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

**SCI CASE NO: CA05-009**

**VEHICLE: 2004 NISSAN TITAN  
LOCATION: MARYLAND  
CRASH DATE: DECEMBER 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.

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<p>16. <i>Abstract</i> This investigation focused on the performance of the Certified Advanced 208-Compliant (CAC) safety system in 2004 Nissan Titan pick-up truck. This advanced occupant protection system was comprised of dual-stage frontal air bags, seat track position sensors for both front seats, front safety belt buckle switch sensors, front seat retractor pretensioners and a front right occupant detection sensor. The CAC system was certified by the manufacturer to have met the requirements of the advanced Federal Motor Vehicle Safety Standard 208. The vehicle's Air bag Control Module (ACM) tailored the deployment of the frontal air bags based the crash severity and inputs from the CAC sensors. The Nissan's ACM had Event Data Recorder (EDR) capability. A secondary focus of this SCI investigation was to download the EDR utilizing a proprietary Nissan Scan tool.  The Nissan Titan was involved in a single vehicle run-off-road/fixed object crash. At the time of the crash, the Nissan was occupied by a 30 year old unrestrained male driver and a 52 year old unrestrained male front right passenger. The driver of the Nissan lost directional control of the vehicle on an icy road, crossed the centerline, departed the left road side and impacted a tree. The force of the impact triggered the deployment of Nissan's frontal air bags. The driver and front right passenger were transported to a local hospital where they were treated for minor injuries and released.</p>			
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***BACKGROUND***

This investigation focused on the performance of the Certified Advanced 208-Compliant (CAC) safety system in 2004 Nissan Titan pick-up truck, **Figure 1**. This advanced occupant protection system was comprised of dual-stage frontal air bags, seat track position sensors for both front seats, front safety belt buckle switch sensors, front seat retractor pretensioners and a front right occupant detection sensor. The CAC system was certified by the manufacturer to have met the requirements of the advanced Federal Motor Vehicle Safety Standard 208. The vehicle's Air bag Control Module (ACM) tailored the deployment of the frontal air bags based the crash severity and inputs from the CAC sensors. The Nissan's ACM had Event Data Recorder (EDR) capability. A secondary focus of this SCI investigation was to download the EDR utilizing a proprietary Nissan Scan tool.



**Figure 1: Front right oblique view of the Nissan Titan.**

The Nissan Titan was involved in a single vehicle run-off-road/fixed object crash. At the time of the crash, the Nissan was occupied by a 30 year old unrestrained male driver and a 52 year old unrestrained male front right passenger. The driver of the Nissan lost directional control of the vehicle on an icy road, crossed the centerline, departed the left road side and impacted a tree. The force of the impact triggered the deployment of Nissan's frontal air bags. The driver and front right passenger were transported to a local hospital where they were treated for minor injuries and released.

This crash was identified from a list of claims provided by an insurance company to the National Highway Traffic Safety Administration (NHTSA). The list identified Certified Advanced 208-Compliant vehicles that had been involved in traffic crashes. The NHTSA analyzed the list based on vehicle type and crash configuration and then forwarded a list of selected crashes to the Calspan Special Crash Investigations (SCI) team for follow-up investigation. The subject Nissan Titan was located and cooperation was established with the local insurance adjuster and salvage yard. An on-site investigation was assigned to the SCI team on February 7, 2005 and the on-site portion of the investigation took place February 15, 2005.

**SUMMARY**

**VEHICLE DATA: 2004 Nissan Titan**

The 2004 Nissan Titan was identified by the Vehicle Identification Number (VIN): 1N6AA07BX4NS (production sequence deleted). The full size/full frame, four-wheel drive, four-door crew cab pickup truck had a Gross Vehicle Weight Rating (GVWR) of 2,948 kg (6,499 lb). The Nissan was configured on a 355 cm (139.8 in) wheelbase. The vehicle was manufactured in January 2004. The digital odometer read 22,242 km (13,821 miles) at the time of the SCI inspection. The power train consisted of a 5.6 liter/V8 engine linked to a four-speed automatic transmission. The service brakes were a front disc/rear drum system with Anti-Lock Braking System (ABS). The manual restraint system consisted of three-point lap and shoulder belts in the front outboard and rear seat positions. The front center position was lap belt equipped. The front restraints were equipped with retractor pretensioners. The frontal air bag system consisted of advanced dual stage air bags for the driver and front right passenger. The Nissan was equipped with Bridgestone Dueler AT P245/75R17 tires on OEM alloy rims. The recommended tire pressure was 240 kPa (35 PSI) front and rear. The specific measured tire data was as follows:

