

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. 1999-11-196J

RABSS VEHICLE - 1999 DODGE STRATUS ES

LOCATION - STATE OF MICHIGAN

CRASH DATE - DECEMBER, 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> 99-11-196J | 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 Dodge Stratus ES Location - State of Michigan | | 5. <i>Report Date:</i> October, 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> Crash Data Research Center Veridian Engineering Division P.O. Box 400 Buffalo, New York 14225 | | 10. <i>Work Unit No.</i> C01115.0298.(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 - December, 1999 | |
| | | 14. <i>Sponsoring Agency Code</i> | |
| 15. <i>Supplementary Notes</i> NASS investigation of a rear-end collision that involved a 1999 Dodge Stratus ES 4-door sedan equipped with redesigned frontal air bags. | | | |
| 16. <i>Abstract</i> This investigation focused on a two vehicle crash involving a 1999 Dodge Stratus ES 4-door sedan (subject vehicle) and a 1994 Peterbilt 377 conventional tractor-trailer. The Dodge Stratus was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of a rear-end collision with the Peterbilt tractor-trailer. The driver of the Dodge Stratus was operating the vehicle westbound in the outboard lane of a 4-lane divided interstate highway when she completed a passing maneuver and failed to observe the Peterbilt slowing for traffic congestion ahead. As the Dodge re-entered the outboard lane, the frontal area impacted the rear left area of the Peterbilt resulting in moderate damage. The restrained 45 year old female driver of the 1999 Dodge Stratus initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, knee bolster, and deployed redesigned driver air bag. Loading of the manual restraint resulted in a fracture of the right fourth rib while contact to the knee bolster resulted in fractures of the right femur and pelvis. She also sustained bilateral distal fibula fractures from contact to the (intruded) toepan. She was transported by ambulance to a local trauma center for treatment and admitted for 11 days. | | | |
| 17. <i>Key Words</i> Redesigned frontal air bag system Collision Deformation Classification (CDC): 12-FDEW-3 Proper use of the manual belt system Amnesia | | 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 | 3 |
| Interior | 3 |
| REDESIGNED AIR BAG SYSTEM | 3 |
| DRIVER DEMOGRAPHICS | 4 |
| Driver Injuries | 5 |
| Driver Kinematics | 5 |
| NASS SCENE DIAGRAM | 6 |

**REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
SCI TECHNICAL SUMMARY REPORT
NASS CDS CASE NO. 1999-11-196J
RABSS VEHICLE - 1999 DODGE STRATUS ES
CRASH DATE - DECEMBER, 1999**

BACKGROUND

This investigation focused on a two vehicle crash involving a 1999 Dodge Stratus ES 4-door sedan (subject vehicle) and a 1994 Peterbilt 377 conventional tractor-trailer. The Dodge Stratus was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of a rear-end collision with the Peterbilt tractor-trailer. The driver of the Dodge Stratus was operating the vehicle westbound in the outboard lane of a 4-lane divided interstate highway when she completed a passing maneuver and failed to observe the Peterbilt slowing for traffic congestion ahead. As the Dodge re-entered the outboard lane, the frontal area impacted the rear left area of the Peterbilt resulting in moderate damage. The restrained 45 year old female driver of the 1999 Dodge Stratus initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, knee bolster, and deployed redesigned driver air bag. Loading of the manual restraint resulted in a fracture of the right fourth rib while contact to the knee bolster resulted in fractures of the right femur and pelvis. She also sustained bilateral distal fibula fractures from contact to the (intruded) toepan. She was transported by ambulance to a local trauma center for treatment and admitted for 11 days.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 1999-11-196J 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 two vehicle crash occurred during the early morning hours of December, 1999. At the time of the crash, it was dark (street not lighted) with no adverse conditions as the roads were dry. The crash occurred in the westbound lanes of a straight east/west 4-lane interstate highway with a positive grade for westbound traffic (see **Figure 7 - page 6**). The asphalt travel lanes were divided by a grass median and bordered by wide paved shoulders which included a tactile warning device (rumble strips). No traffic control was present at the crash site which had a posted speed limit of 113 km/h (70 mph).

