

**CRASH DATA RESEARCH CENTER**

Calspan Corporation  
Buffalo, NY 14225

**CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION  
SYSTEM CRASH INVESTIGATION**

**SCI CASE NO: – CA09007**

**VEHICLE – 2005 NISSAN MAXIMA 3.5 SL**

**LOCATION – STATE OF NEW YORK**

**CRASH DATE – FEBRUARY 2009**

Contract No. DTNH22-07-C-00043

Prepared for:

U.S. Department of Transportation  
National Highway Traffic Safety Administration  
Washington, D.C. 20590

## **DISCLAIMER**

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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**

1. Report No. CA09007		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Calspan On-Site Side Impact Inflatable Occupant Protection System Crash Investigation Vehicle: 2005 Nissan Maxima Location: State of New York				5. Report Date: March 2009	
				6. Performing Organization Code	
7. Author(s) Crash Data Research Center				8. Performing Organization Report No.	
9. Performing Organization Name and Address Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225				10. Work Unit No. C00500.0000.0123	
				11. Contract or Grant No. DTNH22-07-C-00043	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590				13. Type of Report and Period Covered Technical Report Crash Date: February 2009	
				14. Sponsoring Agency Code	
15. Supplementary Note This on-site investigative effort focused on the side impact inflatable occupant protection system in a 2005 Nissan Maxima 3.5 SL and the injury sources for the 33-year-old female front right passenger					
16. Abstract This on-site investigative effort focused on the side impact inflatable occupant protection system in a 2005 Nissan Maxima 3.5 SL and the injury sources for the 33-year-old female front right passenger. The Nissan was equipped with front seat back mounted side impact air bags and side impact curtain air bags for the four outboard positions. In addition to the front right passenger, the Nissan was occupied by a 44-year-old male driver. The Nissan was involved in an intersection crash with a 2000 Chevrolet Astro minivan. As a result of the crash, the front right seat back mounted side impact air bag and the right side inflatable curtain air bag deployed in the Nissan. The driver was not injured during the crash. The female front right passenger was transported to a hospital the day following the crash where she was treated for soft tissue injuries and released.					
17. Key Words Side impact inflatable occupant protection system				18. Distribution Statement General Public	
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 10	22. Price

## *TABLE OF CONTENTS*

<b>BACKGROUND .....</b>	<b>1</b>
<b>SUMMARY .....</b>	<b>1</b>
CRASH SITE .....	1
VEHICLE DATA .....	2
2005 NISSAN MAXIMA 3.5 SL .....	2
2000 CHEVROLET ASTRO .....	2
CRASH SEQUENCE .....	3
PRE-CRASH .....	3
CRASH .....	4
POST-CRASH .....	4
VEHICLE DAMAGE .....	4
EXTERIOR DAMAGE – 2005 NISSAN MAXIMA 3.5 SL .....	4
INTERIOR – 2005 NISSAN MAXIMA 3.5 SL .....	5
EXTERIOR DAMAGE –2000 CHEVROLET ASTRO .....	6
MANUAL SAFETY BELT SYSTEMS –2005 NISSAN MAXIMA 3.5 SL .....	6
FRONTAL AIR BAG SYSTEM –2005 NISSAN MAXIMA 3.5 SL .....	7
SIDE IMPACT INFLATABLE OCCUPANT PROTECTION SYSTEM .....	7
2005 NISSAN MAXIMA 3.5 SL .....	7
DRIVER DEMOGRAPHICS .....	8
DRIVER INJURIES .....	8
DRIVER KINEMATICS .....	8
FRONT RIGHT PASSENGER DEMOGRAPHICS .....	9
FRONT RIGHT PASSENGER INJURIES .....	9
FRONT RIGHT PASSENGER INJURIES KINEMATICS .....	9

**CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION  
SYSTEM CRASH INVESTIGATION  
SCI CASE NO: – CA09007  
VEHICLE – 2005 NISSAN MAXIMA 3.5 SL  
LOCATION – STATE OF NEW YORK  
CRASH DATE – FEBRUARY 2009**

