CRASH DATA RESEARCH CENTER

Calspan Corporation
Buffalo, NY 14225

CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION CRASH INVESTIGATION

CASE NO: CA07-032

VEHICLE: 2007 ACURA MDX

LOCATION: NEW YORK

CRASH DATE: OCTOBER 2007

Contract No. DTNH22-07-C-00043

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

DISCLAIMER

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 are 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 STANDARD TITLE PAGE

1. Report No. CA07-032	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle Calspan On-Site Side Impact Inflatable Occupant Protection Crash Investigation Vehicle: 2007 Acura MDX Location: State of New York		*5. Report Date*: January 2008 *6. Performing Organization Code*	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00500.0000.0043 *11. Contract or Grant No.* DTNH22-07-C-17002	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		*13. Type of Report and Period Covered* Technical Report Crash Date: October 2007 *14. Sponsoring Agency Code*	
15. Supplementary Note This on-site investigation focused on the side impact air bag system that deployed in a 2007 Acura MDX sport utility vehicle during an intersection crash with a 2008 Land Rover LR2.			
16. Abstract This on-site investigation focused on the side impact air bag system that deployed in a 2007 Acura MDX sport utility vehicle during an intersection crash with a 2008 Land Rover LR2. The Acura was equipped with a Certified Advanced 208-Complaint (CAC) frontal air bag system, seat back mounted thorax air bags in the front outboard positions, and Inflatable Curtain (IC) air bags that provided protection to the six outboard positions. The manufacturer of this vehicle certified that the vehicle meets the advanced air bag requirement of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. Five adult occupants seated in the three right side and the front and second row left side outboard positions occupied the vehicle. The 51-year old female driver of the Acura initiated a left turn across the path of the Land Rover. The right frontal area of the Land Rover struck the right side of the Acura resulting in the deployment of the front right seat back mounted air bag and the right IC air bag. The frontal air bag system in the Land Rover did not deploy. There were no injuries to the occupants of the vehicles.			
17. Key Words Side impact inflatable curtain bag deployment Minor injuries		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 10	*22. Price*

TABLE OF CONTENTS

CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION SYSTEM CRASH INVESTIGATION
SCI CASE NO.: CA07-032
VEHICLE: 2007 ACURA MDX
LOCATION: NEW YORK
CRASH DATE: OCTOBER 2007

BACKGROUND

This on-site investigation focused on the side impact air bag system that deployed in a 2007 Acura MDX sport utility vehicle **(Figure 1)** during an intersection crash with a 2008 Land Rover LR2. The Acura was equipped with a Certified Advanced 208-Complaint (CAC) frontal air bag system, seat back mounted thorax air bags in the front outboard positions, and Inflatable Curtain (IC) air bags that provided protection to the six outboard positions. The manufacturer of this vehicle certified that the vehicle meets the advanced air bag requirement of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. Five adult occupants seated in the three right side and the front and second row left side outboard positions occupied the vehicle. The 51-year old female driver of the Acura initiated a left turn across the path of the Land Rover. The right frontal area of the Land Rover struck the right side of the Acura resulting in the deployment of the front right seat back mounted air bag and the right IC air bag. The frontal air bag system in the Land Rover did not deploy. There were no injuries to the occupants of the vehicles.

Figure 1. Right side damage to the Acura.

The National Motor Vehicle Crash Causation Survey (NMVCCS) of the National Automotive Sampling System (NASS) initially selected this case for investigation. Details of the case were forwarded to the Calspan Special Crash Investigations (SCI) team on October 16. The information received and the images of the Acura were submitted to NHTSA's Crash Investigation Division on October 18th and the case was immediately assigned for on-site investigation. The SCI investigation involved the inspection of the involved vehicles and the crash site. Detailed interviews with the occupants of the Acura were not obtained due to language barriers. The NMVCCS Researcher interviewed the driver of the Land Rover. This narrative report has been linked to the Electronic Data System (EDS).

