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-03-044
LOCATION - TEXAS
VEHICLE - 2004 LEXUS RX 330
CRASH DATE - October 2003

Submitted:

September 8, 2007

Contract Number: DTNH22-01-C-07002

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National Highway Traffic Safety Administration
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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.

Technical Report Documentation Page

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On-site air bag deployment investigation involving a 2004 Lexus RX 330, four-door sport utility vehicle, with manual safety belts and dual front advanced air bags, and a 1995 Nissan Quest, three-door minivan

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 2004 Lexus RX330 (case vehicle) and a 1995 Nissan Quest GXE (other vehicle). This crash is of special interest because the case vehicle was equipped with multiple **A**dvance **O**ccupant **P**rotection **S**ystem (**AOPS**) features, including certified advanced 208-compliant air bags, as well as an **E**vent **D**ata **R**ecorder (**EDR**) and the case vehicle's driver (30-year-old, male) **and** front right passenger (30-year-old, female) sustained only minor injuries as a result of the crash. The trafficway was a seven-lane, divided, U.S. expressway, traversing in northeasterly and southwesterly directions. Both the northeast and southwest roadways had three through lanes while the northeast roadway had an exit ramp. The case vehicle had been traveling in the outside through lane of the northeast roadway and moved into the exit-ramp. The Nissan had been traveling northeast, ahead of the case vehicle, when suddenly the Nissan steered to the right in an attempt to exit the expressway. The Nissan entered the gore that separated the exit ramp and the northeast roadway, initiating the crash sequence. The front left of the Nissan collided with a crash barrier (i.e., barrels) that protected the gore area between the right side of the northeast roadway and the exit ramp. The Nissan entered the exit ramp while rotating approximately 160 degrees counterclockwise after impacting the barrels, and it was most likely traveling backwards in a northeasterly direction. The front right (primarily) of the case vehicle impacted the front right of the rotating Nissan, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. In addition, the case vehicle's driver knee bolster supplemental restraint (air bag) also deployed. Sustained contact occurred between the two vehicles as the case vehicle's front wrapped around the right front of the Nissan enabling the case vehicle's front left to impact the right front door of the Nissan. The case vehicle's driver was seated with his seat track located in the middle position, the tilt steering wheel was located in its center position, and the telescopic steering column was at the center adjustment. He was restrained by his available, active, three-point, lap-and-shoulder, safety belt system and, according to his interview, he sustained minor"burns" on both of his "elbows" from his deploying driver air bag and indicated that he had a whiplash type injury to his neck. The front right passenger who was 15 weeks pregnant at the time of the crash, was seated with her seat track located between its middle and rearmost positions and was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. She sustained, according to the interview with the case vehicle's driver (i.e., husband) and her medical records, a possible cervical strain.

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This investigation was brought to NHTSA's attention on or before November 4, 2003 by NASS GES sampling activities. This crash involved a 2004 Lexus RX330 (case vehicle) and a 1995 Nissan Quest GXE (other vehicle). The crash occurred in October 2003, at 6:45 p.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 **A**dvance **O**ccupant **P**rotection **S**ystem (**AOPS**) features, including certified advanced 208-compliant air bags, as well as an **E**vent **D**ata **R**ecorder (**EDR**) and the case vehicle's driver [30-year-old, White (non-Hispanic) male] **and** front right passenger [30-year-old, White (non-Hispanic) female] sustained only minor injuries as a result of the crash. Permission to harvest the **E**lectronic **C**ontrol **U**nit, which houses the EDR technology, was given by the owner (i.e., insurance company) on November 6, 2003. This contractor inspected the scene on November 11, 2003, and the vehicle inspections were completed November 10, 2003. This contractor interviewed the driver for the case vehicle on December 8, 2003. This report is based on the Police Crash Report, an interview with the case vehicle's driver, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

Crash Environment:

The trafficway was a seven-lane, divided, U.S. expressway, traversing in northeasterly and southwesterly directions. Both the northeast and southwest roadways had three through lanes while the northeast roadway had an exit ramp. There was construction on-going on both the northeastern and southwestern roadways, and the crash location occurred underneath an overpass. At the time of the crash the light condition was dark, but illuminated by overhead street lamps at the area of impact, the atmospheric condition was cloudy, and the road pavement was dry; see **CRASH DIAGRAM** at end.

Pre-Crash:

The case vehicle had been traveling northeastward in the outside through lane of the northeast roadway and had moved onto the exit-ramp. The Nissan had been traveling northeast, ahead of the case vehicle, in the outside through lane of the same northeast roadway when suddenly the Nissan steered to the right in an attempt to exit the expressway onto the exit lane. The Nissan entered the gore that separated the exit ramp and the northeast roadway. The crash sequence was initiated within an interchange area, in the gore associated with the exit ramp.

Crash:

The front left of the Nissan collided with a crash barrier (i.e., barrels) that protected the gore area between the right side of the northeast roadway and the exit ramp. The Nissan entered the exit ramp while rotating approximately 160 degrees counterclockwise after impacting the barrels, and it was most likely traveling backwards in a northeasterly direction. The front right (primarily) of the case vehicle impacted the front right of the rotating Nissan, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. In addition, the case vehicle's driver knee bolster supplemental restraint (air bag) also deployed. Sustained contact

occurred between the two vehicles as the case vehicle's front wrapped around the right front of the Nissan enabling the case vehicle's front left to impact the right front door of the Nissan.

Post-Crash:

The Nissan's counterclockwise rotation was accelerated as a result of the impact and it continued to rotate approximately 40 degrees counterclockwise while being pushed in a northeasterly direction by the case vehicle. The Nissan came to rest obliquely oriented across the exit ramp, heading south. The case vehicle rotated approximately 65 degrees clockwise as it slid along the exit ramp, and its left back corner impacted the crash barrels before coming to final rest between the crash barrels and the Nissan, heading in an east-southeasterly direction. The case vehicle and the Nissan were both towed due to damage.

