CRASH DATA RESEARCH CENTER
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CALSPAN REMOTE ROLLOVER CRASH INVESTIGATION

SCI CASE NO.: CA09069

VEHICLE: 2006 FORD EXPLORER EDDIE BAUER

LOCATION: MICHIGAN

CRASH DATE: SEPTEMBER 2007

Contract No. DTNH22-07-C-00043

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 system.

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LOCATION: MICHIGAN
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BACKGROUND

This remote investigation focused on the rollover of a 2006 Ford Explorer Eddie Bauer sport utility vehicle that resulted in the ejection and death of the 84-year-old male driver. The Ford was equipped with all-wheel drive, Electronic Stability Control (ESC), Certified Advanced 208-Complaint (CAC) frontal air bags, and Inflatable Curtain (IC) air bags with rollover sensing. The IC air bags deployed during the rollover event. **Figure 1** is an on-scene image of the Ford at final rest.

Figure 1. Final rest position of the 2006 Ford Explorer. (Image provided by the investigating police department.)

The crash was identified by the National Highway Traffic Safety Administration (NHTSA) following a review of the Fatal Analysis Reporting System (FARS) for crashes involving rollovers of vehicles equipped with IC air bags. This remote investigation involved the review of the Police Crash Report (PAR) and images that were provided by the investigating police agency. Authorization was received from the investigating police agency to publish the images in the SCI case.

SUMMARY

Crash Site

This single vehicle impact/rollover crash occurred on a rural two lane road during daylight hours. At the time of the crash, it was clear and dry. The roadway was oriented in a southwest to northeast direction and was asphalt surfaced with a posted speed limit of 89 km/h (55 mph). The roadway curved to the right with respect to the direction of travel of the Ford and was level with a slight super elevation noted at the apex of the curve **(Figure 2)**. The travel lanes were delineated by solid double yellow centerlines with solid white fog lines denoting both edges of the lanes. Gravel shoulders were located outboard of both fog lines and grassy areas were located outboard of the shoulders. A dirt and gravel surfaced two lane road intersected the paved roadway at the apex of the right curve. The grassy triangular area between the two roadways was depressed relative to the elevation of the road. An area of

Figure 2. Overall view of the crash site.

trees with diameters of 10-20 cm (4-8 in) was located north of the intersecting roadway. The crash schematic is included as **Figure 10**.

Vehicle Data

2006 Ford Explorer

The case vehicle in this crash was a 2006 Ford Explorer Eddie Bauer, 4-door sport utility vehicle **(Figure 3)**. The Ford was identified by Vehicle Identification Number (VIN): 1FMEU74886Z (production number deleted). The Ford was equipped with four-wheel drive, four-wheel antilock, traction control, ESC, CAC frontal air bags, IC air bags with rollover sensing and seat back-mounted side impact air bags. The tires were an all-season tread design, mounted on OEM multi-spoke alloy wheels. Although the specific tire data was not police reported, the left front tire remained inflated while the right front and both rears appeared to be flat. The left rear alloy wheel appeared to have been damaged in the crash. The Explorer was not equipped with a sunroof. A trailer hitch-mounted cargo carrier was in place at the time of the crash.

Figure 3. Front right three-quarter view of the Ford Explorer.

The interior of the Ford was configured with front bucket seats with adjustable head restraints and a split-bench rear seat. All seated positions were equipped with 3-point lap and shoulder belts. The IC air bags deployed during the rollover crash. There were insufficient images to determine if the CAC driver air bag deployed.

Crash Sequence

Pre-Crash

Prior to the crash, the Ford was police reported as traveling on the roadway in a northeasterly direction at or near the posted speed limit. The investigating officer indicated that the driver may have experienced a medical episode prior to the crash. As the Ford entered the right curve, the driver continued on a straight trajectory and crossed the centerline and the opposing travel lane. The Ford exited the west edge of the roadway onto the gravel shoulder **(Figure 4)**. Four tire marks were present on the gravel shoulder that indicated the vehicle was in a slight clockwise (CW) yaw, probably induced by a (CW) steering input by the driver. The Ford departed the shoulder and entered the depressed grass area on the west roadside. The vehicle traveled a police reported distance of 36 m (119 ft) from the departure point across the gravel and grass surfaces.

