CRASH DATA RESEARCH CENTER
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CALSPAN ON-SITE CHILD SAFETY SEAT FATALITY INVESTIGATION
GRACO SNUG RIDE CHILD SAFETY SEAT
SCI CASE NO: CA07-033

VEHICLE: 1998 FORD EXPLORER
LOCATION: TENNESSEE
CRASH DATE: OCTOBER 2007

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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 are 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 crash dynamics of a 1998 Ford Explorer and the fatal injury sources of a 4 month old female restrained within a Graco Snugride Child Safety Seat (CSS) in the second row left position of the vehicle. The Explorer was driven by a 22 year old restrained female and occupied by a 27 year old restrained male front right passenger, an 8 year old restrained male right rear passenger, and the 4 month old female restrained within the CSS in a rear-facing mode in the left rear position. The CSS was restrained by the vehicle's lap and shoulder belt across the top of the carrier shell. The base of the infant seat was not in use. The 22 year old driver of the Ford Explorer lost control of the vehicle during a steering maneuver to avoid a tree that had fallen onto the road. The Ford travelled down an embankment, tripped over the right side tires, and rolled one-quarter turn impacting a tree with its roof. The tree impact was located over the Explorer's second row seats and resulted in severe intrusion into the occupant space. During the impact, the 4 month old infant was contacted by the intruding roof and sustained a fatal closed head injury. The infant was pronounced deceased at the scene.

It was the opinion of the investigating police officer that the method of restraint was improper and allowed the CSS to rotate (about the safety belt) toward the roof, thus exposing the infant to the injury source. An Internet news article regarding the potential misuse issue was identified by the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) and forwarded the notification to the Calspan Special Crash Investigations (SCI) team for follow-up investigation on October 12, 2007. Through the process of the SCI on-site investigation, analysis, and interviews with the police officer, medical examiner and the driver and front right passenger, it was determined the CSS was not likely misused and that the fatality occurred as a result of the severe roof intrusion related to the tree impact.

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TABLE OF CONTENTS

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BACKGROUND

This on-site investigation focused on the crash dynamics of a 1998 Ford Explorer and the fatal injury sources of a 4 month old female restrained within a Graco Snugride Child Safety Seat (CSS) in the second row left position of the vehicle. **Figure 1** is an on-scene police image of the vehicle at final rest. The Explorer was driven by a 22 year old restrained female and occupied by a 27 year old restrained male front right passenger, an 8 year old restrained male right rear passenger, and the 4 month old female restrained within the CSS in a rear-facing mode in the left rear position. The CSS was restrained by the vehicle's lap and shoulder belt across the top of the carrier shell. The base of the infant seat was not in use. The 22 year old driver of the Ford Explorer lost control of the vehicle during a steering maneuver to avoid a tree that had fallen onto the road. The driver abruptly steered left and then right to maneuver the vehicle around the obstacle. In the process of the maneuver, the driver over-corrected and then steered back to the left in an attempt to correct the vehicle's errant trajectory. The rear tires of the Ford lost traction and the vehicle initiated a counterclockwise rotation. The vehicle yawed approximately 47 m (155 ft) and departed the left roadside. The Ford travelled down an embankment, tripped over the right side tires, and rolled one-quarter turn impacting a tree with its roof. The tree impact was located over the Explorer's second row seats and resulted in severe intrusion into the occupant space. The Ford then rotated clockwise about the tree and came to rest on its wheels. During the impact, the 4 month old infant was contacted by the intruding roof and sustained a fatal closed head injury. The infant was pronounced deceased at the scene. No autopsy was performed. The driver and front passenger sustained police reported minor injuries. The right rear passenger was trapped in the vehicle due to the roof intrusion and sustained police reported serious injuries requiring hospitalization.

Figure 1: Final rest position of the Ford Explorer.

It was the opinion of the investigating police officer that the method of restraint was improper and allowed the CSS to rotate (about the safety belt) toward the roof, thus exposing the infant to the injury source. An Internet news article regarding the potential misuse issue was identified by the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) and forwarded the notification to the Calspan Special Crash Investigations (SCI) team for follow-up investigation on October 12, 2007. Calspan SCI initiated follow-up investigation and established cooperation with the investigating police department and the County Medical Examiner. The vehicle was available for inspection at a local tow yard. The child safety seat

was in possession of the Medical Examiner and was also available for inspection. The on-site portion of the investigation took place on October 22 and 23, 2007. Through the process of the on-site investigation, analysis, and interviews with the police officer, medical examiner and the driver and front right passenger, it was determined the CSS was not likely misused and that the fatality occurred as a result of the severe roof intrusion related to the tree impact.

