

Ford Safety Canopy Investigation/Vehicle Rollover  
Dynamic Science, Inc. / Case Number: DS04017  
2004 Ford Expedition  
New Mexico  
June 2004

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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.**

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**Dynamic Science, Inc.**  
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**Case Number: DS04017**

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## Background

### Description

This on-site investigation focused on the performance of the Ford Safety Canopy system in a 2004 Ford Expedition Eddie Bauer edition sport utility vehicle. The Expedition was being driven by a lap and shoulder belt restrained 48-year-old male who was the sole occupant of the vehicle. The case vehicle was traveling eastbound on a two lane, divided interstate freeway. The driver reported to police that he was fatigued as he crossed the state line between Texas and New Mexico. He fell asleep while driving and the case vehicle drifted off the left side of the roadway. The driver woke up as the vehicle was in the depressed dirt center median and he attempted to steer the vehicle back onto the roadway by steering right. While steering right, he overcorrected and lost control of the vehicle. The Ford Expedition went into a clockwise yaw. The vehicle's tires made contact with the asphalt shoulder, and at this point, the vehicle tipped and began to rollover to the left. The Expedition continued rolling across both eastbound travel lanes, the right shoulder area, and then onto the right dirt area off the roadway's edge. The vehicle rolled twelve quarter turns before coming to final rest on all four wheels, facing southwest. During the rollover sequence, both safety canopy side air bag curtains deployed. The police report indicated that the driver sustained only minor injuries, consisting of minor cuts and scratches to his arms and legs. He was treated at the scene by county paramedics but was not transported for additional medical treatment. When interviewed, the driver indicated that he did seek additional medical treatment at a later time.

This case was initially identified by DSI through existing insurance contacts. DSI was assigned the case on July 28, 2004. All field work was completed on July 30, 2004.



**Figure 1.** Front right view of case vehicle



**Figure 2.** Rear left view of case vehicle



**Figure 3.** Area of road departure-left side (eastbound)

## Summary

### Crash Site

This single vehicle, rollover crash occurred at 0920 hours in June, 2004 in a rural area of New Mexico. The crash occurred on a two-lane divided interstate freeway. This is an east/west interstate. There are two travel lanes in both directions. The eastbound lanes are composed of asphalt and are bordered on the right by a solid white lane line, a rumble strip grooved shoulder, an asphalt shoulder, and dirt beyond the roadway edge. On the left, the interstate is bordered by a solid yellow lane line, a rumble strip grooved shoulder, an asphalt shoulder, and a depressed dirt median that separates the eastbound travel lanes from the westbound travel lanes (approximately 27.0 m [90.0 ft] in width). The posted speed limit for the eastbound travel lanes was 121 km/h (75 mph). At the time of the crash, the weather was clear and dry.

### Pre-Crash

The case vehicle is a 2004 Ford Expedition Eddie Bauer edition four-door sport utility vehicle. The vehicle was being driven by a lap and shoulder belt restrained 48-year-old male who was the sole occupant of the vehicle. The case vehicle was traveling eastbound. The driver reported to a police investigator that he was fatigued as he crossed the state line between Arizona and New Mexico. He fell asleep while driving and the case vehicle drifted off the left side of the roadway. The driver woke up as the vehicle was in the depressed dirt center median and had traveled approximately 183 m (600 ft). The driver attempted to steer the vehicle back onto the roadway by steering to the right. In doing so he overcorrected, lost control and the vehicle went into a clockwise yaw.



**Figure 5.** Area traveled on center median (eastbound)

### Crash

As the vehicle was in a clockwise yaw, the vehicle's tires made contact with the asphalt shoulder. At this point the vehicle tipped and began a left side roll (CDC: 00TDDO4). The vehicle continued rolling across both eastbound travel lanes, the right shoulder area, and then onto the right dirt area off the roadway's edge. The vehicle rolled twelve quarter turns before coming to final rest on all four wheels, facing southwest. During the rollover sequence both safety canopy side curtains deployed.



