INDIANA UNIVERSITY
TRANSPORTATION RESEARCH CENTER
School of Public and Environmental Affairs
222 West Second Street
Bloomington, Indiana 47403-1501
(812) 855-3908 Fax: (812) 855-3537

ON-SITE REDESIGNED AIR BAG INVESTIGATION

CASE NUMBER - IN99-089
LOCATION - TEXAS
VEHICLE - 1998 FORD MUSTANG
CRASH DATE - September, 1999

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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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On-site air bag deployment investigation involving a 1998 Ford Mustang, two-door coupe, with manual safety belts and dual front redesigned air bags, and a 1987 Ford F350 chassis cab with tow truck body

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 1998 Ford Mustang (case vehicle) and a 1987 Ford F350 tow truck (other vehicle). This crash is of special interest because the case vehicle was equipped with redesigned air bags and the case vehicle's driver [37-year-old, Black (non-Hispanic) female] and the front right passenger [8-year-old, Black (non-Hispanic) male] sustained only minor injuries in this collision. The case vehicle was traveling west in the westbound lane of a two-lane, divided, city boulevard and intended to travel through a “Tee” intersection (i.e., both the east and westbound roadways had one wide through lane) The Ford truck had been traveling east on the eastbound roadway and was making a left-hand turn, intending to travel northward across the westbound roadway. The crash occurred in the westbound roadway, within the Tee-intersection of the two trafficways. The front of the case vehicle impacted and underrode the right rear of the Ford truck, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The two vehicles essentially came to rest at the point of impact. The case vehicle's front right passenger was seated with his seat track located between its middle and rearmost positions, and was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. He sustained according to the interview with the case vehicle's driver (i.e., mother) minor injuries which included: abrasions to his right cheek and chin. The case vehicle's driver was seated with her seat track located in its rearmost position, and the tilt steering wheel was located in its down-most position. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to her interview, minor injuries which included: contusions to her whole left arm and a lower abdominal contusion. The back right passenger (another son; 10-year-old male) was seated but his seat track was not adjustable, and he was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. He did not sustain any injuries as a result of this crash.

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BACKGROUND

IN99-089

This on-site investigation was brought to NHTSA's attention on September 27, 1999, by a team coordinator for the National Automotive Sampling System's Western Zone. This crash involved a 1998 Ford Mustang (case vehicle) and a 1987 Ford F350 tow truck (other vehicle). The crash occurred in September, 1999, at 4:00 p.m., in Texas, and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with redesigned air bags and the case vehicle's driver [37-year-old, Black (non-Hispanic) female] and the front right passenger [8-year-old, Black (non-Hispanic) male] sustained only minor injuries in this collision. This contractor inspected the scene and case vehicle on October 6, 1999, and inspected the Ford truck on October 7, 1999. This contractor interviewed the case vehicle's driver on October 6, 1999. This report is based on the Police Crash Report, an interview with the case vehicle's driver, scene and vehicle inspections, occupant kinematic principles, self-reported injuries, and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The case vehicle was traveling west in the westbound lane of a two-lane, divided, city boulevard (**Figure 1**) and intended to continue in its westerly travel path through a "Tee" intersection (i.e., both the east and westbound roadways had one wide through lane). The Ford truck had been traveling east on the eastbound roadway and was making a left-hand turn, intending to travel northward across the westbound roadway. The case vehicle's driver steered to the left, braked, and blew the horn attempting to avoid the crash. The crash occurred in the westbound roadway, within the Tee-intersection of the two trafficways; see **CRASH DIAGRAM**.

