



INDIANA UNIVERSITY

TRANSPORTATION RESEARCH CENTER

School of Public and Environmental Affairs
222 West Second Street
Bloomington, Indiana 47403-1501
(812) 855-3908 Fax: (812) 855-3537

ON-SITE CERTIFIED ADVANCED 208- COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-04-007
LOCATION - Texas
VEHICLE - 2004 FORD F150 PICKUP TRUCK
CRASH DATE - February 2004

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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 be 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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16. <i>Abstract</i> This report covers an on-site investigation of an air bag deployment crash that involved a 2004 F150 pickup truck (case vehicle), a 1994 Nissan Pathfinder (1 st other vehicle), a 1998 Nissan Frontier (2 nd other vehicle), a 1998 Toyota Sienna LE (3 rd other vehicle) and a 1992 Cadillac DeVille (4 th other vehicle), which were involved in an intersection collision. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features, including certified advanced 208-compliant air bags, and the case vehicle's driver (27 year-old, male) and front right passenger (26 year-old female) sustained police-reported "B" (non-incapacitating-evident) injuries as a result of the crash. The case vehicle was traveling northeast in the inside through lane of a multi-lane divided city street approaching a four-leg intersection. The Nissan Pathfinder was traveling northwest in the outside through lane approaching the same intersection. The Nissan Frontier, Toyota and Cadillac were southwest bound, stopped at the traffic signal. The case vehicle and the Pathfinder entered the intersection, and the front of the Pathfinder impacted the right front of the case vehicle causing the case vehicle's driver and front right passenger air bags to deploy. The case vehicle rotated counterclockwise, the Pathfinder rotated clockwise, and the right rear side of the case vehicle and left rear corner of the Pathfinder impacted. Subsequent to this impact the Pathfinder rolled over onto its left side, and the case vehicle traveled north diagonally across the intersection and its front impacted the front of the stopped Frontier driving it backward into the stopped Cadillac. The front left of the case vehicle then impacted the left side of the Toyota. The case vehicle came to rest facing northeast with its front against the front of the Frontier. The Pathfinder came to rest on its wheels facing southeast. The Frontier, Toyota, and Cadillac all came to rest in their lanes of travel facing southwest. The case vehicle's driver and back right passenger were restrained, the front right passenger was not restrained. The driver was not injured in the crash. The front right passenger sustained a contusion on her forehead due to impact with her air bag. The back right passenger sustained a broken right clavicle due to loading her safety belt and a contusion to the right side of her face from impact with the right rear door. The driver was not transported to a medical facility. The front right passenger and back right passenger were transported to a medical facility and were treated and released.					
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This on-site investigation was brought to NHTSA's attention on March 5, 2004 by NASS GES sampling activities. This crash involved five vehicles: a 2004 Ford F150 (case vehicle), a 1994 Nissan Pathfinder (1st other vehicle), a 1998 Nissan Frontier (2nd other vehicle) a 1998 Toyota Sienna LE (3rd other vehicle) and a 1992 Cadillac DeVille (4th other vehicle). The crash occurred in February 2004, at 9:53 a.m. in Texas and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features, including certified advanced 208-compliant air bags, and the case vehicle's driver [27-year-old, White (Hispanic) male] and front right passenger [26 -year-old, White (Hispanic) female] sustained police-reported "B" (non-incapacitating-evident) injuries as a result of the crash. This contractor inspected the case vehicle, the Nissan Pathfinder, the Nissan Frontier and the crash site on 11-12, March 2004. The driver was interviewed, through a translator, on May 5, 2004. This report is based on the police crash report, scene and vehicle inspections, a partial interview with the case vehicle's driver, occupant kinematic principles, front right passenger's medical records and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling northeast in the inside through lane of a multi-lane divided city street approaching a four-leg intersection. The Nissan Pathfinder was traveling northwest in the outside through lane of a multi-lane, divided city street approaching the same intersection. The Nissan Frontier, Toyota and Cadillac were southwest bound, stopped at the traffic signal. The Frontier and Cadillac were in the inside through lane. The Frontier was in front of the Cadillac, and the Toyota was in the center through lane. The case vehicle and the Pathfinder entered the intersection. Neither driver made any known pre-crash avoidance actions. The front of the Pathfinder impacted the right front of the case vehicle (event 1) causing the case vehicle's driver and front right passenger air bags to deploy. The case vehicle rotated counterclockwise, the Pathfinder rotated clockwise, and the right rear side of the case vehicle and left rear corner of the Pathfinder impacted (event 2). The Pathfinder continued to rotate clockwise and rolled over onto its left side (event 3). The case vehicle traveled north diagonally across the intersection and its front impacted the front of the stopped Frontier (event 4). The impact drove the Frontier backward and its back end impacted the front of the stopped Cadillac (event 5). The front left of the case vehicle then impacted the left side of the Toyota (event 6). The case vehicle came to rest facing northeast with its front against the front of the Frontier. The Pathfinder came to rest (based on the police crash schematic) on its wheels facing southeast. The Frontier, Toyota, and Cadillac all came to rest in their lanes of travel facing southwest. At the time of the crash the light condition was daylight, the weather was clear and the roadway pavement was level, dry concrete.

The CDCs for the case vehicle were: **01-RYEW-2 (30 degrees)** for the right front impact with the front of the Pathfinder (event 1), **03-RBEW-2 (90 degrees)** for the side-slap impact with the left rear side of the Pathfinder (event 2), **12-FREW-1 (0 degrees)** for the front impact with the front of the Frontier (event 4) and **12-FLEE-1 (0 degrees)** for the front impact to the left side of the Toyota (event 6). The WinSMASH reconstruction program, missing vehicle, algorithm, was used to reconstruct the case vehicle's highest severity impact (i.e., event one). The Total,

Longitudinal, and Lateral Delta Vs are, respectively: 39.0 km.p.h. (24.2 m.p.h.), -33.8 km.p.h. (-21.0 m.p.h.), and -19.5 km.p.h. (-12.1 m.p.h.). No Delta V information was available from the case vehicle's Event Data Recorder. The case vehicle was not supported by the Vetronix Crash Data Retrieval system at the time this investigation was undertaken.

The CDCs for the Pathfinder were: **70-FYEW-2 (300 degrees)** for the front impact with the case vehicle (event 1), **09-LBAW-2 (270 degrees)** for the side slap impact with the case vehicle (event 2), and **00-LDAO-2** for the rollover (event 3). The WinSMASH reconstruction program, missing vehicle algorithm, was used to reconstruct the Delta Vs for the Pathfinder's front impact with the case vehicle. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 50.0 km.p.h. (31.1 m.p.h.), -25.0 km.p.h. (-15.5 m.p.h.), and 43.3 km.p.h. (26.9 m.p.h.).

The CDCs for the Frontier were determined to be: **11-FYEW-1 (330 degrees)** for the impact with the case vehicle (event 4) and **06-BDEW-1 (170 degrees)** for the impact with the front of the Cadillac (event 5). The WinSMASH reconstruction program, missing vehicle algorithm, was used to calculate the Delta Vs for the Frontier's front impact with the case vehicle. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 30.0 km.p.h. (18.6 m.p.h.), -26.0 km.p.h. (-16.2 m.p.h.), and 15.0 km.p.h. (9.3 m.p.h.).

The CDCs for the Toyota and the Cadillac are not known. Neither of these vehicles were inspected.

