

**TRANSPORTATION SCIENCES  
CRASH RESEARCH SECTION**

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

**NASS CDS CASE NO. 1998-08-124A**

**RABSS VEHICLE - 1998 FORD TAURUS SE**

**LOCATION - STATE OF PENNSYLVANIA**

**CRASH DATE - AUGUST, 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. <i>Abstract</i> <p>This investigation focused on a two-vehicle crash involving a 1998 Ford Taurus SE 4-door sedan (subject vehicle) and a 1994 Ford Ranger XL pickup truck. The Ford Taurus was equipped with redesigned frontal air bags that deployed as a result of a head-on collision with the Ford Ranger. The Taurus was northbound (in the southbound lanes) on a 4-lane roadway and negotiating a right curve. The Ranger was southbound in the #2 curb lane and negotiating a left curve. As the vehicles crested a hill the front left area of the Taurus impacted the front left area of the Ranger resulting in severe damage to each vehicle. Both vehicles rotated counterclockwise as the front of the Ranger overrode the Taurus (with penetration into the windshield). This ramping effect to the pickup truck initiated a 4-quarter turn right side rollover which resulted in moderate top damage. The Taurus came to rest in the northbound lanes facing southwest. The Ranger came to rest (upright) in the southbound lanes facing northeast. The 24 year old male driver of the Ford Taurus was unrestrained (3-point manual lap and shoulder belt system available) and initiated a forward trajectory in response to the 12 o'clock impact force. He bottomed out the deployed redesigned driver air bag and loaded the steering wheel hub/rim resulting in a multitude of severe injuries to include a lacerated liver, thoracic aorta, atrium, ruptured pericardium and fractures of the right 4th-6th ribs (with hemothorax). He subsequently rode the steering column upward which resulted in fractures of the left femur and tibia. Penetration of the Ford Ranger into the passenger compartment resulted in fractures of the maxilla, left parietal bone, both temporal bones and a cerebral subarachnoid hemorrhage. The driver was pronounced dead at the scene as the driver of the Ford Ranger was transported to a local hospital for treatment and admitted for 5 days.</p>			
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CRASH DATE - AUGUST, 1998**

***BACKGROUND***

This investigation focused on a two-vehicle crash involving a 1998 Ford Taurus SE 4-door sedan (subject vehicle) and a 1994 Ford Ranger XL pickup truck. The Ford Taurus was equipped with redesigned frontal air bags that deployed as a result of a head-on collision with the Ford Ranger. The Taurus was northbound (in the southbound lanes) on a 4-lane roadway and negotiating a right curve. The Ranger was southbound in the #2 curb lane and negotiating a left curve. As the vehicles crested a hill the front left area of the Taurus impacted the front left area of the Ranger resulting in severe damage to each vehicle. Both vehicles rotated counterclockwise as the front of the Ranger overrode the Taurus (with penetration into the windshield). This ramping effect to the pickup truck initiated a 4-quarter turn right side rollover which resulted in moderate top damage. The Taurus came to rest in the northbound lanes facing southwest. The Ranger came to rest (upright) in the southbound lanes facing northeast. The 24 year old male driver of the Ford Taurus was unrestrained (3-point manual lap and shoulder belt system available) and initiated a forward trajectory in response to the 12 o'clock impact force. He bottomed out the deployed redesigned driver air bag and loaded the steering wheel hub/rim resulting in a multitude of severe injuries to include a lacerated liver, thoracic aorta, atrium, ruptured pericardium and fractures of the right 4<sup>th</sup>-6<sup>th</sup> ribs (with hemothorax). He subsequently rode the steering column upward which resulted in fractures of the left femur and tibia. Penetration of the Ford Ranger into the passenger compartment resulted in fractures of the maxilla, left parietal bone, both temporal bones and a cerebral subarachnoid hemorrhage. The driver was pronounced dead at the scene as the driver of the Ford Ranger was transported to a local hospital for treatment and admitted for 5 days.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 98-08-124A and was also included in 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 two-vehicle crash occurred during the morning hours of August, 1998. At the time of the crash, it was dark (street lighted) with no adverse conditions as the roads were dry. The crash occurred on a hillcrest in the southbound lanes of a 4-lane north/south asphalt roadway which curved to the right for southbound traffic (see **Figure 10 - page 8**). The speed limit at the crash scene was 64 km/h (40 mph) with no traffic control present.

