

**TRANSPORTATION SCIENCES  
CRASH DATA RESEARCH CENTER**

Advanced Information Engineering Services, Inc.  
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***ON-SITE AIR BAG RELATED CHILD PASSENGER SERIOUS INJURY  
INVESTIGATION***

**GENERAL DYNAMICS CASE NO: CA03-026**

***VEHICLE: 1996 DOGE CARAVAN***

**LOCATION: NEW YORK**

**CRASH DATE: MAY, 2003**

Contract No. DTNH22-01-C-17002

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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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<p>16. Abstract</p> <p>This investigation focused on the injury mechanisms resulting in the serious head injuries sustained by a six year old female passenger seated in the front right position of a 1996 Dodge Caravan. The Dodge was equipped with a Supplemental Restraint System (SRS) consisting of driver and front right passenger air bags that deployed as a result of a front-to-rear impact sequence with a 2002 Dodge Caravan. The 32 year old restrained female driver of the 1996 Caravan applied the brakes and steered right immediately prior to the impact. The 1996 Caravan was then struck from behind by a secondary chain reaction crash involving two other vehicles. The six year old child was improperly restrained by only the lap portion of the Caravan's manual safety belt. The shoulder portion of the webbing was behind her back. As a result of the pre-impact braking, the improperly restrained child was displaced out-of-position and was contacted by the deploying front right passenger air bag resulting in critical head trauma. She was transported to a pediatric hospital and admitted in critical condition. The restrained female driver of the Caravan was transported to a local hospital, examined, and released. None of the other individuals in the crash were injured.</p> <p>The New York State Police investigator notified the General Dynamics Special Crash Investigations team of this serious injury crash. The General Dynamics SCI team subsequently notified the Crash Investigation Division of the National Highway Traffic Safety Administration and an onsite crash investigation was assigned the same day. Coordination with the investigating New York State police was initiated. The subject vehicle was located at a tow yard local to the crash scene and was inspected two days after the crash.</p>			
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**ON-SITE AIR BAG RELATED CHILD PASSENGER SERIOUS INJURY INVESTIGATION**  
**GENERAL DYNAMICS CASE NO: CA03-026**  
**VEHICLE: 1996 DODGE CARAVAN**  
**LOCATION: NEW YORK**  
**CRASH DATE: MAY, 2003**

***BACKGROUND***

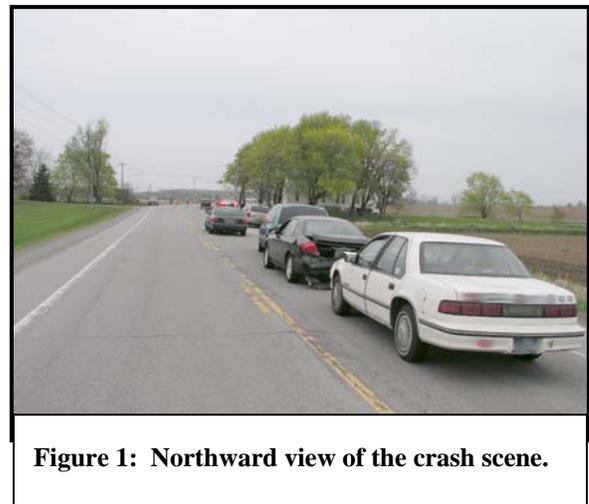
This investigation focused on the injury mechanisms resulting in the serious head injuries sustained by a six year old female passenger seated in the front right position of a 1996 Dodge Caravan. The Dodge was equipped with a Supplemental Restraint System (SRS) consisting of driver and front right passenger air bags that deployed as a result of a front-to-rear impact sequence with a 2002 Dodge Caravan. The 32 year old restrained female driver of the 1996 Caravan applied the brakes and steered right immediately prior to the impact. The 1996 Caravan was then struck from behind by a secondary chain reaction crash involving two other vehicles. The six year old child was improperly restrained by only the lap portion of the Caravan’s manual safety belt. The shoulder portion of the webbing was behind her back. As a result of the pre-impact braking, the improperly restrained child was displaced out-of-position and was contacted by the deploying front right passenger air bag resulting in critical head trauma. She was transported to a pediatric hospital and admitted in critical condition. The restrained female driver of the Caravan was transported to a local hospital, examined, and released. None of the other individuals in the crash were injured.

The New York State Police investigator notified the General Dynamics Special Crash Investigations team of this serious injury crash. The General Dynamics SCI team subsequently notified the Crash Investigation Division of the National Highway Traffic Safety Administration and an on-site crash investigation was assigned the same day. Coordination with the investigating New York State police was initiated. The subject vehicle was located at a tow yard local to the crash scene and was inspected two days after the crash.

