

CRASH DATA RESEARCH CENTER

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**CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT
VEHICLE CRASH INVESTIGATION**

CASE NO: CA05-014

VEHICLE: 2005 DODGE GRAND CARAVAN

LOCATION: VIRGINIA

CRASH DATE: JANUARY 2005

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. <i>Abstract</i> This investigation focused on the performance of the Certified Advanced 208-Compliant safety system in a 2005 Dodge Grand Caravan. The manufacturer of this vehicle has certified that this 2005 Dodge Grand Caravan meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The vehicle was occupied by a 66-year-old restrained male driver. The driver was operating the vehicle on a two-lane curved roadway and became distracted. He relinquished control of the vehicle and the Grand Caravan departed the right roadside in a tracking mode. The vehicle entered a roadside ditch with the front right wheel and continued across a private driveway. The Grand Caravan subsequently struck a mailbox post, a wood post and rail fence, continued through the fence, striking multiple posts with the front aspect. The front of the Grand Caravan subsequently struck a tree located on the roadside adjacent to the fence. The tree impact was sufficient to deploy the driver's air bag and driver's knee air bag, which deployed from behind the knee bolster. The driver did not sustain injury, and did not receive medical treatment.</p>			
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**CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE
INVESTIGATION
CASE NO.: CA05-014
LOCATION: STATE OF VIRGINIA
VEHICLE: 2005 DODGE GRAND CARAVAN
CRASH DATE: JANUARY 2005**

BACKGROUND

This investigation focused on the performance of the Certified Advanced 208-Compliant safety system in a 2005 Dodge Grand Caravan (**Figure 1**). The manufacturer of this vehicle has certified that this 2005 Dodge Grand Caravan meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The vehicle was occupied by a 66-year-old restrained male driver. The driver was operating the vehicle on a two-lane roadway and became distracted. He relinquished control of the vehicle and the Grand Caravan departed the right roadside in a tracking mode. The vehicle entered a roadside ditch with the front right wheel and continued across a private driveway. The Grand Caravan



Figure 1. Damaged 2005 Dodge Grand Caravan

subsequently struck a mailbox post, a wood post and rail fence and subsequently struck a tree located on the roadside adjacent to the fence. The tree impact was sufficient to deploy the driver's frontal air bag and driver's knee air bag, which deployed from behind the knee bolster. The driver did not sustain injury, and did not receive medical treatment.

This crash was identified from a list of claims provided by an insurance company to the National Highway Traffic Safety Administration (NHTSA) that identified Certified Advanced 208-Compliant vehicles that had been involved in crashes. The list was forwarded to the Calspan Special Crash Investigations (SCI) team for follow-up investigation. The Grand Caravan was located and cooperation was established with the salvage yard. An on-site investigation was assigned to the Calspan SCI team on February 10, 2005. The subject vehicle was inspected on February 17, 2005 and crash site inspection was performed on February 15, 2005.

SUMMARY

Vehicle Data – 2005 Dodge Grand Caravan

The 2005 Dodge Grand Caravan was identified by the Vehicle Identification Number (VIN): 2D4GP44LX5R (production sequence omitted). The odometer could not be read due to a lack of power to the vehicle. The vehicle was a four-door minivan that was equipped with a 3.8 liter, V-6 engine, front wheel drive, a four-speed automatic transmission, four-wheel disc brakes with ABS, power steering, a tilt steering wheel, dual power sliding side doors, and "Stow'N-Go" seating. The Grand Caravan was equipped with 40.6 x 16.5 cm (16.0 x 6.5") alloy wheels and

Bridgestone Touranza 215/65R16 tires. The manufacturer’s recommended tire pressure was 250 kPa (36 PSI). The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread	Damage
LF	0.0 kPa	8.7 mm (11/32”)	None
LR	224.1 kPa (32.5 PSI)	8.7 mm (11/32”)	None
RF	217.2 kPa (31.5 PSI)	8.7 mm (11/32”)	None
RR	220.6 kPa (32.0 PSI)	8.7 mm (11/32”)	None

The Dodge Grand Caravan was configured with front bucket seats with adjustable head restraints and folding armrests on the inboard aspects. At the time of the SCI inspection, the driver’s head restraint was in the full-down position and the seat track was adjusted between the mid-track and full-rear positions. The front right passenger’s head restraint was positioned 5.1 cm (2.0”) above the seat back and the seat track was in the full-rear position. The second row “Stow’N Go” bucket seats were equipped with adjustable head restraints and were stowed in the floor at the time of the vehicle inspection. The third row was configured with a 60/40-split bench seat with folding backs and adjustable head restraints for each position.