**BACKGROUND**

This on-site investigative effort focused on the side impact inflatable occupant protection system in a 2005 Nissan Maxima 3.5 SL and the injury sources for the 33-year-old female front right passenger. The Nissan (**Figure 1**) was equipped with front seat back mounted side impact air bags and side impact curtain air bags for the four outboard positions. In addition to the front right passenger, the Nissan was occupied by a 44-year-old male driver. The Nissan was involved in an intersection crash with a 2000



**Figure 1. 2005 Nissan Maxima SL.**

Chevrolet Astro minivan. As a result of the crash, the right seat back mounted side impact air bag and the right side inflatable curtain air bag deployed in the Nissan. The driver was not injured during the crash. The female front right passenger was transported to a hospital the day following the crash where she was treated for soft tissue injuries and released.

Notification of this crash was provided to the Calspan Special Crash Investigations (SCI) team by the driver of the Nissan on February 11, 2009. The Calspan SCI team forwarded the details of the crash to the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) on February 12, 2009. Due to the deployed side impact air bag system into an occupied seating position, an on-site investigation was assigned to the Calspan SCI team the same day. The on-site investigation which included the inspection of the Nissan, Chevrolet, crash site, and interviews with the occupants of the Nissan was conducted on February 17, 2009.

**SUMMARY**

***Crash Site***

This crash occurred during the nighttime hours of February 2009, at a four-leg intersection. At the intersection, each roadway was configured for one-way traffic. The respective travel lanes were oriented in the northbound and westbound directions. Each roadway consisted of a single, level, 9.1 meter (29.8 feet) wide travel lane that was bordered by 10 cm (4”) concrete curbs. Traffic flow through the intersection was controlled by stop signs for the northbound travel lane. On-street parking was permitted against all curbs. At the time of the SCI inspection, it was noted that vehicles were parked against the curbs to approximately 5 meters (16 feet) of the intersection. The

posted speed limit for both roadways was 48 km/h (30 mph). The scene schematic is included as **Figure 13** of this report.

***Vehicle Data***

***2005 Nissan Maxima 3.5 SL***

The 2005 Nissan Maxima 3.5 SL was a four-door sedan that was identified by Vehicle Identification Number (VIN) 1N4BA41E55C (production number deleted). The Maxima was manufactured in 05/05 and was a uni-body design that was powered by a 3.5 liter transverse mounted six-cylinder engine linked to a five-speed automatic transmission with front wheel drive. The braking system consisted of power-assisted front and rear disc brakes with an Antilock Braking System (ABS). The Maxima's standard features also included a traction control system. The tires on the vehicle were Continental Conti Touring Contact, size P225/55R17 mounted on seven-spoke OEM alloy wheels. The vehicle manufacturer recommended cold tire pressure was 228 kPa (33 PSI) for the front and rear. The specific tire data at the time of the SCI inspection was as follows:

<b>Position</b>	<b>Measured Tire Pressure</b>	<b>Measured Tread Depth</b>	<b>Tire/Wheel Damage</b>
Left Front	131 kPa (19 PSI)	4 mm (5/32")	None
Left Rear	172 kPa (25 PSI)	4 mm (5/32")	None
Right Front	152 kPa (22 PSI)	5 mm (6/32")	Rim abrasions
Right Rear	124 kPa (18 PSI)	5 mm (6/32")	None

The interior of the Nissan was configured with leather upholstered five-passenger seating. The front bucket seats were separated by a center console and equipped with Active Head Restraints (AHR) that were height adjustable. The AHR system utilizes head restraints that move forward in a rear-end collision attempting to reduce the chance of a whiplash injury. The front left head restraint was adjusted to 2 cm (0.8") above the full down position and the front right head restraint was adjusted to 3 cm (1.2") above the full down position. The rear seating consisted of a bench seat with a forward folding back feature. Eighty percent of the seat back folded forward with the outboard aspects remaining stationary. The outboard positions of the rear seat were equipped with adjustable head restraints, both adjusted to the full-down positions.

