

**TRANSPORTATION SCIENCES
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**REMOTE REDESIGNED AIR BAG DEPLOYMENT INVESTIGATION
SCI TECHNICAL SUMMARY REPORT**

NASS/SCI COMBO CASE NO. 00-11-078J

VEHICLE - 1999 FORD F150 PICKUP TRUCK

LOCATION - STATE OF MICHIGAN

CRASH DATE - JULY 2000

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

1. <i>Report No.</i> 00-11-078J	2. <i>Government Accession No.</i>	3. <i>Recipient's Catalog No.</i>	
4. <i>Title and Subtitle</i> Veridian Remote Redesigned Air Bag Deployment Investigation Vehicle: 1999 Ford F150 Pickup Truck Location: State of Michigan		5. <i>Report Date:</i> March 2001	
		6. <i>Performing Organization Code</i>	
7. <i>Author(s)</i> Crash Data Research Center		8. <i>Performing Organization Report No.</i>	
9. <i>Performing Organization Name and Address</i> Transportation Sciences Crash Data Research Center Veridian Engineering P.O. Box 400 Buffalo, New York 14225		10. <i>Work Unit No.</i> C01115.0313.(0000-0009)	
		11. <i>Contract or Grant No.</i> DTNH22-94-D-07058	
12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		13. <i>Type of Report and Period Covered</i> Technical Report Crash Date: July 2000	
		14. <i>Sponsoring Agency Code</i>	
15. <i>Supplementary Notes</i> Remote investigation of a run-off-road crash that resulted in critical injury to the driver.			
16. <i>Abstract</i> <p>This remote investigation of NASS CDS Case No. 00-11-078J focused on a single vehicle crash that involved a 1999 Ford F150 pickup truck that was occupied by a 22-year-old male driver. The driver was not restrained by the 3-point belt system. The driver was operating the Ford pickup truck westbound on a two-lane roadway at a high rate of speed while being pursued by police. The pickup truck departed the roadway on the right side while entering a left curve. The pickup truck struck a tree with the front right area, and continued on the roadside across a driveway and lawn area. The vehicle struck a commercial sign post with the front right area and traveled across another driveway and a lawn. The driver was probably displaced from the initial impacts with the first tree and commercial sign post, but probably resumed an upright posture prior to the final impact with a large diameter tree cluster. The front area impacted the tree cluster resulting in severe damage to the pickup truck that was sufficient to deploy the redesigned air bag system. Due to the severe impact force, the driver initiated a forward trajectory and loaded the through the redesigned driver's air bag. He uniformly loaded the steering wheel and steering column which resulted in bilateral rib fractures with a right hemothorax, a right liver contusion, and a capitae fracture of the right humerus. His head flexed over the steering wheel rim and struck the windshield header which resulted in an indirect contact distraction injury of C1 with anterior ring fracture and dislocation of C1-C2, a brain stem injury with subarachnoid/subdural hemorrhage, and loss of consciousness. He was removed from the vehicle by rescue personnel and transported by ambulance to a local trauma center and admitted.</p>			
17. <i>Key Words</i> Driver air bag deployment Crash related injuries Redesigned Air Bags		18. <i>Distribution Statement</i> General Public	
19. <i>Security Classif. (of this report)</i> Unclassified	20. <i>Security Classif. (of this page)</i> Unclassified	21. <i>No. of Pages</i> 8	22. <i>Price</i>

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BACKGROUND

This remote investigation of NASS CDS Case No. 00-11-078J focused on a single vehicle crash that involved a 1999 Ford F150 pickup truck that was occupied by a 22-year-old male driver (**Figure 1**). The driver was not restrained by the 3-point belt system. The driver was operating the Ford pickup truck westbound on a two-lane roadway at a high rate of speed while being pursued by police. The pickup truck departed the roadway on the right side while entering a left curve. The pickup truck struck a tree with the front right area, and continued on the roadside across a driveway and lawn area. The vehicle struck a commercial sign post with the front right area and traveled across another driveway and a lawn. The driver was probably displaced from the initial impacts with the first tree and commercial sign post, but probably resumed an upright posture prior to the final impact with a large diameter tree cluster. The front area impacted the tree cluster resulting in severe damage to the pickup truck that was sufficient to deploy the redesigned air bag system. Due to the severe impact force, the driver initiated a forward trajectory and loaded the through the redesigned driver's air bag. He uniformly loaded the steering wheel and steering column which resulted in bilateral rib fractures with a right hemothorax, a right liver contusion, and a capitae fracture of the right humerus. His head flexed over the steering wheel rim and struck the windshield header which resulted in an indirect contact distraction injury of C1 with anterior ring fracture and dislocation of C1-C2, a brain stem injury with subarachnoid/subdural hemorrhage, and loss of consciousness. He was removed from the vehicle by rescue personnel and transported by ambulance to a local trauma center and admitted.



