CRASH DATA RESEARCH CENTER

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CALSPAN REMOTE ROLLOVER CRASH INVESTIGATION

SCI CASE NO.: CA09062

VEHICLE: 2006 FORD EXPLORER

LOCATION: SOUTH CAROLINA

CRASH DATE: JUNE 2006

Contract No. DTNH22-07-C-00043

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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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BACKGROUND

This remote investigation focused on the rollover of a 2006 Ford Explorer sport utility vehicle. **Figure 1** is a view of an exemplar 2006 Ford Explorer. The Ford was equipped with Certified Advance 208-Complaint (CAC) frontal air bags, front seat back-mounted side impact air bags, and possibly equipped with Inflatable Curtain (IC) air bags with rollover sensing. It could not be determined with certainty if this vehicle was equipped with the optional IC air bag system. The CAC system consisted of dual-stage frontal air bags, safety belt buckle pretensioners, seat track positioning sensors, a front right occupant presence sensor, and safety belt buckle switch sensors for the driver and front right passenger positions. The manufacturer of the Ford has certified that this vehicle is compliant to the advanced air bag requirements of Federal Motor Vehicle Safety Standard No. 208. The Ford was driven by an unrestrained 23-year-old male driver. He lost directional control of the vehicle as he traveled on a straight segment of road. The Ford departed the right road edge and struck two large diameter trees with the right aspect of the front plane. The Ford rotated clockwise (CW) and subsequently overturned. The driver's frontal air bag deployed during the crash event. There was no deployment of IC air bags in the Ford. The driver was subsequently ejected from the vehicle and expired at the scene of the crash.

Figure 1. View of an exemplar Ford Explorer.

The crash was identified through a review of rollover crashes from the Fatal Analysis Reporting System (FARS) by the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA). The Police Crash Report (PAR) was forwarded to the Calspan Special Crash Investigations (SCI) team and was assigned for remote follow-up on September 23, 2009. This report is based on a review and analysis of the police report, the police on-scene images, and a video (VHS) of the crash site. The police agency authorized the SCI team to publish the images for this SCI report.

SUMMARY

Crash Site

This multiple impact/rollover crash occurred off-road of a four-lane, divided asphalt roadway located in a suburban area during the hours of darkness (roadway not lighted). The roadway was oriented in a north/south direction with the north / southbound lanes separated by a painted median. A four-leg intersection with designated right turn lanes was located south of the crash site. Raised concrete gores with mountable curbs separated the right turn lanes from the through lanes. At the time of the crash,

atmospheric conditions were cloudy and all travel surfaces were dry. The road was police reported as straight and level. The east edge of the northbound lanes was bordered by a low barrier curb with a sidewalk located immediately outboard of the curb line. Several trees were located outboard the sidewalk at a police reported distance of 3.5 m (38 ft) from the curb line. The posted speed limit was 64 km/h (40 mph). The crash schematic is attached as **Figure 7** of this report.

Vehicle Data

The case vehicle was a 2006 Ford Explorer Eddie Bauer edition, 4-door sport utility vehicle. The Ford was identified by Vehicle Identification Number (VIN): 1FMEU74E46U (production number deleted). The Ford was equipped with a 4.0-liter, V-6 engine, linked to a 5-speed automatic transmission with 4-wheel drive. The service brakes were power-assisted four-wheel disc with antilock. The Ford was also equipped with traction control and Electronic Stability Control (ESC). The manufacturer recommended tire size was P245/65R17. The Ford was equipped with OEM alloy wheels and a roof rack as standard equipment.

The interior was configured with front bucket seats with adjustable head restraints and a split fold-down rear seat. The front seats were separated by a center console. The safety systems consisted of the CAC frontal air bags for the driver and front right passenger positions, front seat back-mounted side impact air bags, and possibly the optional IC air bags with rollover sensing. All seat positions were equipped with 3-point lap and shoulder belt systems. The front belt systems utilized buckle pretensioners.

Crash Sequence

Pre-Crash

The Ford was traveling northbound on the outboard lane at a police estimated speed of 113 km/h (70 mph). The investigating officer reported that the driver lost directional control as the vehicle drifted to the right as the Ford traveled through the intersection. The right side tires of the Ford overrode the northeast corner of the gore at the east edge of the northbound travel lanes. The Ford continued in a northeasterly direction and overrode the east curb, departing the travel lane north of the intersection. The Ford traversed the sidewalk and the grass roadside and continued in a northeasterly direction for a distance of 60 m (193.5 ft) from the point of departure to the initial impact with a 38 cm (15 in) diameter tree. The investigating officer reported that there was no evidence of braking or steering inputs over this travel distance.

