TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
SCI TECHNICAL SUMMARY REPORT

NASS RABSS CASE NO. 1999-43-801C

RABSS VEHICLE - 1999 FORD CROWN VICTORIA

LOCATION - STATE OF NORTH CAROLINA

CRASH DATE - MAY, 1999

Contract No. DTNH22-94-D-07058

Prepared for:

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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 a two-vehicle crash involving a 1999 Ford Crown Victoria Police Interceptor 4-door sedan (subject vehicle) and a 1995 Buick Century Special 4-door sedan. The Ford Crown Victoria was equipped with redesigned frontal air bags that deployed as a result of a right angle collision with the Buick Century. The Buick was northbound and attempted to turn left (west) at a 4-leg intersection when it crossed into the path of the eastbound Ford. As the Buick turned left and crossed the eastbound lanes the front of the Ford struck the left passenger area of the Buick. Impact resulted in moderate frontal damage to the Ford and moderate left side damage to the Buick. At this point, the Buick rotated clockwise and sideslapped the Ford which resulted in minor side damage to both vehicles. The Ford came to rest in the westbound lanes facing north. The Buick continued its post-impact trajectory into the northeast sector and departed the north pavement edge where it impacted a small diameter tree resulting in minor frontal damage. The Buick came to rest against the tree facing northeast. The 24 year old male driver of the Ford Crown Victoria was properly restrained by the 3-point manual lap and shoulder belt system and initiated a forward trajectory in response to the 12 o'clock impact force, loading the manual restraint and deployed redesigned driver air bag. Contact by the expanding air bag resulted in bilateral abrasions to the anterior aspect of both forearms and left hand. He also sustained a fracture of the right fibula which was an indirect result of loading to the brake pedal during the collision sequence. The driver was transported (along with the driver of the Buick) to a local hospital for treatment and released.			
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CRASH DATE - MAY, 1999

BACKGROUND

This investigation focused on a two-vehicle crash involving a 1999 Ford Crown Victoria Police Interceptor 4-door sedan (subject vehicle) and a 1995 Buick Century Special 4-door sedan. The Ford Crown Victoria was equipped with redesigned frontal air bags that deployed as a result of a right angle collision with the Buick Century. The Buick was northbound and attempted to turn left (west) at a 4-leg intersection when it crossed into the path of the eastbound Ford. As the Buick turned left and crossed the eastbound lanes the front of the Ford struck the left passenger area of the Buick. Impact resulted in moderate frontal damage to the Ford and moderate left side damage to the Buick. At this point, the Buick rotated clockwise and sideslapped the Ford which resulted in minor side damage to both vehicles. The Ford came to rest in the westbound lanes facing north. The Buick continued its post-impact trajectory into the northeast sector and departed the north pavement edge where it impacted a small diameter tree resulting in minor frontal damage. The Buick came to rest against the tree facing northeast. The 24 year old male driver of the Ford Crown Victoria was properly restrained by the 3-point manual lap and shoulder belt system and initiated a forward trajectory in response to the 12 o'clock impact force, loading the manual restraint and deployed redesigned driver air bag. Contact by the expanding air bag resulted in bilateral abrasions to the anterior aspect of both forearms and left hand. He also sustained a fracture of the right fibula which was an indirect result of loading to the brake pedal during the collision sequence. The driver was transported (along with the driver of the Buick) to a local hospital for treatment and released.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 99-43-801C for the Redesigned Air Bag Special Study. The Field Operations Branch of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian/Calspan the task of case review and final report preparation.

SUMMARY

Crash Site

This two-vehicle crash occurred during the early morning hours of May, 1999. At the time of the crash, it was dark (street lighted) with no adverse conditions as the roads were dry. The crash occurred in the eastbound lanes of an 5-lane east/west undivided asphalt roadway **(see Figure 8 - page 6)**. Traffic control at the scene included stop signs for north/southbound traffic. The speed limit at the crash scene was 72 km/h (45 mph).

Pre-Crash

The 24 year old male driver of the 1999 Ford Crown Victoria was operating the police vehicle eastbound **(Figure 1)** responding to a call at a computed speed of 89 km/h (55 mph) and proceeding straight when he observed the Buick Century turn left (west) across his lane of travel.
Upon recognition of the impending harmful event, the driver steered left and braked (40.0 meters (131.2 ft) of

pre-impact skid marks documented at the crash site) in avoidance remaining in the eastbound travel lanes prior to the collision. The 1995 Buick Century was driven by a 24 year old male who was operating the vehicle northbound **(Figure 2)** when he failed to detect the stop sign or Ford as he turned left (west) at a police reported speed of 8 km/h (5 mph).

