CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION

CASE NO: CA04-055

VEHICLE: 2003 DODGE RAM 2500 PICKUP TRUCK

LOCATION: MICHIGAN

CRASH DATE: NOVEMBER 2004

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.

TECHNICAL REPORT STANDARD TITLE PAGE

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CASE NO. – CA04-055
VEHICLE – 2003 DODGE RAM PICKUP TRUCK
LOCATION – MICHIGAN
CRASH DATE – NOVEMBER 2004

BACKGROUND

This on-site investigation focused on the performance of a backless booster seat that was used by a 5-year old male passenger in a severe rollover crash that resulted in the death of the 35-year old male driver. The child was positioned in the left rear of the four-door/quad-cab pickup truck, restrained by the manual 3-point lap and shoulder safety belt system. The driver of the Dodge 2500 pickup truck **(Figure 1)** relinquished control of the vehicle as he entered a left curve. The vehicle traversed the mouth of a three-leg intersection in a clockwise yaw and departed the intersection into a shallow drainage ditch. The Dodge continued to yaw in a CW direction and furrowed into the soft ground which tripped the vehicle into a lateral rollover event. The Dodge Ram pickup truck rolled six-quarter turns before coming to rest on its roof. The roof intruded into the left side of the passenger compartment to the level of the seat backs. The belted driver sustained massive head trauma from the roof intrusion and possible contact with the ground and expired at the scene. The child passenger unbuckled the manual safety belt system and crawled out of the left rear window opening. The child was not injured in the crash. The Dodge was towed from the scene and placed in a covered facility where it was held for this SCI inspection. The investigating officer retrieved the booster seat from the mother of the child passenger and placed the seat back in the vehicle for this investigation.

Figure 1. 2003 Dodge Ram pickup truck.

The crash was identified by NHTSA through an Internet search of potential crashes of interest to the Special Crash Investigations (SCI) program. The notification was forwarded to the Calspan SCI team for follow-up. Cooperation with the investigating officer was obtained and the case was assigned as an on-site investigative effort on December 9, 2004. The vehicle, scene, and child safety seat inspection was conducted on December 16-17.

SUMMARY

Crash Site

The crash occurred off-road of a two-lane roadway during nighttime hours. The roadway consisted of two 3.3 m (10.8') wide travel lanes that were separated by a double yellow centerline. The edges of the roadway were painted with solid white fog lines and bordered by 1 m (3') wide paved shoulders. The roadway extended in a north/south direction; however, in the vicinity of the crash, the road transitioned to a brief east/west travel direction before returning to a north/south direction. The subject vehicle in this

crash was traveling northbound; therefore all references for this segment of road will be considered northbound. At the crash site, the roadway curved to the right for northbound traffic with a radius of curvature of 115 m (376'). The roadway had a positive grade of one percent to the north and a super-elevation of two percent. At the apex of the curve, a two lane local road intersected the roadway at the west road edge. An accumulation of loose gravel was present on the west shoulder of the roadway and at the mouth of the intersection. The area to the northwest of the intersection was a field with a gradual down slope that transitioned to a shallow drainage ditch. This area contained tall grass and the ground was soft due to the above freezing temperatures and frequent precipitation. At the time of the crash, the environmental surfaces were wet due to a moderate snowfall with a temperature of approximately 1 degree C (mid 30 degrees F). Curve warning signs were posted along the west road edge on both sides of the intersection with an advisory speed warning of 56 km/h (35 mph). The posted speed limit for the U.S. route was 89 km/h (55 mph). **Figure 2** is a northbound view of the crash site. The Scene Schematic is included as **Figure 14** of this narrative report.

Figure 2. Northbound view of the crash site.

