

**TRANSPORTATION SCIENCES  
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**VERIDIAN REMOTE AIR BAG RELATED  
ADULT DRIVER FATALITY INVESTIGATION  
VERIDIAN CASE NO. CA01-027  
VEHICLE: 1992 MAZDA MAITA  
LOCATION: VIRGINIA  
CRASH DATE: JUNE 1994**

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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. <i>Abstract</i> This remote investigation focused on the injury mechanisms and the cause of death for a 36 year old female driver of a 1992 Mazda Miata. The Mazda was equipped with a frontal air bag system for the driver's position that deployed as a result of front right impact with a fire hydrant. The driver was found in the vehicle with the engine running and the air bag system deployed. She was in a semi-coherent state and was transported by ambulance to a local hospital where she was treated and released approximately two hours following the crash. A family member found the driver at her residence in a semi-conscious state approximately 10 hours following her discharge from the hospital. She was transported by ambulance to the local hospital where she was admitted for treatment of cervical injuries. Her condition deteriorated and she expired five days following the crash. A 23 year old male front right passenger of the Mazda fled the scene prior to police arrival.			
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***BACKGROUND***

This remote investigation focused on the injury mechanisms and the cause of death for a 36 year old female driver of a 1992 Mazda Miata (**Figure 1**). The Mazda was equipped with a frontal air bag system for the driver's position that deployed as a result of front right impact with a fire hydrant. The driver was found in the vehicle with the engine running and the air bag system deployed. She was in a semi-coherent state and was transported by ambulance to a local hospital where she was treated and released approximately two hours following the crash. A family member found the driver at her residence in a semi-conscious state approximately 10 hours following her discharge from the hospital. She was transported by ambulance to the local hospital where she was admitted for treatment of cervical and closed head injuries and multiple thrombosis. Her condition deteriorated and she expired five days following the crash. A 23 year old male front right passenger of the Mazda fled the scene prior to police arrival.



**Figure 1. Frontal view of the repaired 1992 Mazda Miata.**

This crash file was initially reviewed at the investigating police agency in 1999 by the Veridian SCI personnel and the NHTSA personnel during their involvement with another SCI investigation. At the time of review, the file was reassigned from the Police Homicide Division to the Traffic Division and investigated as an air bag related fatality. The police crash investigator located the repaired Mazda Miata from the June 1994 crash in April 2000, and performed an inspection of the vehicle in the State of Florida. The crash was subsequently assigned to the Veridian SCI team as a remote level investigation on May 24, 2001. Available data for this air bag related investigation included the hospital medical records, the autopsy report, repaired vehicle photographs, the insurance company damage estimate, and the police crash report.

***Crash Site***

The crash occurred on a two-lane county road in a residential area in a posted 56 km/h (35 mph) speed zone. At the time of the crash, the asphalt road surface was dry. The lighting conditions were police reported as clear and dark with no artificial illumination. In the vicinity of the crash site, the road was curved with a grade. The direction of curvature and grade were not reported.

### ***Vehicle Data***

The involved vehicle in this crash was a 1992 Mazda Miata MX5, 2-door convertible. The vehicle was powered by a 1.6 liter gasoline engine linked to a 5-speed manual transmission with a console mounted shifter. Based on the available police photographs and the insurance damage estimate, the Miata was equipped with electrically controlled outside rear view mirrors, power windows, power-assisted steering, and air conditioning. The two passenger sports car was equipped with bucket seats with reclining seat backs and adjustable head restraints. The vehicle restraint systems consisted of 3-point, continuous loop lap and shoulder belt systems with emergency locking retractors and sliding latch plates that extended from the top aspect of the lower B-pillars due to the convertible design. Additional occupant protection was provided by a frontal driver air bag system. The air bag deployed as a result of the frontal impact with the fire hydrant. The Mazda Miata was identified by vehicle identification number JM1NA3512N0 (production number deleted). The odometer reading at the time of the insurance estimate was 21,858 km (13,582 miles). A family member of the driver was the reported vehicle owner. The driver's experience with this vehicle and the standard transmission was unknown.

