CRASH DATA RESEARCH CENTER

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CALSPAN REMOTE ADULT AIR BAG RELATED FATALITY INVESTIGATION

NASS/SCI COMBO CASE NO: 2005-41-039B

VEHICLE: 1999 MITSUBISHI MIRAGE

LOCATION: FLORIDA

CRASH DATE: MARCH 2005

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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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16. Abstract This investigation focused on the fatal injury sources of a 78-year-old restrained female driver of a 1999 Mitsubishi Mirage. The vehicle was equipped with a redesigned frontal air bag system that deployed as a result of a front-to-rear impact with a 1993 Toyota Corolla. The Toyota was stopped for a red traffic signal at a four-leg intersection. The force of the crash displaced the Toyota forward to final rest in the intersection. Following separation, the Mitsubishi continued its northbound trajectory coming to rest on the east road edge, north of the intersection. The Mitsubishi's 78-year-old driver sustained fatal injuries as a result of the crash. Her injuries consisted of AIS-5 level bilateral rib fractures with hemothorax, AIS-4 level bilateral lung contusions and an AIS-4 level liver laceration. The driver was transported to a regional trauma center by ambulance and expired prior to hospital admission.			
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CALSPAN REMOTE ADULT NASS/SCI AIR BAG RELATED FATALITY INVESTIGATION
CASE NO: 2005-041-039B
VEHICLE: 1999 MITSUBISHI MIRAGE
LOCATION: FLORIDA
CRASH DATE: MARCH 2005

BACKGROUND

This investigation focused on the fatal injury sources of a 78-year-old restrained female driver of a 1999 Mitsubishi Mirage **(Figure 1)**. The vehicle was equipped with a redesigned frontal air bag system that deployed as a result of a front-to-rear impact with a 1993 Toyota Corolla. The Toyota was stopped for a red traffic signal at a four-leg intersection. The force of the crash displaced the Toyota forward to final rest in the intersection. Following separation, the Mitsubishi continued its northbound trajectory coming to rest on the east road edge, north of the intersection. The Mitsubishi's 78-year-old driver sustained fatal injuries as a result of the crash. Her injuries consisted of AIS-5 level bilateral rib fractures with hemothorax, AIS-4 level bilateral lung contusions and an AIS-4 level liver laceration. The driver was transported to a regional trauma center by ambulance and expired prior to hospital admission.

Figure 1 - Damaged 1999 Mitsubishi Mirage

This crash was identified and selected for investigation by PSU 41 of the National Automotive Sampling System (NASS) as CDS Case No: 2005-41-039B. The Crash Investigation Division of the National Highway Traffic Safety Administration subsequently assigned a remote combined NASS/SCI investigation to the Calspan Special Crash Investigations team on October 14, 2005. The SCI effort consisted of reviewing the coded EDS data and the preparation of this report.

SUMMARY

Crash Site

This two-vehicle crash occurred during daylight hours in the state of Florida in March 2005. At the time of the crash, there were no adverse weather conditions and the asphalt roadway was dry. The crash occurred in the middle lane at the mouth of a four-leg intersection consisting of a five-lane, north/south roadway crossing a two-lane east/west roadway. The north/south roadway was physically divided by a raised grassy median bordered by concrete curbs. The northbound roadway consisted of two 3.7 m (12.1') wide through lanes delineated by solid white painted lines, a 3.3 m (10.8') left turn-only lane, and .25 m (0.8') wide shoulders. The roadside environment consisted of private homes and natural growth. The roadway was straight and level and had a posted speed

limit of 56 km/h (35 mph). The intersection was controlled by 3-phase traffic control signals. The scene schematic is included as **Figure 11** at the end of this narrative report.

