



REMOTE AIR BAG REPORT

CASE NUMBER - IN97-003

LOCATION - KANSAS

VEHICLE - 1991 MERCURY GRAND MARQUIS GS

CRASH DATE - May, 1992

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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 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.

Technical Report Documentation Page

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16. <i>Abstract</i> This report covers a remote investigation of an air bag deployment crash that involved a 1991 Mercury Grand Marquis GS and a wooden utility pole. This crash is of special interest because the Grand Marquis's driver sustained fatal chest and cervical injuries when she contacted her deploying air bag. The Grand Marquis was traveling east in the eastbound lane of a two-lane, undivided, city street and had just exited a right-hand curve when the Grand Marquis drifted off the roadway onto the north roadside. The front right of the Grand Marquis (case vehicle) impacted a wooden utility pole causing the case vehicle's driver side supplemental restraint system (air bag) to deploy. The case vehicle's driver [74-year-old female--155 centimeters and 54 kilograms (61 inches, 120 pounds)] was normally postured, with her seat track located in its forward-most position, and the steering wheel was located in its middle position. She was restrained by her available, active, three-point, lap and shoulder belt and sustained, according to her autopsy and medical records, fatal chest injuries which included: a lacerated aorta and multiple, bilateral, anterior rib fractures--with flail chest. In addition, she sustained a fractured process of C ₂ --with distraction between the fracture fragment and C ₁ ; a contusion to her left forehead, possibly when it was swiped by the air bag module's top cover flap; a large abrasion under her chin; and a compound fracture of her left forearm (i.e., bone not specified), most likely when her arm struck the left instrument panel/dash area. The front right passenger in the case vehicle (79-year--old male) was abnormally postured (i.e., bracing with his hands at impact), with his seat track located in its middle position, and was restrained by his available, active, three-point, lap and shoulder belt. According to his interview, he did not sustain any injuries as a result of this crash.					
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CASE SUMMARY
TRC/IU REMOTE AIR BAG REPORT
SCI Team #2, TRC/IU Case Number IN97-003
Kansas
May, 1992

This remote report was brought to NHTSA's attention in January, 1997. The crash occurred in May, 1992, at 4:04 p.m., in Kansas and was investigated by the applicable city police department. This crash involved a 1991 Mercury Grand Marquis GS, 4-door sedan and a wooden utility pole. This contractor interviewed the front right passenger (and owner) of the Grand Marquis on February 3, 1997. This crash is of special interest because the Grand Marquis's driver (74-year-old female) sustained fatal chest and cervical injuries from contacting her deploying driver side air bag. This summary is based on the Police Accident Report, interviews with the front right passenger and the son of the case vehicle's driver, vehicle photographs, occupant kinematic principles, and this contractor's evaluation of the evidence.

The Grand Marquis (case vehicle) was traveling east in the eastbound lane on a two-lane, undivided, city street and intended to continue in her eastward direction of travel. The case vehicle's front right passenger [79-year-old male (i.e., in 1992)] was looking out the right front glazing and heard a sound from the driver. When he turned toward the driver he observed the case vehicle heading toward a wooden utility pole. The case vehicle's driver made no avoidance maneuvers prior to the crash. The crash occurred off the north side of the road. According to the available photographs, the front right of the case vehicle impacted the wooden utility pole causing the case vehicle's driver side supplemental restraint (air bag) to deploy.