Figure 1. Eastbound approach for the 1999 Ford Crown Victoria.

Figure 2. Northbound approach for the 1995 Buick Century.

Crash

As the Buick crossed the eastbound lanes of the 5-lane roadway, the front of the Ford struck the left passenger area of the Buick. The impact induced deceleration was sufficient to deploy the Ford's redesigned frontal air bag system. The damage algorithm of the WinSMASH program computed velocity changes of 34.9 km/h (21.7 mph) for the subject vehicle and 44.8 km/h (27.8 mph) for the struck Buick. Respective longitudinal components were -34.4 km/h (-21.4 mph) and -28.8 km/h (-17.9 mph). The Collision Deformation Classification (CDC) for this impact to the Ford Crown Victoria was 12-FDEW-2 and 10-LYEW-4 for the Buick Century. During the impact sequence, the Buick rotated clockwise and sideslapped the Ford resulting in minor side damage to both vehicles. The Collision Deformation Classification (CDC) for this secondary impact to the Ford was 03-RPEN-1 and 09-LBEW-1 for the Buick. The Ford Crown Victoria came to rest in the westbound lanes facing north. The Buick continued on its post-impact trajectory and subsequently departed the north pavement edge where it impacted a small diameter tree resulting in minor frontal damage. The Buick Century came to rest against the tree facing northeast.

Post-Crash

The driver of the Ford Crown Victoria exited the vehicle under his own power (exit status of the Buick driver was unknown). Treatment was rendered at the scene by emergency medical technicians (EMT's) and fire department personnel. The driver of the Ford Crown Victoria (along with the driver of the Buick Century) were transported to a local hospital for treatment and released. Both vehicles were towed from the scene.

RABSS VEHICLE

The 1999 Ford Crown Victoria was identified by the Vehicle Identification Number (VIN): 2FAFP71WXXX (production sequence deleted). The vehicle was a 4-door sedan equipped with rear wheel drive and a 4.6 liter, V-8 engine. The vehicle's odometer reading was 10,546 km (6,553 miles) at the time of the crash. The police report listed the vehicle as city-owned. The seating was configured with front bucket seats and a rear bench. The driver reported no previous crashes or maintenance on the air bag system (original equipment). No cell phone was present or in use at the time of the collision.

VEHICLE DAMAGE

Exterior Damage

The Ford Crown Victoria sustained moderate frontal damage as a result of the impact with the Buick Century **(Figure 3)**. The direct contact damage encompassed the full frontal width resulting in a combined direct and induced damage length (Field L) of 136.0 cm (53.5 in). Six crush measurements were documented at the level of the bumper: C1= 48.0 cm (18.9 in), C2= 43.0 cm (16.9 in), C3= 33.0 cm (13.0 in), C4= 26.0 cm (10.2 in), C5= 18.0 cm (7.1 in), C6= 13.0 cm (5.1 in). Damage was noted to the hood which was displaced up and rearward from engagement against the side surface of the Buick. A rubber transfer was documented to the front bumper from the left front wheel/tire of the Buick. The left fender was displaced rearward which restricted the left front wheel/tire (not deflated). The windshield was fractured from exterior forces (only). Post-crash damage was also noted to the left front door from a forced opening. Direct damage was documented to the right front door from the secondary (sideslap) impact **(Figure 4)**. The direct contact damage began 57.0 cm (22.4 in) rearward of the right front axle and extended 37.0 cm (14.6 in) rearward. The impact resulted in a combined direct and induced damage length (Field L) of 56.0 cm (22.0 in). Six crush measurements were documented at the level of the sill: C1= 1.0 cm (0.4 in), C2= 3.0 cm (1.2 in), C3= 5.0 cm (2.0 in), C4= 5.0 cm (2.0 in), C5= 4.0 cm (1.6 in), C6= 2.0 cm (0.8 in).

Figure 3. Frontal damage to the 1999 Ford Crown Victoria.

Figure 4. Sideslap damage to the right side.

