TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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REMOTE REDESIGNED AIR BAG DEPLOYMENT INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

VERIDIAN CASE NO. CA99-065

RABSS VEHICLE - 1998 DODGE RAM PICKUP TRUCK

LOCATION - STATE OF NEW YORK

CRASH DATE - NOVEMBER 1998

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.

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15. *Supplementary Notes* Remote investigation of a head-on crash of a Dodge Ram pickup truck with a tractor/semi-trailer truck that resulted in a deployment of the redesigned frontal air bag system in the pickup truck and the death of the 27-year-old male driver.			
16. *Abstract* This investigation focused on a two vehicle crash that involved a 1998 Dodge Ram conventional cab pickup truck (subject vehicle) and a tractor/semi-trailer. The 6-axle power unit was a 1997 Volvo conventional cab, and the 2-axle Trailmobile trailer was a van/enclosed box type. The Dodge pickup truck was equipped with redesigned frontal air bags that deployed as a result of the collision with the tractor/semi-trailer truck. The Dodge pickup truck was southbound on a two-lane undivided state highway when it detected the tractor/semi-trailer encroaching into the lane from the opposite direction. The tractor/semi-trailer had initiated a passing maneuver around an uninvolved vehicle and upon recognition of the impending harmful event with the Dodge pickup truck, attempted several unsuccessful avoidance maneuvers. The front left corner of the Dodge pickup truck struck the left drive axles of the power unit and continued to under ride the left front corner of the trailer, which caused severe damage to the front and left side of the pickup truck and moderate damage to the Volvo power unit and trailer. The forward momentum of the tractor/semi-trailer caused rapid deceleration of the Dodge pickup truck and pushed it rearward to final rest on the west side of the roadway. The tractor/semi-trailer came to rest in a jackknife position with the front aspect of the power unit against the east side guardrail. The 27-year-old driver of the Dodge pickup truck loaded the manual restraint and probably contacted the deploying air bag as the various interior components intruded into the passenger compartment. He sustained fatal injuries as a result of the collision and was pronounced dead at the scene. The front right passenger of the Dodge pickup truck was also restrained by the 3-point lap and shoulder belt system and initiated a forward trajectory. He loaded the manual restraint and contacted the deployed air bag which provided additional restraint. He was transported by ambulance to a local hospital with unspecified elbow/lower arm/hand injuries. His admission status was not reported. The driver of the Volvo tractor/semi-trailer was transported by ambulance to a local hospital with unspecified back injuries.			
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BACKGROUND

This investigation focused on a two vehicle crash that involved a 1998 Dodge Ram conventional cab pickup truck (subject vehicle) and a tractor/semi-trailer. The 6-axle power unit was a 1997 Volvo conventional cab, and the 2-axle Trailmobile trailer was a van/enclosed box type. The Dodge pickup truck was equipped with redesigned frontal air bags that deployed as a result of the collision with the tractor/semi-trailer truck. The Dodge pickup truck was southbound on a two-lane undivided state highway when it detected the tractor/semi-trailer encroaching into the lane from the opposite direction. The tractor/semi-trailer had initiated a passing maneuver around an uninvolved vehicle and upon recognition of the impending harmful event with the Dodge pickup truck, attempted several unsuccessful avoidance maneuvers. The front left corner of the Dodge pickup truck struck the left drive axles of the power unit and continued to under ride the left front corner of the trailer, which caused severe damage to the front and left side of the pickup truck and moderate damage to the Volvo power unit and trailer. The forward momentum of the tractor/semi-trailer caused rapid deceleration of the Dodge pickup truck and pushed it rearward to final rest on the west side of the roadway. The tractor/semi-trailer came to rest in a jackknife position with the front aspect of the power unit against the east side guardrail. The 27-year-old driver of the Dodge pickup truck loaded the manual restraint and probably contacted the deploying air bag as the various interior components intruded into the passenger compartment. He sustained fatal injuries as a result of the collision and was pronounced dead at the scene. The front right passenger of the Dodge pickup truck was also restrained by the 3-point lap and shoulder belt system and initiated a forward trajectory. He loaded the manual restraint and contacted the deployed air bag which provided additional restraint. He was transported by ambulance to a local hospital with unspecified elbow/lower arm/hand injuries. His admission status was not reported. The driver of the Volvo tractor/semi-trailer was transported by ambulance to a local hospital with unspecified back injuries.

