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ON-SITE CERTIFIED ADVANCED 208- COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-04-031
LOCATION - TEXAS
VEHICLE - 2004 Lexus RX 330
CRASH DATE - August 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.

Technical Report Documentation Page

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16. <i>Abstract</i> This report covers an on-site investigation of an air bag deployment crash involving a 2004 Lexus RX 330 (case vehicle) and a 1996 Nissan Sentra (other vehicle) four-door sedan. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features, including manufacturer Certified Advanced 208-Compliant (CAC) air bag system, and the case vehicle's driver (58 year-old male) sustained a police reported "C" (possible) injury as a result of the crash. The case vehicle was westbound in the outside lane of a four lane, divided city street and was stopped for the traffic signal at a four leg intersection. The Nissan was traveling southbound in the left, inside through lane of a four lane city street approaching the intersection. The case vehicle proceeded into the intersection from a stop. The front of the Nissan impacted the case vehicle's right side doors and right rear wheel. The impact caused the case vehicle's right side curtain air bag to deploy. The case vehicle then rotated clockwise and rolled over one quarter roll onto its left side. The case vehicle came to final rest on its left side on the west side of the intersection across the two westbound lanes facing southwest. The impact caused the Nissan to rotate clockwise approximately 55 degrees. It came to final rest in the intersection facing southwest. At the time of impact, the case vehicle's driver was seated in an upright position with both hands on the steering wheel, and he was restrained by his manual, three-point lap and shoulder belt. He sustained a contusion to his left thigh from contact with the left front door arm rest as the case vehicle rolled onto its left side. He was treated by EMS at the scene and then subsequently treated by his own doctor. The driver's use of his manual, three-point, lap-and-shoulder safety belt prevented his interaction with the case vehicle's frontal interior components during the initial impact and restrained him in his seat during the rollover.					
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This investigation was brought to NHTSA's attention on or about September 17, 2004 by NASS CDS/GES sampling activities. This crash involved a 2004 Lexus RX330 (case vehicle) and a 1996 Nissan Sentra (other vehicle). The crash occurred in August 2004, at 3:20 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 Advanced Occupant Protection System (AOPS) features, including manufacturer Certified Advanced 208 Compliant (CAC) air bags, as well as an Event Data Recorder (EDR), and the case vehicle's driver [58-year-old, White (non-Hispanic) male] sustained a police reported "C" (possible) injury. This contractor inspected both vehicles and harvested the Electronic Control Unit (ECU), which contains the EDR, on October 7, 2004 and inspected the scene on October 11, 2004. This contractor interviewed a witness on October 27, 2004, and interviewed the driver of the case vehicle on October 28, 2004. This report is based on the police crash report, interviews with the case vehicle's driver and a witness, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was westbound in the outside lane of a four lane, divided city street and was stopped for the traffic signal at a four leg intersection. The Nissan was traveling southbound in the left, inside through lane of a four lane city street approaching the intersection. The case vehicle's driver stated he did not see the approaching Nissan and took no crash avoidance actions. The case vehicle proceeded into the intersection from a stop, and the front of the Nissan impacted the case vehicle's right side doors and right rear wheel. The impact caused the case vehicle's right side curtain air bag to deploy. The case vehicle then rotated clockwise and rolled over one quarter roll onto its left side. The case vehicle came to final rest on its left side on the west side of the intersection across the two westbound lanes facing southwest. The impact caused the Nissan to rotate clockwise approximately 55 degrees. It came to final rest in the intersection facing southwest. The deployment of the case vehicle's right side curtain air bag had no affect on the driver in this crash.

The CDC for the case vehicle's impact with the Nissan was determined to be **02-RZEW-1 (70 degrees)**. The CDC for the rollover was determined to be: **00-LDAO-2**. The WinSMASH reconstruction program, damage only algorithm calculated the case vehicle's Total, Longitudinal, and Lateral Delta Vs for the right side impact respectively as: 12 km.p.h. (7.5 m.p.h.), -4.1 km.p.h. (2.5 m.p.h.), and -11.3 km.p.h. (-7.0 m.p.h.). The collision fits the reconstruction model, but the results appeared to be low. The severity of the rollover was minor.

The CDC for the Nissan was determined to be: **11-FDEW 1 (330 degrees)**. The WinSMASH reconstruction program, damage only algorithm calculated the Nissan's Total, Longitudinal, and Lateral Delta Vs for the front impact respectively as: 20 km.p.h. (12.4 m.p.h.), -17.3 km.p.h. (10.6 m.p.h.), and 10.0 km.p.h. (6.2 m.p.h.). The collision fits the reconstruction model but the results appeared to be low.

