

On Site Infant Safety Seat Investigation / Vehicle to Vehicle  
Dynamic Science, Inc. / Case Number: DS03032  
1994 Ford Explorer  
North Dakota  
August, 2003

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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 crash-worthiness performance of the involved vehicle(s) or their safety systems.*

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16. Abstract <p>This two vehicle crash occurred in August, 2003 at 1755 hours. The crash occurred on a gravel covered two lane county roadway. There are grass covered ditches on both sides of the roadway. The roadway was dry and the weather clear. The speed limit is 89 km/h (55 mph). The case vehicle is a 1994 Ford Explorer XL 4x4 four-door utility vehicle. The vehicle was being driven by a restrained 15-year-old male who was driving without a license. There were three additional occupants. The front right seat was occupied by a restrained 15-year-old female. The rear middle seat was occupied by a six-month-old male in an infant safety seat. The seat had not been anchored to the vehicle. The rear right seat was occupied by an unrestrained 19-year-old female. The other vehicle was a 1990 Freightliner heavy truck. This vehicle was being driven by a 40-year-old male.</p> <p>The case vehicle was traveling southbound. The other vehicle was traveling northbound. The driver of the case vehicle moved his vehicle too far to the right and entered a ditch. He steered back to the left and lost control of the vehicle. The vehicle went into a counterclockwise rotation and slid into the center of the roadway. The case vehicle was struck in the right side by the front of the other vehicle. The case vehicle rotated in a clockwise direction and came to rest near the east ditch facing southwest. The other vehicle slid a short distance before coming to rest facing northwest. During the rotation of the case vehicle, the two rear seat occupants were ejected. The 19-year-old occupant was fatally injured. The infant remained in the infant seat during its ejection and sustained only minor injuries.</p>				
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**Dynamic Science, Inc.**  
**Crash Investigation**  
**Case Number: DS03032**

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## BACKGROUND:

**Description:** This Infant Safety Seat case was initially identified by the Fatality Analysis Reporting System (FARS). DSI was notified on October 9, 2003 with instructions to determine if both the case vehicle and the child safety seats would be available for inspection. On October 9, 2003, DSI spoke with the mother of the decedent and located the case vehicle. The child safety seat was removed by the investigating police agency and was in their control. Permission was given to inspect the vehicle. This was an on-scene investigation. Field work was completed on October 14, 2003.

**Investigation Type:** Infant Safety Seat  
**Crash Location:** North Dakota  
**Crash Date:** August, 2003  
**Notification Date:** October 9, 2003  
**Field Work Completed:** October 14, 2003

## SUMMARY

### Crash Site

This two vehicle crash occurred in August, 2003 at 1755 hours. The crash occurred on a level gravel covered two lane county roadway. There are grass covered ditches on both sides of the roadway. The roadway was dry and the weather clear. The speed limit is 89 km/h (55 mph).

### Pre-Crash

The case vehicle is a 1994 Ford Explorer XL 4x4 four-door utility vehicle. The vehicle was being driven by a restrained 15-year-old male who was driving without a license.

There were three additional occupants. The front right seat was occupied by a restrained 15-year-old female. The rear middle seat was occupied by a six-month-old male in a Cosco Arriva (model number 22-002-JAS) infant safety seat. The seat had not been anchored to the vehicle.



**Figure 1.** Final rest, case vehicle (looking north)

Both rear outboard seats were equipped with locking clips that had been incorrectly installed. The rear right seat was occupied by an unrestrained 19-year-old female.

The other vehicle was a 1990 Freightliner heavy truck. This vehicle was being driven by a 40-year-old male.

The case vehicle was traveling southbound at a driver estimated speed of 80 km/h (50 mph). He indicated that he had slowed to 64 km/h (40 mph) and begun to move to the right in order to let the other vehicle go by. The other vehicle was traveling northbound at a driver estimated speed of 72-80 km/h (45-50 mph).