***SUMMARY***

***Crash Site***

This four-vehicle, front-to-rear, chain reaction crash occurred in the afternoon hours of May, 2003. At the time of the crash, it was daylight and there were no adverse weather conditions. The road surface was dry. The crash occurred on a two-lane north/south state route in a rural setting. At the scene, a large agri-business was located on the west side of the road. Reportedly, there was a back-up in traffic due to slow moving agricultural equipment that contributed to the cause of the crash. The speed limit in the area of the crash was 89 km/h (55 mph). **Figure 1** is a northward view of the crash scene taken by the police investigator.



## ***Crash Sequence***

### ***Pre-Crash***

The 1996 Dodge Caravan was northbound driven by a 32-year old restrained female. A six year old female was improperly restrained by only the lap portion of the 3-point manual restraint in the front right position. The shoulder portion of the restraint webbing was behind her back. A 2002 Ford Taurus was traveling north behind the 1996 Dodge followed by a 1990 Chevrolet Lumina. The Ford was driven by a 16 year old restrained female and the front right position was occupied by a 16 year restrained female. A 19 year old restrained male was the driver of the Chevrolet. Directly in front of the 1996 Dodge Caravan, a 2002 Dodge Caravan was northbound driven by a 41-year old restrained female. This driver reported that she had been traveling behind a line of five to six vehicles for approximately 1.6 km (1.0 mile) at a slow speed.

Prior to the crash, the line of vehicles began to accelerate and then the lead vehicles suddenly decelerated resulting in a traffic back-up. The driver of the 2002 Dodge Caravan applied the brakes and was nearly stopped behind the traffic ahead of her position. She recalled looking in her rear view mirror and realized the 1996 Dodge was not going to be able to avoid the impact. The driver of the 1996 Dodge Caravan failed to recognize the slowing/stopping traffic and applied the brakes and steered right late in the pre-crash envelope in her attempt to avoid the crash. The sudden application of the brakes caused the improperly restrained child to initiate a forward trajectory and the child began to jackknife at the waist over the lap belt.

### ***Crash***

The subject crash occurred when the front bumper system of the 1996 Dodge Caravan impacted and underrode the back plane of the 2002 Dodge Caravan. The force of the impact caused the frontal air bag system in the 1996 Dodge to deploy. At the time of the deployment, the child was out-of-position in close proximity to the passenger air bag module. The deploying front right passenger air bag contacted the head and neck of the child resulting in the reported head trauma. **Figure 19**, page 15, is a schematic of the crash.

The impact momentum of the 1996 Caravan was absorbed through the deformation of the respective vehicles and probably displaced the vehicles north of the point of impact several feet. The delta V of the 1996 Caravan calculated by the Damage Algorithm of the WINSMASH model was 16.1 km/h (10.0 mph). After the impact, the driver of the 2002 Caravan moved her vehicle forward and off to the right side of the road. The 1996 Caravan came to rest in the northbound travel lane.

The female driver of the 2002 Ford Taurus, directly behind the 1996 Dodge, was able to brake her vehicle to a complete stop. The male driver of the 1990 Chevrolet Lumina braked late in his pre-crash sequence and impacted the back plane of the Taurus. The momentum of the Chevrolet then displaced both vehicles forward. The front bumper of the Ford Taurus then impacted the back plane of the 1996 Dodge Caravan in a minor secondary impact. These vehicles all came to rest approximately in-line with each other in the northbound lane.

### ***Post-Crash***

The police, fire and ambulance personnel responded to the crash. The child passenger was found in the front right position of the 1996 Caravan and she was unresponsive. Her Glasgow Coma Score was five. Only the lap portion of her manual restraint was being used at the time of the crash; the shoulder belt was behind her back. The webbing was cut by the EMS personnel and she was removed from the vehicle. Due to the severity of her condition, she was life-flighted to a regional pediatric trauma center located approximately 80 km (50 miles) from the crash scene with a reported closed head injury. Diagnostics tests at the pediatric trauma center identified a cerebral diffuse axonal injury in the frontal region (AIS 5), a left tentorial subdural hematoma (AIS 4), and a left mesial temporal contusion (AIS 3) as a result of contact with the deploying front right passenger air bag.

The driver of the 1996 Dodge was transported to a local hospital, examined and released. She was not injured in the crash. The occupants of the other vehicles were not injured and refused medical attention. At the conclusion of the police investigation, the 2002 Dodge Caravan was driven from the scene by the owner. The 1996 Dodge Caravan, 2002 Ford Taurus and 1990 Chevrolet Lumina sustained disabling damage and had to be towed.

