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

NASS CDS CASE NO. 1999-11-089J

RABSS VEHICLE - 1998 DODGE CARAVAN SE

LOCATION - STATE OF MICHIGAN

CRASH DATE - MAY, 1999

Contract No. DTNH22-94-D-07058

Prepared for:

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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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16. *Abstract* This investigation focused on a single vehicle crash involving a 1998 Dodge Caravan SE equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of a frontal collision with a large diameter tree. The driver of the Dodge was operating the vehicle in a southeasterly direction on a 2-lane rural roadway when she failed to negotiate a left turn (east) at a 3-leg "Y" intersection. The Dodge proceeded through the intersection and subsequently departed the south pavement edge where the front left area impacted a large diameter tree resulting in moderate damage. The restrained 73 year old female driver of the Dodge Caravan initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in multiple soft tissue injuries to the neck and chest. She also sustained a fracture and dislocation of the right foot from contact to the brake pedal. The driver was transported to a local trauma center for treatment and admitted for 5 days. The unrestrained 79 year old male front right passenger was out-of-position slightly forward and bracing with his left arm extended outward. He initiated a forward trajectory in response to the 12 o'clock impact force and loaded the glove compartment door and deployed redesigned passenger air bag. Loading of the glove compartment door resulted in bilateral knee contusions and fractures of the right femur and pelvis. Contact to the deployed passenger air bag resulted in multiple soft tissue injuries to the face and upper extremities. He also sustained a cerebral subdural hematoma which was an indirect result of contact to the deployed passenger air bag. The front right passenger was transported to a local trauma center for treatment and expired after 17 days of admission.			
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BACKGROUND

This investigation focused on a single vehicle crash involving a 1998 Dodge Caravan SE equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of a frontal collision with a large diameter tree. The driver of the Dodge was operating the vehicle in a southeasterly direction on a 2-lane rural roadway when she failed to negotiate a left turn (east) at a 3-leg "Y" intersection. The Dodge proceeded through the intersection and subsequently departed the south pavement edge where the front left area impacted a large diameter tree resulting in moderate damage. The restrained 73 year old female driver of the Dodge Caravan initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in multiple soft tissue injuries to the neck and chest. She also sustained a fracture and dislocation of the right foot from contact to the brake pedal. The driver was transported to a local trauma center for treatment and admitted for 5 days. The unrestrained 79 year old male front right passenger was out-of-position slightly forward and bracing with his left arm extended outward. He initiated a forward trajectory in response to the 12 o'clock impact force and loaded the glove compartment door and deployed redesigned passenger air bag. Loading of the glove compartment door resulted in bilateral knee contusions and fractures of the right femur and pelvis. Contact to the deployed passenger air bag resulted in multiple soft tissue injuries to the face and upper extremities. He also sustained a cerebral subdural hematoma which was an indirect result of contact to the deployed passenger air bag. The front right passenger was transported to a local trauma center for treatment and expired after 17 days of admission.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 1999-11-089J 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 single vehicle crash occurred during the evening hours of May, 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 off the south pavement edge of a level 3-leg "Y" intersection **(see Figure 8 - page 7)**. The asphalt roadway was bordered by narrow paved shoulders with tree clusters just off the south pavement edge. Traffic control through the intersection was controlled by an overhead signal system in green phase for southbound traffic. The posted speed limit at the crash site was 72 km/h (45 mph).

Pre-Crash

The 73 year old female driver of the 1998 Dodge Caravan SE was operating the vehicle in a southeasterly direction **(Figures 1 & 2)** at a (driver reported) speed of 64 km/h (40 mph) when she failed to negotiate a left turn at a 3-leg intersection. As the Dodge entered the intersection, the vehicle continued in a forward tracking mode and departed the right (south) pavement edge **(Figure 3)**. Upon recognition of the impending harmful event, the driver steered left/braked in avoidance, traveling approximately 21.8 meters (71.5 feet) alongside the south shoulder prior to impact.

Figure 1. Southeasterly approach for the 1998 Dodge Caravan SE.

Figure 2. Southeasterly approach for the 1998 Dodge Caravan SE.

Figure 3. Pre-crash road departure (east view).

