster and deployed redesigned driver air bag. Loading of the knee bolster resulted in multiple soft tissue injuries to the lower extremities and fractures of the right tibia and fibula, with associated bilateral fractures of the pelvis. Contact to the deployed driver air bag resulted in multiple soft tissue injuries to the face. He loaded through the air bag and struck the steering wheel rim which resulted in multiple soft tissue injuries to the chest, multiple bilateral rib fractures and underlying lacerations to the left lung, liver and mesentery. The driver continued the kinematic response pattern into the left A-pillar which resulted in additional soft tissue injuries to the face and a cerebral subarachnoid hemorrhage. He also sustained fractures of the left radius and ulna from contact to the instrument panel. The driver was transported to a local trauma center for treatment and expired approximately 5 ½ hours following the crash.			
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TABLE OF CONTENTS

REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
SCI TECHNICAL SUMMARY REPORT
NASS CDS CASE NO. 1999-06-029A
RABSS VEHICLE - 1998 FORD WINDSTAR
CRASH DATE - MARCH, 1999

BACKGROUND

This investigation focused on a two vehicle crash involving a 1998 Ford Windstar (subject vehicle) and a 1997 Honda Accord LX 4-door sedan. The Ford Windstar was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of an offset frontal collision with the Honda Accord. The 19 year old male driver of the Honda Accord was operating the vehicle southbound when he allowed the vehicle to cross the centerline and into the path of the northbound Ford Windstar. As the Honda entered the northbound lane, the frontal area impacted the front left area of the Ford resulting in severe damage to both vehicles. The unrestrained 43 year old male driver of the 1998 Ford Windstar initiated a forward trajectory in response to the 12 o'clock impact force and loaded the knee bolster and deployed redesigned driver air bag. Loading of the knee bolster resulted in multiple soft tissue injuries to the lower extremities and fractures of the right tibia and fibula, with associated bilateral fractures of the pelvis. Contact to the deployed driver air bag resulted in multiple soft tissue injuries to the face. He loaded through the air bag and struck the steering wheel rim which resulted in multiple soft tissue injuries to the chest, multiple bilateral rib fractures and underlying lacerations to the left lung, liver and mesentery. The driver continued the kinematic response pattern into the left A-pillar which resulted in additional soft tissue injuries to the face and a cerebral subarachnoid hemorrhage. He also sustained fractures of the left radius and ulna from contact to the instrument panel. The driver was transported to a local trauma center for treatment and expired approximately 5 ½ hours following the crash.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 1999-06-029A 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 March, 1999. At the time of the crash, it was dark (street lighted) with no adverse conditions as the road was dry. The crash occurred in the northbound lane of a (level) 2-lane north/south urban roadway **(see Figure 8 - page 7)**. The asphalt roadway was bordered by bike lanes and parking spaces. No traffic control was present at the crash site which had a posted speed limit of 56 km/h (35 mph).

Pre-Crash

The 19 year old male driver of the 1997 Honda Accord LX was operating the vehicle southbound **(Figure 1)** when he allowed the vehicle to cross the centerline into the path of the northbound Ford Windstar. The driver stated during the NASS interview that he attempted to go around a construction area straddling the west shoulder when he observed the northbound Ford. Upon recognition of the

impending harmful event, the driver braked in avoidance. The front right seating position was occupied by a 16 year old female in the lap of a 20 year old male. The rear left seating position was occupied 15 year old male as the rear center position was occupied by a 15 year old female and a 19 year old male (sitting side by side). The rear right seating position was occupied by a 20 year old male.

The 43 year old male driver of the 1998 Ford Windstar was operating the vehicle northbound **(Figure 2)** when he observed the southbound Honda encroach into his lane of travel. Upon recognition of the impending harmful event, the driver steered left and braked in avoidance. This maneuver was evidenced by the brake mark observed in the NASS scene images, however, it was not plotted on the scene diagram nor captured in the case file.

Figure 1. Southbound approach for the 1997 Honda Accord LX.

Figure 2. Northbound approach for the 1998 Ford Windstar.

Crash

As the Honda Accord entered the northbound lane of the 2-lane roadway, the frontal area impacted the front left area of the Ford Windstar resulting in severe damage to both vehicles. The WinSMASH reconstruction program computed *SCI revised* velocity changes of 49.2 km/h (30.6 mph) for the subject vehicle and 51.8 km/h (32.2 mph) for the struck Honda. Respective longitudinal components were -48.4 km/h (-30.1 mph) and -44.8 km/h (-27.8 mph). The impact induced deceleration was sufficient to deploy the frontal air bag systems in both vehicles. At this point, the Honda rotated approximately 130 degrees counterclockwise and came to rest along the west bike lane facing northeast. The Ford Windstar rotated approximately 50 degrees counterclockwise and came to rest along the east bike lane facing northwest.

