CRASH DATA RESEARCH CENTER

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CALSPAN REMOTE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION SYSTEM CRASH INVESTIGATION

CASE NO: CA04-004

VEHICLE: 2000 MAZDA MPV

LOCATION: MICHIGAN

CRASH DATE: OCTOBER 2003

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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 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.

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TABLE OF CONTENTS

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BACKGROUND

This remote investigation focused on the crash severity and the source of injury that resulted in left side rib fractures, a left pulmonary contusion, a Grade IV spleen laceration, and a chest wall contusion to a 44-year old female driver of a 2000 Mazda MPV minivan **(Figure 1)**. The Mazda was equipped with redesigned frontal air bags and seat back mounted side impact air bags for the driver and front right passenger positions. The Mazda was involved in a sideswipe-type crash with a Ford Ranger pickup truck. The impact resulted in moderate left side damage to the Mazda and deployment of the left side impact air bag. The driver of the Mazda was transported by ground ambulance to a regional trauma center where she was diagnosed with the internal injuries and admitted for treatment.

Figure 1. 2000 Mazda MPV minivan.

The NHTSA Crash Injury Research Engineering Network (CIREN) provided notification of this crash to the Special Crash Investigations (SCI) Division due to the serious nature of the driver's injuries and the deployment of the side impact air bag. The crash was forwarded to the Calspan SCI team on February 5, 2004 and assigned as a remote investigative effort.

SUMMARY

Crash Site

The crash occurred on a two-lane roadway during daylight hours under an overcast sky. The road surface was reported as dry and straight. There were no traffic controls for the north/southbound traffic. The posted speed limit was 89 km/h (55 mph).

Vehicle Data

2000 Mazda MPV

The subject vehicle in this crash was a 2000 Mazda EX MPV minivan. The vehicle was powered by a 2.5 liter, transverse mounted V-6 engine linked to a four-speed automatic transmission with a column mounted transmission selector lever. The service brakes were powered assisted front disc/rear drum with anti-lock (ABS). The minivan was configured with two front conventionally hinge doors, two sliding side doors, and a rear lift gate. A sunroof was mounted over the front seated positions. The Mazda was equipped with P215/60R16 all-season tires mounted on six-spoke alloy wheels.

The interior of the minivan was configured for seven passenger seating with leather surfaced captains chairs for the front and second row positions. The third row was a removable three-passenger bench seat with a forward folding seat back and adjustable head restraints. The third row head restraints were removed prior to the crash. The front and second row seats were equipped with adjustable head restraints. The driver's head restraint was adjusted approximately 5 cm (2") above the seat back.

1992 Ford Ranger

The Ford Ranger was identified by the police reported VIN: 1FTCR10A3NT (production number deleted). The vehicle was a rear-wheel drive platform powered by a 2.3 liter I4 engine. This vehicle was not inspected; therefore additional information was not available.

Crash Sequence

Pre-Crash

The driver of the 2000 Mazda MPV minivan was traveling in a northbound direction on the two-lane roadway, following a non-contact vehicle. The driver of the non-contact vehicle encountered a slower moving northbound vehicle and initiated a passing maneuver by entering the southbound lane. Following the successful passing maneuver, this driver re-entered the northbound lane. The driver of the Mazda followed the non-contact vehicle and entered the southbound lane in an attempt to pass the slower moving vehicle. The Ford Ranger was traveling in a northbound direction and noted the Mazda enter his lane of travel. He attempted to steer right in an attempt to avoid the Mazda; however, the narrow road did not have adequate width to accommodate three vehicles. It was unknown if the driver of the Mazda attempted to avoid the crash. The Crash Schematic is included as **Figure 10** of this report.

