

**TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER**

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

CASE NO. CA03-007

VEHICLES – 1993 DODGE CARAVAN / 1997 FORD F-150 PICKUP TRUCK

LOCATION - STATE OF NEW YORK

CRASH DATE – JANUARY 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 This on-site investigation focused on the installation and performance of two forward-facing convertible child safety seats (CSS) installed a 1993 Dodge Caravan and a forward-facing CSS installed in a 1997 Ford F-150 extended-cab pickup truck. The Caravan was occupied by a 37-year-old female driver, a 21-month-old male in a forward-facing convertible CSS, and a 4-year-old male in a forward-facing belt-positioning booster (BPB). Both children were positioned in the second row bench seat. The F-150 was occupied by a 32-year-old female driver and a 4-year-old female who was positioned in a forward-facing CSS with a 5-point harness behind the driver. The Caravan crossed the centerline of a two-lane roadway in a counterclockwise (CCW) yaw and was struck on the right side by a southbound 1997 Ford-F-150 pickup truck. The impact resulted in the deployment of the frontal air bag systems in both vehicles. The Caravan was displaced laterally onto the roadside and tipped onto its left side. The driver of the Caravan sustained a critical closed-head injury from contact with the intruded right B-pillar, a liver laceration, a lung contusion, fractured ribs, and a sacral fracture. The 4-year-old child sustained facial abrasions and lacerations, lip and gum lacerations, and a right temporal contusion. The 21-month-old was fatally injured and sustained a skull fracture, left pneumothorax, right thigh contusion, forehead laceration, and bilateral arm contusions. The driver and 4-year-old were transported by helicopter to a regional trauma center. The driver was admitted and placed on life-support. The 4-year-old was admitted for three days. The 21-month-old was transported by ambulance to a local hospital and transferred to a regional trauma center where he expired 32 hours following the crash. The driver and 4-year-old child sustained minor injuries and were transported by ambulance to a local hospital where they were treated and released.</p>			
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**GENERAL DYNAMICS ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
SCI SUMMARY TECHNICAL REPORT
CASE NO. – CA03-007
SUBJECT VEHICLES – 1993 DODGE CARAVAN/1997 FORD F-150 PICKUP TRUCK
LOCATION - STATE OF NEW YORK
CRASH DATE - JANUARY 2003**

BACKGROUND

This on-site investigation focused on the installation and performance of two forward-facing convertible child safety seats (CSS) installed in a 1993 Dodge Caravan and a forward-facing CSS installed in a 1997 Ford F-150 extended-cab pickup truck. The Caravan was occupied by a 37-year-old female driver, a 21-month-old male in a forward-facing convertible CSS, and a 4-year-old male in a forward-facing belt-positioning booster (BPB). Both children were positioned in the second row bench seat. The F-150 was occupied by a 32-year-old female driver and a 4-year-old female who was positioned in a forward-facing CSS with a 5-point harness behind the driver. The Caravan crossed the centerline of a two-lane roadway



Figure 1. On-scene photo of vehicles at final rest

in a counterclockwise (CCW) yaw and was struck on the right side by a southbound 1997 Ford-F-150 pickup truck. The impact resulted in the deployment of the frontal air bag systems in both vehicles. The Caravan was displaced laterally onto the roadside and tipped onto its left side (**Figure 1**). The driver of the Caravan sustained a critical closed-head injury from contact with the intruded right B-pillar, a liver laceration, a lung contusion, fractured ribs, and a sacral fracture. The 4-year-old child sustained facial abrasions and lacerations, lip and gum lacerations, and a right temporal contusion. The 21-month-old was fatally injured and sustained a skull fracture, left pneumothorax, right thigh contusion, forehead laceration, and bilateral arm contusions. The driver and 4-year-old were transported by helicopter to a regional trauma center. The driver was admitted and placed on life-support. The 4-year-old was admitted for three days. The 21-month-old was transported by ambulance to a local hospital and transferred to a regional trauma center where he expired 32 hours following the crash. The driver and 4-year-old child sustained minor injuries and were transported by ambulance to a local hospital where they were treated and released.

This crash was identified by a regional National Automotive Sampling System (NASS) GES researcher. The notification was forwarded to the Veridian Special Crash Investigations team and subsequently forwarded to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) due to the presence of the multiple CSS's. Cooperation with the investigating police agency was established and on-site investigation was initiated.

CRASH SITE

This two-vehicle crash occurred on a two-lane undivided north/south roadway during daylight hours of January 2003. At the time of the crash, it was cloudy and the roadway surface was wet.

The roadway was configured with one travel lane in each direction separated by a double-yellow centerline. The crash occurred on a straight segment of the roadway between two opposing curves. A sag was present between the curves and the roadway had an approximate 2 percent positive northbound grade at the crash site. The travel lanes were bordered by asphalt shoulders that measured 1.3m (4.3') in width. A drainage ditch that measured 1.2 m (3.9') in width and 0.6 m (2.0') in depth was located 2.6 m (8.5') from the east roadside and was parallel with the roadway. The roadside environment consisted of snow-covered grassy areas. The posted speed limit for the roadway was 72 km/h (45 mph). There was no traffic control present at the crash site. The scene schematic is included as **Figure 28** at the end of this report.

VEHICLE DATA – 1993 Dodge Caravan

The 1993 Dodge Caravan was identified by the Vehicle Identification Number (VIN): 2B4GH2537PR (production sequence omitted). The vehicle was a three-door minivan that was equipped with 3.0 liter, V-6 engine, front wheel drive, a 3-speed automatic transmission, power steering, and a tilt steering wheel. At the time of the vehicle inspection, the vehicle’s odometer read 186,124 km (116,110 miles). The Caravan was configured with Michelin Roadhandler Sport 205/70R14 tires. The manufacturer’s recommended tire pressure was 241 kPa (35 PSI). The specific tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Tire/Wheel Damage
LF	227.5 kPa (33.0 PSI)	4.8 mm (6/32")	No	None
LR	231.0 kPa (33.5 PSI)	5.6 mm (7/32")	No	None
RF	227.5 kPa (33.0 PSI)	4.8 mm (6/32")	No	None
RR	199.9 kPa (29.0 PSI)	4.8 mm (6/32")	No	None

The front seating positions in the 1993 Dodge Caravan was configured with box-mounted bucket seats with integrated head restraints. The driver’s seat track was jammed and appeared to be located between the mid-track and full-rear positions at the time of the vehicle inspection. The front right seat track could not be measured due to damage. The second row was configured with a three-person bench seat.