The driver of the case vehicle moved his vehicle too far to the right and entered a ditch. He steered back to the left and lost control of the vehicle. The vehicle went into a counterclockwise rotation and slid into the center of the roadway.

### Crash

The case vehicle was struck in the right side (03RZAW03) by the front of the other vehicle (12FDEW01). The total velocity change calculated by the Barrier algorithm of the WINSMASH collision model was 35.0 km/h (21.7 mph). The longitudinal and lateral delta V components were  $-6.1$  km/h ( $-3.8$  mph) and  $-34.5$  km/h ( $-21.4$  mph), respectively.

The case vehicle rotated in a clockwise direction and came to rest near the east ditch facing southwest. The other vehicle slid a short distance before coming to rest facing northwest.



**Figure 2.** Final rest for both vehicles (looking south)



**Figure 3.** Right side, case vehicle



**Figure 4.** Right rear, case vehicle

## Post-Crash

The driver of the case vehicle sustained a laceration above his right eye, a contusion to the right hip, and a contusion to the left leg. He was transported by ground ambulance to a local hospital. He arrived with a Glasgow Coma Severity Scale score (GCS) of 15 at 1829 hours. He was treated and then released at 1910 hours.

The front right occupant of the case vehicle sustained lumbar fractures, an abrasion to the right elbow and “blunt thoracoabdominal trauma”. She was extricated from the vehicle by emergency personnel and transported by ground ambulance to a local hospital. She was later transported to a second hospital where she arrived with a GCS score of 15 at approximately 1930 hours. She was admitted and was hospitalized for three days.

The rear middle seat occupant was ejected through the rear window during the clockwise vehicle rotation. He remained harnessed to the infant seat. His final rest position was in the eastern ditch that paralleled the roadway. He sustained a minor facial contusion on the left side of the upper lip, edema on the left lower side of the lower jaw, forehead abrasions, and multiple minor puncture wounds. He was transported by ground ambulance to a local hospital and arrived at 1830 hours. He was hospitalized overnight as a precaution.



Figure 5. Front, other vehicle



Figure 6. Front seating area

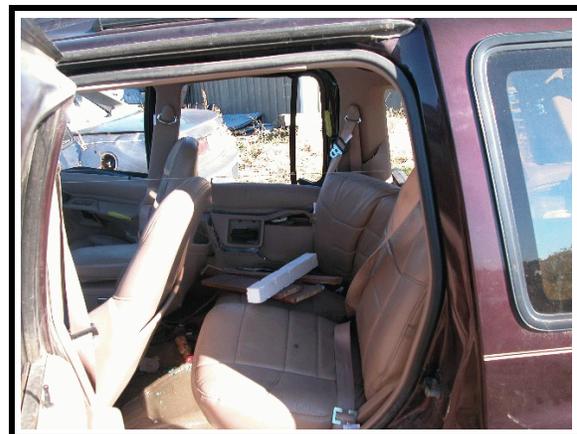


Figure 7. Rear seating area

The rear right seat occupant was ejected through the rear window during the clockwise vehicle rotation. She came to rest on the east side of the roadway. She was fatally injured. She sustained a spinal cord transection, pneumothorax, a mediastinum contusion, and a facial contusion. She died while at the scene. According to the death certificate, she died at 1821 hours. An autopsy was not performed.

The driver of the other vehicle was not injured.

The case vehicle sustained heavy damage to the right side and all four tires were flattened. The case vehicle was towed due to damage and placed on a police hold. The other vehicle sustained minor damage to the bumper, grille, and hood. It was driven from the scene.

The owner of the case vehicle has been charged with permitting a vehicle to be driven without insurance and permitting an unlicensed minor to drive.



**Figure 8.** Overview of right side interior intrusion



**Figure 9.** Cosco Arriva infant safety seat

**VEHICLE DATA - 1994 Ford Explorer XL 4x4 four door sport utility vehicle**

The case vehicle is a 1994 Ford Explorer XL 4x4 Eddie Bauer edition four door sport utility vehicle. The vehicle was equipped with a 4.0 liter, V6 engine, an automatic transmission, and power steering.