Pre-Crash

The 45 year old female driver of the 1999 Dodge Stratus ES was operating the vehicle westbound (**Figure 1**) in the outboard lane at a (driver reported) speed of 121 km/h (75 mph) when she changed lanes to the left to pass a westbound (non-contact) slow moving vehicle traveling ahead. She completed

the passing maneuver and re-entered the outboard lane behind the Peterbilt. The Dodge driver subsequently failed to observe the Peterbilt slowing for traffic congestion. Upon recognition of the impending harmful event, the Dodge driver steered left in avoidance.

Crash

As the Dodge Stratus re-entered the outboard (westbound) lane, the frontal area impacted the rear left area of the Peterbilt resulting in moderate damage. Although the impact was classified as out-of-scope, the WinSMASH reconstruction program computed a barrier equivalent velocity change of 44.9 km/h (27.9 mph) with a longitudinal component of -44.2 km/h (-27.5 mph). The impact induced deceleration was sufficient to deploy the Dodge's redesigned frontal air bag system. At this point, the Dodge traveled approximately 28.0 meters (91.9 feet) onto the north shoulder and came to rest facing northwest (**Figure 2**) as the Peterbilt was driven to final rest along the north shoulder facing west.



Figure 1. Westbound approach for the 1999 Dodge Stratus ES.



Figure 2. Look back view (east) from vehicle final rest showing post-impact yaw marks onto north shoulder.

Post-Crash

The driver of the Dodge exited the vehicle with some assistance from a witness. The exit status (and *any* subsequent treatment) of the Peterbilt driver was unknown, however, he was reported by police as uninjured. The Dodge was towed from the scene due to disabling damage as the Peterbilt was driven from the scene.

RABSS VEHICLE

The 1999 Dodge Stratus ES was identified by the vehicle identification number (VIN): 1B3EJ56HXXN (production number deleted). The vehicle was a 4-door sedan equipped with front-wheel drive and a 2.5 liter, V-6 engine. The police report did not identify the owner of the vehicle. At the time of the crash, the odometer had recorded 9,656 km (6,000 miles). The seating was configured with front bucket and rear bench seats (with folding backs). The driver reported no previous crashes or maintenance on the Dodge's frontal air bag system. A cell phone was present but not in-use at the time of the collision.

VEHICLE DAMAGE

Exterior

The 1999 Dodge Stratus ES sustained moderate frontal damage as a result of the impact with the Peterbilt (**Figure 3**). The direct contact damage encompassed the entire end width resulting in a combined direct and induced damage length (Field L) of 81.0 cm (31.9 in). Six crush measurements were documented at the level of the lower radiator (*bumper reinforcement bar and fascia separation*): C1= 28.0 cm (11.0 in), C2= 49.0 cm (19.3 in), C3= 51.0 cm (20.1 in), C4= 53.0 cm (20.9 in), C5= 46.0 cm (18.1 in), C6= 37.0 cm (14.6 in). The Collision Deformation Classification (CDC) for this impact to the Dodge was 12-FDEW-3 with a principal direction of force of (-)10 degrees. The hood was deformed up and rearward from engagement against the rear surface of the Peterbilt. The windshield was fractured from exterior impact forces and the interior front right passenger air bag deployment. A 15.2 cm (6.0 in) slit was identified along the right lower windshield from possible penetration of the opposing vehicle. The right fender was deformed rearward which jammed the front door. The left fender was deformed laterally which restricted the left front wheel/tire (not deflated). Induced contact damage also produced buckling of both A-pillars, front roof side rails, and roof. Reduction in the right side wheelbase measured 4.0 cm (1.2 in).



Figure 3. Frontal damage to the 1999 Dodge Stratus ES.

Interior

Interior damage to the Dodge Stratus identified through the vehicle inspection was minimal and was attributed to occupant contact and component intrusion (**Figure 4**). Scuff marks were documented on the left knee bolster (rigid plastic type), sunvisor, and roof panel. The instrument cluster located on the center instrument panel was slightly pushed inward with the surrounding trim panel displaced. The rearview mirror was displaced to the right (undamaged). The roof glazing was disintegrated. Longitudinal intrusions into the front occupant space involved 7.0 cm (2.8 in) of right toepan, 5.0 cm (2.0 in) of left toepan, 5.0 cm (2.0 in) of left instrument panel, 4.0 cm (1.6 in) of center instrument panel, and 6.0 cm (2.4 in) of right instrument panel intrusion. Vertical intrusions into the driver space involved 3.0 cm (1.2 in) of roof intrusion.

