

Booster Seat Investigation / Vehicle to Vehicle  
Dynamic Science, Inc. / Case Number: DS06027  
1999 Lincoln Navigator  
California  
November 2006

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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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1. Report No. DS06027	2. Government Accession No.		3. Recipient Catalog No.	
4. Title and Subtitle Booster Seat Investigation		5. Report Date May 6, 2007		
		6. Performing Organization Report No.		
7. Author(s) Dynamic Science, Inc.		8. Performing Organization Report No.		
9. Performing Organization name and Address Dynamic Science, Inc. 299 West Cerritos Avenue Anaheim, CA 92805		10. Work Unit No. (TRAI5)		
		11. Contract or Grant no. DTNH22-01-C-27002		
12. Sponsoring Agency Name and Address U.S. Dept. of Transportation (NRD-32) National Highway Traffic Safety Administration 400 7th Street, SW Washington, DC 20590		13. Type of report and period Covered [Report Month, Year]		
		14. Sponsoring Agency Code		
15. Supplemental Notes				
16. Abstract <p>This on-site investigation focused on a booster seat that was installed in the center rear position of a 1999 Lincoln Navigator. The Navigator was occupied by a 31-year-old female restrained driver and a 5-year-old female, restrained in the booster seat. The backless booster seat was being used in conjunction with the vehicle's manual lap belt. This booster seat is designed to work only with the lap and shoulder belts. The Navigator was struck on the left side by a 1995 Ford Club Wagon. The impact resulted in sufficient longitudinal deceleration of the Navigator to command the deployment of the frontal air bags. The Club Wagon was deflected laterally across the intersection and struck a stop light pole. The driver of the Navigator sustained a facial contusion and a neck strain. She was transported to a local hospital where she was treated and released. The 5-year-old child sustained serious neck injuries. She was found to be unresponsive by the driver and a witness. One of the witnesses began administering CPR to the child. She was transported to a local hospital. She was later transferred by air to an area trauma center.</p>				
17. Key Words Booster seat, side impact, frontal air bags, deployment, passenger, serious injury		18. Distribution Statement		
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price	

**Dynamic Science, Inc.**  
**Crash Investigation**  
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## BACKGROUND

This on-site investigation focused on a booster seat that was installed in the center rear position of a 1999 Lincoln Navigator. The Navigator (see Figure 1) was occupied by a 31-year-old female restrained driver and a 5-year-old female, restrained in the booster seat. The backless booster seat was being used in conjunction with the vehicle's manual lap belt. This booster seat is designed to work only with the lap and shoulder belts. The Navigator was struck on the left side by a 1995 Ford Club Wagon. The impact resulted in sufficient longitudinal deceleration of the Navigator to command the deployment of the frontal air bags. The Club Wagon was deflected laterally across the intersection and struck a stop light pole. The driver of the Navigator sustained a facial contusion and a neck strain. She was transported to a local hospital where she was treated and released. The 5-year-old child sustained serious neck injuries. She was found to be unresponsive by the driver and a witness. One of the witnesses began administering CPR to the child. She was transported to a local hospital. She was later transferred by air to an area trauma center.



**Figure 1.** 1999 Lincoln Navigator

This Child Safety Seat case was identified by NHTSA through an on-line news article. DSI was instructed to locate the vehicle and child seat. DSI located the vehicle and obtained permission for inspection on December 7, 2006. DSI was assigned the case on December 8, 2006. The inspections took place on December 13-14, 2006.

## SUMMARY

### Crash Site

This two vehicle crash occurred in November 2006 at 1122 hours in an urban area of California. At the time of the crash, it was raining and the asphalt roadway was wet. The crash occurred within the confines of a four-leg intersection. The northwestern leg of the intersection was comprised of a southeastbound travel lane, a left turn lane, and a northwestbound travel lane. The turn lane is separated from the travel lane by double yellow lines. The southwest leg of the intersection was comprised of a southwestbound travel lane, a left turn lane, and a combination right turn lane/northeastbound through lane. The intersection is controlled by tri-color traffic



**Figure 2.** Approach to area of impact (northeast)

signals. The posted speed limit for the northwest / southeast roadway was 72 km/h (45 mph) and the posted speed limit for the southwest /northeast roadway was 40 km/h (25 mph).

### Pre-Crash

The case vehicle is a 1999 Lincoln Navigator driven by a 31-year-old female. There was a 5-year-old female occupant seated in the third row middle seat position and was restrained in an Evenflo Big Kid booster seat. It has been reported that the female driver of the Navigator was talking on a cell phone prior to the crash. The driver had just picked up the child occupant from a nearby elementary school. The other vehicle is a 1995 Ford Club Wagon driven by an 82-year-old male. This driver is hearing impaired.