Case Vehicle:

The 2004 Lexus RX 330 was a front wheel drive, four-door sport utility vehicle (VIN: JTJGA31U140------) and was **C**ERTIFIED **A**DVANCED **208-C**OMPLIANT. The case vehicle was equipped with four wheel, anti-lock brakes with electronic brake force distribution, multi-stage front air bags, a driver's knee air bag, front seat back-mounted side impact air bags, and front and back side curtain air bags. Furthermore, the case vehicle was equipped with a LATCH system and a new tire pressure monitor. In addition, there was an occupant weight sensor for the front right passenger seating position. The occupant sensing system automatically switches the right front-passenger front air bag on or off based on the passenger's weight and the type of pressure on the seat. Finally, the case vehicle was also equipped with an **E**lectronic **C**ontrol **U**nit, which houses the **E**vent **D**ata **R**ecorder (**EDR**) technology.

Vehicle Exterior:

Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **12-FDEW-1** (**0** degrees) and **09-LBEW-1** (**280** degrees). The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 15.0 km.p.h. (9.3 m.p.h.), -15.0 km.p.h. (-9.3 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). These figures are used only as an estimate because the WinSMASH missing vehicle algorithm assumes contact with an exemplary vehicle. The Nissan had sustained a frontal impact before any contact with the case vehicle and, as a result, sustained overlapping damage, invalidating the WinSMASH damage only algorithm.

Crash Data Recording:

The **E**lectronic **C**ontrol **U**nit, which houses the **EDR** technology, was removed by this contractor and submitted to the agency where it was scrutinized for relevant data. The data downloaded from the case vehicle's **EDR** showed that the driver's and front right passenger's seat belt buckle status was buckled, the driver's third stage and the front right passenger's second stage of their multi-stage and dual stage air bags, respectively, were activated, the front right passenger was an "adult" and, for the deployment event (2nd event), the Delta V reached a value of 28.2 km.p.h. (17.5 m.p.h.) at the 150 millisecond mark of recorded data but was still increasing.

Other Vehicle:

The 1995 Nissan Quest GXE was a front wheel drive, three-door minivan (VIN: 4N2DN11W8SD------). The Nissan was equipped with four wheel, anti-lock brakes.

Case Vehicle's Driver:

The driver of the case vehicle's driver (30-year-old, male) was seated with his seat track located in the middle position with the front edge of the seat 45 centimeters (17.7 inches) forward of the left "B"-pillar, the tilt steering wheel located in its center position, and the telescopic steering column was at the center adjustment. He was restrained by his available, active, three-point, lap-and-shoulder, safety belt system; the belt system was equipped with a retractor-mounted pretensioner with force load limiters, housed within the "B"-pillar. The case vehicle's driver sustained, according to his interview, minor"burns" on both of his "elbows" from his deploying driver air bag and indicated that he had a whiplash type injury to his neck that bothered him for a couple weeks after the accident.

Case Vehicle's Front Right Passenger:

The front right passenger (30-year-old, female), who was 15 weeks pregnant at the time of the crash, was seated with her seat track located between its middle and rearmost positions and was also restrained by her available, active, three-point, lap-and-shoulder, safety belt system; the belt system was equipped with a retractor-mounted pretensioner with force limiters, housed within the "B"-pillar. According to the driver's interview and her medical records, it was confirmed that she was approximately fifteen weeks pregnant and may have sustained a minor whiplash type injury as a result of this crash, most likely from her deploying air bag.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway was a seven-lane, divided, U.S. expressway, traversing in northeasterly and southwesterly directions. Both the northeast and southwest roadways had three through lanes while the northeast roadway had an exit ramp. There was construction on-going on both the northeastern and southwestern roadways (i.e., probably adding an additional through lane in each direction), and the crash location occurred underneath an overpass (**Figure 1**). The U.S. highway was straight and had an unmeasured grade positive to the northeast (i.e., an upgrade in the case vehicle's direction of travel), at the area of impact. The pavement was concrete, but traveled, and the width of the inside northeastbound lane was most likely 3.7 meters (12.0 feet) and the exit lane was unmeasured but appeared to be wider (**Figure 2** below). The shoulders were improved (i.e., concrete), and there was a short, unmeasured southwestern shoulder prior to the longitudinal barrier (i.e.,

Figure 1: Nissan's northeastward travel path toward initial impact with crash barrels (i.e., arrow) which separate inside northeastbound through lane from exit lane; Note: construction barricades widen for exit lane (case photo #03)

New Jersey type) which separated and protected the northeast roadway from the construction area. The northwestern shoulder was similarly configured with a short, unmeasured shoulder prior to the concrete longitudinal barrier that protected the median between the roadways (i.e., the overpass's bridge support pillars). The roadway was not bordered by curbs. Pavement markings consisted of raised pavement markers, grouped into fours (4s), so as to appear as dashed lines (**Figure 1** above). Groupings (of four markers) were used to separate the through lanes while continuous raised pavement markers were used to identify the roadway's edges and the gore area where the exit lane began. The estimated coefficient of friction was 0.65 for the case vehicle. Traffic controls consisted of an **ADVISORY EXIT SPEED** sign (Manual on Uniform Traffic Control Devices, W13-2–**Figure 1** above) of 30 m.p.h. (48 km.p.h.), and an informational arrow sign identified the exit ramp (**Figure 2**). Furthermore, a crash cushion (i.e., a single line of barrels) was used to protect a longitudinal barrier in the gore area. The speed limit was 97 km.p.h. (60 m.p.h.). No regulatory speed limit sign was posted near the crash site. At the time of the crash the light condition was dark, but illuminated by overhead street lamps at the area of impact, the atmospheric condition was cloudy, and the road pavement was dry. Traffic density was heavy, and the site of the crash was urban commercial; see **CRASH DIAGRAM** at end.