Vehicle Data – 1999 Mitsubishi Mirage

The 1999 Mitsubishi Mirage was manufactured in 07/98 and was identified by the Vehicle Identification Number (VIN): JA3AY26A6XU (production sequence omitted). The vehicle was a four-door sedan equipped with a 1.5 liter, 4-cylinder engine, front-wheel-drive, an automatic transmission, and power assisted front disc/rear drum brakes. At the time of the vehicle inspection, the odometer read 89,728 km (55,754 miles). The vehicle was equipped with varied P175/70R13 tires mounted on 33 cm (13") diameter steel wheels. The manufacturer's recommended tire pressure was 210 kPa (31 PSI). The specific tire information at the time of the SCI vehicle inspection was as follows:

Position	Tire	Measured Pressure	Measured Tread	Damage
LF	Sigma Shadow	186 kPa (27 PSI)	5 mm (6/32")	None
LR	Futura Euro 82T	200 kPa (29 PSI)	6 mm (8/32")	None
RF	Sigma Shadow	186 kPa (27 PSI)	4 mm (5/32")	None
RR	Futura Euro 82T	186 kPa (27 PSI)	3 mm (4/32")	None

The 1993 Toyota Tercel was configured with front bucket seats with adjustable head restraints for the driver and front right passenger positions. The driver's seat track was adjusted to the rear-most track position at the time of the NASS inspection; however, based on the height of the driver, the track position was probably altered by emergency personnel. The Tercel was configured with a split bench seat with folding backs in the second row. The two outboard positions were equipped with integral head restraints.

Vehicle Data – 1993 Toyota Corolla

The 1993 Toyota Corolla was manufactured in 03/93 and was identified by the VIN: 1NXAE09E4PZ (production sequence omitted). The vehicle was a four-door sedan equipped with a 1.8 liter, 4-cylinder engine, front-wheel-drive, a four-speed automatic transmission, and power assisted front disc/rear drum brakes. At the time of the vehicle inspection, the odometer read 209,555 km (130,211 miles). The vehicle was equipped with Sigma Tempest P185/65R14 tires mounted on 36 cm (14") diameter steel wheels and the manufacturer's recommended tire pressure was 241 kPa (35 PSI). The specific tire information at the time of the SCI vehicle inspection was as follows:

Position	Tire	Measured Pressure	Measured Tread	Damage
LF	Sigma Tempest	152 kPa (22 PSI)	6 mm (8/32")	None
LR	Sigma Tempest	221 kPa (32 PSI)	5 mm (6/32")	None
RF	Sigma Tempest	152 kPa (22 PSI)	6 mm (8/32")	None
RR	Sigma Tempest	214 kPa (31 PSI)	6 mm (8/32")	None

Crash Sequence

Pre-Crash

The 78-year-old female driver of the Mirage was traveling northbound in the center lane of the roadway and was approaching the intersection. The 2003 Toyota Corolla was stopped for a red traffic signal in the middle lane at the intersection. The driver of the Toyota stated that she did not see or hear the other vehicle approaching until the impact. There was no scene evidence indicating that any pre-crash avoidance actions were attempted prior to impact. **Figures 2 and 3** illustrate the point of impact and look back from the point of impact.

Figure 2 - Northbound view of the area of impact.

Figure 3 - Southbound view of the area of impact.

Crash

The frontal plane of the Mirage impacted the rear plane of the Corolla at the intersection. The directions of force for the 1999 Mirage and 2003 Corolla were 12 o'clock and 6 o'clock, respectively. The impact resulted in moderate damage to both vehicles and was sufficient to deploy the frontal air bag system in the Mirage. The damage-only routine of the WinSMASH program computed a total delta-V of 34 km/h (21.1 mph) for the Mirage and 32 km/h (19.9 mph) for the Corolla, based on the respective crush profiles. The specific longitudinal and lateral components were -34 (-21.1 mph) km/h and 0 km/h for the Mirage and 32 km/h (19.9 mph) and 0 km/h for the Corolla. The impact displaced the Mirage forward and to its right. The Mirage traveled through the intersection and drifted northbound approximately 50 m (165'), before partially exiting the east roadside. The Mirage came to final rest straddling the road edge and facing a northbound direction. The Corolla was redirected forward from the point of impact and came to rest 10.2 m (26') north in the intersection.

