TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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

NASS RABSS CASE NO. 1998-45-801E

RABSS VEHICLE - 1998 FORD F-150 PICKUP TRUCK

LOCATION - STATE OF TENNESSEE

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.

TECHNICAL REPORT STANDARD TITLE PAGE

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16. *Abstract* This investigation focused on a single vehicle crash involving a 1998 Ford F-150 pickup truck. The Ford pickup was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with a concrete barrier. The driver was operating the vehicle southbound on a 4-lane divided highway when he apparently had fallen asleep and allowed the vehicle to depart the left (east) pavement edge of the southbound lanes. As the vehicle departed the east pavement edge, the left side surface sideswiped the median concrete barrier resulting in minor damage. At this point, the vehicle re-entered the southbound travel lanes and subsequently exited the right (west) pavement edge where the front right area impacted the second concrete barrier resulting in moderate damage. The vehicle rotated 40 degrees clockwise and came to rest perpendicular to the southbound lanes facing west. The 20 year old male driver of the Ford pickup truck was restrained by the available 3-point manual lap and shoulder belt system with the seat track adjusted to the mid-to-rear position. At impact with the second barrier, he initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint and redesigned driver air bag. The driver was uninjured in the collision and was arrested for suspicion of driving under the influence. The 18 year old male front right passenger was also restrained by the available 3-point lap and shoulder belt system with the seat track adjusted to the mid-to-rear position. At impact with the second barrier, he initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint and deployed redesigned passenger air bag. Loading of the manual restraint resulted in abrasions and contusions to the right chest. He also sustained a laceration to the right scalp from rebound contact into the B-pillar. The front right passenger was transported to a local hospital for treatment and released.			
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TABLE OF CONTENTS

REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
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BACKGROUND

This investigation focused on a single vehicle crash involving a 1998 Ford F-150 pickup truck. The Ford pickup was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with a concrete barrier. The driver was operating the vehicle southbound on a 4-lane divided highway when he apparently had fallen asleep and allowed the vehicle to depart the left (east) pavement edge of the southbound lanes. As the vehicle departed the east pavement edge, the left side surface sideswiped the median concrete barrier resulting in minor damage. At this point, the vehicle re-entered the southbound travel lanes and subsequently exited the right (west) pavement edge where the front right area impacted the second concrete barrier resulting in moderate damage. The vehicle rotated 40 degrees clockwise and came to rest perpendicular to the southbound lanes facing west. The 20 year old male driver of the Ford pickup truck was restrained by the available 3-point manual lap and shoulder belt system with the seat track adjusted to the mid-to-rear position. At impact with the second barrier, he initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint and redesigned driver air bag. The driver was uninjured in the collision and was arrested for suspicion of driving under the influence. The 18 year old male front right passenger was also restrained by the available 3-point lap and shoulder belt system with the seat track adjusted to the mid-to-rear position. At impact with the second barrier, he initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint and deployed redesigned passenger air bag. Loading of the manual restraint resulted in abrasions and contusions to the right chest. He also sustained a laceration to the right scalp from rebound contact into the B-pillar. The front right passenger was 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 98-45-801E 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 single vehicle crash occurred during the early morning hours of July, 1998. At the time of the crash, it was dark with no adverse conditions as the roads were dry. The crash occurred off the southbound lanes of a 4-lane north/south asphalt roadway **(see Figure 6 - page 6)** which was divided by concrete jersey barriers. The area was designated as a construction zone for highway improvements. No traffic controls were present at the scene which had a posted speed limit of 89 km/h (55 mph).

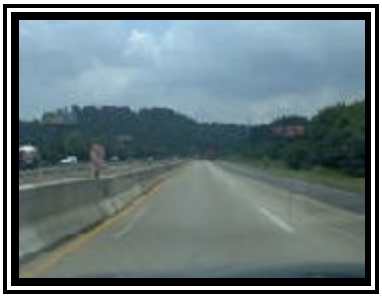

Figure 1. Southbound approach for the 1998 Ford F-150 pickup truck.

