

On-Site Certified Advanced 208-Compliant Air Bag Investigation  
Dynamic Science, Inc. (DSI), Case Number DS08034  
2008 Lexus RX350  
Washington  
August 2008

---

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

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

The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points 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.

---

1. Report No. DS08034	2. Government Accession No.	3. Recipient Catalog No.	
4. Title and Subtitle On-Site Certified Advanced 208-Compliant Air Bag Investigation		5. Report Date September 3, 2009	
		6. Performing Organization Report No.	
7. Author(s) Dynamic Science, Inc.		8. Performing Organization Report No.	
9. Performing Organization name and Address Dynamic Science, Inc. 299 West Cerritos Avenue Anaheim, CA 92805		10. Work Unit No. (TRAIS)	
		11. Contract or Grant no. DTNH22-07-00045	
12. Sponsoring Agency Name and Address U.S. Dept. of Transportation (NVS-411) National Highway Traffic Safety Administration 1200 New Jersey Ave, SE Washington, DC 20590		13. Type of report and period Covered [Report Month, Year]	
		14. Sponsoring Agency Code	
15. Supplemental Notes			
<p>16. Abstract</p> <p>This on-site Certified Advanced 208-Compliant (CAC) Air Bag Investigation focused on the air bags in a 2008 Lexus RX350 that was involved in a frontal crash with a 1992 Chevrolet K1500 Blazer. The Lexus was equipped with advanced dual-stage Certified Advanced 208-Compliant (CAC) driver and front right passenger frontal air bags. The air bags were certified by the manufacturer to be compliant with the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208.</p> <p>The crash occurred in August 2008 in the state of Washington. The crash site was at the intersection of a north/south roadway and a commercial driveway. The Lexus was being driven southbound by a 49-year-old female. The Chevrolet was being driven northbound by a 21-year-old male. The driver of the Chevrolet initiated a left turn across a two-way left turn lane and the southbound travel lanes and the front end of the Chevrolet impacted the front end of the Lexus. At impact, the Lexus' frontal air bags and the driver's knee air bag deployed.</p> <p>The driver and front right occupant of the Lexus sustained moderate injuries and were transported to a local hospital. The Lexus was towed due to damage and was later declared a total loss by the insurance company. The driver of the Chevrolet was not injured and the vehicle was driven from the scene.</p>			
17. Key Words Air bag, injury, CAC, Certified Advanced 208-Compliant		18. Distribution Statement	
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price

**Dynamic Science, Inc.**  
**Crash Investigation**  
**Case Number: DS08034**

**TABLE OF CONTENTS**

Background. ....	1
Summary. ....	1
Crash Site.....	1
Pre-Crash. ....	2
Crash. ....	2
Post-Crash. ....	3
Vehicle Data - 2008 Lexus RX350. ....	3
Vehicle Damage	
Exterior Damage. ....	4
Interior Damage. ....	4
Manual Restraints. ....	5
Supplemental Restraint Systems. ....	5
Vehicle Data - 1992 Chevrolet K1500 Blazer.....	7
Occupant Demographics. ....	7
Occupant Kinematics.....	8
Occupant Injuries.....	9
Attachment 1. Scene Diagram. ....	10

## Background

This on-site Certified Advanced 208-Compliant (CAC) Air Bag Investigation focused on the air bags in a 2008 Lexus RX350 (**Figure 1**) that was involved in a frontal crash with a 1992 Chevrolet K1500 Blazer. The Lexus was equipped with advanced dual-stage Certified Advanced 208-Compliant (CAC) driver and front right passenger frontal air bags. The air bags were certified by the manufacturer to be compliant with the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208.



**Figure 1.** Subject vehicle, 2008 Lexus RX350

The crash occurred in August 2008 in the state of Washington. The crash site was at the intersection of a north/south roadway and a commercial driveway.

The Lexus was being driven southbound by a 49-year-old female and was occupied by a 48-year-old female passenger. The Chevrolet was being driven northbound by a 21-year-old male. The driver of the Chevrolet initiated a left turn across a two-way left turn lane and the southbound travel lanes and the front end of the Chevrolet impacted the front end of the Lexus. At impact, the Lexus' frontal air bags and the driver's knee air bag deployed.

The driver and front right occupant of the Lexus sustained moderate injuries and were transported to a local hospital. The Lexus was towed due to damage and was later declared a total loss by the insurance company. The driver of the Chevrolet was not injured and the vehicle was driven from the scene.

