TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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GENERAL DYNAMICS ON-SITE CHILD SAFETY SEAT INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

CASE NO. CA03-036

VEHICLE – 1994 DODGE GRAND CARAVAN

LOCATION - STATE OF NEW YORK

CRASH DATE – JUNE 2003

Contract No. DTNH22-01-C-17002

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.

TECHNICAL REPORT STANDARD TITLE PAGE

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16. Abstract This on-site investigation focused on the performance of an integrated forward-facing child safety seat (CSS) that was present in a 1994 Dodge Grand Caravan. The Grand Caravan was occupied by a 62-year-old male driver, a 33-year-old male front right passenger, a 32-year-old female left second seat passenger, and a 13-month-old female child passenger who was restrained in the second bench seat's right side integrated CSS. All of the adult passengers were restrained by the manual 3-point lap and shoulder belts. The Grand Caravan was involved in an angled offset head-on collision with a 1988 Pontiac 6000 that crossed the centerline of a two-lane roadway. The impact resulted in severe damage to both vehicles and was sufficient to deploy the frontal air bag system in the Grand Caravan. The occupants of the Grand Caravan initiated forward trajectories and loaded the manual restraints and the driver and front right passenger loaded the deployed frontal air bags. The driver sustained a left ulna fracture and a left forearm contusion from contact with the left door panel and left rib fractures from loading the restraint. He also sustained a left posterior hip dislocation and left acetabular fracture from loading to the knee bolster. Left toe pan intrusion resulted in fractures of the left cuboid bone, left talus, left calcaneus, and a left ankle dislocation. A left adrenal hematoma was also sustained from probable rebound into the seat back. He was transported by helicopter to a regional trauma center and admitted for treatment. The front right male passenger was not injured and did not receive medical treatment. The left second seated female adult passenger sustained a left shoulder abrasion and contusion from shoulder belt loading, and a left knee abrasion and lower leg contusion from contact with the driver's seat back. She also sustained a right pulmonary contusion and a first right posterior rib fracture from probable rebound against the seat back. She was transported by ambulance to a regional trauma center and admitted for treatment. The 13-month-old child passenger did not sustain visible injuries but was transported by ambulance to a local hospital for observation.			
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TABLE OF CONTENTS

BACKGROUND **1**

VEHICLE DATA – 1994 DODGE GRAND CARAVAN **2**

VEHICLE DATA – 1988 PONTIAC 6000 ..... **2**

CRASH SITE **2**

CRASH SEQUENCE **3**

- PRE-CRASH 3
- CRASH 3
- POST-CRASH 4

VEHICLE DAMAGE **4**

- EXTERIOR DAMAGE – 1994 DODGE GRAND CARAVAN 4
- INTERIOR DAMAGE -1994 DODGE GRAND CARAVAN 5
- EXTERIOR DAMAGE – 1988 PONTIAC 6000 6

MANUAL RESTRAINT SYSTEMS – 1994 DODGE GRAND CARAVAN **7**

CHILD SAFETY SEAT – INTEGRATED FORWARD-FACING CSS **8**

SUPPLEMENTAL RESTRAINT SYSTEMS – 1994 DODGE GRAND CARAVAN **10**

OCCUPANT DEMOGRAPHICS – 1994 DODGE GRAND CARAVAN **11**

- DRIVER 11
- DRIVER INJURIES 11
- DRIVER KINEMATICS 11
- FRONT RIGHT PASSENGER 12
- FRONT RIGHT PASSENGER KINEMATICS 12
- SECOND SEAT LEFT PASSENGER 12
- SECOND SEAT LEFT PASSENGER INJURIES 13
- SECOND SEAT LEFT PASSENGER KINEMATICS 13
- SECOND SEAT RIGHT CHILD PASSENGER (INTEGRATED CSS) 13
- SECOND SEAT RIGHT CHILD PASSENGER (INTEGRATED CSS) KINEMATICS 14

FIGURE 18. SCENE SCHEMATIC **15**

GENERAL DYNAMICS ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
SCI TECHNICAL SUMMARY REPORT
CASE NO. – CA03-036
SUBJECT VEHICLE – 1994 DODGE GRAND CARAVAN
LOCATION - STATE OF NEW YORK
CRASH DATE – JUNE 2003