Pre-Crash

The 20 year old male driver of the 1998 Ford F-150 pickup truck was operating the vehicle southbound when he apparently had fallen asleep and allowed the vehicle to depart the left (east) pavement edge of the northbound lanes **(Figure 1)**.

Crash

As the Ford departed the east pavement edge of the 4-lane divided highway, the left side surface sideswiped the median concrete barrier which resulted in minor damage. The Collision Deformation Classification (CDC) for this initial impact to the Ford F-150 pickup truck was 12-LDES-1. At this point, the driver re-directed the vehicle across the southbound lanes and subsequently exited the right (west) pavement edge where the front right area impacted a second concrete barrier resulting in moderate damage. The CDC for this secondary impact to the Ford was 11-FZEW-2. The impact induced deceleration was sufficient to deploy the Ford's redesigned frontal air bag system. The damage algorithm of the WinSMASH program computed a (barrier equivalent) velocity change of 20.1 km/h (12.5 mph). The respective longitudinal component was -18.9 km/h (-11.7 mph). The Ford rotated 40 degrees clockwise and came to rest perpendicular to the southbound lanes facing west.

Post-Crash

Both occupants of the Ford pickup truck exited the vehicle under their own power. Treatment was rendered at the scene by emergency medical technicians (EMT). The driver was arrested for suspicion of driving under the influence. The front right passenger was transported to a local hospital for treatment and released. The vehicle was towed from the scene.

RABSS VEHICLE

The 1998 Ford F-150 pickup truck was identified by the Vehicle Identification Number (VIN): 1FTDF1723WN (production sequence deleted). The police report listed the driver as the owner of the vehicle. The vehicle was a regular cab pickup truck equipped with rear wheel drive, ABS (rear only) and a 4.2 liter, V-6 engine. The vehicle's odometer reading was 4,270 km (2,653 miles) at the time of the crash. The seating was configured with a split bench (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.

Figure 2. Frontal damage to the 1998 Ford F-150 pickup truck.

VEHICLE DAMAGE

Exterior Damage

The Ford pickup sustained moderate frontal damage as a result of the impact with the second concrete barrier **(Figure 2)**. The direct contact damage began at the front right bumper corner and extended 69.0 cm (27.2 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 165.0 cm (65.0 in). Six crush measurements were documented at the level of the bumper: C1= 3.0 cm (1.2 in), C2= 4.0 cm (1.6 in), C3= 9.0 cm (3.5 in), C4= 15.0 cm (5.9 in), C5= 19.0 cm (7.5 in), C6= 28.0 cm (11.0 in). Induced

damage was noted to the right fender which restricted the right front wheel/tire (not deflated) and jammed the right door. The right wheelbase was displaced 7.0 cm (2.8 in). Superficial contact damage was identified on the left side of the Ford which was attributed to the first barrier impact. The damage began 10.0 cm (3.9 in) aft of the front left bumper corner and extended rearward 500.0 cm (196.9 in). This damage pattern deflated the left side wheels (not restricted). The windshield was fractured from interior occupant contact (only).

Interior Damage

Interior damage to the Ford pickup identified through the NASS vehicle inspection was minimal and was attributed to occupant contact. Smudge marks were identified to the left lower quadrant of the air bag along with black vinyl transfers to multiple sections of the air bag from expansion within the module. A 7.0 cm (2.8 in) diameter thermal burn was also noted to the upper left quadrant of the air bag from deflation against the inflator. The left windshield was fractured with a smudge mark surrounding the damage. The left sunvisor was scuffed with the mounting bracket fractured. Scuff marks were documented to the left and right knee bolsters (rigid plastic type). A scuff mark was also found on the lower left quadrant of the passenger air bag. No deformation was noted to the steering wheel rim (tilt column set to the center position). No intrusions were found in the vehicle.

