

Rollover Investigation
Dynamic Science, Inc. / Case Number: DS07014
2006 Mitsubishi Raider
California
March 2007

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. DS07014	2. Government Accession No.		3. Recipient Catalog No.	
4. Title and Subtitle Rollover Investigation			5. Report Date October 16, 2007	
			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 (NRD-32) National Highway Traffic Safety Administration 400 7th Street, SW Washington, DC 20590			13. Type of report and period Covered [Report Month, Year]	
			14. Sponsoring Agency Code	
15. Supplemental Notes				
16. Abstract <p>This on-site investigation focused on a 2006 Mitsubishi Raider that was involved in a rollover crash. This two vehicle crash occurred in March 2007 at 2100 hours. The crash occurred on a three-lane divided state highway near the approach to an interstate on-ramp/transition road. The speed limit at this location is 89 km/h (55 mph). The case vehicle is a 2006 Mitsubishi Raider extended cab pickup that was being driven by a restrained 52-year-old male. The front right seat was occupied by a restrained 48-year-old female. The other vehicle was a 2001 Freightliner tractor-trailer that was being driven by a 37-year-old male. The Mitsubishi Raider was traveling westbound on the state highway in the first lane from the right at a police reported speed of 97 km/h (60 mph). The other vehicle was traveling westbound in the second lane from the right at a police reported speed of 72 km/h (45 mph). The driver of the other vehicle changed lanes to the right. The front right of the other vehicle struck the left side of Raider. The driver of Raider lost control of his vehicle. The Raider rotated out in a clockwise direction and struck a curb with its left front tire. The Raider continued on out of control onto an embankment where the vehicle overturned. The Raider came to rest on its roof. There were no indications of any injuries to any of the parties involved, but an ambulance did respond to the scene. The Mitsubishi Raider was towed from the scene due to damage. It was later declared to be a total loss by the insurance company. The Freightliner was driven from the scene.</p>				
17. Key Words Rollover, no injuries			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: DS07014

TABLE OF CONTENTS

Background	1
Summary	1
Crash Site	1
Pre Crash	2
Crash	2
Post Crash	2
Vehicle Data - 2006 Mitsubishi Raider	3
Vehicle Damage	4
Exterior Damage	4
Interior Damage	5
Manual Restraints	6
Supplemental Restraint Systems	6
Rollover Dynamics	6
Occupant Demographics	7
Occupant Kinematics	8
Occupant Injuries	8
Attachment 1. Scene Diagram	9

BACKGROUND

This on-site investigation focused on a 2006 Mitsubishi Raider that was involved in a rollover crash (**Figure 1**). This two vehicle crash occurred in March 2007 at 2100 hours. The crash occurred on a three-lane divided state highway near the approach to an interstate on-ramp/transition road. The speed limit at this location is 89 km/h (55 mph). The case vehicle is a 2006 Mitsubishi Raider extended cab pickup that was being driven by a restrained 52-year-old male. The front right seat was occupied by a restrained 48-year-old female. The other vehicle was a 2001 Freightliner tractor-trailer that was being driven by a 37-year-old male. The Mitsubishi Raider was traveling westbound on the state highway in the first lane from the right at a police reported speed of 97 km/h (60 mph). The other vehicle was traveling westbound in the second lane from the right at a police reported speed of 72 km/h (45 mph). The driver of the other vehicle changed lanes to the right. The front right of the other vehicle struck the left side of Raider. The driver of Raider lost control of his vehicle. The Raider rotated out in a clockwise direction and struck a curb with its left front tire. The Raider continued on out of control onto an embankment where the vehicle overturned. The Raider came to rest on its roof. There were no indications of any injuries to any of the parties involved, but an ambulance did respond to the scene. The Mitsubishi Raider was towed from the scene due to damage. It was later declared to be a total loss by the insurance company. The Freightliner was driven from the scene.



Figure 1. 2006 Mitsubishi Raider

This Rollover case was identified by NHTSA during a review of General Estimates System (GES) police reports. DSI was faxed the report on April 7, 2007. DSI located the case vehicle and obtained permission to inspect the vehicle on April 13, 2007. DSI was assigned the case on April 13, 2007. The case vehicle was inspected on April 15, 2007. Field work was completed on April 25, 2007.