BACKGROUND

This on-site investigation focused on the performance of an integrated forward-facing child safety seat (CSS) that was present in a 1994 Dodge Grand Caravan. The Grand Caravan was occupied by a 62-year-old male driver, a 33-year-old male front right passenger, a 32-year-old female left second seat passenger, and a 13-month-old female child passenger who was restrained in the second bench seat's right side integrated CSS **(Figure 1)**. All of the adult passengers were restrained by the manual 3-point lap and shoulder belts. The Grand Caravan was involved in an angled offset head-on collision with a 1988 Pontiac 6000 that crossed the centerline of a two-lane roadway. The impact resulted in severe damage to both vehicles and was sufficient to deploy the frontal air bag system in the Grand Caravan. The occupants of the Grand Caravan initiated forward trajectories and loaded the manual restraints and the driver and front right passenger loaded the deployed frontal air bags. The driver sustained a left ulna fracture and a left forearm contusion from contact with the left door panel and left rib fractures from loading the restraint. He also sustained a left posterior hip dislocation and left acetabular fracture from loading to the left knee bolster. Left toe pan intrusion resulted in fractures of the left cuboid bone, left talus, left calcaneus, and a left ankle dislocation. A left adrenal hematoma was also sustained from probable rebound into the seat back. He was transported by helicopter to a regional trauma center and admitted for treatment. The front right male passenger was not injured and did not receive medical treatment. The left second seated female adult passenger sustained a left shoulder abrasion and contusion from shoulder belt loading, and a left knee abrasion and lower leg contusion from contact with the driver's seat back. She also sustained a right pulmonary contusion and a first right posterior rib fracture from probable rebound against the seat back. She was transported by ambulance to a regional trauma center and admitted for treatment. The 13-month-old child passenger did not sustain visible injuries but was transported by ambulance to a local hospital for observation.

Figure 1. Integrated CSS in the 1994 Dodge Grand Caravan

This crash was identified by the General Dynamics SCI team through a local news agency. The crash information was forwarded from the SCI team to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) due to the presence of the CSS. An on-site investigation was initiated on June 30, 2003. Attempts were made to interview the driver and occupants of the vehicle, however, the driver refused an interview and attempts to contact the remaining occupants was unsuccessful.

VEHICLE DATA – 1994 DODGE GRAND CARAVAN

The 1994 Dodge Grand Caravan was identified by the Vehicle Identification Number (VIN): 1B4GH54R1RX (production sequence omitted). At the time of the vehicle inspection, the Grand Caravan's odometer read 257,058 km (159,733 miles). The vehicle was a front-wheel-drive, three-door mini-van that was equipped with a 3.3 liter, V-6 engine, a four-speed automatic transmission, sport suspension, power brakes, power steering, and a tilt steering wheel. The Grand Caravan was equipped with aluminum/alloy wheels and All Season P205/75R15 steel-belted radial tires. The specific tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0.0 kpa	4 mm (5/32")	Yes	Tears in sidewall
LR	199.9 kpa (29.0 psi)	6 mm (7/32")	No	None
RF	220.6 kpa (32.0 psi)	2 mm (3/32")	No	None
RR	0.0 kpa	6 mm (7/32")	No	None

The front seating positions in the Grand Caravan were configured with box mounted bucket seats with adjustable head restraints. The driver's seat track was jammed and was positioned 17.8 cm (7.0") rear of full-forward and 2.5 cm (1.0") forward of full-rear. Rescue personnel stated that hydraulic spreaders were used to displace the driver's seat rearward to assist in his extrication from the vehicle. The front right passenger's seat was positioned at the full-forward track position by rescue personnel post-crash. The pre-crash location of the front right passenger's seat track was unknown. An aftermarket back support was present on the front right passenger's seat. The second row was configured with a two-person bench seat with integrated CSS's and a folding back. The third row was configured with a three-person bench seat with a folding back. The second and third row bench seats were removable.

VEHICLE DATA – 1988 PONTIAC 6000

The 1988 Pontiac 6000 was identified by the VIN 1G2AF51R7JT (production sequence omitted). The vehicle was a four-door sedan that was equipped with a 2.5 liter, 4-cylinder engine, automatic transmission, front wheel drive, and power steering. The Pontiac 6000 was equipped with Cornell 205/75R14 steel-belted radial tires.

CRASH SITE

This two-vehicle crash occurred during the daylight hours of June 2003 in the state of New York. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The crash occurred on a two-lane east/west state roadway. The roadway was configured with one travel lane in each direction separated by a broken yellow centerline, and bordered by asphalt shoulders. The roadway exhibited a slight positive westbound grade at the crash site and a hillcrest was located 70.6 m (231.6') west of the crash site. The roadside environment consisted of wooded areas and grassy drainage ditches. The posted speed limit was 89 km/h (55 mph). The scene schematic is included as **Figure 18** of this report.

CRASH SEQUENCE

Pre-Crash

The 62-year-old male driver of the Dodge Grand Caravan was operating the vehicle eastbound on the two-lane roadway **(Figure 2)**. A 19-year-old female driver was operating the Pontiac 6000 westbound on the same roadway **(Figure 3)**. The driver of the Pontiac 6000 drifted over the centerline in a tracking mode into the path of the oncoming Grand Caravan. The cause of the 19-year-old driver's inattention was not known. The driver of the Grand Caravan detected the Pontiac encroaching into the eastbound lane and attempted to avoid the collision by steering right onto the asphalt shoulder. The Pontiac continued across the eastbound lane onto the asphalt shoulder into the path of the Grand Caravan. Based on the damage patterns and post-impact trajectories, it appeared that one or both of the drivers attempted to steer back onto the roadway prior to the impact, however, this could not be confirmed.