Immediately prior to the crash the case vehicle's driver was seated in an upright posture with his back against the seat back. His left foot was on the floor, his right foot was on the accelerator, and both hands were on the steering wheel. His seat track was located in its rear-most position. The seat back was upright, and the tilt steering wheel was located between its center and full down position. The driver was restrained by his manual, three-point, lap-and-shoulder safety belt system, and he was wearing glasses at the time of the crash.

The case vehicle's impact with the Nissan caused the driver's safety belt to lock. The driver continued forward and moved to the right along a path opposite the case vehicle's 70 degree direction of principal force as the case vehicle decelerated longitudinally and accelerated latterly to the left, and he loaded his safety belt. The driver moved to the left against his door as the vehicle rotated clockwise and began to rollover driver side leading. He stayed against the door as the case vehicle rolled over one quarter turn onto its left side. The driver impacted his left thigh against the left front door armrest as the vehicle's left side impacted the ground causing a contusion to his left thigh. The driver remained restrained in his seat following the crash and exited the case vehicle without assistance. The driver's use of his manual, three-point, lap-and-shoulder safety belt prevented his interaction with the case vehicle's frontal interior components during the initial impact and restrained him in his seat during the rollover.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle was traveling was a two-way, divided, city street, traversing in an east and west direction, and the case vehicle was stopped at a four-leg intersection (**Figure 1**). The case vehicle's approach roadway had two through lanes in each direction and was divided by a raised, curbed, grass median. The average lane width was 3.4 meters (11.2 feet), and the median was 4.9 meters (16.1 feet) in width. The trafficway on which the Nissan was traveling was a one-way, undivided city street traversing in a north and south direction. The Nissan's approach roadway was curved to the right with two through lanes, one right turn lane and one left turn lane. The average width of the through lanes was 3.2 meters (10.5 feet). The average width of the turn lanes was 3.6 meters (11.8 feet). Pavement markings for the case vehicle consisted of broken white lane lines, solid white edge lines, and a solid yellow median line. Pavement markings for the Nissan consisted of broken white lane lines, through lane arrows and solid white turn lane edge lines. The approach of both vehicles to the intersection was controlled by three phase traffic signals. The speed limit for the case vehicle was 48 km.p.h. (30 m.p.h.). The speed limit for the Nissan was 56 km.p.h. (35 m.p.h.). At the time of the crash the light condition was daylight, the atmospheric condition was cloudy, and the roadway pavement was dry concrete with a positive 1.5% grade for the case vehicle and a negative 1.2% grade for the Nissan. The estimated roadway coefficient of



Figure 1: Approach of case vehicle westbound in outside lane and stopped for the traffic signal

friction was 0.65. Traffic density was heavy, and the site of the crash was urban commercial. See the Crash Diagram at the end of this report

Pre-Crash: The case vehicle was westbound in the outside lane and was stopped for the traffic signal at the intersection (**Figure 1** above). The Nissan was traveling southbound in the left, inside through lane approaching the intersection (**Figure 2**), and the driver was intending to continue southbound through the intersection. The case vehicle's driver stated he did not see the approaching Nissan and took no avoidance actions. The crash occurred within the intersection of the two trafficways (**Figure 3**).



Figure 2: Approach of Nissan to the intersection, southbound in the inside through-lane

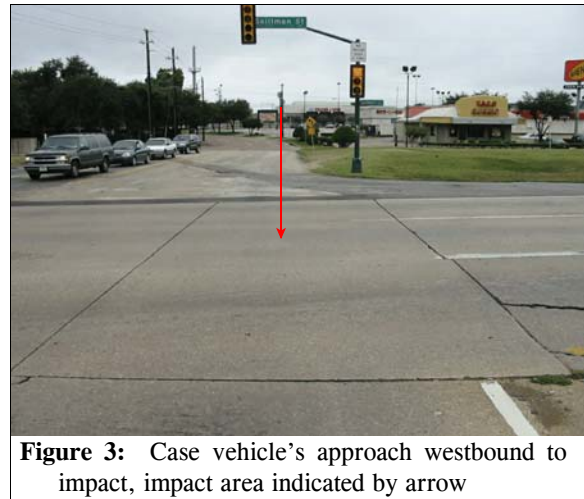


Figure 3: Case vehicle's approach westbound to impact, impact area indicated by arrow