VIN: 1FMDU34X5RUDXXXXX  
 Odometer: 209,594 km (130,236 miles)  
 Engine: 4.0 L, V6  
 Reported Defects: None related to this crash  
 Cargo: Pieces of wood, car seat < 45 kg (100 lbs)

The 1994 Ford Explorer was equipped with Uniroyal Laredo P235/75R15 tires. The specific tire data is as follows:

<b>Tire</b>	<b>Tread</b>	<b>Pressure</b>	<b>Manufacturer Recommended Maximum Pressure</b>
LF	4.7 mm (6/32 in)	Flat	179.0 kpa (26.0 psi)
LR	2.3 mm (3/32 in)	Flat	179.0 kpa (26.0 psi)
RF	4.7 mm (6/32 in)	Flat	179.0 kpa (26.0 psi)
RR	2.3 mm (3/32 in)	Flat	179.0 kpa (26.0 psi)

The front seating positions in the 1994 Ford Explorer were configured with leather covered bucket seat with integral head restraints. The left front seat was adjusted to between the forward most and middle track position. The front right was adjusted to the middle track position. Both seats were slightly reclined. The rear seating positions were configured with bench seats that could be folded back to make room for cargo. The seats were, by design, slightly reclined to the rear.

## VEHICLE DAMAGE

### Exterior Damage - 1994 Ford Explorer

Damage Description:	Major right side damage. Right side doors jammed shut. Tailgate jammed shut. Right side and rear side glass disintegrated. The right rear tire was broken off.	
CDC:	03RZAW03	
Delta V <sup>1</sup> :	Total	35.0 km/h (21.7 mph)
	Longitudinal	-6.1 km/h (-3.8 mph)
	Latitudinal	-34.5 km/h (-21.4 mph)
	Energy	90,122 joules (66,471 ft lbs)

The case vehicle sustained 267.0 cm (105.1 in) of direct contact damage that began 81 cm (31.8 in) rear of the front axle. The residual crush measured above the sill was as follows: C1=0 cm (0 in), C2=48.0 cm (18.9 in), C3=46.0 cm (18.1 in), C4=45.0 cm (17.7 in), C5=13.0 cm (5.1 in), C6=0 cm (0 in). The maximum crush was 48.0 cm (18.9 in) and was located at C2. The principle direction of force was within the 9 o'clock sector and was an estimated 80 degrees. There was intrusion along the entire right side.



Figure 10. Right side, case vehicle

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<sup>1</sup>Calculated using WinSmash version 2.32, barrier option. WinSmash run violates vehicle beyond scope criteria but is provided for informational purposes.

## Interior Damage - 1994 Ford Explorer

Interior damage to the Explorer was major and attributed to occupant contacts and passenger compartment intrusion. The windshield was fractured from impact forces. All the right side windows were disintegrated from impact forces. The sun roof was disintegrated from impact forces. The right front door, right rear door, and rear hatchback were jammed shut. There was intrusion to the right front B pillar, right front door, right roof rail, right sill, and the right C pillar. The maximum intrusion was to the right rear door and measured 33.0 cm (12.9 in). There was loading to the right front door arm rest from the right front occupant. There were contacts (scuffing) to the right rear door and C pillar. There were a variety of longitudinal scuffs along both sides of the interior roof. The left side marks appear to be related to the ejection of the middle occupant while those on the right appear to be related to the ejection of the right rear occupant.



Figure 11. Interior view (from moon roof)

## MANUAL RESTRAINT SYSTEMS - 1994 Ford Explorer

The 1994 Ford Explorer was configured with manual 3-point lap and shoulder belts with sliding latch plates for both front positions and the rear outboard positions. There were no anchorage adjustments available for the shoulder belts. A 2-point lap belt with a sewn on latch plate was present for the rear center position. The front and rear outboard seats were configured with emergency locking retractors (ELRs). The driver and front right seat belt were in use at the time of the crash. The front right occupant seat belt was cut off the occupant by EMS personnel.