Figure 1: Case vehicle's westward travel path toward Tee intersection in wide, westbound lane; Note: bushes and trees obstruct view of Tee intersection's extension through median (case photo #02)

The city roadway was straight and had a 3.3% grade positive to the west (i.e., an upgrade in the case vehicle's direction of travel), at the area of impact. The pavement was bituminous, but traveled, and the width of the westbound roadway was 5.2 meters (17.1 feet) and the eastbound roadway was 6.0 meters (19.7 feet). The south side of the westbound roadway had a narrow improved (i.e., concrete) shoulder but there was no shoulder prior to the 11 meter (36.1 feet) wide unprotected grassy median. The westbound roadway was bordered by 15.2 centimeter (6 inch) barrier curbs. No pavement markings or edge lines were present. The estimated coefficient of friction was 0.70. There were no visible traffic controls prior to the Tee intersection or in the immediate area of the crash. The statutory speed limit was 56 km.p.h. (35 m.p.h.) for both the east and westbound roadways. No regulatory speed limit sign was posted near the crash site. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the road pavement was dry. Traffic density was light, and the site of the crash was primarily urban residential.

The front (**Figure 2**) of the case vehicle impacted and underrode the right rear of the Ford truck (**Figures 3** and **4**), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The two vehicles essentially came to rest at the point of impact.

Figure 2: Case vehicle's frontal damage; Note: torn-off front bumper fascia and reinforcement bar (case photo #13)

Figure 3: Ford truck's damaged right rear; Note: this type of tow truck is called a "roll back" (case photo #58)

Figure 4: Close-up of Ford truck's damaged right rear showing primary damage to undercarriage; Note: yellow dot indicates forward-most point of direct damage (case photo #60)

CASE VEHICLE

The 1998 Ford Mustang was a rear wheel drive, four-passenger, two-door coupe (VIN: 1FAFP4040WF------) equipped with a 3.8L, V-6 engine and a five-speed manual transmission. Anti-lock brakes are an option for the case vehicle, but the driver was uncertain if the case vehicle was so equipped. The case vehicle's wheelbase was 257 centimeters (101.3 inches), and the odometer reading at inspection was 41,949 kilometers (26,066 miles).

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat with separate back cushions but without head restraints for the back seating positions; and continuous loop, three-point, lap-and-shoulder, safety belt systems at the front and back outboard positions. The front seat belt systems were not equipped with manually operated upper anchorage adjusters for the "D"-rings. The vehicle was equipped with knee bolsters for both the driver and front right passenger, neither of which were deformed. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. Both frontal air bags deployed as a result of the case vehicle's frontal impact with the Ford truck.

The case vehicle's contact with the Ford truck involved its entire front (**Figure 5** below). Direct damage began at the front left bumper corner and extended, a measured distance of distance of 142 centimeters (55.9 inches), along the front bumper to the front right bumper corner.

Residual maximum crush was measured as 13 centimeters (5.1 inches) at C_4. The case vehicle's wheelbase was unaltered from the crash. The case vehicle's front bumper, bumper fascia, grille, hood, and left headlight and turn signal assemblies were directly damaged and crushed rearward (**Figure 2** above and **Figure 5**). None of the case vehicle's tires were damaged, deflated, or physically restricted. The right headlight and turn signal assemblies sustained induced damage as well as the hood and both the right and left fenders.

Figure 5: Case vehicle's damaged front end showing torn off bumper fascia placed back onto reinforcement bar (case photo #16)

Inspection of the case vehicle's interior revealed that there was a possible contact point (i.e., a rub mark) on the driver's sun visor. In addition, the left (i.e., primarily left upper) portion of the steering wheel rim was bent toward the left instrument panel, 2 centimeters (0.8 inches), as a result of the driver loading the air bag, momentarily blocking the air bag's forward expansion, and causing the air bag to expand against and bend the steering wheel rim.

Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDEW-1 (350)**. Although this collision is out-of-scope for the WinSMASH reconstruction program because of the underriding nature of the impact, the WinSMASH barrier algorithm was used to generate a Barrier Equivalent Speed estimate. The Barrier Equivalent Speed was calculated as 18.9 km.p.h. (11.7 m.p.h.) for the case vehicle's highest severity impact. Thus, the crash severity to the case vehicle was estimated to be low [14-23 km.p.h. (9-14 m.p.h.)]. The case vehicle was towed due to disabling damage.