### **Pre-Crash**

The 24 year old male driver of the 1998 Ford Taurus SE was operating the vehicle northbound (**Figure 1**) in the southbound lanes and negotiating a right curve at a (police reported) speed of 89 km/h (55 mph). The 20 year old male driver of the 1994 Ford Ranger XL was operating the vehicle southbound in the #2 curb lane (**Figure 2**) and negotiating a left curve (police reported speed unknown). Upon recognition of the impending harmful event, the driver braked (approximately 13.0 meters (42.7 ft) of pre-impact skid marks present but not documented by the NASS researcher) in avoidance remaining in the southbound travel lane prior to the collision.



**Figure 1. Northbound approach for the 1998 Ford Taurus SE.**



**Figure 2. Southbound approach for the 1994 Ford Ranger XL pickup truck.**

### **Crash**

As both vehicles crested the hill in the southbound lanes of the 4-lane roadway, the front left area of the Taurus struck the front left area of the Ranger. The impact induced deceleration was sufficient to deploy the Taurus' redesigned frontal air bag system. The damage algorithm of the WinSMASH program computed velocity changes of 63.2 km/h (39.3 mph) for the subject vehicle and 57.5 km/h (35.7 mph) for the struck Ranger. The specific longitudinal components were -63.2 km/h (-39.3 mph) (results somewhat high) and -57.5 km/h (-35.7 mph). The Collision Deformation Classification (CDC) for this impact to the Ford Taurus was 12-FYAW-6 and 12-FYEW-5 for the Ford Ranger. During the impact sequence, both vehicles rotated counterclockwise as the Ranger overrode the Taurus and subsequently penetrated the windshield continuing into the passenger compartment prior to vehicle separation. This ramping effect to the Ford Ranger initiated a 4-quarter turn right side rollover resulting in moderate top damage. The Collision Deformation Classification (CDC) for this secondary impact to the Ranger was 00-TDDO-2. The Ford Taurus came to rest in the northbound lanes facing southwest. The Ford Ranger came to rest (upright) in the southbound lanes facing northeast.

### **Post-Crash**

The driver of the Ford Taurus was entrapped by extensive interior intrusions and was pronounced dead at the scene. The driver of the Ford Ranger was removed from the vehicle with perceived serious injuries and was transported to a local hospital for treatment and admitted for 5 days. Treatment was rendered at the scene by emergency medical technicians (EMT's) and fire department personnel. Both vehicles were towed from the scene.

## ***RABSS VEHICLE***

The 1998 Ford Taurus SE was identified by the Vehicle Identification Number (VIN): 1FAFP52UXWG (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 police report listed a rental company as the owner of the vehicle. The seating was configured with a front split bench (with separate backs) and a rear bench. The NASS interview was not obtained, therefore previous crashes or maintenance on the air bag system were unknown.

## ***VEHICLE DAMAGE***

### **Exterior Damage**

The Ford Taurus sustained severe frontal damage as a result of the impact with the Ford Ranger pickup truck (**Figure 3**). The direct contact damage began at the front left bumper corner and extended 57.0 cm (22.4 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 96.0 cm (37.8 in). Six crush measurements were documented at the level of the bumper: C1= 83.0 cm (32.7 in), C2= 72.0 cm (28.3 in), C3= 50.0 cm (19.7 in), C4= 33.0 cm (13.0 in), C5= 18.0 cm (7.1 in), C6= 0 cm. Contact damage continued rearward to the A-pillar which restricted the left front door opening and shattered the side glazing. Additional damage was noted to the hood, A-pillar and windshield header area from the underride (**Figure 4**). Induced buckling was documented to the left rear door and roof area. The windshield was fractured from exterior forces and was removed by rescue personnel during the driver's extrication from the vehicle (roof pillars also cut). The left front wheel/tire was restricted and deflated.



**Figure 3. Frontal damage to the 1998 Ford Taurus SE.**



**Figure 4. Left side view of the 1998 Ford Taurus SE.**



**Figure 5. Frontal damage to the 1994 Ford Ranger XL.**

The Ford Ranger XL supercab 4x4 pickup truck sustained severe frontal damage as a result of the impact with the Ford Taurus (**Figure 5**). The direct contact damage began at the left front corner and extended 74.0 cm (29.1 in) inboard. Damage was noted to the hood which was displaced up and rearward from the impact force. The left front wheel was displaced 93.0 cm (36.6 in) rearward to the fire wall. The left fender was displaced rearward to the A-pillar which restricted the door opening and shattered the side glazing. The A-pillar and roof buckled from induced impact forces. Bed contact to the cab area displaced the rear panel into the passenger compartment area. Rollover damage was noted to the left, right and top areas of the vehicle with 3.0 cm (1.2 in) of maximum crush documented at the left C-pillar. The right rear wheel separated from the axle during the rollover. Post-crash damage was also noted to the left front door from a forced opening.