### ***VEHICLE DATA***

#### ***1996 Dodge Grand Caravan LE***

The 1996 Dodge Grand Caravan, (**Figure 2**), was identified by the Vehicle Identification Number (VIN): 1B4GP54R6TB (production sequence deleted). The four-door mini-van was equipped with a 3.3 liter/V6 engine linked to a four-speed automatic transmission. The service brakes consisted of front disc/rear drum with four-wheel ABS. The vehicle was configured for seven passenger seating. Its seating system consisted of captain's chairs in the first and second row, and a third row bench seat. All seven seat positions were equipped with manual 3-point lap and shoulder restraints. The Supplemental Restraint System consisted of driver and front right passenger air bags that deployed as a result of the crash. The vehicle's date of manufacture was 5/96. The electronic odometer could not be read at the time of the inspection.

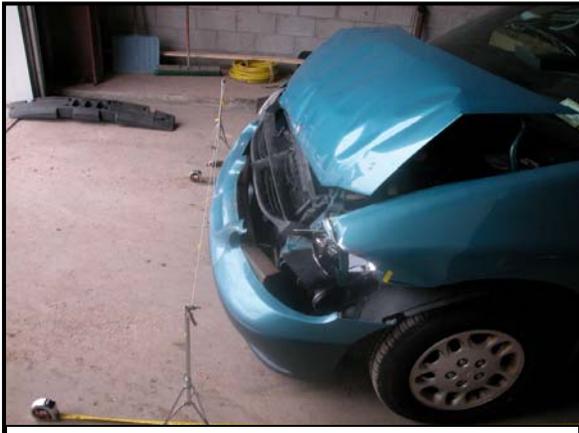


**Figure 2: 1996 Dodge Grand Caravan front view.**

### ***Exterior Damage***

The front plane of the Caravan sustained 132.6 cm (52.2 in) of direct contact damage as a result of the impact with the 2002 Caravan. The direct contact began 54.4 cm (21.4 in) right of center and extended to the left corner. The combined with of the direct and induced damage extended across the entire 156.4 cm (61.6 in) end width of the vehicle. The nature and profile of the impact damage was indicative of an underride. **Figure 3** is a left lateral view of the damage. There was no measurable residual crush at the elevation of the front bumper. Minor abrasions were observed on the vertical face of the bumper fascia that wrapped onto the fascia's horizontal face. This contact pattern then transitioned into direct impact damage to the center grille area. All the residual impact damage was above the elevation of the front bumper with the greatest crush located along the upper radiator support and leading edge of the hood. The severity of the impact was determined by an averaged residual crush profile as an input to the Damage Algorithm of the WINSMASH model. This averaged profile was: C1 = 0, C2 = 11 cm (4.3 in), C3 = 12 cm (4.7 in), C4 = 11 cm (4.3 in), C5 = 0, C6 = 0. There was no reduction in the vehicle's wheelbase measurements and all the doors remained operational. The calculated total delta V was 16.1 km/h (10.0 mph). The longitudinal and lateral components of the delta V were -16.1 km/h (10.0 mph) and 0 km/h, respectively. The Collision Deformation Classification (CDC) for the impact was 12-FDMW-1.

The rear bumper of the Caravan sustained minor damage as a result of a secondary impact from the Ford Taurus, **Figure 4**. The residual crush profile of the rear bumper reinforcement was as follows: C1 = 7.0 cm (2.8 in), C2 = 8.0 cm (3.1 in), C3 = 16.0 cm (6.3 in), C4 = 7.0 cm (2.8 in), C5 = 5.0 cm (2.0 in), C6 = 3.0 cm (1.2 in). The rear hatch remained closed and was operational. However, its operation was restricted by the deformation of the rear bumper fascia. The delta V of the rear impact was approximately 14.5 km/h (9.0 mph). The CDC was 06-BDEW-1.



**Figure 3: Left lateral view.**



**Figure 4: Rear bumper deformation.**

### ***2002 Dodge Grand Caravan***

The 2002 Dodge Grand Caravan, **Figure 5**, was identified by the Vehicle Identification Number (VIN): 2B4GP44382R (production sequence deleted). The four-door mini-van was equipped with a 3.3 liter/V6 engine linked to a four-speed automatic transmission. This vehicle was also configured for seven passenger seating. Its seat system consisted of two bucket seats in the front row, two captain's chairs in the second row and a third row bench seat. All seven seat positions were equipped with manual 3-point lap and shoulder restraints. The manual restraints for the front seat were equipped with buckle pretensioners. The Supplemental Restraint System consisted of dual stage driver and front right passenger air bags. The vehicle's date of manufacture was 04/02. The owner reported the electronic odometer had recorded approximately 28,018 km (17,410 miles) at the time of the crash. The vehicle was still operational and had been routinely driven by the owner since the date of the crash. The Dodge was to be repaired once the insurance details were finalized.

