CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION INVESTIGATION

SCI CASE NO. – CA05-056

SUBJECT VEHICLE – 2005 FORD EXPLORER

LOCATION - STATE OF NEW YORK

CRASH DATE – SEPTEMBER 2005

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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 on-site investigation focused on the performance of the safety canopy occupant protection system in a 2005 Ford Explorer sport utility vehicle. The system consisted of safety canopy air bags that deployed from the roof side rails. The system was designed to deploy in a side impact or rollover crash. In addition, the Ford was also equipped with dual stage frontal air bags that did not deploy in this crash, buckle mounted safety belt pretensioners, and a Restraints Control Module (RCM) that had event data recording capabilities. The RCM was recovered and was forward to NHTSA for download by Ford. The RCM output is summarized in this report. The subject vehicle was occupied by an unrestrained 24-year-old female driver. The Ford was involved in a run-off-road collision and subsequent rollover. As a result of the crash, the left and right side safety canopy air bags deployed. The driver of the Ford sustained police reported complaint of pain to her left arm; however, she refused medical treatment. The Ford sustained moderate damage and was towed from the crash site.			
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BACKGROUND

This on-site investigation focused on the performance of the safety canopy occupant protection system in a 2005 Ford Explorer sport utility vehicle **(Figure 1)**. The system consisted of safety canopy air bags that deployed from the roof side rails. The system was designed to deploy in a side impact or rollover crash. In addition, the Ford was also equipped with dual stage frontal air bags that did not deploy in this crash, buckle mounted safety belt pretensioners, and a Restraints Control Module (RCM) that had event data recording capabilities. The RCM was recovered and was forward to the National Highway Traffic Safety Administration (NHTSA) for download by Ford. The RCM output is summarized in this report. The subject vehicle was occupied by an unrestrained 24-year-old female driver. The Ford was involved in a run-off-road collision and subsequent rollover. As a result of the crash, the left and right side safety canopy air bags deployed. The driver of the Ford sustained police reported complaint of pain to her left arm; however, she refused medical treatment. The Ford sustained moderate damage and was towed from the crash site.

Figure 1. Subject vehicle 2005 Ford Explorer.

Notification of this crash was provided to the Crash Investigation Division of the NHSTA by the insurance company. The crash was assigned as an on-site investigative effort due to the deployment of the safety canopy air bag system in the 2005 Ford Explorer. The vehicle was located at a local salvage where it was inspected on October 24, 2005**.**

Summary

Crash Site

This run-off-road crash occurred during the early morning hours of September 2005. At the time of the crash, the weather was clear with no adverse conditions. The crash occurred on the east roadside of a north/south roadway. The north/southbound roadway was configured with one travel lane in each direction with an S-curve. The north/south roadway was delineated by double-yellow centerlines and had a slight uphill grade for northbound travel. The east roadside consisted of an embankment, logs, boulders, and a tree line. There was no posted speed limit within the vicinity of the crash site; therefore, the speed limit defaults to the state limit of 89 km/h (55 mph). The scene schematic is included as **(Figure 11)** of this report.

Vehicle Data– 2005 Ford Explorer XLT

The 2005 Ford Explorer was identified by the Vehicle Identification Number (VIN): 1FMDU73K35 (production sequence omitted). The odometer reading at the time of the inspection was unknown. The Explorer was a full-size, four-door sport utility vehicle that was equipped with a 4.0-liter, V6 engine, 5-speed automatic transmission, 4-wheel drive, power-front and rear disc brakes with anti-lock, OEM alloy wheels, power-steering, tilt steering wheel, and steel tubular step rails. The Ford was also equipped with AdvanceTrac, Rollover Stability Control, direct tire pressure monitoring system, and power adjustable pedals. The Ford was equipped with BF Goodrich Rugged Trail T/A tires, size P245/65R17. The maximum pressure for these tires was 303 kPa (44 PSI). The manufacturer recommended tire pressure was 241 kPa (35 PSI). The specific tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	214 kPa (31 PSI)	9 mm (11/32)	No	Abrasions on outer rim bead
LR	214 kPa (31 PSI)	9 mm (11/32)	No	Abrasions on outer rim bead
RF	Unknown, tire missing	Unknown	Unknown	Unknown
RR	214 kPa (31 PSI)	9 mm (11/32)	No	None

The front seating positions in the Ford were leather surfaced front bucket seats with height adjustable head restraints. The front seat head restraints were both adjusted to the full-down positions at the time of the vehicle inspection. The second row seat was a three-passenger split bench (60/40) seat with height adjustable head restraints for the outboard positions. These head restraints were adjusted to the full-down positions.