SUMMARY

Crash Site

The crash occurred within a "T" intersection of a two-lane east/west roadway and a two-lane north/south roadway in the State of New York in October 2007. At the time of the crash, the east/west asphalt roadway was dry and there were no adverse weather conditions. The roadway experienced a 3 percent negative slope for westbound traffic. The roadway was configured with one lane in each direction and was separated by a

painted double-yellow centerline. The lanes were 3.3 m (7.5 ft) in width and were bordered by painted white fog lines and grassy shoulders. The roadside environment consisted of natural growth within a rural setting. The posted speed limit for the east/south roadway was 89 km/h (55 mph). The north/south roadway consisted of one lane in each direction with no lane markings. The SCI Crash Schematic is included as **Figure 11** at the end of the narrative report.

Vehicle Data

2007 Acura MDX

The subject vehicle in this crash was a 2007 Acura MDX sport utility vehicle. The Acura was manufactured in June 2007 and was identified by Vehicle Identification Number (VIN): 2HNYD285X7H (production number deleted). The vehicle was powered by a 3.7 liter V-6 engine linked to a 5-speed automatic transmission with a console-mounted shifter. The interior was configured with seven-passenger seating (2-3-2). The exterior of the Acura was equipped with a roof rack and sill mounted running boards that extended from the A-to the C-pillars.

The Acura was a full-size four-door SUV that was equipped with the Super-Handling All Wheel Drive (SH-AWD) package. This package provides enhanced performance by providing power to the wheel(s) that maintain traction, thus preventing wheel spin. In addition to this package, the Acura was equipped with power-assisted four-wheel disc brakes with anti-lock, Electronic Brake Distribution, Brake Assist, Vehicle Stability Assist (VSA), a direct Tire Pressure Monitoring System (TPMS), and a rear view-backing camera with a display through the center instrument panel navigation system monitor. The restraint systems included a dual stage, dual threshold frontal air bag system that meets the advanced air bag requirement of FMVSS No. 208, front seat back mounted side impact air bags, side curtain air bags, 3-point lap and shoulder belts for all seven positions and front seat active head restraints.

The Gross vehicle Weight Rating (GVWR) for this vehicle was 2,700 kg (5,520 lb) that was distributed 1,310 kg (2,888 lb) front and 1,440 kg (2995 lb) rear. The Acura was equipped with Michelin P255/55R18 all-season tires mounted on OEM five-spoke alloy wheels. The vehicle manufacturers recommended tire pressure was 220 kPa (32 PSI). The measured tire data at the time of the SCI inspection was as follows:

Position	Measured Tread Depth	Measured Tire Pressure	Tire/Wheel Damage
LF	8 mm (10/32”)	221 kPa (32.0 PSI)	None
RF	8 mm (10/32”)	221 kPa (32.0 PSI)	Rubber transfers on wheel with gouge
LR	8 mm (10/32”)	221 kPa (32.0 PSI)	None
RR	8 mm (10/32”)	221 kPa (32.0 PSI)	None

2008 Land Rover LR2

The striking vehicle in this crash was a 2008 Land Rover LS2 SE. The vehicle was a four-door sport utility vehicle that was configured with five-passenger seating. The all-wheel drive Land Rover was manufactured in the United Kingdom on March 2007 and

was registered as a 2008 model year vehicle. The VIN for this vehicle was SALFP24N68H (production number deleted). The GVWR for the vehicle was 2,505 kg (5,520 lb) with 1,310 (2,885 lb) distributed to the front axle and 1,360 kg (2,995 distributed to the rear. The LS2 was powered by a 3.2 liter, in-line 6-cylinder engine linked to a six-speed automatic transmission with full-time all-wheel drive. The service brakes were four-wheel disc with anti-lock. The vehicle was equipped with 46 cm (18") alloy wheels and Continental Cross Contact P235/60R18 tires. The vehicle manufacturer's recommended cold tire pressure was 221 kPa (22 PSI).

Crash Sequence

Pre-Crash

The driver of the Acura was traveling in a westerly direction on the two-lane road during daylight hours. As he approached a four-leg intersection, the driver initiated a left turn across the path of the eastbound Land Rover. A witness that was traveling behind the Acura reported that the vehicle initiated a left turn and then stopped inside the intersection. The driver of the Land Rover, however, indicated that the Acura proceeded to turn left without stopping. The 31-year old male driver of the Land Rover braked and steered left in an attempt to avoid the Acura. **Figures 2** and **3** are the approach views of both vehicles.

