**CRASH DATA RESEARCH CENTER** 

Veridian Engineering Division Buffalo, New York 14225

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

## NASS CDS CASE NO. 1999-11-146J

## **RABSS VEHICLE - 1998 FORD F-150 SUPER CAB PICKUP TRUCK**

# LOCATION - STATE OF MICHIGAN

## **CRASH DATE - SEPTEMBER, 1999**

Contract No. DTNH22-94-D-07058

Prepared for:

U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590

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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

<i>1. Report No.</i> 99-11-146J	2. Government Accession No.	3. Recipient's Catalog	No.
<ul> <li>4. Title and Subtitle         Redesigned Air Bag Special Study (RABSS)         RABSS Vehicle - 1998 Ford F-150 Super Cab Pickup Truck         Location - State of Michigan     </li> </ul>		5. <i>Report Date</i> : October, 2001	
		6. Performing Organization Code	
7. Author(s) Crash Data Research Center		8. Performing Organization Report No.	
<ul> <li>9. Performing Organization Name and Address Crash Data Research Center Veridian</li> <li>Engineering Division</li> <li>P.O. Box 400</li> <li>Buffalo, New York 14225</li> </ul>		10. Work Unit No. C01115.0298.(000	0-0009)
		11. Contract or Grant No. DTNH22-94-D-07058	
<ul><li>12. Sponsoring Agency Name and Address</li><li>U.S. Department of Transportation</li><li>National Highway Traffic Safety Administration</li></ul>		<ul><li>13. Type of Report and Period Covered Technical Report Crash Date - September, 1999</li></ul>	
Washington, D.C. 20590		14. Sponsoring Agency Code	
15. Supplementary Notes NASS investigation of a frontal collision redesigned frontal air bags.	on (into a fixed object) that involved a 1	998 Ford F-150 pickup ti	ruck equipped with
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<ul> <li>17. Key Words</li> <li>Redesigned frontal air bag system</li> <li>Collision Deformation Classification (Cl</li> <li>Proper use of the manual belt system</li> <li>Forehead abrasions</li> </ul>	DC): 11-FYEW-3	18. Distribution Staten General Public	nent
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 7	22. Price

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## REDESIGNED AIR BAG SPECIAL STUDY (RABSS) SCI TECHNICAL SUMMARY REPORT NASS CDS CASE NO. 1999-11-146J RABSS VEHICLE - 1998 FORD F-150 SUPER CAB PICKUP TRUCK CRASH DATE - SEPTEMBER, 1999

### BACKGROUND

This investigation focused on a single vehicle crash involving a 1998 Ford F-150 Super Cab pickup truck equipped with a redesigned frontal air bag system that included a cutoff switch for the passenger air bag. The switch was in the off position, therefore, only the driver air bag deployed as a result of a frontal collision with a large diameter tree. The driver of the Ford was operating the vehicle eastbound on a 2-lane rural roadway when he crossed over a wooden railroad bridge at a high rate of speed and subsequently allowed the vehicle to depart the left (north) road edge into a wooded area. As the vehicle exited the left road edge, the front right area impacted a small diameter tree resulting in minor damage. The front left area subsequently struck a large diameter tree which resulted in severe damage. At impact with the second tree, the restrained 16 year old male driver of the 1998 Ford F-150 pickup truck initiated a forward and slightly lateral trajectory in response to the 11 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Loading of the knee bolster resulted in fractures of the left femur and pelvis. Contact to the deployed redesigned driver air bag resulted in an abrasion across the forehead and contusion over the left eyebrow. The driver was transported to a local trauma center for treatment and admitted for 6 days.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 1999-11-146J 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 single vehicle crash occurred during the late evening hours of September, 1999. At the time of the crash, it was dark (street not lighted) with no adverse conditions as the road was dry. The crash occurred off the north road edge of a (straight) 2-lane rural roadway with a sag reported just west of the crash site (**see Figure 9 - page 7**). The dirt roadway was bordered by wooded areas with a wooden railroad bridge approximately 98.0 meters (321.5 feet) west of the crash site. No traffic control was present at the scene which had a posted speed limit of 89 km/h (55 mph).