The case vehicle was traveling eastbound approaching the four-leg intersection (see Figure 2). The driver of the case vehicle may have stopped at the intersection for some time and then rolled into the intersection. The other vehicle was traveling southbound (see Figure 3).

### Crash

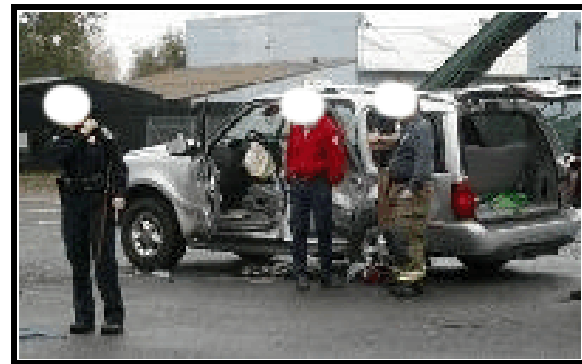
As the case vehicle entered the intersection it was struck on the left side by the other vehicle. The impact was moderate and result in the deployment of the frontal air bag system in the Navigator. The missing vehicle algorithm of the WinSmash program computed a total delta V of 13.0 km/h (8.1 mph). The longitudinal and lateral components were -8.4 km/h (-5.2 mph) and 10.0 km/h (6.2 mph), respectively. The results appear borderline and low. The case vehicle rotated sharply in a counterclockwise direction and came to rest facing east in the intersection (see Figure 4). The other vehicle continued in a southeast direction and struck a traffic signal pole in the southeast corner of the intersection.

### Post-Crash

The 31-year-old driver of the Navigator sustained a facial contusion and a neck strain. She was transported to a local hospital where she was treated and released. The 5-year-old rear seat occupant sustained an atlanto-axial fracture dislocation with a spinal cord injury and a deep laceration to the upper eye lid that went all the way to the bone. She also sustained bilateral hip abrasions. She was found to be unresponsive by the driver and a witness. One of the witnesses began administering CPR to the child shortly after the crash. It appears that the child was moved from the third row seat to the cargo area of the SUV. She arrived at an area hospital with an EMS reported Glasgow Coma Scale (GCS) score of 4. Upon arrival at the hospital she was



**Figure 3.** Approach to area of impact (southeast)



**Figure 4.** 1999 Lincoln Navigator at final rest (looking south)

intubated and paralyzed and the GCS score was indeterminable.

She was later transferred by air to an area trauma center. A chronology of the transfer is shown below:

Flight dispatched:	1518
Flight arrived:	1518
Flight departed:	1529
Flight arrived:	1611

The driver of the other vehicle sustained minor injuries. He was transported to a local hospital where he was treated and released.

## VEHICLE DATA -1999 Lincoln Navigator

The 1999 Lincoln Navigator was identified by the Vehicle Identification Number (VIN): 5LMPU28A9XLJxxxxxx. The Navigator was a four-door seven-passenger sport utility vehicle that was equipped with a 5.4 liter V8 engine, four-wheel drive, an automatic transmission, front/rear disc brakes with ABS, power steering, and a tilt steering wheel. The Navigator was configured with Wildcat Radial A/T LT265/70R17 tires. The tire manufacturer's recommended tire pressure was 345 kPa (50 psi). The specific tire information is as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	241 kPa (35 psi)	6 mm (7/32 in)	None	None
RF	262 kPa (38 psi)	6 mm (7/32 in)	None	None
LR	Flat	12 mm (15/32 in)	None	Debeaded
RR	303 kPa (44 psi)	10 mm (12/32 in)	None	None

The seating in the Lincoln Navigator was configured with leather covered front bucket seats with adjustable head restraints, two second row leather covered bucket seats, and a third row leather covered bench seat. The driver's seat was located 28.0 cm (11.0 in) rearward of the A pillar, the seat back was slightly reclined, and the head restraint was in the full down position. The front right passenger's seat was located 33.0 cm (13.0 in) rearward of the A pillar, the seat back was slightly reclined, and the head restraint was in the full down position. The second row left seat and third row left seat were each deformed by the lateral intrusion into the vehicle.

