

**CRASH DATA RESEARCH CENTER**

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

**NASS CDS CASE NO. 1999-13-174J**

**RABSS VEHICLE - 1999 DODGE GRAND CARAVAN**

**LOCATION - STATE OF MICHIGAN**

**CRASH DATE - OCTOBER, 1999**

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.

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16. <i>Abstract</i> This investigation focused on a single vehicle crash involving a 1999 Dodge Grand Caravan 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 northbound on a 2-lane roadway when she reportedly lost consciousness and allowed the vehicle to depart the right (east) pavement edge in a forward tracking mode. As the Dodge exited the right pavement edge, the front right area impacted a tree which resulted in severe damage. The restrained 35 year old female driver initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, center instrument panel and deployed redesigned driver air bag. Loading of the center instrument panel resulted in multiple soft tissue injuries to the right lower leg and an associated pelvic fracture. Contact to the deployed driver air bag resulted in a chin abrasion and contusion to the right eyelid. The driver was transported to a local hospital for treatment and admitted for 6 days.			
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***BACKGROUND***

This investigation focused on a single vehicle crash involving a 1999 Dodge Grand Caravan 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 northbound on a 2-lane roadway when she reportedly lost consciousness and allowed the vehicle to depart the right (east) pavement edge in a forward tracking mode. As the Dodge exited the right pavement edge, the front right area impacted a tree which resulted in severe damage. The restrained 35 year old female driver initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, center instrument panel and deployed redesigned driver air bag. Loading of the center instrument panel resulted in multiple soft tissue injuries to the right lower leg and an associated pelvic fracture. Contact to the deployed driver air bag resulted in a chin abrasion and contusion to the right eyelid. The driver was transported to a local hospital for treatment and admitted for 6 days.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 1999-13-174J and was 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.

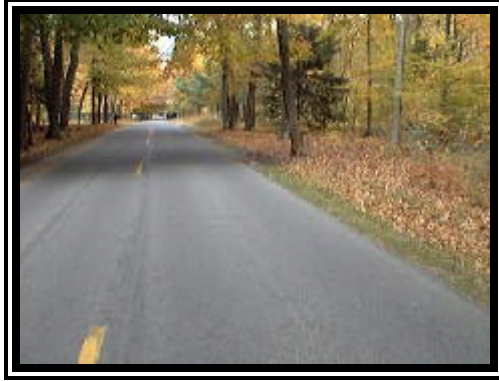
***SUMMARY***

**Crash Site**

This single vehicle crash occurred during the afternoon hours of October, 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 (straight/level) 2-lane north/south asphalt roadway (see **Figure 7 - page 6**) which was bordered by tree clusters. No traffic control was present at the scene which had a posted speed limit of 72 km/h (45 mph).

**Pre-Crash**

The 35 year old female driver of the 1999 Dodge Grand Caravan was operating the vehicle northbound (**Figure 1**) when she reportedly lost consciousness due to a pre-existing medical condition and allowed the vehicle to depart the east pavement edge in a forward tracking mode.



**Figure 1. Northbound approach for the 1999 Dodge Grand Caravan.**



**Figure 2. Struck tree and vehicle final rest area.**

### **Crash**

As the Dodge exited the right (east) pavement edge of the 2-lane roadway, the front right area impacted a large diameter tree (**Figure 2**) resulting in severe damage. The WinSMASH reconstruction program computed a (*SCI revised*) barrier equivalent velocity change of 43.9 km/h (27.3 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 clockwise and came to rest partially in the roadway facing northeast.

### **Post-Crash**

The driver of the Dodge was removed from the vehicle by rescue personnel due to perceived serious injury. On-scene paramedics reported that the driver was an insulin dependent diabetic with a low blood sugar level (of 60). She was subsequently transported by ambulance to a local hospital for treatment and admitted for 6 days. The vehicle was towed from the crash site due to disabling damage.