## **Pre-Crash**

The 16 year old male driver of the 1998 Ford F-150 pickup truck was operating the vehicle eastbound at a (driver reported) speed of 129 km/h (80 mph) when he crossed the bridge (**Figure 1**) and encountered the sag in the road which reportedly launched the vehicle airborne. As the Ford made contact with the ground the driver was unable to regain control of the vehicle as it subsequently departed the left (north) road edge (**Figure 2**) in a clockwise yaw. The front center and right positions were occupied by a 16 year old female and 15 year old male, respectively.



Figure 1. Eastbound approach for the 1998 Ford F-150 pickup truck showing the wooden railroad bridge.



Figure 2. Northeasterly approach into the wooded area.

#### Crash

As the Ford pickup truck exited the left (north) road edge, the front right area made initial contact to a small diameter tree (running it completely over) resulting in minor damage. The vehicle continued in a northeasterly direction 1.7 meters (5.6 feet) as the front left area struck a large diameter tree which resulted in moderate damage (**Figure 3**). The WinSMASH reconstruction program computed a velocity change of 36.3 km/h (22.6 mph) with a longitudinal component of -34.1 km/h (-21.2 mph). The impact induced deceleration was sufficient to deploy the Ford's redesigned driver air bag system. At this point, the vehicle rotated approximately 45 degrees counterclockwise and came to rest in close proximity to the final impact facing northeast.

#### **Post-Crash**

The driver of the Ford pickup was removed from the vehicle by rescue personnel due to perceived serious injury as the front center passenger exited with some assistance. The front right passenger exited the vehicle under his own power. The driver and front center passenger were transported by ambulance to a local hospital for treatment. The driver was admitted for 6 days as the front center passenger was treated and released. The front right passenger sought treatment later at a medical facility. The vehicle was towed from the crash site due to disabling damage.



Figure 3. North view of struck trees.

#### **RABSS VEHICLE**

The 1998 Ford F-150 was identified by the vehicle identification number (VIN): 2FTZX18W5WC (production number deleted). The vehicle was a 3-door Super Cab styleside pickup truck equipped with four-wheel drive and a 4.6 liter, V-8 engine. The police report did not identify the owner of the vehicle. At the time of the crash, the odometer had recorded 36,016 km (22,380 miles). The seating was configured with a front and rear split bench seats (with folding backs). The driver reported no previous crashes or maintenance on the Ford's frontal air bag system. A cell phone was present in the vehicle but it was unknown if it was in-use at the time of the collision.

# VEHICLE DAMAGE

### Exterior

The 1998 Ford F-150 Super Cab pickup truck sustained severe frontal damage as a result of the impact with the large diameter tree (**Figure 4**). The direct contact damage began at the front left bumper corner and extended 77.0 cm (30.3 in) inboard. The impact deformed the entire front end width resulting in a combined direct and induced damage length (Field L) of 142.0 cm (55.9 in). Six crush measurements were documented at the level of the bumper: C1= 83.0 cm (32.7 in), C2= 50.0 cm (19.7 in), C3= 38.0 cm (15.0 in), C4= 22.0 cm (8.7 in), C5= 8.0 cm (3.1 in), C6= 0 cm. The



Figure 4. Front left damage to the 1998 Ford F-150 Super Cab pickup truck.

Collision Deformation Classification (CDC) for this secondary impact to the Ford was 11-FYEW-3 with a principal direction of force of (-)20 degrees. Although the vehicle was reportedly airborne precrash, the damage pattern suggests the Ford was horizontal during the tree impacts (with a +20 degree beta angle). The hood was deformed up and rearward from engagement against the trees. The windshield was fractured as the right and left front tempered glazings were disintegrated by exterior impact forces (only). The left fender was displaced rearward which restricted/deflated the left front wheel/tire and jammed the left door. The left rear tire was deflated (not restricted). Reduction in the left side wheelbase measured 29.0 cm (11.4 in).

Direct contact damage was also identified along the front right area attributed to the initial tree impact. The direct damage began 12.0 cm (4.7 in) to the left of the front right bumper corner and extended 31.0 cm (12.2 in) inboard. The estimated (SCI revised) CDC for this impact to the Ford was 11-FREN-1. Although classified as overlapping damage, the vehicle bumper probably sustained no crush from this yielding object, and thus, would not invalidate any WinSMASH outputs for the highest Delta-V event. The engine reportedly caught fire following the crash which resulted in minor damage, however, this was not confirmed by the researcher during the NASS vehicle inspection. The windshield and A-pillars were cut as the left door was removed by rescue personnel during occupant extrication activities post-crash.