Post-Crash

Both drivers were removed from their respective vehicles by rescue personnel in an unconscious state as the exit status of the remaining Honda occupants were unknown. The Ford driver was transported by ambulance to a local trauma center for treatment and expired approximately 5 ½ hours after the crash. The Honda occupants were also transported by ambulance to a local trauma center for treatment. The Honda driver and front right male passenger were admitted for one day and 7 days, respectively; with the lap seated front right occupant admitted for an unknown length of time. The rear left occupant of the Honda was admitted for 1 day. The rear center male and female occupants were admitted for 1 day and 27 days, respectively. The rear right occupant was admitted for an unknown length of time. Both vehicles were towed from the crash site due to disabling damage.

RABSS VEHICLE

The 1998 Ford Windstar was identified by the vehicle identification number (VIN): 2FMZA5148WB (production number deleted). The vehicle was a 4-door minivan equipped with front-wheel drive and a 3.8 liter, V-6 engine. The police report listed the driver as the owner of the vehicle. At the time of the crash, the odometer had recorded 2,591 km (1,610 miles). The seating was configured with front box-mounted (van type) and bench seats (with folding backs) for the second and third row seating positions. The NASS surrogate interview was not obtained, therefore, previous crashes or maintenance on the Ford's frontal air bag system were unknown.

VEHICLE DAMAGE

Exterior

The 1998 Ford Windstar sustained severe frontal damage as a result of the impact with the Honda Accord **(Figure 3)**. The direct contact damage began at the front left bumper corner and extended 100.0 cm (39.4 in) inboard. The impact deformed the entire front end width resulting in a combined direct and induced damage length (Field L) of 124.0 cm (48.8 in). *Erroneous field documentation necessitated SCI revision of the crush profile.* Six crush measurements were documented at the level of the reinforcement bar *(bumper fascia separation)*: C1= 78.0 cm (30.7 in), C2= 69.0 cm (27.2 in), C3= 52.0 cm (20.5 in), C4= 33.0 cm (13.0 in), C5= 15.0 cm (5.9 in), C6= 0 cm. The *SCI revised* Collision Deformation Classification (CDC) for this impact to the Ford was 12-FYEW-4 with a principal direction of force of (-)10 degrees. The hood was deformed rearward from the impact force. The fenders were displaced rearward which restricted/deflated both front wheels/tires. Induced contact damage also produced extensive rearward displacement of the left A-pillar and windshield header. This resulted in roof buckling and outward displacement of the left front door upper-window frame (with integrity loss). Although structure failure was coded in the NASS case file as a source of the left front door opening, the researcher provided no closeup images of the door structure or latch/striker assembly for SCI verification. The windshield was fractured from exterior impact forces only. Reduction in the left side wheelbase measured 69.0 cm (27.2 in) as the right side wheelbase was elongated 13.0 cm (5.1 in). Surface scratching was noted to the left passenger area, however, this damage was not attributed to any subsequent event and was probably pre-existing.

Figure 3. Front left damage to the 1998 Ford Windstar.

The 1997 Honda Accord LX sustained severe frontal damage as a result of the impact with the Ford Windstar **(Figure 4)**. The direct contact damage encompassed the entire front end width resulting in a combined direct and induced damage length (Field L) of 124.0 cm (48.8 in). Six crush measurements were documented at the level of the reinforcement bar *(bumper fascia separation)*: C1= 74.0 cm (29.1 in), C2= 72.0 cm (28.3 in), C3= 72.0 cm (28.3 in), C4= 72.0 cm (28.3 in), C5= 54.0 cm (21.3 in), C6= 48.0 cm (18.9 in). The *SCI revised* CDC for this impact to the Honda was 81-FDEW-3 with a principal

Figure 4. Front left damage to the 1997 Honda Accord LX.

direction of force of (+)30 degrees (principal direction of force incremented by “80" to reflect shifting of the end structure to the left). Shifting of the end structure to the left *(extent not measured by the NASS researcher)* and rearward displacement of the left fender restricted/deflated the left front wheel/tire and jammed the left front door. The hood was deformed rearward from the impact force. The windshield was fractured from exterior impact forces and interior occupant contact. The roof was cut as the front doors were pried open during post-crash occupant extrication activities by rescue personnel. Reduction in the left side wheelbase measured 35.0 cm (13.8 in) while reduction in the right side wheelbase measured 4.0 cm (1.6 in).