The case vehicle's driver [155 centimeters and 54 kilograms (61 inches and 120 pounds)] was restrained by her available, active, three-point, lap and shoulder belt. The driver air bag was located in the steering wheel hub. The case vehicle's driver made no avoidance maneuvers prior to the crash. Because there were no reported avoidance maneuvers coupled with her use of her available safety belts, the driver most likely did not move prior to impact. The case vehicle's impact with the wooden utility pole, not only deployed the driver side air bag, but thrust the driver forward and slightly upward. As the driver moved forward, she loaded the lap and torso portion of her safety belts and contacted her deploying driver side air bag. Because of her stature, the case vehicle's driver positioned her seat at its forward-most position, and as a result, she was struck forcefully by her deploying air bag. After the impact, the case vehicle's driver most likely rebounded backwards toward her seat back where she struck the seat back and subsequently rebounded forward striking her face against the steering wheel. According to the case vehicle's front right passenger, she bloodied her nose when she struck the steering wheel. More likely, the observed hemorrhage was a byproduct of her injuries. At final rest the case vehicle's driver was slumped over the steering wheel.

The driver was transported by ambulance to the hospital. She sustained fatal injuries and was examined and pronounced dead 41 minutes post-crash, three minutes after arrival at the medical facility. The injuries sustained by the case vehicle's driver are: a lacerated aorta; multiple, bilateral, anterior rib

fractures--with flail chest; a fractured process of C₂--with distraction between the fracture fragment and C₁; and a large abrasion under her chin. These injuries were caused by her deploying air bag. In addition, she sustained a contusion to her left forehead, possible when it was swiped by the air bag module's top cover flap, and a compound fracture of her left forearm (i.e., bone not specified), most likely when her arm struck the left instrument panel/dash area. This contractor's determined that the driver's fatal injuries resulted from her age, her proximity to the steering wheel, and her contact with her deploying driver side air bag.

The case vehicle was a 1991 Mercury Grand Marquis GS (VIN: 2MECM74F1MX-----). The case vehicle was not equipped with anti-lock brakes. The case vehicle was towed from the scene, but the towing was not because of damage. Based on the available photographs, the CDC was determined to be: **12-FZEN-1** for the case vehicle [maximum crush was estimated at 15 centimeters (6 inches)]. The SMASH reconstruction program, damage only (barrier option) algorithm using estimated "L", "D", and "C" values, was used on the highest severity impact to the case vehicle. The estimated Total, Longitudinal, and Lateral Delta Vs are, respectively: 13 km.p.h. (8 m.p.h.), -13 km.p.h. (-8 m.p.h.), and 0 km.p.h. (0 m.p.h.).

Immediately prior to the crash it is believed that the case vehicle's driver was seated upright with her back against the seat back, her left foot on the floor, her right foot on or near a control pedal, and both hands on the steering wheel. The exact location of her right foot is unknown; most likely, she was attempting to use the brake pedal. Her seat track was in its forward-most position and her tilt steering wheel was located in its middle position.

The case vehicle's front right passenger [175 centimeters and 70 kilograms (69 inches, 155 pounds)], was restrained by his available, active, three-point, lap and shoulder belt. He was sitting upright with his back against the seat back, both feet on the floor, and both arms stretched out toward the dash attempting to brace for the pole impact. His seat track was in its middle position, and the seat back was upright. The case vehicle's front right passenger was neither transported to a medical facility nor sought medical treatment, and he did not sustain any injuries as a result of this crash.

TRC/IU REMOTE AIR BAG REPORT

TRC/IU CASE NO. IN97-003

FLEET - PRIVATE VEHICLE

LOCATION - KANSAS

CRASH DATA

Location/Street:	City Street
State:	Kansas
Area/Type:	Urban, City Park
Crash Date/Time:	May, 1992, @ 4:04 p.m.
Investigating Police Agency:	City Police Department
Crash Type:	Car - Ran Off Road/Fixed Object
Occupant Injury Severity (air bag vehicle):	Lacerated Aorta with hemorrhage not confined to mediastinum (AIS-6)

AMBIENT CONDITIONS

Light Conditions:	Daylight
Weather Condition:	Clear
Precipitation:	None
Road Surface:	Dry
Temperature:	75° F @ Pittsburg State University, Kansas, at 7:00 p.m.--high: 78° F, low: 57° F