This crash was identified through a search of the Fatality Analysis Reporting System (FARS) for fatalities that occurred in vehicles equipped with redesigned air bags. The crash occurred in November 1998 and was assigned to the Veridian Special Crash Investigation Team on September 2, 1999 as a remote investigation effort. Police photographs and insurance data were obtained which provided the basis for this narrative report.

SUMMARY

Crash Site

This two vehicle crash occurred during the nighttime hours of November 1998. At the time of the crash, it was dark and the roadway was unlighted. There were no adverse road conditions as the asphalt road surface was dry. The crash occurred on a straight and level portion of a 2-lane undivided highway that curved to the left approximately 0.40 km (.25 miles) north of the crash site. The roadside environment consisted of asphalt shoulders adjacent to the roadway, the east shoulder bordered by a guardrail that extended into the curve. Adjacent to the shoulders were grass and wooded areas. There were no traffic controls present at the scene. The posted speed limit was 89 km/h (55 mph) **(Figure 1)**.

Figure 1. View of crash site looking south

Pre-Crash

The tractor/semi-trailer was northbound and had initiated a passing maneuver around an uninvolved vehicle. The driver of the tractor/semi-trailer saw the illumination of the headlights from the Dodge pickup truck approaching from around the curve. The driver of the tractor/semi-trailer attempted to avoid the collision and applied the air brakes in full-lockup and steered to the right, attempting to re-enter the northbound lane **(Figure 2)**. As the power unit entered the northbound lane, the driver began to lose control and steered left in an attempt to regain control of the tractor/semi-trailer **(Figure 3)**. The loss of control was attributed to trailer swing caused by the multiple steering inputs. The power unit re-entered the southbound lane which caused the tractor/semi-trailer to travel in a slightly clockwise (CW) articulation into the path of the pickup truck.

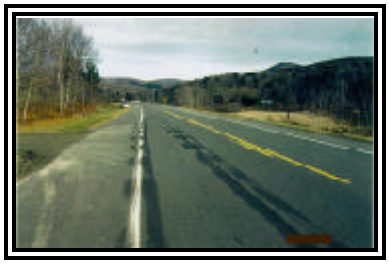

Figure 2. Northbound approach for the tractor/semi-trailer prior to steering inputs showing skid marks from power unit and trailer

Figure 3. Northbound approach for the tractor/semi-trailer showing skid marks from attempted avoidance maneuvers

The 27-year-old male driver was operating the Dodge Ram pickup truck southbound and was exiting a curve to the right onto the straight portion of the roadway when he detected the oncoming tractor/semi-trailer traveling in the opposite direction in the same lane **(Figure 4)**. The driver of the Dodge pickup truck realizing the impending harmful event, steered right and traveled onto the shoulder in an attempt to avoid the collision with the tractor/semi-trailer truck. The tractor/semi-trailer driver steered hard right immediately prior to the impact, while the trailer continued in a forward direction of travel.

Figure 4. Southbound approach for the Dodge pickup truck

Crash

The front left area of the Dodge pickup truck impacted the left leading drive axle of the power unit. As the tractor/semi-trailer engaged the Dodge pickup truck, the forward momentum of the tractor/semi-trailer arrested the forward momentum of the pickup truck. The principal direction of force was in the 11 o'clock sector for the pickup truck. The left leading drive axle and leading left corner of the trailer penetrated the frontal plane of the pickup truck outboard of the left frame rail and continued down the left side to the rear axle. The left A-pillar impacted the front left corner of the trailer which caused severe rearward and lateral displacement of the sheet metal and severe damage to the left side of the greenhouse area **(Figure 5)**. The momentum of the tractor/semi-trailer and clockwise (CW) yaw of the power unit redirected the pickup truck rearward while it rotated approximately 90 degrees in a counterclockwise (CCW) direction to final rest on the west road side facing east **(Figure 6)**. The tractor/semi-trailer power unit traveled across the centerline in a CW yaw, and came to rest against the east guide rail in a jackknife position **(Figure 7)**.