Post-Crash

Emergency personnel arrived on the scene and removed the 78-year-old female driver of the Mitsubishi Mirage. She sustained AIS-5 level critical injuries and was transported to a regional trauma center by ambulance. She expired 23 minutes after arriving at the trauma center. The driver of the Corolla exited her vehicle under her own power and was not injured.

Vehicle Damage

Exterior Damage – 1999 Mitsubishi Mirage

The 1999 Mitsubishi Mirage sustained moderate damage as the result of the front-to-rear impact with the Toyota Corolla **(Figure 4)**. The NASS investigation revealed that the direct contact damage began at the front right bumper corner and extended 89 cm (35”) to the left. The direct and induced damage encompassed the entire front end and measured 142 cm (56”) in width. The hood buckled and was deflected rearward. The maximum crush was located at the front right bumper corner and was 30 cm (11.8”) in depth. The Collision Deformation Classification (CDC) for the impact with the Corolla was 12-FZEW-2. Six equidistant crush measurements were documented along the front bumper and were as follows: C1 = 0 cm, C2 = 4 cm (1.6”), C3 = 13 cm (5.1”), C4 = 25 cm (9.8”), C5 = 25 cm (9.8”), C6 = 30 cm (11.8”).

Figure 4 - Damaged 1999 Mitsubishi Mirage.

Interior Damage - 1999 Mitsubishi Mirage

1999 Mitsubishi Mirage sustained minor interior damage as the result of the impact the Corolla. The knee bolster cover panel slightly separated from its base possibly from contact with the driver’s knees. No correlative knee injuries were diagnosed at the medical facility. There were no intrusions associated with this impact. Based on the available images, there was no bending of the steering wheel rim or any compression of the steering column **(Figure 5)**.

Figure 5 - Lateral view of undamaged steering wheel rim.

Exterior Damage – 1993 Toyota Corolla

The 1993 Toyota Corolla sustained moderate severity rear damage from the impact with the 1999 Mitsubishi Mirage **(Figure 6)**. The NASS vehicle inspection revealed that the direct contact damage began at the left rear bumper corner and extended 66 cm (26”) to the right. The combined direct and induced damage encompassed the entire rear plane and measured 115 cm (45.2”) in width. The bumper cover was deformed and shifted to the left while the left quarter panel was buckled outboard of the vehicle’s bodyline. The maximum crush was located 35 cm (13.8”) left of the vehicle’s centerline and measured 65 cm (25.6”) in depth.

Figure 6 - Damaged 1993 Toyota Corolla.

The CDC for the rear impact with the Mirage was 06-BYEW-4. Six equidistant crush measurements were documented along the rear bumper and were as follows: C1 = 0 cm, C2 = 0 cm, C3 = 17 cm (6.7”), C4 = 39 cm (15.4”), C5 = 65 cm (25.6”), C6 = 64 cm (25.2”).

Manual Restraints – 1999 Mitsubishi Mirage

The 1999 Mitsubishi Mirage was equipped with continuous loop, manual 3-point lap and shoulder belts with D-rings for all four outboard seating positions. The second row center position was configured with a lap belt. The driver’s safety belt was designed with a belt-sensitive, Emergency Locking Retractor (ELR) and the remaining belts were designed with belt-sensitive, ELR/Automatic Locking Retractors (ALR). The driver’s D-ring was set in the full-up position at the time of the NASS inspection. The driver’s belt contained an aftermarket seatbelt extension **(Figures 7 and 8)**, which provided additional belt length for the driver. The extension contained a buckle mechanism, approximately 10 cm (4”) of additional webbing, and a latch plate. The extension in totality provided approximately 25 cm (10”) of additional belt. The NASS investigation did not trace any specific loading on the belt system; measurements of the webbing were not taken.

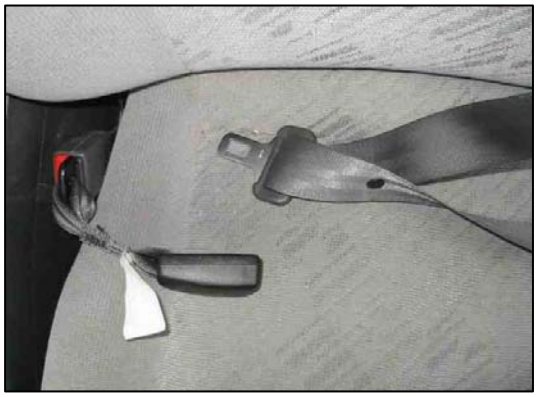

Figure 7 - Engaged safety belt extender.