Crash

The Ford Ranger and the Mazda MPV impacted in a sideswipe configuration in the center of the roadway. The initial contact on the Mazda began on the left side surface of the front bumper fascia and extended the full length of the vehicle. Minimal snagging occurred at the leading edges of the doors, left C-pillar, and the left rear alloy wheel. The resultant directions of force were within the 12 o'clock sector for both vehicles. Although the Mazda experienced a 12 o'clock impact force, the frontal air bag system did not deploy due to the low and elongated velocity change experienced by the vehicle. The left B-pillar mounted side impact air bag crash sensor detected side impact crash and deployed the left seat back mounted side impact air bag. Due to the sideswipe nature of the crash, the vehicles did not reach a common velocity; therefore the crash was outside the scope of the WINSMASH reconstruction program. Following the engagement, the vehicles continued on their respective trajectories and came to rest unspecified distances from the point of impact.

Post-Crash

The driver of the Mazda was transported from the scene of the crash to a regional trauma center where she was admitted for treatment of her injuries. Both vehicles sustained disabling damage and were towed from the crash site.

Vehicle Damage

Exterior – 2000 Mazda MPV

The exterior of the Mazda MPV sustained moderate severity sideswipe damage that was distributed along the full length of the vehicle **(Figure 2)**. The damage began on the side surface of the front bumper fascia and continued rearward, involving the left front wheel, front fender, left front door, left outside rear view mirror, the left sliding door, left quarter panel, the left rear alloy wheel and tire, and the side surface of the rear bumper fascia **(Figure 3)**. The direct contact damage involved black rubber transfers, abrasions, dents, and a cut of the left rear tire sidewall. The damage extended vertically from the above the sill level to the beltline. Maximum crush was 3-5 cm (1-2") located at various points along the side surface. The Collision Deformation Classification (CDC) was 12-LDAS-2. The side view mirror of the Ford Ranger contacted the upper left A-pillar of the Mazda. The sideswipe impact snagged the leading edges of the left side doors, the dog-leg of the lower C-pillar, and the left rear alloy wheel.

Figure 2. Left sideswipe damage to the Mazda MPV.

Figure 3. Continuation of the sideswipe damage to the Mazda.

Exterior – 1992 Ford Ranger

The Ford ranger was not inspected during the CIREN investigation; therefore, the specific damage to the vehicle was unknown.

Interior – 2000 Mazda MPV

The interior of the Mazda MPV minivan sustained minor severity damage as a result of side impact air bag deployment and driver contact. There was no intrusion of the passenger compartment. The left seat back mounted side impact air bag deployed from the outboard aspect of the seat back. A localized contact point was noted to the upper rear aspect of the driver's door panel. The padded panel was compressed with a black scuff surrounding the contact **(Figures 4 and 5)**. This possibly resulted from the side impact air bag expanding between the driver's left arm and her torso, displacing her left elbow laterally into the door panel. The driver loaded the manual safety belt system

which was evidenced by a frictional transfer on the D-ring. There were no other contact points within the Mazda.

Figure 4. Left door panel driver contact point.

Figure 5. Close-up view of the contact point.

Frontal Air Bag System – 2000 Mazda MPV

The Mazda was equipped with redesigned frontal air bags for the driver and front right passenger positions. The frontal air bags did not deploy during the crash. The driver's air bag was conventionally mounted within the four-spoke steering wheel rim and concealed by a single cover flap. The front right air bag was a top mount design incorporated into the right upper instrument panel. The module was concealed by a single forward hinged cover flap.

Side Impact Air Bag System – Mazda MPV

The MPV was equipped with supplemental side impact air bags for the driver and front right passenger positions. These side impact air bags were incorporated into the outboard aspect for the front seat backs and deployed in a forward and upward direction offering head and thorax protection for side impact crashes. The Mazda was struck on the left side; therefore the left seat back mounted air bag deployed **(Figure 6)**. Remote side impact crash sensors were located in the lower B-pillars of the Mazda with the air bag control module located on the forward aspect of the center tunnel.

Figure 6. Deployed side impact air bag.

The left side impact air bag was concealed within the leather fabric of the seat back. As the air bag deployed, it tore the seam stitching of the seat back and deployed in a forward and upward direction. The air bag was tethered by a D-shaped stitch pattern in the center of the bag. In

its extended, but deflated stated, the side impact air bag measured 30 cm (12”) wide and approximately 51 cm (20”) in height. There was no damage or contact evidence on the air bag.