Figure 1. 1999 Ford F150 pickup truck

This crash was selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 00-11-078J. The crash occurred in July 2000. Initial notification of this crash was made to the Veridian Special Crash Investigations team following a NASS CDS case review. The NASS PSU performed the vehicle inspection and scene inspection. Due to the high severity crash and bottoming out of the redesigned air bag, NHTSA assigned the tasks of case review and report preparation to the Veridian Special Crash Investigation (SCI) team on October 10, 2000.

SUMMARY

Crash Site

This single vehicle crash occurred during the nighttime hours of July 2000. At the time of the crash, there were no adverse weather conditions and the asphalt road surface was dry. The two-lane east/west roadway curved to the left and had a level grade. At the apex of the curve, the roadway was bordered by an asphalt parking lot on the right side, and dirt shoulder on the left. The lawn area adjacent to the parking lot had a negative slope toward the roadway. As the roadway continued in a straight direction, it was bordered by dirt shoulders. The roadside environment consisted of grassy lawn areas, trees, and residential driveways.

Pre-Crash

The 1999 Ford F150 pickup truck was traveling westbound on a two-lane roadway at a high rate of speed while being pursued by police. As the pickup truck entered the curve to the left, the vehicle drifted to the right and departed the roadway on the right side (**Figure 2**). The Ford pickup truck traveled onto the asphalt parking lot and then onto a lawn which had a negative slope toward the roadway. Due to the negative slope to the left, the front right undercarriage area of the pickup truck gouged the lawn (**Figure 3**).



Figure 2. Approach #1 for the pickup truck showing parking lot

Crash

The 1999 Ford F150 pickup truck sustained multiple impact events as follows:

<u>Event Number</u>	<u>Object Contacted</u>	<u>CDC Value</u>
1	Tree > 10 cm (4") in diameter	12-FRW99
2	Sign post > 10 cm (4") but < 30cm (12")	12-FRE99
3	Tree cluster 1.5 m (4.9') in diameter	12-FZEW-5

The front right wheel area struck a tree and the pickup truck continued to travel in a west direction across a driveway and lawn area in a tracking mode. The principal direction of force was 10 degrees. The tree was located 7.0 m (23.0') north of the right road edge (**Figure 3**).



Figure 3. First impact with tree

The front right area of the pickup truck sideswiped a non-breakaway commercial sign post with a concrete base and continued to travel in a west direction across another driveway and lawn area maintaining a tracking mode. The principal direction of force was 10 degrees. The sign post was located 11.6 m (38.1') north of the right road edge (**Figure 4**).



Figure 4. Second impact with sign post

The Ford pickup truck traveled across a third driveway and continued across a lawn area prior to impact with a second tree cluster. A gouge mark was noted in the vehicle's trajectory in the lawn prior to where it crossed the third driveway. The pickup truck traveled on the lawn approximately 4 m (13') from the western edge of the driveway to the edge of the tree. The lawn sloped upward from the edge of the driveway to the base of the tree approximately 0.3 m (1.0'). The front right area of the Ford F150 pickup truck impacted the common trunk of a tree cluster measuring 1.5 m (4.9') in diameter (**Figure 5 and Figure 6**). The tree cluster was located 14.3 m (46.9') north of the right road edge. The principal direction of force was 10 degrees. The damage algorithm of the WinSMASH program computed a velocity change of 98.6 km/h (61.3 mph). The longitudinal and latitudinal components were -97.1 km/h (-60.3 mph) and -17.1 km/h (-10.6 mph), respectively. The impact force was sufficient to deploy the redesigned frontal air bag system in the Ford F150 pickup truck. The severe impact force probably caused the rear of the pickup truck to pitch upward. The pickup truck rotated approximately 30 degrees clockwise (CW) to final rest adjacent to the tree.



Figure 5. Point of impact



Figure 6. Damage to the Ford F150 pickup truck

Post-Crash

The driver was found unconscious in the vehicle and was removed by rescue personnel. He was transported by ambulance to a local trauma center and admitted for treatment. The Ford F150 pickup truck was towed from the scene due to severe damage.