***2000 Chevrolet Astro***

The 2000 Chevrolet Astro was identified by the VIN 1GNEL19W3YB (production number omitted) and was manufactured in 02/00. The Chevrolet Astro was constructed as a body on frame minivan. The power-train consisted of a 4.3-liter six-cylinder engine linked to an electronically controlled four-speed transmission with all-wheel drive. The Chevrolet was equipped an Anti-lock Braking System (ABS). The tires on the vehicle were Uniroyal Liberator AX, size P215/75R15 mounted on multi-spoke OEM alloy wheels. The vehicle manufacturer recommended cold tire pressure was 241 kPa (35 PSI) for the front and rear. The specific tire data at the time of the SCI inspection was as follows:

<b>Position</b>	<b>Measured Tire Pressure</b>	<b>Measured Tread Depth</b>	<b>Tire/Wheel Damage</b>
Left Front	186 kPa (27 PSI)	8 mm (10/32")	None
Left Rear	207 kPa (30 PSI)	9 mm (11/32")	None
Right Front	186 kPa (27 PSI)	8 mm (10/32")	None
Right Rear	172 kPa (25 PSI)	8 mm (10/32")	None

### *Crash Sequence*

#### *Pre-Crash*

The restrained 44-year-old male driver of the Nissan was traveling north approaching the intersection where his intention was to continue northbound (**Figure 2**). The vehicle was also occupied by a restrained 33-year-old female front right passenger. The driver of the Nissan decelerated and stopped at the regulatory stop sign at the intersection.

A 54-year-old male was operating the 2000 Chevrolet Astro westbound approaching the intersection (**Figure 3**). Westbound traffic was not regulated through the intersection. This driver was not required to stop at the intersection.

During the SCI interview, the driver of the Nissan stated that as he stopped at the intersection, he did not observe any on-coming traffic and began to slowly enter the intersection. He accelerated forward, extending beyond the parked vehicles on the south curb to obtain a clearer view of the westbound travel lane. At this point, he did not see the Chevrolet and began traversing the intersection.



**Figure 2. Nissan's pre-crash northbound travel path.**



**Figure 3. Westbound trajectory of the Chevrolet.**

### ***Crash***

The front left aspect of the Chevrolet impacted the right front of the Nissan within the intersection. **Figure 4** is a view of the area of impact from the Nissan's northbound approach. The resultant directions of force for the Nissan and the Chevrolet were within the 3 and 12 o'clock sectors, respectively. The Damage Algorithm of the WinSMASH program was used to compute the severity of the crash (delta-V). The total velocity change for the Nissan was 12 km/h (8 mph), with a longitudinal component of -2



**Figure 4. Area of impact from the northbound approach of the Nissan.**

km/h (-1 mph) and a lateral component of -12 km/h (-8 mph). The total delta-V for the Chevrolet was 10 km/h (6 mph). The longitudinal and lateral components for the Chevrolet were -10 km/h (-6 mph) and 2 km/h (1 mph), respectively.

The impact location was forward of the Nissan's center of gravity; therefore the impact rotated the Maxima counterclockwise approximately 65 degrees. The vehicle came to rest within the intersection. The Chevrolet was deflected to the right and came to rest within the northwest quadrant of the intersection. There was no physical evidence or police documentation to support the exact final rest positions of the vehicles.

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

The restrained 44-year-old male driver of the Nissan was not injured during the crash and was not transported to a hospital. The restrained 33-year-old female front right passenger of the Nissan sustained soft tissue injuries; however, she declined medical transport. She sought medical attention at a hospital one day post-crash where she was treated and released. The Nissan was towed from the crash site to a repair facility where it was inspected for the SCI investigation. The Chevrolet was driven from the crash site to the driver's residence where it was inspected. The driver of the Chevrolet was not injured.