Figure 4: Damage to front of the Nissan from impact with the case vehicle

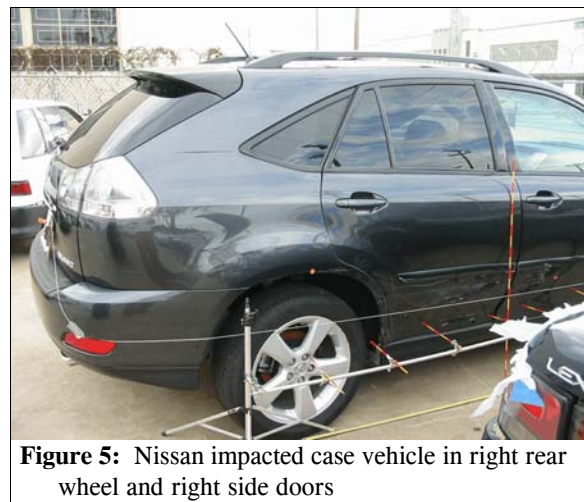


Figure 5: Nissan impacted case vehicle in right rear wheel and right side doors

Crash: The crash occurred as the case vehicle proceeded into the intersection. The front of the Nissan (**Figure 4**) impacted the right side doors and right rear wheel of the case vehicle (**Figure 5**) causing the case vehicle's right side curtain air bag to deploy. The case vehicle rotated clockwise and rolled over one quarter roll onto its left side (**Figure 6** below). The case vehicle's driver air bag, driver knee air bag, front right air bag, and front right seat back-mounted side impact air bag did not deploy because the case vehicle sustained no frontal impact and there was no front right occupant seated in the case vehicle. The weight sensor in the front right seat

properly determined the absence of an occupant and suppressed deployment of the front right seat back-mounted side impact air bag.

Post-Crash: The case vehicle came to final rest on its left side on the west side of the intersection across the two westbound lanes facing southwest (**Figure 7**). The impact caused the Nissan to rotate clockwise approximately 55 degrees. It came to final rest in the intersection facing southwest.



Figure 6: Overview of rollover damage to left side of case vehicle



Figure 7: View southwest to area of final rest of case vehicle (red arrow) and Nissan (green arrow)

CASE VEHICLE

The 2004 Lexus RX330 was a front wheel drive, five-door, sport utility vehicle (VIN: JTJGA31U240-----) equipped with 3.3L, V6 engine; four speed automatic transmission, four wheel anti-lock brakes, electronic traction control, vehicle stability control, and a tire pressure monitor. The front seating row was equipped with dual stage driver and front right passenger air bags, driver knee air bag, front seat back-mounted side impact air bags, front and rear side curtain air bags, driver seat position sensor; and driver and front right passenger, height adjustable, three point, lap-and-shoulder safety belts with belt usage sensors, belt pretensioners and belt force limiters. The back seat was equipped with three point lap and shoulder safety belts in all three seat positions, as well as a child seat lower anchors and tethers (LATCH) system in the outboard seat positions. The front right seat was also equipped with a weight sensor to detect the presence of an occupant. Lastly, the manufacturer of the case vehicle has certified that it meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The case vehicle's wheelbase was 271 centimeters (106.7 inches). The mileage at the time of the vehicle inspection was unknown because the vehicle was equipped with an electronic odometer.

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 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.

Exterior Damage: The case vehicle’s impact with the Nissan involved the right front door, right rear door, right quarter panel, rear portion of the sill, and the right rear wheel. The direct damage began 128 centimeters (50.4 inches) rear of the right front axle and extended 140 centimeters (55.1 inches) along the right side of the case vehicle (**Figure 8**). Crush measurements were taken at the lower door level. The maximum crush was measured as 4.0 centimeters (1.6 inches) occurring at C₄. The C₁ position was located at the right rear wheel, which had been directly impacted by the front left corner of the Nissan. There was no sheet metal crush at this position; however, the right rear wheel was bent in at the front about 3.0 centimeters (1.2 inches).



Figure 8: Damage to right rear wheel, right rear door, sill and right front door [each stripe on rods is 5.0 centimeters (2.0 inches)]

The table below shows the case vehicles right side 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	140	4	155	0	0	2	4	1	0	-64	-55
in		55.1	1.6	61.0	0.0	0.0	0.8	1.6	0.4	0.0	-25.2	-21.7

The case vehicle’s rollover involved the entire left side of the vehicle. The direct damage began immediately rearward of the left headlamp/turn signal assembly and extended down the entire left side of the vehicle (**Figures 9 and 10**). The left fender, left front wheel, left A-pillar, left front door, rear view mirror, left rear door, left roof side rail, left luggage rack, left quarter panel, and left rear wheel were all directly damaged.