### ***Exterior Damage***

**Figure 6** is rear view of the rear bumper damage. The rear bumper system of the Dodge sustained minor impact damage as a result of the crash. The width of the direct damage measured 138.5 cm (54.5 in). The direct contact began 55.9 cm (22.0 in) left of center and extended to the right rear corner. The width of the direct and induced damage extended across the entire 165.1 cm (65.0 in) undeformed end width. The deformation of the vehicle was confined to the structures of the rear bumper system; there was no visible damage to the vehicle's rear uni-body structure. The residual crush profile of the rear bumper reinforcement was as follows: C1 = 0, C2 = 4.0 cm (1.6 in), C3 = 4.0 cm (1.6 in), C4 = 5.0 cm (2.0 in), C5 = 9.0 cm (3.5 in), C6 = 10.0 cm (3.9 in). The electronic rear hatch was not damaged in the crash and was still operational. There were no glazing fractures and the wheelbase dimensions were unchanged. The delta V calculated by the Damage Algorithm of the WINSMASH model was 16.3 km/h (10.1 mph). The CDC was 06-BDEW-1.



**Figure 5: 2002 Dodge Caravan.**



**Figure 6: Rear view of the 2002 Caravan.**

### 2002 Ford Taurus

The 2002 Ford Taurus was identified by the Vehicle Identification Number (VIN): 1FAFP56S12G (production sequence deleted). The vehicle's power train consisted of a 3.0 liter, V-6 engine linked to a 4-speed automatic overdrive transmission. The vehicle was equipped with 4-wheel disc anti-lock brakes. The cloth trimmed interior was equipped with a power package that included power steering, brakes, windows, door locks, and mirrors, adjustable foot controls and a power driver seat. The driver seat was equipped with a seat track position sensor. The manual restraint system consisted of 3-point lap and shoulder belts for the five seat positions. The front restraints were equipped with buckle pretensioners. The vehicle was also equipped with an Advanced Occupant Protection System (AOPS) that consisted of dual-stage frontal air bags for the driver and front right passenger. There was no deployment of the seat belt pretensioners or frontal air bags during the crash sequence.

**Figures 7 and 8** are views of the Ford's rear bumper and trunk damage. The rear bumper of the Ford sustained 157 cm (62 in) of direct contact damage that extended across the entire end width of the vehicle as a result of the impact from the Chevrolet. The crush of the bumper reinforcement was uniform and directed longitudinally forward. The force of the crash collapsed the trunk space capturing the vehicle's spare tire that was housed within the trunk's lower section. The residual crush profile of the rear bumper reinforcement was as follows: C1 = 20.0 cm (7.9 in), C2 = 28.0 cm (11.0 in), C3 = 32.0 cm (12.6 in), C4 = 29.0 cm (11.4 in), C5 = 26.0 cm (10.2 in), C6 = 22.0 cm (8.7 in). The CDC of this impact was 06-BDEW-3. The delta V calculated by the Missing Vehicle Algorithm of the WINSMASH model was approximately 23.7 km/h (14.7 mph).



**Figure 5: Rear view of the Taurus.**



**Figure 6: View of the trunk collapse.**

The northbound momentum of the Chevrolet displaced the Ford forward into a secondary front-to-rear impact with the 1996 Caravan. **Figures 9 and 10** are front views of the Taurus. There was no residual damage to the front bumper system of the Taurus. During the minor impact, the center aspect of the front bumper elastically deformed rearward approximately 2.0 cm (0.8 in) along the vehicle's centerline and then rebounded to its original position. The movement of the center section was evidenced by longitudinal abrasions on the horizontal surface of the fascia,

Figure 9. The abrasions resulted from frictional contact between the fascia and the lower surface of the center grille. The minor nature of the frontal impact did not warrant deployment of the Taurus's safety systems given that both front occupants were restrained by the 3-point manual lap and shoulder belt.



**Figure 7: Front view of the Ford.**



**Figure 8: Abrasions to the center section of the fascia.**

### ***1990 Chevrolet Lumina***

The 1990 Chevrolet Lumina was not available for inspection. A review of the police photographs indicated the vehicle sustained moderate frontal damage as a result of its impact with the rear bumper of the Ford, **Figure 11**. The collision damage extended across the vehicle's front end width and was uniform. The estimated crush was approximately 25 cm (10 in). The vehicle was equipped with 3-point lap and shoulder belts for the front occupants. It was not equipped with a Supplemental Restraint System.



**Figure 9: Front view of the Chevrolet Lumina.**

## **1996 DODGE CARAVAN**

### ***Interior Damage***

The interior damage to the Caravan was consistent with the deployment of the Supplemental Restraint System and the occupant interior contacts. There was no interior damage or intrusion into the occupant space related to the exterior forces of the impact.