Just prior to the crash the case vehicle's driver, front right passenger and back right passenger were most likely seated in an upright position. The driver and front right passenger's seats were adjusted to between the middle and forward most track position, and their seat backs were slightly reclined. The steering column was adjusted to its center position, and the adjustable pedals were adjusted to their full rear position (i.e., closest to the driver's seat). The driver and the back right passenger were restrained by their manual, three-point, lap-and-shoulder safety belts. The front right passenger was not restrained. Upon impact with the Pathfinder, all three occupants continued forward and moved to the right along a path opposite the case vehicle's 30 degree direction of principal force as the case vehicle decelerated longitudinally and accelerated latterly to the left. The driver loaded his safety belt and his face and upper chest impacted his deployed air bag. He was uninjured, but complained of lower back pain. The front right passenger's face and chest impacted her deployed air bag causing a contusion to her forehead. She also complained of lower back pain. The back right passenger loaded her safety belt system causing a fracture to her right clavicle. She also moved to the right during the secondary side-slap impact with the Pathfinder, and impacted the right side of her face on the right rear door causing a contusion to her face and a bloody nose. The driver and back right passengers again loaded their safety belts during the subsequent impacts with the Frontier and the Toyota, and they remained restrained in their seat positions. The front right passenger most likely impacted the instrument panel and her now deflated air bag during the impact with the Frontier. It is not known if she remained in her seat position. The driver's use of his safety belt system and the deployment of his air bag mitigated his interaction with the interior frontal components and prevented him from being injured in the crash. The deployment of the front right passenger's air bag mitigated the front right passenger's interaction with the instrument panel and most likely prevented her from

sustaining more serious injuries in the initial impact. The back right passenger's use of her safety belt restrained her in her seat position and prevented her from impacting the back of the front right passenger's seat.

The driver, front right passenger and back right passenger all sustained police reported "B" (non-incapacitating-evident) injuries. The driver was not transported from the scene to a medical facility. He did not seek any subsequent medical treatment, but lost one work day a result of the crash. The front right passenger and back right passengers were transported from the scene to a medical facility and were treated and released from the emergency room.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle, Nissan Frontier, Toyota, and Cadillac were traveling was a seven-lane, divided, city street, traversing in a northeast and southwest direction. The case vehicle was traveling northeast approaching a four-leg intersection and the other vehicles were stopped at the traffic signal heading southwest at the same intersection. The northeast bound roadway had three through lanes and a left turn lane. The southwest bound roadway had three through lanes and a right and left turn lane. The travel lanes for each roadway were approximately 3.3 meters (10.8 feet) in width, and the roadways were divided by a raised, curbed, concrete median 1.2 meters (3.9 feet) in width. The trafficway on which the Nissan Pathfinder was traveling was a seven lane, divided, city street traversing in a northwest and southeast direction. The Pathfinder was traveling northwest approaching the intersection. The northwest bound roadway had three through lanes and a left turn lane. The southeast bound side of the roadway had three through lanes. Each travel lane was approximately 3.3 meters (10.8) in width and the roadway was divided by a raised, curbed concrete median 1.4 meters (4.6 feet) in width. Pavement markings consisted of broken white lane lines with "Bots Dots" and white crosswalk delineations. The speed limit for all vehicles was 64 km.p.h. (40 m.p.h.), and the intersection was controlled by multiple, three-phase traffic signals. At the time of the crash the light condition was daylight, the weather was clear, and the roadway pavement was dry concrete with an estimated coefficient of friction of 0.65. Traffic density at the time of the crash is not known. The crash location was urban commercial. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was traveling northeast in the inside through lane (**Figure 1**), and the driver was intending to continue straight ahead. The Nissan Pathfinder was traveling northwest in the outside through lane, and the driver was intending to proceed straight through the intersection (**Figure 2** below). The Nissan Frontier, Toyota, and the Cadillac were all southwest bound and stopped at the traffic signal (**Figure 3** below). The Frontier and Cadillac were in the inside through lane, and the Frontier was in front of the Cadillac. The Toyota was in the



Figure 1: Approach of case vehicle northeast bound to the intersection in the inside through lane.

center through lane. The case vehicle's driver made no known avoidance maneuvers prior to the crash. The crash occurred in the intersection of the two trafficways.



Figure 2: Approach of the Nissan Pathfinder northwestbound to the intersection.



Figure 3: View southwest to the intersection. The Cadillac, Frontier and the Toyota were stopped in the two center through lanes.



Figure 4: Insurance photo showing right front damage to the case vehicle from the initial impact with the Pathfinder.



Figure 5: Front damage to the Pathfinder from the initial impact with case vehicle.

Crash: The right front (**Figure 4**) of the case vehicle was impacted by the front (**Figure 5**) of the Pathfinder (event 1), causing the case vehicle's driver and front right passenger air bags to deploy. As a result of the impact, the case vehicle rotated counterclockwise and the Pathfinder rotated clockwise. The right rear side (**Figure 6**) of the case vehicle and the left rear corner (**Figure 7** below) of the Pathfinder then impacted (event 2). Following the side-slap impact with the case vehicle, the Pathfinder continued to rotate clockwise and rolled over onto its left side (event 3). The case vehicle traveled diagonally across the intersection, entered the southwest bound leg of the intersection, and its front (**Figure 4**) impacted the front (**Figure 8** below) of the stopped



Figure 6: Damage to the right rear side of the case vehicle from the side-slap impact with Pathfinder.

Nissan Frontier (event 4). The Frontier was forced backwards by the impact and its back end (**Figure 9**) impacted the front of the stopped Cadillac (event 5). The front left of the case vehicle then impacted the left side of the Toyota (event 6).



Figure 7: Damage to the left rear corner of Pathfinder from the side-slap impact with the case vehicle, scratches forward of the left rear corner are from the rollover.



Figure 8: Damage to front of Frontier from impact with front of case vehicle.

Post-Crash: The case vehicle came to rest beside the Toyota facing northeast with its front against the Frontier. The Pathfinder came to final rest (based on the police schematic) on its wheels facing southeast indicating it rolled back onto its wheels after rolling onto its left side. The Frontier, Toyota and the Cadillac all came to final rest in their lanes of travel facing southwest.



Figure 9: Overview of damage to back of Frontier from impact with the front of the Cadillac

CASE VEHICLE

The 2004 Ford F150 XLT, was a four wheel drive (4x4), four-door Supercrew cab pickup truck (VIN: 1FTPW14524K-----) equipped with a 5.4L, V8 engine; four speed automatic transmission with overdrive and four-wheel anti-lock brakes. The case vehicle was equipped with dual-stage driver and front right passenger air bags, driver and front right passenger safety belt buckle switch sensors, front right seat passenger weight sensor, driver and front right passenger safety belt buckle-mounted pretensioners with load limiting retractors and power assisted adjustable pedals (**Figure 10**). In addition, the back seat was equipped with a LATCH system for securing child safety seats. The case vehicle's wheelbase was 353 centimeters (138.8 inches), and the mileage

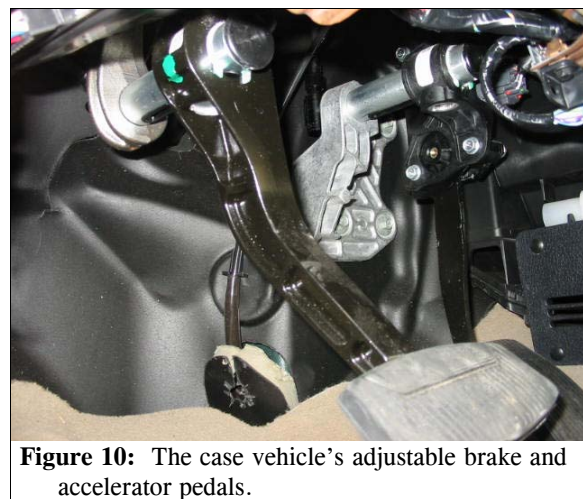


Figure 10: The case vehicle's adjustable brake and accelerator pedals.

at the time of the inspection could not be determined because the case vehicle was equipped with an electronic odometer.

