CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE ADULT AIR BAG RELATED FATALITY INVESTIGATION

SCI CASE NO.: CA05-003

SUBJECT VEHICLE – 1996 MERCURY GRAND MARQUIS

LOCATION - STATE OF NEW YORK

CRASH DATE – DECEMBER 2004

Contract No. DTNH22-01-C-17002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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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.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. CA05-003	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle Calspan On-Site Adult Air Bag Related Fatality Investigation Vehicle: 1996 Mercury Grand Marquis Location: State of New York		*5. Report Date*: January 2007 *6. Performing Organization Code*	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00410.0000.0259 *11. Contract or Grant No.* DTNH22-01-C-17002	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		*13. Type of Report and Period Covered* Technical Report Crash Date: December 2004 *14. Sponsoring Agency Code*	
15. Supplementary Note This on-site investigation focused on the injury source and the cause of death for a 66-year-old male driver of a 1996 Mercury Grand Marquis.			
16. Abstract This on-site investigation focused on the injury source and the cause of death for a 66-year-old male driver of a 1996 Mercury Grand Marquis. The Mercury was equipped with a non-redesigned frontal air bag system for the driver and front right passenger positions that deployed as a result of a parking lot crash with a concrete base that supported a light pole. The unrestrained 66-year-old male driver of the Mercury was traveling in an easterly direction in a church parking lot approaching the exit. The center frontal area of the vehicle impacted the concrete base support. Several family members witnessed the crash and immediately responded to the vehicle. The family entered the vehicle by breaking the left rear glazing due to the locked status of the doors. The driver was removed from the vehicle and placed on the pavement. A family member, who was a surgical nurse with CPR training, initiated CPR until police and Emergency Medical Services (EMS) personnel arrived at the scene. EMS personnel continued CPR during the ambulance transport to a local hospital. The driver was pronounced dead upon arrival at the hospital approximately 35 minutes post-crash. The driver sustained a thoracic aorta laceration, bilateral rib fractures with left hemothorax, sternum fracture, heart contusion, a collapsed left lung, and soft tissue injuries. Based on the interior inspection, the driver was in a forward position in the path of the deploying frontal air bag, which resulted in the thoracic injuries. The vehicle sustained moderate frontal damage and was towed from the scene.			
17. Key Words Frontal Air Bag Deployment		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 9	*22. Price*

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BACKGROUND

This on-site investigation focused on the injury source and the cause of death for a 66-year-old male driver of a 1996 Mercury Grand Marquis **(Figure 1)**. The Mercury was equipped with a non-redesigned frontal air bag system for the driver and front right passenger positions that deployed as a result of a parking lot crash with the concrete base that supported a light pole. The unrestrained 66-year-old male driver of the Mercury was traveling in an easterly direction in a church parking lot approaching the exit. The center frontal area of the vehicle impacted the concrete base support. Several family members witnessed the crash and immediately responded to the vehicle. The family entered the vehicle by breaking the left rear glazing due to the locked status of the doors. The driver was removed from the vehicle and placed on the pavement. A family member, who was a surgical nurse with CPR training, initiated CPR until police and Emergency Medical Services (EMS) personnel arrived at the scene. EMS personnel continued CPR during the ambulance transport to a local hospital. The driver was pronounced dead upon arrival at the hospital approximately 35 minutes post-crash. The driver sustained a thoracic aorta laceration, bilateral rib fractures with left hemothorax, sternum fracture, heart contusion, a collapsed left lung, and soft tissue injuries. Based on the interior inspection, the driver was in a forward position in the path of the deploying frontal air bag, which resulted in the thoracic injuries. The vehicle sustained moderate frontal damage and was towed from the scene.

Figure 1. Subject vehicle 1996 Mercury Grand Marquis.

Notification of the crash was provided to the Calspan Special Crash Investigations (SCI) team by a local resident who was related to the driver. Details of the crash were forwarded to the National Highway Traffic Safety Administration (NHTSA). Due to the possible air bag related fatal injuries, an on-site investigation of the crash was assigned to the Calspan SCI team on January 10, 2005. The vehicle and crash site were inspected on January 18, 2005, following attorney approval.