## Interior

Interior damage to the Ford pickup identified through the vehicle inspection was moderate and was attributed to occupant contact and component intrusion (**Figure 5**). Scuff marks were documented on the left knee bolster, sunvisor, steering column, center instrument panel, and glove compartment door. Indentations were also identified on the left knee bolster and left door interior surface. The steering column was displaced slightly upward and to the right. The brake pedal was deformed to the right. Longitudinal intrusions into the occupant space involved 16.0 cm (6.3 in) of left



Figure 5. Interior view.

toepan, 14.0 cm (5.5 in) of left instrument panel, and 6.0 cm (2.4 in) of center instrument panel intrusion. Lateral intrusions into the driver space involved 12.0 cm (4.7 in) of kicker panel intrusion.

## REDESIGNED AIR BAG SYSTEM

The 1998 Ford F-150 pickup truck was equipped with a redesigned frontal air bag system that included a cutoff switch for the passenger air bag (**Figure 6**). The switch was in the off position, therefore, only the driver air bag deployed as a result of the frontal collision with the large diameter tree. 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 19.0 cm (7.5 in) in height while the lower flap measured 19.0 cm (7.5 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, blood spattering was noted on the upper centered portion of the air bag face. The NASS researcher measured



Figure 6. Passenger air bag cutoff switch (in the off position).

the diameter of the driver air bag at 52.0 cm (20.5 in) in its deflated state (**Figure 7**). 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 was mounted in the right mid-instrument panel area with a single cover flap design hinged at the top aspect (**Figure 8**). No contact evidence was identified on the exterior surface of the module cover flap.



Figure 7. 1998 Ford F-150 pickup truck deployed redesigned driver air bag.



Figure 8. 1998 Ford F-150 pickup truck passenger air bag module.

## DRIVER DEMOGRAPHICS

Age/Sex:	16 year old male
Height:	180 cm (71 in)
Weight:	61 kg (135 lb)
Seat Track Position:	Middle position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Medical report, driver interview
Eyeware:	None
Type of Medical	
Treatment:	Transported to a local trauma center and admitted (6 days)

Driver Injuries		
Injury	Severity (AIS 90)	Injury Mechanism
*Fracture left pelvis (posterior acetabular wall-displaced/comminuted)	Serious (852604.3,2)	Left knee bolster (indirect contact injury)
*Fracture left femur (mid-shaft)	Serious (851814.3,2)	Left knee bolster
#Abrasion forehead (across eyebrows)	Minor (290202.1,7)	Driver air bag
#Contusion left eyebrow	Minor (290402.1,7)	Driver air bag

sources - discharge summary\* / ER report#

#### **Driver Kinematics**

The 16 year old male driver of the 1998 Ford F-150 pickup truck was restrained by the available 3point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the middle position. Contrary to the NASS case file, belt usage was determined by the lack of chest injury relative to the driver's stated pre-crash seat track position in this high severity crash. At impact with the first tree, the driver probably remained in his pre-impact posture as this minor (yielding) impact offered no resistance to the vehicle nor produce any occupant kinematic response. At impact with the second tree, he initiated a forward and slightly lateral trajectory in response to the 11 o'clock impact force and loaded the manual restraint, knee bolster/steering column and deployed redesigned driver air bag. Loading of the knee bolster resulted in a mid-shaft fracture of the left femur and associated fracture of the left pelvis, evidenced by the scuff marks and indentations documented to this component. Although the pelvic fracture was sourced to the left side door hardware in the NASS case file, the comminuted posterior displacement of the fracture suggested this was a typical indirect contact injury from femur loading onto the knee bolster. Contact to the deployed redesigned driver air bag resulted in abrasions and contusions across the eyebrows. Although these injuries were sourced to the left sunvisor in the NASS case file, the driver air bag is a more probable mechanism given the aspect of the injury and kinematic response pattern relative to the vehicle's horizontal orientation upon the final impact. The driver was removed from the vehicle by rescue personnel due to perceived serious injury while the lower extremities were reportedly pinned by the (intruded) instrument panel, however, the NASS researcher's intrusion measures seem deficient to substantiate this scenario. He was transported by ambulance to a local trauma center for treatment and admitted for 6 days. The redesigned air bag provided protection against further contact to the steering wheel hub/rim, and potential serious injury.