There were eight NHTSA safety recalls associated with the 1993 Dodge Caravan. The status of the recall remedies was not known. A local repair facility performed a mechanical inspection on the vehicle after the crash. The repair facility found no mechanical problems and stated that the Caravan would have passed the state inspection.

VEHICLE DATA – 1997 Ford F-150 Pickup Truck

The 1997 Ford F-150 pickup truck was identified by the Vehicle Identification Number (VIN): 1FTEX18L4VN (production sequence omitted). The vehicle was a three-door, extended-cab, 4 x 4, pickup truck that was equipped with a 5.4 liter, V-8 engine, power brakes, anti-lock brakes, power steering, and a tilt steering wheel. The third door was located on the right side and was hinged at the rear aspect of the cab. At the time of the vehicle inspection, the vehicle’s odometer read 65,175 km (40,499 miles). The F-150 was equipped with Goodyear Wrangler RT/S

P265/70R17 tires. The manufacturer’s recommended tire pressure was 200 kPa (29 PSI) for the front tires and 221 kPa (32 PSI) for the rear tires. The specific tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Tire/Wheel Damage
LF	0.0 kPa	5.6 mm (7/32”)	No	Minor rim deformation
LR	124.1 kPa (18.0 PSI)	4.0 mm (5/32”)	No	No
RF	179.3 kPa (26.0 PSI)	4.0 mm (5/32”)	No	No
RR	141.3 kPa (20.5 PSI)	4.0 mm (5/32”)	No	No

The front seating positions in the Ford F-150 was configured with bucket seats with folding backs and integral head restraints. The driver’s seat position was adjusted post-crash and was found in the full-rear track position. The seat back recline angle was 40 degrees aft of vertical. The rear seating positions were configured with a split folding bench seat with a single fixed seat back. A vinyl seat back organizer was present on the rear aspect of the driver’s seat back. It was empty at the time of the vehicle inspection. The Ford F-150 pickup truck was configured with a fiberglass cap on top of the bed.

Pre-Crash

The 37-year-old female driver was operating the 1993 Dodge Caravan southbound on the two-lane roadway, exiting a left curve into the straight segment of the roadway (**Figure 2**). Witnesses stated that the Caravan was traveling somewhat erratically, and described the pre-crash movement as “fishtailing.” Two non-contact vehicles were stopped in the southbound lane approximately 20 m (66’) south of the point of impact waiting to make left turns into a driveway. As the Caravan entered the sag portion of the roadway, it crossed the centerline in a rapid CCW yaw. It was not known if the driver relinquished control or steered left intentionally. It was possible that she was distracted by the children in the bench seat. The 32-year-old driver of the Ford F-150 was operating the vehicle in a northbound direction on approach to the roadway sag (**Figure 3**). The driver stated that when she detected the Caravan encroaching into the northbound lane she applied the brakes but could not avoid the collision. Police documented a tire mark on the northbound travel lane; however, at the time of the scene inspection, there was no physical evidence present.



Figure 2. Southbound approach for the Dodge Caravan



Figure 3. Northbound approach for the Ford F-150

Crash

The front aspect of the Ford F-150 struck the right side aspect of the Dodge Caravan. Impact resulted in severe damage to the Dodge Caravan and moderate damage to the Ford F-150. The impact was sufficient to deploy the frontal air bag systems in both vehicles. The directions of force were in the 2 o'clock sector for the Caravan and in the 12 o'clock sector for the F-150. The damage algorithm of the WinSMASH program computed a total delta-V of 52.0 km/h (32.3 mph) for the Caravan and a total delta-V of 38.0 km/h (23.6 mph) for the F-150. The longitudinal and lateral components for the Caravan were -26.0 km/h (-16.2 mph) and -45.0 km/h



Figure 4. View of final rest positions

(-28.0 mph), respectively. The longitudinal and lateral components for the F-150 were -37.4 km/h (-23.3 mph) and 6.6 km/h (4.1 mph), respectively. At impact, the CCW yaw of the Caravan was arrested as the van was redirected in a clockwise (CW) rotation onto the roadside. Based on the final rest positions and vehicle damage, it appeared that there was sustained contact between the vehicles as they traveled to final rest. The Caravan was redirected onto the east roadside in a CW rotation and as it traveled into the drainage ditch, the high center of gravity combined with its CW rotation resulted in a tip over onto the left side. The Caravan came to rest on its left side facing north. The Ford F-150 came to rest against the undercarriage of the Caravan, facing north and straddling the east roadside (**Figure 4**).

Post-Crash

Passing motorists stopped to assist immediately after the crash. One passing motorist entered the van and turned off the ignition switch, as the Caravan's engine was still running. A second passer-by entered the van and removed the 21-month-old male child from the forward-facing CSS. He passed the child out of the vehicle and another passer-by with medical training began attempts to resuscitate the child. The 21-month-old child was found to have crackers lodged in his airway and was not breathing when removed from the vehicle. The medically-trained passing motorist attempted to clear the airway and perform rescue breathing prior to the arrival of rescue personnel. The passer-by in the van assisted the 4-year-old who was found in the left rear cargo area. The 4-year-old child was removed from the vehicle by rescue personnel. Rescue personnel cut the right side A- and B-pillars, cut the roof in a lateral direction behind the B-pillars, and folded the roof outward to gain access to the driver. The driver was removed from the vehicle by rescue personnel. The 21-month-old child was transported by ambulance to a local hospital and transferred to a regional trauma center. He expired 32 hours after the crash. The driver and 4-year-old child were transported by helicopter to a regional trauma center and admitted. The 4-year-old child was released three days following the crash. At the time of this PCS, the driver is still hospitalized in critical condition.

The driver of the Ford F-150 exited the vehicle under her own power. She removed the 4-year-old from the forward-facing CSS. Both were transported by ambulance to a local hospital and treated and released.