SUMMARY

Crash Site

This two vehicle crash occurred in March 2007 at 2100 hours. The crash occurred on a three-lane divided state highway near the approach to an interstate on-ramp/transition road (**Figure 2**). At the time of the crash, there were no adverse weather conditions and the concrete roadway surface was dry. It was dark at the time of the crash and the street lights were on. The westbound roadway was configured with three



Figure 2. Approach to area of impact and rollover

lanes that were separated by dashed white lines. The on-ramp was bordered on both sides by solid white lines. To the right of the on-ramp is an asphalt shoulder that is bordered on the right by an asphalt curb. To the right of the curb is a steep grass/direct covered embankment. The speed limit at this location was 89 km/h (55 mph).

Pre Crash

The case vehicle is a 2006 Mitsubishi Raider extended cab pickup that was being driven by a restrained 52-year-old male. The front right seat was occupied by a restrained 48-year-old female. The other vehicle was a 2001 Freightliner tractor-trailer. The Mitsubishi Raider was traveling westbound on the state highway in the first lane from the right at a police reported speed of 97 km/h (60 mph). The Freightliner was being driven by a 37-year-old male and was traveling westbound in the second lane from the right at a police reported speed of 72 km/h (45 mph). The Mitsubishi Raider was passing the other vehicle prior to the crash.

Crash

The driver of the Freightliner changed lanes to the right in preparation for taking the off-ramp/transition road. The right side of the Freightliner struck the left side of Raider (Event 1). As a result of this impact, the driver of Raider lost control of his vehicle. The Raider traveled out of control in a northwesterly direction while rotating in a clockwise direction. The Raider crossed the right shoulder and struck the asphalt curb with the left front tire (Event 2). The Raider continued forward and contacted the embankment with its front end (Event 3). The Raider continued out of control up the embankment where it overturned with its left side leading two quarter turns (Event 4). The Raider came to rest on its roof. The driver of the Freightliner maintained control of his vehicle and parked it on the shoulder of the ramp.

Post Crash

There were no indications of any injuries to any of the parties involved, but an ambulance did respond to the scene. The interviewee did not report any injuries. The Mitsubishi Raider was towed from the scene due to damage. It was later declared to be a total loss by the insurance company. The other vehicle was driven from the scene.

Vehicle Data - 2006 Mitsubishi Raider

The Mitsubishi Raider Club Cab pickup was identified by the Vehicle Identification Number (VIN): 1Z7HC22K76Sxxxxxx. The vehicle mileage was 34,245 km (21,279 miles) at the time of the vehicle inspection. The Mitsubishi Raider 5-passenger pickup truck was equipped with a 3.7 liter V-6 engine, a four-speed automatic transmission, rear wheel drive, front disc/rear drum brakes with a rear Anti-lock Brake System (ABS), power steering, and a tilt steering wheel. The Raider was configured with Goodyear Wrangler P245/70R16 tires. The vehicle manufacturer's recommended tire pressure was 241 kPa (35 psi). The specific tire information is as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Flat	7 mm (9/32 in)	No	Rim dented, side wall torn
LR	193 kPa (28 psi)	9 mm (11/32 in)	No	None
RR	138 kPa (20 psi)	9 mm (11/32 in)	No	None
RF	172 kPa (25 psi)	8 mm (10/32 in)	No	Rim scratched

The seating in the Mitsubishi Raider was configured with fabric covered front split bench 40-20-40 seats with adjustable head restraints and rear 40-40 jump seats with fixed head restraints. The driver's seat was located in the full forward track position; the front right seat located in the full rearward track position. The driver's seat back was at a 12 degree angle from the vertical; the seat cushion was at a 9 degree angle from the horizontal. The front right seat back was a 13 angle from the vertical; the seat cushion was a 9 degree angle from the horizontal. Both front seat backs were covered by T shirts.