Figure 2: Construction barrels impacted by Nissan (i.e., arrow) and case vehicle's northeastward travel path to impact with redirected Nissan (case photo #05)

Pre-Crash: The case vehicle had been traveling northeastward in the outside through lane of the northeast roadway (**Figure 1** above) and had moved onto the exit-ramp, intending to continue in its direction of travel on the ramp. The Nissan had been traveling northeast, ahead of the case vehicle, in the outside through lane of the same northeast roadway when suddenly the Nissan steered to the right in an attempt to exit the expressway onto the exit lane. The Nissan entered the gore that separated the exit ramp and the northeast roadway (**Figure 2**). It is unknown whether the Nissan's driver made any avoidance maneuvers just prior to the crash. The crash sequence was initiated within an interchange area, in the gore associated with the exit ramp.

Crash: The front left (**Figure 3**) of the Nissan collided with a crash barrier (i.e., barrels) that protected the gore area between the right side of the northeast roadway and the exit ramp (**Figure 4** below). The Nissan entered the exit ramp while rotating approximately 160 degrees counter-clockwise after impacting the barrels, and it was most likely traveling backwards in a northeasterly

Figure 3: Elevated view of Nissan's overlapping frontal damage viewed from left of front; Note: front left half damage most likely from initial impact with barrels (case photo #54)

direction. Recognizing the impending collision, the case vehicle's driver "briefly" braked, attempting to avoid the crash. The front right (primarily) of the case vehicle (**Figure 5**) impacted the front right of the rotating Nissan (**Figure 6**), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. In addition, the case vehicle's driver knee bolster supplemental restraint (air bag) also deployed. Sustained contact occurred between the two vehicles as the case vehicle's front wrapped around the right front of the Nissan enabling the case vehicle's front left (**Figure 7**) to impact the right front door of the Nissan (**Figure 8** below).

Figure 4: Impact area–Nissan hit barrels (1st event), case vehicle impacted Nissan (2nd event), and case vehicle's left rear impacted barrels (3rd event); Note: barrel type and/or configuration likely different from date of crash (case photo #07)

Figure 5: Case vehicle's frontal damage viewed from right of front; Note: bumper fascia missing and contour gauge shows bumper crush (case photo #24)

Figure 6: Overlapping frontal damage to Nissan viewed from right of front with contour gauge showing aggregate crush to bumper; Note: case vehicle impacted Nissan's front right, with wrap-around damage extending to right front door (case photo #62)

Figure 7: Case vehicle's frontal damage from impact with Nissan viewed from left of front; Note: lesser damage to front left resulted from contact with Nissan's right front door as case vehicle wrapped around Nissan's right side (case photo #13)

Post-Crash: The Nissan's counterclockwise rotation was accelerated as a result of the impact and it continued to rotate approximately 40 degrees counterclockwise while being pushed in a northeasterly direction by the case vehicle. The Nissan came to rest obliquely oriented across the exit ramp, heading south. The case vehicle rotated approximately 65 degrees clockwise as it slid

along the exit ramp, and its left back corner (**Figure 9**) impacted the crash barrels (**Figure 4** above) before coming to final rest between the crash barrels and the Nissan, heading in an east-southeasterly direction.

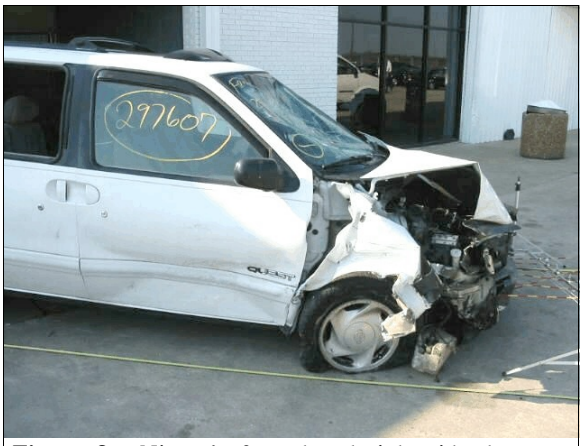


Figure 8: Nissan's frontal and right side damage viewed from right front; Note: displacement of right front wheel assembly and damage on right front door caused by wrap-around damage from impact with case vehicle (case photo #60)

Figure 9: Damage to back portion of case vehicle's left rear quarter panel and bumper from impact with barrels during clockwise rotation to final rest (case photo #17)

CASE VEHICLE

The 2004 Lexus RX 330 was a front wheel drive, five-passenger, four-door sport utility vehicle (VIN: JTJGA31U140------) equipped with a 3.3L, V-6 engine and a five-speed automatic transmission. Braking was achieved by a power-assisted, front and rear disc, four-wheel, anti-lock system with electronic brake force distribution. The case vehicle's wheelbase was 272 centimeters (106.9 inches), and the odometer reading at inspection is unknown because the case vehicle was equipped with an electronic odometer.