Figure 2 - Westbound approach of the Acura.

Figure 3 - Eastbound approach of the Land Rover.

Crash

The front right area of the Land Rover struck the right passenger area of the Acura. The directions of force were in the 1 o'clock and 12 o'clock sectors for the Acura and Land Rover, respectively. The impact was sufficient to deploy the Acura's right seat back mounted side air bag and the right side IC air bag. The air bags in the Land Rover did not deploy. The damage algorithm of the WinSMASH program computed a total delta-V of 13 km/h (8.1 mph) for the Acura and 15 km/h (9.3 mph) for the Land Rover. The specific longitudinal and lateral velocity changes were -10 km/h (-6.2 mph) and -8 km/h (-5 mph) for the Acura and -15 km/h (-9.3 mph) and 0 km/h for the Land Rover. The Acura was displaced slightly to the left of the point of impact. The Land Rover came to rest at the point of impact.

Post-Crash

Following the crash, the driver of the Land Rover reversed direction, backed up from the point of impact, and parked on the south roadside. He exited his vehicle and proceeded to the Acura to check on the status of the vehicle's occupants. After inquiring as to their condition, the driver reported that they appeared alert and uninjured; however, a language barrier prevented a full assessment. There were no injuries to any of the occupants in either vehicle. Both vehicles were towed to a local repair facility.

Vehicle Damage

Exterior Damage - 2007 Acura MDX

The 2007 Acura MDX sustained moderate damage as the result of the impact with the Land Rover **(Figure 4)**. The direct contact damage began 69 cm (27") forward of the right rear axle and measured 191 cm (75") in length. The combined direct and induced damage began 13 cm forward of the right rear axle and measured 284 cm (116") in length. The maximum crush was located between C3 and C4, 170 cm (67") forward of the right rear axle. The maximum crush measured 22 cm (8.7") in depth. The crush profile consisted of six equidistant measurements taken along the mid-door level of the vehicle's right side and was as follows: C1 = 0 cm, C2 = 2 cm (0.5"), C3 = 10 cm (4"), C4 = 19 cm (7.5"), C5 = 4 cm (1.5"), C6 = 0 cm. The Collision Deformation Classification (CDC) for this impact was 01-RYEW-2.

Figure 4 - Damaged right side of the Acura.

Interior Damage – 2007 Acura MDX

The 2007 Acura MDX sustained minor damage to the right side of the vehicle due to minor intrusion and probable occupant contact. The most significant intrusion occurred to the second row door panel, which intruded laterally 10 cm (4"). The right B-pillar intruded laterally 9 cm (3.5"), and the right front door panel intruded laterally 9 cm (3.5"). A scuff was identified on the lateral aspect of the right front armrest located 36 – 43 cm (14 – 17") aft of the mid instrument panel and 15 – 17 cm (5.75 – 6.5") above the seat cushion. The scuff was attributed to the front right passenger's right arm.

Exterior Damage – 2008 Land Rover LR2

The 2008 Land Rover LR2 sustained minor damage during the impact with the 2007 Acura MDX **(Figure 5)**. The direct contact damage began 36 cm (14") right of the vehicle's centerline and extended 48 cm (19") to the front right bumper corner. The direct and induced damage encompassed the full frontal bumper width and measured 160 cm (63"). The maximum crush was to the front right bumper corner and measured 22 cm (8.7") in depth. Six

Figure 5 - Damaged front plane of the Land Rover.

equidistant crush measurements were taken along the front bumper of the Land Rover and were as follows: C1 = 0 cm, C2 = 0 cm, C3 = 0 cm, C4 = 1 cm, C5 = 2 cm, C6 = 12 cm (4.7”). The CDC for the impact with the Land Rover was 12-FDEW-1.

Manual Restraint Systems – 2007 Acura MDX

The 2007 Acura MDX was equipped with manual 3-point lap and shoulder belts for each of the seven seating positions. The driver’s belt was configured with a sliding latch plate, Emergency Locking Retractor (ELR), and retractor pretensioner. There was no discernable loading evidence on the driver’s belt webbing or the hardware and the pretensioner did not actuate. The front right belt was configured with a sliding latch plate, a switchable ELR/Automatic Locking Retractor (ALR), and a retractor pretensioner. A frictional abrasion was present on the top side of the latch plate and a black substance transfer was located on the outboard aspect of the right front lap belt webbing 14 – 18 cm (5.5 – 7”) above the belt’s anchor point. The retractor pretensioner did not actuate during the crash.