Figure 2. Eastbound approach for the Grand Caravan

Figure 3. Westbound approach for the Pontiac 6000

Crash

The Grand Caravan impacted the Pontiac 6000 in an angled, offset, head-on configuration. The impact resulted in severe damage to both vehicles, and resulted in the deployment of the frontal air bag system in the Grand Caravan. The directions of force were in the 12 o'clock sectors for both vehicles. The damage algorithm of the WinSMASH program computed a total delta-V of 54.0 km/h (33.6 mph) for the Grand Caravan and a total delta-V of 76.0 km/h (47.2 mph) for the Pontiac 6000 based on the respective crush profiles. The vehicles remained engaged and rotated in a counterclockwise (CCW) direction. Due to the continued engagement and rotation of the vehicles, direct contact from the Pontiac 6000 extended down the left side of the Grand Caravan. Two curved tire marks from the Grand Caravan's front tires were present on the asphalt shoulder from the post-impact rotation and travel to final rest. The vehicles separated and the Grand Caravan came to rest on the grassy roadside facing northwest. The Pontiac 6000 came to rest straddling the centerline facing southeast. Final rest positions are shown in **Figure 4**.

Figure 4. On-scene police photograph of crash site and final rest positions

Post-Crash

The driver of the Grand Caravan was trapped in the vehicle due to passenger compartment intrusion and was extricated approximately 45 minutes after the crash. He was transported by helicopter to a regional trauma center and admitted for treatment. The front right passenger and second seat adult passenger exited the Grand Caravan under their own power and were found walking outside the vehicle when emergency personnel arrived on-scene. The front right passenger did not sustained injury and did not receive medical treatment. The second seat female adult passenger sustained moderate/minor injuries and was transported by ambulance to a regional trauma center and admitted for treatment. The 13-month-old child was removed from the vehicle by the front right passenger. Emergency personnel found the front right passenger holding the child upon their arrival. The child did not sustain visible injuries and was placed in an air-conditioned police car prior to being transported to a local hospital by ambulance for observation. The driver of the Pontiac 6000 sustained police-reported severe injuries and was transported by helicopter to a regional trauma center and admitted for treatment.

VEHICLE DAMAGE

Exterior Damage – 1994 Dodge Grand Caravan

The 1994 Dodge Grand Caravan **(Figures 5 and 6)** sustained severe damage as a result of the frontal impact with the Pontiac 6000. The direct damage began 5.1 cm (2.0”) left of the centerline and extended 78.7 cm (31.0”) to the front left bumper corner. Abrasions and paint transfers were present on the left aspect of the bumper fascia and the bumper fascia was separated from the vehicle. The bumper beam and upper and lower radiator supports were crushed rearward. The maximum crush at the bumper beam was located at the front left corner and measured 94.0 cm (37.0”). The front left aspect of the hood was deflected down and rearward from direct contact and the entire hood was rotated slightly clockwise (CW). The left rear aspect of the hood was separated. The left front fender was completely separated and the left front wheel sustained direct contact, evidenced by tears on the sidewall of the tire and abrasions on the alloy wheel. The frontal crush resulted in a 43.0 cm (16.9”) reduction of the left wheelbase. Due to the post impact engagement and rotation, direct contact abrasions and paint transfers extended along the left side of the Grand Caravan beginning at the left front corner and terminating at the left B-pillar, 123.0 cm (48.4”) aft of the damaged left front axle. The combined direct and induced damage involved the entire frontal width of the Grand Caravan. The bumper

Figure 5. Damaged Dodge Grand Caravan

Figure 6. Frontal view of the damaged Dodge Grand Caravan

beam was shifted to the left and the right front fender was deflected inward at its forward aspect. The left sill was buckled and the plastic cladding along the lower aspect of the left side of the Grand Caravan was separated. Rescue personnel removed the left front door, cut the left and right A- and B-pillars, and folded the roof rearward to facilitate the extrication of the driver. Hydraulic spreaders were used to increase the distance between the left A- and B-pillars, which resulted in post crash deformation to both pillars. The left front door exhibited blue paint transfers and abrasions that extended the entire length of the door. Paint transfers and scuff marks were also present on the plastic cladding that was separated from the bottom aspect of the door. Six crush measurements were documented along the front bumper beam as follows: C1 = 94.0 cm (37.0”), C2 = 73.6 cm (29.0”), C3 = 50.2 cm (19.8”), C4 = 29.8 cm (11.8”), C5 = 12.1 cm (4.8”), C6 = 0.0 cm. The Collision Deformation Classification (CDC) for the impact with the Pontiac 6000 was 12-FYEW-5.