This investigation was initiated by the National Highway Traffic Safety Administration (NHTSA) as a result of the sampling activities of the General Estimates System (GES). On August 26, 2008, DSI was forwarded the police report with instructions to obtain cooperation. On September 3, 2008, DSI obtained permission to inspect the subject vehicle, and the inspection was completed on September 16, 2008.

## Summary

### Crash Site

The crash site was at the intersection of a north/south roadway and a commercial driveway (**Figure 2**). The north/south roadway was configured with two lanes for each direction of travel and a center two-way left turn lane. The through lanes were separated by white dash stripes and the two-way left turn lane was separated from the through lanes by yellow dashed and solid stripes. The roadway was straight, level, and had a asphalt surface. The roadway was bordered on each side with raised curbs and sidewalks. The posted speed limit was 56 kmph (35 mph).

Approximately 30 m (100 ft) west of the roadway was a commercial shopping center. The entrance/exit to the shopping center parking lot was a two-way paved and level driveway that was 9.1 m (30.0 ft) in width.

### Pre-Crash

This crash occurred in August 2008 during daylight at 1903 hours. The weather was clear and the roadway was dry. The Lexus was being driven by a 49-year-old female and was traveling southbound in the inboard lane at a driver-estimated speed of 56-61 km/h (35-38 mph) (**Figure 3**). A 48-year-old female occupant was seated in the vehicle's front row right position. The driver of the Lexus had both hands on the steering wheel, her right foot on the accelerator, and her left foot on the floor. She observed the Chevrolet approaching from the opposite direction; she braked and steered to the right in an evasive response.

The Chevrolet was being driven by a 21-year-old male and was traveling northbound in the inboard lane. The driver of the Chevrolet initiated a left turn with the intention of entering the commercial shopping center parking lot from the driveway to the west of the roadway. The Chevrolet traveled across the two-way left turn lane, then entered the path of the Lexus in the inboard southbound lane.

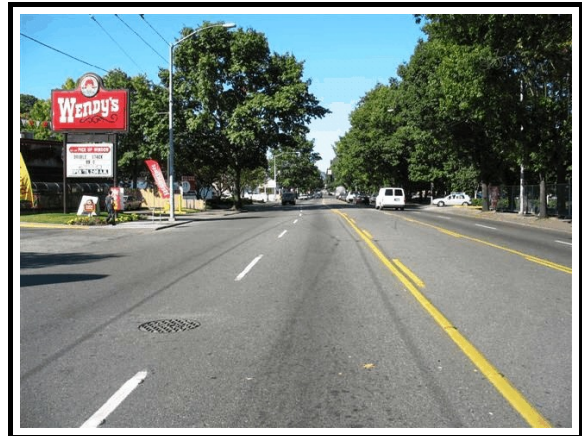
### Crash

The front end of the Chevrolet impacted the front end of the Lexus. The principal direction of force was in the 11 o'clock sector.

For the Lexus, the Missing Vehicle algorithm of the WinSMASH program computed a Total Delta-V of 36 km/h (22.4 mph); the longitudinal and lateral components were -33.8 km/h (-21.0 mph) and 12.3 km/h (7.6 mph), respectively. The WinSMASH results appear reasonable based on the Lexus' crush profile.

For the Chevrolet, the Missing Vehicle algorithm of the WinSMASH program computed a Total Delta-V of 33 km/h (20.5 mph); the longitudinal and lateral components were -32.5 km/h (-20.2 mph) and -5.7 km/h (-3.5 mph), respectively. The results appear reasonable based on the borderline reconstruction.

At impact, the frontal air bags in the Lexus deployed. The driver's knee air bag also deployed, and



**Figure 2.** Crash site, looking north



**Figure 3.** Southbound approach, subject vehicle

the front row safety belt retractor pretensioners actuated. After the impact, the vehicles disengaged, were displaced a short distance, and then came to rest on the roadway near the point of impact.

### **Post-Crash**

After the crash, the driver of the Lexus exited the vehicle via the first row left side door with assistance from on-scene responders. She was transported by ground ambulance to a local hospital, treated in the emergency room, and released approximately four hours later. The driver sustained injuries including a cervical strain, abrasions and contusions to the left neck and chest, and bilateral lower leg abrasions. The police reported a driver loss of consciousness at the crash site. She sought chiropractic treatment later for her cervical strain, and missed four weeks of work due to her injuries.