**Figure 4.** Returned to roadway and began to rollover



## Post-Crash

The police report indicated that the driver sustained only minor injuries, consisting of minor cuts and scratches to his arms and legs. He was treated at the scene by county paramedics and was apparently not transported. During a short interview, the driver indicated that he sought additional medical treatment at a later time.

The Ford Expedition was towed from the scene due to damage. There was rollover damage to all sides of the vehicle. All of the right side glazing and backlight had disintegrated due to impact forces. All of the left side windows with the exception of the left rear door's wing window also disintegrated during the crash. The windshield was cracked and holed. There was intrusion along both roof rails (mainly to the front right seating position). The front right seat was deformed from vertical roof intrusion. The right front door was jammed shut; the other three doors remained closed and operational. The vehicle was later declared a total loss.



Figure 6. Final rest area

## Vehicle Data - 2004 Ford Expedition

The 2004 Ford Expedition was identified by the Vehicle Identification Number (VIN): 1FMFU17L94Lxxxxxx. The Ford Expedition Eddie Bauer is a four-door, 4x2 rear wheel drive, sport utility vehicle with a rear hatch and seating for eight. It was equipped with a 5.4 liter 8-cylinder engine, 4 speed automatic transmission, four wheel anti-lock brake system, power adjustable accelerator and brake pedals, a tilt steering wheel and front and rear ventilated disc brakes. The Expedition's vented disk brakes have two additional features that enhance the vehicle's braking performance. The electronic Brake Assist feature recognizes when there is an emergency braking situation and automatically applies and maintains full braking force even if the driver relaxes the brake pedal pressure.



Figure 7. Front left view of case vehicle

The Electronic Brake Force Distribution system “automatically balances brake force proportioning for various vehicle load conditions”. The Expedition also comes equipped with a Reverse Sensing System that alerts the driver to the closing distance when the vehicle is backing up towards an object.

This 2004 Ford Expedition was also equipped with the Ford Personal Safety System which includes the restraints control module, front row safety belt pretensioners, driver's seat position sensor, dual-stage front air bags, front safety belt usage sensors, load limiting retractors, and front crash severity sensors. The vehicle was also equipped with Ford's optional Safety Canopy System with advanced rollover sensors that will deploy a side air curtain in certain side-impact collisions or rollover events. The system consists of side curtain air bags, side-impact sensors and a rollover sensor. The curtain remain inflated for a longer period of time in order to keep occupants inside of the vehicle and to enhance head protection. When they are deployed, the curtains cover nearly two-thirds of the 1st and 2<sup>nd</sup> row side window glazing.



**Figure 8.** Right side of case vehicle

The vehicle mileage could not be obtained from the digital odometer because the vehicle had no power.

The 2004 Ford Expedition Eddie Bauer was equipped with Continental Contitrac SUV P265/70R17 tires. This vehicle comes equipped with a tire pressure monitoring system that alerts the driver when tire pressure is low. The manufacturer's recommended cold tire pressure for the front and rear tires was 241 kPa (35 psi). The specific tire information is as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Flat	9 mm (11/32 in)	No	Rim cracked, tire de-beaded
LR	Flat	8 mm (10/32 in)	No	Rim cracked, tire de-beaded
RR	269 kPa (39 psi)	8 mm (10/32 in)	No	None
RF	228 kPa (33 psi)	8 mm (10/32 in)	Yes	None

The front seating positions in the 2004 Ford Expedition Eddie Bauer were configured with leather covered bucket seats with integral head restraints. The driver's head restraint was undamaged but the front right head restraint was deformed by vertical roof intrusion. The bucket seats have adjustable seat tracks and seat back cushions.

The second row was configured as a leather covered 40/20/40 split bench seat with folding backs. The two outboard seating positions were equipped with adjustable head restraints that were not damaged. The center seating position had an integral head restraint that also was not damaged. The two outboard seating positions did not have adjustable seat tracks, but the center seat did have a CenterSlide adjustable seat track feature.

The third row was configured as a vinyl 60/40 split bench seat with folding backs. The two



outboard seating positions were equipped with adjustable head restraints that were not damaged. The center seating position was not equipped with a head restraint. This row did not have an adjustable seat track.

