

Ford Safety Canopy/Child Safety Seat Investigation /Rollover  
Dynamic Science, Inc. / Case Number: DS04016  
2003 Ford Expedition  
California  
July, 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 This on-site investigation focused on the performance of child safety seats that were installed in the second and third row seats of a 2003 Ford Expedition. The investigation also focused on the performance of the Ford Expedition safety canopy. The Ford Expedition was occupied by a total of nine occupants. The Ford Expedition was traveling northbound on an interstate roadway. The driver lost control of the Expedition and the vehicle overturned. During the rollover sequence both side air curtains deployed. As the vehicle rolled, the third row left female occupant (27-year-old) was fully ejected through the right rear side glass. She came to rest in the fourth travel lane from the right. As the vehicle continued to roll it traveled in a northeast direction and crossed all four travel lanes. At some point during this movement the second row middle seat male occupant (4-month-old) was ejected. The vehicle came to rest on its wheels on the east side shoulder facing southeast. All but one of the occupants were injured.				
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**Dynamic Science, Inc.**  
**Crash Investigation**  
**Case Number: DS04016**

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## BACKGROUND:

This on-site investigation focused on the performance of child safety seats (CSS) that were installed in the second and third row seats of a 2003 Ford Expedition. The investigation also focused on the performance of the Ford Expedition Safety Canopy. The Ford Safety Canopy consists of a rollover sensor and side curtain air bags. The Ford Expedition was occupied by a total of nine occupants. The first CSS was a Graco Snug Ride seat that was installed in the second row middle position. The CSS was in the rear facing configuration and was occupied by a 4-month-old male. The seat was anchored to the vehicle using the manual lap belt but the child was not wearing the internal CSS harness. The second CSS was a Dorel Safety 1<sup>st</sup> seat that was improperly installed in the third row middle seat. The CSS was in the forward facing configuration and was occupied by a 1-year-old female. The seat was anchored to the vehicle using the manual lap belt and the child was wearing the internal CSS harness.



Figure 1. Front left, Ford Expedition

The Ford Expedition was traveling northbound on an interstate roadway. The driver lost control of the Expedition and the vehicle overturned. During the rollover sequence both side air curtains deployed. As the vehicle rolled, the third row left female occupant was fully ejected through the right rear side glass which is not covered by the air bag curtain. She came to rest in the fourth travel lane from the right. As the vehicle continued to roll it traveled in a northeast direction and crossed all four travel lanes. At some point during this movement the second row middle seat occupant was ejected. The vehicle came to rest on its wheels on the east side shoulder facing southeast.

This CSS/Side Air Curtain case was initially identified by DSI from a series of news reports. NHTSA was initially notified on July 5, 2004. DSI obtained permission to inspect the case vehicle and NHTSA assigned the case to DSI on July 23, 2004. The case vehicle was inspected on July 24, 2004.

## SUMMARY

### Crash Site

The crash occurred in the northbound lanes of an eight lane interstate highway. Just south of the scene, the roadway curves slightly to the right, but straightens prior to the area of impact. The roadway



Figure 2. Overview of crash scene - north

was flat and of concrete construction. The west roadway edge is bordered by a solid yellow line, a paved asphalt median that transitions into a dirt/gravel median, and a concrete median barrier. The east roadway edge is bordered by a solid white line, an asphalt paved shoulder, and a raised asphalt paved median that separates this roadway from a transition roadway. It was clear and dry at the time of the crash. It was daylight at the time of the crash. The speed limit is 105 km/h (65 mph).

### Pre-Crash

This single vehicle rollover crash occurred at 1950 hours in July, 2004 in southern California. The case vehicle is a 2003 Ford Expedition four-door sport utility vehicle (VIN: 1FMEU17W83LCxxxxx). The vehicle had been involved in a previous collision (08/23/03) to the front right area. It was repaired approximately one month later. When the driver received his car back he felt it was pulling to one side. The driver returned the vehicle to the body shop two days later. The vehicle was realigned and the wheels were re-balanced. The driver was satisfied that the vehicle was working properly from that time on.

There were a total of nine occupants in the vehicle. This Ford package only allows for eight person seating. An overview of seating positions, restraint usage, and injuries is shown in the following table.