<b>Tire</b>	<b>Measured Pressure</b>	<b>Tread Depth</b>	<b>Restricted</b>	<b>Damage</b>
LF	240 kPa (35 PSI)	3 mm (4/32)	No	None
LR	228 kPa (33 PSI)	6 mm (7/32)	No	None
RF	0 kPa	6 mm (7/32)	No	Inner sidewall cut, rim spokes fractured by impact
RR	179 kPa (26 PSI)	6 mm (8/32)	No	None

**CRASH SITE**

The crash occurred during the nighttime hours of December 2004. At the time of the crash, it was dark without any artificial lighting. The weather conditions were snow and sleet. Severe crosswinds were noted on the police report. The asphalt road surface was icy. The crash occurred on a two lane north/south road in a rural residential setting. At the crash site, the road was straight and had a negative grade estimate less than two percent in the southbound direction. The traffic lanes measured 3.4 m (11 ft) in width and were separated by broken and solid/broken yellow centerlines. The road edges were delineated by white fog lines. In the area of the crash, the east road side was bordered by a grass shoulder and a tree line that was located approximately 3 m (6 ft) east of the road edge. The speed limit in the area of the crash was 48km/h (30 mph). Due to the passage of time between the dates of the crash and the on-site



**Figure 2: View of the Nissan’s trajectory.**

scene inspection, there was no physical evidence within the area of the crash that identified the point of impact. **Figure 2** is a view of the Nissan Titans southbound trajectory.

## ***CRASH SEQUENCE***

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

The 2004 Nissan Titan was southbound driven by a 30 year old unrestrained male. A 52 year old unrestrained male was the vehicle's front right passenger. Due to a combination of excessive speed and poor road conditions, the driver lost directional control of the Nissan on the icy road and the rear tires of the vehicle lost traction. The Nissan began to rotate counterclockwise, crossed the center line of the road and departed the east roadside. A schematic of the crash is included at the end of this report as **Figure 8**.

### ***Crash***

The crash occurred with the forward aspect of the Nissan's right plane impacting a tree. The impact occurred approximately at the right front tire location. The force of the impact fractured the spokes of the wheel rim and separated the wheel from the suspension. The Nissan continued its counterclockwise rotation and separated from the tree coming to rest in the northbound lane of the road. The impact induced longitudinal deceleration of the crash was sufficient to cause the deployment of the Nissan's advanced frontal air bags. The damage based delta V of the crash computed by the WINSMASH model was 6.0 km/h (3.7 mph). The longitudinal and lateral components were -3.8 km/h (-2.4 mph) and -4.6 km/h (-2.9 mph), respectively. The computed delta V underestimated the severity of the crash due to the default stiffness coefficients used to analyze an impact to vehicle (the wheel/suspension) with a localized high stiffness value.

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

The police and ambulance personnel responded to the crash. The driver and front right passenger were removed from the vehicle due to perceived serious injuries and were transported via ground ambulance to a regional trauma center located 32 km (20 miles) from the crash site. The driver sustained an AIS 2 closed head injury and minor abrasions/contusions to his lower extremities. The front right passenger also sustained an AIS 2 closed head injury, as well as a laceration to the right temporal region of his scalp. Both occupants were treated and released from the hospital within 24 hours of the crash.

