

Remote SCI/NASS Combination Side Air Bag Investigation
Dynamic Science, Inc. (DSI), Case Number 2010-74-127J
2010 Mazda 3
Nebraska
July 2010

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. 2010-74-127J	2. Government Accession No.		3. Recipient Catalog No.	
4. Title and Subtitle Remote SCI/NASS Combination Side Air Bag Investigation			5. Report Date January 3, 2011	
			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				
16. Abstract This remote investigation focused on the deployment of the side air bags in a 2010 Mazda 3 and the ejection of the 23-year-old male driver. The Mazda was equipped with Certified Advanced 208-Compliant (CAC) frontal air bags, seat-mounted side air bags, and side impact inflatable curtain (IC) air bags. This single vehicle crash occurred in the eastbound lane of a two-lane rural roadway. The driver lost control of the vehicle and it began a clockwise rotation. The vehicle entered the westbound travel lane, crossed back into the eastbound travel lane, and having rotated approximately 160 degrees from its original heading angle, departed the roadway on the right side. The Mazda traveled off road and began a left side leading rollover before impacting a wooden utility pole with its left side. After impacting the pole the unrestrained driver was ejected and the vehicle continued the rollover. The vehicle rolled four quarter-turns before coming to rest on its wheels. During the crash sequence both IC air bags and the driver seat-mounted side air bag deployed. The driver sustained a spinal fracture and lacerations to the head and ear. He was transported to a local trauma center and hospitalized for one day.				
17. Key Words Side air bag, inflatable curtain air bag, ejection, injury, rollover			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: 2010-74-127J

TABLE OF CONTENTS

Background	1
Summary	1
Crash Site	1
Pre-Crash	2
Crash	2
Post-Crash	2
Vehicle Data - 2010 Mazda	2
Vehicle Damage - 2010 Mazda 3	3
Exterior Damage	3
Interior Damage	3
Manual Restraints	3
Supplemental Restraint Systems	3
Rollover	4
Injuries	6
Occupant Kinematics	6
Attachment 1. Scene Diagram	7

BACKGROUND

This remote investigation focused on the deployment of the side air bags in a 2010 Mazda 3 (**Figure 1**) and the ejection of the 23-year-old male driver. The Mazda was equipped with Certified Advanced 208-Compliant (CAC) frontal air bags, seat-mounted side air bags, and side impact inflatable curtain (IC) air bags. This single vehicle crash occurred in the eastbound lane of a two-lane rural roadway. The driver lost control of the vehicle and it began a clockwise rotation. The vehicle entered the westbound travel lane, crossed back into the eastbound travel lane, and having rotated approximately 160 degrees from its original heading angle, departed the roadway on the right side. The Mazda traveled off road and began a left side leading rollover before impacting a wooden utility pole with its left side. After impacting the pole the unrestrained driver was ejected and the vehicle continued the rollover. The vehicle rolled four quarter-turns before coming to rest on its wheels. During the crash sequence both IC air bags and the driver seat-mounted side air bag deployed. The driver sustained a spinal fracture and lacerations to the head and ear. He was transported to a local trauma center and hospitalized for one day.



Figure 1. Subject vehicle, 2010 Mazda 3

This investigation was initiated in response to a report by the local National Automotive Sampling System (NASS) team of a side impact IC air bag deployment with an occupant ejection. DSI was notified and assigned the case on October 7, 2010.

SUMMARY

Crash Site

The crash site was the eastbound lane of a rural roadway (**Figure 2**). The roadway was configured with single east and westbound lanes that were separated by double solid yellow centerlines. The travel lanes were bordered by white fog lines and asphalt shoulders. The asphalt roadway was straight, level, and dry. The area beyond the shoulders was grass-covered, partially mowed, and contained areas of standing water. It was dark at the time of the crash and the street lights were illuminated. According to the nearest reporting station, the temperature was 25° C (77° F), the humidity was 69 percent, and the wind was from the south at 18.5 km/h (11.5 mph). The posted speed limit was 64 km/h (40 mph). A crash scene diagram is included at the end of this report as Attachment 1.



Figure 2. Eastbound travel lane

Pre-Crash

The Mazda was being driven by a 23-year-old male and was traveling eastbound at an unknown speed. The driver lost control of the vehicle and it began a clockwise rotation. The vehicle entered the westbound travel lane, crossed back into the eastbound travel lane, and having rotated approximately 160 degrees from its original heading angle, departed the roadway on the right side.

Crash

The Mazda traveled off road and began a left side leading rollover before impacting a wooden utility pole with its left side. After impacting the pole the unrestrained driver was ejected and the vehicle continued the rollover. The vehicle rolled four quarter-turns before coming to rest on its wheels. During the crash sequence both IC air bags and the driver seat-mounted side air bag deployed.