Figure 4. Impacted tree (east view).

Crash

As the Dodge Caravan departed the south pavement edge of the 3-leg intersection, the front left area impacted a large diameter tree **(Figure 4)** resulting in moderate damage. The WinSMASH reconstruction program computed a velocity change of 32.8 km/h (20.4 mph) with a matching negative longitudinal component. The impact induced deceleration was sufficient to deploy the Dodge's redesigned frontal air bag system. At this point, the vehicle rotated approximately 25 degrees counterclockwise and came to rest in close proximity to the point of impact facing east.

Post-Crash

Both occupants of the Dodge were removed from the vehicle by rescue personnel due to perceived serious injury. The driver and front right passenger were transported by ambulance to a local trauma center for treatment and admitted for 5 days and 17 days, respectively. The vehicle was towed from the crash site due to disabling damage.

RABSS VEHICLE

The 1998 Dodge Caravan SE was identified by the vehicle identification number (VIN): 2B4GP4532WR (production number deleted). The vehicle was a 4-door minivan equipped with front-wheel drive and a 3.0 liter, 6 cylinder engine. The police report did not identify the owner of the vehicle. The odometer reading was unknown at the time of the crash. The seating was configured with front box-mounted (van type) and a rear bench seat (with folding back). The driver reported no previous crashes or maintenance on the Dodge's frontal air bag system. No cell phone was present or in-use at the time of the collision.

VEHICLE DAMAGE

Exterior

The 1998 Dodge Caravan SE sustained moderate frontal damage as a result of the impact with the tree **(Figure 5)**. The direct contact damage began 18.0 cm (7.5 in) to the right of the front left bumper corner and extended 32.0 cm (12.6 in) inboard. The impact deformed the entire front end width resulting 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 bumper: C1= 18.0 cm (7.1 in), C2= 48.0 cm (18.9 in), C3= 30.0 cm (11.8 in), C4= 12.0 cm (4.7 in), C5= 0 cm, C6= 0 cm. The Collision Deformation Classification (CDC) for this impact to the Dodge was 12-FLEN-3 with a principal direction of force of 0 degrees. The hood was deformed up and rearward from engagement against the tree. The windshield was fractured from exterior impact forces (only). Reduction in the left side wheelbase measured 16.0 cm (6.3 in).

Figure 5. Front left damage to the 1998 Dodge Caravan SE.

Interior

Interior damage to the Dodge Caravan identified through the vehicle inspection was minimal and was attributed to occupant contact and component intrusion. Scuff marks were documented on the left knee bolster, center/right mid-instrument panel, and glove compartment door. Blood spattering was noted on the foot controls. Longitudinal intrusions into the driver space involved 6.0 cm (2.4 in) of toepan intrusion.

REDESIGNED AIR BAG SYSTEM

The 1998 Dodge Caravan SE 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 asymmetrical in shape as the upper flap measured 18.0 cm (7.1 in) in width and 1.0 cm (0.4 in) in height while the lower flap measured 18.0 cm (7.1 in) in width and 9.0 cm (3.5 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, blood spattering was noted at the lower right quadrant of the air bag face. The NASS researcher measured the diameter of the driver air bag at 60.0 cm (23.6 in) in its deflated state **(Figure 6)**. The bag was tethered by two internal straps. No vent ports were present.

The front right passenger air bag deployed from the right mid-instrument panel area with a horizontally oriented flap tear seam (H-configuration). No contact evidence was identified on the exterior surface of the module cover flaps. The cover flaps were rectangular and symmetrical in shape and measured 31.0 cm (12.2 in) in width and 7.0 cm (2.8 in) in height. The NASS researcher measured the passenger air bag at 44.0 cm (17.3 in) in width and 75.0 cm (29.5 in) in height in its deflated state **(Figure 7)**. A fabric transfer that measured 6.0 cm (2.4 in) in width and 16.0 cm (6.3 in) in height was identified at the left (centered) quadrant of the air bag face. No internal tether straps or vent ports were present.

Figure 6. 1998 Dodge Caravan SE deployed redesigned driver air bag.