Manual Safety Belt Systems

The Mazda was configured as a seven passenger vehicle with captain chair seating for the first two rows and a third row bench seat. The six outboard positions were equipped with continuous loop lap and shoulder belt systems with sliding latch plates. The driver’s belt system utilized an Emergency Locking Retractor (ELR) wile the remaining belt systems utilized switchable ELR/Automatic locking Retractors. The first two rows were equipped with adjustable D-rings. The driver’s D-ring was adjusted to the full-down position. The center rear lap belt was affixed to the removable seat frame and utilized a locking latch plate.

Figure 7. D-ring frictional transfer.

The driver was the sole occupant of the Mazda at the time of the crash. She was restrained by the belt system, evidenced by subtle frictional transfers to the D-ring **(Figure 7)** and latch plate. There was no damage or loading evidence to the belt webbing.

Occupant Demographics/Data

Driver – Mazda MPV

Age/Sex:	44-year old/Female
Height:	170 cm (67”)
Weight:	52 kg (114 lb)
Manual Safety Belt Usage:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Seat Track Position:	Mid track
Mode of Transport From Scene:	Ambulance
Type of Medical Treatment:	Admitted to a regional trauma center for treatment of her abdominal injuries

Driver Injures

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Grade IV spleen laceration	Severe (544226.4,2)	Deploying side impact air bag
Left pulmonary contusion, low and posterior	Serious (441406.3,2)	Deploying side impact air bag
Non-displaced posterior rib fractures, 9 and 11	Moderate (450220.3,2)	Deploying side impact air bag

Left posterior chest wall contusion	Minor (490402.1,2)	Deploying side impact air bag

Driver Kinematics

The 44-year old female driver of the Mazda was seated in a presumed upright posture with her seat track adjusted to a mid track position. She was restrained by the manual 3-point lap and shoulder belt system.

At impact, the left seat back mounted head and thorax side impact air bag deployed **(Figure 8)**. The air bag expanded against the left posterior chest of the driver resulting in the left lower chest wall contusion, left rib fractures 9 and 11, a left lower lobe pulmonary contusion, and a the grade IV spleen laceration. There was no contact evidence to the deployed air bag.

The air bag may have deployed between the driver's left arm and her torso, displacing the arm laterally left. A circular area of compression occurred to the upper rear aspect of the left front door panel **(Figure 9)**. This contact area was concealed by the deployed side impact air bag. The driver did not sustain injury from this suspected contact.

The driver loaded the manual safety belt system during the sideswipe engagement. A subtle frictional abrasion was noted to the D-ring. There was no additional loading evidence to the safety belt system or injury to the driver.

Following the crash, the driver was transported to a regional trauma center where she was evaluated and diagnosed with her thoracic and abdominal injuries and admitted for treatment.

Figure 8. Deployed side impact air bag.

Figure 9. Driver contact to the left door panel.

Second Row Left Passenger

Age/Sex:	9-year old/Female
Height:	132 cm (52”)
Weight:	34 kg (75 lb)
Manual Safety Belt Usage:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Seat Track Position:	Full-forward
Mode of Transport From Scene:	Not transported
Type of Medical Treatment:	Not injured

Third Row Left Passenger

Age/Sex:	11-year old/Male
Height:	155 cm (61”)
Weight:	39 kg (86 lb)
Manual Safety Belt Usage:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Seat Track Position:	Not adjustable
Mode of Transport From Scene:	Not transported
Type of Medical Treatment:	Not injured

Third Row Right Passenger

Age/Sex:	11-year old/Female
Height:	157 cm (62”)
Weight:	39 kg (86 lb)
Manual Safety Belt Usage:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Seat Track Position:	Not adjustable
Mode of Transport From Scene:	Not transported
Type of Medical Treatment:	Not injured

Rear Seat Child Passenger Kinematics

The three rear seat child passengers of the Mazda MPV were restrained by the manual safety belt system. At impact, they probably initiated a slight forward trajectory and loaded the manual safety belt systems. They were not injured in the crash.

Figure 9 – Scene Schematic