The driver seat was located in a mid-track position that measured 6.4 cm (2.5 in) forward of full rear. The total seat track travel measured 19.1 cm (7.5 in). The seat back was reclined 20 degrees aft of vertical and the anti-submarine angle of the seat cushion measured 10 degrees. The horizontal distance from the seat back to the center hub of the steering wheel measured 60.5 cm (23.8 in). There was no deformation of the four-spoke steering wheel rim and there was no displacement of the steering column's shear capsules. Examination of the driver's knee bolster was unremarkable.

The driver's manual restraint consisted of a 3-point lap and shoulder belt with continuous loop webbing, a cinching latch plate and an emergency locking retractor. The restraint was stowed within the retractor upon initial inspection. The adjustable D-ring was in its lowest position. The webbing was extended from the retractor; the retractor was operational. Examination of the webbing and the hardware surrounding the latch plate did not reveal any crash related evidence. A subtle short transfer on the rear aspect of the D-ring's surface was identified. It was inconclusive if the transfer was related to occupant loading during the crash or if it was the result of routine use. The overall condition of the restraint and the latch plate surface was indicative of historical use. Inspection of the driver's restraint coupled with the lack of significant interior contacts and the occupant kinematics indicated the driver was probably restrained at the time of the crash.

The front right passenger seat was adjusted to a full rear track position at inspection. The seat back was reclined 43 degrees aft of vertical. Presumably, the seat back was reclined by EMS personnel during their rescue efforts and the position of the seat back was not its at-crash position. The horizontal distance from the seat back to the vertical face of the instrument panel (the location of the mid-mount front right passenger air bag module) measured 100.3 cm (39.5 in). This measurement was taken 41 cm (16 in) above the seat cushion. The longitudinal distance from the seat bight to the instrument panel measured 82.0 (32.3 in) along the seat cushion. There was no evidence of contact to the right knee bolster or glove box door.

The six year old child passenger was restrained only by the lap portion of the restraint at the time of the crash. The shoulder portion of the belt was behind her back. The webbing of the front right manual restraint was cut above the floor anchor and above the latch plate by the EMS responders. In this manner, the restraint could be removed without moving the child. As a result the restraint was in three sections. A 44.4 cm (17.5 in) section of webbing was attached to the outboard floor anchor and a 50.8 cm (20.0 in) webbing section was found in the right foot-well. The balance of the webbing was allowed to spool back into the retractor and it was not inspected. **Figure 12** is a view of the front right restraint in a reconstructed position. The cinching latch plate was found on the seat cushion. Examination of the plate revealed evidence of historical use. There was no evidence of loading identified on the latch plate hardware or on the D-ring surface. The D-ring was noted to be in its lowest adjustment.



**Figure 10: Front right restraint webbing.**

The right aspect of the windshield was fractured forward of the front right seat position, **Figure 13**. The center of the fracture site located 15.7 cm (6.2 in) below the header and 37.6 cm (14.8 in) inboard of the right A-pillar. The fracture was caused by the altered deployment of the front right passenger air bag. Air bag contact scuffs that measured 5 cm (2 in) in length were observed on the interior surface of the laminate adjacent to the fracture site. The air bag also contacted and abraded the right A-pillar trim. The abrasion measured 5.6 cm (2.2 in) in length and began 33 cm (13 in) above the surface of the instrument panel.



**Figure 11: View of the windshield fracture and abraded A-pillar trim.**

### ***Supplemental Restraint System***

The Supplemental Restraint System in the 1996 Dodge Caravan consisted of driver and front right passenger air bags. The air bags deployed as a result of the above-threshold crash. The driver air bag module was located in the center hub of the steering wheel rim. The asymmetrical H-configuration module cover flaps were not damaged. The upper flap measured 16.5 cm by 8.4 cm (6.5 in by 3.3 in), width by height. The lower flap measured 16.5 cm by 3.3 cm (6.5 in by 1.3 in). There was no evidence of occupant contact to the flaps. The deployed driver air bag measured 66 cm (26 in) in its deflated state. The bag was tethered by four internal straps. It was not externally vented. **Figure 14** is a view of the face of the driver air bag. It should be noted that the steering wheel was rotated 180 degrees at the time of the inspection. The 6 o'clock sector of the air bag is at the top of the figure.

The driver contacted the 6 o'clock sector of the deployed air bag. The physical nature and position of the contact evidence was consistent with the driver contacting the deployed bag in this orientation (i.e. with the steering wheel rotated). The driver contact evidence consisted of a pair of lip stick contacts and a 3.3 cm (1.3 in) diameter area of blood tinged fluid. This area was probably expelled from her nose. The lower lip lipstick contact measured 3.3 cm (1.3 in) in length and was located 8.4 cm (3.3 in) from the center of the bag. The upper lipstick contact measured 5 cm (2 in) in length and was located 9.7 cm (3.8 in) from the center of the bag. The area of fluids was located 13 cm (5 in) from the bag's center.



