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ON-SITE ROLLOVER INVESTIGATION

CASE NUMBER - IN10014
LOCATION - TEXAS
VEHICLE - 2010 NISSAN ROGUE SL
CRASH DATE - March 2010

Submitted:

July 6, 2010

Contract Number: DTNH22-07-C-00044

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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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15. *Supplementary Notes* On-site rollover investigation involving a 2010 Nissan Rogue SL.			
16. *Abstract* This on-site investigation focused on the rollover of a 2010 Nissan Rogue SL. The crash involved the Nissan and a 2007 Lexus IS 250 that crashed within a 4-leg urban intersection. The restrained 32-year-old male driver of the Nissan was traveling northwest in the through/left turn lane. The driver was in the process of executing a left turn at the intersection, intending to proceed south. The Lexus was stopped at the intersection in the second lane from the right heading southeast. The driver proceeded into the intersection on a green traffic signal. The front plane of the Lexus impacted the right side plane of the Nissan (event 1). The direction of force on the Nissan was within the 2 o'clock sector and the impact force was sufficient to trigger deployment of the Nissan's rollover/side impact inflatable curtain (IC) air bags and seat-mounted side impact air bags. Following the impact, the Nissan rotated clockwise and rolled over (event 2), left side leading two quarter turns. The Nissan came to final rest on its top plane heading north in the mouth of the south leg of the intersection. The driver of the Nissan sustained a police-reported C (possible) injury. He was treated at the crash scene by emergency medical personnel and was not transported. The Nissan was towed due to damage. The driver of the Lexus was not injured and drove the Lexus from the crash scene.			
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This on-site investigation focused on the rollover of a 2010 Nissan Rogue SL (**Figure 1**). This crash was brought to the attention of the National Highway Traffic Safety Administration (NHTSA) on March 29, 2010 by the sampling activities of the National Automotive Sampling System (NASS). This investigation was assigned on April 12, 2010. The crash involved the Nissan and a 2007 Lexus IS 250. The crash occurred in March, 2010 at 1835 hours, in Texas and was investigated by the city police. The Nissan and crash scene were inspected on April 15, 2010. The Lexus had been repaired and was not inspected. This report is based on the police crash report, vehicle and crash scene inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

Figure 1: The damaged 2010 Nissan Rogue SL

CRASH CIRCUMSTANCES

Crash Environment: This crash occurred within an interchange area on a 10-lane, divided city street at dusk during clear weather conditions. The roadway traversed in a northwest-southeast direction and both vehicles were approaching a 4-leg intersection with a U.S. Highway service road. The northwestbound roadway had three through lanes, a through/left turn lane, and a left turn lane. It was separated from the southeast bound roadway by a raised concrete median. The southeastbound roadway had five through lanes and was separated from the northwestbound roadway by a raised concrete median. The roadways were bordered by 15 cm (6 in) curbs. Each travel lane was approximately 3.7 m (12 ft) in width. The roadway pavement markings consisted of broken white lane lines and designated pedestrian crossings at the intersection. The posted speed limit was 64 km/h (40 mph) and the intersection was controlled by 3-phase traffic signals. Both roadways were dry, level concrete. The traffic density was moderate and the site of the crash was urban commercial. The Crash Diagram is on page 8 of this report.

Pre-Crash: The restrained 32-year-old male driver of the Nissan was traveling northwest in the through/left turn lane. The driver was in the process of executing a left turn at the intersection (**Figure 2**), intending to proceed south on the service road. The Lexus was stopped at the intersection in the second lane from the right (**Figure 3**) heading southeast. The driver proceeded into the intersection when the traffic signal changed to green. The driver intended to proceed straight through the intersection.

Figure 2: Travel path of the Nissan to impact area

Crash: The front plane of the Lexus impacted the right side plane of the Nissan (**Figure 4**) (event 1). The direction of force on the Nissan was within the 2 o'clock sector and the impact force was sufficient to trigger deployment of the Nissan's rollover/side impact inflatable curtain (IC) air bags and seat-mounted side impact air bags. Following the impact, the Nissan rotated clockwise and rolled over (event 2), left side leading two quarter turns. The Nissan came to final rest on its top plane heading north in the mouth of the south leg of the intersection. The Lexus rotated clockwise and came final rest in the intersection heading southeast.