Crash

The right aspect of the Ford's front plane impacted the tree. The impact crushed the corner of the bumper and engaged the right side surface of the Ford as the vehicle continued in a northerly direction. The impact force was within the 12 o'clock sector and was outside the scope of the WinSMASH reconstruction program due to the corner engagement. This impact separated the right front wheel from the vehicle, displaced the right A-pillar rearward, and opened the right front door. The Ford initiated a slight clockwise (CW) yaw as it continued in a northerly direction for a distance of 8.7 m (28.5 ft) to impact with a second 38 cm (15 in) diameter tree. This second tree impact involved

the right aspect of the Ford's front plane and accentuated the CW yaw as the Ford separated from the tree with its center of gravity redirected in a northwesterly direction. The video images of the Ford showed severe frontal damage; however, a crush profile could not be estimated from the video due to the poor quality of the tape. The direction of force was estimated at 11 o'clock. Due to the lack of detailed images and overlapping damage from the tree impacts, a delta V was not generated for the second tree impact. **Figure 2** is a view of one of the struck trees at the crash site.

Figure 2. Struck tree at the crash site.

The offset impact induced further CW rotation to the Ford as it separated from the tree in a left side leading trajectory. The lateral forces exerted on the sidewalls de-beaded the tires. The alloy wheels gouged the dirt roadside and tripped the Ford into a left side leading rollover event as it traveled in a northwesterly direction, back toward the roadway. The Ford rolled 4-quarter turns to the left before coming to rest in the first northbound travel lane, on its wheels, facing in a southeasterly direction. The vehicle traveled approximately 16 m (53 ft) from the trip point to final rest. The total distance traveled between the initial roadway exit point and final rest was approximately 26 m (275 ft). The rollover event was classified as a tripped/uninterrupted rollover.

The unrestrained driver was ejected from the vehicle during the third-quarter turn of the rollover. He came to rest on his left side and back, perpendicular to the sidewalk with his head on the sidewalk approximately 1.8 m (6 ft) forward of the front right corner of the Ford. Based on his proximity to the vehicle, the driver was ejected through the right front door opening. He expired at the scene to due blunt force injuries of the head and neck.

Post-Crash

Police and rescue personnel responded to the crash site. The driver was pronounced deceased at the scene and his body was removed by the coroner. The Ford was towed from the scene due to disabling damage.

Vehicle Damage

Exterior

The initial impact with the tree involved the right aspect of the Ford's front plane. The 12 o'clock direction of force impact crushed the front bumper outboard of the frame rail. As the Ford continued forward, the right side area engaged the tree in a continuous impact event. The damage extended to the right C-pillar area of the Ford **(Figure 3).** The impact resulted in separation of the right front fender, the right front tire and wheel from the driveline and suspension, and

Figure 3. Right side view of the initial impact damage to the Ford.

rearward displacement of the right A-pillar. As a result of pillar displacement, the right front door deformed and opened. The right front tire separated from the alloy wheel. The CDC for this impact was estimated at 12-FRAE-9.

The second tree impact involved the right aspect of the Ford's front plane with the direct contact damage occurring inboard of the right frame rail location. The combined damage from the two tree impacts appeared to have separated the front bumper, fractured the grille and headlight assemblies, and crushed the hood face. Although a crush profile could not be estimated from the on-scene police images and video, a CDC of 11-FZEW-3 was estimated for the second tree impact damage.

Figure 4. Left side view of the Ford.

The rollover of the Ford was classified as a tripped event based on the de-beading of the left side tires. The alloy wheels did not appear to be damaged. Dirt and grass debris was embedded into the side surfaces of the vehicle supporting the four-quarter turn rollover **(Figure 4)**. The maximum vertical roof crush was estimated at 10-13 cm (4-5 in) located at the right upper A-pillar area. Photographic documentation was not sufficient to establish the extent of lateral roof crush. It should be noted that the majority of the vertical roof crush was caused during the initial right front corner impact with the first tree. The crush/displacement was the result of rearward displacement of the A-pillar, deflecting the roof structure downward. This initial impact also caused the right door to open and partially separate. The driver's door remained closed during the crash. The on-scene images indicated the driver's door glazing was fully open at the time of the crash. The left rear door glazing was 2/3rds open and was not damaged. The left rear door quarter window was intact while the rear quarter window was disintegrated. The backlight remained closed and intact. All right side glazing appeared to have disintegrated during the crash events. The CDC for the rollover was estimated at 00-TDDO-3.