**Figure 12: Driver air bag. Note, the steering wheel is rotated 180 degrees.**

The following manufacture's nomenclature identified the driver air bag:

**P1216903-03B**  
**TM05871703603**

The front right passenger air bag module was a mid-mount design located in the right aspect of the instrument panel. The H-configuration module cover flaps were symmetrical and measured 28.4 cm by 7.1 cm (11.2 in by 2.8 in), width by height. There was no damage or occupant contact to the exterior surface of the flaps. The flaps were constructed of vinyl and were backed by a 3 mm (0.125 in) thick plastic stiffener. An 8.1 cm by 3.8 cm (3.2 in by 1.5 in) rectangular section of this backer, located on the inboard aspect of the lower flap, was fractured during the altered deployment sequence.

The face of the deployed front right passenger air bag measured 46 cm by 61 cm (18 in by 24 in), width by height, **Figure 15**. The rearward excursion of the bag measured 46 cm (18 in) from the vertical face of the instrument panel. The only contact evidence to the face of the air bag consisted of gray transfers to the fabric of the bag. These transfers measured approximately 5

cm (2 in) and 13 cm (5 in), respectively and were located in the upper outboard aspect of the bag's face and extended to its perimeter. These transfers were consistent with the contact evidence identified on the right A-pillar trim.

Examination of the bottom section of the air bag revealed three regions of occupant contact. **Figure 16** is a view of the 46 cm by 30 cm (18 in by 12 in) section of the air bag immediately below the bag's face. The section formed the bottom of the bag during normal inflation. This section exhibited two areas of occupant contact. An elliptical region measuring approximately 8 cm by 15 cm (3 in by 6 in), width by height was identified in the center aspect of the bag. The center of this region was located approximately 15 cm (6 in) above the fabric construction seam used as a reference. Remnants of tissue and possible makeup were identified through the region. A 6.4 cm by 5 cm (2.5 in by 2 in) red/brown transfer was located 18 cm (7 in) left of the outboard edge of the bag and 3.8 cm (1.5 in) above the seam. The third contact region was located 3.8 cm (1.5 in) below the fabric seam and 10 cm to 18 cm (4 in to 7 in) right of the inboard edge of the bag, **Figure 17**. This region measured 7.6 cm by 4.6 cm (3.0 in by 1.8 in), width by height and was gray/black in color. These three regions were indicative of direct occupant contact very early in the deployment sequence.



**Figure 135: View of the face of the PAB.**



**Figure 16: Contact to the bottom surface of the PAB.**

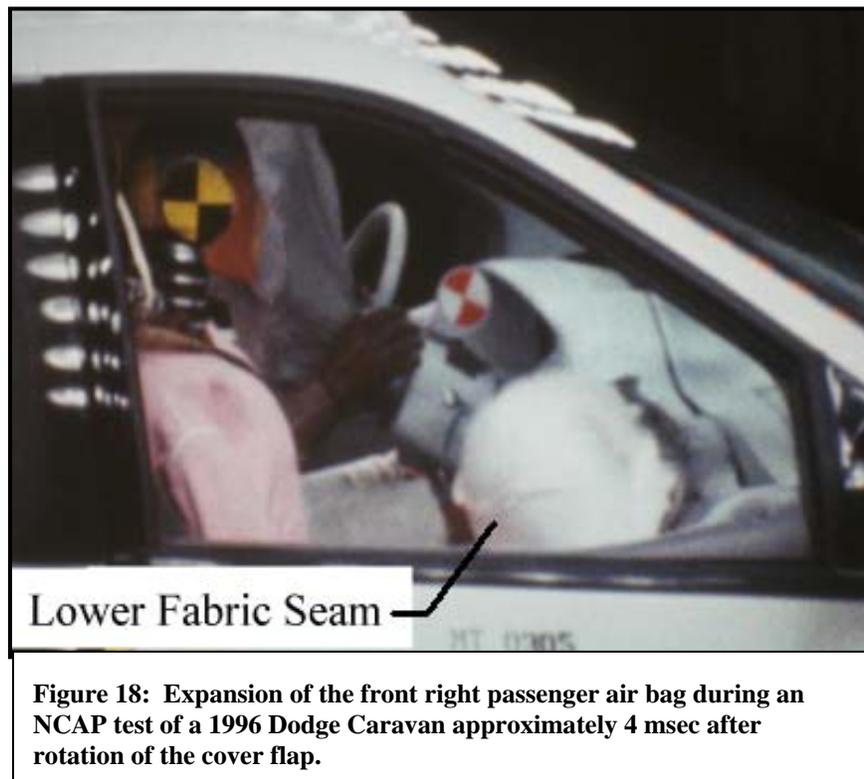


**Figure 17: Contact to the bottom surface of the PAB.**

On September 19, 1996, a New Car Assessment Program (NCAP) test of a 1996 Dodge Caravan was conducted at the Calspan SRL crash test facility in Buffalo, NY. This test was identified by the NHTSA test number: 2453. The high-speed film of this crash test was reviewed in order to obtain a greater understanding of the typical deployment parameters of the front right passenger air bag. These parameters included the general or typical deployment path of the air bag, the