Crash Site

This single-vehicle crash occurred in January 2005 in the state of Virginia on a two-lane roadway during nighttime hours. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The north/south roadway was configured with one lane in each direction separated by a double-yellow centerline. The roadway exhibited a gradual left southbound curve and a negative 3 percent grade. North of the crash site, the southbound grade increased to 5 percent. White fog lines bordered the roadway and the roadside environment was residential. A drainage ditch, private driveways, mailbox posts, and trees also bordered the west roadside. A metal culvert pipe was present under a private asphalt driveway, immediately north of the struck fence. The culvert pipe exhibited minor deformation from a previous unrelated crash. South of the private driveway (**Figure 2**), a mailbox post and a wood post and rail fence were present, the fence being parallel to the roadside with a section extending along the driveway at a 90-degree angle. Each fence post measured 10 x 10 cm (4 x 4”). The posts were spaced on 2.4 m (8.0’) centers. A row of trees was located inside the fenced area beyond the driveway. The struck tree consisted of a common trunk, which diverged into two main trunks, collectively measuring 49.5 cm (19.5”) in diameter. The posted speed limit was 56 km/h (35 mph). The scene schematic is included as **Figure 14** at the end of this narrative report.



Figure 2. View of replaced fence, mailbox, and struck tree

Crash Sequence

Pre-Crash

The 66-year-old male driver was operating the Grand Caravan in a southbound direction on the two-lane roadway. He became distracted while looking at an object on the right roadside, and the Grand Caravan drifted off the right roadside in a tracking mode (**Figure 3**). The right aspect of the undercarriage gouged the roadside in a longitudinal orientation, outboard of the west fog line as the right front wheel of the Grand Caravan entered the ditch (**Figure 4**). The driver of the vehicle applied his brakes, but continued in a tracking mode across the private driveway.



Figure 3. Southbound approach



Figure 4. Roadside departure showing gouges

Crash

The front right aspect of the Grand Caravan struck the corner post of the wood fence. The impact resulted in minor damage due to the yielding nature of the post and rail fence. Immediately after the fence contact, the front left aspect struck the mailbox post to the left of the fence, which also resulted in minor damage. Neither impact was sufficient to deploy the frontal air bags in the Grand Caravan. The vehicle continued in a tracking mode through the fence, striking four additional posts with the front aspect. The Grand Caravan subsequently struck the 49.5 cm (19.5") diameter tree located inboard of the fence with the front right aspect (**Figure 5**). The impact resulted in moderate damage to the Grand Caravan and was sufficient to deploy the driver's air bag, fire the driver's safety belt buckle pretensioner, and deploy the driver's knee air bag. The damage algorithm of the WinSMASH program computed a total delta-V of 26.0 km/h (16.2 mph) for the tree impact, based on the Grand Caravan's frontal crush profile. The Grand Caravan came to rest adjacent to the tree. The tree sustained scarring that began 15.2 cm (6.0") above the ground and extended 76.2 cm (30.0") upward.



Figure 5. Struck tree

Post-Crash

The driver exited the vehicle under his own power through the front left door. The driver sustained no injuries and received no medical treatment. The Grand Caravan was towed from the scene.

Vehicle Damage

Exterior Damage – 2005 Dodge Grand Caravan

Prior to the SCI inspection, the hood, bumper beam, bumper fascia and front fenders had been removed from the vehicle.

The 2005 Dodge Grand Caravan sustained minor undercarriage damage as a result of the contact with the asphalt road surface as it departed the roadway and traveled into the ditch. The bottom aspect of the fascia sustained longitudinal abrasions that began 19.7 cm (7.8”) right of the centerline and continued to the front right corner (**Figure 6**). The Collision Deformation Classification (CDC) for the impact with the ground was 00-UFZW-1.



Figure 6. Bottom aspect of bumper fascia

The Grand Caravan sustained minor damage due to the multiple frontal impacts with the fence posts, fence rails, and mailbox post. The bumper fascia (**Figure 7**) sustained fractures from the multiple frontal impacts, and was separated from the vehicle at the time of the SCI inspection. The fascia exhibited small fractures that were located 50.1 cm (20.0”) and 68.6 cm (27.0”) left of the centerline. A third fracture was located 36.8 cm (14.5”) left of the centerline at the top aspect of the fascia. Due to the multiple impacts with the fence posts, fence rails, and mailbox post, it was not possible to attribute the frontal damage with specific impacts prior to the tree. The CDC for the combined impacts was 12-FREN-1.