Figure 5. On-scene photograph showing final rest position of the pickup truck

Figure 6. Point of impact and final rest position for the pickup truck

Figure 7. On-scene photograph showing final rest position of the tractor/semi-trailer truck

Post-Crash

The driver of the Dodge pickup truck was pinned in the vehicle due to massive longitudinal and lateral component intrusions. Based on the police report, he was unresponsive upon arrival of rescue personnel and presumed to have died following the initial impact. The front right passenger of the Dodge pickup truck was removed by rescue personnel with hydraulic equipment and transported by ambulance to a local

hospital for treatment. His admission status was not reported. It was unknown how the driver of the tractor/semi-trailer exited the vehicle. He was transported by ambulance to a local hospital and released.

RABSS VEHICLE

The 1998 Dodge Ram Pickup truck was identified by the Vehicle Identification Number (VIN): 1B7HF16Y4WS (production sequence omitted). The vehicle was a 1500-series, 2-door, full size, 4x4, conventional cab pickup truck. It was equipped with a 5.2 liter, V-8 engine. The police report listed the driver as the owner of the vehicle. The seating was configured with a 40/20/40 split-bench front seat with folding backs and fold-down center armrest.

VEHICLE DAMAGE

Exterior Damage - ***1998 Dodge Ram Pickup Truck***

The 1998 Dodge Ram Pickup truck sustained severe left side damage as a result of the impact with the tractor/semi-trailer. The direct contact damage began approximately 44 cm to the left of the center of the bumper and extended approximately 46 cm (18") to the left front bumper corner. The direct damage continued down the left side of the vehicle approximately 398 cm (157") rearward, ending approximately at the rear axle **(Figure 8)**. The dimensions were estimated by comparing the damage of the subject vehicle to an exemplar vehicle. The Collision Deformation Classification (CDC) for this impact was 11-FLAE-9 incremented by 60 due to front end-shift of approximately 20 cm (8"). The direct contact damage extended vertically from the left front wheel up the entire side of the vehicle from the impact with the rear of the power unit. Direct contact damage was noted by longitudinal scratches on the hood from the under ride with the corner of the trailer. Direct contact damage was also noted by damage to the left A-pillar and roof from the impact with the corner of the trailer. The hood was displaced forward and to the right. The front axle, left A-pillar, left B-pillar, and rear bed of the pickup truck were all displaced rearward. The left front wheel rim was bent from contact with the leading drive axle of the power unit, and the left front tire was deflated. The pickup truck bed was displaced upward and rearward from impact forces. The cab was shifted laterally to the right approximately 30 cm (12"). The height of the direct contact damage surpassed the level of the beltline producing induced buckling to the roof and separation of the left front A-pillar at the bottom of the windshield. The left side door tempered glazing had disintegrated from impact forces. The windshield was fractured and bond separation noted along the header and left side areas. The maximum crush was along the left side of the pickup truck outboard of the frame rail and extended from the front left bumper corner to the left rear wheel **(Figure 9)**.

Figure 8. Frontal view of exterior damage to the Dodge pickup truck

Figure 9. Left side damage to the Dodge pickup truck

Interior Damage - ***1998 Dodge Ram Pickup Truck***

Interior damage to the Dodge Ram pickup truck was severe and was attributed to longitudinal component intrusion, the most severe being on the left side of the vehicle **(Figure 10)**. Left front intrusions included the left A-pillar, upper and lower instrument panel and toepan, left door, windshield header and B-pillar. The steering column was displaced rearward and downward coming to rest on top of the driver's thighs. The steering wheel rim was severely deformed with the top portion bent rearward and the sides bowed out from component intrusion. The bottom of the steering wheel rim was bent forward due to occupant contact. The driver's side instrument panel fascia and gauges were displaced **(Figure 11)**. The driver's seat back was displaced rearward and to the left. The webbing on the driver's 3-point lap and shoulder restraint system was cut by rescue personnel. The center armrest was deformed. The passenger seat back was displaced slightly to the left. Right front intrusions included the right A-pillar, upper and lower instrument panel, toepan, windshield header, and right side roof area.