The second row consisted of a 60/40 left side wide split-bench seat equipped with independent folding seat backs. The second row belt systems were configured with sliding latch plates and switchable ELR/ALR retractors; the middle seat had an integrated restraint. No loading evidence was identified on any of the second row belt system components.

The third row was equipped with a split bench seat with folding backs and configured for two outboard occupants. The two belt systems were configured with sliding latch plates, switchable retractors, and fixed D-rings. The left rear seat back was in a folded down unused position. Neither belt displayed any discernable loading evidence.

Certified Advanced 208-Complaint Air Bag System

Frontal Air Bag System – 2007 Acura MDX

The vehicle was equipped with a Certified Advanced 208-Complaint (CAC) frontal air bag system that included dual stage/dual threshold frontal air bags for the driver and front right passenger, seat track position sensors, front safety belt buckle switches and an Occupant Protection Detection System (OPDS) for the front right occupant. The manufacturer of this vehicle certified that the vehicle meets the advanced air bag requirement of FMVSS No. 208. The driver’s bag was housed within the four-spoke steering wheel and the front right bag was housed within the upper right instrument panel. The frontal air bags were not commanded to deploy in this angular side impact crash.

Side Impact Inflatable Air Bags – 2007 Acura MDX

The vehicle was equipped with seat back mounted thorax air bags in the front outboard positions, and roof-rail mounted Inflatable Curtain (IC) air bags that provided protection to the six outboard positions. A system of impact sensors and a rollover sensor controlled the deployment of these air bags dependent on crash type and severity. In this crash, the right side impact resulted in the deployment of the right thorax air bag and the right side IC.

The thorax bag was housed within a module in the outboard aspect of the seat back and expanded forward to offer a measure of inflatable protection between the occupant's thorax and the door panel **(Figure 6)**. The deployed air bag was rectangular and measured 15 cm (5.75") horizontally and 50 cm (20") vertically. The air bag had two stitch patterns that created a chamber effect. The area within the stitched chambers does not inflate during the deployment of the air bag. The front right door panel and right B-pillar intruded 9 cm (3.5") laterally into the vehicle during the impact; however, there remained a sufficient path in between these components and the seat back to allow for the deployment of the thorax bag. During the NMVCCS phase of the investigation, the researcher reported a possible failure of the seat back air bag, specifically, that the bag's deployment path was impeded by the passenger compartment intrusion. It was also reported that the membrane remained partially rolled up, was restricted between the seat back and B-pillar, and did not fully deploy. During the SCI investigation, however, it was determined that the intrusion of the B-pillar did not impede the air bag's path and it deployed correctly. It is probable that the air bag was manipulated post-crash by either the front right occupant or an emergency responder. Further, there was no evidence of occupant contact to the thorax bag nor was there evidence of deployment restriction on the air bag membrane or surrounding components. **Figures 7** and **8** were provided by the NMVCCS investigator to the SCI team for review of the potential air bag failure.

Figure 6 - Seat back mounted side air bag.

Figure 7 - Side impact seat back mounted air bag.

Figure 8 - Seat back mounted side air bag.

The right IC **(Figures 9** and **10)** deployed downward from its mounting in the vehicle's roof side rail. The rectangular IC provided coverage that extended from the A- to the C-pillars. At deployment, the IC was inflated by compressed helium that was stored in a

canister located in the roof-rail behind the C-pillar. The overall dimensions of the air bag measured 224 cm x 53 cm (21" x 88"), length by height, respectively. The IC was tethered at the A-pillar and to the roof side rail between the C- and D-pillars. The front tether was cut at its midpoint post-crash. There was no discernable loading evidence on the deployed side air bags.

Figure 9 - Right side first row inflatable curtain air bag.

