

Ford Safety Canopy Investigation / Rollover
Dynamic Science, Inc. / Case Number: DS04009
2003 Ford Expedition
California
May, 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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16. Abstract <p>This two vehicle impact with a subsequent rollover crash occurred in May, 2004 at 1850 hours in the state of California. The crash occurred within the confines of a three-leg, inverted T intersection. The case vehicle is a 2003 Ford Expedition sport utility vehicle driven by a 47-year-old male. There were two additional occupants in this vehicle. The second row left seat was occupied by a 10-year-old male. The second row middle seat was occupied by an 8-year-old male. The other vehicle was a 2001 Saturn LT200 driven by a 33-year-old female. The front right seat was occupied by a restrained 16-year-old female. The Ford Expedition was traveling westbound. The Saturn was initially traveling southbound. For unknown reasons, the driver of the Saturn pulled into the intersection to begin a left hand turn to head east. The driver of the Expedition saw the Saturn and attempted to avoid the crash by steering to the left. The driver of the Expedition saw that this maneuver would put his vehicle into on-coming traffic and steered back to the right. As the Expedition passed the Saturn, it was struck in the right side by the front of the Saturn. It appears that the Expedition tripped at this point. The vehicle rolled initially onto its left side and then continued rolling until it had completed five quarter turns and came to rest on the driver's side. During the rollover, the side air curtain deployed. There were no reported injuries for anyone involved in the crash.</p>			
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Crash Investigation
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BACKGROUND:

Description:

This on-site investigation focused on the performance of the Safety Canopy installed in a 2003 Ford Expedition sport utility vehicle. The Ford Expedition was occupied by a 47-year-old male restrained driver. There were two additional occupants in this vehicle. The second row left seat was occupied by a lap and shoulder belt restrained 10-year-old male. The second row middle seat was occupied by a lap and shoulder belt restrained 8-year-old male. The Ford Expedition was struck in the right side by a 2001 Saturn LT200 sedan. The Expedition then rolled over and the safety canopies deployed. There were no injuries in the crash.

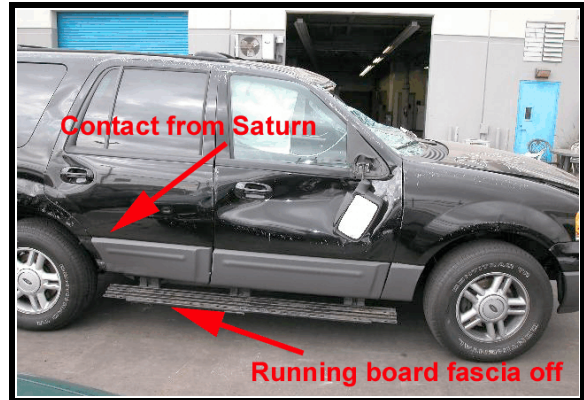


Figure 1. Right side of Expedition, showing impact with Saturn

This Ford Safety Canopy Investigation was initially identified by DSI through existing insurance contacts. NHTSA was notified on May 17, 2004. DSI obtained permissions to inspect the case vehicle and NHTSA assigned the case to DSI on May 25, 2004. The case vehicle was inspected on May 25, 2004. Scene field work was completed on May 30, 2004.

SUMMARY

Crash Site

This two vehicle impact with a subsequent rollover crash occurred in May, 2004 at 1850 hours in the state of California. It was clear and dry at the time of the crash. It was dusk and the street lights were not yet on. The crash occurred within the confines of a three-leg, inverted T intersection. The bottom of the T is an east-west roadway that is comprised of two east bound travel lanes, two west bound travel lanes, and a left hand turn lane in the eastbound leg for turning to the north. There was a positive 5.1% grade approaching the intersection. There was a raised concrete median separating eastbound and westbound traffic. There were no traffic controls and the speed limit is 64 km/h (40 mph). The base of the T is comprised of one northbound travel lane and one southbound travel lane. There was a negative 0.9% grade approaching the intersection. Southbound travel is controlled by a stop sign. The speed limit is 40 km/h (25 mph).