VEHICLE DAMAGE

Exterior Damage – 1993 Dodge Caravan

The 1993 Dodge Caravan sustained severe right side damage as a result of the impact with the Ford F-150 pickup truck (**Figure 5**). The direct contact damage on the right side began at the leading edge of the right front door and extended rearward 175.3 cm (69.0") to the aft edge of the sliding side door. Abrasions from the F-150 pickup truck were present along the entire length of the direct contact area and were present on the entire vertical height of the doors. The combined direct and induced damage began 66.0 cm (26.0") forward of the leading edge of the right front door and measured 351.8 cm (138.5") in length. The maximum crush was vertically located 45.7 cm (18.0") below the beltline, 109.9 cm (43.3") rear of the leading edge of the right front door, and measured 82.7 cm (32.6"). The contour of the F-150's bumper was visible on the Caravan's right side door panels. Induced damage was also noted on the roof and right roof side rail, which were buckled laterally. The exterior panel of the right front door was displaced outward, away from the door structure. The mid-door trim pieces were separated from both doors. The rear aspect of the right front fender and the front aspect of the right rear quarter panel were pulled inward. The right sill was abraded, crushed, and displaced upward 20.3 cm (8.0") at the B-pillar. The sill's sheet metal sustained lateral tears at the B-pillar and the B-pillar was crushed laterally at the bottom aspect. The right side sliding door was completely removed by rescue personnel. The hood and the rear hatch were displaced slightly. The Collision Deformation Classification (CDC) for the impact with the Ford F-150 pickup truck was 02-RPEW-5. Six crush measurements were documented at the sill and mid-door across the damaged right side (**Figure 6**). The crush measurements along the mid-door were: C1 = 0.0 cm, C2 = 29.2 cm (11.5"), C3 = 82.6 cm (32.5"), C4 = 62.2 cm (24.5"), C5 = 17.8 cm (7.0"), C6 = 0.0 cm. The crush measurements along the sill were as follows: C1 = 0.0 cm, C2 = 20.3 cm (8.0"), C3 = 36.8 cm (14.5"), C4 = 39.4 cm (15.5"), C5 = 8.9 cm (3.5"), C6 = 0.0 cm.

Damage to the left side of the Dodge Caravan as a result of the tip over was minor. The left side mirror was displaced, and minor sheet-metal deformation was noted on the left front door and left side body panels. The CDC for the left side tip over was 00-LDAO-2.



Figure 5. View of down the right side plane



Figure 6. View of right side damage



Figure 7. View of interior damage and lateral intrusion

Interior Damage -1993 Dodge Caravan

Interior damage to the Dodge Caravan was severe and attributed to passenger compartment intrusion (**Figure 7**) and occupant contact. The windshield was completely removed by rescue personnel. The left front window glazing, all right side glazing, and the backlight glazing were disintegrated. The right front door was jammed shut, the right side door was removed completely by rescue personnel, and the rear hatch was jammed shut. Crackers were present in the window frames of the intact left rear window and a piece of a fractured head lamp from the Ford F-150 was wedged in the bottom aspect of the left side center window frame.

Intrusion into the passenger compartment was severe (**Figure 8**). Lateral intrusions included the right door, right A-pillar, right B-pillar, right roof side rail, right sill, right rear sliding door, right C-pillar, and the right rear side panel. The front right seat was crushed and displaced downward and laterally to the left. The inboard aspect of the front right seat cushion was wedged under the inboard aspect of the driver's seat cushion. The front right seat back was rotated approximately 80 degrees in a CCW direction and was crushed against the inboard aspect of the driver's seat back. The lateral distance between the forward edge of the right side sliding door and the left side interior panel measured 73.7 cm (29.0"). The specific intrusions were documented as follows:



Figure 8. View of deformed front right seat back and intrusion of right front door and right B-pillar

Position	Intruded Component	Magnitude of Intrusion	Direction
FL/FC	Right front seat	21.6 cm (8.5")	Lateral
FR/FC	Right interior door	69.9 cm (27.5)	Lateral
FR	Right A-pillar	25.4 cm (10.0")	Lateral
FR/FC	Right B-pillar	57.8 cm (22.8")	Lateral
FR	Right roof side rail	31.8 cm (12.5")	Lateral
FR	Right sill	33.0 cm (13.0")	Lateral
RC/RR	Right front seat back	6.4 cm (2.5")	Longitudinal
RR/RC	Right side door (forward aspect)	89.5 cm (35.3")	Lateral
RR/RC	Right side door (rear aspect)	53.3 cm (21.0")	Lateral
RR	Right sill	35.6 cm (14.0")	Lateral
RR	Right roof side rail	43.2 cm (17.0")	Lateral

Position	Intruded Component	Magnitude of Intrusion	Direction
RR	Right C-pillar	36.8 cm (14.5")	Lateral
Rear left cargo area	Rear left seat back	8.9 cm (2.5")	Longitudinal
Rear center cargo area	Rear center seat back	33.0 cm (13.0")	Longitudinal
Rear right cargo area	Rear right seat back	25.4 cm (10.0")	Longitudinal
Rear right cargo area	Right rear interior panel	33.0 cm (13.0")	Lateral
Rear right cargo area	Right roof side rail	12.7 cm (5.0")	Lateral

The driver's seat back was displaced slightly to the right and the knee bolster was fractured from contact with the driver's knees and the lateral crash forces. The accelerator pedal was displaced 6.4 cm (2.5") to the right. The center and right instrument panels were fractured and displaced from the lateral intrusion. The second bench seat was crushed laterally and the seat back was bowed rearward from the lateral displacement (**Figure 9**) that resulted from intrusion. The post-crash seat back angle measured 40 degrees from vertical at the center aspect.



Figure 9. View from the backlight showing intrusion and contacts

The D-ring on the right B-pillar exhibited hair from the driver from occupant contact. Body fluid was noted on the right C-pillar adjacent to the CSS position on the second seat from contact with the 21-month-old child's head. The right side sliding interior door panel exhibited a 27.9 x 15.2 cm (11.0 x 6.0") plastic abrasion from contact with the convertible CSS positioned on the right side of the second seat. The interior trim of the right C-pillar was fractured from the lateral displacement and contact with the intruded right side door. Body fluid was noted on the left aspect of the second seat back and on the left rear corner of the cargo area from the 4-year-old child. A minor dent was present on the plastic speaker cover that was located on the upper left aspect of the interior rear hatch. Numerous crackers and body fluid were present in the fractured outline of the rear hatch glazing.