Interior Damage -1994 Dodge Grand Caravan

The 1994 Dodge Grand Caravan sustained moderate interior damage as a result of passenger compartment intrusion and occupant contact. **Figure 7** shows the overall front seating positions and related interior damage. The left front door was jammed shut and removed by rescue personnel. The remaining doors were operational. Damage to the windshield and glazing from crash forces could not be determined. The left and right side glazing surrounding the A- and B-pillars was completely removed by rescue personnel to facilitate the removal of the left front door and the folding of the roof. The knee bolster was displaced and deformed on both sides of the steering column from contact with the driver’s knees. The tilt steering column was compressed forward and jammed in the full-up position. The plastic cover on the bottom aspect of the steering column was fractured. The steering wheel rim was compressed forward slightly, evidenced by minor separation at the 2, 4, and 8 o’clock spoke locations. The brake pedal arm was cut and the brake pedal removed by rescue personnel to facilitate extrication of the driver. The accelerator pedal was compressed between the left aspect of the center console and the intruded left toe pan. The driver’s seat was displaced left and rotated CCW on the seat base. The right instrument panel sustained a diagonal linear impression located 22.9 cm (9.0”) inboard of the right instrument panel corner that measured 4.0 cm (1.5”) in length. **Figure 8** shows the longitudinal intrusions into the front seating positions. The floor intruded vertically from induced buckling on the left side front and second seat position areas, and measured 8.9 cm (3.5”) vertically at the forward aspect of the driver’s seat. Lateral intrusions included the left side panel forward of the left A-pillar,

Figure 7. Overall view of damaged front seating positions

Figure 8. View of displaced driver's seat and related intrusions

left B-pillar and the left side panel rear of the left B-pillar. The driver's seat back was reclined rearward at the time of the vehicle inspection as a result of rescue efforts.

Specific intrusions were as follows:

Position	Intruded Component	Magnitude of Intrusion	Direction
LF	Left A-pillar (base)	27.9 cm (11.0")	Longitudinal
LF	Left A-pillar (at level of latch/striker)	19.7 cm (7.8")	Longitudinal
LF	Left toe pan	10.2 cm (4.0")	Longitudinal
LF	Parking brake pedal	10.2 cm (4.0")	Longitudinal
LF	Floor	8.9 cm (3.5")	Vertical
LF	Left B-pillar	11.4 cm (4.5")	Lateral
LF	Left side panel (fwd of A-pillar)	27.9 cm (11.0")	Lateral
2nd L	Floor	8.9 cm (3.5")	Vertical
2nd L	Left side panel rear of the left B-pillar	15.2 cm (6.0")	Lateral
2nd C	Floor	8.9 cm (3.5")	Vertical

Exterior Damage – 1988 Pontiac 6000

The 1988 Pontiac 6000 sustained severe damage **(Figures 9 and 10)** as a result of the frontal impact with the Dodge Grand Caravan. The direct damage on the bumper fascia began 11.4 cm (4.5") left of the centerline and extended 69.9 cm (27.5") to the front left corner. The bumper fascia was fractured and completely separated from the vehicle. The hood sustained direct contact abrasions and was crushed and buckled rearward. The front bumper beam exhibited two vertical fractures that were located 27.9 cm (11.0") and 54.6 cm (21.5") left of the centerline. The maximum crush at the front left corner measured 116.8 cm (46.0"). The combined direct and induced damage involved the entire frontal width of the Pontiac 6000. The vehicle frame was buckled and deformed laterally between the B- and C-pillars. The front half of the vehicle was deflected to the right, and the magnitude of the lateral deflection on the right side between the right B-pillar and right C-pillar measured 39.4 cm (15.5"). The right front fender was deflected significantly to the left. The left front wheel was crushed rearward and restricted. The entire left sill was buckled and the left front door was deformed, buckled, and pulled outward from the top aspect by rescue personnel. The frontal crush and frame deflection resulted in a 68.0 cm (26.8") reduction of the left wheelbase and a 9.0 cm (3.5")

Figure 9. Frontal view of damaged Pontiac 6000

Figure 10. Left side view of damaged Pontiac 6000

reduction in the right wheelbase. The rear axle was also displaced due to the vehicle deformation. The roof was removed by rescue personnel to facilitate the extrication of the driver. Six crush measurements were documented along the front bumper beam and were as follows: C1 = 116.8 cm (46.0”), C2 = 109.8 cm (43.2”), C3 = 95.8 cm (37.7”) C4 = 62.8 cm (24.7”), C5 = 42.5 cm (16.7”), C6 = 33.6 cm (13.2”). The CDC for this vehicle was 12-FYEW-5.