Figure 10. Interior view from the left side

Figure 11. Instrument panel showing deformation and front right passenger's air bag cut off switch

Exterior Damage -***1997 Volvo Tractor/Semi-Trailer***

The 1997 Volvo tractor/semi-trailer sustained moderate damage to the left rear of the power unit, and minor damage to the left front corner of the trailer. Direct contact damage began just forward of the left drive axles of the power unit and extended to the left front corner of the trailer **(Figure 12)**. Both rear axles of the power unit were displaced counterclockwise (CCW) approximately 15 degrees from contact with the Dodge pickup truck **(Figure 13)**. The Truck Deformation Classification (TDC) for this impact was 11-LWEW-2. The left rear drive axle rim was deformed by contact with the left front wheel of the Dodge pickup truck. Damage to the trailer was attributed to the left A-pillar and windshield header of the Dodge pickup truck as evidenced by paint transfers and deformation to the front left corner **(Figure 14)**.

Figure 12. Damage to the power unit of the tractor/semi-trailer

Figure 13. Counterclockwise displacement of drive axles

Figure 14. Damage to front left corner of the trailer

REDESIGNED AIR BAG SYSTEM

The 1998 Dodge Ram 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 collision with the Volvo tractor/semi-trailer truck. Air bag warning labels were affixed to each sun visor. The redesigned driver's air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). There were some blood smears noted on the left aspect of the air bag and clothing transfers on the center exterior surface. The cover flaps were symmetrical in shape.

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. No contact evidence was noted on the air bag or cover flap. A cutoff switch for the passenger air bag was located in the center mid-instrument panel area, but the position of the switch could not be determined from the available photographs.

OCCUPANT DEMOGRAPHICS - Dodge Ram Pickup Truck

Driver

Age/Sex:	27-year-old male
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Mid-to-full rear
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Police report, on-scene photographs
Eyewear:	Not reported
Type of Medical Treatment:	Expired at scene

Driver Kinematics

The 27-year-old male driver of the Dodge Ram pickup truck was presumed to be seated in an upright posture with the seat track adjusted between to a mid-to-full rear position. He was restrained by the available 3-point manual lap and shoulder belt system. Belt usage was confirmed by on-scene police photographs, and the webbing cut for extrication purposes. At impact with the Volvo tractor/semi-trailer, the driver initiated a forward trajectory in response to the frontal impact force and loaded the manual restraint system. The severe impact probably caused him to ride down the air bag and load into the rapidly intruding frontal components, causing fatal injuries. He was pinned in the vehicle by massive longitudinal and lateral component intrusions. Based on the police report, he was unresponsive upon arrival of rescue personnel and presumed to have died following the initial impact.

Front Right Passenger

Age/Sex:	59-year-old male
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Mid-to-full rear
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Police report
Eyewear:	Not reported
Type of Medical Treatment:	Transported by ambulance to a local hospital however, his admission status was not reported.

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90)	Possible Injury Mechanisms
Elbow/lower arm/hand fracture, NFS	Moderate (751800.2,9)	A-pillar, as a result of the front right passenger's air bag expansion

*Injury source: Police accident report

Front Right Passenger Kinematics

The 59-year-old passenger of the Dodge Ram pickup truck was presumed to be seated in an upright posture with the seat track adjusted to a mid-to-full rear position. He was restrained by the available 3-point manual lap and shoulder belt system. He may have extended his arms in an attempt to brace prior to the impact. At impact with the Volvo tractor/semi-trailer, the redesigned passenger air bag deployed, and probably redirected his arms. The front right passenger initiated a forward trajectory in response to the frontal impact force and loaded the manual restraint. The deployed redesigned front right passenger's air bag provided additional protection form the frontal impact force and contact with the instrument panel. According to the police report, he sustained an elbow/lower arm/hand fracture, probably as a result contact with the A-pillar as a result of the deploying air bag redirecting his arms. He was transported by ambulance to a local hospital however, his admission status was not reported.