### ***RABSS VEHICLE***

The 1999 Dodge Grand Caravan was manufactured in May, 1999 and identified by the vehicle identification number (VIN): 1B4GP44LXXB (production number deleted). The vehicle was a 4-door minivan equipped with front-wheel drive and a 3.8 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 box-mounted (van type) seats for the first and second row seating positions with a bench (with folding back) for the third row seating positions. The driver reported no previous crashes or maintenance on the Dodge's frontal air bag system. A cell phone was present in the vehicle (but not in use) at the time of the crash.

## VEHICLE DAMAGE

### Exterior

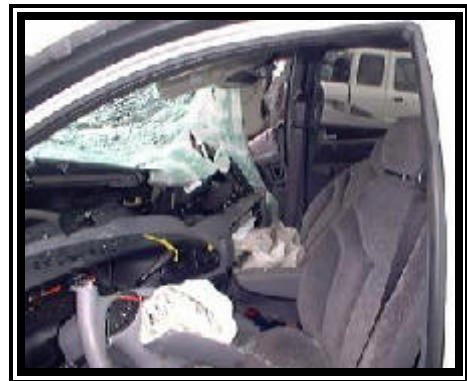
The 1999 Dodge Grand Caravan sustained severe frontal damage as a result of the impact with the tree (**Figure 3**). *Erroneous field documentation by the NASS researcher necessitated multiple SCI revisions to the crush profile.* The *revised* direct contact damage began at the front right bumper corner and extended approximately 35.0 cm (13.8 in) inboard. The impact deformed the entire front end width resulting in a combined direct and induced damage length (Field L) of 100.0 cm (39.4 in). Six crush measurements were documented at the level of the reinforcement bar (*bumper fascia separation*): C1= 6.0 cm (2.4 in), C2= 8.0 cm (3.1 in), C3= 24.0 cm (9.4 in), C4= 36.0 cm (14.2 in), C5= 46.0 cm (18.1 in), C6= 77.0 cm (30.3 in). *Contrary to the NASS case file*, the damage pattern exhibits a narrow end engagement with direct contact damage extending rearward to the A-pillar. Semi-circular buckling along the right windshield header area suggests possible tree penetration into the passenger compartment resulting in a *SCI revised* Collision Deformation Classification (CDC) of 12-FRAE-7. The hood was deformed up and rearward from engagement against the tree. The right fender was displaced rearward which restricted the right front wheel/tire (not deflated) and jammed the right side doors. Induced contact damage also produced outward buckling to the right front door (with integrity loss) and roof buckling aft of the B-pillar area. The windshield was fractured with a slit located along the right lower portion which measured 20.0 cm (7.9 in). Reduction in the right side wheelbase measured 80.0 cm (31.5 in).



**Figure 3. Front right damage to the 1999 Dodge Grand Caravan.**

### Interior

Interior damage to the Dodge identified through the vehicle inspection was severe and was attributed to occupant contact and component intrusion (**Figure 4**). Scuff marks and indentations were documented on the center instrument panel at the junction with the left knee bolster. Possible skin tissue was identified on the right lower windshield. The top portion of the steering wheel rim was cut by rescue personnel during driver extrication activities post-crash. The front right seat was deformed by multiple component intrusions. Longitudinal intrusions into the front right passenger space involved 80.0 cm (31.5 in) of instrument panel, 62.0 cm (24.4 in) of windshield, and 52.0 cm (20.5 in) of toepan intrusion. Longitudinal intrusions into the front center area involved 50.0 cm (19.7 in) of instrument panel, and 39.0 cm (15.4 in) of windshield intrusion. Longitudinal intrusions into the driver space involved 17.0 cm (6.7 in) of windshield intrusion. The NASS researcher failed to provide adequate (vertical) windshield header, roof and A-pillar intrusion measures.



