

**TRANSPORTATION SCIENCES  
CRASH RESEARCH SECTION**

Veridian  
Calspan Operations  
Buffalo, New York 14225

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

**NASS RABSS CASE NO. 1999-13-801E**

**RABSS VEHICLE - 1999 FORD TAURUS SE**

**LOCATION - STATE OF MICHIGAN**

**CRASH DATE - MAY, 1999**

Contract No. DTNH22-94-D-07058

Prepared for:

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

## **DISCLAIMER**

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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> 99-13-801E	2. <i>Government Accession No.</i>	3. <i>Recipient's Catalog No.</i>	
4. <i>Title and Subtitle</i> Redesigned Air Bag Special Study (RABSS) RABSS Vehicle - 1999 Ford Taurus SE Location - State of Michigan		5. <i>Report Date:</i> August, 1999	
		6. <i>Performing Organization Code</i>	
7. <i>Author(s)</i> Crash Research Section		8. <i>Performing Organization Report No.</i>	
9. <i>Performing Organization Name and Address</i> Transportation Sciences Crash Research Section Veridian Engineering (Calspan Operations) P.O. Box 400 Buffalo, New York 14225		10. <i>Work Unit No.</i> C01115.0225.(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 Summary Report Crash Date: May, 1999	
		14. <i>Sponsoring Agency Code</i>	
15. <i>Supplementary Notes</i> NASS investigation of a right side collision (into a fixed object) that involved a 1999 Ford Taurus SE with redesigned frontal air bags.			
16. <i>Abstract</i> <p>This investigation focused on a single vehicle crash involving a 1999 Ford Taurus SE 4-door sedan. The Ford Taurus was equipped with redesigned frontal air bags that deployed as a result of a right side collision with a large diameter tree. The Ford was southbound on a 2 lane rural roadway when a non-contact vehicle traveling northbound encroached into the path of the Ford. The Ford subsequently exited the left (east) pavement edge in a counterclockwise yaw following multiple steering maneuvers by the driver. As the Ford departed the left pavement edge, the front right area struck a small diameter tree resulting in superficial damage. At this point, the right front area impacted a large diameter tree which resulted in severe damage. The vehicle came to rest in close proximity to the point of impact facing northeast. The 18 year old male driver of the Ford Taurus was properly restrained by the 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the full rearward position. At impact, he initiated a forward/lateral trajectory in response to the 1 o'clock impact force and loaded the manual restraint resulting in a fractured left clavicle and associated contusions and abrasions to the chest/abdomen. Loading to the steering column resulted in a contusion to the medial aspect of the left knee. He also sustained a contusion to the posterior aspect of the right forearm from contact to the center instrument panel. The driver was transported by his parents to a local hospital for treatment and released.</p>			
17. <i>Key Words</i> Redesigned frontal air bag system Proper use of the manual belt system Collision Deformation Classification (CDC): 01-RFEW-3 Clavicle fracture		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> 6	22. <i>Price</i>

**TABLE OF CONTENTS**

BACKGROUND ..... 1

SUMMARY

    Crash Site ..... 1

    Pre-Crash ..... 1

    Crash ..... 2

    Post-Crash ..... 2

RABSS VEHICLE ..... 2

VEHICLE DAMAGE

    Exterior Damage ..... 3

    Interior Damage ..... 3

REDESIGNED AIR BAG SYSTEM ..... 3

DRIVER DEMOGRAPHICS ..... 4

    Driver Injuries ..... 4

    Driver Kinematics ..... 5

NASS SCENE DIAGRAM ..... 6

**REDESIGNED AIR BAG SPECIAL STUDY (RABSS)  
SCI TECHNICAL SUMMARY REPORT  
NASS RABSS CASE NO. 1999-13-801E  
RABSS VEHICLE - 1999 FORD TAURUS SE  
CRASH DATE - MAY, 1999**

***BACKGROUND***

This investigation focused on a single vehicle crash involving a 1999 Ford Taurus SE 4-door sedan. The Ford Taurus was equipped with redesigned frontal air bags that deployed as a result of a right side collision with a large diameter tree. The Ford was southbound on a 2 lane rural roadway when a non-contact vehicle traveling northbound encroached into the path of the Ford. The Ford subsequently exited the left (east) pavement edge in a counterclockwise yaw following multiple steering maneuvers by the driver. As the Ford departed the left pavement edge, the front right area struck a small diameter tree resulting in superficial damage. At this point, the right front area impacted a large diameter tree which resulted in severe damage. The vehicle came to rest in close proximity to the point of impact facing northeast. The 18 year old male driver of the Ford Taurus was properly restrained by the 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the full rearward position. At impact, he initiated a forward/lateral trajectory in response to the 1 o'clock impact force and loaded the manual restraint resulting in a fractured left clavicle and associated contusions and abrasions to the chest/abdomen. Loading to the steering column resulted in a contusion to the medial aspect of the left knee. He also sustained a contusion to the posterior aspect of the right forearm from contact to the center instrument panel. The driver was transported by his parents 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 99-13-801E 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.