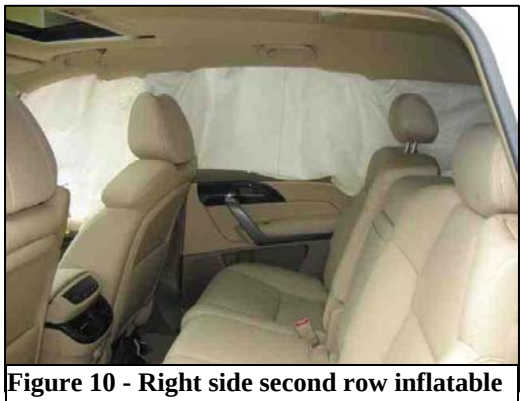

Figure 10 - Right side second row inflatable curtain air bag.

Occupant Demographics

Row 1

	Driver	**Front Right Passenger**
Age/Sex:	51-year old/Male	50-year old/Male
Height:	Not reported	Not reported
Weight:	Not reported	Not reported
Seat Track Position:	Mid-track [13 cm (5") aft of full forward 10 cm (4")] forward of full rear	Mid to rear-track [16 cm (6.25") aft of full forward 7 cm (2.75")] forward of full rear
Restraint Use:	3-point lap and shoulder belt	3-point lap and shoulder belt
Usage Source:	Vehicle inspection	Vehicle inspection
Medical Treatment:	None, not injured	None, not injured

Row 2

	Second Row Left Passenger	**Second Row Right Passenger**
Age/Sex:	46-year old/Female	48-year old/Female
Height:	Not reported	Not reported
Weight:	Not reported	Not reported
Seat Track Position:	Not adjustable	Not adjustable
Restraint Use:	3-point lap and shoulder belt	3-point lap and shoulder belt
Usage Source:	Vehicle inspection	Vehicle inspection
Medical Treatment:	None, not injured	None, not injured

Row 3

	Third Row Right Passenger
Age/Sex:	13-year old/Female

Height:	Not reported
Weight:	Not reported
Seat Track Position:	Not adjustable
Restraint Use:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Medical Treatment:	None, not injured

Driver Injuries

Neither the driver nor the four passengers in the 2007 Acura MDX sustained any injuries during the crash. They each declined medical attention.

Driver Kinematics

Prior to the crash, the 51-year old driver was seated in a mid-track position and was restrained by the 3-point lap and shoulder belt. The driver initiated a left turn directly across the path of the Land Rover precipitating the crash. At impact, the driver responded to the low velocity 1 o'clock direction of force by initiating a slight trajectory forward and toward the right aspect of the vehicle. The driver slightly loaded the belt webbing and rode down the force of the impact. He exited the vehicle under his own power and was uninjured.

Front Right Passenger Kinematics

The restrained 50-year old male front right passenger was seated in an unknown posture at the time of the crash. He was restrained by the manual 3-point lap and shoulder belt. At impact, the thorax and IC air bags deployed and the front right passenger was redirected slightly forward and to the right and loaded lap belt webbing and thorax bag. This was evidenced by a frictional abrasion on the top side of the latch plate and a black substance transfer located on the outboard aspect of the right front lap belt. The right front door panel and B-pillar intruded 9 cm (3.5"). The thorax bag compressed between the flank of the front right passenger and the door panel resulting in a scuff to the right armrest. Following the crash, the front right passenger rebounded left back into his seat. He exited the vehicle under his own power and was uninjured.

Second Row Left Passenger Kinematics

The 46-year old restrained female second row left passenger was seated in an unknown posture and responded to the crash forces by initiating a trajectory to the right. She loaded the manual lap and shoulder belt and remained in the second row left seating position. She was able to exit the vehicle under her own power post-crash and sustained no injuries.

Second Row Right Passenger Kinematics

The second row right passenger utilized the manual lap and shoulder belt and was seated in an unknown posture. At impact, the IC air bag deployed and she was minimally displaced forward and right responding to the 1 o'clock direction of force. She loaded the belt system and IC air bag and rebounded left after riding down the crash forces. The right rear door panel was laterally intruded 10 cm (4"); however, no discernable evidence

was identified on the door panel, the belt system, or the IC air bag. She exited the vehicle under her own power and was uninjured.