Figure 2. Approach of case vehicle to area of impact

Pre-Crash

The case vehicle is a 2003 Ford Expedition 4x4 XLT four-door sport utility vehicle driven by a lap and shoulder belt restrained 47-year-old male. There were two additional occupants in this vehicle. The second row left seat was occupied by a lap and shoulder belt restrained 10-year-old male. The second row middle seat was occupied by a lap and shoulder belt restrained 8-year-old male.

The other vehicle was a 2001 Saturn LT200 driven by a restrained 33-year-old female. The front right seat was occupied by a restrained 16-year-old female.

The Ford Expedition was traveling westbound at a driver reported speed of 64 km/h (40 mph). The Saturn was initially traveling southbound. The driver of the Saturn pulled into the intersection to begin a left hand turn to the east.

A brick wall on the northeast corner of the intersection blocks the view of the southbound lane from westbound traffic. At 96 m (314 ft), vehicles in the southbound lane become visible. A vehicle traveling at the 64 km/h (40 mph) speed limit would take 5.34 seconds to reach the intersection. In order to stop, a vehicle would require 4.59 seconds to stop (5.09 seconds - 0.5 seconds reaction time).

The driver of the Expedition saw the Saturn and attempted to avoid the crash by steering to the left. The driver of the Expedition saw that this maneuver would put his vehicle into on-coming traffic and steered back to the right.

Crash

As the Expedition passed the Saturn it was struck in the right side (12RPLS1) by the front of the Saturn. The Expedition began a clockwise rotation. The vehicle rotated until it was facing at a 90 degree angle relative to its initial direction of travel. It appears that the Expedition tripped at this point. The vehicle rolled initially onto its left side and then continued rolling until it had completed five quarter turns and came to rest on the driver's side. During the rollover, the side air curtain deployed.



Figure 3. Driver's view from southbound roadway



Figure 4. Area of rotation and vehicle overturning - case vehicle

Post-Crash

There were no reported injuries for anyone involved in the crash. All three occupants remained in their seat and were held in place by the seat belts. The 8-year-old was crying. The driver removed his seat belt first and went into the back to unlatch the other seat belts. A bystander opened the rear hatch and the driver handed the children out through the back.

The Expedition was towed from the scene due to damage and was subsequently declared a total loss by the insurance company. The Saturn sustained moderate damage and was driven from the scene.

VEHICLE DATA - 2003 Ford Expedition XLT four-door 4x4 sport utility vehicle

The 2003 Ford Expedition was identified by the Vehicle Identification Number (VIN) 1FMFU16L53LXXXXXX. The Expedition was equipped with a 5.4 liter, 8 cylinder engine, 4-wheel-drive¹, disc brakes with 4-sensor ABS and brake assist, 4-speed automatic transmission, power rack-and-pinion steering, and cruise control.

The 2003 Ford Expedition was equipped with Continental ContiTrac TR P265/70R17 tires. The specific tire data is as follows:

Tire	Tread	Measured pressure	Manufacturer recommended pressure
LF	6 mm (7/32 in)	186 kPa (27 psi)	241 kPa (35 psi)
LR	5 mm (6/32 in)	179 kPa (26 psi)	241 kPa (35 psi)
RF	6 mm (7/32 in)	179 kPa (26 psi)	241 kPa (35 psi)
RR	5 mm (6/32 in)	179 kPa (26 psi)	241 kPa (35 psi)

The front seating positions in the 2003 Ford Expedition are configured with dual leather covered bucket seats with integral head restraints that were not damaged. The second row was configured as a leather covered bench seat with folding back (40/20/40 split) with integral head restraints that were not damaged. The third row was configured as a leather covered bench seat with folding back (60/40 split). The outboard positions in the third row were equipped with adjustable head restraints that were not damaged.

¹Vehicle in two wheel drive high mode at time of crash

VEHICLE DAMAGE - 2003 Ford Expedition

Exterior Damage

Damage Description: Moderate rollover damage to all planes. Direct contact includes the top of the hood and 30.0 cm (11.8 in) rearward along the roof from the top of the windshield. Glazing disintegrated on left side. Windshield cracked during rollover.