SUMMARY

Crash Site

This single vehicle crash occurred during the daytime hours of December 2004. At the time of the crash, it was raining and the asphalt pavement was wet. The crash occurred at the eastern end of a large church parking lot. The parking lot consisted of multiple parking spaces and six light poles that were spaced 20.7 m (68') from north to south and 35.6 m (117') from east to west in a rectangular pattern. The struck concrete base support was 61 cm (24") in diameter and 51 cm (20") in height. A 12.7 (5") diameter metal light pole that was approximately 6.4 meters (21 ft) in height was mounted to the concrete base. A travel lane was located adjacent (south) to the concrete base support. The parking lot terminated 12.8 m (42.1') south of the concrete base support. The nearest exit was located 7.1 m (23.2') east of the area of impact. Traffic flow through the parking lot was not regulated by posted speed limits or traffic control devices. **Figure 2** is an overall view of the crash site. The scene schematic is included as **(Figure 11)** of this report.

Figure 2. Overall view of the crash site.

Vehicle Data – 1996 Mercury Grand Marquis

The 1996 Mercury Grand Marquis was identified by the Vehicle Identification Number (VIN): 2MELM74W9T (production sequence omitted) and manufactured in 1/96. The odometer reading was 168,197 kilometers (104,516 miles) at the time of the SCI inspection. The vehicle was a four-door sedan that was equipped with a 4.6-liter, eight-cylinder engine, 4-speed automatic transmission, rear-wheel drive, power brakes, OEM steel wheels with metal hubcaps, and power steering. The Mercury was configured with Hercules Mega TR Touring Radials on the front and Cooper LifeLiner Touring SLE on the rear, size P215/70R15. The maximum pressure for the front tires was 241 kPa (35 PSI) and the rear tires were 304 kPa (44 PSI). The vehicle manufacturer recommended tire pressure was 221 kPa (32 PSI) for the front tires and 241 kPa (35 PSI) for the rear tires. The specific tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	149 kPa (21 PSI)	4 mm (5/32)	No	None
LR	176 kPa (25.5 PSI)	7 mm (9/32)	No	None
RF	172 kPa (25 PSI)	4 mm (5/32)	No	None
RR	183 kPa (26.5 PSI)	6 mm (8/32)	No	None

The interior of the Mercury was configured with a three-passenger split bench front seat with height adjustable head restraints for the outboard positions and separate back cushions. The front head restraints were adjusted to the full-down position at the time of

the SCI inspection. The rear seat was a three-passenger fixed bench seat. The Mercury was also equipped with power door locks, power windows, power seats, and a tilt steering wheel.

Crash Sequence

Pre-Crash

The 66-year-old male driver of the Mercury was traveling in an easterly direction in the church parking lot approaching the exit **(Figure 3)**. A family member who witnessed the crash stated that the driver had traveled some distance through the parking lot prior to the crash. Furthermore, she stated the she did not observe brake lights or avoidance maneuvers prior to the impact.

Figure 3. The Mercury's eastbound travel through the parking lot.

Crash

The center aspect of the Mercury's front bumper impacted the concrete base support of the light pole **(Figure 4)** resulting in a 12 o'clock impact force. The damage and trajectory algorithm of the WINSMASH program was used to calculate an impact speed of 24.1 km/h (14.9 mph). As the vehicle crushed to maximum engagement, the grille and header panel engaged the light pole, which cracked the plastic and fiberglass components. The WINSMASH output calculated a delta V for this crash of 24 km/h (14.9 mph). The longitudinal and lateral components were -24 km/h (-14.9 mph) and 0 km/h, respectively. As a result of the impact, the frontal air bag system deployed. It should be noted that impact damage was centered between the front frame rails, therefore the frontal air bag system could have deployed late in the crash event. This model year vehicle was not equipped with an Event Data Recorder (EDR) to support the late deployment. The Mercury came to rest at the point of impact, engaged against the concrete base.

Figure 4. The Mercury at impact and rest.

Post-Crash

The SCI investigator spoke to a relative who stated that several family members witnessed the crash and immediately responded to the vehicle. They entered the vehicle by breaking the left rear door glazing due to the locked status of the doors. The driver was removed from the vehicle and placed on the pavement. A family member initiated CPR until police and EMS personnel arrived on-scene. EMS personnel continued CPR during the ambulance transport to a local hospital. The driver was pronounced deceased upon arrival to the hospital approximately 35 minutes post-crash. The vehicle sustained moderate frontal damage and was towed from the scene.