Figure 7. Front aspect of fascia, grille, and separated upper radiator support

The tree impact caused moderate frontal damage to the Grand Caravan. The right corner of the bumper fascia sustained a complete vertical fracture as a result of the tree impact, which was located 41.9 cm (16.5”) right of the centerline, and radiated around the inboard aspect of the right fog lamp frame. The frontal structure was crushed rearward because of the tree impact (**Figure 8**). The bumper beam and upper radiator support were both



Figure 8. Frontal crush profile

separated at the time of the SCI inspection. The direct damage on the lower radiator support began 8.9 cm (3.5") right of the centerline and extended 50.2 cm (19.8") to the front right corner. The maximum crush measured 29.8 cm (11.8") and was located 19.1 cm (7.5") right of the centerline. The combined direct and induced damage involved the entire frontal width of the Grand Caravan. The CDC for the impact with the tree was 12-FZEW-2. Six crush measurements were documented along the lower radiator support and were as follows: C1 = 0.0 cm, C2 = 6.4 cm (2.5"), C3 = 12.7 cm (5.0"), C4 = 24.8 cm (9.8"), C5 = 26.0 cm (10.3"), C6 = 13.0 cm (5.1").

The Dodge Grand Caravan also sustained minor damage on the left front door and left sliding door. A semi-circular abrasion was located at the leading edge of the left front door and extended 136.0 cm (53.5") rearward between the mid trim and the sill. A second linear abrasion was present between the beltline and the mid-trim and began 26.0 cm (10.2") aft of the leading edge of the left front door and extended 22.0 cm (8.7") rearward. The left mirror was also separated. It is possible that this damage was sustained during the towing and removal of the vehicle post-crash or from parts of the wooden fence which had earlier shattered during the crash sequence.

Interior Damage – 2005 Dodge Grand Caravan

The 2005 Dodge Grand Caravan sustained minor interior damage related to driver contact and air bag deployment. The knee bolster (**Figure 9**) was separated as a result of the knee air bag deployment. Two scuff marks were present on the face of the knee bolster from contact with the driver's knees. The first scuff mark began 12.7 cm (5.0") right of the bolster centerline, 14.0 cm (5.5") below the top aspect, and extended diagonally upward and to the left 12.1 cm (4.8"). The second scuffmark began 5.1 cm (2.0") right of the bolster centerline, 6.4 cm (2.5") above the bottom aspect, and extended linearly 3.8 cm (1.5") to the right. There was no intrusion of the passenger compartment.



Figure 9. Close-up of damaged knee bolster

Manual Restraints - 2005 Dodge Grand Caravan

The Grand Caravan was configured with manual 3-point lap and shoulder belts with Emergency Locking Retractors (ELR's) and adjustable D-rings for each front seat. Both adjustable D-rings were in the full-up positions at the time of the SCI inspection. The front seat safety belts were also equipped with buckle pretensioners. The driver's safety belt was configured with a sliding latch plate and the front right passenger's safety belt was configured with a cinching latch plate. There was very minor loading evidence on the driver's safety belt. Minor abrasions were present on the driver's plastic-covered latch plate and the driver's D-ring exhibited minor abrasions, as well.

The second row seats and outboard third row seat positions were configured with manual 3-point lap and shoulder belts with cinching latch plates and switchable ELR / Automatic Locking

Retractors (ALR). The third seat center position was configured with a lap belt with a locking latch plate.

Certified Advanced 208-Compliant Safety System

Frontal Air Bag System – 2005 Dodge Grand Caravan

The 2005 Dodge Caravan was equipped with a Certified Advanced 208-Compliant safety system that included dual-stage frontal air bags, safety belt buckle pretensioners, and a driver's knee air bag. The driver's air bag and knee bolster air bag were cut from their respective modules prior to the SCI inspection, and were found in the vehicle. The driver's air bag (**Figure 10**) deployed from the steering wheel hub through a single cover flap hinged at the top aspect. The cover flap measured 20.6 cm (8.1") in width and 11.4 cm (4.5") in height. The deployed driver's air bag measured 66.0 cm (26.0") in diameter. The air bag was tethered by two internal straps that measured 12.7 cm (5.0") in width and were located at the 3 and 9 o'clock positions.