ROADWAY

Case Vehicle

Location:	City street
Number of Travel Lanes:	Two-lanes, undivided
Width:	6.1 meters (20 feet), police supplemental report
Surface Type:	Bituminous per Police Accident Report
Vertical alignment:	Level per Police Accident Report
Horizontal alignment:	Straight per Police Accident Report
Traffic Density:	Light, per interviewee
Speed Limit:	32 km.p.h. (20 m.p.h.), per police supplemental report
Traffic Controls:	None: no scene photographs available

VEHICLES

<u>Case Vehicle</u>	
Year:	1991
Make:	Mercury
Model:	Grand Marquis GS
Body Type:	Four-door sedan, six passenger
V.I.N.	2MECM74F1MX-----
Mileage:	12,315 km (7,652 miles) per Police Accident Report
Windshield damage/source:	None per photographs
Active Restraints:	Three-point, manual, lap and shoulder belts in front and rear outboard seating positions; lap belt only at front and rear center positions
Passive Restraints:	Factory installed driver supplemental restraint system (air bag)
Anti-lock brakes:	Not equipped per Branham's
Fleet:	Private vehicle
Tow status:	Towed, but not because of damage
Reported Defects:	None

VEHICLE DAMAGE

EXTERIOR

Deployment Impact

<u>Case Vehicle</u>	
Event number:	First
Object Struck:	Wooden utility pole
Damage location	
Damaged Plane:	Front
Vertical Location	
On Plane:	Bumper
Direct Begins:	~ 51.0 cm (20.1 in) from front right bumper corner
Length Direct:	30.0 cm (12.0 in)
Field L:	171.0 cm (67.5 in)
C ₁ :	0.0 cm (0.0 in)
C ₂ :	0.1 cm (0.0 in)
C ₃ :	0.1 cm (0.0 in)
C ₄ :	15.0 cm (6.0 in)
C ₅ :	0.1 cm (0.0 in)
C ₆ :	0.0 cm (0.0 in)
D:	34.0 cm (13.4 in)
Maximum Crush:	15.0 cm (6.0 in)

VEHICLE DAMAGE (Continued)

EXTERIOR

Case Vehicle

Deployment Impact

Location:	C ₄
CDC:	12-FZEN-1 (360)
Damaged Components:	Front bumper and splash pan, right front headlight and turn signal assemblies, hood edge, and grille
Repair estimate:	Unknown, vehicle was repaired and sold
Interior damage:	Driver air bag module per photographs

VEHICLE VELOCITY ESTIMATES

HIGHEST DELTA "V"

Case Vehicle

Reconstruction Program:	SMASH
Program Algorithm:	Damage Only, Barrier Option
Barrier Equivalent Delta V:	13.5 km.p.h. (8.4 m.p.h.)
Total Delta "V":	13 km.p.h. (8 m.p.h.)
Longitudinal Delta "V":	-13 km.p.h. (-8 m.p.h.)
Lateral Delta "V":	0 km.p.h. (0 m.p.h.)

COLLISION SEQUENCE

The following is based on the Police Accident Report, interviews with the son of the case vehicle's driver and the front right passenger, photographs provided by the family of the case vehicle's driver, occupant medical records, and this contractor's evaluation of the evidence.

PRE-CRASH: The case vehicle (Grand Marquis) was traveling east, after traversing a right-hand curve, in the eastbound lane of a two-lane, undivided, city street and was attempting to continue in her eastward direction of travel. According to the case vehicle's front right passenger (79-year-old male¹), he and the driver were leaving a senior citizens dance. In the parking lot they saw a couple in a vehicle with dirty windows. As they were leaving the parking lot, they decided to pass close to the other vehicle in order to identify the occupants. The front right passenger was looking out the right front glazing and heard a sound from the driver. When he turned towards the driver, he observed the case vehicle heading off the left side of the roadway towards a wooden pole. According to the front right passenger, he yelled "Stop! Telephone pole". The case vehicle's driver made no pre-crash avoidance maneuvers, and as a result, the case vehicle continued straight ahead prior to impact. The crash occurred off the north side of the road when

¹ This occupant was 79 years old at the time of the crash (i.e., in 1992).