MANUAL RESTRAINT SYSTEMS – 1994 Dodge Grand Caravan

The front seating positions in the Dodge Grand Caravan were configured with manual 3-point lap and shoulder belts. Both front seat safety belts were cut by rescue personnel to facilitate the cutting of the B-pillars, folding of the roof, and extrication of the driver. The driver’s safety belt was configured with a sliding latch plate, adjustable D-ring, and an emergency locking retractor (ELR). The retractor was jammed in the used position, and rescue personnel cut the driver’s safety belt webbing 167.6 cm (66.0”) above the lower anchorage **(Figure 11)**. The remaining webbing, which extended from the retractor, measured 50.8 cm (20.0”) from the opening on the B-pillar to the cut point, and 27.9 cm (11.0”) from the driver’s D-ring (located in the full-up position) to the cut point. The driver’s safety belt webbing exhibited minor stretch marks from occupant loading and the D-ring exhibited faint abrasions. A white paint transfer was located 64.8 cm (25.5”) above the lower anchor on the outboard aspect that measured 16.5 cm (6.5”) in length. The plastic hardware of the latch plate sustained minor abrasions as a result of occupant loading.

Figure 11. View of driver's cut safety belt

The front right passenger’s safety belt was configured with a cinching latch plate and an ELR. The D-ring was located in the full-up position. The front right passenger’s safety belt webbing was cut 88.3 cm (34.8”) from the lower anchor and the remaining webbing was retracted into the B-pillar. A white paint transfer that measured 3.2 cm (1.5”) in length was located on the inboard aspect of the webbing 29.2 cm (11.5”) above the lower anchor.

The second row two-person bench seat **(Figure 12)** was configured with manual 3-point lap and shoulder belts for each seating position. Both had fixed D-ring anchors, ELR’s, and cinching latch plates. The right side safety belt was configured with a steel spring clasp on the lower anchor of the lap belt portion. A plastic sleeve that measured 25.4 cm (10.0”) in length and 5.1 cm (2.0”) in width was located adjacent to the clasp on the webbing. The clasp engaged with one of two steel rings labeled “A” and “B”. The “A” ring was located on the floor on the rear right corner aspect of the second row bench seat. The “B” ring was located on the

Figure 12. View of second row restraints

forward aspect of the interior lower C-pillar, which is where the manual restraint was anchored at the time of the vehicle inspection. The owner's manual stated the following information regarding the anchor placement:

> "If the vehicle has a two passenger seat in the second row, the anchor must be installed in the floor mounting position marked with an "A", next to the seat. If the vehicle has a three-passenger seat or bucket seat in the second row, the seat belt must be installed in the side mounting position. This position is on the lower part of the trim panel, marked with a "B", just rearward of the side door opening."

Although the second row right safety belt was not in use during this crash, it was not in the proper position, given the use of the two-person bench seat. The second row left safety belt webbing exhibited an abrasion on the outboard aspect that was located 144.8 cm (57.0") above the lower anchor. Minor abrasions were noted on the plastic latch plate and faint abrasions were present on the D-ring as a result of occupant loading.

The third row was configured with manual 3-point lap and shoulder belts with fixed D-rings, cinching latch plates, and ELR's for the outboard positions and the center position was configured with a lap belt with a locking latch plate.

CHILD SAFETY SEAT – Integrated Forward-Facing CSS

The 1994 Dodge Grand Caravan was equipped with two integrated forward-facing CSS's **(Figure's 13 and 14)** in the second row bench seat. The CSS seat cushions folded forward from the bench seat back and the CSS head restraints rotated upward from the seat back. The CSS head restraints measured 20.3 cm (8.0") in height, 29.8 cm (11.8") in width, and 5.7 cm (2.3") in thickness in the stowed position. In the used position, the CSS head restraint measured 15.2 cm (6.0") in height. A label was present on the CSS head restraint that read, "This headrest is not intended for use by an adult." A 7.6 cm (3.0") long nylon loop was present on the right aspect of each CSS that protruded from under the head restraints in the stowed position, which released the CSS seat cushions and head restraints from the seat back. The CSS head restraint locked into position when fully extended, and could be released to re-stow by pulling on the spring-loaded nylon loop. The CSS seat cushions measured 27.9 cm (11.0") in width, 33.0 cm (13.0") in length, and 7.6 cm (3.0") in height. The CSS cushions extended 21.6 cm (8.5") forward from the seat back. Horseshoe-shaped removable fabric pads were affixed to each seat cushion with Velcro fasteners, which measured 1.9 cm (0.8") thick. The

Figure 13. Lateral view of second row integrated CSS's

Figure 14. Overhead view of the integrated CSS's

pads were open at the forward/center aspects for access to the harness system buckles. The CSS's were configured with 5-point harnesses with harness adjustment tabs on the forward aspects of each CSS cushion. The harness retainer clips were two-piece plastic clips that locked together when engaged.