## VEHICLE DAMAGE

### Exterior Damage - 1999 Lincoln Navigator

The 1999 Lincoln Navigator sustained moderate left side damage as a result of the impact with the Ford Club Wagon (see Figure 5). The direct damage began 74.0 cm (29.1 in) rear of the left rear axle and extended 221.0 cm (87.0 in) forward along the left side plane. The maximum lateral crush was located at C4, at the sill level, and measured 30.0 cm (11.8 in). The left front door remained closed after the crash, but was forced open during extrication. The left rear door was jammed shut. The right side doors and the tailgate remained closed and operational. The combined direct and induced damage began 74.0 cm (29.1 in) rear of the left rear axle and extended forward



**Figure 5.** Left side damage, 1999 Lincoln Navigator



310.0 cm (122.0 in) along the left side plane. The glazing for the second row left window, third row left window, and tailgate disintegrated. The upper door frame for the left rear door was displaced laterally outward 18.0 cm (7.1 in). This formed a gap beginning at the base of the C pillar and ending at the top of the B pillar (see Figure 6). Six crush measurements were documented at the mid-door level as follows: C1 = 0 cm (0 in), C2 = 9.0 cm (3.5 in), C3 = 24.0 cm (9.4 in), C4 = 28.0 cm (11.0 in), C5 = 5.0 cm (2.0 in), C6 = 0 cm (0 in). Measurements were also documented at the sill level for C3, measuring 37.0 cm (14.6 in), and for C4, measuring 30.0 cm (11.8 in).



**Figure 6.** Gap at second row left door

CDC:	10LPEW3	
Delta V:	Total	13.0 km/h (8.1 mph)
	Longitudinal	-8.4 km/h (-5.2 mph)
	Latitudinal	10.0 km/h (6.2 mph)
	Energy	41402 joules (30537 ft lbs)

### Interior Damage - 1999 Lincoln Navigator

The 1999 Lincoln Navigator sustained moderate interior damage as a result of passenger compartment intrusion (see Figure 7). The left B pillar, left side door, left side panel, and left sill sustained lateral intrusion. As a result of the lateral intrusion, the second row left and third row left seats were compressed. The specific passenger compartment intrusions were documented as follows:

Position	Intruded Component	Magnitude of Intrusion	Direction
Left front	B pillar	8.0 cm (3.1 in)	Lateral
2 <sup>nd</sup> row left	Door	11.0 cm (4.3 in)	Lateral
2 <sup>nd</sup> row left	B pillar	8.0 cm (3.1 in)	Lateral
2 <sup>nd</sup> row left	Sill	6.0 cm (2.4 in)	Lateral
3 <sup>rd</sup> row left	Side panel	5.0 cm (2.0 in)	Lateral

There were indications of loading to the middle third row lap belt. The left side panel was cracked due to intrusion. There was blood found on the side panel and in the third row left seating area.



**Figure 7.** B pillar and left rear door intrusion

### Manual Restraints - 1999 Lincoln Navigator

The 1999 Lincoln Navigator was configured with manual 3-point lap and shoulder belts for all six outboard seating positions. Both front seat safety belts were equipped with adjustable D rings that were in the full down positions. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR).

The remaining outboard safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR).

The third row center lap belt was being used with a backless booster seat. The belt was configured with a locking latch plate. There were indications of loading to the belt webbing (see Figure 8). The distance from the base of the webbing to the latch was 34.0 cm (13.4 in). A lateral marking was located 14.0 cm (5.5 in) from the latch and was between 3.0-4.0 cm (1.2-1.6 in) wide.



**Figure 8.** Third row middle lap belt

## Booster Seat

### Evenflo Big Kid Booster Seat

An Evenflo Big Kid Booster Seat was positioned in the middle seat of the third row of the Lincoln Navigator. The model number was 3341472A and the date of manufacture was March 26, 2005. See Figures 9-10.

The manufacturer's recommended usage of this seat as stated in the user's manual is as follows:

With backrest:

- 13.6-45.3 kg (30-100 lbs)
- Less than 145 cm (57 in) tall
- Child is at least one year old or older

Without backrest:

- 18-45.3 kg (40-100 lbs)
- Less than 145 cm (57 in) tall
- Child is at least one year old or older
- Ears below top of vehicle seat back

The manual further states that: "When using this booster seat, NEVER use a lap belt only (see Figure 11). You MUST use vehicle seat belts that have a lap/shoulder combination."