CDC: Impact 1: 12RPLS1
Impact 2: 00TYDO2 (rollover)

Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

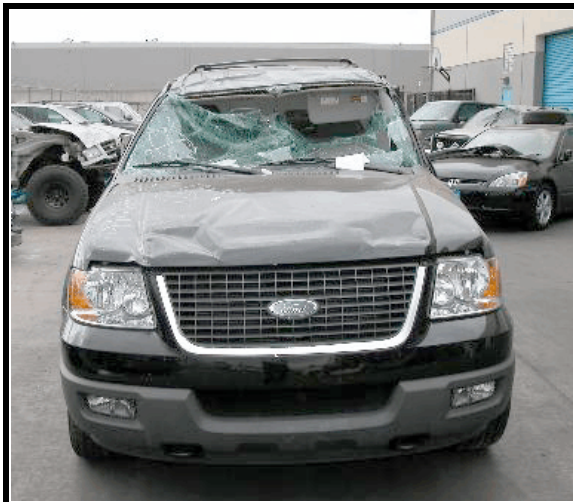


Figure 5. Front, Ford Expedition



Figure 6. Top view, Ford Expedition

Interior Damage - 2003 Ford Expedition

Interior damage to the Ford Expedition was minor and attributed to occupant contacts, passenger compartment intrusion, and artifacts from the safety curtain deployment. The windshield was fractured. The hole found at the time of the inspection was related to heat sag. The driver's and third row left side glass was disintegrated. There was vertical intrusion into the front right seating area from the A pillar and roof rail. The maximum intrusion was 4.0 cm (1.6 in). There was damage to the driver's arm rest and the driver's seat belt upper anchorage. This was most likely related to movements by the driver post-crash—he essentially stepped on these locations as he exited.



Figure 7. Overview of third row of seats

MANUAL RESTRAINT SYSTEMS - 2003 Ford Expedition

The interior of the Ford Expedition consisted of an eight passenger, three row seating configuration with bucket seats for the first row and split bench seats for the second and third rows. The driver's seat was equipped with a 3-point lap and shoulder belt with emergency locking retractors, a sliding latch plate, and an adjustable D ring that was in the full up position. The remaining outboard seats were equipped with 3-point lap and shoulder belts with a switchable retractor in the emergency locking mode and sliding latch plates. The second and third row middle seats were equipped with integral lap and shoulder belts.



Figure 8. Overview of second row of seats

AIR BAG SYSTEMS - 2003 Ford Expedition

The Ford Expedition 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, energy management retractors, and front crash severity sensors. The vehicle was also equipped with Ford’s optional Safety Canopy System 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. Electronic rollover sensors measure whether the vehicle is tilting, how fast the lean angle is changing and whether the combination means the vehicle is headed for a rollover. It has been reported that the curtain air bags remain inflated up to six seconds. The curtain covers the first row side glass and approximately two-thirds of the second row side glass.



Figure 9. Left side curtain



Figure 10. Right side curtain

Both the left and right side curtains deployed during the crash.

The curtains deployed downward from the roof cladding. The curtains are rectangular in shape and measured 135.0 cm (53.1 in) wide by 58.0 cm (22.8 in) high. They are attached to the A pillar by a single 45.0 cm (17.7 in) tether and to the C pillar by a 9.0 cm (3.5 in) tether. The distance from the front of the curtain to the mid point of the B pillar was 42.0 cm (16.5 in) and from the back of the curtain to that same point was 93.0 cm (36.6 in). Both side windows are essentially covered by the deployed air bag. There was no damage or occupant contact found on the right curtain. On the left side curtain there were road abrasions to the exterior of the curtain within the confines of the left front side glass area. The abrasions measured 33.0 cm (13.0 in) at the top left (as facing the left side of the vehicle), declining to 13.0 cm (5.1 in) at the bottom left.

The Ford Expedition was equipped with a driver's front air bag and a front passenger's air bag. The driver's and front right passenger air bags did not deploy, nor would they have been expected to deploy in this crash configuration.