COLLISION SEQUENCE (Continued)

PRE-CRASH: (Continued)

the case vehicle impacted a wooden utility pole (**Figure 1** below).

CRASH: The front right of the case vehicle (**Figures 2 and 3** below) impacted the wooden utility pole causing the driver side supplemental restraint system (air bag) to deploy. The post-impact trajectory, if any, and the vehicle's final rest position are unknown; however, based on the police diagram, the case vehicle was located against or near the wooden utility pole at final rest with little or no rotation.

DRIVER/OCCUPANT DATA

CASE VEHICLE:	<u>Driver</u>	<u>Front Right Passenger</u>
Age:	74-year-old	79-year-old
Sex:	Female	Male
Height:	155 cm (61 in)	175 cm (69 in)
Weight:	54 kg (120 lbs)	70 kg (155 lbs)
Occupation:	Retired	Not applicable
Active Restraint System/Usage:	Three-point lap and shoulder/Used	Three-point lap and shoulder/Used
Usage Source:	Interviewee and Police Accident Report	Interviewee
Passive Restraint System/Usage:	Driver side air bag/Air bag deployed	Not equipped
Usage Source:	Interviewee, Police Accident Report, and photographs	Interviewee, Police Accident Report, and photographs
Eyeglasses/contacts:	Glasses	Not applicable
Vehicle Familiarity:	Three months, once a week	Not applicable
Route Familiarity:	Weekly	Not applicable
Trip Plan:	Social/recreational (i.e., dance) to home	Not applicable
Manner of Leaving Scene:	Ambulance	Friend
Type of Medical Treatment:	Treated and pronounced dead at hospital 41 minutes post-crash	None

CASE VEHICLE DRIVER INJURIES

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Lacerated aorta with hemorrhage not confined to mediastinum	420218.6 untreatable	Air bag, driver's	Probable	Autopsy
2	Fractured, multiple, bilateral anterior ribs ² with flail chest	450260.4 severe	Air bag, driver's	Probable	Autopsy
3	Fracture C ₂ process ³ with distraction ⁴ between fragment and C ₁	650218.2 moderate	Air bag, driver's	Probable	Autopsy
4	Fracture, compound, left forearm (bone not specified)	751800.2 ⁵ moderate	Left instrument panel/dash ⁶	Possible ⁶	Autopsy
5	Contusion left forehead	290402.1 minor	Driver air bag module's top cover flap	Possible	Autopsy
6	Abrasion, large, under chin	390202.1 minor	Air bag, driver's	Probable	Emergency room records

² According to the x-ray taken in the emergency department, there were seven left ribs fractured; however, the autopsy indicated that the patient sustained a flail chest with multiple, bilateral, (i.e., unspecified) fractured ribs.

³ The x-ray taken in the emergency room indicates that the styloid process of C₂ was fractured. This most likely represents a dictation error where the "*styloid process*" should be the "*spinous process*".

⁴ The following term is defined in **DORLAND'S ILLUSTRATED MEDICAL DICTIONARY** as follows:
distraction (dis-trak-shen): a form of dislocation in which the joint surfaces have been separated without rupture of their binding ligaments and without displacement.
According to the autopsy report, the distraction was estimated as 2.5 to 3.0 centimeters.

⁵ This injury code requires that an A.I.S. value of "2" be used; however, if the bone was known (i.e., either radius or ulna), then the A.I.S. for a compound (i.e., open) fracture to either bone is a "3".