Both rear outboard seats were equipped with locking clips that had been incorrectly installed. Neither seat belt was being used at the time of the crash.

Both rear outboard seats were equipped with emergency locking retractors. A locking clip had been incorrectly installed for both seat locations. The clip was installed on the lap portion of the belt but was not secured to the shoulder portion. The clip would have had no effect as it was installed.

## INFANT SAFETY SEAT - 1994 Ford Explorer

The Cosco Arriva (model number 22-002-JAS) infant safety seat was manufactured on 11/06/02. The manufacturer recommends that it be used rear-facing only and would be appropriate only for those infants weighing less than 10 kg (22 lbs) and with a height less than 74 cm (29 in). It can be purchased with or without a base. In this case, a base was not being used. It was equipped with a 3-point harness. The harness had been routed through the lower set of slots and was in use at the time of the crash. The seat is designed to be secured to the vehicle by using either a lap belt or a lap and shoulder belt. In this case, the seat was not anchored to the case vehicle. The seat was also equipped with lower LATCH connectors which were not used during this crash.



Figure 12. Cosco infant seat



Figure 13. Vehicle seat belt routing (lap belt position)

**VEHICLE DATA - other vehicle**

Description:	1990 Freightliner	
VIN:	Unknown	
Odometer:	Unknown	
Engine:	Unknown	
Reported Defects:	None	
Cargo:	Grain, unknown weight	
Damage Description:	Minor damage to bumper and grille. Vehicle driven from scene.	
Truck Deformation Classification:	12FDEW1	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown



Figure 14. Front, other vehicle

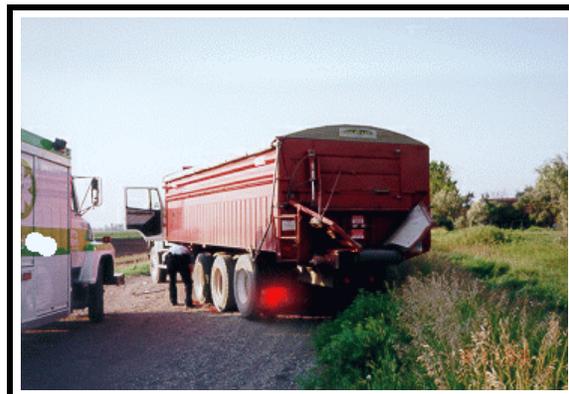


Figure 15. Left rear, other vehicle

**OCCUPANT DEMOGRAPHICS - 1994 Ford Explorer**

	Occupant 1	Occupant 2
Age/Sex:	15/Male	15/Female
Seated Position:	Front left	Front right
Seat Type:	Leather covered bucket seat.	Leather covered bucket seat.
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	None	None
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	NA
Driving Experience:	Presumed to be under one year.	NA
Body Posture:	Presumed to be in a normal, upright position. Pitched to right in response to counterclockwise vehicle rotation.	Presumed to be in a normal, upright position. Pitched to right in response to counterclockwise vehicle rotation.
Hand Position:	Unknown. Actively steering vehicle to the left.	Unknown.
Foot Position:	Right foot likely on brake	Unknown, presumed to be on the floor
Restraint Usage:	Lap and shoulder belt available, used.	Lap and shoulder belt available, used.
Air bag:	Not available.	Not available.

**OCCUPANT DEMOGRAPHICS - 1994 Ford Explorer**

	Occupant 3	Occupant 4
Age/Sex:	6 months/Male	19/Female
Seated Position:	Rear middle	Rear right
Seat Type:	Leather covered bench seat with folding back. Seat back slightly reclined by design.	Leather covered bench seat with folding back. Seat back slightly reclined by design.
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	NA	Unknown
Pre-existing Medical Condition:	None noted	Obesity
Alcohol/Drug Involvement:	NA	NA
Driving Experience:	NA	NA
Body Posture:	Presumed to be in normal supine position in infant seat.	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap belt available to anchor infant seat, not used	Lap and shoulder belt available, not used
Air bag:	NA	NA