**Figure 3.** Overview of roadway—looking toward the north

Table 1. Overview of seating positions

Front left	27 years/Male (01)	Lap and shoulder belt used	Forehead laceration, COP left shoulder
Front right	32 years/Male (02)	Lap and shoulder belt used	Cervical spine fracture, acute cerebral hemorrhagic contusion
Second row left	54 years/Female (03)	Lap and shoulder belt used	Abrasion to left side of face, COP right shoulder
Second row left - on seat or next to Occupant 3	4 years/Female (04)	None used	Abrasion to left side of head and abrasion to lip area
Second row middle	4 month/Male (05)	Graco Snug Ride child safety seat, rear facing	<b>Fatal</b> - blunt force trauma to head. <b>Fully ejected.</b>
Second row right	26 years/Female (06)	Lap and shoulder belt used	Right wrist fracture, right small finger fracture, abrasion to right side of neck, laceration to right side of head, COP right knee
Third row left	27 years/Female (07)	Lap and shoulder belt not used	Left femur fracture, right clavicle fracture, COP to chest Kidney and spleen fracture, left tibia / fibula fracture, right arm fracture <b>Fully ejected.</b>
Third row middle	1 year/Female (08)	Dorel Safety 1 <sup>st</sup> child safety seat, forward facing	Not injured
Third row right	5 year/Female (09)	Lap and shoulder belt used	Two broken arms, head trauma, Abrasion to right side of face

## Crash

Witnesses indicated that the Ford Expedition was traveling at approximately 113 km/h (70 mph) in the fourth lane from the right. The driver indicated that the right front tire blew and he lost control of the vehicle. Police, however, indicate that the driver allowed the case vehicle to drift out of its lane which resulted in an unsafe turning movement to the left when he overcorrected and lost control of the vehicle. Physical evidence at the scene shows that the driver continued to steer left and right several times within the asphalt median and the adjacent lane in an attempt to regain control of the vehicle. As the driver steered to the left and braked the right side wheel rims gouged the roadway.

At this point the vehicle tripped and began a right side roll (CDC: 00TDDO3). During the rollover sequence both side air curtains deployed. As the vehicle rolled, the third row left female occupant (07) was fully ejected through the right rear side glass. She came to rest in the fourth travel lane from the right. As the vehicle continued to roll it traveled in a northeast direction and crossed all four travel lanes. At some point during this movement the second row middle seat occupant (05) was ejected. The vehicle came to rest on its wheels on the east side shoulder facing southeast. The second row middle occupant came to rest on the east side shoulder north of the case vehicle.

## Post-Crash

All the parties on board, with the exception of occupant 08, were injured. The driver sustained minor lacerations. He indicated that he would seek treatment on his own.

The front right occupant (02) sustained a hyper flexion injury with evidence of facet capsule disruption at the C6-C7 level, an acute cerebral hemorrhagic contusion, and a forehead contusion. He also complained of lower back pain. He was unable to extricate himself due to his neck pain and a jammed door. He was extricated by paramedics. He was then transported by ground ambulance to a local trauma center where he arrived with GCS score of 15. For a brief time he left the emergency room to be with his wife and badly injured child, but was subsequently hospitalized for two days.

The second row left occupant (03) sustained facial abrasions and a neck strain. She was transported by ground ambulance to a local trauma center. She arrived with a GCS score of 15. She was treated and then released at 0100 hours the following day.



Figure 4. Left rear, Ford Expedition



Figure 5. Right rear, Ford Expedition



The other second row left occupant (04) sustained a forehead contusion, an abrasion to the left eyelid, a mouth contusion, and a neck strain. She was transported by ground ambulance to a local trauma center where she was treated and released.

The second row middle occupant (05) sustained blunt force trauma to the head. He was transported to a children's pediatric trauma center via air ambulance. Responding paramedics found the child pulse-less and apneic. Paramedics were unable to intubate him in the field. He arrived in the trauma center with assisted respirations and no pulse. Efforts to resuscitated him continued for the next two hours. A CT scan revealed multiple skull base fractures with large areas of subarachnoid bleeding and a loss of grey/white differentiation. His pupils were fixed and dilated and he had no spontaneous respirations. He was extubated at 0110 hours and became asystolic at 0125 hours the following morning, and death was pronounced.

The second row right occupant (06) sustained a wrist fracture and multiple lacerations/abrasions. She was transported by air ambulance to a local trauma center. The third row left occupant (07) sustained multiple fractures and internal injuries. She was transported by ground ambulance to a local trauma center.

The third row middle occupant was not injured (08). She was found by her father (the front right seat occupant) harnessed to the child seat. However, the child seat was essentially upside down.