Figure 5. Left side damage to the 1995 Buick Century.

The Buick Century sustained moderate left side damage as a result of the impact with the Ford Crown Victoria **(Figure 5)**. The direct contact damage began 45.0 cm (17.7 in) forward of the left rear axle and extended 240.0 cm (94.5 in) forward. The impact resulted in a combined direct and induced damage length (Field L) of 292.0 cm (115.0 in). Direct contact damage was noted to the left fender along with the left front

and rear doors, which restricted both doors and shattered the side glazing. The A-pillar was displaced rearward from the longitudinal element of the impact force. The roof and side rails were displaced laterally from the lateral element of the impact force. The left front wheel was displaced laterally to the right which restricted its movement (not deflated). Direct damage was also documented to the left quarter panel from the secondary (sideslap) impact. The direct contact damage began 43.0 cm (16.9 in) rearward of the left rear axle and extended 43.0 cm (16.9 in) rearward.

Interior Damage

Interior damage to the Ford Crown Victoria identified through the NASS vehicle inspection was minimal and was attributed to occupant contact. Black vinyl transfers were noted to the driver air bag from expansion within the module. The brake pedal was bent forward against the (intruded) toepan. A scuff mark was documented to the left knee bolster (rigid plastic type). No steering wheel rim deformation was noted (tilt column set to center position) but an indentation was noted to the steering column just above the knee bolster. Intrusions into the driver space included 10.0 cm (3.9 in) of longitudinal toepan intrusion.

REDESIGNED AIR BAG SYSTEM

The 1999 Ford Crown Victoria was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags had deployed as a result of the crash. The driver air bag was housed in the center of the steering wheel with a single cover flap design hinged at the top aspect. The flap measured 14.5 cm (5.7 in) in width and 11.0 cm (4.3 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flap, blood spattering was identified at the lower left quadrant of the air bag attributed to the driver's forearm injury. The NASS researcher measured the diameter of the driver air bag at 58.0 cm (22.8 in) in its deflated state **(Figure 6)**. The bag was tethered by two internal straps and vented by two ports located at the 11 o'clock and 1 o'clock sectors on the rear aspect of the air bag.

Figure 6. 1999 Ford Crown Victoria redesigned driver air bag.

Figure 7. 1999 Ford Crown Victoria redesigned passenger air bag.

The front right passenger air bag deployed from a mid-mount module in the right instrument panel with a single cover flap design hinged at the top aspect. No contact evidence was identified on the air bag or exterior surface of the module cover flap. The cover flap was rectangular in shape which opened in an upward direction toward the windshield and measured 39.5 cm (15.6 in) in width and 16.0 cm (6.3 in) in height. The NASS researcher measured the passenger air bag at 60.0 cm (23.6 in) in width and 65.0 cm (25.6 in) in height in its deflated state **(Figure 7)**. No tether straps were present. The bag was vented by one port located at the 9 o'clock sector on the side aspect of the air bag. No cutoff switch was reported for the front right air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	24 year old male
Height:	175 cm (69 in)
Weight:	79 kg (175 lb)
Seat Track Position:	Mid-to-rear position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, driver interview, medical records
Eyeware:	None
Type of Medical Treatment:	Transported to a local hospital and released

Driver Injuries

Injury	***Severity (AIS 90)***	***Injury Mechanism***
Fracture right fibula (transverse - at the tip of the lateral malleolus)	Moderate (851608.2,1)	Foot controls (brake pedal) (indirect contact injury)
Abrasion anterior left hand	Minor (790202.1,2)	Front left air bag
Abrasions (bilateral) anterior forearms	Minor (790202.1,3)	Front left air bag

Driver Kinematics

The 24 year old male driver of the 1999 Ford Crown Victoria was seated in an upright posture with his hands at the 10 o'clock and 2 o'clock positions on the steering wheel rim. The seat back was slightly reclined with the seat track adjusted to the mid-to-rear position. He was properly restrained by the 3-point manual lap and shoulder belt system with the anchorage adjustment placed to the full down position. The police report noted that the driver was belted, further evidenced by the lack of substantial interior contacts and injury. At impact, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Contact by the expanding air bag resulted in multiple abrasions to the anterior aspect of both forearms and left hand. This mechanism was evidenced by the pre-crash placement of the hands relative to the inflated diameter of the bag. The air bag provided additional restraint against further contact to the steering wheel hub/rim preventing serious injury. He also sustained a fracture of the right fibula (transverse fracture through the tip of the lateral malleolus) which was an indirect result of loading by the right foot on the brake pedal, evidenced by the location of the fracture in conjunction with the bent brake pedal and pre-impact skid marks documented at the scene which places the driver's right foot on the pedal (compounded by the toepan intrusion). The driver was transported to a local hospital for treatment and released.