### ***Vehicle Damage***

#### ***Exterior Damage – 2005 Nissan Maxima 3.5 SL***

The exterior of the Nissan sustained moderate severity damage as a result of the intersection crash (**Figures 5 and 6**). The direct contact damage for the impact with the Chevrolet began 257 cm (101") forward of the right rear axle and extended 113 cm (45") forward to the right front bumper corner. The maximum crush measured 14 cm (5.5") and was located 337 cm (133") forward of the right rear axle. The impact involved the right front tire and wheel resulting in lateral deformation of the strut tower. A crush profile was documented along the right fender and was as follows: C1 = 0 cm, C2 = 3 cm (1.2"), C3 = 12 cm (4.7"), C4 = 14 cm (5.5"), C5 = 13 cm (5.1"), C6 = 0 cm. The Collision Deformation Classification (CDC) for this impact was 03-RFEW-2. The four doors remained closed during the crash and were operational at the time of the SCI



inspection. The vehicle's glazing was not damaged during the crash. The side glazing and backlight of the Nissan contained an aftermarket tint film.



**Figure 5. Overall view of the right front damage.**



**Figure 6. Overhead view of the deformation.**

#### *Interior – 2005 Nissan Maxima 3.5 SL*

Inspection of the passenger compartment of the Nissan was unremarkable. There was no intrusion or interior damage associated with the exterior crash force. There was no observed evidence of interior occupant contact points. A fabric transfer was noted to the wood trim of the right front door panel from contact with the deploying front right seat back mounted air bag.



**Figure 7. Front passenger compartment area.**

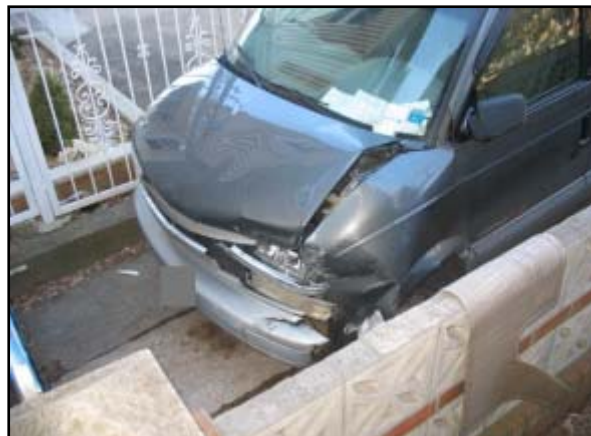
The driver's bucket seat was adjusted to 4 cm (1.6") forward of the full-rear position. The total seat track travel measured 23 cm (9.1"). The driver's seat back was reclined 30 degrees aft of vertical. The front right seat track was adjusted to 5 cm (2") forward of the full-rear position. The front right seat track also measured 23 cm (9.1") in total length. The recline angle of the front right seat back measured 30 degrees aft of vertical. An aftermarket DVD player was located on the floor of the second row. The video screens for this component were facing the second row and were mounted to the back of the front head restraints using velcro straps. The steering column was adjustable in both the vertical and longitudinal directions. The vertical adjustment of the steering column was found to be in the full-down position. The telescoping adjustment was extended to the full-rear position at the time of the SCI inspection. There was no deformation of the steering wheel rim. **Figure 7** is an overall view of the front passenger compartment.

### ***Exterior Damage –2000 Chevrolet Astro***

The 2000 Chevrolet Astro sustained moderate damage as a result of the impact with the Nissan (**Figures 8 and 9**). The direct contact damage was confined to the center and left aspects of the front plane and measured 103 cm (40.5”) in width. The direct damage began 13 cm (5”) right of the centerline and extended 90 cm (35”) to left bumper corner. The maximum crush measured 11 cm (4.3”) and was located at the front left bumper corner. Six equidistant crush measurements were documented along the bumper beam of the vehicle and were as follows: C1 = 11 cm (4.3”), C2 = 0 cm, C3 = 0 cm, C4 = 0 cm, C5 = 0 cm, C6 = 0 cm. The CDC assigned for this impact was 12-FYEW-1.