RABSS VEHICLE - 1999 Ford F150 Pickup Truck

The 1999 Ford F150 pickup truck was identified by the Vehicle Identification Number (VIN): 1FTZX1726XN (production sequence omitted). The vehicle was a 4-door super cab full size 4 x 2 pickup truck with a 2.0 m (6.5') long box. The pickup truck was equipped with a 4.6 liter, 6 cylinder engine, automatic transmission, tilt steering column, and anti-lock brakes. The seating was configured with front bucket seats with integrated head restraints and a 60/40 split rear bench seat (**Figure 7**). The front and rear seats were removed from the vehicle by police. The front seating positions were equipped with manual 3-point lap and shoulder belts. The rear outboard seating positions were equipped with manual 3-point lap and shoulder belts and the rear center position was equipped with a 2-point lap belt.



Figure 7. Front and rear seats

VEHICLE DAMAGE

Exterior Damage

The 1999 Ford F150 pickup truck sustained minor damage from the first tree impact and pole impact. The direct and induced damage for the initial events was masked due to overlapping damage from the third event with the tree. Partial Collision Deformation Classifications (CDCs) for the first tree impact and second impact to the pole were 12-FRW99 and 12-FRE99, respectively.

The 1999 Ford F150 pickup truck sustained severe frontal damage as a result of the impact with the 1.5 m (4.9') diameter tree cluster (**Figure 8**). Maximum crush was located at C4 and measured 121 cm (48"). Direct contact damage began at the center of the frontal plane and extended to the right bumper corner. The combined direct and induced damage involved the entire frontal width of the vehicle and measured 76 cm (30") from bumper corner to bumper corner. The Collision Deformation Classification(CDC) for this impact to the tree was 12-FZEW-5. The right half of the bumper, radiator support, and leading edge of the hood were crushed rearward to the right A-pillar (**Figure 9**). The right front axle position was displaced rearward to the right A-pillar which resulted in a shortening of the right side wheelbase by 77 cm (30"). The hood was buckled at the designated fold points. The left bumper corner was protruded forward toward the center of the vehicle. The left front fender was bowed inward toward the center of the vehicle. Both side view mirrors were displaced and abrasions were noted along the right side of the cab. The roof was buckled on the right side. The windshield was cracked from impact forces and partially separated along the windshield header. All door glazing and back light glazing were disintegrated from impact forces. Six crush measurements were taken by the NASS Researcher at the level of the bumper and were



Figure 8. Frontal view of damage



Figure 9. Right front view of damage

as follows: C1 = 0 cm, C2 = 107 cm (42"), C3 = 117 cm (46"), C4 = 121 cm (48"), C5 = 118 cm (46"), C6 = 110 cm (43").

Interior Damage

Interior damage to the Ford F150 pickup truck was moderate and attributed to occupant contact and compartment intrusion (**Figure 10**). Intruding components included the toe pan, instrument panel, and windshield. The magnitude of intrusion was highest on the right side of the vehicle and measured 46 cm (18") at the right toe pan. The entire instrument panel was displaced rearward and the plastic fascia panels had separated from each other. The steering column was compressed from occupant loading however, there was no damage to the steering wheel rim (**Figure 11**). The top aspect of knee bolster was displaced. The rear view mirror was separated from the windshield. Scuff marks were noted on the knee bolster, the left instrument panel, the top left aspect of the center console, and the windshield header from occupant contact.



Figure 11. Interior damage



Figure 12. Compressed steering column

The NASS researcher documented the following intrusions and associated measurements:

Component	Magnitude of Intrusion	Direction
Right toe pan	46 cm (18")	Longitudinal
Center toe pan	36 cm (14")	Longitudinal
Right windshield	16 cm (6")	Longitudinal
Right instrument panel	16 cm (6")	Longitudinal
Left toe pan	16 cm (6")	Longitudinal
Center instrument panel	11 cm (4")	Longitudinal
Center windshield	5 cm (2")	Longitudinal
Left instrument panel	5 cm (2")	Longitudinal

REDESIGNED AIR BAG SYSTEM

The 1999 Ford F150 pickup truck was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags deployed as a result of the third event with the tree cluster. The driver's redesigned air bag was housed in the center of the steering wheel with asymmetrical H-configuration module cover flaps. The top cover flap measured 19 cm (7") in width and 12 cm (5") height. The lower cover flap measured 19 cm (7") in width and 3 cm (1") in height. The redesigned driver's air bag measured 60 cm (24") in diameter in its deflated state (**Figure 12**). The redesigned driver's air bag was equipped with two internal tether straps and was vented by 2 ports located at the 11 o'clock and 1 o'clock positions on the rear aspect of the air bag. The NASS researcher identified a scuff in the upper left quadrant on the air bag membrane.