The case vehicle was **CERTIFIED ADVANCED 208-COMPLIANT** and was equipped with multi-stage driver and dual stage front right passenger air bag inflators, a driver seat belt sensing system, a driver's knee air bag, front seat back-mounted side impact air bags, and front and back side curtain air bags. Furthermore, the case vehicle was equipped with LATCH system features and a new tire pressure monitor. In addition, there was an occupant weight sensor for the front right passenger seating position. The various sensors in the case vehicle's advanced occupant restraint system analyze a combination of factors including the predicted crash severity and driver and front right passenger seat belt usage to determine the front air bag inflation level appropriate for the severity of the crash. For the front right seating position, an occupant weight sensor in the seat determines first, if a passenger is on the seat and, second, if the weight of the passenger is below a set value [i.e., the specific weight value is not known for the case vehicle, but must be 30 kilograms (66 pounds) or less]. If no front right occupant is seated or the occupant's weight is below the set value, then the sensor will suppress deployment of the front right passenger air bag. The crash sensors in the side of the case vehicle analyze side impact forces and deploy the driver's and/or the front right passenger's seat back-mounted side impact air bag and the roof mounted, side inflatable curtain air bags to provide added protection to passengers seated along the side of the vehicle. Finally, the case vehicle was also equipped with an **E**lectronic **C**ontrol **U**nit, which houses the **E**vent **D**ata **R**ecorder (**EDR**) technology.

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable split back bench seat with adjustable head restraints for all three back seating positions; and continuous loop, three-point, lap-and-shoulder, safety belt systems at all five front and back positions. The front seat belt systems were equipped with manually operated, upper anchorage adjusters for the "D"-rings. The driver's upper anchorage adjuster was located in the upmost position, but the front right passenger's adjuster was located in the middle position. The vehicle was equipped with knee bolsters for both the driver and front right passenger, neither of which showed evidence of occupant contact or deformation; however, there was a driver knee bolster air bag which deployed during this crash. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. In addition, the vehicle was equipped with front, seat back-mounted, side impact air bags and side-inflatable curtain air bags which extend from each of the roof side rails. All three frontal air bags deployed as a result of the case vehicle's frontal impact with the Nissan. The case vehicle's seat back-mounted side air bags and side inflatable curtain air bags did not deployed as a result of the case vehicle's frontal impact with the Nissan.

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's contact with Nissan initially involved the front right. The case vehicle had sustained contact with the Nissan, eventually "wrapping around" the Nissan's right side enabling the entire front of the case vehicle to sustain direct contact damage (**Figure 10**). The case vehicle's front bumper fascia was torn off the bumper and, although it was present at the time of our inspection, the direct contact damage was best measured along the actual bumper and remaining structures, beginning at the front right corner and extending 81 centimeters (31.9 inches) leftward. Residual maximum crush was measured as 13 centimeters (5.1 inches) at C_6. The table below shows the case vehicle's crush profile. Direct damage was also found on the case vehicle's left rear corner, both at the bumper level and above (**Figure 9** above).

Figure 10: Case vehicle's frontal damage from impact with Nissan; Note: contour gauge positioned along actual bumper (case photo #11)

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	81	13	158	0	4	4	6	8	13	20	0
in		31.9	5.1	62.2	0.0	1.6	1.6	2.4	3.2	5.1	7.9	0.0

The wheelbase on the case vehicle's left side was shortened 2 centimeters (0.8 inches) while the right side was shortened 22 centimeters (8.7 inches). The case vehicle's front bumper fascia,

bumper, grille, radiator, hood, right fender, and right headlight and turn signal assemblies were directly damaged and crushed rearward. The front bumper fascia was detached from the vehicle. The left headlight and turn signal assemblies sustained induced damage as well as the hood. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32nd of an inch			
LF	0	0	303	44	7	9	None	No	Yes
RF	0	0	303	44	7	9	Side wall puncture	Yes	Yes
LR	200	29	303	44	7	9	None	No	No
RR	214	31	303	44	7	9	None	No	No

The recommended tire size was: P225/65SR17 but tire size: P235/55HR18, was optional; the case vehicle was equipped with tire size: P235/55R18. The case vehicle's tire data are shown in the table above. In addition, the case vehicle's right front tire was damaged (i.e., a sidewall puncture), deflated, and physically restricted. The left front tire was deflated, but no damage was readily visible. Neither of the rear tires were damaged, deflated, or physically restricted.

Vehicle Interior: Inspection of the case vehicle's interior revealed that there was no evidence of occupant contact on the interior surfaces of the case vehicle (**Figure 11** and **Figure 12** below). Finally, there was no evidence of intrusion to the case vehicle's interior, no evidence of compression to the energy absorbing shear capsules in the steering column, and no deformation to the steering wheel rim.

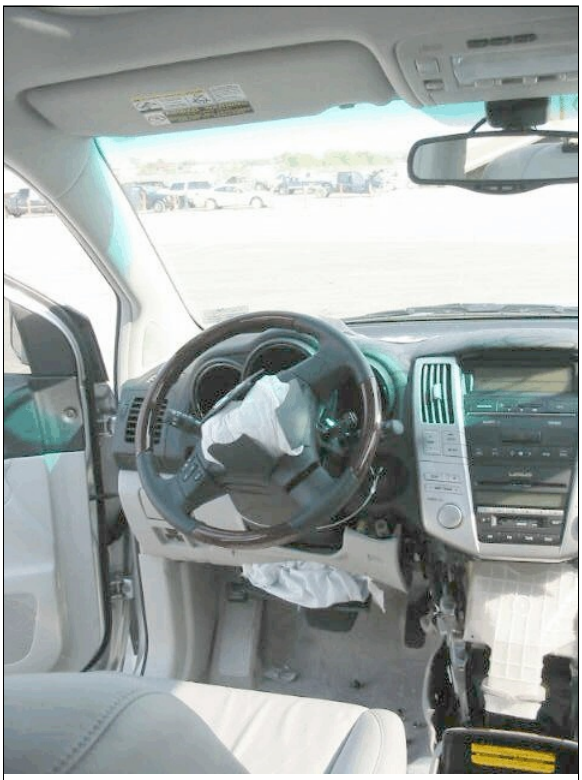


Figure 11: Vertical view of case vehicle's driver seating area showing no apparent evidence of occupant contact (case photo #26a)