## ***2004 NISSAN TITAN***

### ***Exterior Damage***

The forward aspect of the Nissan's right side sustained 60 cm (23.5 in) of direct and induced damage as a result of the tree impact, **Figure 3**. The direct damage began 36 cm (14.1 in) aft of the right front axle location and extended forward 52 cm (20.5 in). The impact was approximately centered on the right front tire. The seven spokes of the alloy wheel rim fractured in the impact and the wheel rim separated from the center hub. The components damaged in the impact included the right front inner and outer fender, right front tire and suspension and the right headlamp assembly. There was no visible damage to the front bumper system, upper radiator support or frame of the Nissan. **Figure 4** depicts the method used to document the residual deformation of the right front fender. The longitudinal dowel rod represented the original location of the inner fender. Its location was determined by referencing the undamaged left side

of the vehicle. The lateral crush was then directly measured from the dowel rod to the crushed component. The residual crush profile was as follows: C1 = 0, C2 = 2 cm (0.6 in), C3 = 6 cm (2.5 in), C4 = 11 cm (4.3 in), C5 = 12 cm (4.8 in), C6 = 6 cm (2.5 in). The maximum crush was located 7 cm (2.9 in) forward of the right front axle location and measured 14 cm (5.6 in). There was no measurable change in the wheelbase dimensions. The left front, left rear, and right rear doors remained closed during the crash and were operational at the time of the SCI inspection. The right front door remained closed during the impact and was opened by the first responders. It could not be latched at the time of the inspection due to deformation of the right side body panels. There was no damage to the windshield or side windows. The Collision Deformation Classification (CDC) of the front impact was 02-RFEW2.



**Figure 3: Right exterior view of the damaged Nissan**



**Figure 4: Overhead view of the engine compartment and right front damage.**

### ***Interior Damage***

The interior of the Nissan Titan sustained minor damage consistent with the deployment of the frontal air bags and occupant contacts. There was no reduction in the volume of the interior compartment or damage directly related to the exterior crash force.

The cloth-upholstered manual driver seat was adjusted to a full rear track position. The total seat track travel measured 24 cm (9.4 in). The seat back was reclined 18 degrees aft of vertical. The anti-submarine angle measured in the center of the seat cushion was 13 degrees. The horizontal distance from the seat back to the center hub of the steering wheel measured 65 cm (25.5 in). This distance was measured 38 cm (15 in) above the seat bight.

The three-spoke tilt steering wheel was adjusted to the center position. The steering wheel mounting flange was deformed throughout the 7 to 10 o'clock sector. The deformed flange closed the manufactured clearance between the steering wheel assembly and steering column on the left and opened that clearance gap to 2 cm



**Figure 5: Overhead view depicting the deformed steering wheel mounting flange.**



(0.6 in) on the right. Refer to **Figure 5**. The deformation resulted from the unrestrained loading by the driver. There was no deformation of the steering wheel rim and there was no displacement of the steering column's shear capsules.

Four driver contact points were observed during the interior inspection. A 5 cm x 13 cm (2 in x 5 in) angular contact scuff mark was identified on the knee bolster immediately below the steering wheel on the centerline of the steering column. This mark was attributed to contact from the driver's left lower extremity. The flip and fold center console was folded down at the time of the crash. It was moved 5 cm (2 in) to the right by contact from the driver's left hip. A 7 cm (2.8 in) contact to the driver's side of the console was located 23 cm (9 in) rearward of its forward edge. The right aspect of the center mirror was fractured by contact from the driver's right hand. This contact resulted in an unspecified laceration to his hand.

The front right seat was adjusted to a full rear track position and its total seat track travel measured 24 cm (9.4 in). The seat back was reclined 20 degrees. The anti-submarine angle of the seat cushion measured 13 degrees. The horizontal distance from the seat back to the vertical face of the instrument panel measured 93 cm (36.5 in). The front right passenger air bag module was recessed 9 cm (3.5 in) forward of the instrument panel's vertical face. The distance from the rearmost edge of the module to the seat back measured 102 cm (40 in).

The right aspect of the windshield, forward of the front right passenger, was scuffed and fractured by contact from the deployed air bag. The fracture site was located 15.5 in right of the right A-pillar and 10.5 in above the open cover flap. A 20 cm (8 in) pattern of vertical scuff marks was located (8 in to 15.5 in) above the flap within the fracture pattern. The scuff marks and windshield fracture resulted from the loading of the deployed front right passenger air bag by the front right occupant. A triangular scuff mark was observed on the right aspect of the glove box door and was attributed to the front right occupant's right lower extremity. The outboard aspect of the sun visor exhibited a 4 cm x 4 cm (1.5 in x 1.5 in) scuff mark from a probable right hand contact. A 2.8 in long scuff mark was located on the central aspect of the right door panel arm rest from contact with the front right occupant's right hip. A head contact evidenced by a blood spatter pattern was observed on the right B-pillar 12 in to 13.5 in below the side rail, **Figure 6**. A spray pattern was located immediately rearward of this contact aft of the adjustable D-ring. Blood evidence was also observed on the outboard bolster of the seat back. This contact resulted in the occupant's right temporal scalp laceration and the identified closed head injury.