Figure 12. Redesigned driver's air bag

The redesigned front right passenger's air bag deployed from the right mid-instrument panel area with a single cover flap design hinged at the top aspect. The cover flap was rectangular in shape and measured 37 cm (15") in width and 20 cm (8") in height. The redesigned front right passenger's air bag measured 57 cm (22") in width and 57 cm (22") in height in its deflated state (**Figure 13**).



Figure 13. Redesigned front right passenger's air bag

A cut off switch for the redesigned front right passenger's air bag was standard equipment for the 1999 Ford F150 pickup truck. It was positioned to the right of the climate controls on the right aspect of the center instrument panel. However, one was not identified in the NASS vehicle inspection because the panel containing the cut off switch was separated from the instrument panel (**Figure 14**).



Figure 14. Center instrument panel showing separated panel

OCCUPANT DEMOGRAPHICS

Driver

Age/Sex: 22-year-old male
Height: 165 cm (65")
Weight: 57 kg (126 lbs)
Seat Track Position: Unknown
Manual Restraint Use: Unrestrained
Usage Source: Vehicle inspection, injury data
Eyewear: Unknown
Type of Medical Treatment: Transported by ambulance to a local hospital and admitted

Driver Injuries

Injury	Injury Severity (AIS 90)	Injury Mechanisms
Brain stem injury with subarachnoid/subdural hemorrhage	Critical (140210.5,8)	Indirect contact injury, windshield header
Unconscious and totally unresponsive	Critical (160824.5,0)	Indirect contact injury, windshield header
Right 2 - 5 rib fractures with hemothorax and left 2 - 4 rib fractures	Severe (450232.4,3)	Steering wheel hub/spoke/rim
Cord contusion - incomplete cord syndrome with fracture of C1 and C1 - C2 dislocation	Severe (640218.4,6)	Indirect contact injury, windshield header
Liver contusion	Moderate (541810.2,1)	Steering wheel hub/spoke/rim
Right humerus capitata fracture	Moderate (752602.2,1)	Steering wheel hub/spoke/rim

*Injury source: Hospital discharge summary

Driver Kinematics

The 22-year-old male driver of the 1999 Ford F150 pickup truck was presumed to be seated in an upright posture. The seat track position was not known however, given the height and weight of the driver, the seat was probably adjusted to the mid-track position. The seat back was slightly reclined prior the crash, and retained its pre-crash orientation during the crash. The driver was not restrained by the available 3-point lap and shoulder belt system. He was operating the vehicle at a high rate of speed and attempting to flee from police pursuit. The driver continued to operate the pickup truck in a straight direction as the roadway curved to the left. The first two impact events with the tree and the sign post may

have displaced the driver which resulted in contacts to the center console and front right seat arm rest however, he probably resumed an upright posture prior to the final impact with the large diameter tree cluster.

At impact with the tree, the redesigned frontal air bag system deployed. The driver initiated a forward trajectory in response to the frontal impact force. Due to the high delta-V, the driver subsequently loaded through the driver's redesigned air bag and uniformly loaded the steering wheel rim and hub. There was no deformation to the steering wheel rim however, the steering column was compressed. The driver sustained right 2-5 rib fractures with hemothorax and left 2-4 rib fractures, a liver contusion, and a right humerus capitae fracture. His knees contacted the knee bolster as evidenced by scuff marks on the rigid plastic bolster cover. His arms contacted the instrument panel as evidenced by scuff marks. His head flexed over the steering wheel rim and struck the windshield header which resulted in an indirect contact distraction injury of C1 with anterior ring fracture and dislocation of C1-C2, a brain stem injury with subarachnoid/subdural hemorrhage, and loss of consciousness. He rebounded rearward into the driver's seat back as the vehicle rotated clockwise (CW) to final rest. He was removed from the vehicle by rescue personnel and transported by ambulance to a local trauma center and admitted.

Medical Treatment

The 22-year-old male driver was hospitalized for twenty days. The day following his admission, he underwent surgery for an occipital cervical fusion and stabilization with a halo. He remained on a ventilator following his admission and seven days after his admission date underwent a percutaneous tracheostomy. During the hospital stay he developed pneumonia which was treated with antibiotics.

He was discharged to a rehabilitation facility. As of the discharge date, the driver had return of motor function, could sit and stand for multiple minutes, but still needed assistance with trunk control. He still had a trach tube and feeding tube in place and he was still being treated with antibiotics for pneumonia.