Due to the integrated nature of the CSS, a model number and date of manufacture were not available. A small label was present under the right side CSS's removable seat pad, which had a number as follows: 13297162. A label was present on the left aspect of the face of the CSS seat cushions that read, "This Child restraint harness is designed for use by children who weighed between 20 and 40 pounds and whose height is 40 inches or less and who are capable of sitting upright alone." A second label on the right aspect of the face of the CSS cushions read, "Snugly adjust the belts provided with this child restraint around your child. SEE OWNER'S MANUAL." A warning label was present on the inboard aspect of the right side CSS seat back area (from where the cushion was stowed) that read, "Do not use this passenger side seat with the adult seat belt." This warning was to prevent the use of the right side CSS as a belt-positioning booster. A similar label was found on the left integrated CSS that read, "The driver's side child seat can be used with the adult shoulder and lap belt for children over 40 pounds."

A 13-month-old female child was restrained in the right side integrated CSS. The left side integrated CSS was not used in this crash. At the time of the vehicle inspection, the right side CSS head restraint was found in the stowed position, and it was not known if it was engaged at the time of the crash. The harness system **(Figure 15)** was adjusted such that the length of the harness webbing measured 67.3 cm (26.5") between the harness slots and the lower anchors. The adjustment tab was adjusted to a residual length of 12.7 cm (5.0"). It should be noted that the left side CSS harness system (not used in this crash) was adjusted to the same parameters, and did not show signs of historical use. The pre-crash position of the harness retainer clip was unknown. The harness retainer clip did not exhibit any abrasions or deformation. Minor stretch marks were present on the harness webbing. The loading to the right harness strap began 12.1 cm (4.5") above the lower anchor and extended upward 45.1 cm (17.8"). The loading to the left harness strap began 5.1 cm (2.0") above the lower anchor and extended upward 57.2 cm (22.5"). The plastic harness slots sustained only faint abrasions from the child loading against the harness straps.

Figure 15. Close-up of harness straps of the right side integrated CSS

SUPPLEMENTAL RESTRAINT SYSTEMS – 1994 Dodge Grand Caravan

The 1994 Dodge Grand Caravan was equipped with frontal air bags for the driver and front right passenger positions that deployed as a result of the frontal impact. The driver's air bag **(Figure 16)** deployed from the center of the steering wheel hub from symmetrical H-configuration cover flaps. The cover flaps measured 5.7 cm (2.5") in height and 17.8 cm (7.0") in width. The driver's air bag measured 66.0 cm (26.0") in diameter. A fluid transfer (possibly body fluid) was present on the face of the driver's air bag that was vertically centered, located 7.6 cm (3.0") below the horizontal centerline, and measured 10.2 cm (4.0") in length. A small circular body fluid transfer was located 22.9 cm (9.0") above the horizontal centerline and 10.2 cm (4.0") to the right of the vertical centerline that measured 1.3 cm (0.5") in diameter. Faint linear vinyl transfers were present on the outboard aspects of the face of the air bag from engagement against the cover flaps during the deployment. The driver's air bag was vented by two circular ports located at the 12 o'clock position on the rear of the air bag. The vent ports measured 2.5 cm (1.0") in diameter and were located 7.0 cm (2.8") from the circumferential seam and were spaced 5.1 cm (2.0") apart. The air bag was not tethered.

Figure 16. Deployed driver's air bag

The front right passenger's air bag **(Figure 17)** deployed from a top-mount module with a single cover flap design. The cover flap was rectangular in shape and measured 14.6 cm (5.8") in height and 30.5 cm (12.0") in width. The front right passenger's air bag measured 66.0 cm (26.0") in height and 45.7 cm (18.0") in width. The air bag was vented back through the module, as there were no vent ports located on the air bag. The air bag was tethered by two internal straps that measured 29.8 cm (11.75") in width and were located 15.2 cm (6.0") above and below the horizontal centerline of the air bag. At the time of the inspection, the top aspect of the front right passenger's air bag was covered with of motor oil and crash debris. There was no occupant contact evidence on the air bag.