Third Row Right Passenger Kinematics

The 13-year old female who was seated in the third row right position was restrained by the manual lap and shoulder belt. She was seated in an assumed upright posture, and as the side air bags deployed as she was displaced forward and to the right responding to the crash forces. She rode down the crash forces as she loaded the manual belt webbing. She exited the vehicle under her own power and was not injured in the crash.

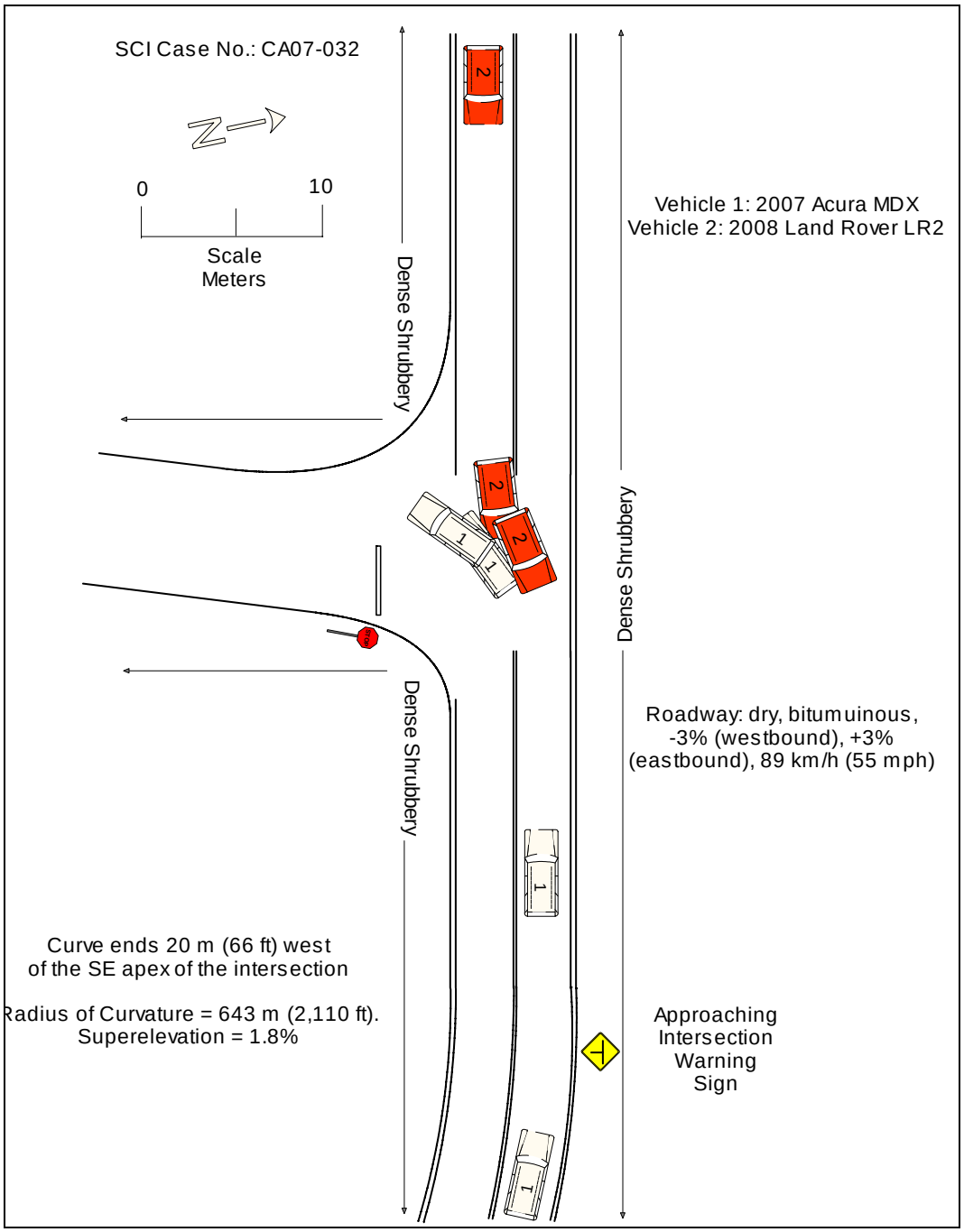

Figure 11 – SCI Crash Schematic