Damage Classification: Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **12-FDEW-1** (**0** degrees) and **09-LBEW-1** (**280** degrees). The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 15.0 km.p.h. (9.3 m.p.h.), -15.0 km.p.h. (-9.3 m.p.h.), and 0.0

km.p.h. (0.0 m.p.h.). These figures are used only as an estimate because the WinSMASH missing vehicle algorithm assumes contact with an exemplary vehicle. The Nissan had sustained a frontal impact before any contact with the case vehicle and, as a result, sustained overlapping damage, invalidating the WinSMASH damage only algorithm. The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

Figure 12: Case vehicle's front right passenger seating area showing no apparent occupant contact evidence (case photo #28)

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained a multi-stage frontal air bag at the driver position (**Figure 11** above) and a dual stage frontal air bag at the front right passenger position (**Figure 12**). In addition, the vehicle was equipped with a driver's knee bolster air bag (**Figure 11** above); front, seat back-mounted, side impact air bags; and side-inflatable curtain air bags which extend from each of the roof side rails. All three frontal air bags deployed as a result of the frontal impact with the Nissan. Based on the **EDR** data, more than one stage of both the driver's and front right passenger's air bags were activated. The case vehicle's seat back-mounted side air bags and side inflatable curtain air bags ***did not deploy*** as a result of the case vehicle's frontal impact with the Nissan.

The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of three cover flaps made of thick vinyl positioned within an overall hexagonal shape. The top flap was essentially a rectangle, except that its bottom was "S-curve"- shaped so as to accommodate the manufacturer's logo. The left and right bottom flaps were pentagonally-shaped and together formed a trapezoid. The width of the seam that separated the top flap from the bottom flaps was 13 centimeters (5.1 inches). The combined width of the lower seam for the two bottom flaps was 7.5 centimeters (3.0 inches), and the vertical height of the two outside seams was 11 centimeters (4.3 inches). An inspection of the air bag module's cover flaps and the air bag's fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two tethers, each approximately 10 centimeters (3.9 inches) in width, positioned at the 9 and 3 o'clock positions and sewn 23 centimeters apart (9.1 inches) at the center of the bag. The driver's air bag had two vent ports, which were essentially slits in the back of the air bag, each approximately 6 centimeters (2.4 inches) in length, located at the 11 and 1 o'clock positions (**Figure 13**). The deployed driver's air bag was

Figure 13: Back top surface of case vehicle's deployed driver air bag showing "slit"-type vent ports (case photo #33)

round with a diameter of 65 centimeters (25.6 inches). An inspection of the driver's air bag fabric revealed no contact evidence readily apparent on the air bag's fabric (**Figure 14**). The distance between the mid-center of the driver's seat back, as positioned at the time of the vehicle inspection, and the front surface of the air bag's fabric at full excursion was not determined.

Figure 14: Case vehicle's deployed driver air bag showing no obvious occupant contact evidence (case photo #32)

The front right passenger's air bag was located in the top of the instrument panel. There were two mirror-imaged, symmetrical, trapezoidal-configuration, cover flaps made of a thick vinyl that were an integral part of the front instrument panel and appeared seamless to the naked eye but were obviously pre-stressed for deployment purposes. The flaps had overall dimensions of 9 centimeters (3.5 inches) at the middle horizontal seam and 21 centimeters (8.3 inches) at the top and bottom horizontal seams. The vertical distance between the top and bottom horizontal seams was 12 centimeters (4.7 inches). An inspection of the front right air bag module's cover flaps and the air bag's fabric revealed no flaps, per se, but rather seams cut into the top of the dashboard, all of which opened at their designated tear points (**Figure 15**). Furthermore, there was no evidence of damage during the deployment to the air bag or evidence of"flap" damage. The front right passenger's air bag was designed without any tethers. The front right air bag had two vent ports, approximately 5 centimeters (2.0 inches) in diameter, located at the 2:30 and 9:30 clock positions. The deployed front right air bag was rectangular with a height of approximately 64 centimeters (25.2 inches) and a width of approximately 56 centimeters (22.0 inches). An inspection of the front right passenger's air bag fabric revealed no contact evidence readily apparent on the front right air bag's fabric (**Figure 16**). The distance between the mid-center of the front right seat back, as positioned at the time of the vehicle inspection, and the front surface of the air bag's fabric at full excursion was 37 centimeters (14.6 inches).

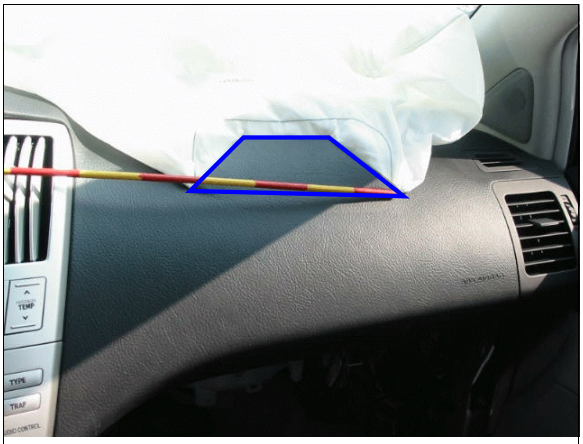


Figure 15: Case vehicle's deployed front right passenger air bag and air bag module's trapezoidal-shaped bottom cover flap (case photo #40)

Figure 16: Case vehicle's deployed front right passenger air bag showing no apparent evidence of occupant contact (case photo #35)

The driver's knee bolster air bag was located directly below the steering column. The knee-bolster air bag module cover consisted of asymmetrical "H"-configuration cover flaps made of thick vinyl with overall dimensions of 25 centimeters (9.8 inches) at the horizontal seam and 3 centimeters (1.2 inches) vertically for the upper flap and 4 centimeters (1.6 inches) vertically for the lower flap. An inspection of the air bag module's cover flaps and the air bag's fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The knee bolster air bag was designed without any tethers or vent ports; however, there was stitching to the outside on both bottom and top surfaces. The driver's knee*r air bag was rectangular with a height of 31 centimeters (12.2 inches) and a width of 58 centimeters (22.8 inches). An inspection of the driver's knee air bag fabric revealed no contact evidence readily apparent on the air bag's fabric (**Figure 17** above and **Figure 18**).