Interior

Figure 5. Interior view of the Ford.

The interior of the Ford Explorer sustained extensive damage that was associated with the frontal impact events. The right A-pillar was displaced rearward. As a result, the right and center instrument panel intruded rearward into the occupant compartment. The rearward displacement separated the upper instrument panel from the mid panel and displaced the driver's knee bolster panel. **Figure 5** is an overall interior view of the Ford.

The unrestrained driver's left knee impacted the left mid/lower instrument panel outboard of the bolster. The panel was fractured with separation of a switch panel. The rear view mirror was separated from its windshield mount.

Frontal Air Bag System

The Ford was equipped with the CAC frontal air bag system that consisted of dual stage air bags for the driver and front right passenger positions, seat track positioning sensors, a front right occupant weight sensor, and safety belt buckle switch sensors. The manufacturer of the Ford has certified that this vehicle is compliant to the advanced air bag requirements of Federal Motor Vehicle Safety Standard No. 208. The initial tree impacts deployed the driver's frontal air bag. The front right seat was unoccupied; therefore the CAC system suppressed the deployment of the passenger frontal air bag.

A Restraints Control Module (RCM) performed the tasks of crash sensing, fault detection and had Event Data Recording (EDR) capabilities. The EDR was supported by the Bosch Crash Data Retrieval software. It is unknown if the police imaged the EDR during their investigation. The available reports provided to the SCI team did not contain a copy of the EDR output.

The driver's air bag deployed from the four-spoke steering wheel rim through asymmetrical cover flaps. The air bag appeared to be free of damage and occupant contact.

Side/Rollover Air Bag System

The Ford was equipped front seat back-mounted side impact air bags as standard equipment. It could not be determined with certainty if the Ford was equipped with the optional roof side rail-mounted IC air bags. The IC air bag option had side impact and rollover sensing and were designed to deploy in both side impact crashes and rollover events. The breakdown of the VIN through the PCVina software package indicated the Ford was equipped with the side impact and head air bags. The side impact air bags did not deploy during this multiple event crash. There was no deployment of IC air bags in the Ford. The interior images were insufficient to confirm the presence of the IC air bags.

Safety Belt Systems

The Ford was equipped with 3-point lap and shoulder belt systems for the five designated seating positions. Based on specifications, the belt systems consisted of continuous loop webbing and sliding latch plates. The driver's belt retracted onto an Emergency Locking Retractor (ELR). The other belt systems utilized switchable ELR/Automatic Locking Retractors (ALR). Both front seat positions were equipped with buckle-mounted pretensioners. The driver did not utilize the safety belt system during the crash; therefore the buckle pretensioner did not actuate.

Occupant Data/Demographics

Driver

Age/Sex:	23-year-old/Male
Height:	175 cm (69 in)
Weight:	70 kg (155 lb)
Seat Track Position:	Rear third
Safety Belt Use:	None
Usage Source:	Police report
Egress from Vehicle:	Complete ejection
Mode of Transport From Scene:	Coroner
Type of Medical Treatment:	None, expired at scene

Driver Injuries

Injury	Injury Severity	Injury Source
Blunt force trauma of the head	Injured unknown severity (115099.7, 0)	Ground
Blunt force trauma of the neck	Injured, unknown severity (315099.7,0)	Ground

Source – Coroner's report contained within the police report

Driver Kinematics

The driver of the Ford Explorer was seated in a rear third track position and was unrestrained. While traveling on a straight segment of road, the driver allowed the vehicle to drift to the right and depart the right road edge. His posture and physical condition prior to the crash events were unknown.

The frontal impacts with the trees deployed the driver's CAC frontal air bag. The driver responded to these frontal crash forces by moving forward and to his left as the Ford began to rotate CW. The driver's left knee impacted the left lower instrument panel. This contact fractured the panel and displaced a switch panel. It is unknown if an injury occurred from this contact point. **Figure 6** is an interior view of the deployed air bag and the knee contact.

Figure 6. Deployed driver's air bag and the left knee contact to the left instrument panel.