MANUAL RESTRAINT SYSTEMS – 1993 Dodge Caravan

The 1993 Dodge Caravan was configured with manual 3-point lap and shoulder belts for all outboard seating positions and a lap belt with a locking latch plate for the second seat center position. The vehicle was not equipped with the Lower Anchors and Tethers for Children (LATCH) system. Both front safety belts were designed with Emergency Locking Retractors (ELR's) and adjustable D-rings that were in the full-down positions. The driver's restraint was configured with a sliding latch plate and remaining outboard restraints were configured with cinching latch plates. The driver's safety belt exhibited minor stretching along the lap and shoulder webbing consistent with occupant loading (**Figure 10**). Both sides of the lap belt webbing sustained multiple minor abrasions and black transfers over a distance of 29.8 cm (11.8"). The driver's plastic latch plate cover exhibited minor abrasions along the entire width of the belt path. Faint abrasions were noted on the driver's plastic D-ring.



Figure 10. View of driver's safety belt

The second seat left restraint was used to restrain the 4-year-old child passenger in the belt-positioning booster CSS. There was no loading evidence present on the D-ring, but the webbing exhibited 31.1 cm (12.3") section of stretching that began 47.0 cm (18.5") above the anchor and minor stretching on the lap belt portion. The rear aspect of the plastic latch plate cover sustained two linear vertical fractures on the rear aspect (**Figure 11**), and the top plastic aspect of the cinch bar was fractured on the front aspect. The second seat right safety belt was severed at the time of the vehicle inspection. The section of webbing between the retractor and the severed edge measured 78.7 cm (31.0") in length and the section between the anchor and the severed edge (**Figure 12**) measured 97.8 cm (38.5") in length. It appeared that the webbing had been cut, evidenced by the lack of CSS displacement. In addition, there were no interior components that appeared to have contacted the safety belt in that area. The safety belt webbing exhibited stretching that began 29.8 cm (11.8") and measured 9.5 cm (3.5") in length from engagement with the edge of the CSS belt path.



Figure 11. View of fractured rear left latch plate



Figure 12. View of rear right safety belt webbing (cut) and latch plate

CHILD SAFETY SEAT – Century Encore Convertible CSS

The Century Encore Convertible CSS was positioned on the second row bench seat on the right position (**Figure 13**). The CSS could not be located for an inspection. Therefore, information regarding the CSS has been obtained from on-scene police photographs and police documentation.



Figure 13. View of post-crash convertible CSS position

The Century Encore CSS was manufactured on December 7, 1998 with a model number of 4612WSC, and was not on the NHTSA recall list. The seat was configured with a 5-point harness system and was designed for rear-facing use for infants from birth to 10 kg (22 lbs) and forward-facing for children 10 – 18 kg (22 – 40 lb), and up to 102 cm (40”). The 21-month-old child was within the recommended height and weight guidelines for this CSS.



Figure 14. Close-up of post-crash convertible CSS

The harness straps were routed through the top slots of the CSS. Both shoulder harness straps exhibited vertical ceases between the harness slots and the harness retainer clip, and both were folded through the respective latch plate slots. The amount of slack in the harness system could not be determined.

The tightness of the installation of the CSS could not be determined from the vehicle inspection. The vehicle’s safety belt was cut, and the intruded passenger compartment resulted in the approximate 70 degree CCW rotation of the CSS on the bench seat (**Figure 14**). The intrusion also resulted in engagement of the CSS against the right side sliding door, evidenced by plastic abrasions on the interior panel of the sliding door.

CHILD SAFETY SEAT – Century Breverra Ascend Belt-Positioning-Booster (BPB)

The Century Breverra Ascend BPB (**Figure 15**) was installed on the second row bench seat on the left position. The model number was 4895SBY, the manufacture date was May 20, 2002, and the BPB was not on the NHTSA recall list. The BPB was not configured with a harness system, and was designed strictly as a high-back belt-positioning booster BPB. The BPB was configured with a plastic shoulder belt positioner on each top outboard aspect. The positioners were configured with three vertical positions. The left positioner was in the mid-position and the right was in the top position. The BPB was designed for use



Figure 15. Century Breverra Ascend Belt-Positioning-Booster

by children who weighted between 14 – 36 kg (30 – 80 lb) and measured between 89 - 127 cm (35 – 50”) in height. The 4-year-old child was within the recommended height and weight guidelines.

The BPB sustained minor damage as a result of the crash. An area of fabric on the left side aspect of the seat cushion that measured 5.1 cm (2.0”) in width was abraded from engagement against the safety belt webbing. A similar area on the right side aspect that measured 8.9 cm (3.5”) in width was also abraded as a result of the safety belt loading. The left plastic shoulder belt positioner was abraded on the inboard and outboard aspects from loading against the shoulder belt. It also sustained minor lacerations on then inboard lower aspect. Minor lacerations were also noted on the outboard aspect of the right armrest.

FRONTAL AIR BAG SYSTEM – 1993 Dodge Caravan

The 1993 Dodge Caravan was equipped with a frontal air bag for the driver that deployed as a result of the lateral impact with the Ford F-150 pickup truck (**Figure 16**). The driver’s air bag was housed in the center of the steering wheel. The air bag was circular in shape and measured 61.0 cm (24.0”) in diameter in its deflated state. The H-configuration vinyl cover flaps were symmetrical in shape and measured 16.5 cm (6.5”) in width at the top and bottom aspects, 6.7 cm (2.6”) in height, and 17.1 cm (6.8”) in width at the tear seam. The air bag was tethered by two internal straps that were located at the 3 and 9 o’clock positions and measured 7.6 cm (3.0”) in width. The air bag was vented by two external ports that measured 3.2 cm (1.3”) in diameter and were located at the 12 o’clock position on the rear aspect of the air bag.



Figure 16. Driver's air bag in the Dodge Caravan

The face of the air bag exhibited an area of faint body fluid transfers in the upper aspect, over an area that measured 15.2 x 16.5 cm (6.0 x 6.5”).