Vehicle Damage

Exterior Damage - 2006 Mitsubishi Raider

The Mitsubishi Raider sustained moderate left side damage as a result of the impact with the Freightliner (**Figure 3**). The direct damage began 63 cm (24.8 in) rear of the rear axle and extended 233 cm (91.7 in) forward along the left side plane. There were spinning tire marks along the front part of the bed. The metal fender well at the left rear was torn in a forward direction. Six crush measurements were documented at the mid door level as follows: C1 = 0, C2 = 0 cm, C3 = 0 cm, C4 = 0 cm, C5 = 0.5 cm (0.2 in), C6 = 0 cm. The maximum lateral crush was located between C5/C6 and measured 6.0 cm (2.4 in). The Collision Deformation Classification (CDC) for this impact was 09LZEW2.

The Raider sustained moderate damage to the left front wheel from the impact with the curb (see **Figure 4**). The steel rim was dented and the tire flattened. The CDC for this impact was 11FLWN3.

The Raider sustained minor contact damage to the front bumper from the impact with the dirt/grass embankment. The CDC for this impact was 09FDLS1.



Figure 3. Left side damage, impact 1



Figure 4. Tire/rim damage, impact 2



Figure 5. Front bumper contact, impact 3

The Raider also sustained moderate damage to top of the vehicle from the rollover (**Figure 6**). The direct damage began at the left hood line. The damage measured 99.0 cm (39.0 in) wide and extended 79.0 cm (31.1 in) rearward along the hood where it stopped. The direct damage began again at the windshield header/windshield area. This damage measured 63.0 cm (24.8 in) wide by 52.0 cm (20.5 in) in length. The maximum vertical crush was located at the left A pillar (**Figure 7**) and measured 4.0 cm (1.6 in). The CDC for this impact was 00TYYO2.



Figure 6. Roof and hood damage



Figure 7. Maximum roof crush

Interior Damage - 2006 Mitsubishi Raider

The 2006 Mitsubishi Raider sustained minor interior damage as a result of the rollover. The left rear door was jammed shut; the remaining doors remained closed and operational. The glazing for the left front door disintegrated. The windshield was cracked but remained in place.

Manual Restraints - 2006 Mitsubishi Raider

The 2006 Mitsubishi Raider was configured with manual 3-point lap and shoulder belts for each of the four outboard seating positions. The front middle seat was equipped with a manual lap belt. Both front seat safety belts were equipped with buckle retractors and adjustable D rings that were in the full down position. The outboard seat belts were configured with Emergency Locking Retractors. The driver's seat belt exhibited a slight amount of loading.

Supplemental Restraint Systems - 2006 Mitsubishi Raider

The Mitsubishi Raider was equipped with advanced occupant protection systems including multi-stage Certified Advanced 208-Compliant driver and front right passenger air bags. The multi-stage air bags were certified by the manufacturer to meet the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The driver's air bag was mounted in the center of the steering wheel hub. The front right passenger air bag was mounted in the right instrument panel. The vehicle was equipped with a front right occupant sensor and a passenger air bag On/Off switch. The switch was found in the On position. There were no air bag deployments.