Vehicle Data

2003 Dodge Ram Pickup Truck

The involved vehicle in this crash was a 2003 Dodge Ram 2500 4x4 pickup truck. The vehicle was a four-door, quad-cab pickup truck with a 2.4 m (8') cargo bed built on a 408 cm (160.5") wheelbase. An aftermarket aluminum cap enclosed the cargo bed of the truck. The Dodge was manufactured on 10/02 and was identified by Vehicle Identification Number (VIN): 3D7KU28CX36 (production number deleted). The truck was powered by a 5.9 liter Cummings diesel engine linked to a 5-speed manual transmission with a floor mounted shifter. The service brakes were 4-wheel power-assisted disc brakes with anti-lock (ABS). The Gross Vehicle Weight Rating (GVWR) was 4.082 kg (9,000 lb) with a front and rear distribution of 2,359 kg (5,200 lb) and 2,722 kg (6,000 lb) respectively. Approximately five 36 kg (80 lb) bags of concrete mix were loose in the cargo bed of the truck. The truck was equipped with full-length tubular step bars that extended along the sills from the A- to the C-pillars. Tow hooks were mounted to the front frame rails. A Class III 5 cm (2") frame receiver hitch was mounted to the rear frame of the Dodge Ram. The Dodge ram was equipped with OEM steel wheels with BF Goodrich Rugged Trail T/A tires, size LT245/70R17. The manufacturer recommended tire pressure was 448 kPa (65 PSI) for the front and 551 kPa (80 PSI) for the rear. The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Damage
Left Front	0 kPa	3 mm (4/32”)	Debeaded
Left Rear*	0 kPa	6 mm (8/32”)	Debeaded
Right Front	321 kPa (46.5 PSI)	5 mm (6/32”)	None
Right Rear	365 kPa (53.0 PSI)	5 mm (6/32”)	None

** The left rear tire was removed by the tow operator and replaced with the spare tire. The tire and wheel involved in the crash was included in the table above.*

The interior was configured with a split bench front seat with adjustable head restraints and a center folding seat back/console. The front seats were manually adjustable for both the track and recline modes. Both front head restraints were in the full down position at the time of the SCI inspection. It was unknown if these were the adjusted positions or the displaced positions caused by the roof intrusion. The rear seat was a 3-passenger bench seat with a forward folding backrest.

Crash Sequence

Pre-Crash

The 35-year old male driver of the 2003 Dodge Ram pickup truck awoke early in the morning and hunted during the daylight hours. He had consumed alcohol during the day and had a Medical Examiner reported BAC of 0.2 at the time of the crash. The driver was en route to his residence and was transporting his 5-year old son who was restrained in a Cosco backless booster seat in the rear left position of the vehicle. He was traveling in a northeasterly direction on the two lane roadway. En route, the driver encountered the right curve with a posted advisory speed of 56 km/h (35 mph). The investigating officer calculated a speed of 76 km/h (47 mph). As the driver entered the curve, he allowed the vehicle to drift to the left and cross the double yellow centerline. The driver applied a clockwise steering input in an attempt to regain his travel lane as the vehicle traversed the mouth of the three-leg intersection. The vehicle overrode loose stone/gravel at the mouth of the intersection which in combination with the vehicle’s speed and steering input induced a clockwise yaw. The Dodge Ram departed the northeast quadrant **(Figure 3)** of the intersection into a grassy roadside that consisted of soft ground that transitioned into a shallow drainage ditch. At roadway departure, the vehicle yawed approximately 26 degrees clockwise to its northeasterly travel direction. The Dodge continued across the roadside as all four tires furrowed into the soft dirt **(Figure 4)**.

Figure 3. Intersection departure of the Dodge Ram pickup truck.

Figure 4. Tire furrows through the soft roadside.

Crash

The furrowing resulted in a tripped rollover event, left side leading. At the point of rollover, the Dodge Ram rotated approximately 60 degrees CW of its initial heading. The vehicle rolled six-quarter turns through the shallow drainage ditch before coming to rest on its roof. At rest, the vehicle was facing in a southerly direction. The rollover event crushed the center of the roof to the beltline and displaced the side rails and upper pillars laterally inward. The driver, although restrained, sustained head trauma from probable contact with the intruding roof and the ground and expired at the scene. The child passenger was restrained in the rear left area of the truck and was not injured.