The Ford initiated a left side leading rollover event across the grass surface. As the vehicle rolled, the driver was ejected from the vehicle during the third quarter turn of the rollover. The ejection portal was the right front door opening, as the door opened and partially separated from the vehicle during the frontal impact events. He came to rest on the road side with his feet at the curb line. The police report noted that his body was positioned approximately 1.9 m (6.3 ft) from the final rest position of the vehicle. He sustained blunt force trauma of the head and neck from contact with the ground and was pronounced deceased at the scene of the crash.

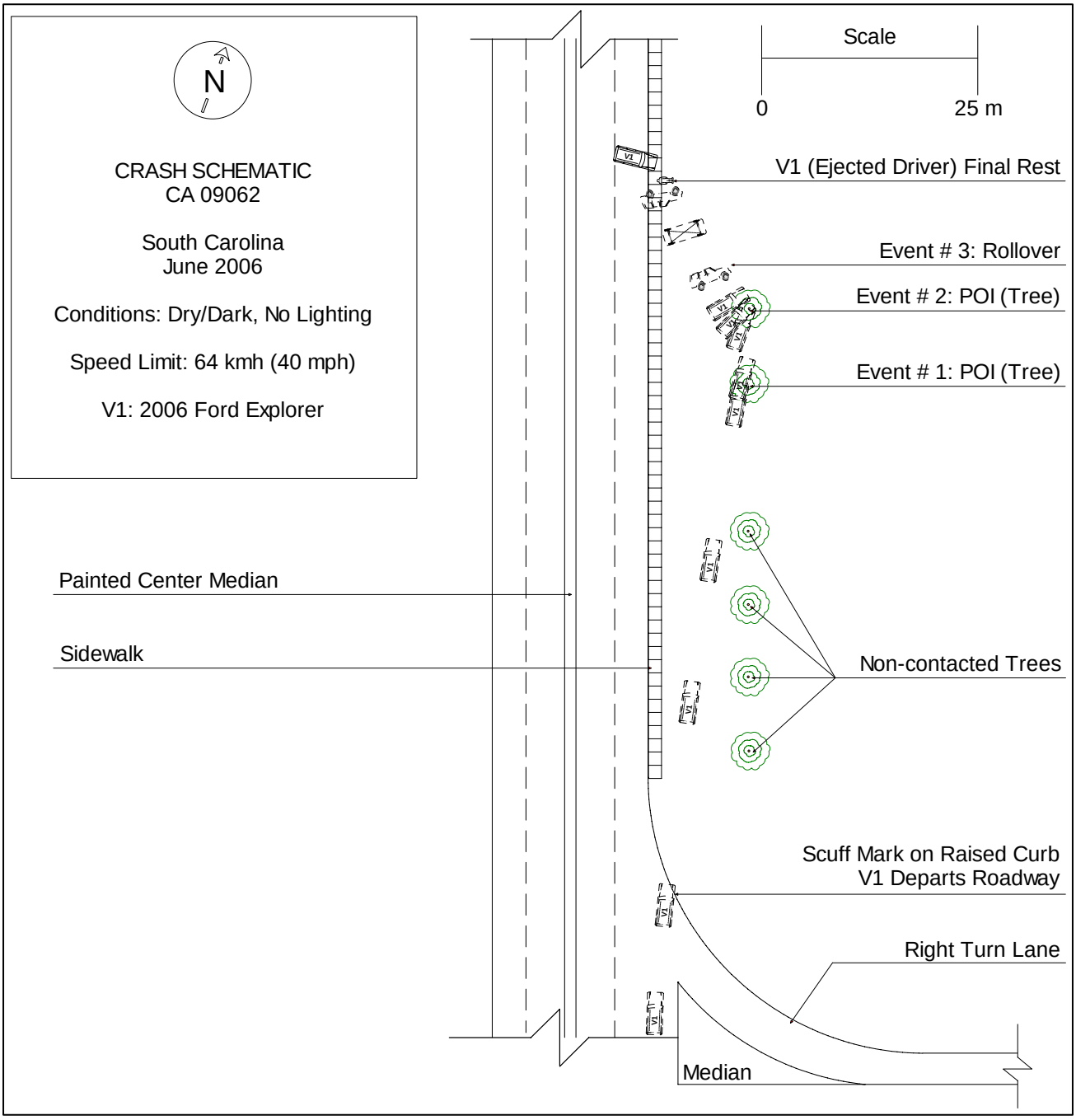

Figure 7. Crash Schematic