Figure 4. Left side road departure.

Crash

As the Ford traversed the grass area between the intersecting roads, the front left area of the vehicle impacted a road sign. This sign impact did not alter the trajectory of the vehicle. The Ford traveled an additional 7 m (24 ft) and struck a stop sign oriented for the intersecting east/west roadway with its front left area. **Figure 5** is a view of the area of the sign impacts.

Figure 5. Impact locations with the road signs.

Following the second impact, the Ford crossed the intersecting roadway and continued to yaw CW on the north side of the gravel roadway. The left side tires of the Explorer furrowed into the grass surface and tripped the vehicle into a side-over-side rollover to the left. The vehicle trip point was located 63 m (206 ft) northeast of the initial roadway departure point. The Ford rolled six-quarter turns to the left over a distance of 25 m (83 ft) and came to rest on its roof, 88 m (289 ft) northeast of the initial departure point, facing southwest **(Figure 6)**. As the Ford completed the sixth-quarter turn, the vehicle struck two trees as it came to rest. These impacts involved the right rear side area and the left rear door area **(Figure 7)** of the vehicle. The rollover event was classified as a tripped / interrupted rollover.

Figure 6. Right side view of the Ford at final rest.

Figure 7. Left side tree impact damage.

The IC air bags deployed during the rollover event. The unrestrained driver was completely ejected from the vehicle during the rollover event. He came to rest on his back approximately 5 m (18 ft) southwest of the final rest of the vehicle.

Post-Crash

A passing motorist observed the crash and called the 9-1-1 emergency response system on his cellular telephone. This motorist did not witness the crash. Emergency medical personnel from a local fire department responded to the call and initiated CPR on the driver. He was unresponsive and efforts to resuscitate him were stopped. The driver was pronounced deceased at the scene. The Ford was photographed at the scene by the police and was subsequently towed due to damage.

Vehicle Damage

Exterior

The Ford sustained moderate severity damage to the side and top planes from this multiple event crash. Based on the supplied images, the left rear and both right side tires appeared to be flat and partially de-beaded. The left rear alloy wheel was fractured at the outboard bead from contact with the ground during the rollover.

The front left area of the Ford impacted two sign posts that produced minimal bumper crush. The yielding object impacts fractured the left headlamp assembly and dented the face of the hood.

The direct contact damage from the rollover event extended the full length and width of the Ford. The roof was crushed downward across the windshield header area with approximately 10 cm (4 in) of vertical displacement at the midpoint of the header. The lateral displacement was minimal. The header displacement fractured the windshield (full width and height); however, the windshield bond remained intact and the glazing was not holed. The right rear door glazing, the left rear quarter window, and the backlight remained intact. All other side glazing disintegrated during the crash. The Ford was equipped with a roof rack that appeared to have stayed in place. The rack did not produce additional intrusion of the roof.

As the Ford initiated the sixth-quarter turn, the right rear side area impacted a tree resulting in damage to the quarter panel and the taillight assembly. The left rear door of the Ford impacted a 15-20 cm (6-8 in) diameter tree as the vehicle came to rest. The non-horizontal impact crushed the door and sill to an estimated depth of 10-15 cm (4-6 in).

The Collision Deformation Classifications (CDC) for these events are detailed in the following table:

Event No.	**Object Contacted**	**CDC**
1	Road sign	12-FLEN-1
2	Stop sign	12-FLEN-1
3	Rollover	00-TDDO-3
4	Tree	00-RBAW-2
5	Tree	00-LPAW-3

Interior

There were no available images of the Ford's interior for this remote investigation. Based on the exterior damage, the front occupant positions were reduced in size by intrusion of the roof, windshield, and windshield header. Maximum intrusion was estimated at 10 cm (4 in) across the header area/windshield area. The roof over the front seated positions intruded approximately 5-8 cm (2-3 in).