VEHICLE DAMAGE

Exterior Damage – 1997 Ford F-150 Pickup Truck

The 1997 Ford F-150 pickup truck sustained moderate frontal damage (**Figure 17**) as a result of the impact with the Dodge Caravan. The direct contact damage extended across the entire frontal width of the vehicle and measured 154.9 cm (61.0”). The penetration depth of the pickup truck and contact with the Caravan’s undercarriage resulted in abrasions on the front aspects of the left and right front fenders which extended rearward to 26.0 cm (10.2”) forward of the front axle (**Figure 18**). Both head lamps were fractured, the grille was separated, the bumper was crushed, and the hood was slightly displaced. The front bumper was displaced 3.2 cm (1.3”) to the right. Contact abrasions were also noted on the center aspect of the leading edge of the hood. The left wheelbase was shortened by 4 cm (1.5”). The right front fender was displaced rearward and overlapped the leading edge of the right front door, which prevented the door from opening fully. The CDC for the frontal impact with the Dodge Caravan was 12-FDEW-1. Six crush measurements were taken along the front bumper and were as follows: C1 = 11.0 cm (4.3”), C2 = 10.2 cm (4.0”), C3 = 12 cm (4.7”), C4 = 11 cm (4.3”), C5 = 9.2 cm (3.6”), C6 = 7.0 cm (2.8”).



Figure 17. View of frontal damage to the Ford F-150



Figure 18. View of front and left side damage on the Ford F-150

Abrasions and slight deformation were noted on the rear outboard corners of the cab and forward outboard corners of the fiberglass cap as a result of interaction between the cab/cap during the crash.

Interior Damage -1997 Ford F-150 Pickup Truck

Interior damage to the 1997 Ford F-150 pickup truck was minor and attributed to occupant contact (**Figure 19**). The windshield was fractured on the right aspect from crash forces. The remaining vehicle glazing was undamaged. The left side of the rearview mirror was displaced upward from probable contact with the driver’s right hand. A faint scuff was present on the knee bolster that was located 10.2 cm (4.0”) left of the center of the steering column and measured 3.8 cm (1.5”) in width and 3.4 cm (2.5”) in height. The top rear aspect of the driver’s integral head restraint and seat back exhibited very minor body fluid spatter.



Figure 19. Interior view of front seat positions

MANUAL RESTRAINT SYSTEMS – 1997 Ford F-150 Pickup Truck

The Ford D-150 was configured with manual 3-point lap and shoulder belts with sliding latch plates for the outboard seating positions. The vehicle was not equipped with LATCH. The driver's safety belt was configured with an ELR and an adjustable D-ring that was located in the second lowest (of five) position. Due to the third door configuration, the front right passenger's safety belt was configured with a fixed D-ring suspended from the right roof side rail aft of the front right seat. The remaining outboard safety belts were configured with switchable/Automatic Locking Retractors (ALR) and fixed D-rings. The center rear position was configured with a lap belt with a locking latch plate. The rear seat buckles were recessed to the level of the seat cushions.

The driver's safety belt (**Figure 20**) exhibited minor stretch marks on the webbing that began 39.4 cm (15.5") from the anchor and extended 90.8 cm (35.5") on the safety belt webbing. Minor abrasions were noted on the driver's D-ring and plastic latch plate cover was abraded from occupant loading.

The rear left safety belt (**Figure 21**) was used to secure the forward-facing CSS in the Ford F-150. It was not known what mode the switchable retractor was in at the time of the crash, as the CSS was removed from the vehicle post-crash. A label was present on the webbing indicating the presence of the switchable retractor for use with CSS's. The webbing exhibited stretching that began 31.8 cm (12.5") from the anchor and extended 83.8 cm (33.0") along the webbing from CSS loading. The plastic latch plate cover was abraded and faint D-ring abrasions were present. When installed in the rear left position, the safety belt webbing had a tendency to gather in the rear aspect of the latch plate, due to the rearward orientation of the CSS belt path combined with the more forward position and angle of the safety belt buckle.

The rear right safety belt (**Figure 22**) was used to secure a forward-facing convertible CSS in the rear right position. Although the CSS was installed in the vehicle, it was unoccupied at the time



Figure 20. View of Ford F-150's driver's safety belt



Figure 21. Rear left safety belt



Figure 22. Rear right safety belt

of the crash. The webbing was distorted from the routing through the CSS belt path. The distortion on the webbing was located 24.1 cm (9.5”) from the stop button and extended 17.1 cm (6.8”) in length. The webbing was also folded in half through the latch plate. The fold began 16.5 cm (6.5”) from the stop button and extended to the leading edge of the stretched area of the webbing.

CHILD SAFETY SEAT – Century Ascend SE Forward-Facing CSS

The Century Ascend SE forward-facing CSS was installed with the manual 3-point lap and shoulder belt on the left side of the rear bench seat (**Figure 23**). The model number was 44892UVT, the manufacture date was March 21, 2001, and the CSS was not on the NHTSA recall list. One of the investigating officers stated that the CSS was not tight within the vehicle’s restraint system after the crash. The CSS was equipped with a tether strap, but it was not used to install the CSS in the F-150. The CSS was designed for use with the harness system for children that weighed between 14 – 18 kg (30 – 40 lb) and measured between 89 – 127 cm (35 – 43”) in height. It was designed to be used without the harness system as a belt positioning booster for children who weight between 14 – 36 kg (30 – 80 lb) and who measured 89 – 127 cm (35 – 50”) in height. Based on the manufacturer’s recommendations, the 4-year-old child’s weight of 22 kg (48 lb) exceeded the recommended weight parameters for use of the CSS with the harness system.



Figure 23. Century Ascend SE Forward-facing CSS in the Ford F-150

The CSS was configured with a 5-point harness system that was routed through the top slots of the CSS seat back. At the time of the vehicle inspection, the harness system was fully extended. The rear aspects of the plastic sleeves in the upper harness slots exhibited minor abrasions from occupant loading. Minor stretching was noted on the left shoulder harness that was gathered in the latch plate. The right harness strap was folded once through the upper harness slot, and exhibited a second fold through the latch plate. The distance from the harness slots to the harness retainer clip measured 39.4 cm (15.5”) in length. The distance from the retainer clip to the outboard cushion slots measured 24.1 cm (9.5”). The right and left upper rear corners of the plastic belt path on the CSS sustained abrasions from loading the vehicle’s safety belt (**Figure 24**).