Figure 9: Rollover damage to front half of the left side of the case vehicle



Figure 10: Rollover damage to back half of the left side of the case vehicle

The case vehicle’s right side wheelbase was shortened 3.0 centimeters (1.2 inches), and the left side wheelbase was shortened 6.0 centimeters (2.4 inches). Induced damage involved the right front door, right rear door, and the right quarter panel.

The recommended tire size was: P225/65R17; however, the vehicle was equipped with P235/55R18 size tires. 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	207	30	207	30	3	4	Wheel bent in slightly at bottom, abrasions on rim	No	No
RF	207	30	207	30	3	4	None	No	No
LR	200	29	207	30	5	6	Abrasions on rim	No	No
RR	207	30	207	30	4	5	Wheel bent in at front, a few abrasions on rim	No	No

Interior Damage: Inspection of the case vehicle’s interior revealed no evidence of occupant contacts to any interior surfaces or components. No intrusion of the passenger compartment was observed (**Figures 11 and 12**). There was also no evidence of compression of the energy absorbing steering column and no deformation of the steering wheel rim (**Figure 13** below).



Figure 11: Overview of case vehicle’s driver seating area



Figure 12: Overview of case vehicle’s windshield, instrument panel and steering wheel

Damage Classification: Based on the case vehicle inspection, the CDC for the impact with the Nissan was determined to be **02-RZEW-1 (70 degrees)**. The CDC for the rollover was determined to be: **00-LDAO-2**. The WinSMASH reconstruction program, damage only algorithm was used to reconstruct the Delta Vs for the case vehicle's right side impact. The Total,

Longitudinal, and Lateral Delta Vs are, respectively: 12 km.p.h. (7.5 m.p.h.), -4.1 km.p.h. (2.5 m.p.h.), and -11.3 km.p.h. (-7.0 m.p.h.). The collision fits the reconstruction model but the results appeared to be low. The low Delta-V results are partly due to the small amount of crush sustained by the case vehicle. It is this contractor's opinion that the case vehicle's crush was minimal because the front left corner of the Nissan impacted the case vehicle's right rear wheel, which is a very stiff component. The impact to the right rear wheel resulted in a rapid clockwise rotation of the case vehicle, and prevented the Nissan from penetrating deeper into the sheet metal of the case vehicle's right side doors.



Figure 13: Left side view of case vehicle's steering column and steering wheel showing no damage

Based on the damage to the left side of the case vehicle, the severity of the rollover was minor. The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a certified advanced 208-compliant air bag system. The case vehicle's driver air bag was located in the steering wheel hub. The driver knee air bag was located in the lower left instrument panel, and the front right passenger air bag was located in the middle of the instrument panel, above the glove box door (Figure 14). The driver's air bag and knee air bag did not deploy because there was no frontal impact, and the longitudinal deceleration due to the right side impact was not severe enough to require a deployment. The front right air bag and front right seat back-mounted side impact air bag did not deploy because the occupant weight sensor in the front right seat determined no occupant was on the seat and suppressed the deployment of the air bags.



Figure 14: Case vehicle's front right air bag located in middle of instrument panel above glove box door

The case vehicle's right side curtain air bag was located in the right roof side rail and right A-pillar. The right side curtain air bag deployed due to the Nissan's impact to the right side of the case vehicle. There was no evidence of damage to the air bag due to the deployment. The deployed right side curtain air bag was rectangular in shape (Figures 15 and 16 below) with a width of approximately 173 centimeters (68.1 inches) and a height of approximately 36 centimeters (14.2 inches). The air bag was attached to the right A-pillar by a triangular shaped anchor strap that was approximately 30 centimeters (11.8 inches) in length at the bottom and was sewn to the front edge of the air bag (Figure 15 below). The air bag had horizontal creases in it indicating it was folded accordion style in its stowed position. The air bag stitching formed three pillow

shaped chambers adjacent to the front right seat (**Figure 15**) and a rectangular chamber and one pillow shaped chamber adjacent to the back right seat (**Figure 16**).



Figure 15: Front portion of case vehicle's right side curtain air bag, each increment on rods is 5.0 centimeters (2.0 inches)



Figure 16: Back portion of case vehicle's right side curtain air bag

CRASH DATA RECORDING

The ECU, which houses the EDR, was harvested from the case vehicle and sent to Washington, D.C., and subsequently forwarded to the manufacturer for download. The data indicated that the case vehicle was not equipped with a side air bag rollover sensor. In addition, no other data was recorded because the case vehicle's front air bags did not deploy in the crash.

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [58-year-old, White (non-Hispanic) male; 175 centimeters and 77 kilograms (69 inches, 170 pounds)] was seated in an upright posture with his back against the seat back. His left foot was on the floor, his right foot was on the accelerator, and both hands were on the steering wheel. His seat track was located in its rear-most position. The seat back was upright, and the tilt steering column was located between its center and full down position. In addition, the case vehicle's driver was wearing glasses at the time of the crash.