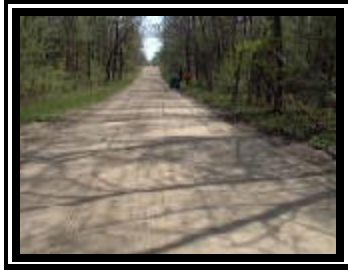
***SUMMARY***

**Crash Site**

This single vehicle crash occurred during the early evening hours of May, 1999. At the time of the crash, it was daylight with no adverse conditions as the road was dry. The crash occurred off the east pavement edge of a 2 lane north/south dirt and gravel roadway (see **Figure 7 - page 6**) which has a posted speed limit of 89 km/h (55 mph). No traffic controls were present at the scene.

**Pre-Crash**

The 18 year old male driver of the 1999 Ford Taurus was operating the vehicle southbound (**Figure 1**) and proceeding straight when he observed a non-contact vehicle traveling northbound encroach into his lane of travel. Upon recognition of the impending harmful event, the driver initially steered right in avoidance, partially exiting the right (west) pavement edge. At this point, the driver steered left/braked and subsequently exited the left (east) pavement edge in a counterclockwise yaw.



**Figure 1. Southbound approach for the 1999 Ford Taurus.**



**Figure 2. Impacted tree.**

### **Crash**

As the Ford exited the east pavement edge of the 2 lane rural roadway, the right front wheel struck an old log lying horizontally on the ground (with no resulting codeable damage). This intensified the counterclockwise rotation as the front right area impacted a small diameter tree resulting in superficial damage. The Collision Deformation Classification (CDC) for this initial impact to the Ford was 01-FREN-1. The Ford continued in a southeasterly direction and struck a large diameter tree (**Figure 2**) which resulted in severe right side damage. The impact induced deceleration was sufficient to deploy the Ford's redesigned frontal air bag system. Although the impact was classified as a yielding object (tree tilted-out of scope), the damage algorithm of the WinSMASH program computed a (barrier equivalent) velocity change of 21.4 km/h (13.3 mph). The respective longitudinal component was -18.6 km/h (-11.6 mph). The CDC for this impact to the Ford Taurus was 01-RFEW-3. The Ford rotated counterclockwise off the tree and came to rest in close proximity to the point of impact facing northeast.

### **Post-Crash**

The driver of the Ford Taurus exited the vehicle under his own power. Treatment was rendered at the scene by emergency medical technicians (EMT) and fire department personnel. The driver was transported by his parents to a local hospital for treatment and released. The vehicle was towed from the scene.

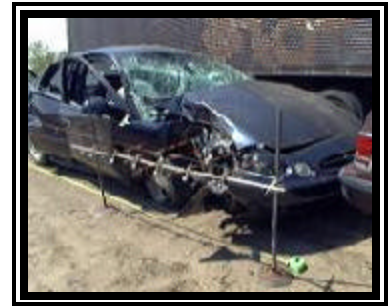
### ***RABSS VEHICLE***

The 1999 Ford Taurus SE was identified by the Vehicle Identification Number (VIN): 1FAFP53S6XG (production sequence deleted). The vehicle was a 4-door sedan equipped with front wheel drive and a 3.0 liter, V-6 engine. The vehicle's odometer reading was unknown at the time of the crash. The seating was configured with front bucket seats and a rear 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.

## **VEHICLE DAMAGE**

### **Exterior Damage**

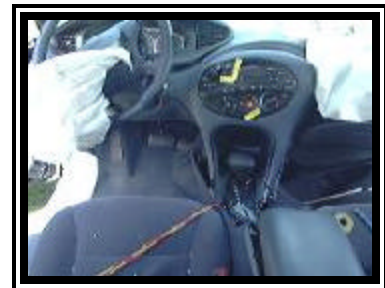
The Ford Taurus sustained severe right side damage as a result of the impact with the tree (**Figure 3**). The direct contact damage began 13.0 cm (5.1 in) aft of the front right bumper corner and extended 78.0 cm (30.7 in) rearward. The impact resulted in a combined direct and induced damage length (Field L) of 140.0 cm (55.1 in). Six crush measurements were documented at the level of the mid-door: C1= 0 cm, C2= 14.0 cm (5.5 in), C3= 44.0 cm (17.3 in), C4= 14.0 cm (5.5 in), C5= 24.0 cm (9.4 in), C6= 3.0 cm (1.2 in). Damage was noted to the hood which was displaced up and to the left from engagement against the tree. The right side wheelbase was displaced 49.0 cm (19.3 in). Induced damage was documented to the right A-pillar/side doors which shattered the side glazing and displaced the left front window frame outward 16.0 cm (6.3 in). Induced buckling was also noted to the roof area between the A and B-pillars. The windshield was fractured from exterior forces and the (interior) front right passenger air bag module cover flap.