Figure 17: Elevated view of case vehicle's deployed, under column-mounted, knee bolster air bag showing no residual evidence of occupant contact (case photo #41)

Figure 18: Seat level view of case vehicle's deployed, under column-mounted, knee bolster air bag showing no residual occupant contact evidence (case photo #42)

CRASH DATA RECORDING

The **E**lectronic **C**ontrol **U**nit, which houses the **EDR** technology, was removed by this contractor and submitted to the agency where it was scrutinized for relevant data. The data downloaded from the case vehicle's **EDR** showed the driver's and front right passenger's seat belt buckle status, time from algorithm enable to deployment (i.e., air bag deployments) for only the system's first stage, the type of passenger in the front right seating position, and the vehicle's speed and brake switch status for the five recorded sample periods preceding the **ALGORITHM ENABLE**. In addition, the vehicle's velocity change (i.e., Longitudinal Delta V) is reported. Downloaded data of interest indicated the following: the case vehicle was gradually accelerating and had reached a speed of at least 95.9 km.p.h. (59.6 m.p.h.) when the driver applied the brake between the 3rd and 2nd recorded sample period prior to **ALGORITHM ENABLE**, the driver's and front right passenger's seat belt status showed they were buckled, the driver's third stage and the front right passenger's second stage of their multi-stage and dual stage air bags, respectively, were activated, the front right passenger was an "adult", and the Delta V reached a value of 28.2 km.p.h. (17.5 m.p.h.) at the 150 millisecond mark of recorded data but was still increasing. In addition, the **EDR** showed that there was a previous **ALGORITHM ENABLE** in this vehicle's history, but this non-deployment event occurred at least 5.1 seconds prior to the crash event. This

contractor believes that the recorded Delta V seems reasonable considering the amount of deformation to the case vehicle's front.

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [30-year-old, White (non-Hispanic) male; 183 centimeters (72 inches) and 86 kilograms (190 pounds)] was seated in an upright posture with his back slightly forward of the seat back, his left foot on the floor, his right foot on the brake, and both hands bracing on the steering wheel. His seat track was located in the middle position with the front edge of the seat 45 centimeters (17.7 inches) forward of the left "B"-pillar, the seat back was slightly reclined, the tilt steering wheel was located in its center position, and the telescopic steering column was at the center adjustment.

Based on this contractor's vehicle inspection, the case vehicle's driver was restrained by his available, active, three-point, lap-and-shoulder, safety belt system; the belt system was equipped with a retractor-mounted pretensioner with force load limiters, housed within the "B"-pillar. There was no mention by the driver of belt pattern bruising and/or abrasions to the driver's body, but the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed evidence of loading (**Figure 19**). Specifically there were friction burns on the torso portion of the webbing. In addition, it should be noted that the seat belt webbing for this seat position spooled and unspooled freely, indicating that the pretensioner may not have actuated.

Figure 19: Loading evidence (i.e., scuffs/friction burns) on webbing of torso portion case vehicle's driver safety belt (case photo #44)

The case vehicle's driver"briefly" braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of his available safety belts, the driver most likely moved slightly forward just prior to impact. The case vehicle's primary impact with the Nissan enabled the case vehicle's driver to continue forward and slightly upward along a path opposite the case vehicle's **0** degree Direction of Principal Force as the case vehicle decelerated. As a result, the driver loaded his safety belts (**Figure 19**) and contacted the deploying driver air bag. Furthermore, he contacted his deploying driver's knee bolster air bag. As the case vehicle rotated clockwise, the driver most likely rebounded backwards from his safety belts and air bags toward the right side of his seat back. When the case vehicle impacted the crash barrels with its left rear, the driver most likely moved slightly toward the left side. As the case vehicle decelerated and came to a rest, the driver most likely returned back to the right and to a more upright position because his movement was restricted by the use of his safety belts. The exact posture of the driver at final rest is unknown, but he was able to exit the case vehicle without assistance.

The driver was not transported by ambulance to the hospital but, according to his interview, he did seek subsequent medical treatment. However, there is no record of any treatment at the facility to which his wife was taken. He sustained minor"burns" on both of his "elbows" from his deploying driver air bag and indicated that he had a whiplash type injury to his neck that bothered him for a couple weeks after the accident.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Strain, {whiplash} cervical, acute, not further specified	minor 640278.1,6	Air bag, driver's	Probable	Interviewee (same person)
2	Abrasions and/or friction burns bilateral elbows (or antecubital fossae)	minor 790202.1,3	Air bag, driver's	Probable	Interviewee (same person)

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The case vehicle's front right passenger [30-year-old, White (non-Hispanic) female; 157 centimeters and 48 kilograms (62 inches, 105 pounds)], who was 15 weeks pregnant at the time of the crash, was seated in a slightly reclined posture with her back against the seat back, her feet on the floor, her right hand/arm on the right door arm rest, and a mobile telephone in her left hand. Her seat track was located between its middle and rearmost positions, the seat back was slightly reclined.