**Figure 4. Interior view.**

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

The 1999 Dodge Grand Caravan 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 17.0 cm (6.7 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, makeup transfers and blood spattering were documented on the upper right quadrant of the air bag face. The NASS researcher measured the diameter of the driver air bag at 65.0 cm (25.6 in) in its deflated state (**Figure 5**). No internal tether straps or 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). The cover flaps were rectangular and symmetrical in shape and measured 29.0 cm (11.4 in) in width and 8.0 cm (3.1 in) in height. No contact evidence was identified on the exterior surface of the module cover flaps. The NASS researcher measured the passenger air bag at 60.0 cm (23.6 in) in width and 50.0 cm (19.7 in) in height in its deflated state (**Figure 6**). No internal tether straps or vent ports were present. Blood pooling was noted on the left mid-portion of the air bag face. Extensive longitudinal intrusion of the right instrument panel into the front right seating area re-directed the proper deployment path of the passenger air bag membrane upward and to the left.



**Figure 5. 1999 Dodge Grand Caravan deployed redesigned driver air bag.**



**Figure 6. 1999 Dodge Grand Caravan deployed redesigned passenger air bag.**

### ***DRIVER DEMOGRAPHICS***

Age/Sex:	35 year old female
Height:	163 cm (64 in)
Weight:	61 kg (135 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
Eyewear:	None
Type of Medical Treatment:	Transported to a local hospital and admitted (6 days)



## Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
*Fracture posterior right pelvis (acetabular column-comminuted)	Serious (852604.3,1)	Center instrument panel (indirect contact injury)
*Sciatic nerve damage right leg (NFS)	Moderate (830499.2,1)	Center instrument panel
*Laceration right gluteus muscle (leg)	Moderate (840600.2,1)	Center instrument panel
+Contusion lateral right eyelid	Minor (297402.1,1)	Driver air bag
+Abrasion chin (4cm)	Minor (290202.1,8)	Driver air bag
#Contusion right shoulder and posterior upper arm	Minor (790402.1,1)	Passenger air bag
+Abrasion posterior right forearm/hand	Minor (790202.1,1)	Passenger air bag
+Lacerations posterior right arm (multiple/tiny)	Minor (790602.1,1)	Flying glass (non-contact injury)
+Contusion right knee	Minor (890402.1,1)	Center instrument panel
+Abrasion right knee	Minor (890202.1,1)	Center instrument panel

*sources - discharge summary\*/ER report+/interview#*

## Driver Kinematics

The 35 year old female driver of the 1999 Dodge Grand Caravan was restrained by the available 3-point manual lap and shoulder belt system and presumed to be seated slightly out-of-position leaned to the right (unconscious). The seat back was slightly reclined as the track was adjusted to a mid-to-rear position. The driver stated she was belted, further evidenced by the lack of substantial contacts and injury in this high severity crash. At impact, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, center instrument panel (at the junction with the knee bolster) and deployed redesigned driver air bag. Loading of the center instrument panel resulted in multiple soft tissue injuries to the right knee as evidenced by the indentation and scuff marks documented to this component. This mechanism also resulted in an associated (indirect) pelvic fracture/dislocation with an underlying gluteus muscle laceration and unspecified sciatic nerve damage. Contact to the deployed driver air bag resulted in a chin abrasion and contusion to the right eyelid, evidenced by the makeup transfers documented to the upper right quadrant of the air bag face. Her abnormal pre-impact posture allowed her right arm and shoulder to move into the path of the (re-directed) passenger air bag deployment. Contact to the deployed passenger air bag resulted in contusions and abrasions to the posterior aspect of the right arm along with multiple "tiny" lacerations

from flying glass (medical reported pieces of shattered glass over clothes). Following the crash, she was removed from the vehicle by rescue personnel due to perceived serious injury and transported by ambulance to a local hospital for treatment and admitted for 6 days. The redesigned air bag provided additional protection against further contact to the steering wheel hub/rim, and potential serious injury.