Vehicle Damage

Exterior Damage – 1996 Mercury Grand Marquis

The 1996 Mercury Grand Marquis sustained moderate severity frontal damage as a result of the impact with the concrete base support **(Figures 5 and 6)**. The damage consisted of longitudinal deformation of the bumper cover and reinforcement beam. The grille and header panel contacted the base of the pole, which fractured these components. The direct contact damage measured 48 cm (19.1") which began 16 cm (6.3") right of the centerline and extended 33 cm (12.8") left of the centerline. Maximum crush was located 14 cm (5.5") left of the centerline on the bumper beam and measured 32 cm (12.7"). Six equidistant crush measurements were used to document the crush at the bumper beam using a combined direct and induced damage width of 138 cm (54.5") and were as follows: C1 = 0 cm, C2 = 19 cm (7.5"), C3 = 32 cm (12.6"), C4 = 24 cm (9.4"), C5 = 10 cm (3.9"), C6 = 3 cm (1.2"). The Collision Deformation Classification (CDC) for this impact was 12-FYEW-2.

Figure 5. Resultant damage from the pole impact.

Figure 6. Close up of the impact damage.

Interior Damage – 1996 Grand Marquis

The 1996 Mercury Grand Marquis sustained minor interior damage as a result of occupant contact. There was no intrusion of the passenger compartment. **Figure 7** is an overall view of the driver's area. The driver's head contacted and fractured the windshield, which was evidenced by a tissue transfer **(Figure 8)**. The fracture was located 13 cm (5") below the windshield header and 32 cm (12.5") inboard of the left A-pillar. Also noted was compression of the steering column, which measured 9 cm (3.5") from the steering wheel rim to the left instrument panel. There was complete separation of the shear capsules. The left shear capsule was fractured and the compression could not be measured. The right shear capsule was compressed 7 cm (2.8"). The upper aspect of the driver's head contacted the headliner **(Figure 9)**, which was evidenced by strands of hair. The first area of contact on the headliner was located

Figure 7. View of the driver's area.

23 cm (9”) rear of the windshield header and 57 cm (22.5”) inboard of the left roof side rail. The second area of contact on the headliner was located 51 cm (20”) rear of the windshield header and 50 cm (19.5”) inboard of the left roof side rail. Also noted was a spot of body fluid on the upper air bag cover flap and a strand of hair on the center instrument panel, which did not appear to result from occupant contact.

Figure 8. Driver's windshield contact.

Figure 9. Headliner contact points.

Manual Restraints System – 1996 Mercury Grand Marquis

The 1996 Mercury Grand Marquis was equipped with manual 3-point lap and shoulder safety belts for the outboard seating positions. The driver safety belt was configured with an Emergency Locking Retractor (ELR), sliding latch plate, and a height adjustable D-ring. The left D-ring was adjusted to the mid position at the time of the inspection. Historical usage was noted to the driver’s safety belt, which consisted of minor abrasions to the latch plate. The driver’s safety belt was not used at the time of the crash, which was supported by the lack of loading evidence, the driver’s trajectory, and contact to the windshield and headliner. Furthermore, the driver’s was found slumped forward and unrestrained by the first responders (family members).

The front right safety belt was configured with a sliding latch plate, height adjustable D-ring, and switchable ELR/Automatic Locking Retractor (ALR). The D-ring was in the full-up position at the time of the inspection. The rear outboard safety belts were equipped with sliding latch plates that retracted onto switchable ELR/ALR’s. The front center and rear center safety belts were equipped with 2-point manual lap belts that consisted of locking latch plates and no retractors.

Frontal Air Bag System – 1996 Mercury Grand Marquis

The 1996 Mercury Grand Marquis was equipped with a frontal air bag system that deployed as result of the crash **(Figure 10)**. The driver’s air bag was configured with asymmetrical H-configuration cover flaps. The top flap measured 17 cm (6.8”) wide and 10 cm (4”) in height. The lower flap was

Figure 10. Deployed driver's air bag.

17 cm (6.8”) wide by 6 cm (2.3”) in height. The diameter of the air bag was 56 cm (22”) in its deflated state. Four internal tether straps tethered the driver’s air bag. Two symmetrical vent ports vented the air bag at the 11 and 1 o’clock positions on the rear panel of the air bag. Although the driver was in a forward position at the time of deployment, there was no evidence of occupant contact to the face of the air bag membrane. A vinyl transfer from the air bag expansion from within the module was noted on the face of the air bag at the 1 o’clock sector, which was indicative of an impeded deployment.