### ***Crash Sequence***

#### ***Pre-Crash***

The 36 year old female driver of the Mazda Miata was traveling in a northerly direction on a two lane road in a posted 56 km/h (35 mph) speed zone. The convertible top was in the down position. A 23 year old male passenger was allegedly in the vehicle at the time of the crash. It was unknown if the driver relinquished control of the vehicle, or if the passenger was assisting with the driving task. The female driver later noted to the police that both she and the passenger were driving the vehicle. The Mazda departed the right roadside in an alleged tracking mode.

#### ***Crash***

The front right area of the Mazda struck a fire hydrant that was located approximately 1 m (3') outboard of the east road edge. Although unconfirmed by vehicle photographs and based solely on the insurance company damage estimate, the impact probably resulted in a 12 o'clock direction of force and an estimated longitudinal velocity change of 11-19 km/h (7-12 mph). This impact induced deceleration deployed the frontal air bag system.

#### ***Post-Crash***

The Mazda came to rest against the struck hydrant with the engine running. The driver was positioned behind the deployed driver's air bag and found in a semi-coherent state. The front right passenger exited the vehicle and fled the scene prior to the arrival of emergency personnel. Police and emergency medical personnel requested ambulance transport to a local hospital. The driver was examined at the hospital and treated for minor injuries. She was discharged two hours following the crash and was driven to her residence by a taxi. The Mazda was subsequently towed from the scene.

The driver was found at her residence in a semi-conscious state by a family member approximately 10 hours following her discharge from the hospital. She was immediately transported back to the local hospital

where she was admitted for treatment. Evaluation of the driver revealed abrasive type marks across her anterior neck and a cervical fracture. Her condition deteriorated and she expired five days following the crash.

### ***Vehicle Damage***

#### ***Exterior***

There were no photographs of the frontal impact damage available for this remote investigation. **Figure 2** is an image of the repaired Mazda that obtained six years following the crash. Based on the insurance company damage estimate and the Police Accident Report (PAR), the impact involved the front right aspect of the vehicle. The Mazda was repaired and retained by the family owner. The damage repair invoice noted that the major replacement parts consisted of the front bumper fascia, the bumper reinforcement beam, the right headlamp assembly, hood, right front fender, and the radiator support panel. In addition to the body damage, the steering wheel, air bag control module, and three front mounted crash sensors were replaced resulting in a total repair cost of \$6,994.58. The estimated Collision Deformation Classification (CDC) was 12-FRE9-9. (Columns 6 and 7 of the CDC were unknown due to the lack of the specific frontal location and extent of the damage.)



**Figure 2. Right frontal view of the repaired Mazda Miata.**

#### ***Interior***

There was no reported intrusion of the passenger compartment. The deployed air bag and steering wheel were replaced as previously noted. The damage estimate also identified the replacement of the steering shaft, however, it was unknown if this was a result of exterior crash forces or the result of occupant loading. **Figure 3** is an overall view of the vehicle's interior and the repaired air bag system.



**Figure 3. Overall view of the driver's compartment.**

#### ***Frontal Air Bag System***

The 1992 Mazda Miata was equipped with a frontal air bag system for the driver only position. The system consisted of three crash sensors that were mounted to the upper radiator support panel, a safing sensor that was located in the center instrument panel, an air bag control module that was located left of center in the lower instrument panel, an air bag indicator lamp, and the steering wheel mounted driver air bag module. According to the police investigation and the insurance company damage estimate, the air bag deployed as a result of a front right impact sequence with the fire hydrant. There were no photographs of the deployed air bag system.

Based on the available post-repair photographs of the involved Mazda Miata and a previous SCI investigation of a similar vehicle, this air bag module consisted of symmetrical H-configuration cover flaps and an internally tethered (four straps) bag membrane that was vented by two ports on the back side of

the bag. It was unknown if the driver air bag was damaged or exhibited contact evidence from driver involvement.