Post-Crash

The child passenger unbuckled the manual safety belt system and crawled out of the left rear window opening where he waited at the crash site for assistance. The driver came to rest within the vehicle, restrained by the manual safety belt system. The first responders checked the status of the driver and failed to identify a pulse. They determined that he was deceased. The local fire department cut the driver's safety belt webbing and used hydraulic equipment to open the left front door to extricate the driver's body from the vehicle. Following the extrication process, the Dodge Ram was up-righted and towed from the scene.

Vehicle Damage:

Exterior

The Dodge Ram pickup truck sustained severe damage to the greenhouse area as a result of the rollover event. The vehicle rolled to its left and completed six quarter turns prior to coming to rest on its roof. The right roof side rail area impacted the ground during the second-to-third quarter-turns which displaced the right roof side rail and right upper pillars to the left. As the vehicle continued to roll, the left roof side rail engaged the ground between quarter-turns 5 and 6. This impact displaced the left roof side and upper left pillars to the vehicle's right. As a consequence of the side rail impacts, the left third area of the roof buckled downward to the level of the beltline. Maximum crush was 70 cm (27.75") located at the roof over the driver's position. This roof deformation resulted in extensive intrusion of the roof into all six occupant positions.

The crush of the roof and greenhouse area was documented at various structural locations to capture the magnitude of the crush and the resulting intrusion. The windshield header deformed to a W-shape **(Figure 5)** with a lateral damage width of 108 cm (42.5"). The maximum crush at this profile was 44 cm (17.5") located 18 cm (7") inboard of the left A-pillar. The crush at six equidistant points along this profile were as follows: C1 (left) = 30 cm (12"), C2 = 27 cm (10.5"), C3 = 27 cm (10.5"), C4 = 37 cm (14.5"), C5 = 41 cm (16"), C6 = 34 cm (13.5").

Figure 5. Crushed windshield header.

The vertical crush of the left roof side **(Figure 6)** rail was documented along a damage length of 131 cm (51.5”) that extended from the C-pillar to the upper A-pillar. The crush values at this level were as follows: C1 (C-pillar) = 11 cm (4.5”), C2 = 17 cm (6.5”), C3 = 19 cm (7.5”), C4 = 24 cm (9.5”), C5 = 29 cm (11.5”), C6 = 29 cm (11.5”).

The right roof side rail crush **(Figure 7)** was documented using the same procedure as the left. The damaged length of this profile was 127 cm (50”). The vertical crush profile was: C1 = 27 cm (10.5”), C2 = 33 cm (13”), C3 = 38 cm (15”), C4 = 39 cm (15.5”), C5 = 43 cm (17”), C6 = 32 cm (12.5”).

The backlight header buckled to a V-shape **(Figure 8)** and was reduced in lateral width. The lateral measurement between the C-pillars was 105 cm (41.5”). The crush profile was as follows: C1 = 4 cm (1.75”), C2 = 41 cm (16”), C3 = 38 cm (15”), C4 = 32 cm (12.5”), C5 = 26 cm (10.25”), C6 = 22 cm (8.5”).

Figure 6. Left side rail crush.

Figure 7. Right side rail crush.

The truck was equipped with an aluminum cap over the cargo bed. The cap was deformed by the rollover and separated during the event. The driver had a minimum number of five bags of concrete mix in the bed of the truck. These loaded the cap during the rollover and were scattered about the crash site.

All body panels were deformed by the rollover which consumed the full length and width of the vehicle. The Collision Deformation Classification (CDC) for this event was 00-TDDO-6.

Figure 8. Backlight header crush.

The driver’s door was jammed closed by the exterior deformation. Rescue personnel opened the left front door to remove the driver’s body from the vehicle. The left rear and right side doors were jammed in the closed positions. The tailgate remained intact and operational post-crash.

The laminated windshield was cracked full height and width with a tear of the plastic laminate along the windshield header and the left A-pillar. The left front door window was opened approximately 10 cm (4") pre-crash and was shattered during the rollover event. The left rear and right side door glazing were closed and shattered during the rollover. The backlight was fixed and was shattered by the roof deformation.