Crash Sequence

Pre-Crash

The restrained 24-year-old female driver of the Ford was operating the vehicle northbound on the roadway **(Figure 2)**. The driver of the Ford was entering the left curve section of the S-curve roadway. She failed to negotiate the curve and departed the right roadside **(Figure 3)**.

Figure 2. Ford's northbound travel direction.

Figure 3. Right side road departure.

Crash

As the driver departed the right road side, she applied a left steering maneuver in an attempt to return to the roadway. The Ford overrode a log, which was displaced upward and contacted the bottom of the right side tubular step rail.

The Ford continued off-road in a northwest trajectory and the lower front right corner of the bumper fascia impacted a boulder. As the vehicle continued its forward movement, the front tire/wheel engaged the boulder, which resulted in the right front wheel assembly to separate from the vehicle. This event triggered the RCM to wake-up; however, the crash forces did reach the deployment threshold from the frontal air bag system. The data recorded by the RCM from the frontal crash forces indicated that the significant velocity crash recording threshold of -6.3 km/h (-3.9 mph) was met 77 ms after frontal algorithm wake-up with the frontal safing criteria met at 22 ms after algorithm wake-up.

Figure 4. Area of rollover initiation.

The impact with the boulder induced a counterclockwise (CCW) rotation. The left side of the Explorer entered the roadway while rotating which resulted in lateral forces to the left vehicle. As a result of the lateral forces, the left side tires rolled under the alloy wheels, which allowed the alloy rims to contact the asphalt road surface. This contact was evidenced by a 0.5 meter (1.6 feet) gouge on the road surface. The wheel contact tripped the Ford and the vehicle rolled one-quarter turn onto its left side **(Figure 4)**. The rollover event triggered the deployment of the left and right canopy air bags. The RCM output indicated that the curtain air bags were commanded to deploy at 588 ms after rollover algorithm wake-up. The safing criteria was met 8 ms after rollover algorithm wake-up. Additionally, the accumulated angle at the time of deployment was -48 degrees (to the left) with an angular rate at the time of the rotational energy criteria was met was -53 degrees per second.

Post-Crash

The driver of the Ford sustained police reported complaint of pain to her left arm; however, she refused medical treatment. The Ford sustained moderate damage and was towed from the crash site and was subsequently deemed a total loss by the insurance company.

Figure 5. Right step rail damage.

Vehicle Damage

Exterior Damage

The 2005 Ford Explorer sustained minor damage as result of the vehicle overriding the log. The log was displaced upward and struck the steel

tubular step rail **(Figure 5)**. The direct contact damage measured 50 cm (19.7") length and began 100 cm (39.3") rear of the right front axle. The step rail was deformed vertically upward approximately 5 cm (2.0"). A crush profile was not documented for this component. The Collision Deformation Classification (CDC) for this impact was 00-UPRW-1.

The Ford sustained moderate severity damage from the impact with the boulder **(Figures 6 and 7)**. The direct contact damage from this impact began 29 cm (11.4") right of the vehicle's centerline and extended 53 cm (20.8") to the right. There was no structural contact to the front of the vehicle and the direct damage consisted of a fractured section of the front right bumper fascia. Therefore, a crush profile was not documented for this impact. Additionally, the impact damage extended to the right front axle, which resulted in separation of the right front wheel from the drive axle, tie rod, and upper and lower control arms. The CDC for this impact was 12-FRLE-4.

Figure 6. Frontal damage from the boulder impact.

Figure 7. Right front axle damage.

The Ford sustained minor damage as a result of the rollover event. The direct contact damage consisted of abrasions to the left side plane. The direct contact damage began 79 cm (31.1") rear of the left rear axle and extended 396 cm (155.9") forward. Additionally, four separate dents were noted on the left side plane of the Explorer. These dents were located at the base of the A-pillar on the left front door, below the left front door handle, upper aspect of the C-pillar, and lower aspect of the D-pillar. The maximum crush for these dents was 2 cm (0.8"), 1 cm (0.3"), 3 cm (1.2"), and 2 cm (0.3"), respectively. Further damage consisted of abrasions to the left side alloy rims from contact with the asphalt road surface. The CDC for this impact was 00-LDAO-2.