Post-Crash

The driver was transported to a local trauma center where he arrived with a Glasgow Coma Score (GCS) of 14. The driver sustained a spinal fracture and lacerations to the scalp and ear. Computed tomography (CT) scans and x-rays were performed and did not indicate any additional injuries. He was hospitalized one day and then released. He did not report any working days lost.

Vehicle Data - 2010 Mazda 3

The 2010 Mazda 3 was a four-door sedan. It was identified by the Vehicle Identification Number (VIN): JM1BL1SF8A1xxxxxx and its date of manufacture was November 2009. The vehicle mileage was not known. The vehicle was equipped with a 2.0-liter, 4-cylinder engine, automatic transmission, front/rear disc brakes, 4-wheel anti-lock brakes (ABS) with electronic brake distribution, power steering with tilt and telescopic column functionality.

The vehicle manufacturer recommended P205/55R16 tires for the front and rear with a cold tire pressure of 241 kPa (35 psi) for the front and rear tires. The vehicle was equipped with Bridgestone Turanza P205/55R16 tires on the front and rear that were mounted on original equipment steel wheels. The tires were manufactured on the 43rd week of 2009.

The specific tire data at the time of the vehicle inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Tire Flat	7 mm (0.3 in)	No	De-beaded
LR	Tire Flat	8 mm (0.3 in)	No	De-beaded
RR	228 kPa (33 psi)	8 mm (0.3 in)	No	None
RF	234 kPa (34 psi)	7 mm (0.3 in)	No	None

The seating in the Mazda was configured with front bucket seats with adjustable head restraints and 60/40 split bench rear seats with adjustable head restraints. The front head restraints were equipped with an active whiplash protection system.

Vehicle Damage - 2010 Mazda 3

Exterior Damage

The Mazda sustained moderate damage left side damage from the impact with the wooden pole (**Figure 3**). The direct damage began 68.0 cm (26.7 in) forward of the rear axle and extended 49.0 cm (19.3 in) forward. The Field L began 16.0 cm (6.3 in) forward of the rear axle and extended forward 127.0 cm (50.0 in). Six crush measurements were taken at the mid-door level as follows: $C_1 = 0$ cm, $C_2 = 1.0$ cm (0.4 in), $C_3 = 11.0$ cm (4.3 in), $C_4 = 42.0$ cm (16.5 in), $C_5 = 15.0$ cm (5.9 in), $C_6 = 5.0$ cm (1.9 in). Maximum crush was located at C4. The Collision Deformation Classification (CDC) for Event 1 was 60LPAW5.



Figure 3. Left side pole damage

The Mazda sustained moderate damage to the roof during the rollover sequence (Event 2). An unknown CDC was generated for this event due to overlapping damage from the pole impact.

Interior Damage

The Mazda sustained moderate interior damage as a result of intrusions, occupant loading, and occupant contacts. Vertical intrusions were located in the front and second rows at the roof and roof side rail. Lateral intrusions were located at the left side at the B-pillar, rear upper quadrant of the front row door, A-pillar, C-pillar, forward upper quadrant of the second row door, and the front seat back. Contact evidence was located at the left front door panel.

Manual Restraints

The vehicle's front row seating was equipped with 3-point manual lap and shoulder safety belts with continuous loop webbing, sliding latch plates, adjustable D-rings, force limiters, and retractor pretensioners. The driver's safety belt was equipped with an Emergency Locking Retractor (ELR) and the front right passenger's safety had a switchable ELR/Automatic Locking Retractor (ALR). The frontal seat belt pretensioners actuated in the crash and were located in the stowed position. Based on the vehicle inspection no restraints were used in the crash.

Supplemental Restraint Systems

The vehicle's Supplemental Restraint System (SRS) included an air bag control module (ACM), driver and passenger frontal air bags, seat-mounted side air bags, side impact IC air bags, and safety

belt retractor pretensioners for the front row. The vehicle manufacturer has certified that this model is compliant with the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system included dual-stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, safety belt pretensioners, and a front right occupant weight-recognition sensor with an automatic air bag switch. According to the owner's manual the side and IC air bags were designed to deploy when the air bag crash sensors detect a side impact of moderate force and inflate only the air bags on the side where the vehicle was hit. During this crash the left and right IC air bags and the driver's seat-mounted side air bag deployed. Presumably, the left IC air bag and driver's seat-mounted side air bag deployed at impact with the pole and the right IC air bag deployed when the right side was impacted during the rollover. The frontal air bags did not deploy.