Interior

The interior of the Dodge Ram pickup truck sustained severe damage due to intrusion of the roof into all six occupant positions. The roof crushed to a V-shape that deformed all six upper pillars inward. Maximum intrusion involved 70 cm (27.75") of vertical displacement of the roof in the front left position. The intrusions are identified in the following table:

Position	Component	Direction	Magnitude
Front Left	Roof	Vertical	70 cm (27.75")
Front Left	Windshield header	Vertical	65 cm (25.75")
Front Left	Left roof side rail	Vertical	27 cm (10.5")
Front Left	Left door window frame	Vertical	41 cm (16")
Front Left	Left upper A-pillar	Vertical	27 cm (10.5")
Front Center	Roof	Vertical	41 cm (16")
Front Center	Windshield header	Vertical	33 cm (13")
Front Right	Roof	Vertical	51 cm (20")
Front Right	Right upper A-pillar	Vertical	36 cm (14")
Front Right	Right roof side rail	Vertical	41 cm (16")
Rear Left	Roof	Vertical	50 cm (19.75")
Rear Center	Roof	Vertical	32 cm (12.5")
Rear Right	Roof	Vertical	33 cm (13")
Rear Right	Right roof side rail	Vertical	19 cm (7.5")

The intruding windshield header contacted the upper steering wheel rim, deflecting the rim forward 2 cm (0.75") and fracturing the tilt column mechanism. The steering wheel was captured between the header and the seat cushion. The left steering wheel spoke was deformed rearward from possible driver bracing during the rollover event.

The driver's head was involved with the intruding left roof side rail, left upper A-pillar, and the headliner. Body fluid was present on these components. There was no distinct damage related to driver contact.

There was no occupant contact evidence or damage in the area of the rear left child passenger.

Manual Restraint Systems

The 2003 Dodge Ram pickup truck was equipped with manual 3-point lap and shoulder belts for the front outboard and three rear seat positions. The center front position was

equipped with a manual lap belt with a locking latch plate. The driver's belt system consisted of continuous loop webbing with a sliding latch plate and an Emergency Locking Retractor (ELR). The B-pillar mounted D-ring was adjustable. The front right belt system utilized a sliding latch plate. The retractor at this position was locked due to damage.

The rear safety belts utilized light-weight locking latch plates with ELR retractors. The outboard positions were configured with fixed D-rings at the upper C-pillars while the rear center safety belt was integrated into the forward folding seat back.

The driver was restrained by the manual safety belt system. Belt usage was determined by the observation of the first responders, a cut of the lap belt webbing, a crease in the webbing at the location of the latch plate, and dried dirt on the shoulder belt webbing that extended from the locked (jammed) retractor. The lap belt webbing was cut 25 cm (10") above the floor anchor point. The shoulder belt webbing was cut 104-111 cm (41-43.75") below the D-ring. This cut was irregular and appeared to involved three separate cuts across the webbing. Based on these cuts, a segment of the webbing was missing from the vehicle. The crease in the webbing was located 26 cm (10.25") above the latch plate stop button. This crease was related to driver loading of the belt system.

The child passenger was restrained in the backless booster seat by the rear left safety belt. There was no distinct loading evidence on the safety belt system. The belt would not retract on the emergency locking retractor due to dirt and debris in the area of the retractor. The safety belt webbing, D-ring, latch plate and buckle were sprayed with dirt and mud during the crash. At the time of the SCI inspection, the latch plate buckled and released normally.

Child Safety Seat

The 5-year old male child passenger was seated in a backless booster seat **(Figure 9)** and was restrained by the vehicle's manual safety belt system. The booster seat was a Graco, Model No. 8491RGB with a Serial No. of JJ0720031194164. It was manufactured on 7/20/03 and was purchased new by the parents of the child. The booster seat was labeled for use by children 4-10 years of age with height and weight limits of 102-145 cm (40-57") and 18-45 kg (40-100 lb). The molded base of the unit had two retractable cup holders built into the forward sides. Two adjustable armrests were present with two sets of adjustment slots. Both armrests were adjusted to the upper adjustment points. The vertical distance between the seat cushion of the booster seat and the top of the armrest was 13 cm (5"). The vehicle safety belt path was located below the armrests indicated by red plastic guides **(Figure 10)**. There was no damage to the booster seat or loading evidence from the manual safety belt system. The booster seat was muddy; however, the area of the cushion where the child was positioned remained relatively clean.