Figure 11. Exterior view of left side curtain



Figure 12. Non-deployed driver's air bag



Figure 13. Non-deployed front right passenger's air bag

OCCUPANT DEMOGRAPHICS - 2003 Ford Expedition

	Occupant 1	Occupant 2
Age/Sex:	47/Male	10/Male
Seated Position:	Front left	Second row left
Seat Type:	Leather covered bucket seat. Seat at rear most track position. Seat back slightly reclined. Integral head restraint with no damage.	Leather covered split bench seat with folding back. Adjustable head restraint in full up position. No damage.
Height:	178 cm (70 in)	152 cm (60 in)
Weight:	84 kg (185 lbs)	39 kg (86 lbs)
Occupation:	Unknown	None
Pre-existing Medical Condition:	None	None
Alcohol/Drug Involvement:	None	NA
Driving Experience:	>20 years	NA
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Both hands on steering wheel, unknown o'clock position	Holding a portable video game in his hands.
Foot Position:	Right foot on brake, left on floor.	Both feet on floor.
Restraint Usage:	Lap and shoulder belt available, used. Shoulder belt upper anchorage in full up position.	Lap and shoulder belt available, used. Shoulder belt upper anchorage in full down position.
Air bag:	Steering wheel mounted driver's air bag, did not deploy. Side air curtain, actuated.	Side air curtain, actuated.

	Occupant 3
Age/Sex:	8/Male
Seated Position:	Second row, middle
Seat Type:	Leather covered split bench seat with folding back. Integral head restraint.
Height:	127 cm (50 in)
Weight:	27 kg (60 lbs)
Occupation:	None
Pre-existing Medical Condition:	None
Alcohol/Drug Involvement:	NA
Driving Experience:	NA
Body Posture:	Normal, upright. Looking to the left at the portable video game in other occupant's hands.
Hand Position:	Unknown
Foot Position:	Both feet on floor.
Restraint Usage:	Integral lap and shoulder belt available, used.

OCCUPANT INJURIES - 2003 Ford Expedition

	<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Driver:	Not injured			
Second row left:	Not injured			
Second row middle:	Not injured.			

OCCUPANT KINEMATICS - 2003 Ford Expedition**Driver kinematics**

The 47-year-old male driver of the Ford Expedition was seated in a normal, upright fashion. The leather covered bucket seat was adjusted to the rear most track position. The seat back was slightly reclined. The driver was using the available lap and shoulder belt. The shoulder belt upper anchorage was in the full up position. Prior to impact, the driver saw Saturn begin pulling out from the intersection. The driver began braking and steering to the left. The driver pitched slightly to the right due to the steering motion and the minor right side impact. The driver then steered sharply to the right, causing the vehicle to go into a clockwise rotation. This movement caused the driver to shift to the left against the door. The Expedition then tripped and rolled five quarter turns and came to rest on the driver's side. The driver was generally held in place by the restraint system and did not sustain any injuries. The driver removed his seat belt first and went into the back to unlatch the other seat belts.

Second row left occupant kinematics

The 10-year-old male second row left occupant was seated in a normal, forward facing fashion. He was wearing a baseball uniform and was playing with a portable video game at the time of the crash. He was seated on a leather covered split bench seat. Both feet were on the floor. He was using the available lap and shoulder belt. The shoulder belt upper anchorage was in the full down position. Prior to impact, the driver saw Saturn begin pulling out from the intersection. The driver began braking and steering to the left. The 10-year-old occupant pitched slightly to the right due to the steering motion and the minor right side impact. The driver then steered sharply to the right, causing the vehicle to go into a clockwise rotation. This movement caused the this occupant to shift to the left against the door. The Expedition then tripped and rolled five quarter turns and came to rest on the driver's side. The 10-year-old occupant was generally held in place by the restraint system and did not sustain any injuries. The driver (his father) assisted him in removing his seat belt.

Second row middle occupant kinematics

The 8-year-old male second row middle occupant was seated in a normal, forward facing fashion. He was wearing a baseball uniform and was watching his brother play with a portable video game at the time of the crash. He was seated on a leather covered split bench seat. Both feet were on the floor. He was using the available integral lap and shoulder belt. Prior to impact, the driver saw Saturn begin pulling out from the intersection. The driver began braking and steering to the left. The 8-year-old occupant pitched slightly to the right due to the steering motion and the minor right side impact. The driver then steered sharply to the right, causing the vehicle to go into a clockwise rotation. This movement caused the driver to shift to the left, possibly against his brother in the rear left seat position. The Expedition then tripped and rolled five quarter turns and came to rest on the driver's side. The 8-year-old occupant was generally held in place by the restraint system and did not sustain any injuries. The driver (his father) assisted him in removing his seat belt.

Attachment 1. Scene Diagram