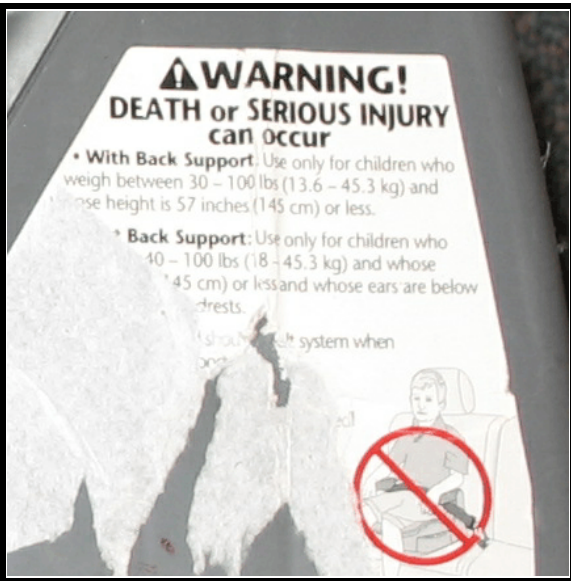
The booster seat was being used without the backrest in the third row middle seat position. The middle seat lap belt was being used at the time of the crash (see Figure 12).



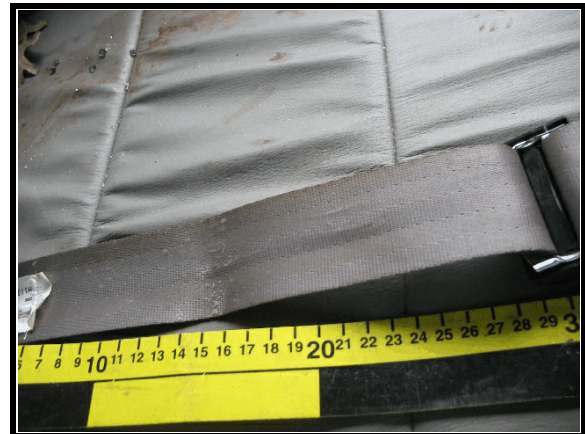
**Figure 9.** Front, Evenflo booster seat



**Figure 10.** Left side, Evenflo booster seat



**Figure 11.** LAP BELT ONLY warning label found on booster seat



**Figure 12.** Load marks on lap belt

## Supplemental Restraint Systems - 1999 Lincoln Navigator

The 1999 Lincoln Navigator was equipped with frontal air bags for the driver and front right passenger positions. The frontal air bags deployed as a result of the longitudinal deceleration of the Navigator during the impact with the Ford Club Wagon.

The driver's air bag deployed from the center of the steering wheel hub through H-configuration module cover flaps (see Figures 13-15). The top flap measured 12.0 cm (4.7 in) in height and 19.0 cm (7.5 in) in width. The bottom flap measured 4.0 cm (1.6 in) in height and 19.0 cm (7.5 in) in width. The deployed driver's air bag measured 59.0 cm (23.2 in) in its deflated state. The air bag was tethered by a single internal strap. The tether was attached to circular stitching in the center of the air bag face. Two circular vent ports were located at the 11 and 1 o'clock aspects on the rear of the air bag. There were eight vertical folds across the air bag face. There was a 12.0 cm (4.7 in) wide by 11.0 cm (4.3 in) high pattern of make up and lip stick transfers immediately below the center stitching (see Figure 13). There was a small accumulation of melted plastic found on the top surface of the air bag near the inflator at the base of the top module cover (see Figure 15).



**Figure 13.** Front of driver's air bag



**Figure 14.** Driver's air bag, showing vent ports and top module cover

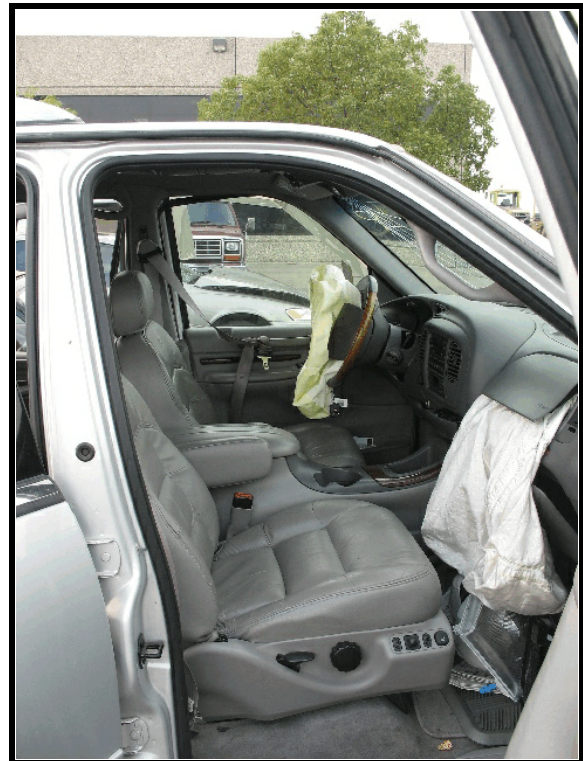


**Figure 15.** Melted plastic near inflator

The front right passenger's air bag deployed from a mid mount module with a rectangular cover flap that was hinged at the forward aspect (see Figures 16-17). The module cover flap measured 39.0 cm (15.4 in) in width and 17.0 cm (6.7 in) in height. The deployed front right passenger air bag measured 60.0 cm (23.6 in) seam to seam and was 71.0 cm (27.9 in) high. There were no vent ports or tethers. There was no damage to the air bag or the module cover.