Interior

Interior damage to the Ford Windstar identified through the vehicle inspection was severe and was attributed to occupant contact and component intrusion **(Figure 5)**. Scuff marks and indentations were documented on the left knee bolster. Deformation to the upper portion of the steering wheel rim measured 4.0 cm (1.6 in) as the steering column was displaced upward approximately 11.0 cm (4.3 in) and 5.0 cm (2.0 in) to the left. The left instrument panel and A-pillar cover panel were fractured and scuffed. The foot controls were bent to the left. A spider-web fracture pattern was identified to the left upper windshield. Longitudinal intrusions into the driver space involved 46.0 cm (18.1 in) of toepan and 4.0 cm (1.6 in) of instrument panel intrusion *(intrusion of additional frontal components not captured by the NASS researcher)*.

Figure 5. Interior view.

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 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 rectangular 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 7.0 cm (2.8 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, an unspecified transfer was reported on the air bag face. The NASS researcher measured the diameter of the driver air bag at 48.0 cm (18.9 in) in its deflated state **(Figure 6)**. 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 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 **(Figure 7)**. No internal tether straps were present. The bag was vented by one port located at the 9 o’clock position on the side aspect of the air bag.

Figure 6. 1998 Ford Windstar deployed redesigned driver air bag.

Figure 7. 1998 Ford Windstar deployed redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	43 year old male
Height:	185 cm (73 in)
Weight:	107 kg (236 lb)
Seat Track Position:	Full rearward position
Manual Restraint Use:	None
Usage Source:	NASS vehicle inspection
Eyeware:	Unknown
Type of Medical Treatment:	Transported to a local trauma center (expired 5 ½ hours following crash)

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
*Flail chest with bilateral lung contusions	Critical (450266.5,3)	Steering wheel rim
*Cerebral subarachnoid hemorrhage (right parietal-small)	Serious (140684.3,1)	Left A-pillar (indirect contact injury)
*Laceration left lung (upper lobe-associated with rib FX)	Serious (441430.3,2)	Steering wheel rim
*Laceration pleura (NFS)	Moderate (441800.2,9)	Steering wheel hub/spoke
*Laceration mesentery (NFS)	Moderate (542020.2,8)	Steering wheel rim
*Laceration liver (minor-1cm)	Moderate (541822.2,1)	Steering wheel rim
*Fracture left radius	Moderate (752802.2,2)	Left instrument panel
*Fracture left ulna	Moderate (753202.2,2)	Left instrument panel
*Fracture right pelvis (with dislocation of the femoral head)	Moderate (852602.2,1)	Left knee bolster (indirect contact injury)
*Fracture left pelvis	Moderate (852602.2,2)	Left knee bolster (indirect contact injury)

Driver Injuries (con't.)

Injury	*Severity (AIS 90)*	*Injury Mechanism*
*Fracture right proximal fibula (NFS)	Moderate (851606.2,1)	Left knee bolster
*Fracture right proximal tibia (NFS)	Moderate (853404.2,1)	Left knee bolster
*Abrasion posterior scalp (8cm)	Minor (190202.1,6)	Roof
*Contusion posterior scalp (8cm)	Minor (190402.1,6)	Roof
*Laceration left forehead (minor-3cm)	Minor (290602.1,7)	Left A-pillar
*Abrasion left forehead (1cm)	Minor (290202.1,7)	Left A-pillar
*Contusion right forehead	Minor (290402.1,7)	Driver air bag
*Contusion left cheek	Minor (290402.1,2)	Left A-pillar
*Abrasion central upper lip	Minor (290202.1,8)	Driver air bag
*Contusion bilateral chest (anterior-lower) (right #1-5, left #1-8)	Minor (490402.1,3)	Steering wheel rim
+Contusion central chest	Minor (490402.1,4)	Steering wheel hub/spoke
*Contusion right elbow (oval-5cm)	Minor (790402.1,1)	Left instrument panel
*Abrasion right posterior middle finger	Minor (790202.1,1)	Left instrument panel
*Laceration right posterior middle finger	Minor (790600.1,1)	Left instrument panel
*Contusion mid-left anterior thigh	Minor (890402.1,2)	Left instrument panel
*Laceration left lateral thigh (minor)	Minor (890602.1,2)	Left door interior surface
*Abrasion left lateral thigh	Minor (890202.1,2)	Left door interior surface
*Contusion left anterior/proximal shin	Minor (890402.1,2)	Left knee bolster
*Laceration left anterior/proximal shin (NFS)	Minor (890600.1,2)	Left knee bolster
*Abrasion right anterior/proximal shin	Minor (890202.1,1)	Left knee bolster
*Contusion right anterior/proximal shin	Minor (890402.1,1)	Left knee bolster