The first row right occupant exited the vehicle via the front row right side door with assistance from on-scene responders. She was transported by ground to a local hospital, treated in the emergency room, and released approximately four hours later. The occupant sustained injuries including cervical strain and abdominal contusions. She missed approximately eight weeks of work due to her injuries.

The Lexus was towed from the scene due to damage and was later declared a total loss by the insurance company.

The driver of the Chevrolet did not report any injuries. He stated to police that he had been in a previous crash less than one block from, and only minutes before, the crash involving the Lexus. Details of the first crash were unknown. The driver explained to police that he was attempting to enter the parking lot so that he could turn around and travel northbound. He stated that after the first crash he was unable to turn his vehicle around to travel northbound, so he proceeded southbound until he reached the driveway entrance. The driver indicated he was upset from the first crash when he attempted to turn left into the parking lot. The Chevrolet was not towed and was driven from the scene by the owner.

### **Vehicle Data - 2008 Lexus RX350**

The 2008 Lexus RX350 was a 4-door sport utility vehicle with a rear hatch. The vehicle was identified by the Vehicle Identification Number (VIN): 2T2HK31U58Cxxxxxx and the date of manufacture was December 2007. The vehicle's electronic odometer could not be read due to the absence of power to the vehicle. The Lexus was equipped with a 3.5-liter, 6-cylinder engine, automatic transmission, all wheel drive transmission, and standard daytime running lights. It was equipped with 4-wheel standard anti-lock braking system (ABS), 4-wheel disc brakes, and ventilated discs on the front. Standard equipment included stability and traction control features. The vehicle manufacturer's recommended tire size was P235/55R18 and the recommended cold tire pressure was 207 kPa (30 psi). The vehicle was equipped with Goodyear Eagle RS-A P235/55R18 tires, which had a tire manufacturer's recommended maximum tire pressure of 303 kPa (44 psi). The tires were manufactured in November 2007. The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	234 kPa (34 psi)	6 mm (8/32 in)	No	None
LR	228 kPa (33 psi)	6 mm (8/32 in)	No	None
RR	234 kPa (34 psi)	6 mm (8/32 in)	No	None
RF	214 kPa (31 psi)	6 mm (8/32 in)	No	None

The Lexus' front row seating was configured with leather-covered bucket seats and adjustable head restraints. The second row seating was configured with a leather-covered split bench seat with folding backs and adjustable head restraints for the three seating positions.

## Vehicle Damage

### Exterior Damage

The Lexus sustained moderate front end damage as a result of the impact with the Chevrolet (**Figure 4**). The front bumper fascia and backing bar were detached from the vehicle, the hood was buckled and the left and right front fenders and headlamps were missing. The bumper backing bar was located in the vehicle's cargo area and was fractured. The radiator was displaced rearward and there was damage to components within the engine compartment.



**Figure 4.** Front end damage, subject vehicle

The front bumper fascia was found within the vehicle's rear cargo area and was used to measure the location and extent of direct damage. The direct damage to the front end began at the front left bumper corner, extended 142 cm (14.2 in) to the right, and ended at the front right bumper corner. Crush measurements were taken at the left and right front bumper mounts and the lower radiator support as follows: C1 = 27 cm (10.6 in), C2 = 25 cm (9.8 in), C3 = 23 cm (9.1 in), C4 = 19 cm (7.5 in), C5 = 15 cm (5.9 in), C6 = 11 cm (4.3 in). The maximum crush to the front end measured 27 cm (10.6 in) and was located at C1. The Collision Deformation Classification (CDC) for the first impact was 11FDEW2.

### Interior Damage

The Lexus sustained minor interior damage as a result of impact damage and occupant contacts. The windshield was cracked and in place and the roof glazing was disintegrated. There were no passenger compartment intrusions and the occupant contacts were located on the deployed air bags.



## Manual Restraints

The Lexus was equipped with 3-point manual lap and shoulder belts for the five seating positions. The front row safety belts were equipped with adjustable D-rings and retractor pretensioners, the second row outboard safety belts were configured with non-adjustable anchorages, and the center safety belt was integrated into the seat back. The safety belts were all configured with sliding latch plates that were scratched indicating historical usage. The driver's safety belt was equipped with an emergency locking retractor (ELR) and the remaining safety belts were equipped with switchable ELR/automatic locking retractors (ALR).