***Driver Demographics***

Age/Sex: 36 year old female  
 Height: 166.4 cm (65.5")  
 Weight: 54 kg (119 lb)  
 Seat Track Position: Unknown, estimated at mid track based on driver's height and vehicle size  
 Manual Belt Usage: None, 3-point lap and shoulder belt was available  
 Usage Source: Driver injuries, follow-up interview data  
 Eyeware: None reported  
 Mode of Transport  
 From Scene: Ambulance to a local hospital  
 Type of Medical  
 Treatment: Initially treated at the local hospital and released within two hours. The driver was transported and admitted to the hospital approximately 10 hours following her initial release. She expired 5 days following the crash.

***Driver Injuries***

<b>Injury</b>	<b>Injury Severity (AIS90/Update 98)</b>	<b>Injury Source</b>
+ C2 avulsion fracture of the anterior/inferior corner	Moderate (650230.2,6)	Extension of the neck due to the expanding driver's air bag membrane
* Fracture of the distal end of the left greater wing on the hyoid bone	Moderate (350200.2,5)	Expanding driver's air bag membrane
* Hemorrhage overlying the soft tissue of the neck	Minor (390402.1,5)	Expanding driver's air bag membrane
* Hemorrhages in the perilaryngeal soft tissue with a few focal laryngeal mucosal hemorrhages	Moderate (340202.2,5)	Expanding driver's air bag membrane
* Multiple brain stem hemorrhages, 1-3 mm	Critical (140210.5,8)	Extension of the neck due to the expanding driver's air bag membrane
* Thrombosis of the superior aspect of the right internal carotid artery	Severe (320222.4,1)	Expanding driver's air bag membrane



<b>Injury</b>	<b>Injury Severity (AIS90/Update 98)</b>	<b>Injury Source</b>
* Cerebral edema with flattened gyri	Serious (140660.3,9)	Expanding driver's air bag membrane
* Hemorrhagic infarct of the right temporal and parietal lobes	Serious (140676.3,1)	Expanding driver's air bag membrane
* Thrombosis of the dural sinuses	Serious (122204.3,9)	Expanding driver's air bag membrane
* Thrombosis of the right middle cerebral artery	Severe (121404.4,0)	Expanding driver's air bag membrane
* Thrombosis of the intracranial segment of the right carotid artery	Severe (121004.4,1)	Expanding driver's air bag membrane
* Abrasion across the anterior upper neck (14x2.5 cm ) with an abrasion (10x0.6 cm) across the submandibular region and left lower neck	Minor (390202.1,0)	Expanding driver's air bag membrane
* Abrasion of the mid-upper chest	Minor (490202.1,4)	Expanding driver's air bag membrane
* Three contusions of the left breast	Minor (490402.1,2)	Expanding driver's air bag membrane
* Abrasion of the upper left chest overlying the left clavicle	Minor (790202.1,2)	Expanding driver's air bag membrane
* Contusion of the ventral right forearm	Minor (790402.1,1)	Expanding driver's air bag membrane
* Bilateral knee contusions, one on the right, three on the left	Minor (890402.1,3)	Knee bolster
* Contusion of the left anterior thigh, 1.9x1.3 cm	Minor (890402.1,2)	Steering wheel rim

*Source of injury data:*      \*Autopsy  
   +Hospital records

### *Driver Kinematics*

The 36 year old female driver of the Mazda Miata was seated in an unknown track position and was in an unknown driving posture at the time of the crash. **Figure 4** is a view of the driver's compartment with the seat track adjusted to the full rear position. It was presumed that she was positioned forward with respect to the steering wheel assembly based on the nature and location of her injuries. The driver was dressed in a sweater and skirt, and was wearing a watch with a stretch-metal band, a faux pearl necklace, earrings or a pendent, and a scarf that possibly wrapped or was loosely tied around her neck. The driver was not wearing the manual belt system as determined from observations of the first responders, injury data, and family member statements to the investigating police agency.