**Figure 8. Residual frontal damage to the Chevrolet.**



**Figure 9. Oblique view of the residual frontal damage.**

### ***Manual Safety Belt Systems –2005 Nissan Maxima 3.5 SL***

The Nissan was equipped with manual 3-point lap and shoulder safety belts for the five designated seat positions. All belt systems utilized continuous loop webbing with sliding latch plates. The driver's belt was equipped with an Emergency Locking Retractor (ELR) and a retractor pretensioner. The upper D-ring was adjustable and was set to the full-up position. The driver used the safety belt at the time of the crash; however, this low delta-V crash did not produce any evidence of frictional abrasions to the latch plate or transfers to the webbing. Evidence of usage at the time of the crash consisted of the B-pillar trim panel that was dislodged from its mounting points from the driver loading of the belt system (**Figure 10**). The driver's pretensioner did not actuate during the crash.



**Figure 10. Dislodged left B-pillar trim panel.**

The front right safety belt system utilized a switchable ELR and Automatic Locking Retractor (ALR) and a retractor pretensioner. The front right safety belt system was used during the crash; however, loading evidence did not occur during this side impact. The retractor pretensioner did not actuate.

The three rear belt systems utilized switchable ELR/ALR. These positions were unoccupied at the time of the crash.

#### ***Frontal Air Bag System –2005 Nissan Maxima 3.5 SL***

The Nissan was equipped with a Certified Advanced 208-Complaint (CAC) frontal air bag system that consisted of dual stage driver and passenger air bags, seat track positioning sensors, an occupant classification weight sensor for the front right seat, retractor pretensioners, and safety belt buckle switch sensors. A CAC vehicle is certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208.

The driver's frontal air bag was conventionally mounted within the center of the three-spoke steering wheel rim. The front right air bag was a top mount design incorporated into the right instrument panel. Neither of the frontal air bags deployed during the crash.

#### ***Side Impact Inflatable Occupant Protection System***

##### ***2005 Nissan Maxima 3.5 SL***

The Nissan was equipped with front seat back mounted side impact air bags and roof rail mounted side impact curtain air bags. The right seat back mounted air bag and the right curtain air bag deployed during the crash (**Figure 11**).



**Figure 11. Deployed right side impact air bag system.**

The right curtain air bag deployed from the roof rail. The air bag membrane measured 164 cm (64.6") in length. At the front right seating position, the membrane measured 38 cm (15") in height extending 4 cm (1.6") below the top of the beltline. The height of the curtain air bag membrane at the right rear position was 38 cm (15") and extended 6 cm (2.4") below the beltline. The height of the curtain air bag membrane provided head protection from the roof rail to belt line of the vehicle.

The curtain air bag was equipped with a single tether at the A-pillar, which measured 60 cm (23.6") in length. Longitudinally, the coverage area of this curtain air bag did not span across the full length of the right front glazing. A triangular shaped gap was present which began at the A-pillar and extended 47 cm (18.5") rearward. In height, the gap measured 37 cm (14.6").

The rear aspect of the curtain air bag contained a non-inflatable section. This section was rectangular in shape and measured 48 cm (18.9") in length and 30 cm (11.8") in height. This non-inflatable section was located 36 cm (14.2") forward of the C-pillar and extended forward 84 cm (33") of the referenced point. The curtain air bag was free of damage and occupant contact points.