**Figure 5.** Abraded latch plate, driver's safety belt

The driver's safety belt retractor was locked with the belt webbing in the used position due to the actuated retractor pretensioner. The plastic casing on the latch plate showed evidence of occupant loading in the form of scuff marks deposited by the safety belt webbing (**Figure 5**). Based on evidence of occupant loading and the locked position of the webbing, it was determined the front row left safety belt was used to restrain the driver.



**Figure 6.** Abraded latch plate, front right occupant's safety belt

The front row right occupant's safety belt retractor was locked with the belt webbing in the used position due to the actuation of the retractor pretensioner. The plastic casing on the latch plate showed evidence of occupant loading in the form of scuff marks left by the safety belt webbing (**Figure 6**) and the webbing was abraded in two areas. The abraded areas were measured with the belt in the buckled position. The first abraded area was located at 13 cm (5.1 in) below the D-ring, and extended 9 cm (3.5 in) toward the buckle. When the occupant loaded the safety belt and the pretensioner actuated, the abraded area was contacted by the D-ring. The second abraded area was contacted by the latch plate, and measured 11 cm (4.3 in) in length. Due to evidence of occupant loading and the locked position of the belt webbing, it was determined the front right safety belt was used to restrain the right occupant.

## Supplemental Restraint Systems

The vehicle's supplemental restraint system included an air bag control module (ACM), driver and passenger frontal air bags, left and right side impact inflatable curtain (IC) air bags, driver knee air bag, left and right seat-mounted side air bags, frontal and side impact sensors, and safety belt

pretensioners for the front seat positions.

The two frontal air bags and the driver's knee air bag deployed during the crash (**Figure 7**). The left and right seat-mounted side air bags and side impact IC air bags did not deploy.



**Figure 7.** Deployed frontal and knee air bags

The driver's frontal air bag deployed from the steering wheel hub through one upper and two lower cover flaps. The cover flaps opened at the tear seams and there was no damage to them or the air bag. The bag was circular in shape and measured 60 cm (23.6 in) in diameter. A circular stitching pattern in the bag's front center measured 22 cm (8.7 in) in diameter and connected the air bag's front panel to two internal tethers. Two vent ports were located on the back of the air bag in the upper aspect. The vent ports comprised a series of three slots which were cut in the shape of small arrows. They measured approximately 5 cm (2.0 in) in length and 1 cm (.4 in) in width.

Three dark-colored transfer marks were located on the front panel of the driver's frontal air bag. The first transfer measured 3 cm (1.2 in) in length and was located in the upper left quadrant, 30 cm (11.8 in) from the center. This transfer was determined to be a makeup transfer deposited when the driver's face loaded the air bag. The second transfer measured 8 cm (3.2 in) in length was located in the upper right quadrant, 22 cm (8.7 in) from the center. This transfer was determined to be a fabric transfer deposited when the air bag contacted the driver's right forearm during deployment. The third transfer measured 3 cm (1.2 in) in length and was located in the lower right quadrant, 26 cm (10.2 in) from the center. This contact was determined to be a fabric transfer deposited when the air bag contacted the driver's right thigh during deployment.

The driver's knee air bag deployed from the lower left instrument panel through one upper and one lower cover flap. The bag was rectangular in shape and measured 60 cm (23.6 in) in width and 35 cm (13.8 in) in length. A rectangular sail that measured 20 cm (7.9 in) in width and 30 cm (11.8 in) in length was stitched to the air bag's lower right quadrant. The knee air bag was designed without vent ports or tethers. Two occupant contacts were located on the front panel of the air bag. One contact was a smudge mark that measured 5 x 15 cm (2.0 x 5.9 in) and was located in the upper left quadrant, and the second contact was a black transfer mark that measured 5 x 2 cm (2.0 x 0.8 in) and was located in the lower right quadrant. The contacts were determined to be fabric transfers deposited when the driver's lower legs loaded the knee air bag.

The right passenger's frontal air bag deployed from the top right instrument panel through a single rectangular cover flap. The flap opened at the tear seams and was not damaged. The air bag was configured with two round vent ports that measured 5 cm (2.0 in) in diameter and were located on the upper rear panel. The bag was octagonal in shape and measured 64 cm (25.2 in) in diameter. No damage or evidence of occupant contact was observed on the air bag.

### Vehicle Data - 1992 Chevrolet K1500 Blazer

The Chevrolet K1500 Blazer was a four-door sport utility vehicle with a rear hatch and was identified by VIN: 1GNEK18K8NJxxxxxx. The vehicle was equipped with a 5.7-liter, 8-cylinder engine, 4-wheel driver, 4-wheel standard anti-lock brakes and standard power steering.