Figure 3: Approach of the Lexus to the intersection

Figure 4: Damage on the right side of the Nissan from the impact with the front of the Lexus

Post-Crash: The police were notified of the crash at 1839 hours and arrived at the crash scene at 1906 hours. Rescue and medical personnel also responded to the scene. The driver of the Nissan sustained minor injuries and was treated at the cash scene. The driver of the Lexus was not injured. Both vehicles were towed due to damage.

ROLLOVER DISCUSSION

The Nissan's rollover mitigation features consisted of Electronic Stability Control (ESC) and a rollover sensor. The NHTSA has given the vehicle a four star rollover rating on a five star scale and a Static Stability Factor of 1.18[1]. A four star rating indicates that the vehicle has a 10%-20% chance of a rollover when involved in a single vehicle crash. The specific chance of rollover for this vehicle model was given as 19%. The Static Stability Factor (SSF) is a calculation based on the vehicle's track width and height of its center of gravity. The result of the calculation is a measure of a vehicle's resistance to rollover. A higher SSF indicates a more stable vehicle. The majority of passenger vehicles have an SSF of 1.30 to 1.50[2]. The NHTSA test vehicle also did not tip-up during the dynamic steering maneuver test in which the test vehicle was put through a fish-hook shaped steering maneuver (i.e., hard left and hard right steer) at between 56 km/h-80km/h (35-50 mph).

The rollover of the Nissan was initiated by the impact with the Lexus. The impact on the Nissan occurred on the right rear wheel and quarter panel, which induced a rapid clockwise rotation causing the vehicle to rollover, left side leading two quarter turns onto its top plane.

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[1] www.safercar.gov, 5/7/10

[2] "Trends in the Static Stability Factor of Passenger Cars, Light Trucks, and Vans", NHTSA Technical Report, DOT HS 809 868, June 2005

Based on the police crash schematic it was estimated that the vehicle rolled over across a distance of approximately 7 m (23 ft).

CASE VEHICLE

The 2010 Nissan Rogue SL was a front-wheel drive, 4-door, sport utility vehicle (VIN: JN8AS5MT1AW------) that was manufactured in July, 2009. It was equipped with a 2.5-liter, 4-cylinder engine, automatic transmission, 4-wheel anti-lock vented disc brakes with electronic brake force distribution, brake assist, traction control, and Electronic Stability Control (ESC). The front row was equipped with bucket seats with active head restraints, lap-and-shoulder safety belts with pretensioners and load limiters, dual stage driver and front right passenger frontal air bags, seat-mounted side impact air bags, and IC air bags that provided protection for the front and second row outboard seating positions. The second row was equipped with a split bench seat with folding backs, integral head restraints at the outboard seating positions, lap-and-shoulder safety belts, and Lower Anchors and Tethers for Children (LATCH) in the outboard seating positions. The vehicle's specified wheelbase was 269 cm (105.9 in).

CASE VEHICLE DAMAGE

Exterior Damage: The Nissan sustained right side plane damage during the impact with the Lexus. The right rear wheel, right quarter panel, and rear bumper fascia were directly damaged. The direct damage began 257 cm (101 in) rear of the right front axle and extended 93 cm (36.6 in) along the side of the right quarter panel and back bumper fascia. The crush measurements were taken along the middle portion of the quarter panel and the maximum residual crush was measured as 5 cm (2 in) at C_2. The right wheelbase was extended 2 cm (0.8 in) and the left wheelbase was extended 1 cm (0.4 in). The table below presents the 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	93	5	93	0	5	4	3	1	0	-168	-168
in		36.6	2.0	36.6	0.0	2.0	1.6	1.2	0.4	0.0	-66.1	-66.1

The top and left side planes of the Nissan sustained direct damage during the rollover. The direct damage on the top plane began at the front of the hood and extended 271 cm (107 in) rearward, and involved the full width of the roof, 130 cm (51 in). The direct damage on the left side plane began 38 cm (15 in) forward of the left front axle and extended 352 cm (138 in) rearward along the left side, A-pillar, and roof rail. The right fender and sideview mirror were damaged when the vehicle was rolled back onto its wheels during removal operations. The maximum vertical crush (**Figure 5**) was 3 cm (1.2 in) and occurred at the right corner of the windshield header, 107 cm (42 in) rear of the front axle. There was no lateral crush.