⁶ It is possible that her left hand slipped off of the steering wheel at impact causing her left forearm to strike the instrument panel/dash; however, it is also possible that she had her left forearm "*diagonally*" across the steering wheel because, according to the right front passenger, prior to the crash they were trying to determine who was sitting in a parked car, with dirty windows, that was located on the right side of the case vehicle. If her forearm was situated across the steering wheel at impact, then the case vehicle's driver side air bag module's cover flap could easily have caused the fracture during the deployment. Unfortunately, the right front passenger cannot say for sure where the driver's arms were positioned because he was looking, first out the right glazing, and second at the wooden utility pole that was struck. Therefore, the instrument panel/dash is coded as the "most likely choice".

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
N/A	Not injured	0	Not applicable	Not applicable	Interviewee (same person)

DISCUSSION

CASE VEHICLE DRIVER: This crash is of special interest because the case vehicle's driver sustained fatal chest injuries (i.e., a lacerated aorta with bilateral rib fractures) and a cervical fracture/dislocation) when she contacted her deploying air bag. According to the case vehicle's front right passenger, immediately prior to the crash the driver was normally postured (i.e., seated upright with her back against the seat back, her left foot on the floor, her right foot on or near a control pedal, and both hands on the steering wheel. The exact location of her right foot is unknown; most likely, she was attempting to use the brake pedal. According to the case vehicle's front right passenger, the driver side seat track was located in its forward-most position, and the tilt steering wheel was located in its middle position. According to the passenger's interview, the driver was also restrained by the available, active, three-point, lap and shoulder belt.

According to a police supplemental report and the case vehicle's front right passenger, the driver made no avoidance maneuvers prior to the crash. Given the driver's reported normal pre-crash posture and her use of the available safety belts, the driver most likely did not move prior to impact.

Based on the Police Accident Report, the vehicle photographs, and occupant kinematic principles [i.e., the estimated improved PDOF (Direction of Principal Force) is 0 degrees], the case vehicle's impact with the utility pole, not only deployed the driver-side air bag, but thrust the driver forward and slightly upward. As the driver moved forward, she loaded the lap and torso portion of her safety belts and contacted her deploying driver side air bag. Because of her stature [155 centimeters and 54 kilograms (61 inches, 120 pounds)], the case vehicle's driver positioned her seat at its forward-most position, and as a result, she was fatally injured by her deploying air bag⁷. According to her autopsy and medical records, she sustained: a lacerated aorta; multiple, bilateral, anterior rib fractures--with flail chest; a fractured process of C₂--with distraction between the fracture fragment and C₁; and a large abrasion under her chin. In addition, she sustained a contusion to her left forehead, possible (**Figure 4** below) when it was swiped by the air bag module's top cover flap, and a compound fracture of her left forearm (i.e., bone not

⁷ It should be noted that the case vehicle's right front passenger adamantly insists that the driver's face struck the center of the steering wheel before the air bag deployed. Although, it is likely that the driver's head moved further forward (i.e., relative to the front of her chest) and downward as a result of loading her safety belts, this contractor discounts this scenario because, first, the right front passenger also indicated that his attention was focused on the wooden utility pole (i.e., he was shouting a warning about the pole) just prior to the crash, and second, if the driver had struck the center of the steering wheel prior to the deployment, then this contractor would have expected many, and more severe, facial injuries to have been reported.

DISCUSSION (Continued)

specified), most likely when her arm struck the left instrument panel/dash area.

After the impact, the case vehicle's driver most likely rebounded backwards, struck her seat back, and subsequently rebounded forward striking her face against the steering wheel. According to the case vehicle's front right passenger, she bloodied her nose when she struck the steering wheel. More likely, the observed hemorrhage was a byproduct of her fatal thoracic cavity injuries. At final rest the case vehicle's driver was slumped over the steering wheel.

CASE VEHICLE FRONT RIGHT PASSENGER: According to the case vehicle's front right passenger (i.e., boyfriend of driver), immediately prior to the crash he was abnormally postured (i.e., seated upright with his back most likely moved forward of the seat back, his feet on the floor, and bracing with one or both of his hands against the dash). According to the front right passenger, his seat track was located in its middle position, and he was restrained by his available, active, three-point, lap and shoulder belt.