The third row right occupant (09) sustained hand and arm fractures, as well as multiple abrasions and contusions. She was transported by ground ambulance to a local pediatric trauma center. She arrived with a GCS score of 15. She was admitted overnight for observation and released the following day.

The Ford Expedition was towed from the scene due to damage. There was rollover damage to all sides of the vehicle. The glazing was disintegrated for all right side positions, the backlight, and the front and rear left side positions. The windshield was cracked. There was intrusion along both roof rails. The vehicle was placed under police hold and was inspected while under police hold.



**Figure 6.** Overview of vehicle interior



**Figure 7.** Third row, right side, area of ejection

**VEHICLE DATA - 2003 Ford Expedition**

The 2003 Eddie Bauer Edition Ford Expedition four-door sport utility vehicle was identified by the Vehicle Identification Number (VIN): 1FMEU17W83LCxxxxx. The Ford Expedition was equipped with a 4.6 liter, eight cylinder engine, rear wheel drive, an automatic transmission, four wheel power disc brakes with antilock braking system, power-assisted, engine-speed sensitive power steering, and a tilt steering wheel. No defects were reported.

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

<b>Tire</b>	<b>Tread</b>	<b>Measured pressure</b>	<b>Manufacturer recommended pressure</b>
LF	7 mm (9/32 in)	186 kPa (27 psi)	241 kPa (35 psi)
LR	6 mm (8/32 in)	Flat	241 kPa (35 psi)
RF	Missing	Missing	Missing
RR	7 mm (9/32 in)	Flat	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.

**VEHICLE DAMAGE****Exterior Damage - 2003 Ford Expedition**

Damage Description: Rollover damage on all planes. Windshield cracked. Side glass and backlight disintegrated. Right front tire missing. Left rear and right rear tires flattened with rim damage. Rim damage to front left.

CDC: 00TDDO3

Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

The vertical crush to the greenhouse area is shown below by pillar location, left to right.

Pillar	Left	Right
A	0 cm (0 in)	15.0 cm (0 in)
B	0 cm (0 in)	16.0 cm (6.3 in)
C	6.0 cm (2.4 in)	2.0 cm (0.8 in)
D	3.0 cm (1.2 in)	2.0 cm (0.8 in)

### Interior Damage - 2003 Ford Expedition

The 2003 Ford Expedition sustained moderate interior damage as a result of passenger compartment intrusion and occupant contacts. The left and right A pillars, windshield header, B pillar, roof and both roof rails intruded into the passenger compartment. The glazing was disintegrated for all right side positions, the backlight, and the front and rear left side positions. The windshield was cracked. Both right side doors were jammed shut. Both side curtains deployed during the rollover sequence. The entire instrument panel was shifted. There were blood patterns found on the left side of the right front seat, on the right side air curtain, on the right roof rail, on the front of the third row right seat, and on the child seats. Strands of hair were found embedded in the remaining side glass at the third row right seat position.

<b>Position</b>	<b>Intruded Component</b>	<b>Magnitude of Intrusion</b>	<b>Direction</b>
Front right	A pillar	23.0 cm (9.0 in)	Vertical
Front right	Windshield header	23.0 cm (9.0 in)	Vertical
Second row right	Roof rail	15.0 cm (5.9 in)	Vertical
Second row right	B pillar	11.0 cm (4.3 in)	Vertical
Third row right	Roof rail	13.0 cm (5.1 in)	Vertical
Third row left	Roof rail	20.0 cm (7.9 in)	Vertical
Third row left	Roof	20.0 cm (7.9 in)	Vertical
Third row right	Roof rail	20.0 cm (7.9 in)	Vertical