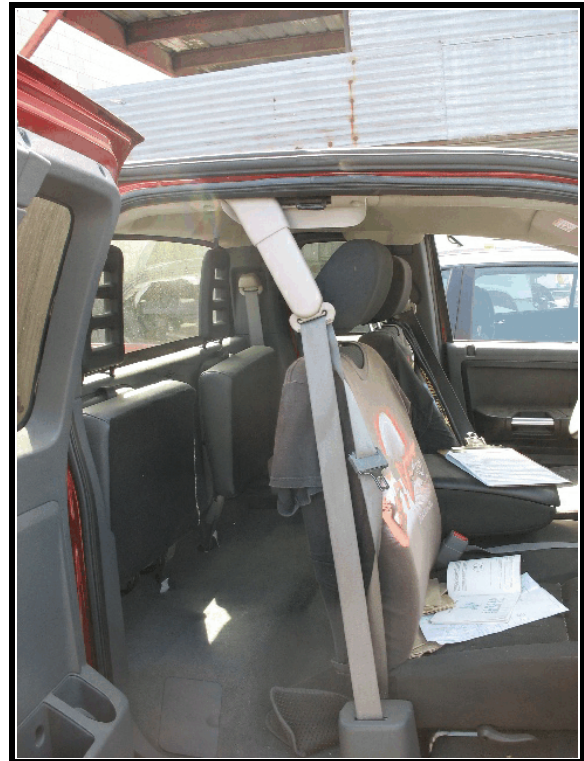


Figure 8. Overview of seat belts and seating

Rollover Dynamics

The Mitsubishi Raider was equipped with a four-speed automatic transmission, rear wheel drive, and front disc/rear drum brakes with rear ABS. The Raider had a four-star rollover rating, which describes a static stability factor range from 1.18 to 1.44 with a 10 to 20 percent chance of rollover.

After the initial impact with the Freightliner the driver of the Raider lost control of his vehicle. The Raider traveled out of control in a northwesterly direction while rotating in a clockwise direction. The Raider crossed the right shoulder and struck the asphalt curb with the left front tire. The Raider continued forward and contacted the embankment with its front end. The Raider continued out of control up the embankment. The combination of the vehicle rotation and the upward slope of the embankment caused a left side leading rollover. The Raider rolled two quarter turns and came to rest on its roof. The two restrained occupants remained in their seats during the rollover sequence. There were no reported injuries.

OCCUPANT DEMOGRAPHICS - 2006 Mitsubishi Raider

	Driver	Front right occupant
Age/Sex:	52/Male	48/Female
Seated Position:	Front left	Front right
Seat Type:	Split bench	Split bench
Height:	165 cm (65 in)	Unknown
Weight:	73 kg (160 lbs)	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	None
Driving Experience:	Presumed >10 years	N/A
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Both hands on steering wheel. Actively steering.	Unknown
Foot Position:	Right foot on brake, left on floor board.	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used
Air bag:	Steering wheel mounted frontal air bag available, did not deploy.	Instrument mounted frontal air bag available, did not deploy.

OCCUPANT KINEMATICS

Driver Kinematics

The 52-year-old male driver was likely seated in an upright posture and was restrained by the 3-point manual lap and shoulder belt. The seat was adjusted to the forward most track position. As other vehicle changed lanes to the right, the right side of the other vehicle struck the left side of Raider. As a result of this impact, the driver of Raider lost control of his vehicle. He likely steered to the right in response to the contact. The Raider traveled out of control in a northwesterly direction while rotating in a clockwise direction. The driver was actively steering and braking. The Raider crossed the right shoulder and struck the asphalt curb with the left front tire. The driver possibly pitched upward in response to this impact and the subsequent path of the vehicle up the embankment. The Raider continued out of control onto the embankment where it overturned with its left side leading. The Raider came to rest on its roof. The driver remained in his seat and was able to exit the vehicle under his own power. There were no reported injuries.

Front Row Right Seat Occupant Kinematics

The 48-year-old male female front right occupant was likely seated in an upright posture and was restrained by the 3-point manual lap and shoulder belt. The seat was adjusted to the rear most track position. As other vehicle changed lanes to the right, the right side of the other vehicle struck the left side of Raider. As a result of this impact, the driver of Raider lost control of his vehicle. He likely steered to the right in response to the contact. The Raider traveled out of control in a northwesterly direction while rotating in a clockwise direction. The driver was actively steering and braking. The Raider crossed the right shoulder and struck the asphalt curb with the left front tire. The front right occupant possibly pitched upward in response to this impact and the subsequent path of the vehicle up the embankment. The Raider continued out of control onto the embankment where it overturned with its left side leading. The Raider came to rest on its roof. The front right occupant remained in her seat and was able to exit the vehicle under her own power. There were no reported injuries.

OCCUPANT INJURIES - 2006 Mitsubishi Raider

Driver: No injuries reported by either the interviewee or the police.

Front Right Seat Occupant: No injuries reported by either the interviewee or the police.

Attachment 1. Scene Diagram