The left seat-mounted side air bag deployed at impact from the outboard aspect of the driver's seat back (**Figure 4**). The air bag was semicircular in shape. There was no damage reported to the air bag.



Figure 4. Left seat back mounted side air bag

The left and right IC air bags deployed from the roof side rails above the front and rear rows (**Figure 5**). The IC air bags were rectangular in shape. The forward aspects of the bags were attached to the A-pillar by tethers that were approximately 30.0 cm (11.8 in) in length and the rear aspects were attached to the C-pillars. The longitudinal area of coverage began approximately 30.0 cm (11.8 in) aft of the A-pillar and extended to the C-pillar. The bag's vertical coverage began at the roof rail and extended below the window frame. The side window measured 13.0 cm (5.1 in) in height at the forward aspect, 39.0 cm (15.3 in) in height at the rear aspect, 92.0 cm (36.2 in) in length at the top, and 79.0 cm (31.1 in) in length at the bottom. The area of the side window not covered by the air bag was approximately 30.0 cm (11.8 in) in length and 32.0 cm (12.6 in) in height and encompassed approximately one-third of the window. At the time of the inspection, the forward tether had been cut. There was no evidence of occupant loading to the IC air bags.



Figure 5. Exterior view, left IC air bag

Rollover

The Mazda had a Static Stability Factor (SSF) of 1.41¹. The SSF of a vehicle is an at-rest

¹Obtained from www.safercar.gov

calculation of its rollover resistance, which is based on its track width and center of gravity. The vehicle had a rollover resistance rating of 4 out of 5 stars, and had a 10-20% risk of rollover. The vehicle was equipped with anti-lock brakes with electronic brake distribution. The driver lost control of the vehicle and it began a clockwise rotation. The vehicle entered the westbound travel lane, crossed back into the eastbound travel lane, and having rotated approximately 160 degrees from its original heading angle, departed the roadway on the right side. The vehicle traveled from the asphalt surface of the roadway onto the shoulder. The area beyond the shoulders was grass-covered, partially mowed, and contained areas of standing water. As the vehicle entered this area the left side tires dug into the soil, tripped, and began a left side leading rollover. The vehicle had rolled to an approximate angle of 45 degrees when it impacted and displaced a wooden utility pole. The vehicle completed the first quarter-turn and continued rolling for an additional three quarter-turns before coming to rest on its wheel. The distance from the roadway shoulder to the trip point was approximately 1.9 m (6.2 ft) and the estimated distance from the trip point to final rest was 17.2 m (56.4 ft).

Occupant Demographics

Driver

Age/Sex:	23/Male
Height:	185 cm (72 in)
Weight:	82 kg (180 lbs)
Seat type:	Bucket
Seat track position:	Between middle and rear most track position
Manual restraint usage:	None
Usage source:	Vehicle inspection
Air bags:	Driver frontal air bag, not deployed. Left IC air bag and seat-mounted side impact air bag deployed.
Alcohol, drug involvement:	Alcohol present. BAC test performed, results unknown.
Type of medical treatment:	Transported to trauma center. Hospitalized for one day.

Injuries

Driver: Injuries obtained from history and physical report, discharge summary, and emergency room records.

<u>Injury</u>	<u>Injury Severity (AIS 2005)</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Cervical spine fracture, C4 pedicle	650226.2,6	Left door panel, rear upper quadrant	Probable
Cervical spine fracture, C5 pedicle	650226.2,6	Left door panel, rear upper quadrant	Probable
Scalp laceration, 3.0 cm (1.2 in), left	110602.1,2	Left side window frame	Probable
Left ear laceration, 1.0 cm (0.4 in), left	210602.1,2	Left side window frame	Probable

Occupant Kinematics

Driver Kinematics

The 23-year-old male was seated in unknown posture with the seat adjusted to the between the middle and rear most track position and the seat back was slightly reclined. He was not using the 3-point manual lap and shoulder belt as evidenced by the belt being locked in the stowed position. The driver lost control of the vehicle and it began a clockwise rotation. He was actively braking and steering. The vehicle entered the westbound travel lane, crossed back into the eastbound travel lane, and having rotated approximately 160 degrees from its original heading angle, departed the roadway on the right side. The Mazda traveled off road and began a left side leading rollover before impacting a wooden utility pole with its left side. At impact with the pole, the driver was displaced sharply to the left. His torso and hip impacted and loaded the driver's door and the left side of his head contacted the window frame as he was fully ejected through the left side window. He probably loaded the forward aspect of the IC air bag and displaced it outboard as he was ejected. He came to rest on the ground at an unknown location.

Attachment 1. Scene Diagram