The various sensors in the case vehicle’s advanced occupant restraint system analyze the combination of the predicted crash severity, proximity of the driver seat to the steering wheel, and driver and front right passenger safety belt usage to determine the front air bag inflation level appropriate for the severity of the crash. For the front right seat position, an occupant weight sensor in the seat cushion determines if an occupant is on the seat and enables or suppresses deployment of the air bag based on the amount of weight on the seat.

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle’s initial contact with the Nissan Pathfinder involved the right front bumper corner, right fender, right front wheel and forward edge of the right front door. Due to the removal of the right fender, right front wheel and front bumper, damage measurements could not be taken to the front and right fender area. The secondary (side-slap) impact to the case vehicle involved the right rear door, right side of the truck bed, and the right rear wheel. Direct damage from this impact began 104 centimeters (40.9 inches) forward of the right rear axle and extended 224 centimeters (88.2 inches) along the right side of the truck bed. Residual maximum crush was 17 centimeters (6.7 inches) occurring at C₂. The table below shows the case vehicle’s crush profile for the secondary side-slap impact.

Units	Event	Direct Damage		Field L	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	2	224	17	224	17	17	11	5	0	0	-160	-160
in		88.2	6.7	88.2	6.7	6.7	4.3	2.0	0.0	0.0	-63.0	-63.0

The case vehicle’s right side wheelbase was shortened approximately 2 centimeters (0.8 inch) while the left side wheelbase was unchanged. The case vehicle sustained direct damage to the front right bumper corner, right fender, right front wheel, forward portion of the right front door, rear portion of the right rear door, right side of the truck bed, right rear wheel and the right rear tail lamp/turn signal assembly. A semi-circular impression from the Pathfinder’s left front wheel could be seen at the forward edge of the right front door. In addition, the top of the right front wheel was tilted inward and a piece off the right rear wheel rim was broken off due to contact with the left rear wheel of the Pathfinder. There was induced damage to the hood, front bumper, left fender, and the truck bed, and the entire front end of the vehicle was displaced to the left a small amount. No other obvious induced damage or remote buckling was noted to the remainder of the case vehicle’s exterior.

The case vehicle’s recommended tire size was: LT275/65R18, and the vehicle was equipped with tires of this size. The case vehicle’s tire data are shown in the table below.

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kpa	psi	kpa	psi	milli-meters	32 nd of an inch			
LF	228	33	276	40	10	12	None	No	No
RF	Unk	Unk	276	40	Unk	Unk	Tilted inward (from insurance photo)	No	No
LR	221	32	276	40	10	12	None	No	No
RR	221	32	276	40	11	14	Piece of rim broken off	No	No

Vehicle Interior: Inspection of the case vehicle's interior revealed a possible occupant contact scuff on the deployed front right air bag. There was no other evidence of occupant contact on any of the interior surfaces or components. Finally, there was no intrusion to the case vehicle's interior, no evidence of compression to the energy absorbing steering column, and no deformation to the steering wheel rim (**Figure 11**).

Damage Classification: The damaged right fender and front bumper had been removed from the case vehicle. However, based on the vehicle inspection and a photograph provided by the insurance adjuster, the CDCs for the case vehicle were determined to be: **01-RYEW-2 (30 degrees)** for the right front impact with the front of the Pathfinder (event 1), **03-RBEW-2 (90 degrees)** for the side-slap impact with the left side of the Pathfinder (event 2), **12-FREW-1 (0 degrees)** for the front impact with the front of the Frontier (event 4) and **12-FLEE-1 (0 degrees)** for the front impact to the left side of the Toyota (event 6). The WinSMASH reconstruction program, missing vehicle algorithm, was used to reconstruct the case vehicle's highest severity impact (i.e., event 1). The Total, Longitudinal, and Lateral Delta Vs are, respectively: 39.0 km.p.h. (24.2 m.p.h.), -33.8 km.p.h. (-21.0 m.p.h.), and -19.5 km.p.h. (-12.1 m.p.h.). The case vehicle was towed due to damage.



Figure 11: Left side view of case vehicle's steering column and steering wheel showing lack of deformation

The WinSMASH reconstruction program, missing vehicle algorithm, was used to reconstruct the case vehicle's second highest severity impact (i.e., event 4), the case vehicle's front impact with the front of the Frontier). The Total, Longitudinal, and Lateral Delta Vs are, respectively: 17.0 km.p.h. (10.6 m.p.h.), -17.0 km.p.h. (-10.6 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.).

The WinSMASH reconstruction program, CDC only algorithm, was used to reconstruct the case vehicle's third highest severity impact (i.e., event 2, the side-slap impact between the right rear side of the case vehicle and the left rear side of the Pathfinder). The Total, Longitudinal, and Lateral Delta Vs are, respectively: 7.0 km.p.h. (4.4 m.p.h.), 0.0 km.p.h. (0.0 m.p.h.), and 7.0 km.p.h. (4.4 m.p.h.). The results appear to be borderline, low.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with certified advanced 208-compliant air bags at the driver and front right passenger positions. The driver and front right passenger's air bags both deployed as a result of the case vehicle's impact with the Pathfinder.

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points. There was no evidence of damage during the deployment to the air bag fabric or the cover flaps. The cover flaps (**Figure 12**) were approximately rectangular in shape. The upper cover flap had a rounded contour at the tear seam that accommodated the Ford emblem, which mated with a concave contour on the lower cover flap. The upper cover flap was 11 centimeters (4.3 inches) in width and 7 centimeters (2.8 inches) in height. The lower cover flap was 11 centimeters (4.3 inches) in width and 10 centimeters (3.9 inches) in height. The driver's air bag was designed with two tethers, each approximately 14 centimeters (5.5 inches) in width, and had two vent ports (**Figure 13**), each approximately 2.5 centimeters (1.0 inches) in diameter, located at the 10:30 and 1:30 o'clock positions. The deployed driver's air bag (**Figure 14** below) was round with a diameter of approximately 60 centimeters (23.6 inches). An inspection of the driver's air bag fabric revealed no evidence of occupant contact to the air bag. The distance between the mid-center of the driver's seat back, as positioned at the time of the vehicle inspection (i.e., between middle and forward most track position), and the front surface of the air bag fabric at approximate full excursion was 26 centimeters (10.2 inches).

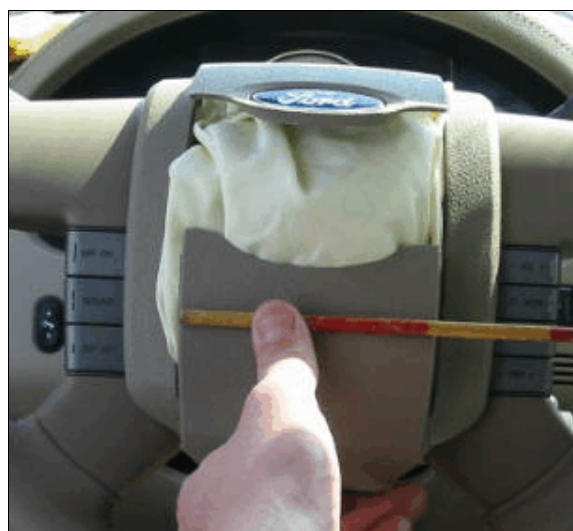


Figure 12: Driver's air bag module cover flaps



Figure 13: Overview of case vehicle driver's air bag vent ports (arrows)



Figure 14: The case vehicle's deployed driver air bag.