Air Bag Systems

Frontal

The Ford was equipped with a CAC frontal air bag system for the driver and front right passenger positions. The CAC system consisted of dual stage frontal air bags, seat track positioning sensors, safety belt buckle pretensioners, safety belt buckle switches and a front right occupant presence sensor. The manufacturer of the vehicle has certified that the Ford is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard No. 208. There were insufficient images of the Ford to determine if the driver's CAC frontal air bag deployed. The police report code box listed no air bags as deployed.

Side and Rollover Systems

The Ford was equipped with seat back-mounted side impact air bags and IC air bags with rollover sensing. The side impact air bags were designed to deploy in side impact crashes with sensors located in the lower B- and C- pillars. The IC air bags were designed to deploy in both side impact and rollover crashes. It is presumed in this crash that the IC air bags deployed as a result of the roll sensor detecting the rollover crash.

The IC air bags provided coverage across the side glazing from the A- to the C-pillars and vertically from the side rail to the beltline. This model year Ford should have incorporated a sail panel at the leading edge of the IC air bag to fill the void at the triangular void at the A-pillar areas. The IC air bags should have also been tethered to the A- and C-pillars. There were insufficient police images to fully confirm the presence of a sail panel and/or tethers.

Figure 8. Suspected tear of the left IC tether.

An on-scene image of the Ford indicates the left IC tether may have torn during the rollover as a result of driver loading **(Figure 8)**. With the Ford inverted, the IC air bag is partially extended out of the left front door window opening. The tether area is concealed by the outside mirror.

Event Data Recorder

The Ford was equipped with an Event Data Recorder (EDR) that was supported by the Bosch Crash Data Retrieval tool. It was unknown if the investigating police department had the capability to image the EDR. There was no CDR file available for this remote level investigation.

Occupant Data

Driver

Age/Sex:	84-year old/Male
Height:	Unknown
Weight:	Estimated at 100 kg (220 lb)
Seat Track Position:	Unknown
Safety Belt Use:	None
Usage Source:	Police report
Egress from Vehicle:	Complete ejection
Type of Medical Treatment:	None, pronounced deceased at scene

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Unknown cause of death	Unknown	Unknown
Avulsion of the dorsal aspect of the left forearm (NFS)	Minor (790800.1,2)	Unknown

Source – Observations from on-scene images of body

Driver Kinematics

The driver of the Ford Explorer was seated in an unknown track position and was not wearing the manual safety belt system. The lack of safety belt used was determined from the police report and the ejected status of the driver. The investigating officer indicated on his report that the driver may have experienced a medical episode pre-crash.

As the Ford initiated its tripped rollover event, the IC air bags deployed from the roof side rails. This 2006 Ford Explorer was equipped with a sail panels at the leading edge of the IC air bags. In addition, the leading edge of the sail panels should have been tethered to the A-pillars. The IC air bags provided coverage from the A- to the C-pillars and the full-height of the glazing. The driver was completely ejected from the Ford and was found approximately 5 m (18 ft) from the final rest position of the vehicle **(Figure 9)**.

Figure 9. Final rest position of the driver in relation to the Ford Explorer.

The ejection portals were limited as the side doors remained closed during the rollover. The laminated windshield was cracked, but remained in place. The left front, left rear, right front and the right rear quarter windows disintegrated during the rollover. The backlight, the right rear door glazing, and the right rear quarter window remained intact.

The driver's weight was estimated at 100 kg (220 lb). Based on his size, it would have been difficult for the driver to have been ejected through the right rear quarter window opening, the only disintegrated glazing area not protected by the IC air bag.

A close review of the available images indicated the forward tether for the left IC air bag may have been torn by the driver as he loaded the IC air bag during the rollover event, thus resulting in an ejection portal through the left front window opening.