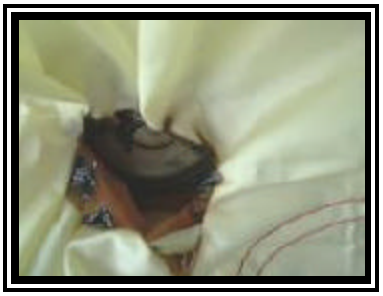

Figure 3. Thermal burn to the driver air bag.

REDESIGNED AIR BAG SYSTEM

The 1998 Ford F-150 pickup truck 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 20.0 cm (7.9 in) in width and 15.0 cm (5.9 in) in height while the lower flap measured 20.0 cm (7.9 in) in width and 9.0 cm (3.5 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, smudge marks were documented on the lower left quadrant of the air bag. Black vinyl transfers were also noted to the right (upper/lower) sections and top section (rear aspect) of the air bag from expansion within the module. In addition, a 7.0 cm (2.8 in) diameter thermal burn **(Figure 3)** was noted to the upper left quadrant of the air bag from deflation against the inflator. The NASS researcher measured the diameter of the driver air bag at 54.0 cm (21.3 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 F-150 redesigned driver air bag.

Figure 5. 1998 Ford F-150 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 was rectangular in shape which opened in an upward direction toward the windshield and measured 39.0 cm (15.4 in) in width and 18.0 cm (7.1 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flap, smudge marks were documented to the lower left quadrant of the air bag. The NASS researcher measured the passenger air bag at 55.0 cm (21.7 in) in width and 65.0 cm (25.6 in) in height in its deflated state **(Figure 5)**. No vent ports or internal tether straps were present. A cutoff switch was found on the center instrument panel and was set to the on position.

DRIVER DEMOGRAPHICS

Age/Sex:	20 year old male
Height:	173 cm (68 in)
Weight:	79 kg (175 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

Driver Injuries

Injury	***Severity (AIS 90)***	***Injury Mechanism***
None reported	N/A	N/A

Driver Kinematics

The 20 year old male driver of the 1998 Ford F-150 pickup truck was restrained by the available 3-point lap and shoulder belt system and presumed to be seated in an upright posture with the seat track adjusted to the mid-to-rear position. The police report noted that he was belted, further evidenced by the lack of significant contact points and injury. At impact with the first barrier, he probably remained in his pre-impact posture as this swiping impact offered no significant resistance to the vehicle or produce any resulting kinematic response from the occupant. At impact with the second barrier, he initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual belt and redesigned driver air bag. Contact to the deployed air bag was evidenced by the smudge marks documented to the lower left quadrant of the air bag. The air bag provided additional restraint against further contact to the steering wheel hub/rim. His lower extremities contacted the knee bolster with a possible upper extremity contact to the windshield. This trajectory was evidenced by the scuff marks documented to the knee bolster and spider-web type fracture to the windshield relative to the existing kinematic pattern. No injuries were reported by the police or interviewee. The driver was subsequently arrested for suspicion of driving under the influence with a (police reported) blood alcohol level of 0.087.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex:	18 year old male
Height:	173 cm (68 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:	Transported to a local hospital and released

Front Right Passenger Injuries

Injury	***Severity (AIS 90)***	***Injury Mechanism***
Abrasion right chest	Minor (490202.1,1)	Shoulder belt webbing
Contusion right chest	Minor (490402.1,1)	Shoulder belt webbing
Laceration right scalp (posterior aspect)	Minor (190602.1,6)	Right B-pillar

Front Right Passenger Kinematics

The 18 year old male front right passenger of the 1998 Ford F-150 pickup truck was restrained by the available 3-point 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 contact points in conjunction with the chest injuries sustained. At impact with the first barrier, he probably remained in his pre-impact posture as this swiping impact offered no significant resistance to the vehicle or produce any resulting kinematic response from the occupant. At impact with the second barrier, he initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual belt and redesigned passenger air bag. Although no injury was reported as a result of contact to the deployed air bag, loading of the manual restraint resulted in abrasions/contusions to the right chest area. His lower extremities contacted the knee bolster with no resulting injury reported. This trajectory was evidenced by the smudge marks documented to the lower left quadrant of the air bag and scuff marks documented to the knee bolster. At this point, he probably rebounded into the seat back and right B-pillar which resulted in the scalp laceration. The front right passenger was transported to a local hospital for treatment and released.