The front right passenger's air bag was located in the top of the instrument panel. It was designed with two tethers, each 20 centimeters (7.9 inches) in width. The two tethers were sewn together at their anchor point and then each tether was sewn separately to the stitching of the face of the air bag. The front right air bag had two vent ports, each approximately 5.5 centimeters (2.2 inches) in diameter, located at the 9:30 and 2:30 o'clock positions. The deployed air bag (**Figure 15**) was rectangular with a height of approximately 62 centimeters (24.4 inches) and a width of approximately 57 centimeters (22.4 inches). The single air bag module cover flap was constructed of metal, covered with vinyl and was rectangular in shape. It was approximately 41.5 centimeters (16.3) in width and about 25 centimeters (9.8 inches) in height. Upon deployment of the air bag, the module cover flap impacted and fractured the windshield in a linear pattern corresponding to the width of the air bag module cover flap (**Figure 16**). Inspection of the front right passenger's air bag fabric revealed some possible deployment scuffs and a possible occupant contact or fluid spill. No other occupant contact evidence was apparent on the air bag fabric. The distance between the mid-center of the front right passenger's seat back, as positioned at the time of the vehicle inspection (i.e., between middle and forward most track position), and the front surface of the air bag fabric at approximate full excursion was 37 centimeters (14.6 inches).



Figure 15: Case vehicle's deployed front right passenger air bag, yellow tape shows area of possible deployment scuffs and possible occupant contact.

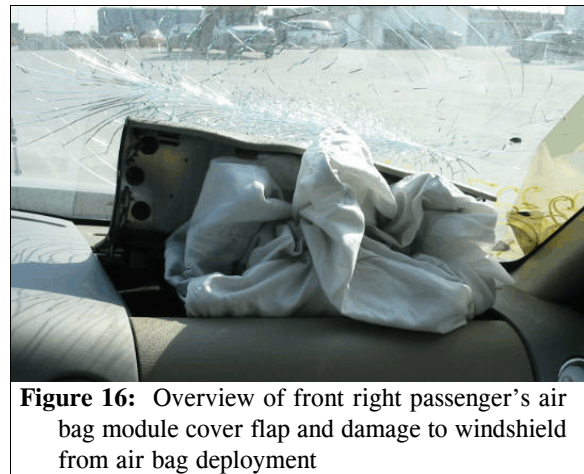


Figure 16: Overview of front right passenger's air bag module cover flap and damage to windshield from air bag deployment

Although the case vehicle was equipped with dual stage driver and front right passenger air bags, no deployment information could be obtained from the case vehicle's Event Data Recorder because the case vehicle was not supported by the Vetronix, Crash Data Retrieval system at the time this investigation was undertaken. Therefore, information regarding the timing of pretensioner deployment, and first stage and second stage air bag deployment are not known.

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash, the case vehicle's driver [27-year-old, White (Hispanic) male, 173 centimeters and 86 kilograms (68 inches, 190 pounds)] was most likely seated in a nominal upright driving position. The position of his hands and arms is unknown. The driver's seat was positioned between its middle and forward most track position, his seat back was slightly reclined, the foot pedals were adjusted to their full rear position (i.e., closest to the driver's seat), and the tilt steering column was adjusted to its center position. It is not known if the driver was wearing glasses at the time of the crash.



Figure 17: Case vehicle driver's seat belt pretensioner, buckle and buckle stalk.

Based on this contractor's vehicle inspection, the case vehicle's driver was restrained by the manual, three-point, lap-and-shoulder safety belt system. The belt system was equipped with a buckle-mounted, pyrotechnic actuated, pretensioner and load-limiting retractor. The inspection of the driver's safety belt buckle assembly showed the pretensioner had activated during the crash as indicated by the compression of the ribbed cover on the stalk of the buckle (**Figure 17**). Inspection of the safety belt webbing revealed a small area of dark transfer that corresponded to the location of the "D"-ring when the safety belt was placed in its approximate in-use configuration (**Figure 18**), and a corresponding small abrasion was found on the "D"-ring.

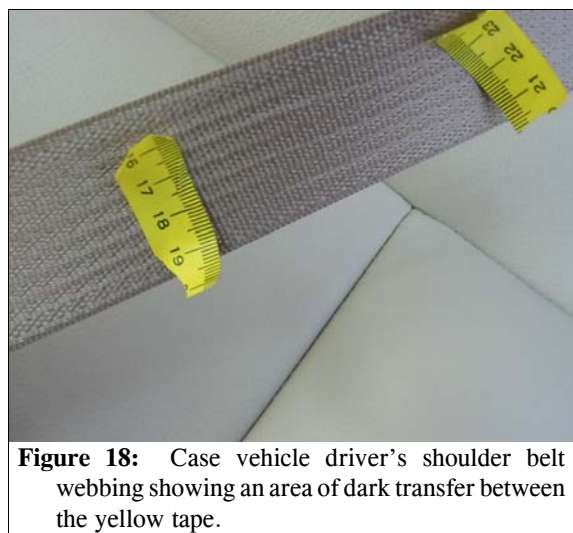


Figure 18: Case vehicle driver's shoulder belt webbing showing an area of dark transfer between the yellow tape.

It is unlikely the case vehicle's driver had sufficient time to take any substantial pre-crash steering or braking avoidance maneuvers that would have altered the driver's or passenger's pre-crash seating position. Two witness statements contained in the police crash report indicate the case vehicle was traveling at a high rate of speed past two lanes of stopped traffic on the right side of the case vehicle. The stopped traffic would constitute a vision obstruction for the case vehicle's

driver of northwest bound traffic up to a point very near the mouth of the intersection. Given these conditions and the distance across the intersection to the impact area, it is unlikely the case vehicle's driver had sufficient time to perceive and react to the impending crash and initiate any significant braking or steering input. In addition, the damage to the case vehicle and Pathfinder indicate a right angle impact, which supports none or very little pre-crash avoidance steering on the part of either driver.

The case vehicle's impact with the Nissan Pathfinder caused the driver to continue forward and move to the right along a path opposite the case vehicle's 30 degree direction of principal force as the case vehicle decelerated longitudinally and accelerated latterly to the left. The driver loaded his lap-and-shoulder belt, and his face and chest impacted his deployed air bag. The driver's upper body then continued to move to the right along a path opposite the case vehicle's 90 degree direction of principal force during the secondary side-slap impact between the case vehicle's right rear side and the Pathfinder's left rear corner.



Figure 19: Overview of the case vehicle's steering wheel and left instrument panel.

The driver remained restrained in his seat position as the case vehicle crossed the intersection approaching impact with the Frontier. The case vehicle's front impact with the Frontier caused the driver to move forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated from the impact, and he again loaded his safety belt. The driver again moved forward and loaded his safety belt as the case vehicle's front left corner impacted the Toyota. The driver remained restrained in his seat as the case vehicle came to final rest against the Toyota and the Frontier. **Figure 19** shows an overview of the driver's seating position, steering wheel and left instrument panel.

CASE VEHICLE DRIVER INJURIES

The case vehicle's driver sustained a police reported "B" (non-incapacitating-evident) injury and was not transported from the crash site to a medical facility. He did not seek any subsequent medical treatment, but lost one work day as a result of the crash. The driver complained of lower back pain as a result of the crash. This was most likely due to the force applied to his body as he loaded his safety belt and air bag during the crash.

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash, the front right passenger [26-year-old, White (Hispanic) female; 163 centimeters and 73 kilograms (64 inches, 160 pounds)] was most likely seated in an upright position with her feet on the floor; however, the positions of her hands and arms is not known. Her seat was positioned between the middle and forward most track position, and her seat back was slightly reclined. It is not known if the front right passenger was wearing glasses at the time of the crash.