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. Both air bags deployed as a result of the frontal impact with the Ford truck. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of two asymmetrical cover flaps made of thick vinyl. The top flap was shaped like an ice scraper with overall dimensions of 14.5 centimeters (5.7 inches) at the lower horizontal seam and 7.5 centimeters (3.0 inches) vertically. The bottom cover flap was trapezoidal in shape with overall dimensions of 14.5 centimeters (5.7 inches) at the top horizontal seam, 10 centimeters (3.9 inches) at the bottom horizontal seam and 5 centimeters (2.0 inches) vertically. An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the

Figure 6: Case vehicle driver air bag module's top cover flap showing (i.e., yellow tape) scratch near flap's logo and vent ports (case photo #46)

deployment to the air bag. Furthermore, there appeared to be a scratch immediately above the horse image (i.e., Mustang) at the center of the driver air bag module's top cover flap (**Figure 6** above). The driver's air bag was designed with two tethers, each approximately 10 centimeters (3.9 inches) in width. The driver's air bag had two vent ports, approximately 2 centimeters (0.8 inches) in diameter, located at the 11:30 and 12:30 o'clock positions. The deployed driver's air bag was rectangular, with a height of 50 centimeters (19.7 inches) and a width of 62 centimeters (24.4 inches). An inspection of the driver's air bag fabric revealed a body fluid stain and slight scratching toward the top left quadrant near the center of the air bag's fabric (**Figure 7** above).

Figure 7: Case vehicle's deployed driver air bag; Note: yellow tape indicates occupant contact points (case photo #47)

The front right passenger's air bag was located in the middle of the instrument panel. There were two, essentially symmetrical, quarter moon shaped modular cover flaps. The cover flaps were made of a thick vinyl over a thick cardboard type frame. Each dimensions were 45 centimeters (17.7 inches) at the horizontal seam and 7.5 centimeters (3.0 inches) vertically at the flap's apex. An inspection of the front right air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The front right passenger's air bag was designed without any tethers. The front right air bag had no vent ports. The deployed front right air bag was rectangular with a height of 52 centimeters (20.5 inches) and a width of 79 centimeters (31.1 inches). An inspection of the front right passenger's air bag fabric revealed that the front right passenger contacted his air bag, depositing some slight scratching on the top left quadrant near the center of the fabric and a body fluid stain just above the bag's horizontal midline about a quarter of the way to the right outside seam (**Figure 8**).

Figure 8: Case vehicle's deployed front right passenger air bag; Note: yellow tape indicates occupant contact points (case photo #50)

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash, the case vehicle's front right passenger [son; 8-year-old, Black (non-Hispanic) male; 122 centimeters and 20 kilograms (48 inches, 43 pounds)] was seated in an upright posture with his back against the seat back and his feet dangling over the front edge of the seat's cushion. In addition, the exact position of his arms and hands are unknown. His seat

track was located between its middle and rearmost positions, and the seat back was sightly reclined.

The case vehicle's front right passenger was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. There were no reported belt pattern bruises and/or abrasions to this passenger; however, his safety belt showing evidence of usage (i.e., the webbing showed evidence of fabric waffling, there was a diagonal crimp to the belt fabric made by the male buckle, and there were three striations to the "D"-ring). The latch plate showed no evidence of loading.

The case vehicle's driver steered to the left, braked, and honked her horn in an attempt to avoid the collision. As a result of these attempted avoidance maneuvers and the use of his available safety belts, the front right passenger most likely moved slightly forward and to his right just prior to impact. The case vehicle's impact with the Ford truck enabled the front right passenger to continue forward and slightly leftward and upward toward the **350** degree Direction of Principal Force as the vehicle decelerated. The front right occupant impacted his deploying air bags and loaded his safety belts. Because the available evidence indicates that the case vehicle did not rotate post-crash (i.e., hood damage indicated only front-to-rear gouging), the front right passenger most likely rebounded backwards into his seat back as the case vehicle came to a stop. The case vehicle's driver had no recollection of the front right passenger's final rest position, but no mention was made of any case vehicle occupant being in a posture or position other than "normal" at final rest.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right occupant was transported by ambulance to a medical facility. He sustained minor injuries and was treated and released. According to the driver, he sustained abrasions to his right cheek and chin.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Abrasion right cheek, not further specified	290202.1 minor	Air bag, front right passenger's	Probable	Interviewee (driver)
2	Abrasion chin, not further specified	290202.1 minor	Air bag, front right passenger's	Probable	Interviewee (driver)

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [mother; 37-year-old, Black (non-Hispanic) female; 164 centimeters but unknown weight (64.5 inches)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the brake, and both hands on the steering wheel. Her seat track was located in its rearmost position, the seat back was slightly reclined, and the tilt steering wheel was located in its down-most position.