**Figure 6: Front right seat and occupant contacts.**

### ***Manual Restraint Systems***

The manual restraint systems in the front row of the Nissan consisted of continuous loop webbing, a sliding latch plate, an adjustable D-ring and B-pillar mounted retractors. The driver's retractor was an Emergency Locking retractor (ELR). The front right passenger retractor was a switchable Automatic Locking/Emergency Locking Retractor (ALR/ELR). The front row retractors were equipped with pretensioners that fired as a result of the impact. Upon inspection, both front row restraints were in the stowed position and locked in place by the fired pretensioner. The webbings were taut. The stowed and locked condition of the restraints indicated that both occupants were unrestrained at the time of the crash. The EDR data downloaded at the time of the inspection reported that the buckle sensors for the driver and front right passenger indicated an "Unbuckled" condition. It should be noted that both the police accident report and the medical records indicated that both occupants were restrained in this crash.

### ***Certified Advanced 208-Compliant Air Bag System***

The Certified Advanced 208-Compliant (CAC) frontal air bag system consisted of advanced dual stage/dual threshold air bags for the driver and front right passenger, seat track position sensors, front safety belt buckle switches, front safety belt pretensioners and a front right occupant detection sensor. The frontal air bag system was certified by the manufacturer to have met the requirements of the advanced Federal Motor Vehicle Safety Standard 208. The CAC system was controlled and monitored by an Air bag Control Module (ACM) located under the center console immediately rearward of the transmission selector. The ACM commanded the deployment of the CAC system based on the severity of the crash and the inputs from the sensors. The ACM was also equipped with Event Data Recorder (EDR) capabilities. The Nissan EDR was downloaded at the time of the SCI inspection through the use of a proprietary scan tool forwarded to the Calspan team by Nissan. The results of that download are identified in the *Event Data Recorder* section of this report.

The driver and front right passenger air bags deployed as a result of the frontal crash, **Figures 7**. The driver air bag deployed from a tri-flap configuration module that was located in the center hub of the steering wheel rim. The upper flap dimensions measured 15cm x 6 cm (6 in x 2.3 in), width by height. The symmetrical lower flaps each measured 5 cm x 5 cm (2 in x 2 in). The flaps opened at the designed tear seams during the deployment sequence and were free from occupant contact. The deployed driver air bag measured 55 cm (21.5 in) in diameter. The bag was tethered by two 11 cm (4.3 in) wide straps in the 6/12 o'clock sectors. The bag was vented by two 2 cm (0.8 in) ports located 14 cm (5.5 in) forward of the perimeter seam in the 11/1 o'clock sectors. There was no residual evidence of occupant contact to the face of the bag. The following manufacture's nomenclature identified the driver air bag:



**Figure 7: View of the deployed frontal air bags.**

The front right passenger air bag was a top mount design located in the right aspect of the instrument panel. The module was a rectangular design. The rectangular cover flap measured 22 cm x 13 cm (8.6 in x 5.3 in), width by height. The flap was constructed of sheet vinyl and had a sheet metal backer that deformed forming a hinge during the deployment sequence. The deflated passenger air bag measured 36 cm x 66 cm (14 in x 25.8 in). The excursion of the face of the bag measured 32 cm (12.5 in) at the location of the tether. The air bag was vented by two 5 cm (2 in) diameter ports on the bag's side panels. It was tethered by a single 20 cm (8 in) wide internal strap. There was no residual evidence of occupant contact to the air bag. The air bag was identified by the following manufacturer's nomenclature:

*603235100CC05*

*NRFPZ60AAD4*

### ***Event Data Recorder***

As previously reported, the EDR was downloaded at the time of the SCI inspection through the use of a proprietary scan tool provided by the Nissan Corporation. The scan tool was connected to the J1962 diagnostic port located under the instrument panel. Electrical power was supplied via an external battery through the fuse panel located under the engine compartment. The software driven scan tool accessed the EDR data and a download of the stored hexadecimal data was retrieved by a hard copy printout. This hexadecimal data was forwarded to Nissan through the offices of the NHTSA. Nissan in-turn supplied a text report of the translated hexadecimal data to the Calspan SCI team.