The right seat back mounted side impact air bag was concealed within the outboard aspect of the seat back. The air bag deployed through a 50 cm (19.7”) tear seam at the forward aspect of the seat back. The air bag membrane measured 54 cm (21.2”) in height and 30 cm (11.8”) in width and was comprised of two panels sewn together at the forward edge. The air bag membrane extended vertically beyond the curtain air bag 12 cm (4.7”). There was no damage or occupant contact points to the seat back mounted side air bag. **Figure 12** depicts the inboard aspect of the right seat back mounted side impact air bag,



**Figure 12. Right seat back mounted side impact air bag.**

### ***Driver Demographics***

Age/Sex: 44-year-old/Male  
 Height: 168 cm (66 in)  
 Weight: 73 kg (160 lb)  
 Seat Track Position: Rear track position  
 Safety Belt Usage: 3-point manual lap and shoulder safety belt  
 Usage Source: SCI vehicle inspection  
 Egress from Vehicle: Self extricated  
 Mode of Transport from Scene: None  
 Type of Medical Treatment: None

### ***Driver Injuries***

<b><i>Injury</i></b>	<b><i>Injury Severity (AIS 90/ Update 98)</i></b>	<b><i>Injury Source</i></b>
Not injured	N/A	N/A

*Source: Driver interview*

### ***Driver Kinematics***

The 44-year-old male driver of the Nissan was seated in a rear track position in a slightly reclined posture. He was restrained by the manual lap and shoulder safety belt system. At impact, the safety belt retractor locked. The driver responded to the 3 o’clock direction of force by initiating a right trajectory. His pelvis loaded the lap portion of the safety belt and the driver’s right hip probably loaded the center console. The use and loading of the safety belt maintained the driver within the front left occupant space and mitigated his potential injury. He was not injured in the crash.

The driver indicated in his interview that as the crash occurred he reached over and pulled the front right passenger away from the right door. This action resulted in possible occupant to occupant contact between the driver’s hand/forearm and the passenger’s

head. The passenger reported that she sustained a frontal scalp contusion located just beyond her hair line. The driver was not injured by this interaction.

***Front Right Passenger Demographics***

Age/Sex: 33-year-old/Female  
 Height: 152 cm (60 in)  
 Weight: 88 kg (195 lb)  
 Seat Position: Rear track position  
 Safety Belt Usage: 3-point manual lap and shoulder safety belt  
 Usage Source: SCI vehicle inspection  
 Egress from Vehicle: Self extricated  
 Mode of Transport from Scene: Self transported one day post-crash  
 Type of Medical Treatment: Treated and released