**Figure 3. Right side damage to the 1999 Ford Taurus SE.**

### **Interior Damage**

Interior damage to the Ford Taurus identified through the NASS vehicle inspection was moderate and was attributed to intrusions/occupant contact (**Figure 4**). A scuff mark was noted to the left knee bolster (rigid plastic type). No steering wheel rim deformation was noted (tilt column placed between the full up and center position), however, a scuff mark was noted to the steering column just above the knee bolster. Although no contact evidence was identified on the air bags or exterior surface of the module cover flaps, black vinyl transfers were noted to the face of the driver air bag from expansion within the module. The center instrument panel and rear view mirror were smudged and fractured. The right mid-windshield area was fractured from the passenger air bag module cover flap. Intrusions into the front right passenger space included 17.0 cm (6.7 in) of longitudinal instrument panel intrusion, 8.0 cm (3.1 in) of longitudinal toepan intrusion, 28.0 cm (11.0 in) of lateral side panel intrusion and 7.0 cm (2.8 in) of vertical floor pan intrusion.



**Figure 4. Interior damage.**

## **REDESIGNED AIR BAG SYSTEM**

The 1999 Ford Taurus SE 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). No contact evidence was identified on the air bag or exterior surface of the module cover flaps. The flaps were rectangular in shape as the upper flap measured 15.5 cm (6.1 in) in width and 8.0 cm (3.1 in) in height while the lower flap measured 15.5 cm (6.1 in) in width and 6.0 cm (2.4 in) in height. Black vinyl transfers were noted to the



**Figure 5. 1999 Ford Taurus SE redesigned driver air bag.**

face of the air bag from expansion within the module. The NASS researcher measured the diameter of the driver air bag at 50.0 cm (19.7 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 a top mount module in the right instrument panel with a single cover flap design hinged at the forward 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 which opened in an upward direction toward the windshield (fractured) and measured 40.0 cm (15.7 in) in width and 25.0 cm (9.8 in) in height. The NASS researcher measured the passenger air bag at 50.0 cm (19.7 in) square in its deflated state (**Figure 7**). No tether straps were present. The bag was vented by two ports located at the 3 o'clock and 9 o'clock sectors on the side aspect of the air bag. No cutoff switch was reported for the front right air bag.



**Figure 6. 1999 Ford Taurus SE redesigned passenger air bag.**

**DRIVER DEMOGRAPHICS**

Age/Sex:	18 year old male
Height:	178 cm (70 in)
Weight:	66 kg (145 lb)
Seat Track Position:	Full rearward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, driver interview, medical records
Eyewear:	Contact lenses
Type of Medical Treatment:	Transported to a local hospital and released

**Driver Injuries**

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
Fracture left clavicle	Moderate (752200.2,2)	Shoulder belt webbing
Contusion left shoulder	Minor (790402.1,2)	Shoulder belt webbing
Abrasion left shoulder	Minor (790202.1,2)	Shoulder belt webbing
Contusion mid chest	Minor (490402.1,4)	Shoulder belt webbing
Abrasion mid chest	Minor (490202.1,4)	Shoulder belt webbing



<b>Driver Injuries (con't)</b> <i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
Contusion right posterior forearm	Minor (790402.1,1)	Center instrument panel
Contusion abdomen	Minor (590402.1,8)	Lap belt webbing
Abrasion abdomen	Minor (590202.1,8)	Lap belt webbing
Contusion bilateral knees (inside aspect)	Minor (890402.1,3)	Non-contact injury (knees knocked together)
Contusion right pelvis	Minor (890402.1,1)	Center armrest
Abrasion right pelvis	Minor (890202.1,1)	Center armrest
Contusion left pelvis	Minor (890402.1,2)	Left door panel
Contusion left medial knee	Minor (890402.1,2)	Steering column