manner the air bag unfolds and inflates, and the timing of the deployment sequence. A review of the high speed film determined that the bottom aspect of the air bag deployed first from the module. The bottom aspect initially expanded rearward toward the occupant and then rolled downward forming the bag's bottom surface as the face of the bag expanded vertically to full inflation. Approximately 21 milliseconds elapsed during the inflation of the front right passenger air bag. For the purposes of this report, the initiation of the air bag deployment sequence began when the front right air bag module cover flaps began to visually rotate open.

**Figure 18** is a frame of the high speed film depicting the inflating front right passenger air bag early in the deployment sequence and by-way of reference the lower seam of the bag is identified. This stop-action frame occurred approximately 4 milliseconds after initiation of the deployment sequence (i.e. the initial rotation of the cover flaps). By comparing the location of the contact evidence in Figures 15 to Figure 17, it is clear that the occupant was contacted by the inflating air bag very early in the deployment sequence and her forward position impeded its normal expansion.



## **OCCUPANT DEMOGRAPHICS**

### **1996 Dodge Caravan**

	<b><i>Driver</i></b>	<b><i>Front Right Child Passenger</i></b>
<b><i>Age/Sex:</i></b>	32 year old female	6 year old/female
<b><i>Height:</i></b>	Unknown	Unknown
<b><i>Weight:</i></b>	Unknown	20 kg (44 lb)
<b><i>Seat Track Position:</i></b>	Mid-track	Full rear track
<b><i>Manual Restraint Use:</i></b>	3-point lap and shoulder belt	Lap belt (with shoulder webbing behind her back)
<b><i>Usage Source:</i></b>	SCI inspection	SCI inspection
<b><i>Type of Medical Treatment:</i></b>	Treated and released	Hospitalized for 13 days

### **DRIVER INJURY**

The 32 year old driver of the 1996 Dodge Caravan was not injured in the crash.

### **DRIVER KINEMATICS**

The 32 year old restrained female driver was seated in a mid-track position in an upright posture. Upon impact, the driver initiated a forward trajectory in response to the 12 o'clock direction of the impact. The driver contacted and loaded the locked safety belt system with her chest and began to ride down the force of the crash. The inertia of the unrestrained driver's head caused her neck to flex forward and the driver's face contacted the deployed driver air bag. The contact to the driver bag was evidenced by the lipstick transfer to the face of the bag. The driver then rebounded back into her seat and exited the vehicle under her own power.

### **FRONT RIGHT CHILD PASSENGER INJURY**

<b><i>Injury</i></b>	<b><i>Injury Severity (AIS update 98)</i></b>	<b><i>Injury Mechanism</i></b>
Cerebral diffuse axonal injury in frontal and temporal lobes, Cognitive functional deficit, Unconscious at scene upon initial observation; GCS=5	Critical (140628.5,6)	Deploying front right passenger air bag
Left tentorial subdural hematoma, NFS	Severe (140650.4,2)	Deploying front right passenger air bag
Left mesial temporal contusion	Serious (140604.3,2)	Deploying front right passenger air bag
Contusion below the right eye, right eye swollen, significant periorbital edema	Minor (290402.1,1)	Deploying front right passenger air bag

*Note: The above injuries were identified from the occupant's Transfer Summary, Radiology reports and Emergency room records.*

### ***FRONT RIGHT CHILD PASSENGER KINEMATICS***

The 6 year old female child passenger was seated in the front right position of the Dodge in an upright posture. The seat was adjusted to a full rear track position. The child was restrained by only the lap portion of the 3-point manual safety belt. The shoulder webbing was behind her back. Immediately prior to the impact, the driver rapidly applied the brakes and steered right in response to the slow traffic directly ahead.