**OCCUPANT DEMOGRAPHICS - other vehicle**

Age/Sex:	40/Male
Seated Position:	Front left
Seat Type:	Unknown
Height:	Unknown
Weight:	Unknown
Occupation:	Truck driver
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Presumed to be > 10 years
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Right foot presumed to be on brake, left on floor
Restraint Usage:	None used, per police report

**OCCUPANT INJURIES -1994 Ford Explorer**

	<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Driver:	Laceration, right upper eyelid, 4.0 cm (1.6 in)	290602.1,1	Unknown, possibly the front right occupant	Unknown
	Contusion, right hip	890402.1,1	Lap belt	Certain
	Contusion, left leg	890402.1,2	Unknown	Unknown
Front right occupant:	L2/L3 fracture	650616.2,8	Door side panel	Certain
	Abrasion, right elbow	790202.1,1	Door side panel	Certain
	Blunt abdominal trauma	515099.7	Door side panel	Certain
Rear middle occupant:	Contusion, left side of upper lip	290402.1,8	Unknown	Unknown
	Edema, left lower side of lower jaw	290402.1,8	Interior of child seat	Possible
	Abrasion, forehead	290202.1,7	Unknown	Unknown
	Multiple puncture wounds to head	290602.1,0	Glass fragments	Probable
	Contusion, right clavicle	790402.1,1	Child seat harness	Probable
Rear right occupant:	Spinal cord transection	640640.5,8 <sup>2</sup>	Unknown	Unknown
	Mediastinum contusion, with pneumothorax	442202.3,9	Door side panel	Possible
	Facial contusion	290402.1,9	Unknown	Unknown

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<sup>2</sup>Coded to lumbar spine

**OCCUPANT INJURIES - other vehicle**

	<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Driver:	Not injured			

## OCCUPANT KINEMATICS - 1994 Ford Explorer

The 15-year-old male driver of the case vehicle was likely seated in a normal, upright fashion. The leather covered bucket seat was adjusted to between the forward most and middle track position. The seat back was slightly reclined. He was wearing the available lap and shoulder belt. There was no upper anchorage adjustment for the shoulder belt. Prior to impact, the driver had steered the case vehicle sharply to left and the vehicle was in a counterclockwise rotation with the right side leading. Both hands were likely on the steering wheel and the driver was likely pitched slightly to the right due to rotation. At impact, he responded to the 80 degree direction of force by moving to the right before being held in place by the restraint system. He sustained a contusion to the right hip while loading the lap belt. He also sustained a laceration above his right eye that may have been as a result of contact with the front right occupant and a left leg contusion from an unknown source. He was able to exit the vehicle on his own.

The 15-year-old female front right occupant of the case vehicle was likely seated in a normal, upright fashion. The leather covered bucket seat was adjusted to the middle track position. The seat back was slightly reclined. She was wearing the available lap and shoulder belt. There was no upper anchorage adjustment for the shoulder belt. Prior to impact, the driver had steered the case vehicle sharply to left and the vehicle was in a counterclockwise rotation with the right side leading. At impact, she responded to the 80 degree direction of force by moving to the right before engaging the front right door panel with her right side. This contact resulted in several lumbar fractures, an abrasion to the right elbow and “blunt thoracoabdominal trauma”. She was extricated from the vehicle by emergency personnel and transported by ground ambulance to a local hospital. She was admitted and was hospitalized for three days.