Figure 17. Deployed front right passenger's air bag

OCCUPANT DEMOGRAPHICS – 1994 Dodge Grand Caravan

Driver

Age/Sex:	62-year-old male
Height:	175 cm (69”)
Weight:	77 kg (170 lb)
Seat Track Position:	Appeared to be near mid-track (displaced by rescue equipment)
Manual Restraint Use:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported by helicopter to a regional trauma center and admitted for 12 days

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Left ulna distal 1/3 fracture	Moderate (753202.2,2)	Left A-pillar
Left posterior hip dislocation	Moderate (850610.2,2)	Indirect – knee bolster, force transmitted through femur
Avulsion fracture of left calcaneus laterally	Moderate (851400.2,2)	Toe pan
Comminuted fracture of the left cuboid bone	Moderate (852200.2,2)	Toe pan
Left ankle dislocation	Moderate (852210.2,2)	Indirect - toe pan
Left acetabular fracture	Moderate (852600.2,2)	Indirect – knee bolster, force transmitted through femur
Comminuted fracture of the body of the left talus posteriorly and medially	Moderate (853200.2,2)	Indirect - toe pan
Left adrenal hematoma	Minor (540210.1,2)	Driver’s seat back
Left forearm contusion	Minor (790402.1,2)	Left A-pillar

Injury source: Emergency room records, discharge summary

Driver Kinematics

The 62-year-old driver of the Dodge Grand Caravan was seated in an upright posture and was restrained by the manual 3-point lap and shoulder belt. His arms were most likely bracing against the steering wheel prior to impact, evidenced by partial deflection of the spokes of the steering wheel. At impact, the frontal air bag system deployed and the driver initiated a forward trajectory. The deploying driver’s air bag displaced his left arm in a fling motion, which resulted in a left distal 1/3 ulna fracture and a left forearm contusion from probable contact with the left A-pillar. He loaded the safety belt and the driver’s air bag, which mitigated additional contact with the steering wheel. His knees struck the bolster evidenced by deformation and displacement of the knee bolster. He sustained a left posterior hip dislocation and a left acetabular fracture as a

result of loading to the knee bolster. The intrusion of the left toe pan resulted in a left ankle dislocation, a comminuted fracture of the body of the left talus posteriorly and medially, an avulsion fracture of left calcaneus laterally, a comminuted fracture of the left cuboid bone, and trapped his right foot between the toe pan and the brake pedal. Rescue personnel removed the brake pedal by cutting the brake pedal arm to free his right foot. The driver was removed from the vehicle by rescue personnel. He was transported by helicopter to a regional trauma center and admitted for 12 days.

Front Right Passenger

Age/Sex:	33-year-old male
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Unknown (moved post-crash)
Manual Restraint Use:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection, lack of injury
Eyewear:	Unknown
Type of Medical Treatment:	Did not sustain injury and did not receive medical treatment

Front Right Passenger Kinematics

The 33-year-old male front right passenger was restrained by the manual 3-point lap and shoulder belt. The pre-crash seat track position was unknown, as the seat had been moved post-crash. At impact, the frontal air bag system deployed and the front right passenger initiated a forward trajectory. He loaded the safety belt and deployed front right passenger's air bag and rebounded into the seat back. The front right passenger did not sustain injury and exited the vehicle under his own power. He did not receive medical treatment.

Second Seat Left Passenger

Age/Sex:	32-year-old female
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Fixed
Manual Restraint Use:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a regional trauma center and admitted for 3 days

Second Seat Left Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Right upper pulmonary contusion	Serious (441406.3,1)	Possible rebound into seat back
Non-displaced fracture involving the posterior aspect of the right first rib near the costotransverse articulation	Minor (450212.1,1)	Possible rebound into seat back
Left shoulder abrasion	Minor (790202.1,2)	Shoulder belt webbing
Left shoulder contusion	Minor (790402.1,2)	Shoulder belt webbing
Left knee abrasion	Minor (890202.1,2)	Driver's seat back
Left lower leg contusion	Minor (890402.1,2)	Driver's seat back

Injury source: Emergency room records, discharge summary

Second Seat Left Passenger Kinematics

The 32-year-old female adult passenger was seated on the left aspect of the second row bench seat. Although medical records report that she was unrestrained, the lack of significant injury and contact evidence in the vehicle support safety belt usage. It should be noted however, that proper restraint usage could not be confirmed. At impact, she initiated a forward trajectory and loaded the manual restraint. She sustained a left shoulder abrasion and contusion from loading the safety belt webbing. Although there was no supporting contact evidence, she probably contacted the driver's seat back, which resulted in a left knee abrasion and left lower leg contusion from contact. She rebounded rearward and slightly left against the seat back as the vehicle rotated to rest. The female passenger sustained a non-displaced fracture of the posterior right first rib and a right upper lung contusion. Due to the nature of the injury and lack of additional related injuries, it was possible that they were a result of her rebound into the seat back, but it could not be confirmed. The 32-year-old female exited the Grand Caravan under her own power and was transported by ambulance to a regional trauma center and admitted for 3 days.