## Vehicle Damage

### Exterior Damage - 2004 Ford Expedition Eddie Bauer

Damage Description: The 2004 Ford Expedition Eddie Bauer sustained moderate damage as a result of the rollover event. Direct damage was evident on the top, left and right sides of the vehicle, with the majority of vertical and lateral rollover crush occurring in the passenger compartment area. Both left side tires were de-beaded, had cracked rims and were flat. The left wheelbase was lengthened by 9.0 cm (3.5 in) and the right wheelbase was lengthened by 15.0 cm (5.9 in). There was integrity loss to multiple side windows, the backlight, the sunroof and windshield. The windshield was cracked, holed and was found to be partially out of place at the inspection. The right front door was jammed shut; the other three doors and rear liftgate remained closed and operational.

CDC: 00TDDO4

There was vertical crush due to the rollover. The following table depicts the extent of crush by pillar location.

	<b>Left</b>	<b>Right</b>
<b>A pillar</b>	0 cm (0 in)	24.0 cm (9.4 in)
<b>B pillar</b>	0 cm (0 in)	18.0 cm (7.0 in)
<b>C pillar</b>	0 cm (0 in)	8.0 cm (3.1 in)
<b>D pillar</b>	27.0 cm (10.6 in)	9.0 cm (3.5 in)

## Interior Damage - 2004 Ford Expedition

The 2004 Ford Expedition sustained moderate interior damage due to normal air bag deployment related damage but sustained significant passenger compartment damage due to intrusion.

There was glazing integrity loss. The windshield was cracked and holed. The left front, left rear, right front, right rear, backlight and sunroof glazing all disintegrated during the crash. The left and right side rearmost windows and the wing window located just behind the right rear glazing also disintegrated. The right front door was jammed shut; the other three doors and rear liftgate all remained closed and operational.



Figure 9. Roof intrusion

The exterior side of the left side curtain was peppered with dirt marks from the rollover event. The second row outboard seat belt retractors were locked in place due to C pillar damage. The third row left seat belt retractor was also locked in place due to D pillar damage.

In the front left seating area, there was vertical roof and windshield header intrusion. In the front row center area, there was longitudinal intrusion of the center instrument panel. In the front right seating position, there was vertical roof, A pillar and roof side rail intrusion. The maximum intrusion was to the roof rail and was estimated at 33.0 cm (13.0 in). The front right integral head restraint and seat back were deformed due to the vertical intrusion. In the second row left seating location there was vertical roof, B and C pillar intrusion. In the second row center seating position, there was vertical roof intrusion. In the second row right seating position, there was vertical B and C pillar, roof, and roof rail intrusion. In the third row left and right seating positions there was vertical D pillar and roof intrusion. The amount of individual component intrusion is not known.



Figure 10. Front right head restraint and seat back damage

## Manual Restraint Systems - 2004 Ford Expedition

The 2004 Ford Expedition Eddie Bauer was configured with manual 3-point lap and shoulder belts for each of the eight seating positions. Both front seat belts were equipped with pretensioners with load limiters and seat belt height adjusters. It is not known whether or not the front seat belt pretensioners actuated during the crash. The driver and front right passenger seat belt height adjusters were in the full down position. The driver's safety belt was configured with

a sliding latch plate and an emergency locking retractor (ELR). The right front safety belt had a sliding latch plate and a switchable ELR/Automatic Locking Retractor. The second row outboard seating positions were equipped with seat belt anchorage adjustments. Both adjusters were in the full down position. The second row center seat belt was integrated into the seat back. All three second row safety belts had sliding latch plates and switchable retractors. The third row seating positions were not equipped with seat belt anchorage adjustments and the center belt was integrated into the seat back. The outboard seat belts are configured with sliding latch plates. The center seat belt's latch plate type could not be determined. The third row left seat belt retractor type could not be determined because the belt was locked in place due to intrusion. The center seat belt retractor type is also unknown. The right seat belt was equipped with a switchable retractor.