Figure 24. Close-up of abraded left side belt path corner

At the time of the CSS inspection, the harness retainer clip appeared low on the harness straps, although, it’s pre-crash position was not known. The investigating agency stated that the CSS was not very tight in the vehicle post-crash.

CHILD SAFETY SEAT – Cosco Olympian Convertible CSS

A Cosco Olympian Convertible CSS was positioned in the rear right position of the Ford F-150 pickup truck (**Figure 25**). The CSS was not available for inspection and information was obtained from police reports and police photographs.



Figure 25. Post-crash photograph showing both CSS in the Ford F-150

At the time of the crash, the CSS was unoccupied. The CSS model number was 02803PRI and the manufacture date was March 21, 2000. One of the investigating officers stated that the CSS was not tight within the vehicle's restraint system after the crash. The Cosco Olympian was configured with a tray shield and was installed in a forward-facing orientation. Based on police photographs showing the installed CSS, the harness straps were routed through the top slots and the kickstand was in the down position. Similar to the forward-facing CSS on the rear left position, the vehicle's safety belt webbing had a tendency to gather in the rear aspect of the latch plate, due to the rearward orientation of the CSS belt path combined with the more forward position and angle of the safety belt buckle.

FRONTAL AIR BAG SYSTEM – 1997 Ford F-150 Pickup Truck

The 1997 Ford F-150 pickup truck was equipped with frontal air bags for the driver and front right passenger positions (**Figure 26**). The air bags deployed as a result of the frontal crash with the Dodge Caravan. The driver's air bag was housed in the center of the steering wheel that was configured with asymmetrical H-configuration cover flaps. The top flap measured 19.4 cm (7.6") in height, the bottom flap measured 8.9 cm (3.5") in height, and both measured 19.1 cm (7.5") in width at the tear seam. The driver's air bag measured 61.0 cm (24.0") in diameter and was vented back through the module. The air bag was tethered by two internal straps at the 12 and 6 o'clock positions. There was no contact evidence present on the air bag surface.



Figure 26. Deployed frontal air bags in the Ford F-150

The front right passenger's air bag deployed from a top-mount module on the right instrument panel. The air bag cover flap was rectangular in shape and was hinged at the forward aspect. The cover flap measured 38.7 cm (15.3") in width and 19.1 cm (7.5") in height. The plastic frame around the air bag module sustained multiple fractures on the bottom center aspect which resulted in sharp, jagged edges along the bottom aspect of the module.

The front right passenger’s air bag measured 71.1 cm (28.0”) in width and 61.0 cm (24.0”) in height. The air bag extended laterally across the center instrument panel area in addition to the right aspect. Black vinyl transfers were present on the bottom right corner of the air bag membrane, and a 3.2 cm (1.3”) diameter hole was present 8.9 cm (3.5”) inboard of the outer right seam on the bottom edge of the air bag (**Figure 27**). The hole was most likely a result of interaction against the jagged edge of the fractured bottom aspect of the module during the deployment.



Figure 27. Vinyl transfers and hole on the bottom right aspect of the front right passenger's air bag

An on-off key-switch was present on the right aspect of the center instrument panel for the front right passenger air bag. The switch was in the “on” position at the time of the vehicle inspection.

OCCUPANT DEMOGRAPHICS – 1993 Dodge Caravan

Driver

Age/Sex: 37-year-old female
 Height: 170 cm (67”)
 Weight: 57 kg (126 lb)
 Seat Track Position: 8.3 cm (3.3”) rear of full-forward and 12.1 cm (4.8”) forward of full-rear
 Manual Restraint Use: Manual 3-point lap and shoulder belt
 Usage Source: Vehicle inspection
 Eyewear: Prescription glasses
 Type of Medical Treatment: Transported by helicopter to a regional trauma center and admitted for treatment

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Diffuse axonal injury (NFS)	Critical (140628.5,9)	Motion of brain from right head strike against the right B-pillar
Intracranial hemorrhage (NFS)	Severe (140638.4,9)	Right B-pillar
Traumatic subarachnoid hemorrhage (NFS)	Serious (140684.3,9)	Right B-pillar
Right lung contusion	Serious (441406.3,1)	Right B-pillar
Right rib fractures 1-3	Moderate (450220.2,1)	Right B-pillar
Liver laceration – interparenchymal (NFS)	Moderate (541820.2,1)	Shoulder belt webbing
Sacral fracture (NFS)	Moderate (852600.2,6)	Driver’s seat inboard arm rest

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Right lower leg abrasion	Minor (890402.1,1)	Knee bolster

Injury source: Emergency room records

Driver Kinematics

The 37-year-old driver of the 1993 Dodge Caravan was presumed to have been seated in an upright posture at impact, but it could not be confirmed. The seat track was adjusted to 8.3 cm (3.3”) rear of the full-forward position and 12.1 cm (4.8”) forward of the full-rear position. The driver was restrained by the manual 3-point lap and shoulder belt. At impact with the Ford F-150, the driver initiated a lateral trajectory to the right. The frontal air bag system deployed as a result of the forward deceleration. The driver loaded the safety belt webbing that resulted in a liver laceration. She also loaded the driver’s inboard arm rest which caused a sacral fracture. She sustained a right lower leg abrasion from contact with the knee bolster. She continued laterally to the right and loaded the intruded right B-pillar. She sustained a right lung contusion and right rib fractures of ribs 1-3. Her head struck the intruded right B-pillar, evidenced by hair deposits on the right D-ring. She sustained intracranial hemorrhage and a traumatic subarachnoid hemorrhage as a result of the head contact. The motion of the brain due to the head strike resulted in a diffuse axonal injury. The driver came to rest in the front left seat. She was removed from the vehicle by rescue personnel and transported by helicopter to a regional trauma center where she was admitted.