The supplied text report indicated the following:

- The frontal air bag system was operating properly before the crash. There were no Diagnostic Trouble Codes (DTC) present before the impact.
- The front right occupant was of sufficient size to be classified as an adult.
- The buckle sensors for the driver and front right occupant indicated that these individuals were unrestrained when the frontal air bags deployed.
- The frontal air bags and seat belt pretensioners deployed in this crash.
- The deployment commanded was a Stage 1 deployment command of the dual stage air bag system.

The EDR data was not capable of recording Pre-Crash data and did not report delta V data. The translated EDR data supplied to the SCI team was consistent with the observations of the on-site vehicle inspection.

### ***OCCUPANT DEMOGRAPHICS***

	<b><i>Driver</i></b>	<b><i>Front Right Passenger</i></b>
Age / Sex:	30 year old / Male	52 year old / Male
Height:	Not Available	Not Available
Weight:	Not Available	Not Available
Seat Track Position:	Full rear	Full rear
Manual Restraint Use:	None	None
Usage Source:	SCI vehicle inspection, EDR	SCI vehicle inspection, EDR
Medical Treatment:	Transported to a local hospital, Treated and released	Transported to a local hospital, Treated and released

### ***DRIVER INJURY***

<b><i>Injury</i></b>	<b><i>Injury Severity (AIS 98 Update)</i></b>	<b><i>Injury Source</i></b>
Loss of consciousness (<1 hr), Closed head injury (not further specified),	Moderate (160202.2,0)	Occupant to occupant interaction
Left lower extremity abrasion, NFS	Minor (890202.1,2)	Knee bolster
Left lower extremity contusion, NFS	Minor (890402.1,2)	Knee bolster

*Note: the above injuries were identified in the treating hospital's emergency room records.*

### ***DRIVER KINEMATICS***

The 30 year old driver was seated in a full rear track position in a presumed upright posture. He was not utilizing the vehicle's manual restraint. The driver lost directional control of the vehicle due to a combination of poor road conditions and vehicle speed. The vehicle departed the left side of the road with a counterclockwise rotation. Upon impact, the driver responded to the 2 o'clock direction of the impact by initiating a right and forward trajectory. This right hip loaded and displaced the center console to the right. His left lower extremity contacted the knee bolster evidenced by the scuff mark to that component and the corresponding minor contusion and abrasion to that extremity. The driver loaded the inboard side of the deployed air bag with his chest. This loading deformed the mounting flange of the steering wheel during the ride down of the crash. As the ride down ensued, the driver loaded through the driver air bag and his head impacted the center mirror. During this kinematic pattern, the driver likely interacted with the rebounding front right passenger. This interaction was the probable cause of the identified closed head injury.

***FRONT RIGHT OCCUPANT INJURY***

<b><i>Injury</i></b>	<b><i>Injury Severity (AIS 98 Update)</i></b>	<b><i>Injury Source</i></b>
Loss of consciousness (<1 hr), Closed head injury (not further specified), vomiting en-route to hospital, concussion	Moderate (160202.2,0)	Rebound contact to right B-pillar
10 cm right temporal scalp laceration	Minor (190602.1,1)	Rebound contact to right B-pillar

*Note: the above injuries were identified in the treating hospital's emergency room records.*

***FRONT RIGHT OCCUPANT KINEMATICS***

The 52 year old front right occupant was seated in a full rear track position in a presumed upright posture. He was unrestrained. Upon impact, the occupant initiated a right and forward trajectory in response to the 2 o'clock direction of the impact. The occupant loaded the deployed front right passenger air bag with his chest. This loading was evidenced by the air bag transfer and fracture to the windshield. The occupant's right lower extremity contacted and scuffed the glove box door without injury. The occupant then rebounded. During this rebound phase, this occupant interacted with the driver which altered his rebound trajectory to the right. His right hip contacted and scuffed the right door panel. The occupant's head contacted the right B-pillar evidenced by the blood transfers. This contact resulted in a right temporal scalp laceration and the AIS 2 closed head injury. The occupant then came to rest in his seat where he was found.