The case vehicle's driver stated he was using his manual, three-point, lap-and-shoulder safety belt system. The safety belt system was equipped with a retractor mounted pretensioner and load limiter. Manipulation of the safety belt revealed it was free to move in and out of the retractor, indicating that the pretensioner most likely did not activate in this crash. Inspection of the safety belt assembly revealed no load markings on the safety belt webbing, latch plate, or "D"-ring. However, numerous scratches on the latch plate indicated the seat belt had been used regularly.

The case vehicle's driver stated in his interview that he took no pre-crash avoidance actions because he never saw the approaching Nissan. As a result, his pre-impact seating position did not change, and he remained in his upright driving position at the time of the impact. The case

vehicle's impact with the Nissan caused the driver's safety belt retractor to lock. The driver continued forward and moved to the right along a path opposite the case vehicle's 70 degree direction of principal force as the case vehicle decelerated longitudinally and accelerated latterly to the left, and he loaded his safety belt. The driver moved to the left against his door as the case vehicle rotated clockwise and began to roll over driver side leading. He stayed against the door as the case vehicle rolled over one quarter turn onto its left side. The driver impacted his left thigh against the left front door armrest as the vehicle's left side impacted the ground causing a contusion to his left thigh. The driver remained restrained in his seat following the crash and exited the case vehicle without assistance. The driver's use of his manual, three -point, lap-and-shoulder safety belt prevented his interaction with the case vehicle's frontal interior components during the initial impact and restrained him in his seat during the rollover. The deployment of the case vehicle's right side curtain air bag had no affect on the driver in this crash.

CASE VEHICLE DRIVER INJURIES

The police crash report indicated the driver sustained a "C" (possible) injury and was treated at the scene by EMS personnel. The driver stated he visited his doctor subsequent to the crash and was treated and released. He did not miss any work days as result of the crash, and sought no other treatment. The table below shows the case vehicle driver's injury and injury mechanism.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion {bruise} left thigh, not further specified	minor 890402.1,2	Left side interior hardware and/or armrest	Probable	Interviewee (driver)

OTHER VEHICLE

The 1996 Nissan Sentra XE was a front wheel drive, four-door sedan (VIN: 3N1AB41D4T1-----) equipped with a 1.6L, I4 engine and a three speed automatic transmission. Four wheel anti-lock brakes were an option, but it is not known if the Nissan was so equipped. The vehicle was also equipped with driver and front right passenger air bags that deployed as a result of the impact with the case vehicle.

Exterior Damage: The Nissan's front impact with the case vehicle involved the full front end of the vehicle. The front bumper, hood, grille and front of the fenders were directly contacted and crushed rearward. The direct damage began at the left front bumper corner and extended 141 centimeters (55.5 inches) across the front end of the vehicle. The residual maximum crush was measured at 20 centimeters (7.9 inches) occurring at C₂ and C₃. The table below shows the Nissan's 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	141	20	320	19	20	20	18	16	16	0	0
in		55.5	7.9	126.0	7.5	7.9	7.9	7.1	6.3	6.3	0.0	0.0

The Nissan's right side wheelbase was shortened 1 centimeter (0.4 inch), while the left side wheelbase was unchanged. Induced damage involved both fenders and the hood. In addition, the deployment of the front right passenger air bag fractured the windshield.

The Nissan's recommended tire size was: P175/70R13, and the vehicle was equipped with tires of this size. The Nissan'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	221	32	228	33	4	5	None	No	No
RF	200	29	228	33	5	6	None	No	No
LR	179	26	200	29	5	6	None	No	No
RR	179	26	200	29	5	6	None	No	No

Damage Classification: Based on the vehicle inspection, the CDC for the Nissan was determined to be: **11-FDEW 1 (330 degrees)**. The WinSMASH reconstruction program, damage only algorithm was used to reconstruct the Delta Vs for the Nissan's front impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 20 km.p.h. (12.4 m.p.h.), -17.3 km.p.h. (-10.6 m.p.h.), and 10.0 km.p.h. (6.2 m.p.h.). The collision fits the reconstruction model but the results appear to be low. The Nissan was towed due to damage.

Nissan's Occupant: According to the police crash report, the Nissan's driver [65-year-old, White (unknown if Hispanic) female] was restrained by her manual, three-point, lap-and-shoulder safety belt system. The police crash report indicated the driver sustained a "C" (possible) injury and was treated at the scene by EMS personnel.