The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. She reported belt pattern bruising to her lower abdomen. Inspection of the driver's seat belt webbing showed fabric waffling and fluid-based transfers, but there were no indications of loading to the "D"-ring or latch plate.

The case vehicle's driver steered to the left, braked, and honked her horn in an attempt to avoid the collision. As a result of these attempted avoidance maneuvers and the use of her available safety belts, the driver most likely moved slightly forward and to her right just prior to impact. The case vehicle's impact with the Ford truck enabled the driver to continue forward and slightly leftward and upward toward the **350** degree Direction of Principal Force as the vehicle decelerated. The driver impacted her deploying air bag and loaded her safety belts. Because the available evidence indicates that the case vehicle did not rotate post-crash (i.e., hood damage indicated only front-to-rear gouging), the case vehicle's driver most likely rebounded backwards into her seat back as the case vehicle came to a stop. The case vehicle's driver had no recollection of her final rest position, but no mention was made of any case vehicle occupant being in a posture or position other than "normal" at final rest.

CASE VEHICLE DRIVER INJURIES

The driver accompanied her son in the ambulance. She sustained minor injuries but received no official medical attention. Her self-reported injuries consisted of contusions to her whole left arm and a lower abdominal contusion.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion lower abdomen, not further specified	590402.1 minor	Lap portion of safety belt system	Probable	Interviewee (same person)
2	Contusion whole left arm, not further specified	790402.1 minor	Left side interior surface, excluding hardware and/or armrest	Probable	Interviewee (same person)

CASE VEHICLE BACK RIGHT PASSENGER KINEMATICS

The case vehicle's back right passenger [another son; 10-year-old, Black (non-Hispanic) male; 122 centimeters and 21 kilograms (48 inches, 46 pounds)] was seated in an upright posture with his back against the seat back and his feet dangling over the front edge of the seat's cushion; Once again, the exact position of his arms and hands is unknown. His seat track and seat back were not adjustable.

The case vehicle's back right passenger was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there was no evidence of belt pattern bruising

and/or abrasions to the back right passenger's body, and the inspection of the back right passenger's seat belt webbing and latch plate showed no evidence of loading.