The Chevrolet was involved in an earlier crash prior to impacting the Lexus. The extent of damage to the vehicle was not determined. The driver of the Chevrolet was not injured and the vehicle was driven from the scene.

### Occupant Demographics - 2008 Lexus RX350

	<b>Driver</b>	<b>Occupant 2</b>
Age/Sex:	49/Female	48/Female
Seated Position:	Front left	Front right
Height:	155 cm (61 in)	152 cm (60 in)
Weight:	60 kg (132 lb)	57 kg (125 lb)
Seat Type:	Bucket	Bucket
Seat Track Position:	Between forward- and mid-track	Mid-track
Manual Restraint Usage:	Lap and shoulder belt	Lap and shoulder belt
Usage Source:	Vehicle inspection	Vehicle inspection
Body Posture:	Upright	Upright
Hand Position:	Both hands on steering wheel	Hands at sides
Foot Position:	Right foot on brake, left foot on floor	Both feet on floor
Air Bags:	Frontal air bag and knee air bag, deployed; seat-mounted side air bag and IC air bag, not deployed	Frontal air bag, deployed; seat-mounted side air bag and IC air bag, not deployed
Alcohol/Drug Involvement:	None	None
Medical Treatment:	Transported, treated and released	Transported, treated and released

## Occupant Kinematics - 2008 Lexus RX350

### Driver Kinematics

The 49-year-old female driver was seated in an upright posture and restrained by the 3-point manual lap and shoulder belt. She was actively steering the vehicle with her hands near the 10 and 2 o'clock positions and her right foot was on the accelerator. The subject vehicle was traveling at a driver-estimated speed of 56 - 61 km/h (35 - 38 mph). Just prior to impact, the driver observed the approach of the other vehicle and she steered right and braked in an effort to avoid the impact.

The front end of the Chevrolet impacted the front end of the Lexus. At impact, the driver's frontal and knee air bags deployed and the driver was displaced forward and slightly left in response to the 11 o'clock direction of force. She loaded the safety belt (**Figure 6**) with her chest resulting in a chest contusion. The shoulder belt webbing contacted her left neck resulting in a neck abrasion. The driver's face loaded the frontal air bag in the upper left quadrant and deposited a makeup transfer. The police report stated she sustained a loss of consciousness and she stated in the interview that she sustained a cervical strain. Those injuries resulted from a combination of impact forces and contact with the frontal air bag. Her right forearm and right thigh loaded the frontal air bag and deposited fabric transfers. The driver's lower legs loaded the knee air bag depositing fabric transfers and she sustained bilateral lower leg abrasions. The driver was held in her seat by the vehicle's safety belt until the vehicle came to rest.

After the crash, the driver exited the vehicle with assistance due to her injuries and was transported, treated, and released after four hours. She was later treated for her cervical strain injury by a chiropractor for several weeks. The driver missed approximately four weeks of work due to her injuries.

### Occupant 2 Kinematics

The 48-year-old female occupant was seated in an upright posture and was restrained by the 3-point manual lap and shoulder belt. At impact, the passenger's frontal air bag deployed and the occupant was displaced forward and slightly left in response to the 11 o'clock direction of force. The occupant loaded the belt restraint with her abdomen and sustained abdominal contusions. She sustained a cervical strain resulting from impact forces. No occupant contact to the frontal air bag was observed.

The police reported the occupant was semiconscious after the crash. She exited the vehicle with assistance due to her injuries and was transported, treated, and released. She was later treated by a personal physician and missed approximately eight weeks of work due her injuries.

**Occupant Injuries - 2008 Lexus RX350****Driver Injuries**

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Cervical strain	640278.1,6	Impact forces	Probable
Abrasion, left neck	390202.1,2	Safety belt webbing	Certain
Contusion, chest	490402.1,4	Safety belt webbing	Certain
Abrasions, bilateral lower legs	890202.1,3	Knee air bag	Probable
Police-reported loss of consciousness	Not codeable <sup>1</sup>		

**Occupant 2 Injuries**

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Cervical strain	640278.1,6	Impact forces	Probable
Contusion, abdomen	590402.1,4	Safety belt webbing	Certain
Police-reported loss of consciousness	Not codeable <sup>1</sup>		

---

<sup>1</sup> The level of consciousness and its duration must be observed by emergency or medical personnel

Attachment 1. Scene Diagram