The driver was pronounced deceased at the scene of the crash. The only visible injury was an avulsion to his left forearm.

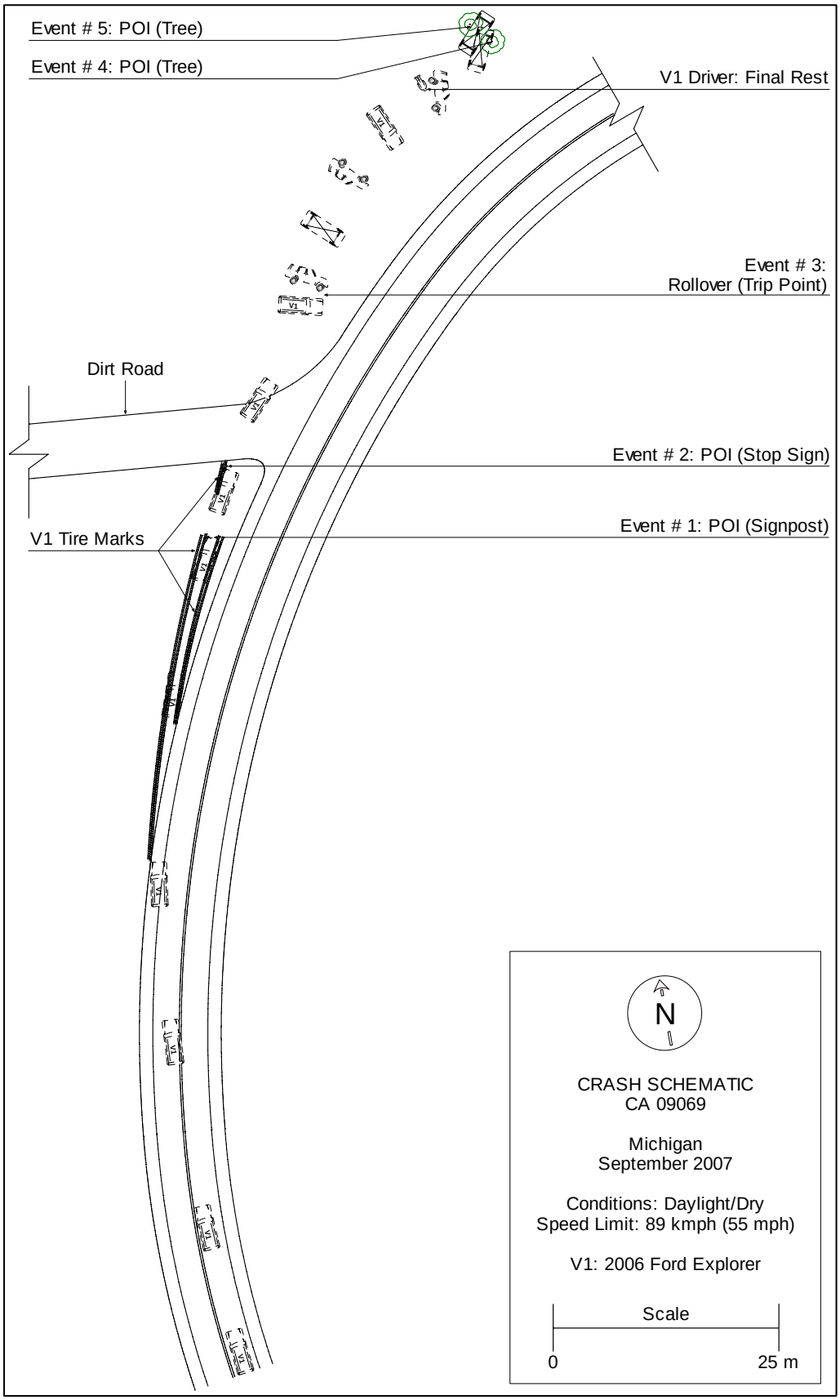

Figure 10. Crash Schematic