Damage Classification: The Nissan's Collision Deformation Classifications were 02RBEW1 (60 degrees) for the right side plane impact with the Lexus and 00TYDO2 for the rollover. The Missing Vehicle algorithm of the WinSMASH program calculated the Nissan's total Delta-V for the right side impact as 4 km/h (2.5 mph). The longitudinal and lateral velocity changes were -2 km/h (-1.2 mph) and -3 km/h (-1.9 mph), respectively. The results appeared low since the right rear wheel was directly engaged resulting in negligible crush on the sheet metal of the quarter panel. Based on the extent of the roof crush, the severity of the rollover damage was minor.

Figure 5: The maximum crush occurred on the right windshield header

The vehicle manufacturer's recommended tire size was P225/60R17. The Nissan was equipped with tires of the recommended size. The vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	241	35	228	33	7	9	None	No	No
LR	248	36	228	33	8	10	None	No	No
RR	248	36	228	33	8	10	None	No	No
RF	248	36	228	33	6	8	None	No	No

Vehicle Interior: The inspection of the Nissan's interior revealed no discernable evidence of occupant contact. There was no deformation of the steering wheel or compression of the energy absorbing steering wheel.

All the vehicle's doors remained closed and operational. The pre-crash status of all the window glazings was either fixed for operable windows or closed the others. The left and right front glazings were disintegrated from to the rollover. The vehicle did not sustain any passenger compartment intrusions.

AUTOMATIC RESTRAINT SYSTEM

The Nissan was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that consisted of dual stage driver and front passenger frontal air bags, driver seat position sensor, safety belt sensors, a pattern recognition sensor in the right front passenger seat, and

retractor mounted pretensioners with load limiters. The manufacturer has certified that the vehicle is compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. Neither of the frontal air bags deployed in this crash.

The Nissan was also equipped with IC air bags and front seat-mounted side impact air bags. The side impact sensors were located in the lower B-pillars. Both IC air bags and both seat-mounted side impact air bags deployed in this crash.

Figure 6: Left side IC and seat-mounted side impact air bags

The IC air bags were located along the roof side rails inside the headliner (**Figure 6**) and extended from the top of the A-pillar to slightly behind the C-pillar. The deployed IC air bags were 154 cm (60.6 in) in width and 61 cm (24 inches) in height. They were attached at the front end by a non-inflating fabric that was 23 cm (9.1 in) wide. This fabric was connected to the IC air bags by a 10 cm (3.9 in) rope tether. The IC air bags extended 20 cm (7.9 in) below the beltline. There was no visible tether at the C-pillar. Inspection of the IC air bags revealed no discernable evidence of occupant contact, and they did not sustain damage.

Figure 7: Driver's seat mounted side impact air bag

The driver's seat-mounted side impact air bag was located in the outboard side of the driver's seat back and deployed through vertical tear seam. The deployed air bag (**Figure 7**) was 53 cm (20.9 inches) in height and 21 cm (8.2 in) in width. There was one vent port, 3 cm (1.2 in) in diameter, located at the top of the outboard side. Inspection of the deployed air bag revealed no damage and no discernable evidence of occupant contact.

The passenger's seat-mounted side impact air bag was located in the outboard side of the passenger's seat back and deployed along a vertical tear seam. The deployed air bag was 29 cm (11.4 in) in height and 21 cm (8.2 in) in width. There were no vents or tethers and inspection of the deployed air bag showed no damage.