**Figure 11.** Driver's seat belt

All three second row seating positions were equipped with the lower anchor points that are part of this vehicle's Lower Anchors and Tethers for Children (LATCH) system. These seating positions were also equipped with child safety seat top tether anchor points, located on the base of the second row seat cushions. The first and third rows were not equipped with the LATCH system.



**Figure 12.** Driver's side curtain

### **Supplemental Restraint System - 2004 Ford Expedition**

This 2004 Ford Expedition Eddie Bauer sport utility vehicle was equipped with the Ford Personal Safety System which includes the restraints control module, safety belt pretensioners, driver's seat position sensor, dual-stage front air bags, front safety belt usage sensors, load limiting retractors, and front crash severity sensors. The vehicle was also equipped with Ford's optional Safety Canopy System with rollover sensing that will deploy a side air curtain in certain side-impact collisions or rollover events. The system consists of side curtain air bags, side-impact sensors and a rollover sensor. When they are deployed, the curtains cover nearly two-thirds of the 1st and 2<sup>nd</sup> row side window glazing.

Both the left and right canopy side curtains deployed during the crash. The curtains deployed downward from the roof side rails. The curtains were rectangular in shape and measured 139.0 cm (54.7 in) wide by 50.0 cm (19.7 in) high. They are attached to the A pillar by a single 47.0 cm (18.5 in) tether and to the C pillar by a 11.0 cm (4.3 in) tether. Both side windows are essentially covered by the deployed air bag.

There was no damage or occupant contacts found on the left curtain. The exterior side of the curtain was peppered with dirt marks from the dirt area on the right side of the roadway. On the right side curtain there were module cover transfers on the exterior side of the curtain. The front tethers on both side curtains were cut. The left rear tether had also been cut.

The driver and front right passenger air bags did not deploy, nor would they have been expected to deploy in this type of crash configuration.



**Figure 13.** Driver's side curtain - Dirt on bag



**Figure 14.** Front right side curtain

**Occupant Demographics - 2004 Ford Expedition**

	Driver
Age/Sex:	48/Male
Seated Position:	Front left
Seat Type:	Bucket
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Manual lap and shoulder belt
Air bag:	Front air bag - nondeployed. Side curtain air bag - deployed.

**Occupant Injuries - 2004 Ford Expedition**

Driver: Injuries obtained from the police report.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Minor arm lacerations	790602.1,3	Flying glass	Probable
Minor leg lacerations	890602.1,3	Flying glass	Probable



## Occupant Kinematics - 2004 Ford Expedition

### Driver Kinematics

The 48-year-old male driver appears to have been seated in an upright posture in the leather covered bucket seat and was restrained by the available 3-point manual lap and shoulder belt. The shoulder belt anchorage was in the full down position. The seat was adjusted to between the center and rearward most track position. The seat back was reclined at a 105 degree angle. The seat bottom angle is unknown. The driver was asleep when the case vehicle drifted off the left side of the freeway. The driver woke up as the vehicle was in the depressed dirt center median and he tried to get the vehicle back onto the roadway by steering right. While steering right, he overcorrected and lost control of the vehicle. The Ford Expedition went into a clockwise yaw, causing the restrained driver to pitch to his left. The vehicle's left tires made contact with the asphalt shoulder, causing the vehicle to tip and begin to rollover to the left. The Expedition continued rolling across both eastbound lanes, the right shoulder area, and then onto the right dirt area off the roadway's edge. The vehicle rolled twelve quarter turns before coming to final rest on all four wheels, facing southwest. During the rollover event, it is likely that the restrained male driver pitched right and left within his seating area, but very little evidence of occupant contact was found. During the rollover event, the driver's side curtain air bag deployed. It is likely that the driver's upper left torso and head contacted the deployed curtain, but no evidence of occupant contact was found.



Figure 15. Driver's seating area

The police report indicated that the driver sustained only minor injuries, consisting of minor cuts and scratches to his arms and legs. He was treated at the scene by county paramedics but was not transported for additional medical treatment. When interviewed, the driver indicated that he sought medical treatment at a later time. The level of treatment he received and what, if any, injuries were diagnosed is not known.



Attachment 1. Scene Diagram