source - autopsy report/ER report+*

Driver Kinematics

The unrestrained 43 year old male driver of the 1998 Ford Windstar was presumed to be seated in an upright posture with the seat track adjusted to the full rearward position. The lack of belt usage was determined by the extent of interior contacts and injury in conjunction with the lack of loading evidence documented on the front left restraint during the NASS vehicle inspection. At impact, the driver initiated a forward trajectory in response to the 12 o'clock impact force and loaded the knee bolster and

deployed redesigned driver air bag. Loading of the knee bolster resulted in multiple bilateral soft tissue injuries to the shins, fractures of the right tibia/fibula, and associated bilateral fractures of the pelvis as evidenced by the deformation documented to this component. Contact to the deployed redesigned driver air bag resulted in multiple abrasions and contusions to the face as evidenced by the transfer documented to the air bag. He loaded through the driver air bag and struck the steering wheel rim (and spokes) which resulted in chest contusions, multiple bilateral rib fractures and underlying lacerations to the pleura, left lung, mesentery, and liver. These injury mechanisms were evidenced by the deformation identified to the top aspect of the steering wheel rim and upward shifting of the column. It should be noted that the steering column shifted vertically upward as a result of the frontal damage (intrusion) and occupant loading. This displacement minimized the effectiveness of the deployed redesigned driver air bag. At this point, the driver continued the kinematic response pattern into the left A-pillar which resulted in additional soft tissue injuries to the face and a cerebral subarachnoid hemorrhage, evidenced by the scuff marks and fractured cover panel documented on the A-pillar. His arms impacted the left mid-instrument panel area resulting in multiple soft tissue injuries to the right elbow/hand and a fracture of the left radius/ulna as evidenced by the deformation documented to this component. He rebounded into the seat as the head contacted the (intruded) roof resulting in a contusion/abrasion to the posterior aspect of the scalp. The driver was removed from the vehicle by rescue personnel in an unconscious state and subsequently transported by ambulance to a local trauma center for treatment where he expired approximately 5 ½ hours following the crash.

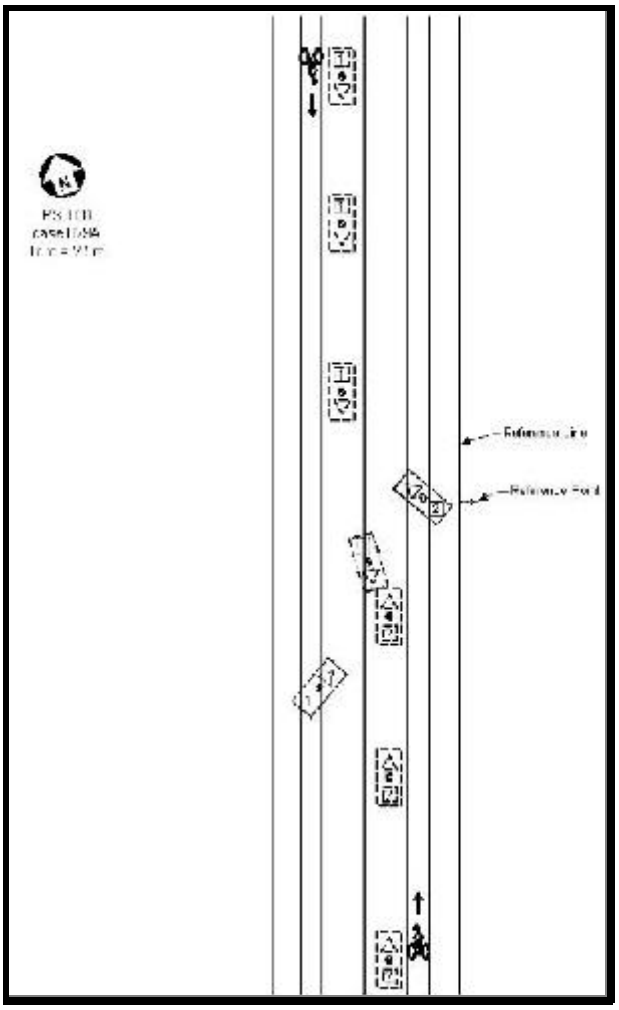

Figure 8. NASS Scene Diagram.