***Front Right Passenger Injuries***

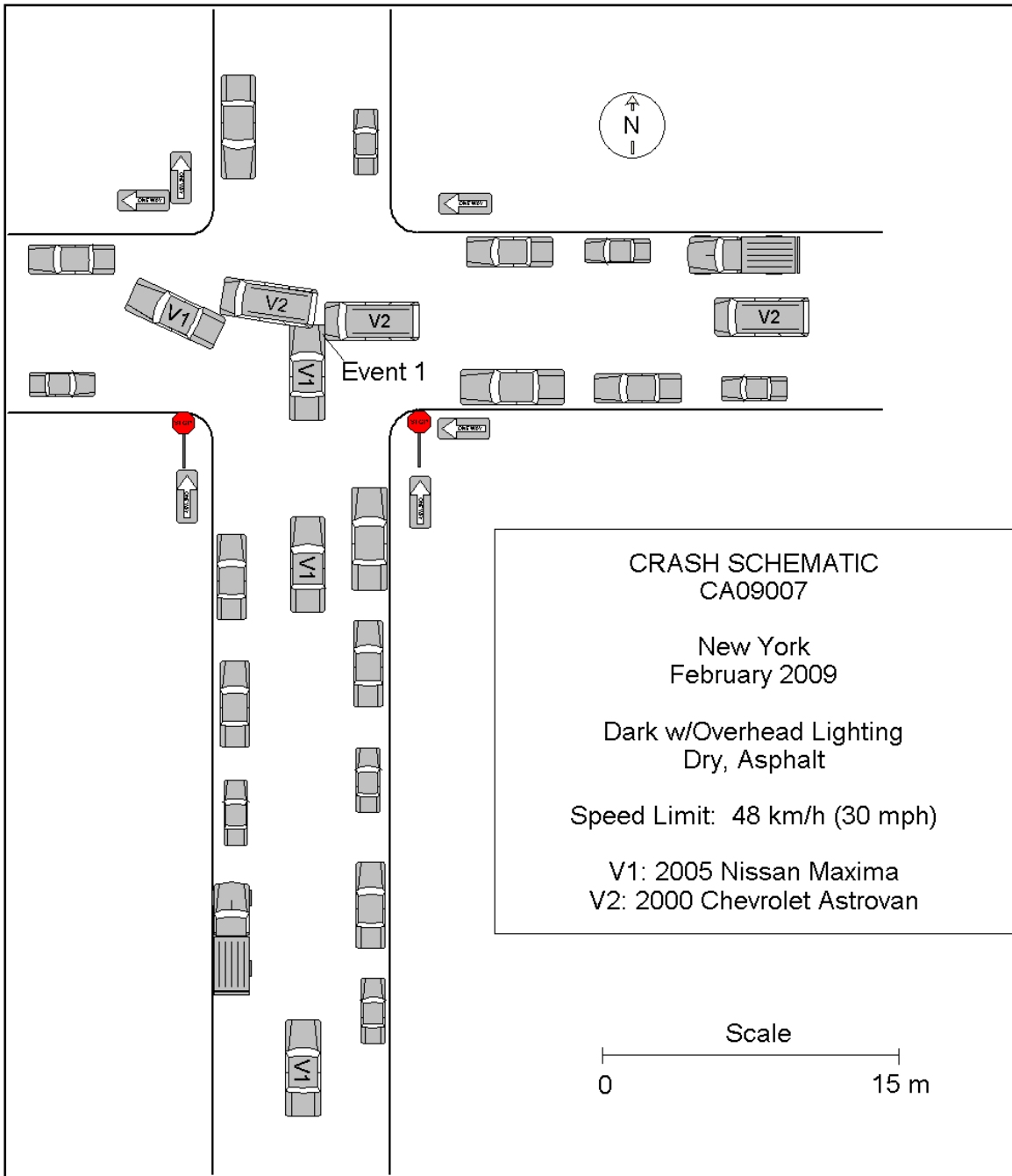
<b><i>Injury</i></b>	<b><i>Injury Severity (AIS 90/ Update 98)</i></b>	<b><i>Injury Source</i></b>
Multiple right knee and thigh contusions	Minor (890402.1,1)	Door panel – lower forward quadrant
Frontal scalp contusion, located beyond the hair line (sourced by interview)	Minor (190402.1,5)	Occupant to occupant, possible
Lower right back pain	N/A	Crash force

*Source: Hospital Discharge Summary and interview.*

***Front Right Passenger Injuries Kinematics***

The 33-year-old female was seated in a rear track position in a slightly reclined posture and was restrained by the manual safety belt. At impact, the safety belt retractor locked and the right seat back and curtain air bags deployed. The passenger initiated a lateral trajectory in response to the 3 o'clock direction of the impact. The passenger's pelvis loaded the lap portion of the safety belt and her torso was displaced laterally under the shoulder webbing. The passenger's right flank loaded the deployed seat back mounted air bag and the aft aspect of the door panel. Her head contacted the deployed curtain air bag. The passenger's right lower extremity contacted the lower forward quadrant of the door panel resulting in contusions to the right knee and thigh.

The passenger rebounded from the right side contacts back to the left. During the later stages of the crash, the driver indicated that he reached over and attempted to pull the passenger away from the door panel. During this interaction, the passenger possibly sustained the frontal scalp contusion as a result of contact with the driver's hand/forearm. Other possible sources for this injury were considered; however, given the type of injury and its location coupled with the protection offered by the available restraints (safety belt and deployed air bags) the occupant to occupant interaction was viewed as the most likely injury source.



**Figure 13: Scene Schematic**