## MANUAL RESTRAINT SYSTEMS - 2003 Ford Expedition

The eight passenger 2003 Ford Expedition was configured with manual 3-point lap and shoulder belts for all seating positions. The front row seat belts were equipped with pretensioners and load limiting retractors. The front and second row outboard positions were equipped with seat belt height adjusters. The driver's seat belt was configured with a sliding latch plate and an emergency locking retractor (ELR). The seat belt height was adjusted to the mid position. There were indications of historical usage. The belt was used in this crash and was found with the webbing trapped in the D ring. The pretensioner does not appear to have actuated. The front right seat was configured with a sliding latch plate and a switchable retractor that was in the ELR mode. The seat belt height was adjusted to the full down position. There were indications of historical usage. The pretensioner does not appear to have actuated. The second row seat belts were configured with sliding latch plates and switchable ELR/ALR retractors. All three seat belts were found in the ELR mode. The seat belt height for the two outboard seat positions were in the full down position. The second row left seat belt was not in use at the time of the crash. The belt was found locked in the stowed position. The second row middle seat belt was being used with a child safety seat. The seat belt was cut during the extrication of the child occupant. The second row right seat did not show any signs of historical usage, but reports indicate that the occupant in this position was belted. The LATCH system was available for all three second row positions but was not in use at the time of the crash. The Graco child seat was configured for LATCH usage. The third row seat belts were configured with sliding latch plates and switchable ELR/ALR retractors. All three seat belts were found in the ELR mode. The third row left seat belt was not in use at the time of the crash and the occupant in this position was ejected. The third row middle seat belt was in use with the Dorel child seat at the time of the crash. The third row right seat belt was in use at the time of the crash. The third row seat belts were configured with sliding latch plates and switchable ELR/ALR retractors. All three seat belts were found in the ELR mode.



**Figure 8.** Driver's seat belt, webbing locked in D ring



**Figure 9.** Second row, center, seat belt cut

## AIR BAG SYSTEM - 2003 Ford Expedition

This 2003 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. The curtain covers the 1st- and approximately two-thirds of the 2nd-row side glass.

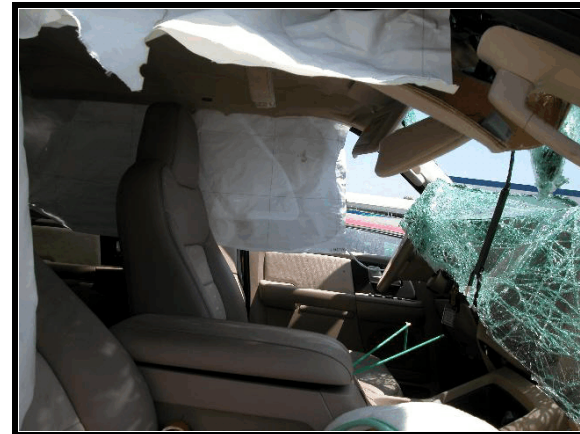
Both the left and right side curtains deployed during the crash. The curtains deployed downward from the roof cladding. The curtains are rectangular in shape and measured 135.0 cm (53.1 in) wide by 58.0 cm (22.8 in) high. They are attached to the A pillar by a single 45.0 cm (17.7 in) tether and to the 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).

There was no damage or occupant contacts found on the left curtain. On the right side curtain there were road abrasions to the exterior of the curtain within the confines of the front right glass area. The front tether and portions of the curtain had been cut during extrication efforts. There was blood found on the inside of the curtain from the B pillar rearward.

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 10.** Road abrasions to front right portion of side curtain



**Figure 11.** Left front interior view of side air curtain



**Figure 12.** Blood pattern to right interior side curtain

## Child Safety Seat Discussion

The 4-month-old male second row middle seat occupant (05) was seated in a Graco Snug Ride Model 7446 STA infant safety seat (Mfg. date 11/25/03). He was not using the child seat harness. The manufacturer recommends that the infant car seat is to be used rear-facing only and is for infants up to 9 kg (20 lbs) and less than 66 cm (26 in) tall. The seat is designed with a stay-in-vehicle base. The seat is equipped with a lower anchorage attachment. According to EMS personnel, the seat base had been tightly anchored to the vehicle using the available lap and shoulder belt and the child seat was still attached to the seat base. The belt was equipped with a switchable retractor but it is not known if the belt was in the automatic locking or emergency locking mode. Emergency personnel found it necessary to cut the seat belt in order to extricate other occupants.

The child in this seat was ejected and fatally injured. The child seat and seat base remained in the vehicle.



**Figure 13.** Graco Snug Ride infant safety seat, second row middle seat position



**Figure 14.** Second row, center, seat belt cut

The 1-year-old female third row middle seat occupant was seated in a forward facing Dorel Safety 1<sup>st</sup> Vantage Point child safety seat (Mfg. date 12/17/2001). The Vantage Point 02-460 is designed for children from 10-45 kg (22-100 lbs). For children 10-18 kg (22-40 lbs), the 5-point harness adjusts with a front pull adjust system. The harness has 3 height positions to adapt to the child's growth. The harness was found in the top most position at the time of inspection. With the harness removed, the seat converts to a belt-positioning booster for children 14-45 kg (30-100 lbs). Five-position belt guides on both sides help provide shoulder belt fit. The child seat was anchored to the vehicle seat. Apparently there was too much slack which allowed the child seat to rotate during the crash. The child was using the internal 5-point harness. It is not known if the harness was being used properly. There was some loading to the left arm rest and it was deformed outward. There was also blood found on the base of the seat on the right side.