Second Seat Right Child Passenger (integrated CSS)

Age/Sex:	13-month-old female
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Fixed
Manual Restraint Use:	Forward-facing integrated CSS with a 5-point harness
Usage Source:	Vehicle inspection, CSS inspection
Eyewear:	None
Type of Medical Treatment:	Transported by ambulance to a local hospital for observation and released

Second Seat Right Child Passenger (integrated CSS) Kinematics

The 13-month-old female child passenger was restrained in the integrated, forward-facing, CSS on the right aspect of the second row bench seat. She was restrained in the CSS by the 5-point harness system, although the tightness of the harness system was not known. At impact, she initiated a forward trajectory and loaded the 5-point harness system, evidenced by minor stretch marks on the harness straps. She rebounded rearward into the CSS and did not sustain visible injuries. She was removed from the CSS by the front right passenger who held her until emergency personnel arrived on scene. She was placed in the rear seat of an air-conditioned police car until an ambulance arrived, and was subsequently transported by ambulance to a local hospital and admitted for observation. Although the child was transported, she was probably evaluated and released without treatment, as there were no records of treatment at any of the local hospitals.

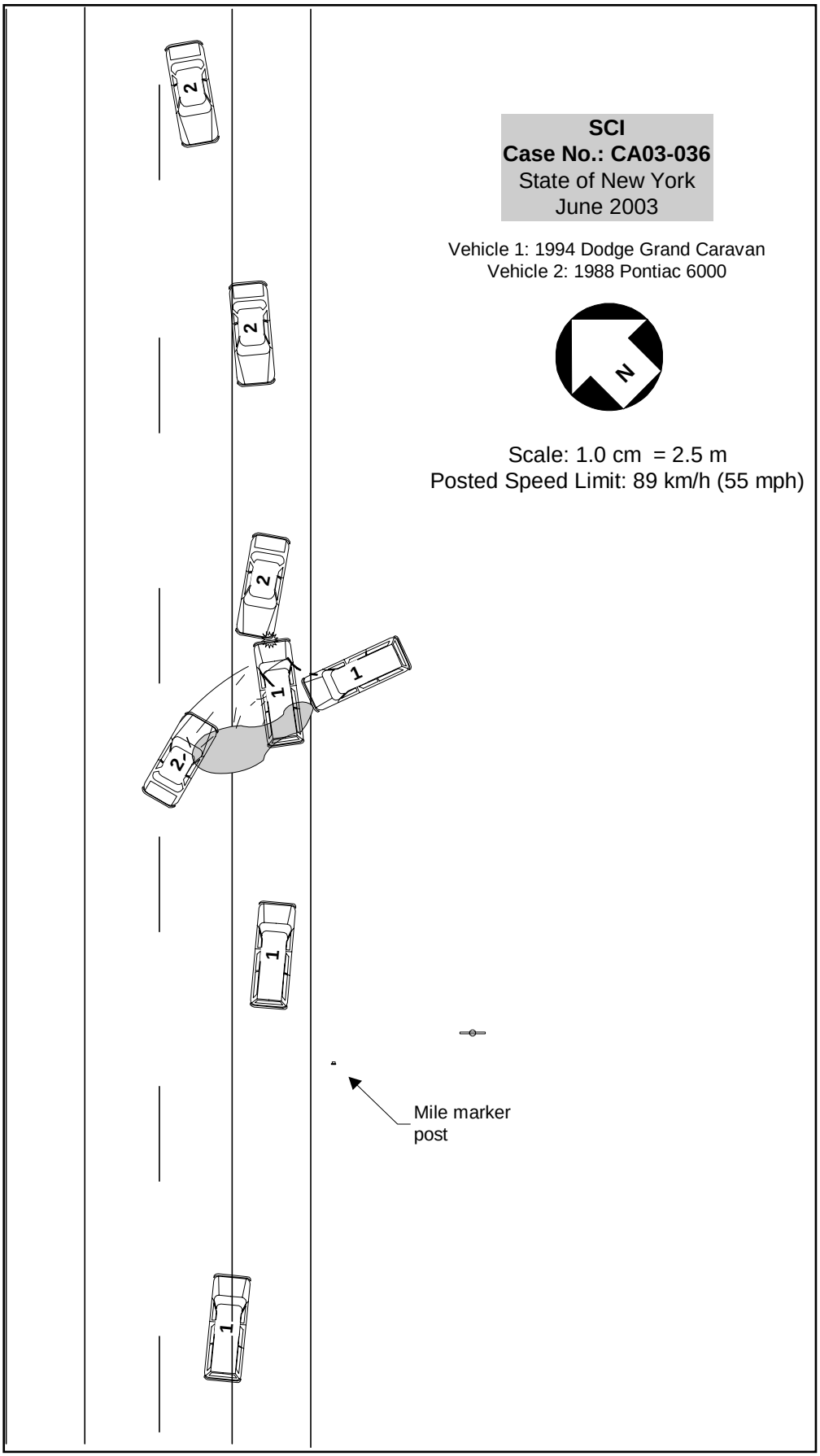

Figure 18. Scene schematic