The front right air bag was a mid mount design in the front right instrument panel. The front right air bag deployed as a result of the crash. The air module consisted of a single cover flap that measured 39 cm (15.3”) wide by 15 cm (6”) in height. The air bag was not tethered and was vented by a single vent port at the 9 ‘o’clock position on the side panel. The air bag membrane measured 81 cm (32”) in width and 56 cm (22”) in height. There was no damage or occupant contact evidence to the front right air bag.

OCCUPANT DEMOGRAPHICS – 1996 Mercury Grand Marquis

Driver

Age/Sex:	66-year-old/Male
Height:	169 cm (66.5”)
Weight:	77 kg (169 lbs)
Seat Track Position:	3 cm (1.4”) forward of full rear [25 cm (10”) of track travel]
Manual Restraint Use:	None Used
Usage Source:	Vehicle inspection
Eyewear:	Prescription eyeglasses
Type of Medical Treatment:	Transported by ambulance to a local hospital where he was pronounced dead on arrival

Driver’s Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Bilateral rib fractures with left hemothorax 1000 cc (right ribs 1-5 and left ribs 1-7)	Critical (450242.5,3)	Expanding driver’s frontal air bag
Laceration to the descending thoracic aorta at the arch	Severe (420206.4,4)	Expanding driver’s frontal air bag
Sternum fracture, NFS	Moderate (450804.2,4)	Expanding driver’s frontal air bag
Heart contusion, NFS	Minor (441002.1,4)	Expanding driver’s frontal air bag
5 x 3cm (2x 1”) mid forehead abrasion	Minor (290202.1,7)	Windshield
Irregular 4 x 3cm (1.5 x 1”) laceration to the left parietal scalp	Minor (190602.1,2)	Windshield

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Frontal subgaleal contusion	Minor (190402.1,5)	Windshield
Collapsed left lung	Not coded under AIS	Expanding driver's frontal air bag

Source = Autopsy

Driver Kinematics

The 66-year-old male driver of the 1996 Mercury Grand Marquis was seated in a presumed upright posture at impact with his seat adjusted to a rear track position. The seat back angle was measured at 12 degrees aft of vertical. In this position, the horizontal distance between the center of the driver air bag module and the seat back support was 55 cm (21.7"), measured 44 cm (17.5") above the seat bight. The driver was not restrained by the manual 3-point lap and shoulder belt. The lack of belt usage was determined by the driver's trajectory, contact points within the vehicle, the lack of loading evidence on the belt system, and the post-crash observation of the driver by the first responders (family members) to the crash scene.

The frontal air bag system deployed at impact with the concrete base for the light pole. The impact was located between the front frame rails and potentially resulted in a late deployment event. This vehicle did not have and EDR to support the deployment timing of the air bag system. The unrestrained driver was in a forward position at deployment with his torso positioned within the deployment path of the driver's air bag. This forward position was due to a possible medical event or as a result of his forward response to the frontal impact force prior to the deployment of the air bag system.

During the early stage of deployment, the air bag membrane expanded against the driver's chest resulting in multiple bilateral rib fractures with left hemothorax, a fracture of the sternum, a laceration of the descending aortic arch, and a heart contusion. The air bag expansion in conjunction with the driver's forward trajectory in response to crash forces compressed the energy absorbing steering column 7 cm (2.8"), resulting in complete separation of the shear brackets from the mounting blocks. There was no deformation of the steering wheel rim or spokes.

The expansion forces redirected the driver's forward movement from the initial crash forces to an upward and rearward direction. As a result of the upward trajectory, the driver's forehead contacted and fractured the windshield directly forward of the steering assembly. This contact resulted in the frontal subgaleal contusion, mid forehead abrasion, and the laceration to the left parietal scalp. The continued expansion of the driver's air bag redirected him rearward as he rebounded into the front left seat. His head contacted the headliner, which was evidenced by strands of hair in the fabric headliner. He came to rest in the driver's seat slumped forward against the steering assembly.