**Figure 15.** Dorel Safety 1<sup>st</sup> child safety seat, front view



**Figure 16.** Dorel Safety 1<sup>st</sup> child safety seat, side view



**OCCUPANT DEMOGRAPHICS - 2003 Ford Expedition**

	Driver	Occupant 2
Age/Sex:	27/Male	32/Male
Seated Position:	Front left	Front right
Seat Type:	Leather covered bucket seat	Leather covered bucket seat
Height:	165 cm (65 in)	Unknown
Weight:	82 kg (180 lbs)	Unknown
Occupation:	Unknown	Grocery store worker
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	NA
Driving Experience:	Unknown	NA
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used
Air bag:	Front air bag available, did not deploy. Side air curtain available, deployed.	Front air bag available, did not deploy. Side air curtain available, deployed.

**OCCUPANT DEMOGRAPHICS**

	Occupant 3	Occupant 4
Age/Sex:	54/Female	4/Female
Seated Position:	Second row left	Second row left, next to Occupant 3.
Seat Type:	Leather covered split bench with folding back	Leather covered split bench with folding back
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	NA	NA
Driving Experience:	NA	NA
Body Posture:	Normal, upright	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, used	None used
Air Bag:	Side air curtain available, deployed.	Side air curtain possibly available, deployed.

**OCCUPANT DEMOGRAPHICS**

	Occupant 5	Occupant 6
Age/Sex:	4 month/Female	26/Female
Seated Position:	Second row middle	Second row right
Seat Type:	Leather covered split bench with folding back	Leather covered split bench with folding back
Height:	74 cm (29 in) <sup>1</sup>	Unknown
Weight:	11 kg (24 lbs)	Unknown
Occupation:	NA	Unknown
Pre-existing Medical Condition:	None	None noted
Alcohol/Drug Involvement:	NA	NA
Driving Experience:	NA	NA
Body Posture:	Normal, rear facing child seat position	Normal, upright
Hand Position:	Unknown	Unknown
Foot Position:	NA	Unknown
Restraint Usage:	Lap and shoulder belt used with Graco Snug Ride child safety seat	Lap and shoulder belt available, used
Air Bag:	None	Side air curtain available, deployed.

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<sup>1</sup>Additional measurements: 48.0 cm (18.9 in) crown to rump, head circumference 49.0 cm (19.3 in)

**OCCUPANT DEMOGRAPHICS**

	Occupant 7	Occupant 8
Age/Sex:	27/Female	1/Female
Seated Position:	Third row, left	Third row, middle
Seat Type:	Leather covered split bench with folding back	Leather covered bench with folding back
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	NA
Pre-existing Medical Condition:	None noted	None
Alcohol/Drug Involvement:	NA	None
Driving Experience:	NA	NA
Body Posture:	Unknown	Upright, child safety seat
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, not used	Lap and shoulder belt available, used with child seat.

**OCCUPANT DEMOGRAPHICS**

	Occupant 9
Age/Sex:	5/Female
Seated Position:	Third row, right
Seat Type:	Leather covered split bench with folding back
Height:	Unknown
Weight:	40 kg (88 lbs)
Occupation:	NA
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	NA
Driving Experience:	NA
Body Posture:	Normal, upright
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt available, used

**OCCUPANT INJURIES - 2003 Ford Expedition**

Driver: Injuries obtained from police report.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Minor, non-specific lacerations	990600.1,9	Unknown	Unknown

First row right occupant (02): Injuries obtained from emergency room records, radiological reports, and police report. MRI revealed hyperflexion injury with evidence of facet capsule disruption at the C6-C7 level.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
C7 fracture, bone fragment in neural foremen with neurological deficit to left arm (slight)	650216.2,6	Hyper flexion	Probable
Acute cerebral hemorrhagic contusion	140602.3,9	A pillar	Possible
Slight bruise, right forehead	290402.1,7	A pillar	Possible

Second row left occupant (03): Injuries obtained form emergency records and a radiology report. The x-ray was negative for an injury to the right shoulder.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Linear abrasions, left forehead	290202.1,7	Side air curtain	Possible
Linear abrasions, left cheek	290202.1,2	Side air curtain	Possible
Neck strain	640278.1,6	Impact forces	Possible