### **Interior Damage**

Interior damage to the Ford Taurus identified through the NASS vehicle inspection was severe (**Figure 6**) and was attributed to occupant contact and interior intrusions. Blood spattering and a scuff mark were documented to the lower section of the driver air bag. Several cuts to the air bag material were also identified from rescue efforts post-crash (steering wheel removed). Extensive damage was noted to the steering wheel rim with 10.0 cm (3.9 in) of displacement to the right half of the rim and 8.0 cm (3.1 in) to the left half. The (tilt-unknown position) steering column was displaced upward approximately 18.0 cm (7.1 in) to an almost vertical position. The left knee bolster (rigid plastic type) and instrument panel were fractured and scuffed from extensive loading. Longitudinal intrusions into the driver space included 45.0 cm (17.7 in) of instrument panel intrusion, 37.0 cm (14.6 in) of toepan intrusion, 43.0 cm (16.9 in) of windshield header intrusion, 30.0 cm (11.8 in) of A-pillar/steering assembly intrusion and an estimated opposing vehicle penetration of 30.0 cm (11.8 in). Vertical intrusions into the driver space included 17.0 cm (6.7 in) of roof panel intrusion and 11.0 cm (4.3 in) of roof side rail intrusion. Lateral intrusions into the driver space included 23.0 cm (9.1 in) of B-pillar intrusion, 18.0 cm (7.1 in) of kicker panel intrusion and 28.0 cm (11.0 in) of sill intrusion. Other intrusions included 13.0 cm (5.1 in) of longitudinal toepan/instrument panel intrusion into the front right seating area.



**Figure 6. Interior view of the 1998 Ford Taurus SE.**

### ***REDESIGNED AIR BAG SYSTEM***

The 1998 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). The flaps were rectangular in shape as the upper flap measured 15.0 cm (5.9 in) in width and 7.0 cm (2.8 in) in height as the lower flap measured 13.0 cm (5.1 in) in width and 6.0 cm (2.4 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, blood spattering and a scuff mark were documented to the lower section of the air bag. The air bag was also cut as rescue personnel removed the windshield (and steering wheel) during driver extrication. The NASS researcher measured the diameter of the driver air bag at 50.0 cm (19.7 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.



**Figure 7. 1998 Ford Taurus SE redesigned driver air bag.**



**Figure 8. 1998 Ford Taurus SE redesigned passenger 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. There was no contact evidence on the air bag or module cover flap which opened in an upward direction toward the windshield. The cover flap was asymmetrical in shape and measured 40.0 cm (15.7 in) in width and 27.0 cm (10.6 in) in height along the left edge of the flap and 16.0 cm (6.3 in) along the right edge. The NASS researcher measured the passenger air bag at 60.0 cm (23.6 in) in width and 40.0 cm (15.7 in) in height in its deflated state (**Figure 8**). No internal straps or vent ports were present. No cutoff switch was reported for the front right air bag.

**DRIVER DEMOGRAPHICS**

Age/Sex: 24 year old male  
 Height: 173 cm (68 in)  
 Weight: 69 kg (153 lb)  
 Seat Track Position: Middle position  
 Manual Restraint Use: None  
 Usage Source: NASS vehicle inspection, medical report, police report  
 Eyeware: Unknown  
 Type of Medical Treatment: Fatal at scene

**Driver Injuries**

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
Laceration thoracic aorta (intimal)	Severe (420202.4,4)	Steering wheel rim
Fracture both temporal bones	Severe (150206.4,8)	Exterior surface of opposing vehicle
Subarachnoid hemorrhage cerebellum	Serious (140466.3,6)	Exterior surface of opposing vehicle
Laceration right atrium	Serious (441008.3,4)	Steering wheel hub/rim
Contusion right lung (all lobes)	Serious (441406.3,1)	Steering wheel hub/rim
Fracture right 4 <sup>th</sup> - 6 <sup>th</sup> ribs (with hemothorax)	Serious (450222.3,1)	Steering wheel hub/rim
Fracture right radius (comminuted)	Serious (752804.3,1)	Left instrument panel
Fracture right ulna (comminuted)	Serious (753204.3,1)	Left instrument panel
Fracture left radius (comminuted)	Serious (752804.3,2)	Left instrument panel