Based on this contractor's vehicle inspection and interview information, the case vehicle's front right passenger was not restrained by her manual, three-point, lap-and-shoulder safety belt system. The belt system was equipped with a buckle mounted, pyrotechnic actuated, pretensioner and load-limiting retractor. The pretensioner activated as a result of the crash. The inspection of the front right passenger's safety belt webbing, "D"-ring, and latch plate revealed no evidence of loading. In addition there was no mention by the interviewee of belt pattern bruising to the front right passenger's torso.

The case vehicle's impact with the Nissan Pathfinder caused the front right passenger to continue forward and move to the right along a path opposite the case vehicle's 30 degree direction of principal force as the case vehicle decelerated longitudinally and accelerated laterally to the left. She impacted her deployed air bag causing a contusion to her forehead and abdomen. The front right passenger rebounded off her air bag and continued to move to the right along a path opposite the case vehicle's 90 degree direction of principal force during the secondary side-slap impact between the case vehicle's right rear side and the Pathfinder's left rear corner.



Figure 20: Overview of the case vehicle's front right instrument panel and front right air bag location.

The front right passenger most likely remained in her seat as the case vehicle crossed the intersection approaching impact with the Frontier. The case vehicle's front impact with the Frontier caused the front right passenger to continue forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated from the impact, and she most likely impacted her now deflated air bag and the underlying instrument panel. The front right passenger again moved forward as the case vehicle's front left corner impacted the Toyota. It is not known if the front right passenger remained in her seat following these two impacts, or how she exited the case vehicle. **Figure 20** shows an overview of the front right seat position and instrument panel.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right passenger sustained a police reported "B" (non-incapacitating-evident) injury and was transported by ambulance from the crash scene to a local hospital and was treated and released. The table below shows the front right passenger's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion {bruise}, small, on forehead, not further specified	minor 290402.1,7	Air bag, front right passenger's	Possible	Interviewee (driver)

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
	Pain lower back, not further specified	Not coded			Interviewee (driver)
2	Contusion abdomen, inferior-based on medical sketch	minor 590402.1,8	Air bag, front right passenger's	Probable	Emergency room records
3	Contusion right hip on lateral surface, not further specified	minor 890402.1,1	Right side interior hardware and/or armrest	Probable	Emergency room records

CASE VEHICLE BACK RIGHT PASSENGER KINEMATICS

Immediately prior to the crash, the back right passenger [5-year-old, White (Hispanic) female; 104 centimeters and 27 kilograms (41 inches, 60 pounds)] was most likely seated in an upright position, however the positions of her hands, arms, feet, and legs are not known. Her seat track and seat back were not adjustable. **Figure 21** shows the back right seating position.

Based on this contractor's vehicle inspection and interviewee reported injury data, the case vehicle's back right passenger was restrained by her manual, three-point, lap-and-shoulder safety belt system. While inspection of the safety belt assembly revealed no evidence of loading on the belt webbing, latch plate, or the "D"-ring, there was also no indication of contact to the back of the front right passenger seat. The nature of this passenger's reported injuries, as discussed below, indicate she was restrained at the time of the crash.

The case vehicle's impact with the Nissan Pathfinder caused the back right passenger's safety belt to lock and she moved forward and to the right along a path opposite the case vehicle's 30 degree direction of principal force as the case vehicle decelerated longitudinally and accelerated laterally to the left. The passenger loaded her safety belt system causing a fracture of her right clavicle. She continued to move to the right along a path opposite the case vehicles 90 degree direction of principal force during the secondary side-slap impact between the case vehicle's right rear side and the Pathfinder's left rear corner. As a result of this impact, she contacted the right rear door with the right side of her face causing a contusion to her face as well as a bloody nose. The passenger remained restrained in her seat as the case vehicle crossed the intersections approaching impact with the Frontier. The case vehicle's front impact with the Frontier and left side of the Toyota caused the back right passenger to move forward opposite the case vehicle's 0 degree direction of principal force and she again loaded her

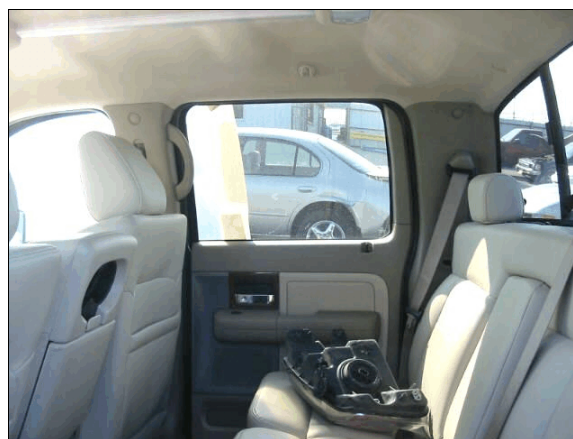


Figure 21: Overview of the back right seat position.

safety belt. She remained in her seat as the case vehicle came to final rest against the front of the Frontier and left side of the Toyota. **Figure 21** shows an overview of the back right passenger seat position.

CASE VEHICLE BACK RIGHT PASSENGER INJURIES

The back right passenger sustained a police reported “B” (non-incapacitating-evident) injury and was transported by ambulance from the crash scene to a local hospital and treated and released from the emergency room. It is not known if the back right passenger received any follow-up treatment for her injuries. The table below shows the back right passenger’s injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture right clavicle (collar bone), not further specified	moderate 752200.2,1	Torso portion of safety belt system	Probable	Interviewee (driver)
2	Contusion {bruise} right side of face, not further specified	minor 290402.1,1	Right side interior surface, excluding hardware and/or armrest	Probable	Interviewee (driver)

1ST OTHER VEHICLE

The 1999 Nissan Pathfinder was a rear wheel drive, five-door sport utility vehicle (VIN: JN8HD17S3RW-----) equipped with a 3.0L, V6 engine; three speed, automatic transmission and power assisted front disc brakes and rear drum anti-lock brakes. The Pathfinder was also equipped with driver and front right passenger air bags, which deployed as a result of this vehicle’s impact with the case vehicle. The Pathfinder’s wheelbase was 265 centimeters (104.3 inches). The vehicle’s mileage is not known because the interior was not inspected.

Exterior Damage: The Pathfinder’s initial impact with the case vehicle involved the front of the vehicle. The front bumper, left headlamp/turn signal assembly, left fender, hood and grille were directly contacted and crushed rearward and to the right. The direct damage began at the left bumper corner and extended 85 centimeters (33.5 inches) to the right. The maximum residual crush occurred at C₁ and was measured as 34 centimeters (13.4 inches). The secondary side-slap impact with the case vehicle involved the left rear corner and quarter panel of the Pathfinder. The left corner of the back bumper and the quarter panel were directly damaged and crushed inward. The maximum residual crush was estimated as 9 centimeters (3.5 inches), occurring at C₁. The rollover involved the left side of the Pathfinder. Direct damage involved the left “A”-pillar, left front door, left rear door and the quarter panel. Maximum crush due to the rollover consisted of surface scratches. The table below shows the crush profile for the Pathfinder’s front impact.

Units	Event	Direct Damage		Field L	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	85	25	144	34	25	31	24	8	10	-31	0
in		33.5	9.8	56.7	13.4	9.8	12.2	9.4	3.2	3.9	-12.2	0.0

The Pathfinder's left side and right side wheelbase was reduced 6 centimeters (2.4 inches). Induced damage involved the Pathfinder's hood, front bumper, both fenders, left side doors and left quarter panel.