Figure 7. 1998 Dodge Caravan SE deployed redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	73 year old female
Height:	157 cm (62 in)
Weight:	79 kg (175 lb)
Seat Track Position:	Mid-to-forward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, driver interview, medical report
Eyeware:	Prescription glasses
Type of Medical Treatment:	Transported to a local trauma center and admitted (5 days)

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
*Fracture right talus (foot)	Moderate (853200.2,1)	Foot controls
*Dislocation right tarsus (ankle)	Moderate (850210.2,1)	Foot controls
*Contusion left inferior neck	Minor (390402.1,2)	Shoulder belt webbing
*Abrasion left inferior neck	Minor (390202.1,2)	Shoulder belt webbing
*Abrasion left anterior chest	Minor (490202.1,2)	Shoulder belt webbing
*Contusion left anterior chest	Minor (490402.1,2)	Shoulder belt webbing
+Contusion right posterior hand	Minor (790402.1,1)	Center instrument panel
*Contusion right knee	Minor (890402.1,1)	Left knee bolster
*Contusion right medial ankle	Minor (890402.1,1)	Foot controls

sources - discharge summary/ER report+*

Driver Kinematics

The 73 year old female driver of the 1998 Dodge Caravan SE 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-forward position. Her hands were placed at the 9 o'clock and 2 o'clock positions on the steering wheel rim. Belt usage was determined by the lack of significant interior contacts relative to the soft tissue injuries sustained across the occupant belt path. 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 abrasions/contusions to the left inferior neck and left anterior chest. Contact to the knee bolster resulted in a right knee contusion as evidenced by the scuff mark documented to this component. Her right hand struck the climate controls which resulted in a contusion to the posterior aspect of the hand as evidenced by the scuff mark documented to the mid-right portion of the center instrument panel area. She also sustained a fracture and dislocation of the right foot (with an associated contusion of the right ankle) from contact to the brake pedal, evidenced by the driver's stated placement of the right foot on the brake pedal during pre-crash avoidance maneuvers. Following the crash, she was transported by ambulance to a local trauma center for treatment and admitted for 5 days. The redesigned air bag provided additional protection against further contact to the steering wheel hub/rim, and potential serious injury.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex:	79 year old male
Height:	183 cm (72 in)
Weight:	79 kg (175 lb)
Seat Track Position:	Full rearward position
Manual Restraint Use:	None
Usage Source:	Vehicle inspection, driver interview, medical report
Eyeware:	None
Type of Medical Treatment:	Transported to a local trauma center and admitted (17 days)

Front Right Passenger Injuries

Injury	***Severity (AIS 90)***	***Injury Mechanism***
*Cerebral subdural hematoma (frontal-small)	Severe (140652.4,9)	Passenger air bag
*Fracture right femur (supracondylar)	Serious (851822.3,1)	Glove compartment door
*Fracture right femur (condylar)	Serious (851804.3,1)	Glove compartment door
* Fracture left pelvis (posterior acetabular wall-closed)	Moderate (852602.2,2)	Glove compartment door (indirect contact injury)
*Fracture left carpus (finger-spiral)	Moderate (752002.2,2)	Right instrument panel
*Fracture left metacarpus (thumb/middle finger-comminuted)	Moderate (752002.2,2)	Right instrument panel
*Laceration chin (minor)	Minor (290602.1,8)	Passenger air bag
*Contusion left shoulder	Minor (790402.1,2)	Passenger air bag
*Abrasion left shoulder	Minor (790202.1,2)	Passenger air bag
*Abrasion left posterior forearm/hand	Minor (790202.1,2)	Passenger air bag
*Contusion left finger	Minor (790402.1,2)	Right instrument panel
*Abrasion left finger	Minor (790202.1,2)	Right instrument panel
*Contusion bilateral knees	Minor (890402.1,3)	Glove compartment door