#### FRONT CENTER PASSENGER DEMOGRAPHICS

Age/Sex:	16 year old female
Height:	163 cm (64 in)
Weight:	43 kg (95 lb)
Seat Track Position:	Mid-to-rear position
Manual Restraint Use:	2-point lap belt system
Usage Source:	Vehicle inspection, driver interview, police/medical report
Eyeware:	None
Type of Medical	
Treatment:	Transported to the emergency room of a local hospital and released

Front Center Passenger Injuries		
Injury	Severity (AIS 90)	Injury Mechanism
#Fracture left zygomatic arch (cheek)	Moderate (251800.2,2)	Center instrument panel
#Concussion (with vomiting)	Minor (160402.1,0)	Center instrument panel
*Contusion left jaw	Minor (290402.1,8)	Center instrument panel

source - EMS report\* / ER report#

## Front Center Passenger Kinematics

The 16 year old female front center passenger of the 1998 Ford F-150 pickup truck was restrained by the available 2-point manual lap belt system, seated in an upright posture with the seat track adjusted to the mid-to-rear position. Belt usage was evidenced by the lack of interior contacts and substantial injury in this high severity crash.

At impact with the first tree, the front center passenger probably remained in her pre-impact posture as this minor impact offered no resistance to the vehicle nor produce any occupant kinematic response. At impact with the second tree, she initiated a forward and slightly lateral trajectory in response to the 11 o'clock impact force and loaded the manual restraint. The lap belt restrained her lower body as her upper torso flexed forward. Her face struck the center instrument panel which resulted in a contusion to the left jaw and fracture of the left cheek bone, evidenced by the scuff marks documented to this component. She also sustained a concussion which may have been a result of further head contact to the center instrument panel. Although this injury was sourced to the left sunvisor in the NASS case file, the passenger's height and associated restraint use makes the center instrument panel a more probable mechanism. Following the crash, the front center passenger exited the vehicle with some assistance from rescue personnel and was subsequently transported by ambulance to the emergency room of a local hospital for treatment and released.

## FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex:	15 year old male
Height:	163 cm (64 in)
Weight:	57 kg (125 lb)
Seat Track Position:	Mid-to-rear position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Vehicle inspection, driver interview, police/medical report
Eyeware:	None
Type of Medical	
Treatment:	Treatment later at a medical facility

## Front Right Passenger Injuries

Injury	Severity (AIS 90)	Injury Mechanism
#Laceration left frontal scalp (2-3cm)	Minor (190602.1,5)	Radar detector
#Laceration posterior bilateral arms	Minor (790602.1,3)	Flying glass (non-contact injury)

source - ER report#

#### **Front Right Passenger Kinematics**

The 15 year old male front right passenger of the 1998 Ford F-150 pickup truck 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. Belt usage was evidenced by the lack of significant interior contacts and injury in this high severity crash.

At impact with the first tree, he probably remained in his pre-impact posture as this minor impact offered no significant resistance to the vehicle nor produce any occupant kinematic response. At impact with the second tree, the passenger initiated a forward and slightly lateral trajectory in response to the 11 o'clock impact force and loaded the manual restraint. He reportedly sustained a laceration to the left frontal scalp from contact to a radar detector, however, this could not be confirmed as the injury mechanism given the lack of supporting data on the location of this equipment during the NASS interview. He also sustained minor lacerations to the posterior aspect of both forearms from flying glass. Following the crash, the front right passenger exited the vehicle under his own power and sought treatment later at a medical facility.

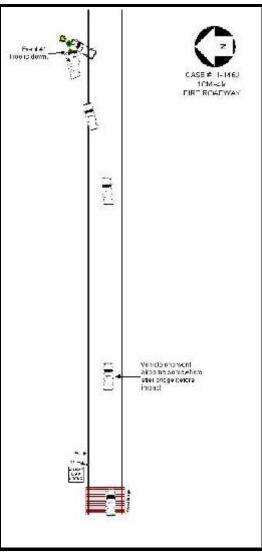


Figure 9. NASS Scene Diagram (pre-impact clockwise yaw not plotted by researcher).