The Nissan was equipped with lap-and-shoulder safety belts for the driver and front passenger seating positions. The driver's safety belt consisted of continuous loop belt webbing, an Emergency Locking Retractor (ELR), sliding latch plate, and an adjustable upper anchor that was in the full-up position. The front passenger safety belt consisted of continuous loop belt webbing, an ELR/Automatic Locking Retractor (ALR), sliding latch plate, and an adjustable upper anchor that was located in the full-up position. The driver and front right passenger safety belts were equipped with retractor-mounted pretensioners and load limiters. The second row lap-and-shoulder safety belts were similar to the front passenger safety belt but had fixed upper anchors and no pretensioners.

Figure 8: The front right passenger's seat-mounted side impact air bag

Inspection of the driver's safety belt assembly revealed load marks on the belt webbing located 126 cm (49.6 in) from the stop button (**Figure 9**). The latch plate showed historical usage scratches and load abrasions were present on the latch plate belt guide. This evidence indicated that the driver was restrained by the lap-and-shoulder belt at the time of the crash. Actuation of the pretensioner could no be confirmed since the retractor was not jammed and spooled freely.

Figure 9: Load marks on the driver's safety belt webbing

Inspection of the front right passenger safety belt assembly revealed that the retractor-mounted pretensioner actuated in the crash. The belt webbing was retracted and locked tightly. This seat position and the remaining seat positions were unoccupied.

CASE VEHICLE DRIVER KINEMATICS

Nissan's driver (32-year-old, male; unknown height and weight) was seated in an unknown posture. The seat track was adjusted to the rear position, the seat back was slightly reclined and the head restraint was adjusted to the full-up position. The distance from the top of the seat back to the top of head restraint was 28 cm (11 in). The tilt steering column was located in the full down position.

The initial impact to the right quarter panel of the Nissan displaced the driver to the right and forward, opposite the 2 o'clock direction of force and he loaded the safety belt. As the vehicle rolled over to its left side and onto the top plane, the driver was redirected to the left and toward the roof and loaded the safety belt again. While there was no discernable evidence of occupant contact on the left IC air bag and seat-mounted side impact air bag, the driver probably contacted these air bags during the rollover. There was no discernable evidence to suggest that the driver contacted the roof during the rollover.