Figure 8. Left side rollover damage.

The left front, left rear wing, and left rear glazing were disintegrated from contact with the ground. The remainder of the Ford's glazing was intact and all doors remained closed during the crash and operational post-crash.

Interior Damage

There was no damage to the interior of the 2005 Ford Explorer. The minor rollover event did not produce passenger compartment intrusion. The interior was free occupant contact points.

Safety Canopy Air Bag System

The 2005 Ford Explorer was equipped with safety canopy air bags for the left and right outboard seating positions. The system consisted of curtain-type air bags that deployed from the roof side rails. The canopy air bags were designed to deploy in the event of a side impact or rollover crash. The air bags were designed by the manufacturer to remain inflated for a period of six seconds following deployment. In the subject crash, the left and right canopy air bags deployed as result of the rollover event. The left and right air bags were rectangular in shape and measured 40 cm (15.7") vertically from the roof side rail and 145 cm (57.0") in length. The air bags were tethered at the A- and C-pillars. The A-pillar tether was a rope-type and measured 46 cm (18.1") in length. The C-pillar tether was a rope-type and measured 4 cm (1.6") in length. No damage or occupant contacts were noted to the canopy air bags. Present on the left canopy air bag was dirt from post-crash handling. The following information was embossed on the face of the left and right canopy air bags:

LISA
Sealing Technology / 80014-D
30335725G

Figure 9. Left side canopy air bag.

Figure 10. Right side canopy air bag.

Frontal Air Bags

The 2005 Ford Explorer was equipped with dual-stage frontal air bags that did not deploy in this crash **(Figure 16)**. The driver's frontal air bag was located in the center of the steering wheel hub. The front right air bag was mid-mounted on the front right instrument panel.

Restraints Control Module

The 2005 Ford Explorer was equipped with a Restraints Control Module (RCM) that had Event Data Recording (EDR) capabilities. Insurance company permission was obtained to remove the RCM from the Ford. The RCM was located within the center tunnel which required partial disassembly to facilitate the removal. The RCM was removed and was forward to NHTSA for download by Ford. The RCM data showed that the driver's seat track was normal and the driver's safety belt was unbuckled. The RCM output indicated that the curtain air bags were commanded to deploy at 588 ms after rollover algorithm wake-up. The safing criterion was met 8 ms after rollover algorithm wake-up. The accumulated angle at the time of deployment was -48 degrees (to the left) with an angular rate at the time of the rotational energy criteria was met was -53 degrees per second. Additionally, there were not faults at the time of the event recording; however, seven internal faults were recorded as a result of a low battery condition. The details of the faults were not described in the output data.

In addition to the rollover information, frontal crash forces were recorded by the RCM. This data indicated that the significant velocity crash recording threshold of -6.3 km/h (-3.9 mph) was met 77 ms after frontal algorithm wake-up with the frontal safing criteria met at 22 ms after algorithm wake-up. Although frontal crash forces were recorded, the algorithm did reach the deployment threshold from the frontal air bag system.

Manual Restraints Systems

The 2005 Ford Explorer was equipped with manual 3-point lap and shoulder safety belts for the four outboard seating positions. The second row center seat was an integrated lap and shoulder safety belt. The driver's safety belt was configured with a sliding latch plate, Emergency Locking Retractor (ELR), buckle mounted pretensioner, and a height adjustable D-ring that was adjusted to the full-up position. The driver did not utilize the safety belt in the crash, which was supported by the lack of loading evidence on the belt system and the non-fires status of the pretensioner.

The remaining four safety belts consisted of sliding latch plates and retracted onto switchable ELR/Automatic Locking Retractor (ALR). The front right safety belt also contained a buckle mounted pretensioner which did not fire in the subject crash.

Occupant Demographics	***Driver***
Age/Sex:	24-year-old/Female
Height:	Not available
Weight:	Not available
Seat Track Position:	Unknown moved post-crash
Manual Restraint Use:	None used
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	None, refused medical treatment

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Complaints of pain to the left arm, NFS	Not coded under AIS	Unknown

Injury source = Police Accident Report

Driver Kinematics

The 24-year-old female driver of the 2005 Ford Explorer was seated in a presumed upright posture and was not restrained by the 3-point lap and shoulder belt system. The undercarriage impact with the log was minor and resulted in no displacement of the driver.