*source - discharge summary**

Front Right Passenger Kinematics

The unrestrained 79 year old male front right passenger of the 1998 Dodge Caravan SE was seated out-of-position and reportedly “hunched forward” with his left elbow on the instrument panel and head turned to the right. However, the injury pattern suggests the passenger was only slightly forward and bracing with his left arm extended outward. The lack of belt usage was determined by the absence of

loading evidence on the front right restraint in conjunction with the extent of injuries sustained. At impact, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the glove compartment door and deployed redesigned passenger air bag. Loading of the glove compartment door resulted in bilateral knee contusions, multiple fractures of the right femur, and an associated (indirect) left pelvic fracture. These injury mechanisms were evidenced by the scuff marks documented to the glove compartment door and typical posterior fracture pattern of the acetabular wall. Contact to the deployed passenger air bag resulted in a chin laceration, abrasions/contusions to the left shoulder, and left posterior forearm/hand, evidenced by the specific location of the injuries relative to the fabric transfer documented to the left centered portion of the air bag face. He also sustained a (frontal) cerebral subdural hematoma which was an indirect result of contact to the deployed air bag. Bracing against the right instrument panel resulted in multiple fractures and contusions of the left fingers. Following the crash, the passenger was transported by ambulance to a local trauma center for treatment and admitted for 17 days before he expired from complications involving renal failure and adult respiratory distress.

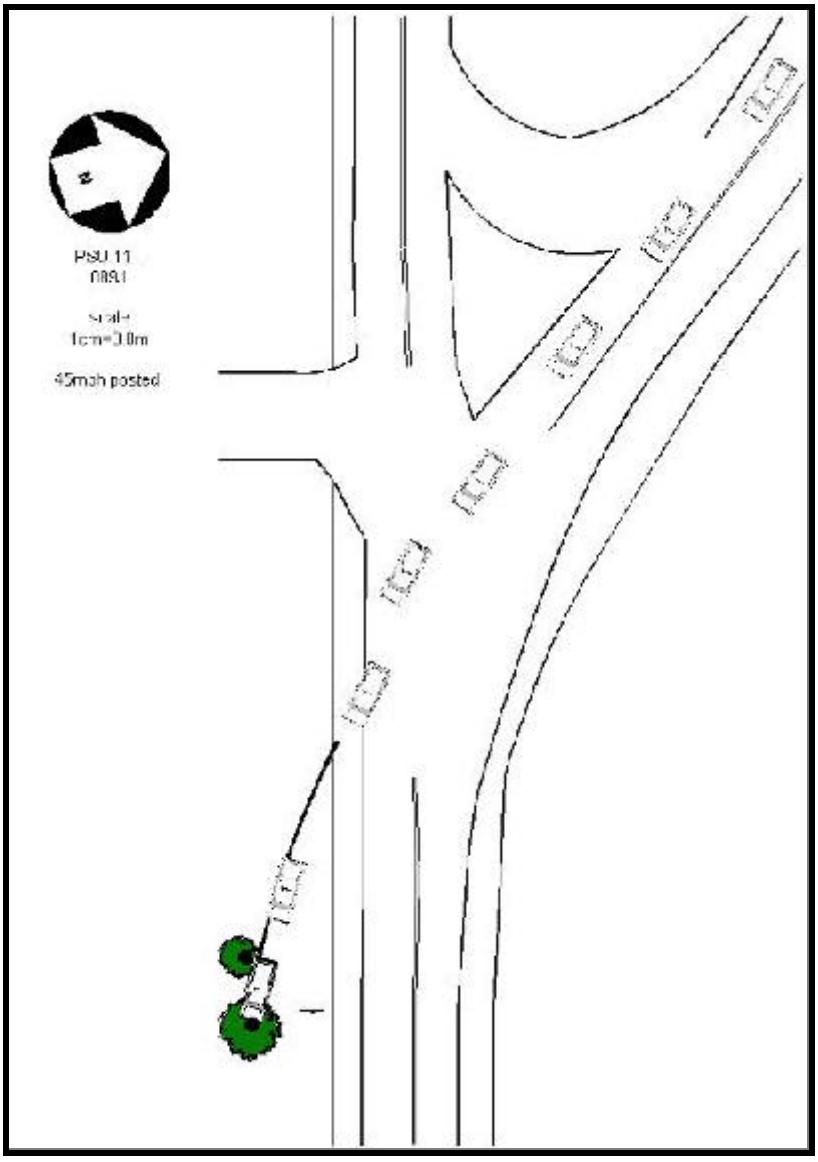

Figure 8. NASS Scene Diagram.