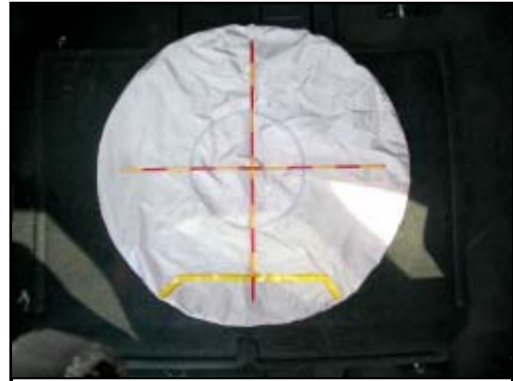


Figure 10. Driver's air bag (cut from module)

The 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 1.9 cm (0.8") in diameter and were located 3.8 cm (1.5") inboard from the circumferential seam. A red neoprene liner was present in the steering wheel hub around the inflator. The driver's air bag exhibited a blue transfer on the bottom aspect consistent with fabric. The transfer began 18.4 cm (7.3") left of the centerline, extended 34.9 cm (13.8") to the right along the bottom aspect of the air bag, and was located 23.5 cm (9.3") below the horizontal centerline.

The driver's knee air bag (**Figure 11**) deployed from behind the knee bolster as a result of the crash. Dodge's website identified the knee air bag as a "Driver's Side Inflatable Knee Blocker." It further described the knee air bag's purpose was to protect the driver's knees and keep the driver in position in the event of a crash. The deployment of the knee air bag displaced the knee bolster rearward, and the air bag inflated between the lower instrument panel and the knee bolster. The knee air bag was rectangular in shape and measured 48.3 cm (19.0") in width and 35.6 cm (14.0") in height. A lateral tether that measured 22.2 cm (8.8") in width and 10.1 cm (4.0") in depth was located in the center of the air bag.



Figure 11. Driver's knee air bag (cut from module). Rear aspect of knee bolster is below air bag.

The air bag was attached to a metal backing plate on the rear aspect of the knee bolster by two 2.5 cm (1.0”) wide straps that were spaced 15.2 cm (6.0”) apart (**Figure 12**). The knee air bag was also secured to the lower instrument panel by two 2.5 cm (1.0”) wide straps that were located 7.6 cm (3.0”) apart. Each strap was secured by a metal bolt/nut. The air bag was inflated by a tubular inflator mounted horizontally on the lower instrument panel (**Figure 13**). The inflator measured 22.9 cm (9.0”) in length and 3.8 cm (1.5”) in diameter, and exhausted on the inboard aspect. The air bag fabric on the outboard aspect was looped around the inflator and slid laterally around the inflator canister, which possibly acted as a venting mechanism for the knee air bag.

The Grand Caravan was not equipped with a knee air bag for the front right passenger position.



Figure 12. Top of knee bolster/air bag looking down, showing metal plate and attachment straps



Figure 13. View of forward aspect of knee air bag and inflator from left

The driver’s safety belt buckle pretensioner fired in conjunction with the frontal air bag system. The net piston travel within the canister measured 6.4 cm (2.5”). The front right passenger’s safety belt buckle pretensioner did not fire.

Occupant Sensing System – 2005 Dodge Grand Caravan

The Certified Advanced 208-Compliant (CAC) safety system was configured with a weight sensor in the front right seat cushion. The system was designed to detect occupant presence and automatically suppress the front right passenger’s air bag if it detected a weight consistent with a child seat, a booster seat, or a child sitting in the front seat, or it if determined that the front seat was not occupied. A light on the upper aspect of the center instrument panel confirmed the air bag on/off status. Since the front right seat was not occupied and the safety belt buckle was not engaged, the CAC system suppressed the front right passenger’s air bag and did not fire the front right safety belt buckle pretensioner.

The Grand Caravan was not equipped with an Event Data Recorder (EDR) that could be downloaded by commercially available tools during the SCI inspection.

Occupant Demographics

Driver

Age/Sex:	66-year-old/Male
Height:	152.4 cm (60.0")
Weight:	60.0 kg (130 lbs)
Seat Track Position:	Between center and full rear
Manual Restraint Use:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	None
Type of Medical Treatment:	Refused medical treatment

Driver Kinematics

The 66-year-old male driver was distracted while operating the vehicle. He was seated in an upright attitude and was restrained by the manual 3-point lap and shoulder belt. The driver was slightly displaced to the right as the Grand Caravan departed the roadside and entered a ditch. The multiple minor frontal impacts to a fence post, fence rails, and mailbox post resulted in minor displacement of the driver. Upon impact with the tree, the safety belt buckle pretensioner fired, the frontal air bag deployed, and the knee air bag deployed. The driver's air bag revealed a transfer - the bottom of the air bag may have deployed across a blue coat or pants. The driver could not recall the clothing he was wearing and could not provide substantiation of this contact. The driver initiated a forward trajectory and loaded the safety belt, evidenced by abrasions on the plastic-covered latch plate and D-ring. His knees loaded the knee bolster, evidenced by scuff marks. The deployed knee bolster air bag most likely provided a "ride-down" for the driver's knees as he loaded the bolster. He also loaded the deployed driver's air bag, which mitigated contact with the steering wheel. He rebounded rearward and came to rest in the driver's seat. The driver exited the vehicle under his own power through the front left door. He did not sustain injury and did not receive medical treatment.