Second Seat Left Child Passenger (Belt-Positioning-Booster)

Age/Sex: 4-year-old male
Height: 122 cm (48”)
Weight: 20 kg (44 lb)
Seat Track Position: Fixed
Manual Restraint Use: Forward-facing BPB
Usage Source: Vehicle inspection, injury data
Eyewear: Prescription glasses
Type of Medical Treatment: Transported by helicopter to a regional trauma center and admitted for treatment

Second Seat Left Child Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Large right temporal contusion	Minor (190402.1,1)	Convertible CSS on right bench seat/possible occupant-to-occupant contact with the 21-month-old
Minor right temporal laceration	Minor (190602.1,1)	Convertible CSS on right bench seat/possible occupant-to-occupant contact with the 21-month-old

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Laceration of the mid-line lower gum	Minor (243204.1,8)	Convertible CSS on right bench seat/possible occupant-to-occupant contact with the 21-month-old
Facial abrasions	Minor (290202.1,9)	Convertible CSS on right bench seat
Nasal laceration (NFS)	Minor (290600.1,4)	Convertible CSS on right bench seat
Mid-forehead laceration	Minor (290600.1,7)	Convertible CSS on right bench seat
3.0 cm (1.2”) full-thickness lower lip laceration 0.3 cm (0.1”) laceration on the upper lip Minor laceration to the inside of the upper lip	Minor (290602.1,8)	Convertible CSS on right bench seat/possible occupant-to-occupant contact with the 21-month-old
Left neck laceration	Minor (390600.1,2)	Shoulder belt webbing

Injury source: Emergency room records

Second Seat Left Child Passenger Kinematics

The 4-year-old child was seated on the Century Ascend high back BPB on the left side of the second bench seat. He was restrained by the vehicle’s manual 3-point lap and shoulder belt. His exact posture prior to the crash was not known. He was wearing a winter coat that most likely introduced some slack in the safety belt system. Interaction with the shoulder belt against his neck resulted in a left neck laceration, which may have occurred when the vehicle crossed the centerline. At impact, he initiated a lateral trajectory to the right toward the 2 o’clock direction of force. As he continued laterally to the right, he most likely struck the convertible CSS as it was displaced laterally to the left due to the passenger compartment intrusion and rebound. Facial contact with the plastic shell of the convertible CSS resulted in facial abrasions, a nasal laceration, and a mid-forehead laceration. Occupant-to-occupant contact with the 21-month-old child in the convertible CSS was also probable. The combination of contact with the 21-month-old and contact with the convertible CSS caused a large right temporal contusion, a minor right temporal laceration, a laceration of the mid-line lower gum, a 3.0 cm (1.2”) full-thickness lower lip laceration, a 0.3 cm (0.1”) laceration on the upper lip, and a minor laceration to the inside of the upper lip.

It was not known exactly how the child came to rest. The 4-year-old was found in the cargo area adjacent to the left D-pillar by the first passer-by. Body fluid was present on the interior surface of the left D-pillar which confirmed the child’s final rest position. Given the abrasions on the outboard aspects of the BPB from the lap belt, safety belt loading, and the nature of the child’s trajectory, it was unlikely that he was completely displaced from the BPB and safety belt, and unlikely that he was further displaced into the cargo area during the crash. Body fluid was present on the top left aspect of the second bench seat back, which suggests the child may have initially come to rest in the area of the bench seat, and there was no contact evidence in the area

of the left D-pillar that suggested the child was displaced there during the crash. The 4-year-old may have crawled to the cargo area after the vehicle came to rest, but it could not be confirmed. The child was removed from the Caravan by rescue personnel and transported to a regional trauma center by helicopter. He was admitted for 3 days and released.

Second Seat Right Child Passenger (Forward-Facing Convertible CSS)

Age/Sex: 21-month-old male
 Height: 76 cm (30")
 Weight: 13 kg (29 lb)
 Seat Track Position: Fixed
 Manual Restraint Use: Forward-facing convertible CSS
 Usage Source: Vehicle inspection, injury data
 Eyewear: None
 Type of Medical Treatment: Transported by ambulance to a local hospital and transferred to a regional trauma center where he expired 32 hours after the crash

Second Seat Right Child Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Intraventricular hemorrhage (right side)	Severe (140678.4,1)	Right C-pillar
Diffuse edema (NFS)	Serious (140660.3,9)	Right C-pillar
Subarachnoid hemorrhage	Serious (140684.3,9)	Right C-pillar
Left pneumothorax	Serious (442202.3,2)	Left CSS shoulder harness
Skull fracture (NFS)	Moderate (150400.2,9)	Right C-pillar
2.0 cm (0.8") vertical laceration to the left forehead	Minor (290602.1,7)	Possible occupant-to-occupant contact with the 4-year-old
Right arm contusion	Minor (790402.1,1)	Right side of CSS shell
Left arm contusion	Minor (790402.1,2)	Left side of CSS shell
Right thigh contusion	Minor (890402.1,1)	Right side of CSS shell

Injury source: Emergency room records

Second Seat Right Child Passenger Kinematics

The 21-month-old child passenger was restrained in the Century Encore convertible CSS that was installed on the right side of the second bench seat. The child was most likely eating small crackers prior to the crash, as they were occluding his airway post-crash. It was not known if he was choking prior to the crash.

The child was wearing a bulky winter coat and it was not known how tight the 5-point harness system was. At impact, the child initiated a lateral trajectory and loaded the harness system. The CSS loaded the 3-point manual restraint, evidenced by stretch marks on the safety belt webbing. Due to the 2 o'clock direction of force, the loading to the left harness strap caused a left

pneumothorax. He loaded the right aspect of the CSS that resulted in a right thigh contusion. His right arm contacted the outboard aspect of the plastic CSS shell that resulted in a right arm contusion. The intrusion of the right C-pillar was severe, and the combined intrusion and lateral trajectory resulted in head contact with the right C-pillar. He sustained right intraventricular hemorrhage diffuse edema, subarachnoid hemorrhage, and a skull fracture due to the head strike. The CSS rotated CCW on the bench seat as a result of the severe right side intrusion. The 21-month-old rebounded to the left as the Caravan rapidly rotated in a CW direction. As he traveled to the left he probably sustained occupant-to-occupant contact with the 4-year-old which may have contributed to the head injuries and caused a 2.0 cm (0.8”) vertical laceration on the left forehead. His left arm contacted the outboard aspect of the left side of the CSS, which resulted in a left arm contusion.

The child was removed from the CSS and from the vehicle by a passer-by. A medically trained passer-by began to treat the child prior to rescue personnel arriving on-scene. The 21-month-old child was not breathing and was unresponsive upon removal from the Caravan. His airway was cleared and the child was transported by ambulance to a local hospital. He was transferred to a regional trauma center and expired 32 hours after the crash.