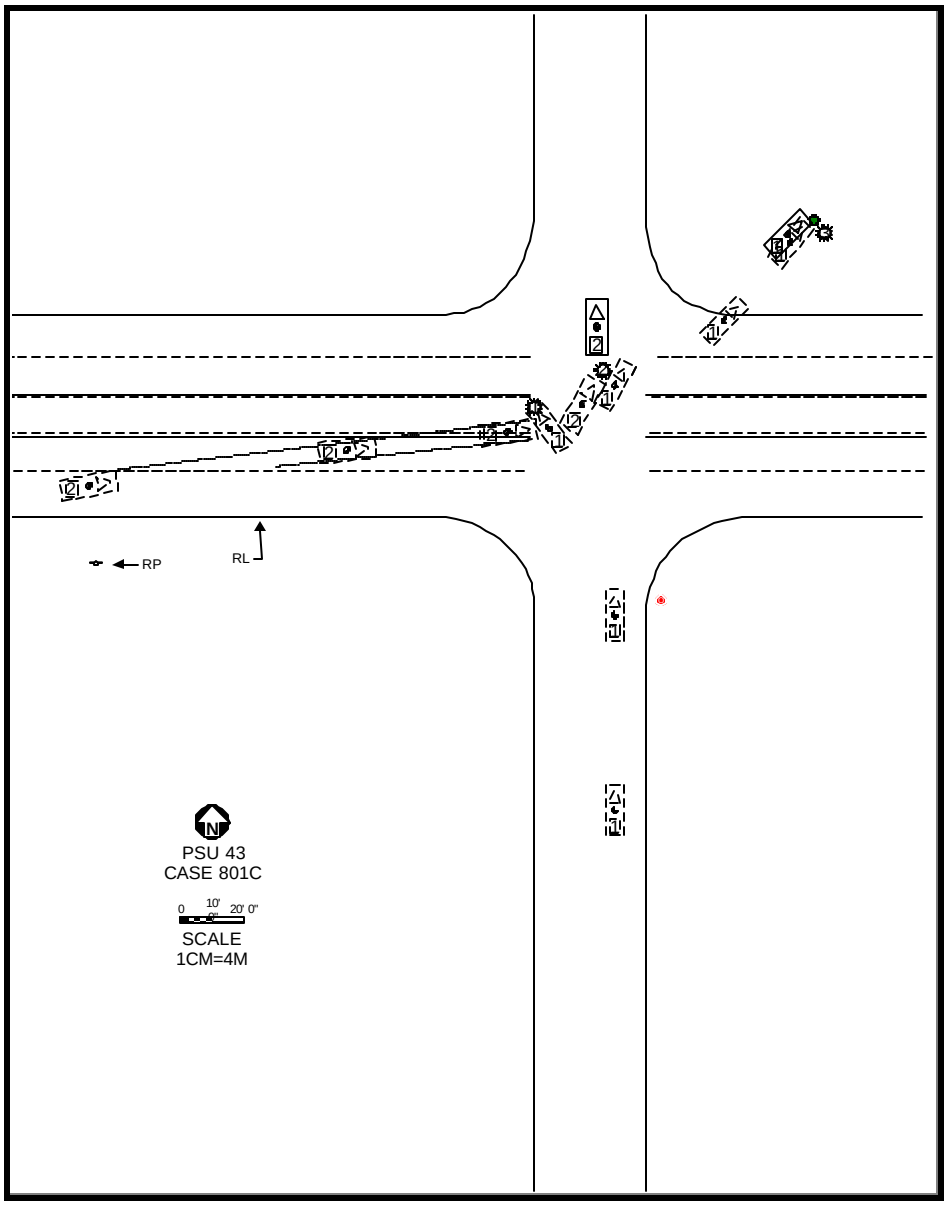

Figure 8. NASS Scene Diagram