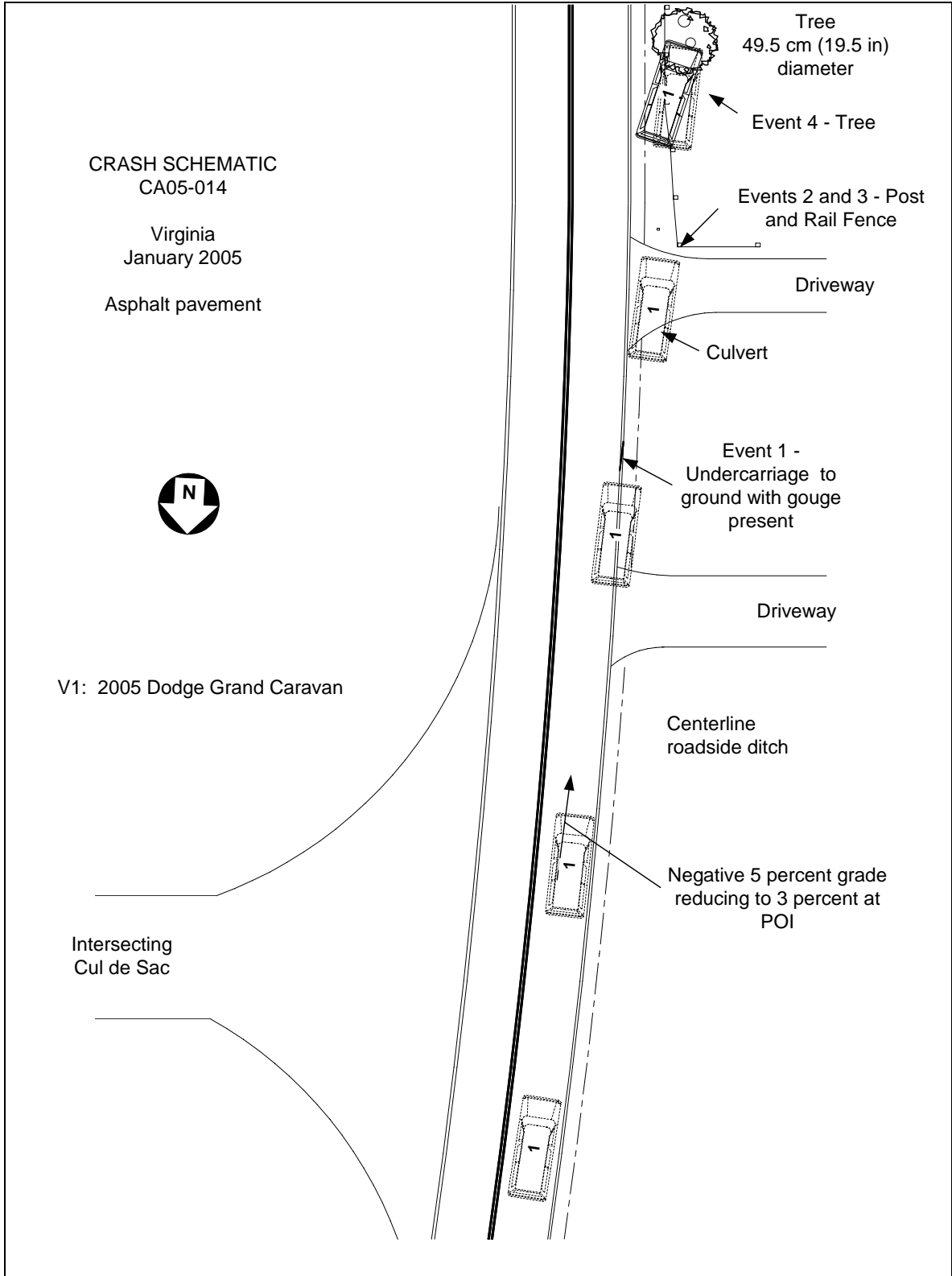


Figure 14. Scene schematic