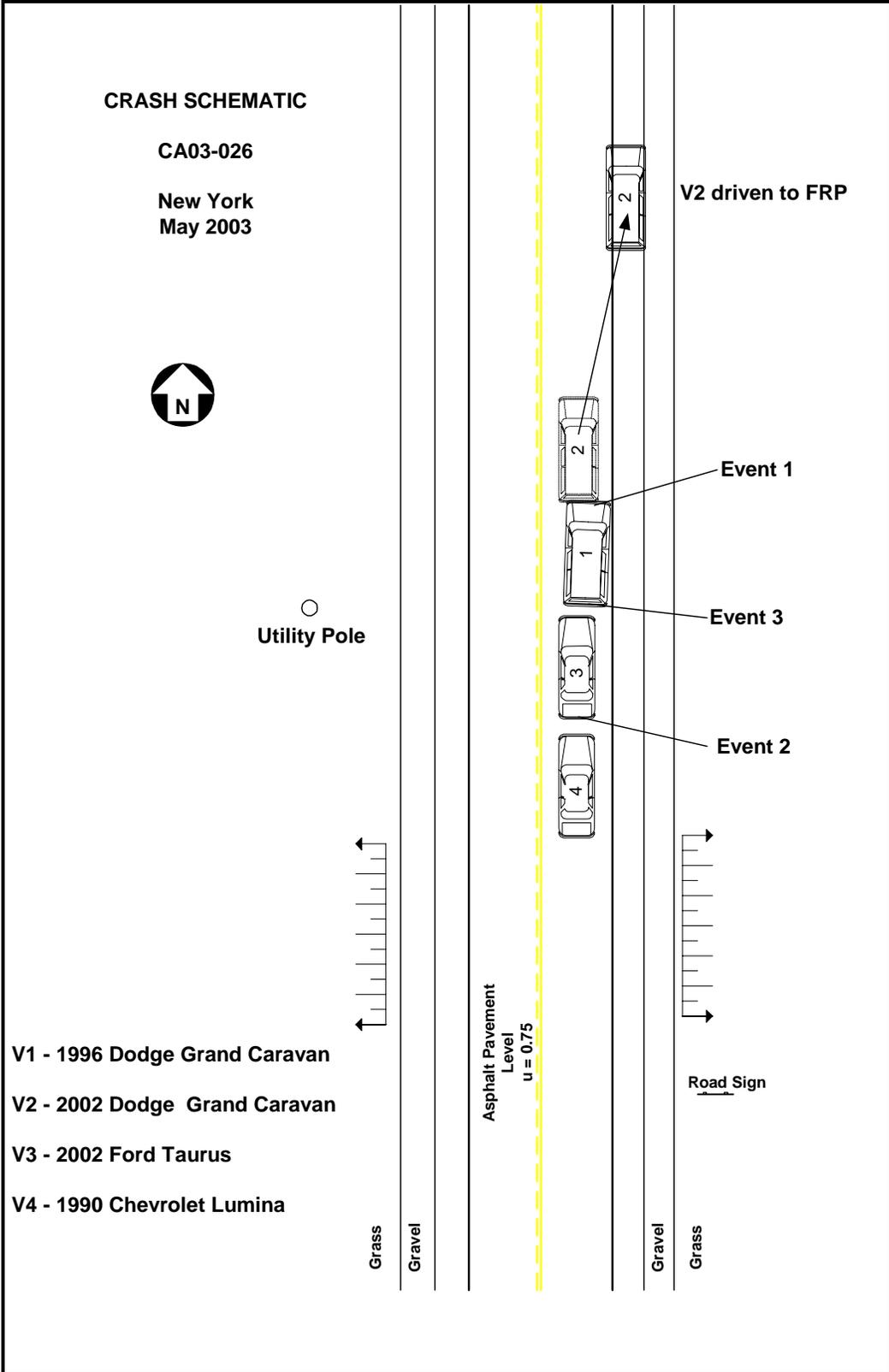
The child responded to the vehicle's dynamics by initiating a forward trajectory. The child loaded the lap belt with her pelvis and abdomen, and began to jackknife forward about the restraint. This kinematic pattern positioned her head and upper torso in close proximity to the front right air bag module.

Upon impact, the vehicle's air bags deployed. The cover flap rotated open without occupant contact. The contact evidence identified on the bottom surface of the front right passenger air bag indicated the bag contacted the child very early in its expansion. The forward position of the child impeded the deployment of the air bag and her forward trajectory in response to the frontal impact deflected the bag forward into the windshield and right A-pillar. This contact was evidenced by the identified windshield fracture and A-pillar scuffs.

The expansion of the air bag caused the child to rebound back into her seat where she was found. The first responders found the child in the front right position and unresponsive (GCS=5). As a result of the contact by the expanding front right passenger air bag, the child sustained a facial contusion below the right eye (with associated swelling), a left tentorial subdural hematoma, a left mesial temporal contusion, and a cerebral diffuse axonal injury in frontal temporal lobe.

### ***MEDICAL TREATMENT***

The child was transported to a pediatric trauma center via Life-Flight. She was admitted in critical condition into the Intensive Care Unit (ICU) and was supported by a ventilator. On hospital day six, the child began to follow verbal commands; and on hospital day seven, she was successfully removed from the ventilator. The medical records indicated that the child demonstrated neurological improvement through the following days. On hospital day 10, the child was moved out of the ICU into a step-down unit. She was then transferred to an inpatient rehabilitation unit on hospital day 13.



**Figure 19: Crash schematic.**