Given that no avoidance maneuvers were attempted prior to the crash and the use of his available safety belts, the front right passenger's only pre-crash movement was slightly forward because of his attempt to brace for the impending impact.

Based on the Police Accident Report, the vehicle photographs, and occupant kinematic principles [i.e., the estimated improved PDOF (Direction of Principal Force) is 0 degrees], the case vehicle's impact with the utility pole thrust the front right passenger forward and slightly upward. As the front right passenger moved forward, he loaded the lap and torso portion of his safety belts and most likely pressed against the dash (**Figure 5** below). Because of his seat track location and the use of his safety belts, the front right passenger, according to the Police Accident Report and his interview, did not sustain any injuries as a result of this crash.

After the impact, the case vehicle's front right passenger most likely rebounded backwards toward his seat back where he struck the seat back and subsequently came to rest post-crash at or near his pre-crash position. According to the front right passenger, he exited the case vehicle without any assistance and did not seek any medical attention.

SELECTED PHOTOGRAPHS



Figure 1: Eastward view of wooden utility pole impacted by case vehicle; Note: pole was located 2.4 meters (8 feet) north of north road edge (case photo #01)

Selected Photographs (Continued)



Figure 2#: Case vehicle's frontal damage from impact with wooden utility pole (case photo #02)



Figure 3: Close-up of case vehicle's frontal damage viewed from right of front (case photo #03)

Selected Photographs (Continued)



Figure 4: Case vehicle's driver seating area and deployed driver air bag; Note: no obvious contact evidence to air bag module's top cover flap (case photo #04)

Selected Photographs (Continued)

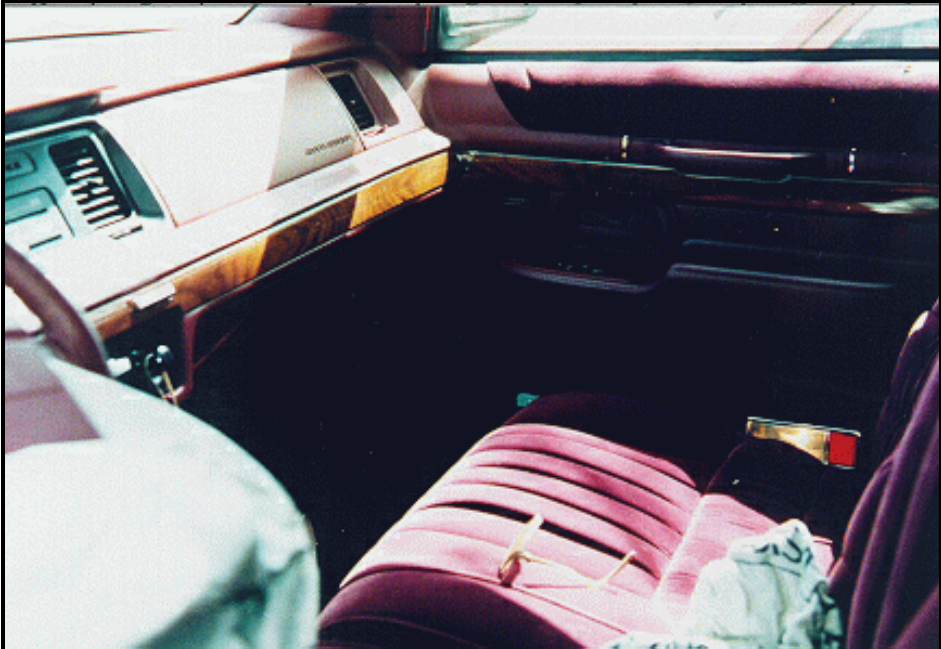


Figure 5 Case vehicle's front right seating area; Note: no evidence of occupant contact to front dash (case photo #05)