Second row left occupant (04): Injuries obtained form emergency records and radiology reports. The x-ray was negative for an injury to the chest. CAT scan of head neck showed mild focal tissue swelling of the left supraorbital area.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Contusion, forehead	290402.1,7	Left door panel	Possible
Neck strain	640278.1,6	Impact forces	Possible
Minor abrasion, left upper eyelid	297202.1,2	Left door panel	Possible
Contusion, left lip	290402.1,8	Left door panel	Possible

Third row middle occupant (05): Injuries obtained from autopsy report.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Linear fracture extending from vertex over left parietal and occipital skull. V shaped fracture, left mid occipital scalp.	150402.2,6	Ground	Possible
Linear fracture extending from vertex across right parietal skull. Linear fracture, right temporal bone through middle cranial fossa <sup>2</sup> extending to right lambdoid suture.	150402.2,1	Ground	Possible
Linear fracture, right frontal bone at the brow ridge – frontal fracture extends down to the ethmoid plate over right orbital plate	150402.2,5	Ground	Possible
Linear fracture through middle cranial fossa	150402.2,6	Ground	Possible
Subdural hemorrhage, 5-8 cc, over cerebral convexities bilaterally	140654.5,3	Ground	Possible
Lacerations, right frontal and left parietal and temporal cortex underlying skull fractures	140688.4,1 140688.4,2	Ground	Possible
Subarachnoid hemorrhage over pons and medulla	140210.5,8 140684.3,9	Ground	Possible
Subgaleal hematoma over calvarium involving frontal, parietal and occipital bones	190402.1,5 190402.1,5 190402.1,2	Ground	Possible
Contusion/abrasions, right forehead	290202.1,7 290402.1,7	Ground	Probable
Contusion/abrasions, right cheek. Contusions, right ear.	290202.1,1 290402.1,1	Ground	Probable
Contusion/abrasions, right scalp. Abrasion, right parietal scalp 2.5-2.0 cm (1.0 x 0.75 in).	190402.1,1 190202.1,1	Ground	Probable
Contusion, oval shaped, 5.0-2.0 cm (2.0 x 0.75 in), mid frontal scalp, within hairline	190402.1,5	Ground	Possible
Laceration, scalp, 1.2 cm (0.5 in)	190600.1,9	Unknown	Unknown
Abrasion, right occipital scalp	190202.1,1	Ground	Probable

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<sup>2</sup>Coded as basilar fracture

Abrasion, right lower occipital scalp 5.0-1.2 cm (2.0 x 0.5 in)	190202.1,1	Ground	Probable
Petechial hemorrhages, right upper eyelid, lower eyelid, and conjunctiva	240416.1,1	Ground	Possible
Abrasion, left cheek in front of left earlobe, 2.0-0.07cm (0.75 x 0.03 in)	290202.1,2	Ground	Possible
Abrasion, right elbow and dorsal forearm, 5.0-2.5 cm (2.0 x 1.0 in)	790202.1,1	Ground	Probable
Superficial lacerations, palmar surface of right hand	790602.1,1	Ground	Probable
Contusion mid knuckle, right index finger	790202.1,1 790402.1,1	Ground	Probable
Abrasion, left elbow 3.8-2.5cm (1.5 x 1.0 in)	790202.1,2	Ground	Probable
Abrasions, anterior right thigh 10.1-5.0 cm (4.0 x 2.0 in)	890202.1,1	Ground	Probable
Abrasion, right knee 3.8-2.5 cm (1.5 x 1.0 in)	890202.1,1	Ground	Probable
Contusion, dorsal surface right foot; contusions second, third and fourth toes	890402.1,1	Ground	Probable
Abrasion, heel of right foot	890202.1,1	Ground	Probable
Contusion with superficial lacerations, left gluteal crease, 8.9-2.5 cm (3.5 x 1.0 in)	890402.1,6	Ground	Probable
Contusion, left posterior thigh 1.3 cm (0.5 in)	890402.1,2	Ground	Probable
Abrasion, left ankle and shin, 7.6-5.0 cm (3.0 x 2.0 in)	890202.1,2	Ground	Probable
Contusions, anterior left thigh	890402.1,2	Unknown	Unknown
Abrasion, left knee, 5.0-1.3 cm (2.0 x 0.5 in)	890202.1,2	Unknown	Unknown
Contusions, dorsal surface of left foot; contusions fourth and fifth toes	890402.1,2	Ground	Possible