Figure 9. Graco backless booster seat.

Figure 10. Right side belt path of the booster seat.

Frontal Air Bag System

The 2003 Dodge Ram pickup truck was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bag system did not deploy in the rollover crash. The Dodge was not equipped with safety belt pretensioners or side impact air bags.

Occupant Demographics/Data

Driver

Driver:	35-year old/Male
Height:	185 cm (73.0”)
Weight:	95 kg (210 lb)
Eyewear:	Not reported
Seat Track Position:	Appeared to be rear track
Manual Restraint Usage:	3-point lap and shoulder belt system
Usage Source:	Vehicle inspection, observation of the first responders
Egress from Vehicle:	Body removed by first responders
Type of Medical Treatment:	None, pronounced deceased at scene

Driver Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source/Contact
Massive head trauma	Unknown (115099.7,0)	Intruding roof/side rail and or ground

Source – Lay Coroner

Driver Kinematics

The driver of the Dodge Ram was seated in a presumed upright posture with the driver’s seat adjusted to a rear track position. He was reportedly intoxicated and smoking a cigar with the left door window partially open. The driver was restrained by the vehicle’s manual 3-point lap and shoulder safety belt system. Belt usage was determined by loading evidence on the webbing, a cut of the webbing during extrication of the driver,

and observations of the first responders who observed the driver deceased in the vehicle restrained. Immediately prior to impact, the driver probably had both hands on the steering wheel rim as he attempted to regain control of the Dodge Ram pickup truck.

Figure 11. Intrusion of the driver's compartment.

As the vehicle initiated a lateral rollover to the left, the driver responded to the lateral forces and moved to his left. During the continued rollover event, the driver's head was impacted by the intruding roof **(Figure 11)**. It was possible that his head was partially ejected through the left door window opening. He sustained massive trauma of the head and expired at the scene. Body fluid was present on the roof, side rail, and left upper A-pillar.

His body was removed from the vehicle by rescue personnel and transported to the county morgue. There was no autopsy performed.

Child Passenger

Age/Sex:	5-year old/Male
Height:	Not reported
Weight:	Not reported
Eyewear:	None
Seat Track Position:	Fixed
Manual Restraint Usage:	Restrained in a backless Graco booster seat by the vehicle's 3-point lap and shoulder belt system
Usage Source:	Vehicle inspection
Egress From Vehicle:	Exited unassisted through left rear door window opening
Type of Medical Treatment:	None, not injured

Child Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source/Contact
Not injured	N/A	N/A

Child Passenger Kinematics

The 5-year old child passenger was seated in a Graco backless booster seat and restrained by the vehicle's manual 3-point lap and shoulder belt system in the rear left position of the Dodge Ram pickup truck **(Figure 12)**. Safety belt usage was determined by mud and debris that was present of the safety belt webbing and the lack of injury or ejection of the child passenger.

At the on-set of the rollover, the ELR retractor locked. The child passenger would have initiated a lateral trajectory to his left in response to the lateral forces exerted on the vehicle. There was no contact evidence to the left rear door panel. As the vehicle continued to rollover, the child loaded the manual belt system which held the child in position and prevented him from ejection. The booster seat elevated the child to provide a better fit of the manual belt system. The severe roof intrusion was located immediately above the child passenger's position **(Figure 13)**. He did have sufficient occupant space left of his seated position. The vertical distance between the leading edge of the booster seat cushion and the intruding roof measure d 27 cm (10.5"). The aft edge of the booster seat cushion to the roof measured 38 cm (15.1").

Figure 12. Left side view of the booster seat.

Figure 13. Lateral view across the rear seat area and the roof intrusion.

The child passenger came to rest in the vehicle suspended upside down, held in position by the manual safety belt. He unbuckled the belt system and crawled out of the left rear door window opening. The glazing was shattered by the rollover event. He waited at the scene for emergency assistance. He did not sustain injury and was not medically treated.