**Figure 16.** Front right passenger air bag face



**Figure 17.** Side view of front right passenger air bag and module cover

**VEHICLE DATA - 1995 Ford Club Wagon**

Description:	1995 Ford Club Wagon	
VIN:	Unknown	
Odometer:	Unknown	
Engine:	Unknown	
Reported Defects:	None noted	
Cargo:	Unknown	
Damage Description:	Moderate frontal damage	
CDC:	Unknown	
Delta V:	Total	13.0 km/h (8.1 mph)
	Longitudinal	-12.8 km/h (-8.0 mph)
	Latitudinal	-2.3 km/h (-1.4 mph)
	Energy	8819 joules (6505 ft lbs)



**OCCUPANT DEMOGRAPHICS - 1999 Lincoln Navigator**

	Driver	Occupant 2
Age/Sex:	31/Female	5/Female
Seated Position:	Front left	Third row middle
Seat Type:	Bucket	Bench
Height:	173 cm (68 in)	Unknown
Weight:	66 kg (145 lbs)	Unknown
Occupation:	Unknown	NA
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	NA
Driving Experience:	Unknown	NA
Body Posture:	Normal, upright	Presumed to be normal, upright in booster seat
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap belt used
Air bag:	Steering wheel mounted frontal air bag, deployed	None

**OCCUPANT INJURIES - 1999 Lincoln Navigator**

Driver: Injuries obtained from emergency room records.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Abrasion, face, right cheek	290202.1,1	Air bag	Certain
Abrasion, face, chin	290202.1,8	Air bag	Certain
Neck pain, left side	Not coded		

Third row middle occupant: Injuries obtained from EMS records, ER records, Post-ER Medical Records and Radiology reports.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Lacerations (2), left eyelid extending to eyebrow, each 6.0 cm in length and extending to bone	297602.1,2	Window frame	Probable
Abrasion, right hip	590202.1,1	Seat belt webbing	Certain
Abrasion, left hip	590202.1,2	Seat belt webbing	Certain
Fracture, odontoid (dens, with dislocation of C1 and C2	650228.3,6	Window frame (in direct)	Probable

## OCCUPANT KINEMATICS - 1999 Lincoln Navigator

### Driver Kinematics

The 31-year-old female driver was seated in an upright posture and was restrained by the 3-point manual lap and shoulder belt. She was apparently using a cell phone at the time of the crash. Her right foot was on the accelerator with the left presumably on the floor. The seat track was in the middle position and the head restraint was in the down position. At impact, the frontal air bags deployed. The female driver initiated a lateral and slightly forward trajectory to the left. The driver contacted the air bag with her face, causing a minor contusion. She also sustained a neck strain. She was able to exit the vehicle under her own power. She was transported to a local hospital where she was treated and released.



**Figure 18.** Lipstick/makeup contact to air bag face

### Third Row Middle Occupant Kinematics

The 5-year-old female child was restrained in the booster seat by the manual lap belt. The booster seat was installed in the third row middle seat position. This booster seat was not designed to be used with a lap belt. At impact, the child initiated a lateral and slightly forward trajectory to the left. She loaded the lap belt and likely flexed over the belt to the left and struck the side panel with the left side of her face. She sustained a deep laceration to the upper eye lid that went all the way to the bone. As her head struck the panel, her torso continued moving causing an atlanto-axial fracture dislocation with a spinal cord injury. Given an estimated seated height of 59.8 cm<sup>1</sup> (23.5 in), and the mid seat position to side panel distance of 62.5 cm (24.6in), it appears that the child likely struck the side panel while still in the confines of the lap belt.



**Figure 19.** Left side panel/third row

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<sup>1</sup>50<sup>th</sup> percentile 4.5-5.5 year old female, “Anthropometry of Infants, Child, and Youths to Age 18 for Product Safety Design”

She was found lying against the side panel immediately after the crash. It is not known if the booster seat moved. She was found to be unconscious and unresponsive by the driver and a witness. She was moved, apparently by the witness, to the rear cargo area where CPR was initiated. She was transported by ground ambulance to a local hospital and later transferred by air to a trauma center.



**Figure 20.** Overview of middle and left third row seat positions

**Attachment 1. Scene Diagram**