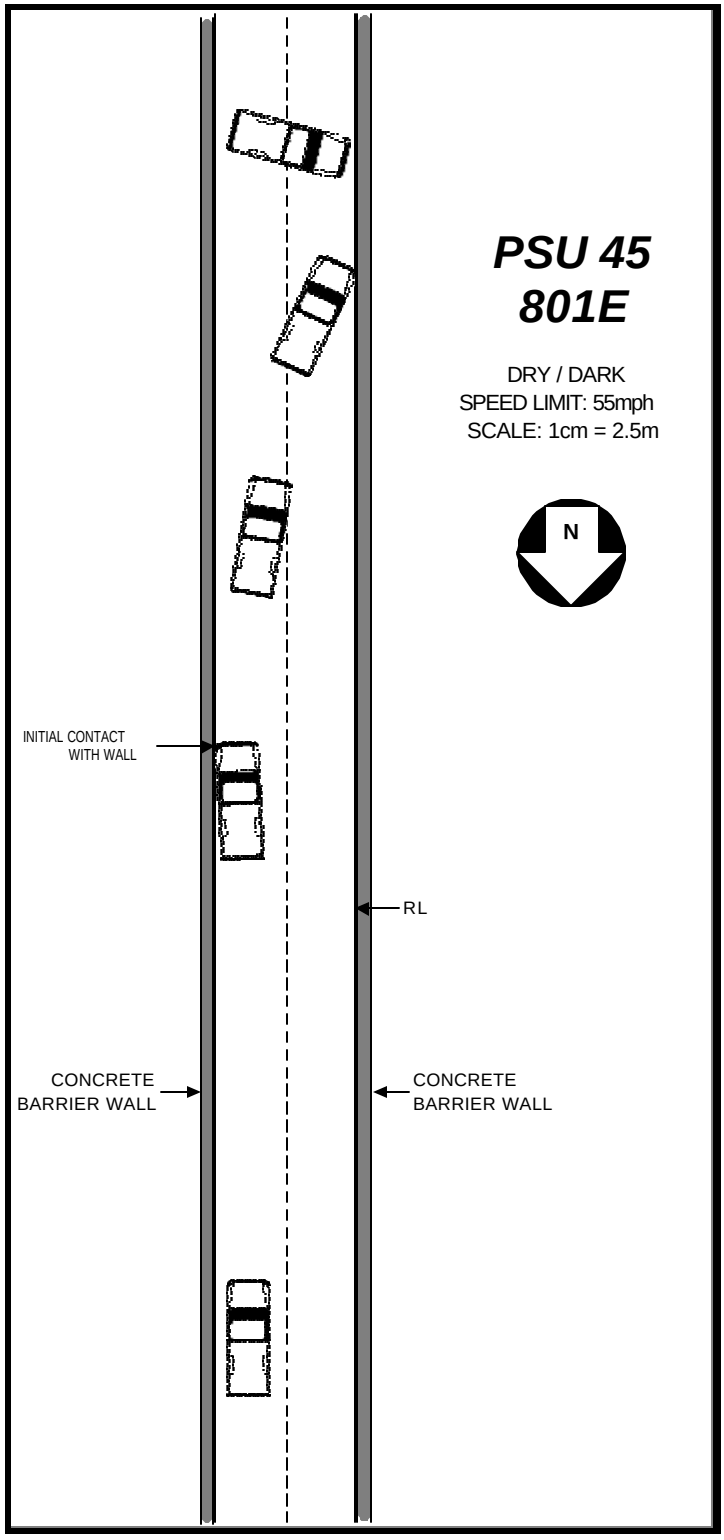

Figure 6. NASS Scene Diagram