Fracture left ulna (comminuted)	Serious (753204.3,2)	Left instrument panel
<b>Driver Injuries (con't.)</b>		
<b><i>Injury</i></b>	<b><i>Severity (AIS 90)</i></b>	<b><i>Injury Mechanism</i></b>
Fracture left distal femur (comminuted/open)	Serious (851800.3,2)	Steering column
Fracture left proximal tibia (comminuted/open)	Serious (853404.2,2)	Knee bolster
Rupture pericardium	Moderate (441602.2,4)	Steering wheel hub/rim
Laceration liver (anterior right lobe-6 cm x 10 cm)	Moderate (541822.2,1)	Steering wheel rim
Fracture maxilla (comminuted)	Moderate (250802.2,9)	Exterior surface of opposing vehicle
Fracture left parietal bone	Moderate (150400.2,2)	Exterior surface of opposing vehicle
Fracture left clavicle	Moderate (752200.2,2)	Steering wheel rim (upper portion)
Abrasion nose (2 cm x 1 cm)	Minor (290202.1,4)	Windshield
Laceration chin (3 cm x 1 cm)	Minor (290602.1,8)	Windshield
Abrasion left scalp (6 cm x 4 cm)	Minor (190202.1,2)	Exterior surface of opposing vehicle
Laceration left scalp (5 cm x .4 cm)	Minor (190602.1,2)	Exterior surface of opposing vehicle
Contusion left scalp	Minor (190402.1,2)	Exterior surface of opposing vehicle
Abrasion left lateral chest (linear/vertical-4 cm x .5 cm)	Minor (490202.1,2)	Steering wheel hub/rim
Abrasions (bilateral) lower extremities (proximal to knee-linear)	Minor (890202.1,3)	Steering wheel rim (lower portion)
Abrasion right lower extremity (distal to knee-5 cm x 3 cm)	Minor (890202.1,1)	Knee bolster
Contusion (bilateral) lower extremities (proximal to knee-5 cm x 4 cm)	Minor (890402.1,3)	Steering wheel rim (lower portion)
Laceration left knee (12 cm x 6 cm)	Minor (890602.1,2)	Steering column
Laceration left lower extremity (distal to knee-2 cm x 1 cm)	Minor (890602.1,2)	Knee bolster
Contusion right posterior forearm	Minor (790402.1,1)	Left instrument panel

### Driver Kinematics

The 24 year old male driver of the Ford Taurus was presumed to be seated in an upright posture with the seat back slightly reclined and the seat track adjusted to the middle position. The police report noted that he was not belted, further evidenced by the lack of loading marks to the manual restraint webbing and extensive occupant contact damage to the vehicle interior.



**Figure 9. Steering wheel rim/hub deformation.**

At impact, the driver initiated a forward trajectory in response to the 12 o'clock impact force and bottomed out the deployed redesigned driver air bag, subsequently loading the steering wheel hub/rim resulting in extensive multiple injuries which included fractures of the right 4<sup>th</sup>-6<sup>th</sup> ribs (with hemothorax), a contusion to the right lung, a lacerated liver, thoracic aorta, right atrium and a ruptured pericardium. This mechanism was evidenced by the severe deformation to the steering wheel hub/rim (**Figure 9**) relative to the driver's lack of restraint use. His upper extremities contacted the mid-instrument panel area which resulted in bilateral fractures of the radius/ulna as evidenced by the indentations and displacement of the left instrument panel. His lower extremities loaded the knee bolster and steering column (shifted to an almost vertical position) resulting in bilateral contusions/abrasions and fractures of the left femur and tibia/fibia, evidenced by the scuff marks and displacement documented to these components.