Figure 20: Case vehicle's front right passenger safety belt showing limit of belt's post-crash extension (case photo #47)

The case vehicle's front right passenger was restrained by her available, active, three-point, lap-and-shoulder, safety belt system; the belt system was equipped with a retractor-mounted pretensioner with force limiters, housed within the "B"-pillar. There was no mention by the driver of belt pattern bruising and/or abrasions to the front right passenger's body, but the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate revealed that the pretensioner had actuated (**Figure 20**) and showed evidence of loading, specifically friction burns on the torso portion of the belt's webbing (**Figure 21** below). This occupant's seat belt webbing did not spool or unspool freely but rather, was frozen at the "D"-ring, indicating that the pretensioner had actuated.

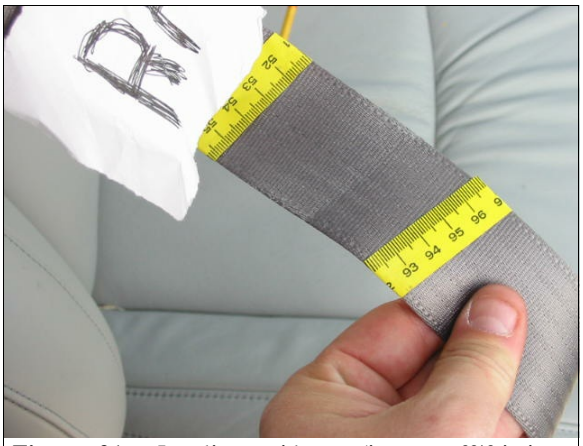


Figure 21: Loading evidence (i.e., scuff/friction burn) on webbing of case vehicle's front right safety belt (case photo #48)

The case vehicle's driver"briefly" braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of his available safety belts, the front right passenger most likely moved slightly forward just prior to impact. The case vehicle's primary impact with the Nissan enabled the case vehicle's front right passenger to continue forward and slightly upward along a path opposite the case vehicle's **0** degree Direction of Principal Force as the case vehicle decelerated. As a result, the front right passenger loaded her safety belts and contacted the deploying front right passenger air bag. As the case vehicle rotated clockwise, the front right passenger most likely rebounded backwards from her safety belts and air bag toward the right side of her seat back. When the case vehicle impacted the crash barrels with its left rear, the front right passenger most likely moved slightly toward her left side. As the case vehicle decelerated and came to a rest, the front right passenger most likely returned back to the right and to a more upright position because her movement was restricted by the use of her safety belts. The exact posture of the front right passenger at final rest is unknown, but she was able to exit the case vehicle with some assistance.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The right front passenger was taken to a hospital emergency room after the crash by private conveyance. Routine tests for a pregnant female were run as a precaution, and she was treated and released. According to the driver's interview and her medical records, it was confirmed that she was approximately fifteen weeks pregnant and may have sustained a minor whiplash type injury as a result of this crash, most likely from her deploying air bag.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
	15 weeks obstetrical with living fetus, unremarkable, no abnormalities noted				Emergency room records
	Possible flexion–extension injury [i.e., strain, {whiplash} cervical] with tenderness (cervialgia) posterior neck and slight reversal of lordotic curvature of upper cervical spine with straightening; no diagnosis made	no injury	Air bag, front right passenger's	Probable	Emergency room records

Based on the VIN and manufacturer's specifications, the 1995 Nissan Quest GXE was a front wheel drive, seven-passenger, three-door minivan (VIN: 4N2DN11W8SD------) equipped with a 3.0L, V-6 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The Nissan's wheelbase was 285 centimeters (112.2 inches), and the odometer reading is unknown because the Nissan's interior was not inspected. Furthermore, the vehicle was equipped with an air bag for the driver's seat position only. The front outboard seating positions were equipped with a combination of automatic, motorized, two-point, shoulder belts and manual, two-point, lap belts. The specific safety belt systems provided for the second and back seating positions are unknown because the interior was not inspected; however, the back center seat most likely had a manual, two-point, lap belt. The interior was equipped with bucket seats for the driver, front right passenger, and second seating areas. In addition, there was a back bench seat.

Exterior Damage: Although the front of the Nissan sustained overlapping damage, the initial contact with the crash barrels most likely involved the front left. After rotating approximately 160 degrees counterclockwise, the Nissan's contact with the case vehicle initially involved its front right, but the contact was sustained, wrapping around the Nissan and involving its right fender and right front door. The combined direct damage involved the entire front bumper, from corner to corner, and extended a measured distance of 160 centimeters (63.0 inches) along the front bumper (**Figure 22**). The combined residual maximum crush was measured as 28 centimeters (11.0 inches) at C_6. The table below shows the case vehicle's composite crush profile for the three tree impacts.

Figure 22: Overlapping damage to Nissan's front from impact with barrels and case vehicle; Note: contour gauge positioned along actual bumper (case photo #52)

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	160	28	160	14	13	20	23	18	28	0	0
in		63.0	11.0	63.0	5.5	5.1	7.9	9.1	7.1	11.0	0.0	0.0

The wheelbase on the Nissan's left side was shortened 17 centimeters (6.7 inches) while the right side was shortened 9 centimeters (3.5 inches). The Nissan's front bumper, bumper fascia, grille, radiator, hood, right fender, and right and left headlight and turn signal assemblies were directly damaged and crushed rearward. Furthermore, the Nissan's right fender and right front door were crushed inward during the wrap around portion of the crash sequence. There was