Second row right occupant (06): Injuries obtained from police report.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Fracture, right wrist	751800.2,1	Right door	Possible
Fracture, right little finger	752404.1,1	Right door	Possible
Abrasion, right side of neck	390202.1,1	Shoulder belt	Probable
Laceration, right side of head	190600.1,1	Unknown	Unknown
Complained of pain to right knee	NA		

Third row left occupant (07): Injuries obtained from doctor's statement to police.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Fracture, left femur	851800.3,2	Ground	Probable
Fracture, right clavicle	752200.2,1	Ground	Probable
Fracture (laceration), kidney	541620.2,9	Ground	Probable
Fracture (laceration), spleen	544220.2,2	Ground	Probable
Fracture, left tibia	853404.2,2	Ground	Probable
Fracture, left fibula	851605.2,2	Ground	Probable
Fracture, right arm	751800.2,1	Side panel	Possible

Third row right occupant (09): Injuries obtained from admission history and physical records, emergency room records, and radiology reports. A CT scan was performed and the result was negative for head injuries.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Non displaced fracture, right, distal ulna	753202.2,1	Interior side panel	Probable
Minimally displaced fracture, right, proximal first metacarpal	752002.2,1	Interior side panel	Unknown
Non displaced fracture, right, distal second metacarpal	752002.2,1	Interior side panel	Unknown
Fracture, left, distal fifth metacarpal	752002.2,2	Interior side panel	Unknown
Non displaced fractures, left, proximal third and fourth metacarpals	752002.2,2 752002.2,2	Unknown	Unknown
Non displaced fracture, left medial epicondyle of distal humerus	752602.2,2	Child safety seat in middle rear position	Possible

## **OCCUPANT KINEMATICS - 2003 Ford Expedition**

### **Driver kinematics**

The 27-year-old male driver of the case vehicle was seated in what is presumed to be a normal, upright position in the leather covered bucket seat. The seat track had been adjusted to the mid position. The seat back was slightly reclined. The driver had allowed his vehicle to drift out of its lane to the left. The driver overcorrected to the right and lost control of the vehicle. Physical evidence at the scene shows that the driver continued to steer left and right several times within the asphalt median and the adjacent lane in an attempt to regain control of the vehicle. The driver shifted left and right in response to the steering maneuvers. As the driver steered to the left and braked the right side wheel rims gouged the roadway. At this point the vehicle tipped and began a right side roll. The driver pitched sharply to the right. As the roll continued, the driver pitched back and forth. The driver sustained minor lacerations that were likely from flying glass. He was able to exit the vehicle under his own power.

### **Front right seat occupant kinematics (02)**

The 32-year-old male front right seat occupant was seated in what is presumed to be a normal, upright position in the leather covered bucket seat. The seat track had been adjusted to the mid position. The seat back was slightly reclined. As the driver lost control of the vehicle and overcorrected to the right, the driver continued to steer left and right several times within the asphalt median and the adjacent lane in an attempt to regain control of the vehicle. The driver shifted left and right in response to the steering maneuvers. The vehicle eventually tripped and began a right side roll. The front right occupant pitched sharply to the right. As the roll continued, this occupant pitched back and forth. This movement resulted in a hyperflexion neck fracture. This occupant also likely contact the right A pillar, causing a small forehead contusion and a cerebral hemorrhagic contusion. He also complained of lower back pain. He was unable to extricate himself due to his neck pain and a jammed door. He was extricated by paramedics, transported to a local trauma center, and subsequently hospitalized for two days.

### **Second row left seat occupant kinematics (03)**

The 54-year-old female second row left occupant was seated in what is presumed to be a normal, upright position on the leather covered bench seat. She was wearing the available 3-point lap and shoulder belt. The seat back was fixed at a slight recline. Occupant 4 was seated next to or possibly in front of this occupant. As the driver lost control of the vehicle and overcorrected to the right, the driver continued to steer left and right several times within the asphalt median and the adjacent lane in an attempt to regain control of the vehicle. The driver shifted left and right in response to the steering maneuvers. The vehicle eventually tripped and began a right side roll. The front right occupant pitched sharply to the right. This movement resulted in a neck strain. As the roll continued, this occupant pitched back and forth. At some point during the roll the left side curtain deployed and this occupant's face possibly came into contact with the curtain—causing linear abrasions to the left cheek and left forehead. There were no indications of contact to the air bag. During the rollover, she also likely came into contact with Occupant 4 and possibly the child seat in the middle of the row. She was transported by ground ambulance to a local trauma center. She arrived with a GCS of 15. She complained of pain to her right shoulder

but x-rays were negative for any injury.