Figure 16. Overview of right rear seat area

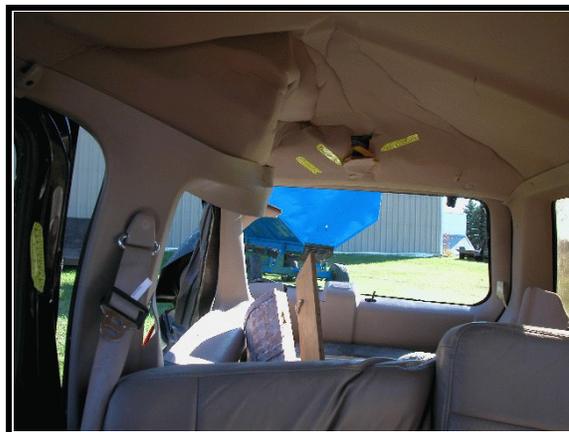


Figure 17. Right rear seat area/door contact



Figure 18. Ejection path towards backlight

The 6-month-old male rear seat middle occupant was seated in a Cosco Arriva (model number 22-002-JAS) infant safety seat. The seat was being used in a rear facing fashion and was not anchored to the vehicle. The child appears to have been properly harnessed to the safety seat. The seat had been placed on the leather covered bench seat with folding back. The seat back was slightly reclined by design. Prior to impact, the driver had steered the case vehicle sharply to the left and the vehicle was in a counterclockwise rotation with the right side leading. At impact, the infant seat responded to the 80 degree direction of force by moving to the right and likely engaged the right rear occupant to some extent. The case vehicle was pushed into a sharp clockwise rotation by the striking vehicle. The infant seat slid up the right side of the vehicle and responded to the centrifugal forces by sliding along the roof towards the backlight. The backlight glass had likely already disintegrated by the time the infant seat reached it. The infant seat was ejected through the backlight during the spinning rotation and came to rest along the east roadway edge. The child sustained a minor facial contusion on the left side of the upper lip, edema on the left lower side of the lower jaw, a clavicle contusion, forehead abrasions, and multiple minor puncture wounds. The puncture wounds would appear to be related to flying glass fragments. The clavicle contusions was likely related to interaction with the child seat harness. The sources of the remaining injuries are essentially unknown, given the impact and the post-impact ejection. The child was transported by ground ambulance to a local hospital and arrived at 1830 hours. He was hospitalized overnight as a precaution.

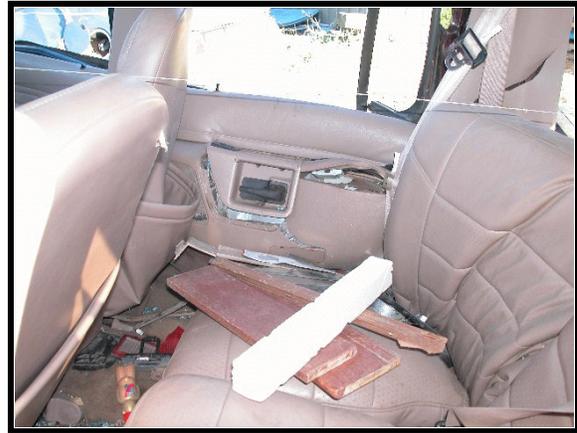


**Figure 19.** Overview of hatch area/likely ejection area



**Figure 20.** Marks along roof from ejected occupants

The 19-year-old female rear seat right occupant was seated on the leather covered bench seat with folding back. The seat back was slightly reclined by design. Prior to impact, the driver had steered the case vehicle sharply to left and the vehicle was in a counterclockwise rotation with the right side leading. At impact, the rear right occupant responded to the 80 degree direction of force by moving to the right and engaged the right rear door with her torso—causing the thoracic injuries. This occupant also sustained a spinal cord transection. She also likely contacted the C pillar/side glass frame area—possibly causing the facial contusion. According to the non-invasive death certificate, this occupant sustained a spinal cord transection. The location of the transection is not known. The injury mechanism for this injury is not known. The case vehicle was pushed into a sharp clockwise rotation by the striking vehicle. This occupant slid up the right side of the vehicle and responded to the centrifugal forces by sliding along the roof towards the backlight. The backlight glass had likely already disintegrated by the time she reached it. This occupant was ejected through the backlight during the spinning rotation and came to rest along the east roadway edge. She was fatally injured.