Figure 8 - Disengaged safety belt extender.

Redesigned Frontal Air Bag System – 1999 Mitsubishi Mirage

The 1999 Mitsubishi Mirage was equipped with redesigned frontal air bags for the driver and front right passenger seating positions. The driver’s air bag deployed **(Figure 9)** from a trapezoidal top-mounted single cover flap. The top aspect of the cover flap was 17 cm (6.7”) in width and the bottom aspect was 8 cm (3.1”). The cover flap was 12 cm (4.7”) in height. The deployed driver’s air bag was 70 cm (27.6”) in diameter in it deflated state. The air bag reportedly contained one tether strap the location of which was not recorded. The air bag was vented by two ports located in the 11 and 1 o’clock positions. The NASS inspection was unable to locate any discernable occupant contact on the air bag.

The front right air bag **(Figure 10)** deployed from a mid mount module cover flap that measured 32 cm (12.6”) in width and 18 cm (7.1”) in height. The cover flap was a single ply molded vinyl flap that was hinged at the top surface, which allowed the flap to open

in an upward direction. The deployed front right air bag measured 70 cm (27.6") vertically and 80 cm (31.5") horizontally. The air bag reportedly was not tethered and was vented by two ports located in the 3 o'clock and 9 o'clock positions.

Figure 9 - Driver's air bag.

Figure 10 - Front right passenger's air bag.

Occupant Data/Demographics

Driver – 1999 Mitsubishi Mirage

Age/Sex:	78-year-old/Female
Height:	147 cm (57.9")
Weight:	75 kg (165 lb)
Seat Track Position:	Undetermined (seat track was adjusted post-crash)
Safety Belt Usage:	3-point lap and shoulder belt with belt extender
Usage Source:	Vehicle inspection, medical data
Mode of Transport:	Ambulance
Type of Medical Treatment:	Expired 23 minutes after arrival at regional trauma center

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Bilateral rib fractures (2-6) with hemothorax.	Critical (450242.5,3)	Expanding driver's air bag
Bilateral lung contusions	Severe (441410.4,3)	Expanding driver's air bag
Liver laceration (major)	Severe (541826.4,1)	Manual belt system/extender

Source: Autopsy.

Driver Kinematics

Driver Kinematics

The 78-year old female driver of the 1999 Mitsubishi Mirage was seated in a presumed forward track position due to her short stature of 147 cm (57.9"). In this position, her torso was in close proximity to the steering wheel and the driver's air bag module. She was restrained by the manual 3-point lap and shoulder belt system. This driver used the belt extender which changed the geometry of the belt system across her body. The extender repositioned the lap belt high across her abdomen and the junction of the lap and

shoulder belt at the latch plate would have been positioned at the upper right area of her abdomen.

At impact, the frontal air bag system deployed. Due to the front-to-rear engagement between the vehicles, the frontal air bag system in the Mitsubishi could have deployed late in the crash sequence. The deploying driver's air bag contacted the driver in the chest which resulted in symmetrical bilateral rib fractures 2-6 with hemothorax. The driver responded to the frontal crash forces by initiating a forward trajectory and loading the manual safety belt system. Her loading force against the belt at the area of the latch plate resulted in a severe liver laceration. The autopsy report identified the liver laceration as 12-15 cm (4.7-5.9") in length and 3 cm (1.2") in depth.

The driver's knees contacted and scuffed the knee bolster. This contact sequence did not result in reported injury.

Medical Treatment

Emergency medical personnel arrived on scene and found the driver unconscious in the vehicle. She was removed from the Mitsubishi and transported by ground ambulance to a regional trauma center where she expired 23 minutes following arrival. An autopsy provided the injury data noted above.

Figure 11 - NASS Scene Schematic