**Figure 4. Profile view of the driver's compartment with the seat track adjusted to the full rear position.**

At impact with the fire hydrant, the driver air bag system deployed. The driver was positioned within the deployment path of the air bag as the expanding air bag membrane contacted her anterior neck and submental area. As a result of the bag expansion, the driver sustained a band-like abrasion pattern across the upper neck that measured 14x2.5 cm with an abrasion across the submandibular region and lower left neck. The scarf that was presumed to be positioned across the anterior neck of the driver, protected the mid and lower aspects of the neck from abrasion. This expansion contact fractured the distal end of the left greater wing of the hyoid bone and hyper-extended the neck. The hyper-extension probably stretched the anterior ligaments of the cervical region which resulted in an avulsion fracture of the anterior/inferior aspect of C2. In addition, the driver sustained hemorrhages overlying the soft tissue of the neck, hemorrhages in the perilyngeal soft tissue with a few laryngeal mucosal hemorrhages, 1-3 mm hemorrhages of the brain stem, and a hemorrhagic infarct of the right temporal and parietal lobes. Additionally, the driver developed thrombosis of the superior aspect of the right internal carotid artery, thrombosis of the dural sinuses, thrombosis of the right mid cerebral artery, and thrombosis of the intracranial segment of the right carotid artery.

The air bag membrane expanded against her right forearm which resulted in a contusion of the ventral aspect of the forearm. Continued expansion of the bag against her chest resulted in three contusions of the left breast, an abrasion of the mid upper chest, and an abrasion of the upper left chest overlying the clavicle.

The driver initiated a forward trajectory in response to the 12 o'clock impact force. Her knees probably contacted the knee bolster which resulted in bilateral contusions of the knees. As the air bag expanded against her neck, the driver was probably displaced upward which allowed her left anterior thigh to contact the bottom edge of the steering wheel rim. This was evidenced by a contusion of the thigh that measured 1.9x1.3 cm.

The driver was found in the vehicle slumped forward with her head down. The watchband was broken and the watch had separated from her wrist. An earring or pendent was found wedged between the center

console and the seat cushion. Her scarf was found in the area behind the front seat with jagged edges and blood on the fabric. The investigating officer noted that her sweater appeared to be stretched and the skirt was in disarray. He further noted that no tears were apparent to the clothing. Her necklace apparently remained on her neck as it was handed to her by paramedics as they applied a neck brace prior to removal from the vehicle.

### ***Medical Treatment***

The driver was transported by ambulance to a local hospital where she was treated for minor soft tissue abrasions, X-rayed (cervical region), and released within two hours of the crash. The driver was driven to her residence by a taxi and dropped-off within her townhouse community at no specific address. The driver apparently walked to her residence.

A family member checked on the status of the driver approximately two hours following her arrival to her residence. This family member noted that the driver was in her bed with a light on. The light was turned-off without response from the driver. Another family member checked on the driver's condition approximately four hours later. The driver was observed in bed and appeared to be sleeping.

This same family member again checked on the status of the driver approximately four hours later (12 hours following the crash) and found the driver in convulsions on the floor of her bedroom. She was transported by ambulance to the local hospital and admitted. An arteriogram demonstrated the driver sustained a traumatic occlusion of the right internal carotid artery. She subsequently developed edema in the right cerebral hemisphere, massive infarction in the area of the right anterior and middle cerebral arteries and transtentorial herniation. She expired five days following the crash.

### ***Front Right Passenger Demographics***

Age/Sex:	23 year old male
Height:	75.0" (190.5 cm)
Weight:	Unknown
Manual Belt Usage:	Unknown
Usage Source:	No data to determine belt usage
Mode of Transport	
From Scene:	Fled scene
Medical Treatment:	N/A, not injured

### ***Front Right Passenger Kinematics***

The front right adult male passenger of the Mazda Miata was probably seated in a full-rear track position. There was no evidence to determination belt usage at the time of the crash since the occupant fled the scene and the vehicle was inspected by the investigating police agency approximately six years after the crash. The insurance damage estimate did not list replacement components to the right interior of the vehicle.

At impact, the passenger initiated a forward trajectory and probably braced against the upper instrument panel. The Miata was not equipped with a front right air bag. Immediately following the crash, the passenger exited the convertible and fled the scene prior to police arrival. Although his injury status was not coded on the police report, it was doubtful that this passenger was injured during the crash.