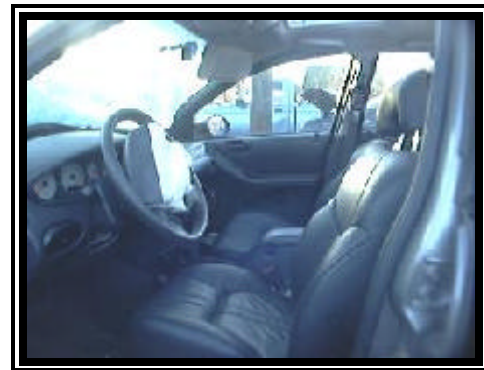


Figure 4. Interior view.

REDESIGNED AIR BAG SYSTEM

The 1999 Dodge Stratus was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags 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 symmetrical in shape and measured 21.0 cm (8.3 in) in width and 7.0 cm (2.8 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, blood spattering was noted on the right portion of the air bag face. The NASS researcher measured the diameter of the driver air bag at 55.0 cm (21.7 in) in its deflated state (**Figure 5**). The bag was tethered by two internal straps and vented by one port located at the 12 o'clock sector on the rear aspect of the air bag.

The front right passenger air bag deployed from the right top instrument panel area with a single cover flap design hinged at the forward aspect. The cover flap was rectangular in shape and measured 37.0 cm (14.6 in) in width and 21.0 cm (8.3 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flap, blood spattering was also noted along the lower left quadrant of the air bag face. The NASS researcher measured the passenger air bag at 66.0 cm (26.0 in) in width and 68.0 cm (26.8 in) in height in its deflated state (**Figure 6**). No internal tether straps or vent ports were present.



Figure 5. 1999 Dodge Stratus ES deployed redesigned driver air bag.



Figure 6. 1999 Dodge Stratus ES deployed redesigned passenger air bag.

DRIVER DEMOGRAPHICS

| | |
|----------------------------|--|
| Age/Sex: | 45 year old female |
| Height: | 173 cm (68 in) |
| Weight: | 77 kg (170 lb) |
| Seat Track Position: | Mid-to-rear position |
| Manual Restraint Use: | 3-point lap and shoulder belt system |
| Usage Source: | NASS vehicle inspection, driver interview, police report |
| Eyeware: | None |
| Type of Medical Treatment: | Transported to a local hospital and admitted (11 days) |

Driver Injuries

| <i>Injury</i> | <i>Severity (AIS 90)</i> | <i>Injury Mechanism</i> |
|---|--------------------------|--|
| *Fracture right femur (head) | Serious (851808.3,1) | Left knee bolster |
| *Fracture left distal radius (displaced / comminuted) | Serious (752804.3,2) | Left instrument panel |
| *Fracture left fibula (bimalleolar ankle) | Serious (851614.3,2) | Left toepan |
| +Awake upon admission with reported amnesia | Moderate (160410.2,0) | Driver air bag |
| *Fracture right pelvis (posterior acetabulum - closed) | Moderate (852602.2,1) | Left knee bolster (indirect contact injury) |
| *Fracture right distal fibula (involving lateral malleolus) | Moderate (851608.2,1) | Left toepan |
| *Fracture right anterior fourth rib (no associated pneumothorax) | Minor (450212.1,1) | Shoulder belt webbing |
| #Laceration right posterior wrist (small) | Minor (790602.1,1) | Center instrument panel |

sources - discharge summary / ER report+ / interviewee#*

Driver Kinematics

The 45 year old female driver of the 1999 Dodge Stratus ES 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. Her hands were placed at the 10 o'clock and 2 o'clock positions on the steering wheel rim. The driver stated she was belted, further evidenced by the lack of significant interior contacts and injury.

At impact, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, knee bolster, and deployed redesigned driver air bag. Loading of the manual restraint resulted in a fracture of the right anterior fourth rib, evidenced by the location of the fracture relative to the driver's stated belt placement pre-crash (*injury erroneously assigned to the right third rib with a pneumothorax in the NASS case file*). Contact to the knee bolster resulted in a right femur fracture which produced an associated (indirect contact) fracture of the right pelvis. These injury mechanisms were evidenced by the scuff marks documented to the knee bolster and associated posterior fracture pattern of the acetabular wall. Although no direct head trauma was reported, the driver had no recollection of crash events (amnesia) which was sourced to the deployed redesigned driver air bag in the NASS case file. She also sustained a distal left radius (wrist) fracture as a result of contact to the left mid-instrument panel area. A possibility exists that this fracture may have been a result of an air bag fling type injury into the left sunvisor, however, the lack of supporting soft tissue injury to the anterior aspect of the forearm made this an unlikely mechanism. Her right hand struck the climate controls which resulted in a small laceration to the posterior wrist, evidenced by the deformation documented to this