The Pathfinder's recommended tire size was: P235/75R15. The Pathfinder was equipped with tires size P255/70R15 on the front and tires size P265/70R15 on the rear. The Pathfinder's tire data are shown in the table below.

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kpa	psi	kpa	psi	milli-meters	32 nd of an inch			
LF	159	23	179	26	4	5	Sidewall scraped	Yes	No
RF	138	20	179	26	2	2	None	No	No
LR	0	0	179	26	4	5	Side wall puncture	No	Yes
RR	200	29	179	26	3	4	None	No	No

Damage Classification: Based on the vehicle inspection, the CDCs for the Pathfinder were determined to be: **70-FYEW-2 (300 degrees)** for the front impact with the case vehicle (event 1), **09-LBAW-2 (270 degrees)** for the side slap impact with the case vehicle (event 2), and **00-LDAO-2** for the rollover (event 3). The WinSMASH reconstruction program, missing vehicle algorithm, was used to reconstruct the Delta Vs for the Pathfinder's front impact with the case vehicle. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 50.0 km.p.h. (31.1 m.p.h.), -25.0 km.p.h. (-15.5 m.p.h.), and 43.3 km.p.h. (26.9 m.p.h.). The Pathfinder was towed due to damage.

Pathfinder's Occupants: According to the police crash report, the Pathfinder's driver [22-year-old, White (unknown if Hispanic) male], front right passenger [47-year-old, (unknown race and ethnic origin) male], and back right passenger [38-year-old, (unknown race and ethnic origin) female] were restrained by their manual, three-point, lap-and-shoulder safety belt systems. All three occupants were transported by ambulance to the hospital. The driver and front right passenger sustained police-reported "B" (non-incapacitating-evident) injuries. The back right

passenger sustained a police-report “C” (possible) injury. The police crash report indicates that none of this vehicle’s occupants were ejected from the vehicle as a result of the crash and subsequent rollover.

2ND OTHER VEHICLE

The 1998 Nissan Frontier was a rear wheel drive , two-door pickup truck (VIN: 1N6DD21S0WC-----) equipped with a 2.4L, I4 engine; five speed, manual transmission and power assisted front disc and rear drum brakes. The Frontier was also equipped with driver and front right passenger air bags, which deployed as a result of this vehicle’s impact with the case vehicle. The Frontier’s wheelbase was 264 centimeters (103.9 inches). The vehicle’s mileage is not known because the interior was not inspected.

Exterior Damage: The Frontier’s impact with the case vehicle involved the front of the vehicle. The front bumper, left fender, left headlamp/turn signal assembly, hood and grille were directly contacted and crushed rearward. The direct damage began at the front left bumper corner and extended 83 centimeters (32.7 inches) to the right along the front of the Frontier. The residual maximum crush was measured as 22 centimeters (8.7 inches) occurring at C₁. The Frontier’s impact with the Cadillac involved the back of the vehicle. The back bumper was directly damaged and crushed forward, and there was minor direct damage to the tailgate. No damage measurements were taken for the rear bumper impact. The table below shows the Frontier’s front crush profile.

Units	Event	Direct Damage		Field L	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	83	22	158	22	20	19	14	8	14	-33	0
in		32.7	8.7	62.2	8.7	7.9	7.5	5.5	3.2	5.5	-13.0	0.0

The Frontier’s left side wheelbase was extended 3 centimeters (1.2 inches), while the right side wheelbase was reduced 1 centimeter (0.4 inch). Induced damage involved the Frontier’s hood, front bumper, grille, left fender and back bumper.

The Frontier’s recommended tire size was: P215/65R15, and the vehicle was equipped with tires of this size. The case vehicle’s tire data are shown in the table below.

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kpa	psi	kpa	psi	milli-meters	32 nd of an inch			
LF	228	33	179	26	6	8	None	Yes	No
RF	296	43	179	26	5	6	None	No	No
LR	165	24	241	35	4	5	None	No	No
RR	138	20	241	35	6	8	None	No	No

Damage Classification: Based on the vehicle inspection, the CDCs for the Frontier were determined to be: **11-FYEW-1 (330 degrees)** for the impact with the case vehicle (event 4) and **06-BDEW-1 (170 degrees)** for the impact with the front of the Cadillac (event 5). The WinSMASH reconstruction program, missing vehicle algorithm, was used to reconstruct the Delta Vs for the Frontier's front impact with the case vehicle. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 30.0 km.p.h. (18.6 m.p.h.), -26.0 km.p.h. (-16.1 m.p.h.), and 15.0 km.p.h. (9.3 m.p.h.). The Frontier was towed due to damage.

Frontier's Occupants: According to the police crash report, the Frontier's driver [29-year-old, White (unknown if Hispanic) male] was restrained by his manual, three-point, lap-and-shoulder safety belt system. The driver was transported by ambulance to the hospital, and he sustained a police-reported "B" (non-incapacitating-evident) injury as a result of this crash.

3RD OTHER VEHICLE

The 1998 Toyota Sienna LE was a front wheel drive, five door, minivan (VIN: 4T3ZF13C7WU-----) equipped with a 3.0L, V6 engine and automatic transmission. The vehicle was equipped with driver and front right passenger air bags, which did not deploy as a result of this vehicle's impact. The Sienna's wheelbase was 290 centimeters (114.7 inches). The vehicle's mileage is not known because the Sienna was not inspected.

Exterior Damage: The Toyota sustained an impact to its left side from the front left corner of the case vehicle. No CDC is estimable and no damage measurements were taken because this vehicle was not inspected and there were no available vehicle photographs. The Toyota was driven from the crash scene by the driver.

Toyota's Occupants: According to the police crash report, the Toyota's driver [53-year-old, White, (unknown if Hispanic) male] and front right passenger [45-year-old, (unknown race and ethnic origin) female] were restrained by their manual, three-point, lap-and-shoulder safety belt systems. Neither occupant was transported by ambulance to the hospital, and they did not sustain any police reported injuries as a result of this crash.