#### **Second row left seat occupant kinematics (04)**

The 4-year-old female second row left occupant was seated in the area near Occupant 3. Her posture is not known. She was not wearing a seat belt. As the driver lost control and the vehicle rolled, this occupant appears to have possibly contact the left side door—causing facial contusions on the left side. She also sustained a neck strain which was likely a result of impact forces.

#### **Second row middle seat occupant kinematics (05)**

The 4-month-old male second row middle occupant was lying in a rear facing Graco Snug Ride child safety seat. The seat was anchored to the vehicle but it does not appear that the child was using the 5-point harness. As the driver lost control of the vehicle, the vehicle began a right side leading roll. As the vehicle rolled, this occupant likely came out of his seat. It appears that he remained in the vehicle through much of the rollover until being ejected near the area of final rest. It appears more likely than not that he was ejected through the rear hatch window, based on the final rest of this occupant. He sustained serious injuries. He was transported to a children's pediatric trauma center via air ambulance. Responding paramedics found the child pulse-less and apneic. Paramedics were unable to intubate him in the field. He arrived in the trauma center with assisted respirations and no pulse. Efforts to resuscitated him continued for the next two hours. A CT scan revealed multiple skull base fractures with large areas of subarachnoid bleeding and a loss of grey/white differentiation. His pupils were fixed and dilated and he had no spontaneous respirations. He was extubated at 0110 hours and became asystolic at 0125 hours the following morning and death was pronounced.

#### **Second row right seat occupant kinematics (06)**

The 26-year-old female second row right occupant was seated in what is presumed to be a normal, upright position on the leather covered bench seat. She indicated that she was in an out of sleep just prior to the crash. She was wearing the available 3-point lap and shoulder belt. The seat back was fixed at a slight recline. As the driver lost control and the vehicle rolled, this occupant appears to have possibly contacted the side door—causing right hand wrist and finger fractures. During the roll, this occupant loaded the shoulder belt—causing an abrasion to the right side of the neck. She was transported by air ambulance to a local trauma center

#### **Third row left seat occupant kinematics (07)**

The 27-year-old female third row left right occupant was seated in what is presumed to be a normal, upright position on the leather covered bench seat. She was not wearing the available 3-point lap and shoulder belt. The seat back was fixed at a slight recline. As the driver lost control of the vehicle, the vehicle began a right side leading roll. As the vehicle transitioned from the 4<sup>th</sup> quarter roll to the 5<sup>th</sup>, this occupant was fully ejected through the right rear side glass. She came to rest in the fourth travel lane from the right. She sustained fractures to the left femur, left tibia, left fibula, right arm, and right clavicle. She also sustained kidney and spleen injuries. The majority of the injuries appear to have come from contact with the ground after ejected. She was transported by ground ambulance to a local trauma center.

**Third row middle seat occupant kinematics (08)**

The 1-year-old female third row middle seat occupant was seated in a forward facing Dorel Safety 1<sup>st</sup> child safety seat. The seat had been placed on a leather covered bench seat and was improperly anchored to the vehicle using the available lap and shoulder belt. The seat back was fixed at a slight recline. As the driver lost control of the vehicle, the vehicle began a right side leading roll. As the vehicle rolled, this occupant remained harnessed to the child seat; however, there appears to have been considerable play in the seat belt installation. When the vehicle came to rest, the child seat had rotated to a nearly upside down position. She was not injured. She was found by her father (the front right seat occupant) harnessed to the child seat, however the child seat was essentially upside down.

**Third row right seat occupant kinematics (09)**

The 5-year-old female third row right seat occupant was seated in what is presumed to be a normal, upright position on the leather covered bench seat. She was wearing the available 3-point lap and shoulder belt. The seat back was fixed at a slight recline. As the driver lost control and the vehicle rolled, this occupant appears to have probably contacted the right side panel—sustaining right ulna and right metacarpal fractures. She also likely contacted the child safety seat in the middle seat position with her left side—causing a left humerus fracture. She was transported by ground ambulance to a local pediatric trauma center. She was admitted overnight for observation and released the following day.

# Attachment 1. Scene Diagram