component (*injury erroneously sourced to the rear-view mirror in the NASS case file*). Loading of the (intruded) toepan resulted in bilateral distal fibula (ankle) fractures as evidenced by the aspect of the fractures relative to the driver's stated placement of the feet on the floor/control pedals pre-crash. Following the crash, she exited the vehicle with some assistance from her husband (traveling in a separate westbound vehicle) and was transported by ambulance to a local trauma center for treatment and admitted for 11 days. The redesigned air bag provided additional protection against further contact to the steering wheel hub/rim, and potential fatal injury.

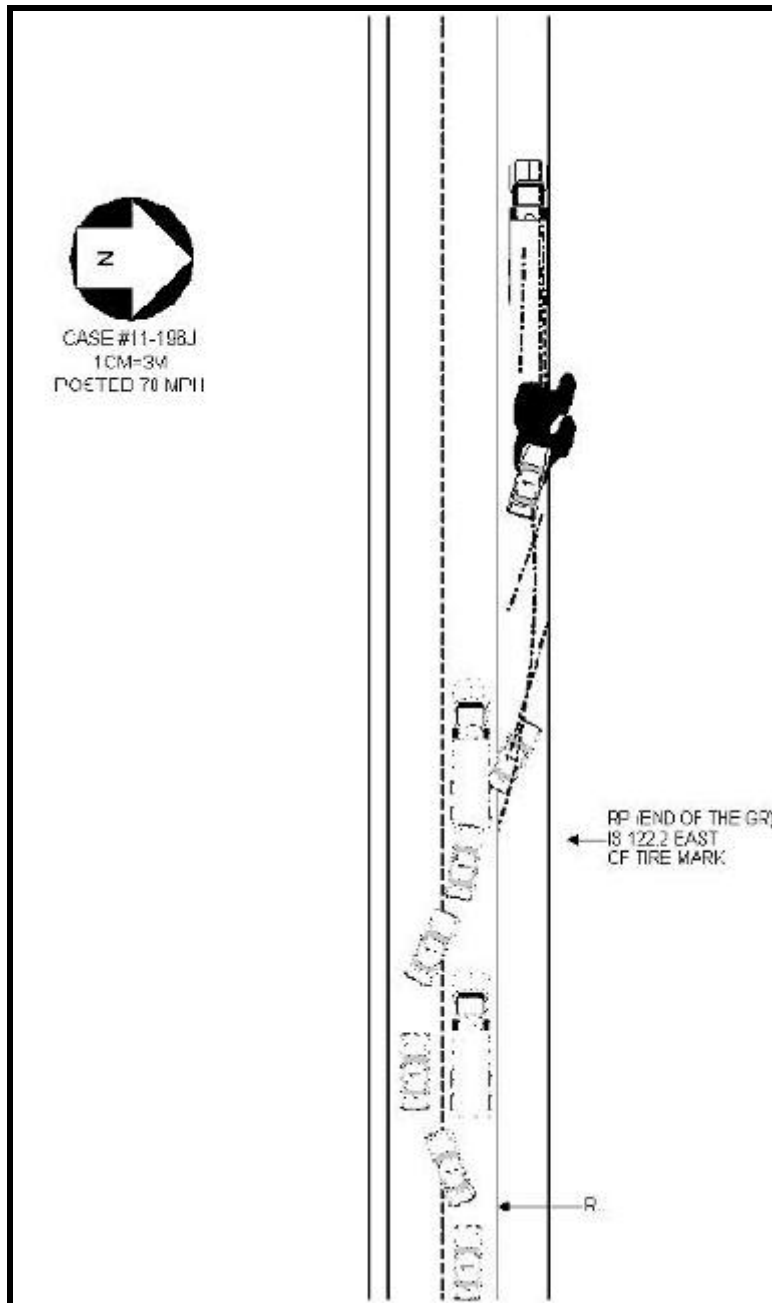


Figure 7. NASS Scene Diagram.