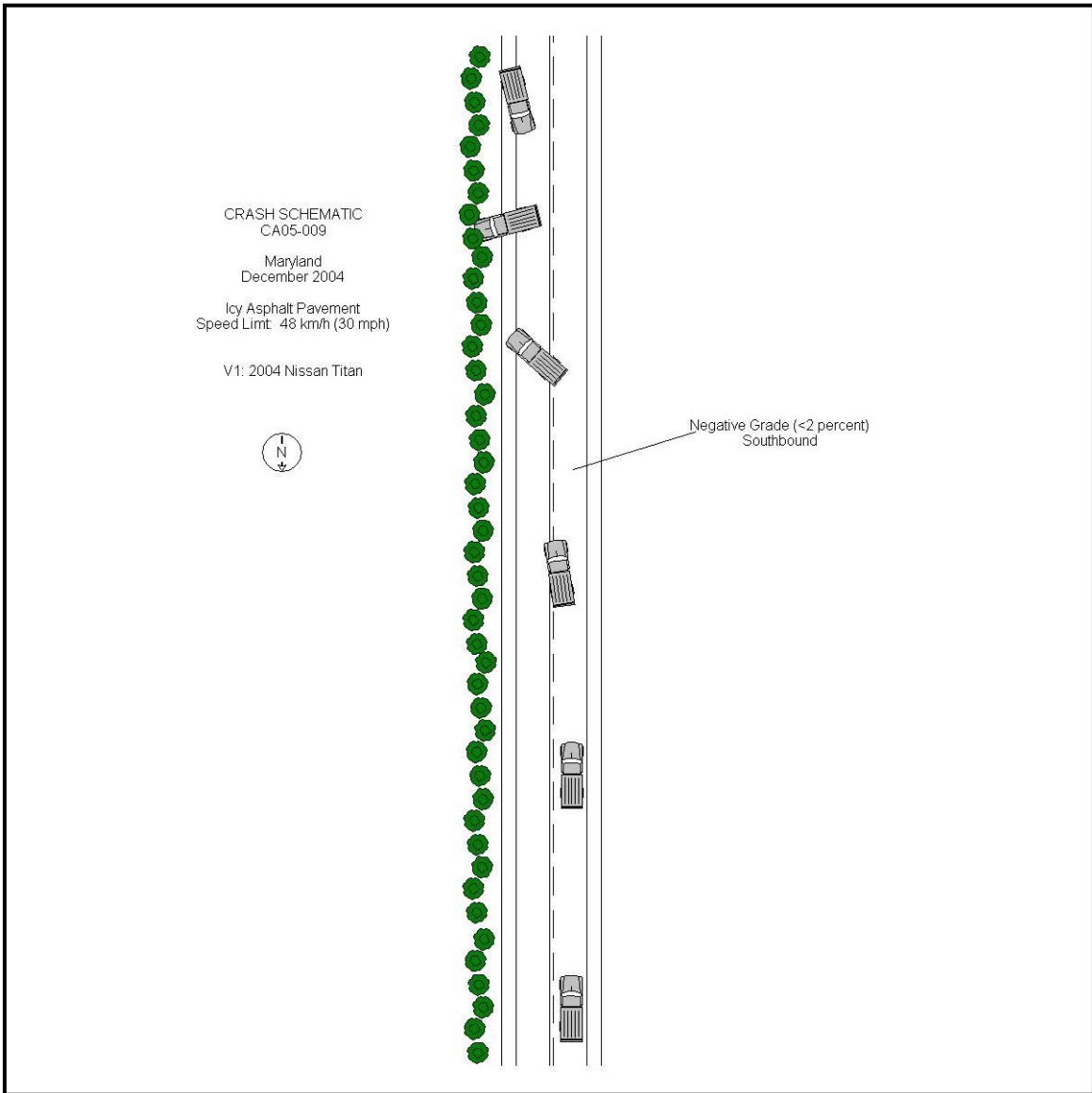


Figure 8: Crash Schematic.