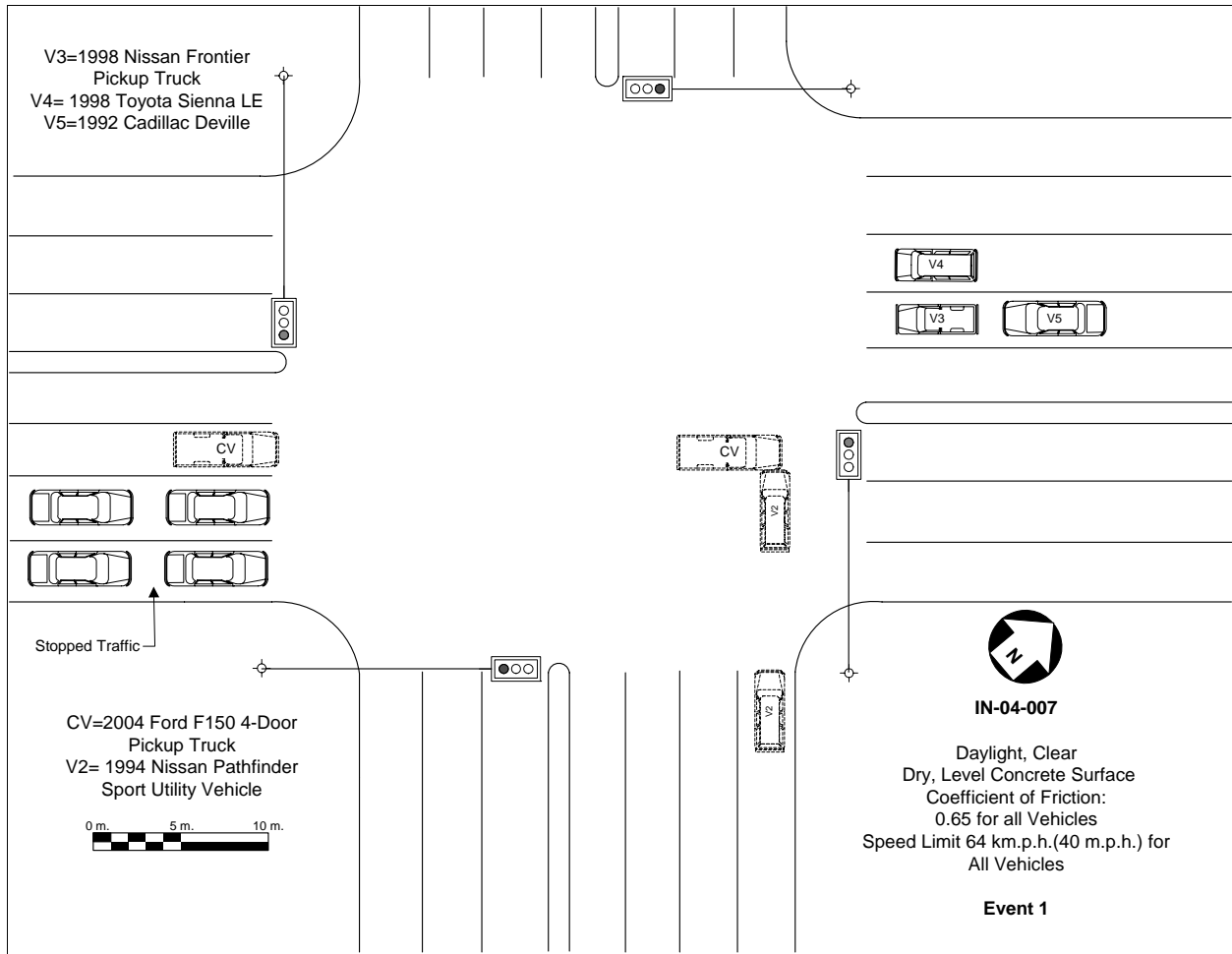
The 1992 Cadillac DeVille was a front wheel drive, four door sedan (VIN: 1G6CD53B6N4-----) equipped with a 4.9L, V8 engine and automatic transmission. This vehicle was equipped with a driver air bag, which did not deploy as a result of this vehicle's frontal impact. The Cadillac's wheelbase was 289 centimeters (113.8 inches). The Cadillac's mileage is not known because the vehicle was not inspected.

Exterior Damage: The Cadillac sustained a frontal impact from the rear bumper of the Nissan Frontier. No CDC is estimable and no damage measurements were taken because this vehicle was not inspected and there were no available vehicle photographs. The Cadillac was towed from the crash scene, but it is not known if it was towed due to damage.

Cadillac's Occupants: The Cadillac's driver [81-year-old, White (unknown if Hispanic) male] and front right passenger [76-year-old (unknown race and ethnic origin) female] were restrained by their manual, three-point, lap-and-shoulder safety belt systems. According to the police crash report, the driver was not transported by ambulance to the hospital, and he did not sustain any injuries as a result of this crash. Based on the police crash report, the front right passenger sustained police-reported "B" (non-incapacitating-evident) injuries as a result of this crash and was transported by ambulance to the hospital. It is not known if she was treated and released or hospitalized.