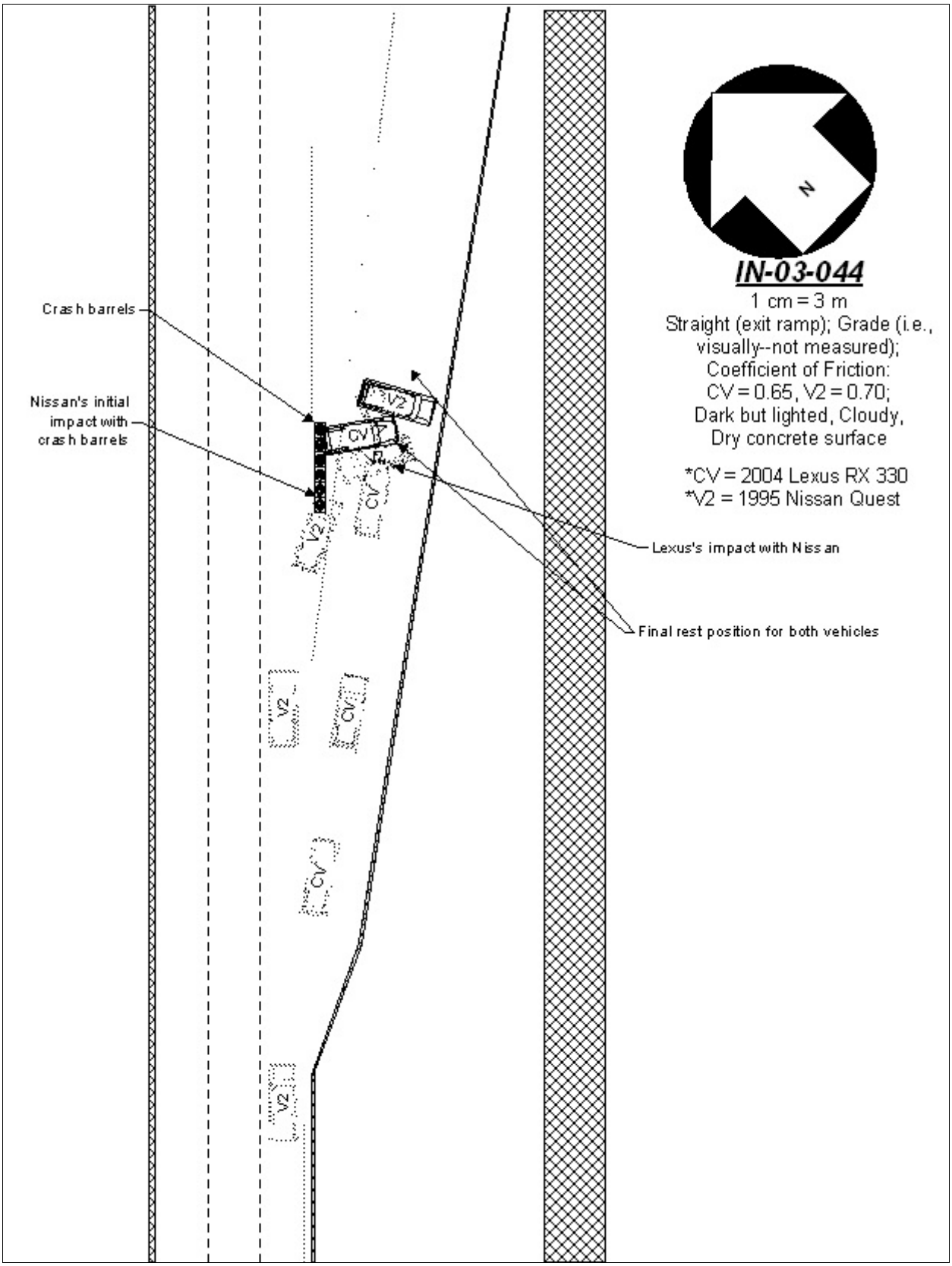
induced damage to the left fender, the windshield's glazing, and both the left and right front doors. No obvious induced damage or remote buckling was noted to the remainder of the Nissan's exterior.

The manufacturer's recommended tire size was: P205/75R15, and the Nissan's tires were the recommended size. The Nissan's tire data are shown in the table below. In addition, both of the Nissan's front tires were damaged, deflated, and physically restricted.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32nd of an inch			
LF	0	0	241	35	4	5	Rim separation	Yes	Yes
RF	0	0	241	35	3	4	Sidewall puncture/cut	Yes	Yes
LR	90	13	241	35	4	5	None	No	No
RR	207	30	241	35	4	5	None	No	No

Damage Classification: Based on the vehicle inspection, the CDCs for the Nissan's two frontal impacts were not estimable because there was overlapping damage to the front of the vehicle. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the Nissan's second highest severity impact with the case vehicle. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 13.0 km.p.h. (8.1 m.p.h.), -12.2 km.p.h. (-7.6 m.p.h.), and -4.4 km.p.h. (-2.7 m.p.h.). The Nissan was towed due to damage.

Nissan's Occupants: According to the Police Crash Report, there were four occupants in the Nissan. The Nissan's driver (34-year-old, Asian or Pacific Islander, female) and the front right passenger [32-year-old, (unknown race and/or ethnic origin) female] were restrained by a combination of their available, passive, motorized, two-point shoulder belt and active, two-point, lap belt safety systems. The driver and front right passenger were transported by ambulance to the hospital. They sustained police-reported "B" (non-incapacitating-evident) injuries as a result of the crash. The Nissan's two second seating area occupants (i.e., both listed on the Police Crash Report as seated in the right position): one a 36-year-old, (unknown race and/or ethnic origin) male and the other an 8-year-old, (unknown race and/or ethnic origin) male, were restrained by their available, most likely active, three-point, lap-and-shoulder, safety belt systems. Neither second seating area occupant was transported by ambulance to the hospital, and they did not sustain any injuries as a result of this crash.


N
IN-03-044
1 cm = 3 m
Straight (exit ramp); Grade (i.e., visually--not measured);
Coefficient of Friction:
CV = 0.65, V2 = 0.70;
Dark but lighted, Cloudy, Dry concrete surface
*CV = 2004 Lexus RX 330
*V2 = 1995 Nissan Quest
Crash barrels
Nissan's initial impact with crash barrels
Lexus's impact with Nissan
Final rest position for both vehicles
V2
CV