**Figure 21.** Right rear door



**Figure 22.** Possible contact to C pillar/side glass frame

Attachment 1. Scene Diagram

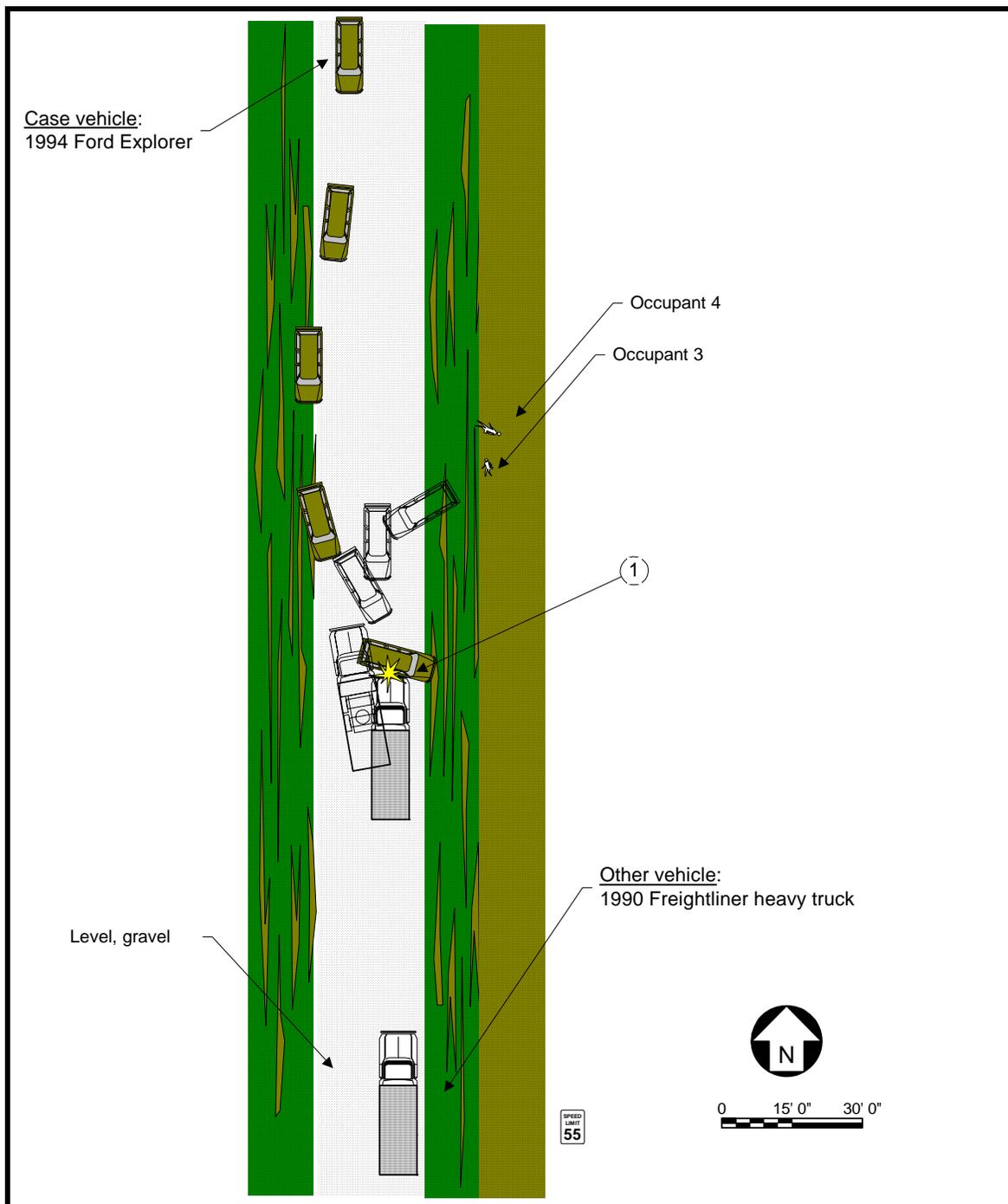


Figure 23. Scene diagram