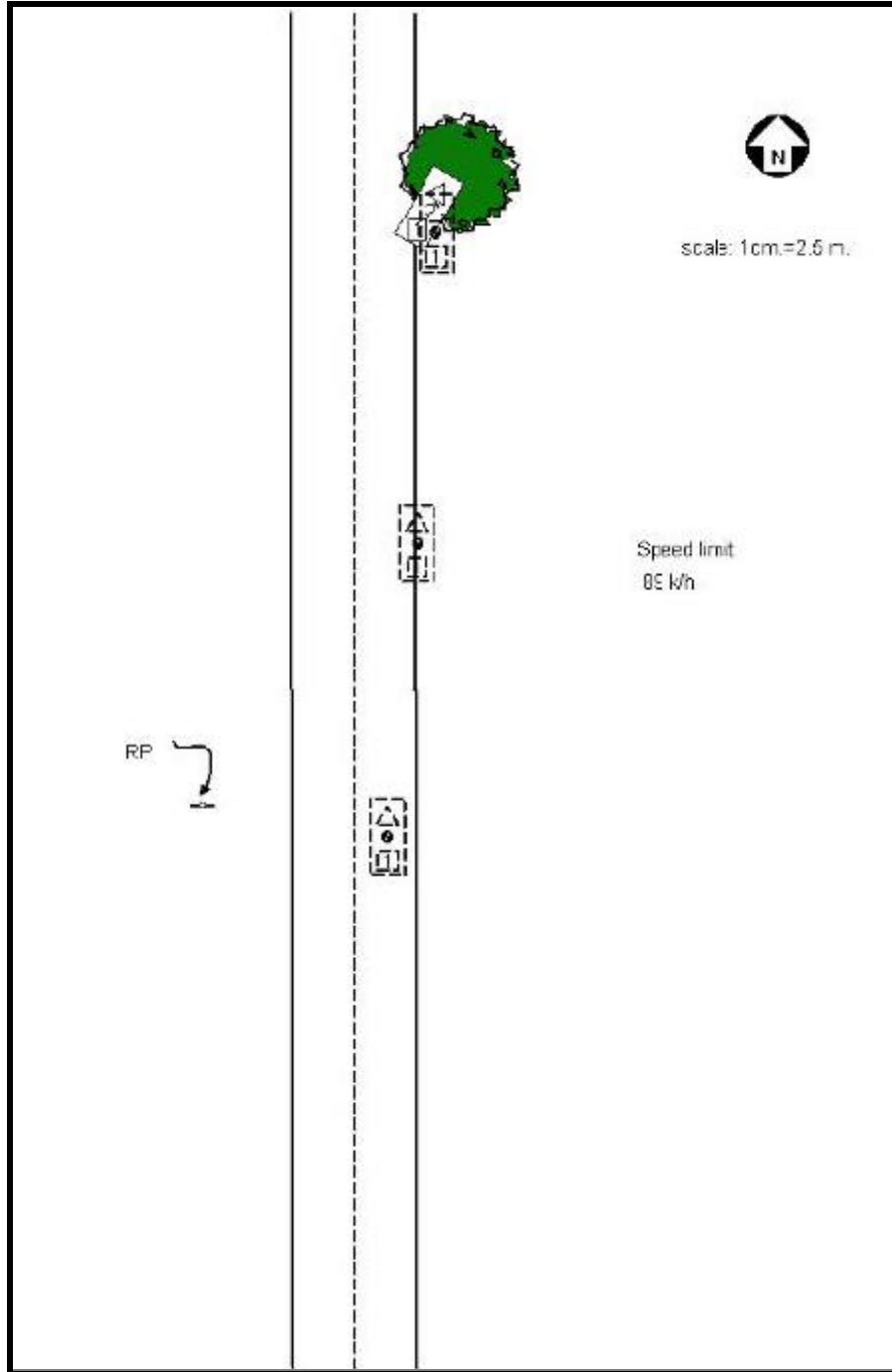


Figure 7. NASS Scene Diagram.