### **Driver Kinematics**

The 18 year old male driver of the 1999 Ford Taurus SE was properly restrained by the available 3-point manual lap and shoulder belt system. He was seated in an upright posture with the seat track adjusted to the full rearward position and the belt anchorage adjustment set to the full-up position. Belt usage was determined by the nature of the injuries sustained relative to the lack of significant contact points within the vehicle. At impact, he initiated a forward/lateral trajectory in response to the 1 o'clock impact force and loaded the manual restraint resulting in a fractured left clavicle and multiple belt related contusions/abrasions to the chest and abdomen. Given the direction of force and resulting kinematic pattern, the driver moved laterally right, failing to contact the deployed redesigned air bag. His left lower extremity loaded the steering column which resulted in a contusion to the medial aspect of the left knee, evidenced by the scuff mark documented to this component. The driver continued the kinematic response pattern towards the front right as his right pelvic area loaded the center armrest, resulting in multiple abrasions and contusions. His posterior forearm struck the center instrument panel which resulted in a small contusion. This trajectory was evidenced by the deformed armrest and center instrument panel in conjunction with the existing kinematic pattern. At this point, he probably rebounded into the seat back and mid-door panel area resulting in a contusion to the left pelvis. The driver was transported by his parents to a local hospital for treatment and released.

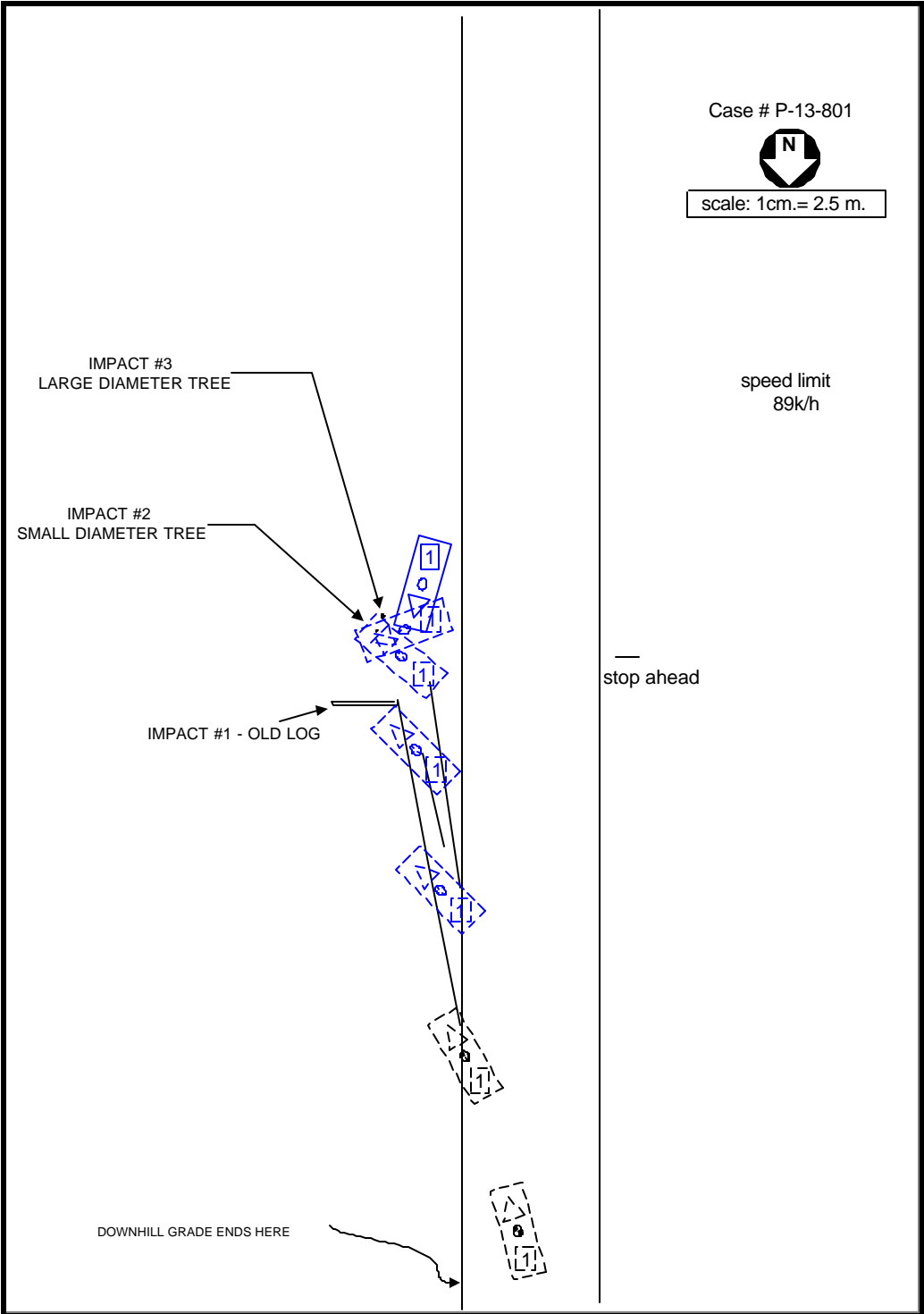


Figure 7. NASS Scene Diagram.