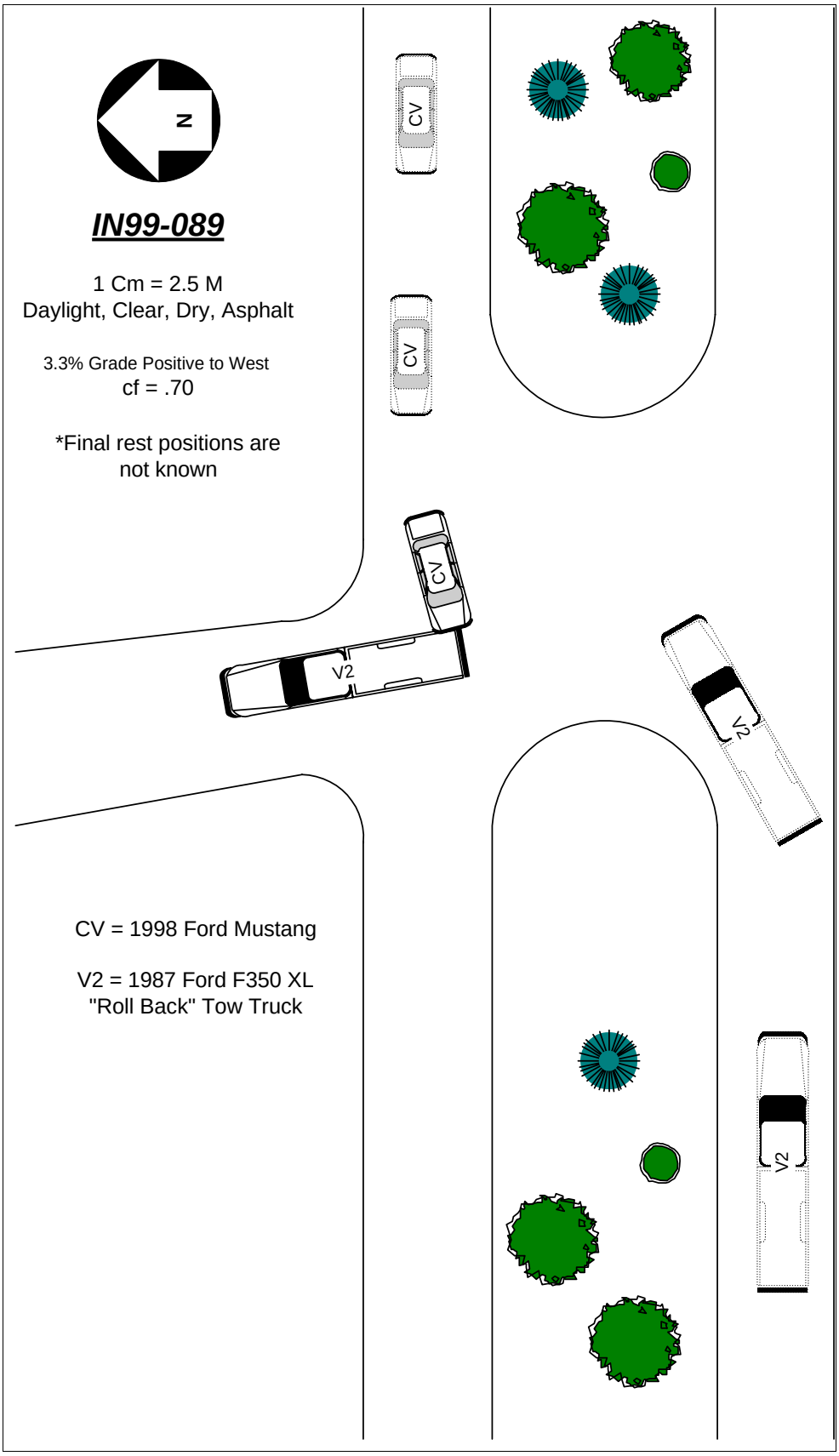
The case vehicle's driver steered to the left, braked, and honked her horn in an attempt to avoid the collision. As a result of these attempted avoidance maneuvers and the use of his available safety belts, the back right passenger most likely moved slightly forward and to his right just prior to impact. The case vehicle's impact with the Ford truck enabled the back right passenger to continue forward and slightly leftward and upward toward the **350** degree Direction of Principal Force as the vehicle decelerated. The back right occupant loaded his safety belts. Because the case vehicle did not rotate post-crash, the back right passenger most likely rebounded backwards into his seat back as the case vehicle came to a stop. The final rest position of the back right passenger is unknown.

CASE VEHICLE BACK RIGHT PASSENGER INJURIES

The back right passenger was uninjured and, thus, was not transported to a medical facility, but he left the scene with a family friend and returned home.

OTHER VEHICLE

The Ford truck was a rear wheel drive, 1987 Ford F350 XL, 4x2, regular cab-chassis with a roll back (platform) wrecker configuration (VIN: 1FDKF3717HN------). Based on the vehicle inspection, the CDC for the Ford truck was determined to be: **03-RBLW-3 (90)**. The Ford truck was driven from the scene.


N
IN99-089
1 Cm = 2.5 M
Daylight, Clear, Dry, Asphalt
3.3% Grade Positive to West
cf = .70
*Final rest positions are not known
CV
CV
CV
V2
V2
V2
CV = 1998 Ford Mustang
V2 = 1987 Ford F350 XL
"Roll Back" Tow Truck