OCCUPANT DEMOGRAPHICS – 1997 Ford F-150 Pickup Truck

Driver

Age/Sex: 32-year-old female
 Height: Unknown
 Weight: 61 kg (135 lb), estimated by hospital staff
 Seat Track Position: Unknown (moved post-crash)
 Manual Restraint Use: Manual 3-point lap and shoulder belt
 Usage Source: Vehicle inspection
 Eyewear: Unknown
 Type of Medical Treatment: Accompanied rear left child passenger in ambulance to hospital and treated and released

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Superficial bilateral knee contusions	Minor (890402.1,3)	Knee bolster

Injury source: Emergency room records

Driver Kinematics

The driver of the 1997 Ford F-150 was seated in an upright posture. The seat track position was not known as it was moved post-crash. At impact, the frontal air bag system deployed and she initiated a forward trajectory. She loaded the manual restraint and struck her knees on the knee bolster which resulted in bilateral knee contusions. She contacted the deployed driver’s air bag which mitigated contact with the steering wheel and instrument panel. The driver rebounded rearward and came to rest in the driver’s seat. She exited the vehicle under her own power.

Second Seat Left Child Passenger (Forward-facing CSS)

Age/Sex: 4-year-old female
Height: Unknown
Weight: 22 kg (48 lb), estimated by hospital staff
Seat Track Position: Fixed
Manual Restraint Use: Forward-facing CSS
Usage Source: Vehicle inspection, injury data
Eyewear: Unknown
Type of Medical Treatment: Transported by ambulance to a local hospital and treated and released

Second Seat Left Child Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Forehead contusion above right eye	Minor (290402.1,7)	Driver's seat back

Injury source: Emergency room records

Second Seat Left Child Passenger Kinematics

The 4-year-old female child was restrained in a forward-facing CSS with a five-point harness that was installed on the rear left position of the Ford F-150 pickup truck. It was not known who installed the CSS. Based on the manufacturer's recommendations, the 4-year-old child's estimated weight of 22 kg (48 lb) exceeded the recommended weight parameters of 18 kg (40 lb) for use of the CSS with the harness system.

At impact with the Dodge Caravan, the child and the CSS initiated forward trajectories. The CSS loaded the vehicle's manual restraint system and the child loaded the CSS harness system. The distance between the driver's seat back and the rear seat back measured 41 cm (16") with the driver's seat back adjusted to a 20 degree recline angle. The close proximity between the seats allowed the 4-year-old's head to contact the rear aspect of the driver's seat back that resulted in a forehead contusion over her right eye. She rebounded rearward and came to rest in the CSS. She was removed from the CSS by the driver and was transported by ambulance to a local hospital where she was treated and released.

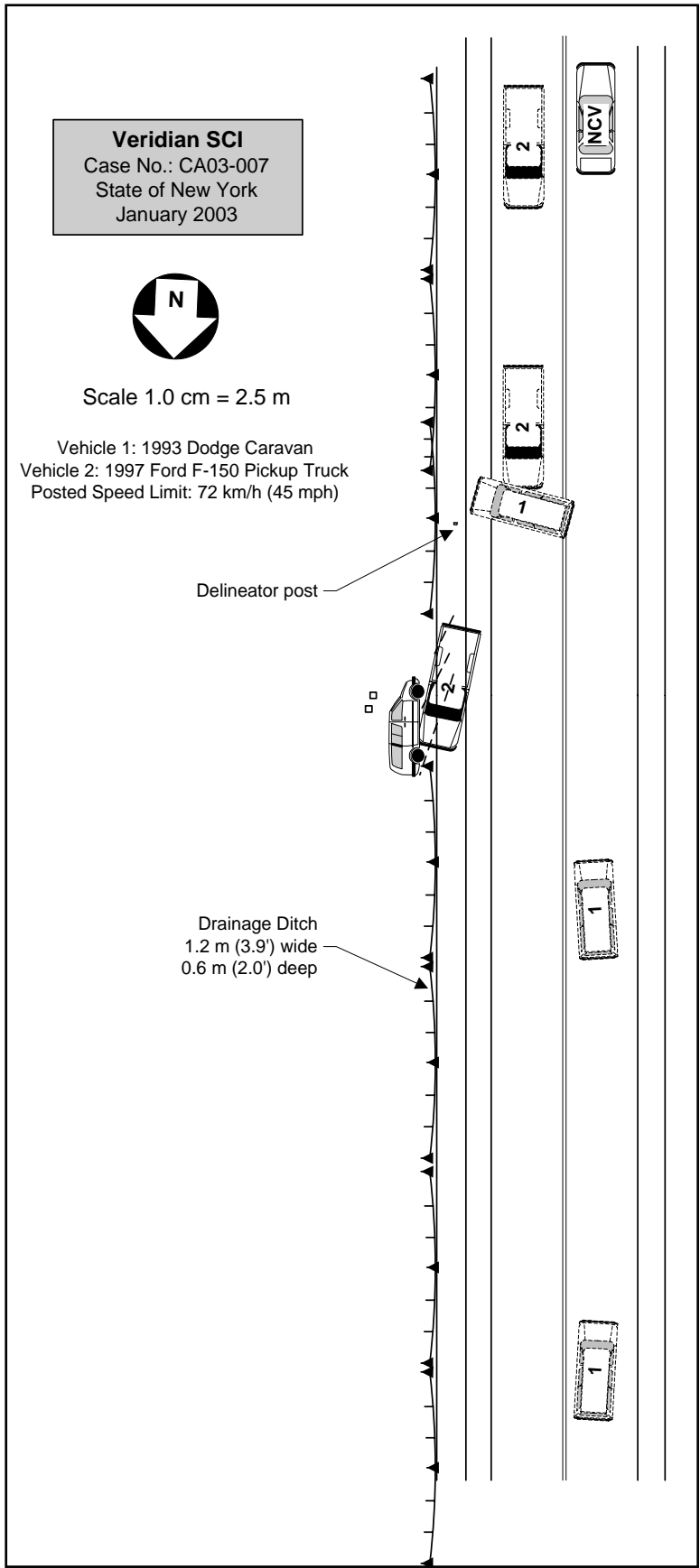


Figure 28. Scene schematic