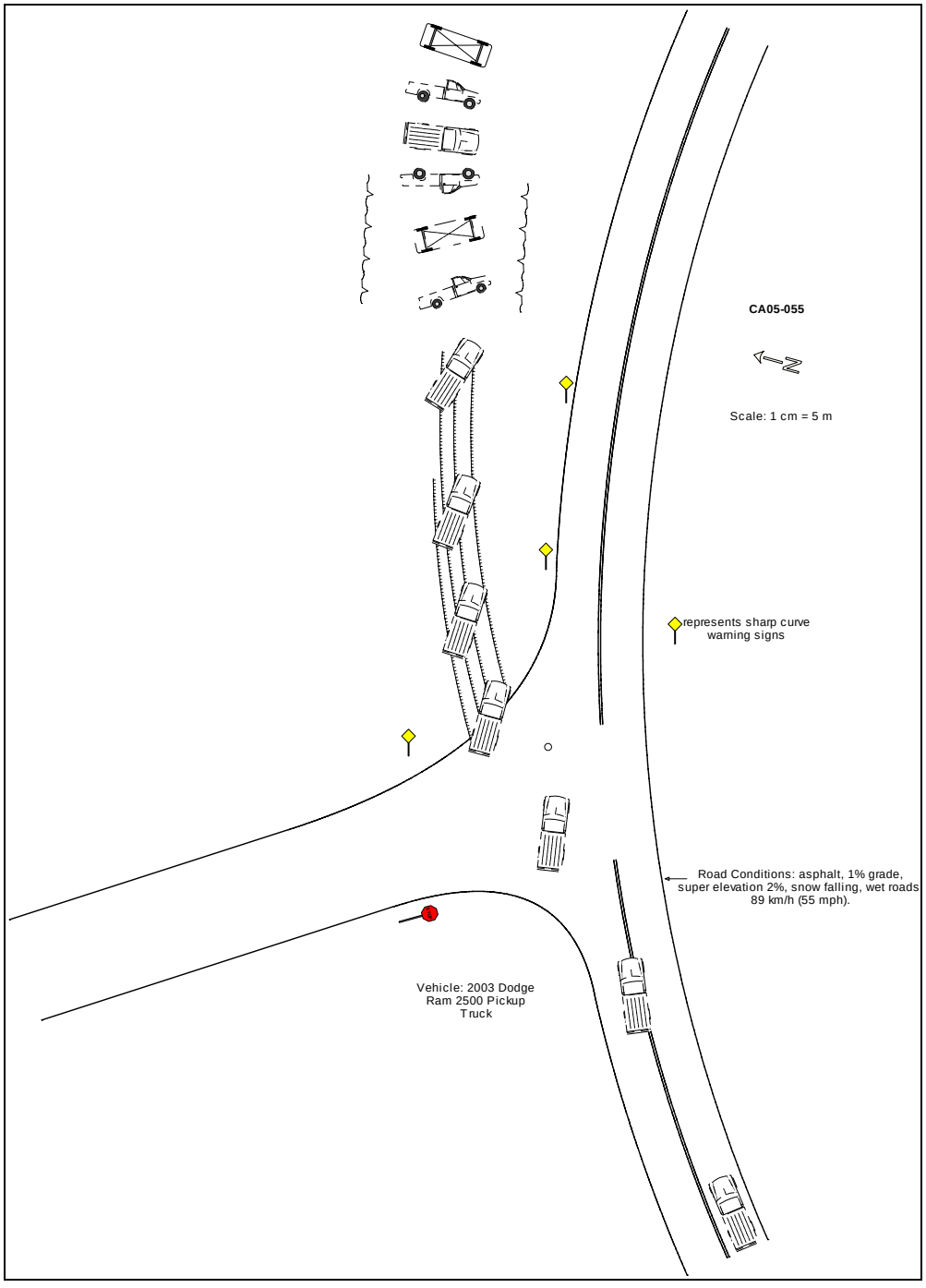

Figure 14 – Scene Schematic