The initial contact with the boulder involved the plastic bumper fascia, which did not produce forward movement of the driver. However, the driver initiated a forward trajectory as the vehicle engaged the bolder with the right front tire/wheel.

The vehicle rotated CCW and rolled onto it left side, which triggered the deployment of the left and right canopy air bags. Although not supported by contact evidence, the driver initiated a left trajectory and loaded the deployed air bag which prevented her from possible ejection and injury. The driver of the Ford sustained police reported complaint of pain to her left arm; however, she refused medical treatment.

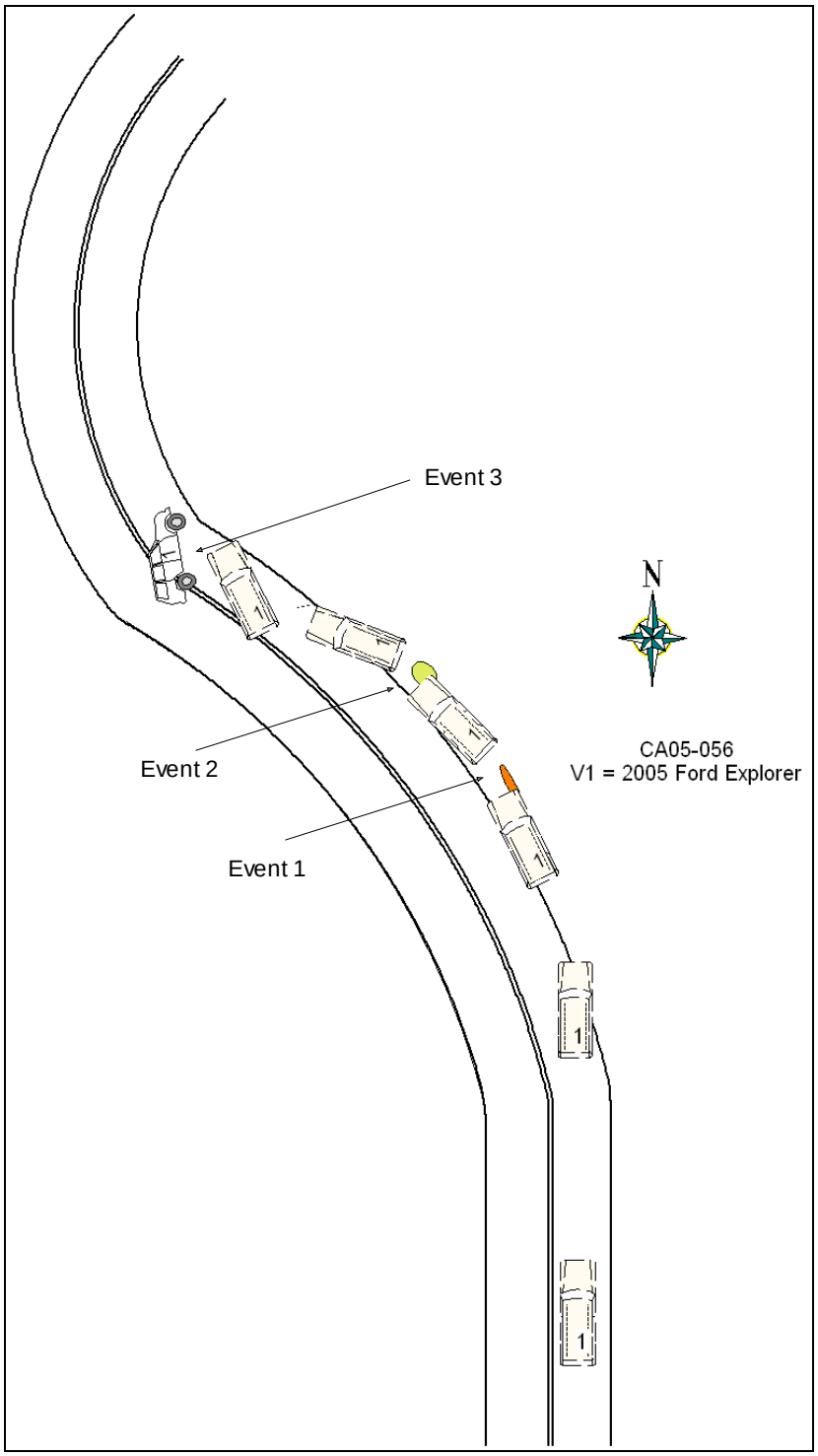

Figure 11. Scene Schematic