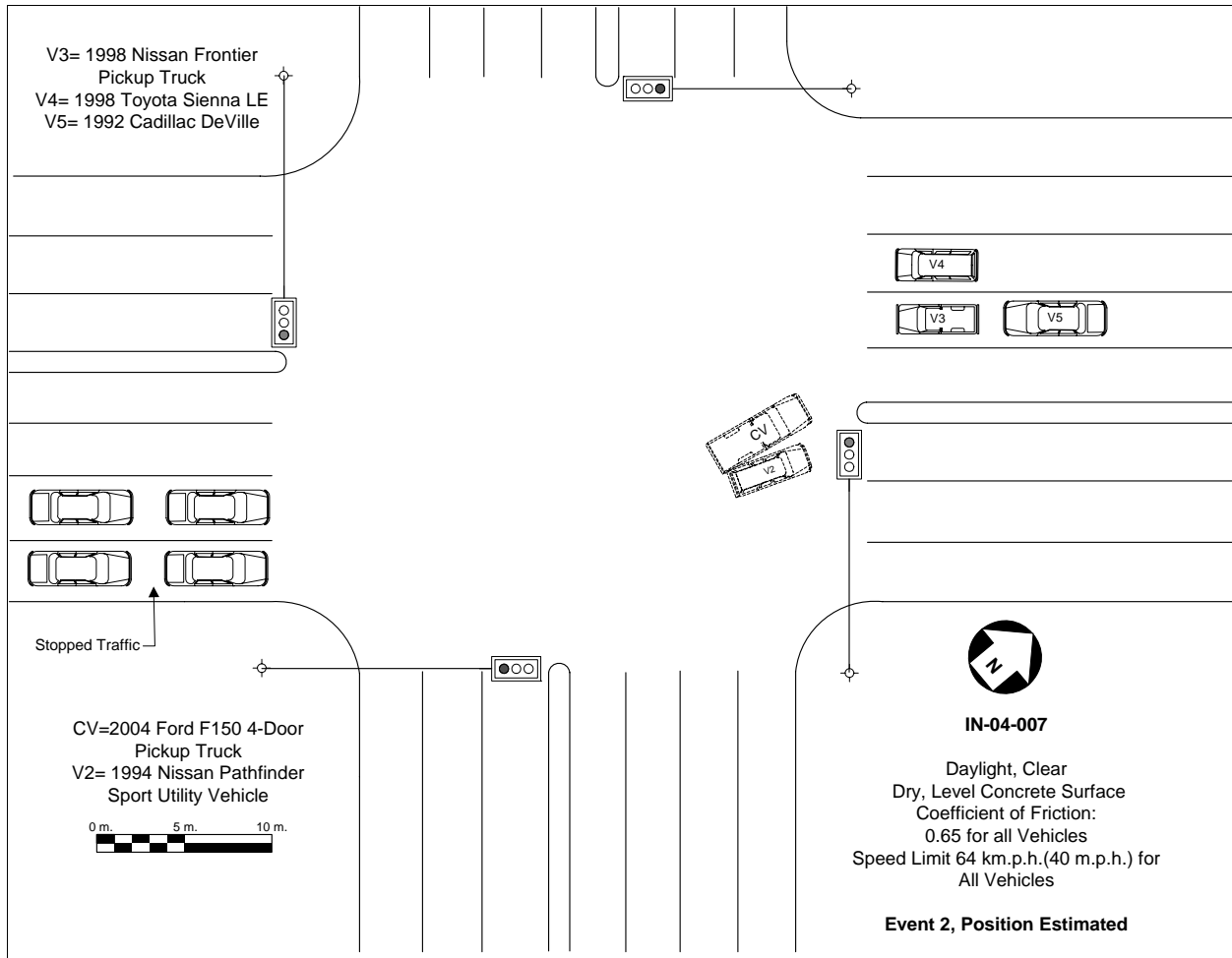
CRASH DIAGRAM, EVENT 1

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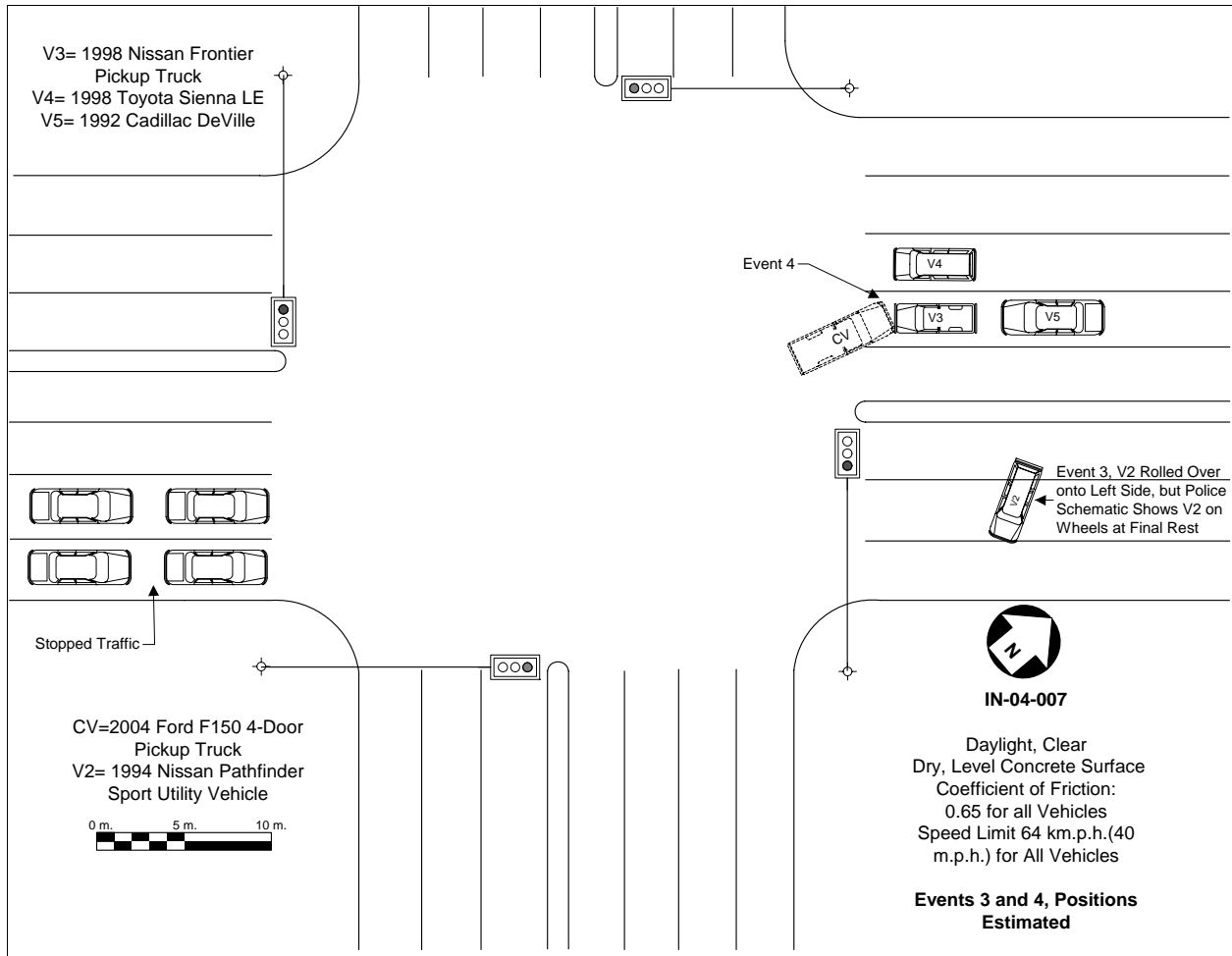
CRASH DIAGRAM, EVENT 2

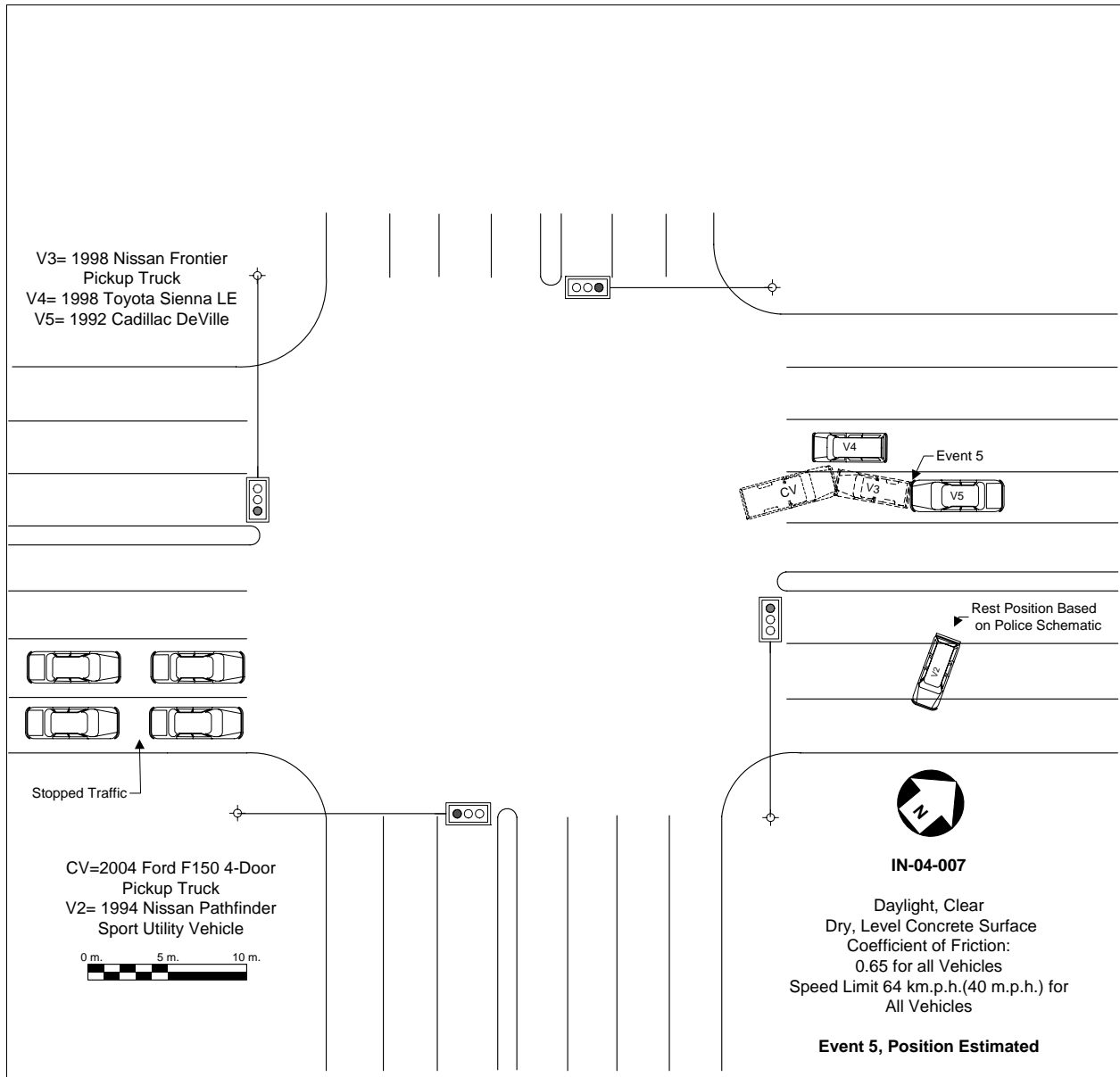
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CRASH DIAGRAM, EVENTS 3 AND 4

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CRASH DIAGRAM, Event 6 and Final Rest Positions

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