At this point, the driver continued the kinematic response pattern into the windshield as the Ford Ranger penetrated the passenger compartment. He probably impacted the frontal area of the Ranger which resulted in a fractured maxilla, left parietal bone, both temporal bones and a cerebral subarachnoid hemorrhage. There was no evidence to support *interior sources* for these injuries, therefore, the SCI investigator concluded the injuries were related to the intrusion of the Ford Ranger. Penetration was evidenced by the longitudinal extent of the damage to the Taurus exterior in relation to the height of the damage at the left A-pillar and windshield header. His lower extremities were entrapped between the steering wheel and toe/floorpan requiring extensive extrication efforts. The driver was pronounced dead at the scene. His blood alcohol content was .252. Given the gross intrusions and the high severity of the crash, it is the SCI investigator's opinion that this was a non-survivable crash. The 3-point manual restraint would have provided some protection, but belt usage in conjunction with the air bag would have proved most beneficial.

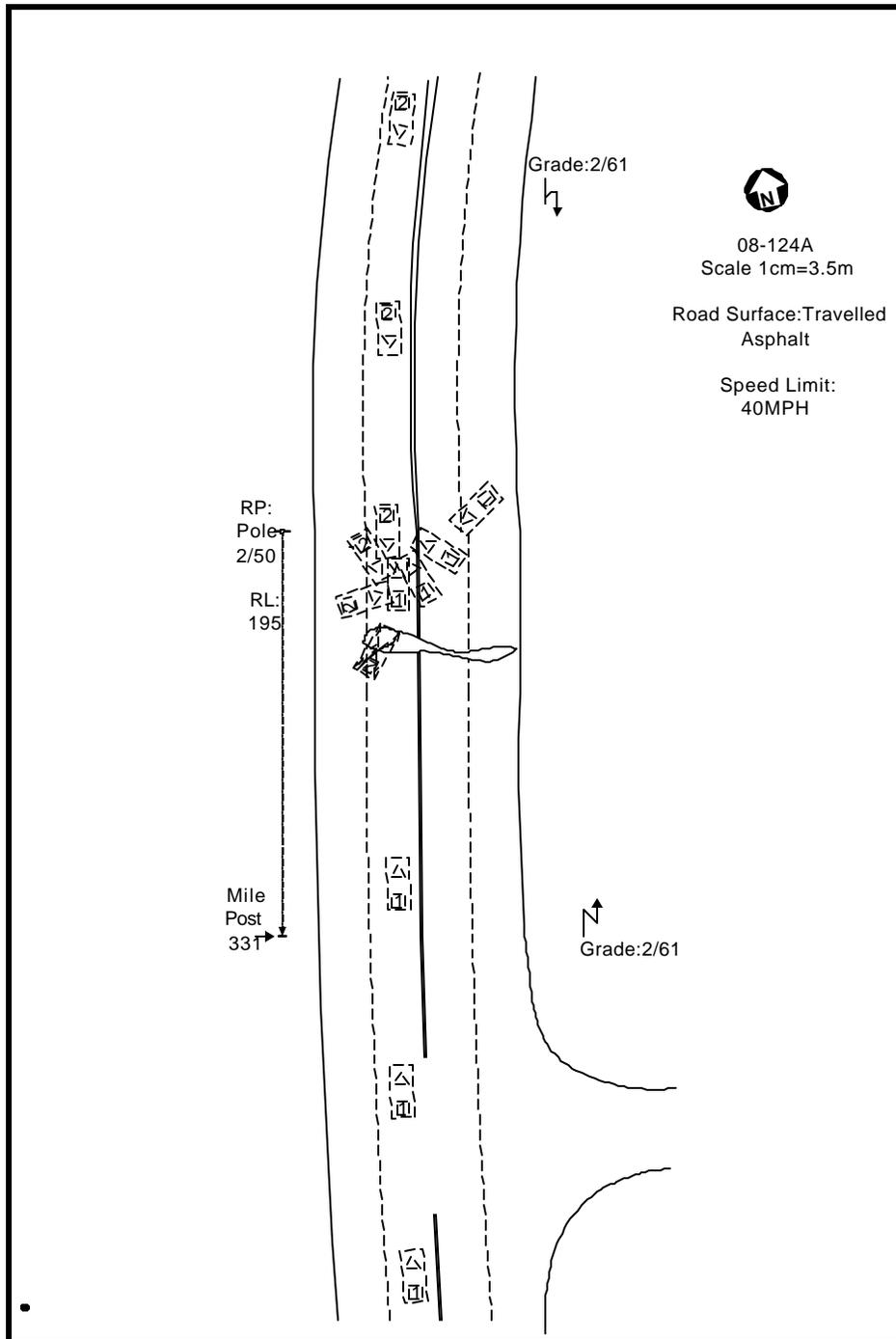


Figure 10. NASS Scene Diagram