CASE VEHICLE DRIVER INJURIES

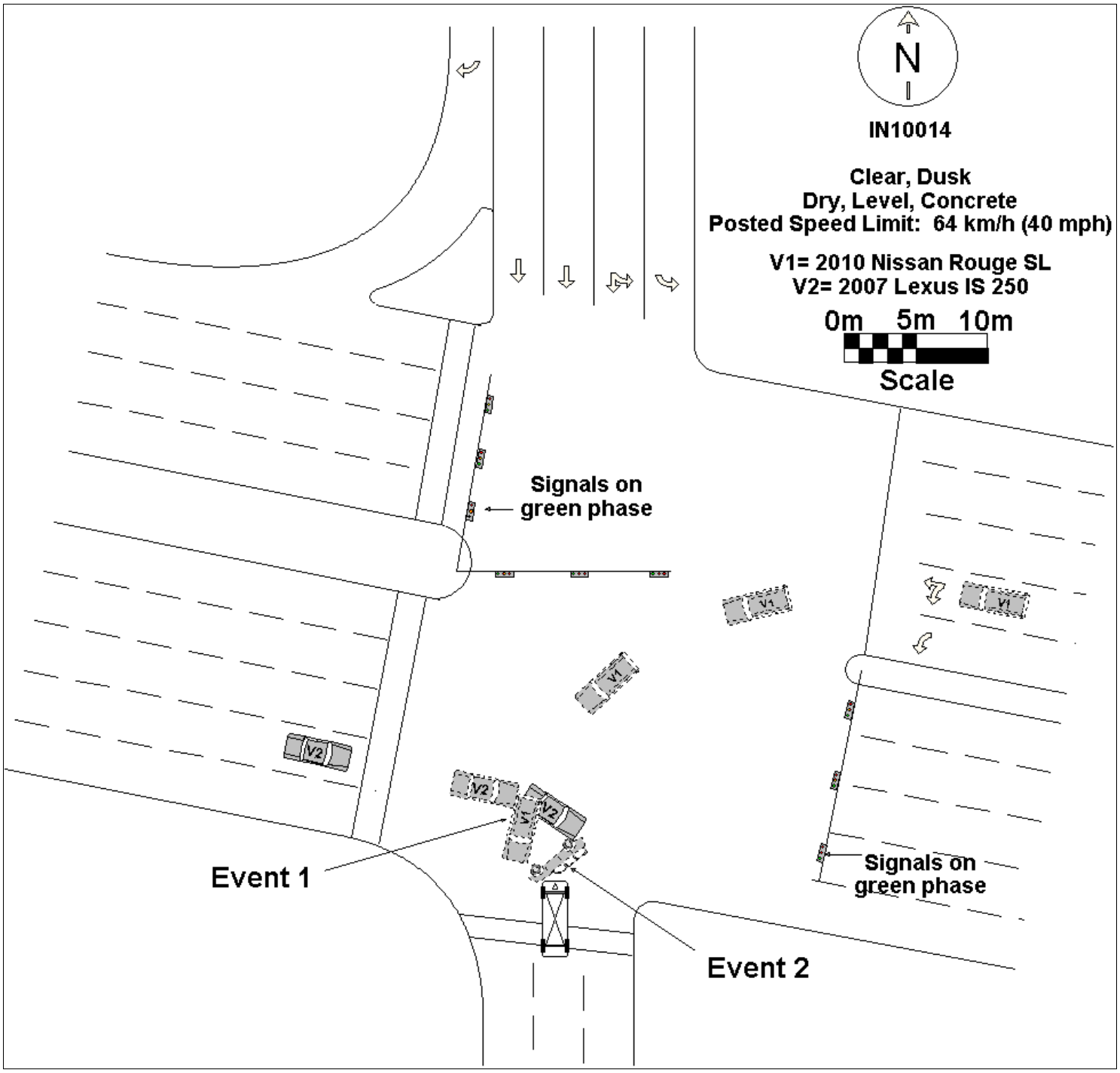
The driver sustained a police-reported C (possible) injury and was treated at the scene by emergency medical personnel. He was not transported to a medical facility. The driver could not be located for an interview and his injuries are unknown.

OTHER VEHICLE

2007 Lexus IS 250 was a rear wheel drive, 5-passenger, 4-door sedan (VIN: JTHBK262372-----) equipped with a 2.5 liter, V-6 engine and a 6-speed transmission. The Lexus was equipped with 4-wheel, anti-lock brakes with electronic brake force distribution, and braking assist, traction control, and electronic stability control. The front row was equipped with dual stage driver and front right passenger frontal air bags, river seat position sensor, front right passenger weight sensor, front seat-mounted side impact air bags, and side impact IC air bags protecting all outboard seating positions. The frontal air bags on this vehicle are certified by the manufacturer to be compliant with the Advanced Air Bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. None of the air bags deployed during the crash. The Lexus was repaired and was not inspected.

The Missing Vehicle algorithm of the WinSMASH program calculated the total Delta-V for the front plane impact on the Lexus as 4 km/h (2.5 mph). The longitudinal and lateral velocity changes were –3 km/h (-1.9 mph) and 2 km/h (1.2 mph), respectively. The results should be considered borderline since they are based only on the crush on the Nissan.

Other Vehicle's Driver: The police crash report indicated that the driver of the Lexus (34-year-old female) was restrained by her lap-and-shoulder safety belt. She was not injured and was not transported for medical treatment.


N
IN10014
Clear, Dusk
Dry, Level, Concrete
Posted Speed Limit: 64 km/h (40 mph)
V1= 2010 Nissan Rouge SL
V2= 2007 Lexus IS 250
0m 5m 10m
Scale
Signals on green phase
Signals on green phase
Event 1
Event 2
V1
V2