Medical Treatment

Family members witnessed the crash and responded immediately to the vehicle at final rest. One of the family members shattered the left rear window to gain access to the Grand Marquis as the doors remained locked post-crash. The driver was removed from the vehicle and placed on the parking lot pavement where another family member administered CPR. The CPR activities were continued until police and EMS personnel arrived at the scene. The driver was placed on a backboard and loaded into a ground ambulance for transport to a local hospital. EMS personnel continued CPR during the transport to a local hospital. The driver was pronounced dead on arrival to the hospital approximately 35 minutes post-crash.

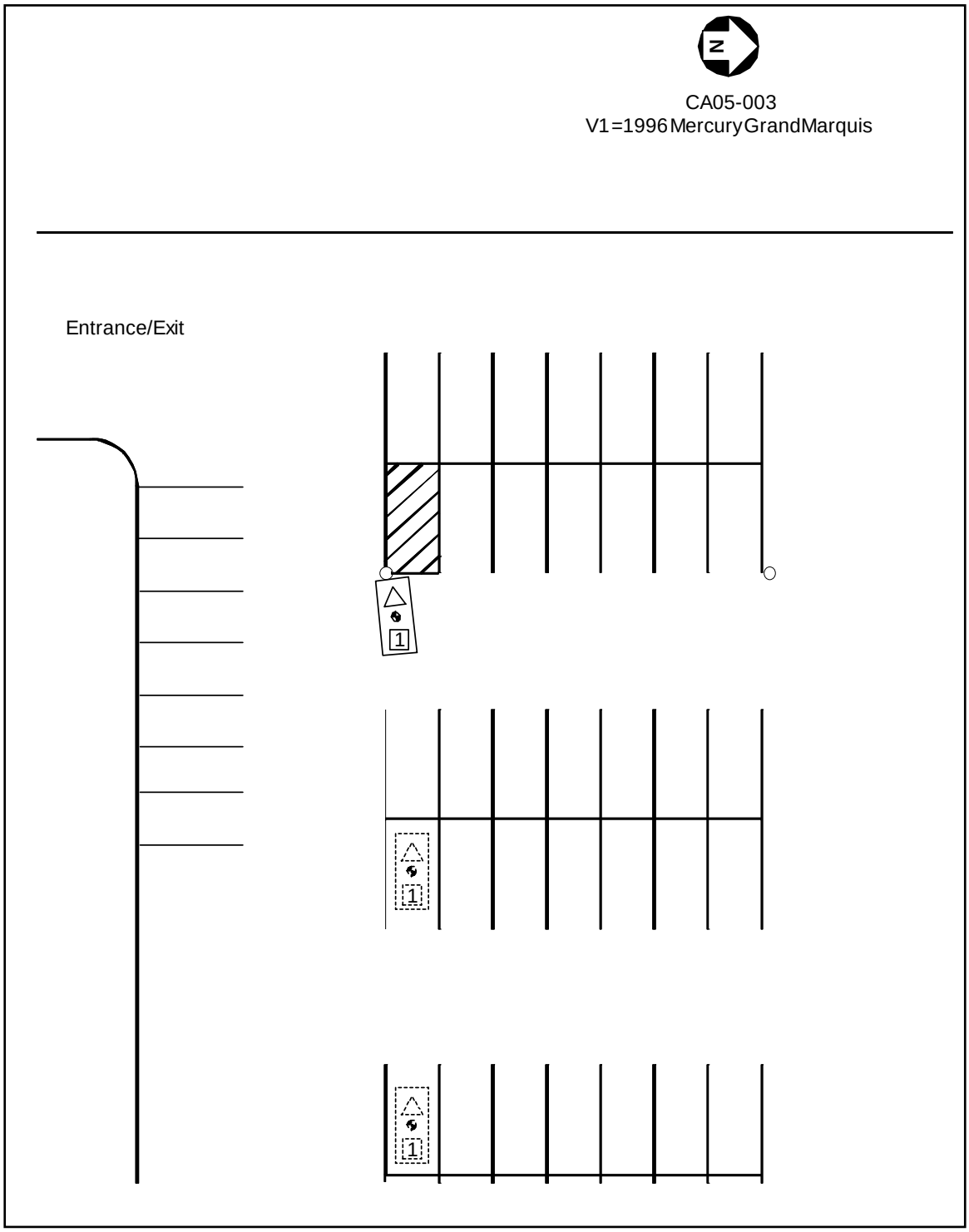

Figure 11. Scene Schematic