SUMMARY

Vehicle Data: 1998 Ford Explorer

The subject vehicle was a 1998 Ford Explorer Sport 4x2, two-door model identified by the Vehicle Identification Number (VIN): 1FMYU22E7WU (production sequence deleted). The Explorer was manufactured in December 1997. **Figure 2** is a left side view of the vehicle. The rear-wheel drive sport utility vehicle was manufactured with a 258 cm (101.7 in) wheelbase. The power train consisted of a 4.0 liter/V6 engine linked to a four-speed automatic transmission. The service brakes were a four-wheel disc system with ABS. The vehicle seating was configured for four passengers (2/2). The front row consisted of cloth upholstered bucket seats. The second row seat system consisted of a 60/40 split bench seat with folding backs. The manual restraint system consisted of three-point lap and shoulder belts for the four seat positions. The Ford Explorer was also equipped with redesigned driver and front right passenger air bags that deployed during the crash. The vehicle was not equipped with side impact protection. The odometer read 299,340 km (186,001 miles) at the time of the SCI inspection. The vehicle manufacturer's recommended tire size was P235/75R15 with a recommended cold inflation pressure of 179 kPA (26 PSI). The subject vehicle was equipped with a Goodyear Eagle P225/70R15 tire at the left front position, Champiro GT Radial P235/75R15 tires at the right front and left rear positions and a Goodyear Wrangler P235/75R15 tire at the right rear position. All four tires were mounted on OEM alloy rims. The specific tire data measured at the time of the SCI inspection was as follows:

Figure 2: Left side view of the Explorer.

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	221 kPa (32 PSI)	6 mm (8/32)	No	None
LR	Tire flat	4 mm (5/32)	No	Tire debeaded
RF	Tire flat	4 mm (5/32)	No	Tire debeaded, Rim abraded
RR	Tire flat	8 mm (10/32)	No	Tire debeaded, Rim abraded

Crash Site

This single vehicle crash occurred during the morning hours of October 2007. It was dark at the time of the crash. The rural roadway was not illuminated by overhead lighting. There were no adverse weather conditions; the asphalt road surface was dry. The crash occurred on a two-lane, north/south road that measured 6.9 m (22.6 ft) in total width. The travel lanes were separated by a yellow center divider that indicated a passing zone in the northbound direction. The road grade measured negative five percent to the north. Solid white lines marked the edges of the travel lanes. The improved west road shoulder measured 1 m (3.4 ft) wide. Beyond the shoulder, the roadside terrain sloped sharply in the westerly direction. Two meters (6 ft) beyond the shoulder, the slope of the roadside measured negative 50 percent. The final rest location of the vehicle was approximately 7.6 m (25 ft) below the grade of the road. Numerous trees and small brush populated the sides of the road. A 56 cm (22 in) diameter hardwood tree, located 23.1 m (76 ft) down stream of the roadside departure and 14.6 m (48 ft) west of the road, was the point of impact. At the time of the crash, a tree located on the east roadside had fallen into the road and was obstructing the north travel lane. The fallen tree was located approximately 79 m (260 ft) upstream (south) of the vehicle's road departure. A schematic of the crash is attached to the end of this report as **Figure 15.**

Crash Sequence

Pre-Crash

The 1998 Ford Explorer was northbound driven by the 22 year old female. The driver was restrained by the vehicle's 3-point lap and shoulder belt. The occupants of the Ford consisted of a 27 year old restrained male front right passenger, an 8 year old restrained male right rear passenger and a 4 month old female restrained in a rear-facing child safety seat in the left rear position. The driver was the mother of the infant. The driver was transporting the front right passenger to his place of employment at the time of the crash. The crash site was located within 5 km (3 miles) of the driver's residence. As the Ford travelled north, the vehicle encountered the tree that had fallen onto the northbound lane. The driver steered counterclockwise (left) and then clockwise (right) to maneuver around the tree. In the process of this maneuver, the driver over-corrected during the return to the northbound lane. Realizing the errant trajectory of the vehicle, the driver then steered back counterclockwise (left). The rear tires lost traction and the vehicle initiated a counterclockwise yaw.

The investigating police officer documented the yaw marks with photographs and basic measurements. **Figure 3** in a north trajectory view at the initiation of the right rear yaw mark. The yaw mark began in the outer third of the travel lane (denoted by the arrow). The mark initially traveled toward the east edge line and then arced to the northwest. The length of the right rear yaw mark measured 47 m (155 ft). The right front yaw mark measured 35 m (115 ft). Due to the passage of time between the crash date and the SCI on-site inspection, the yaw marks in the travel lanes had deteriorated. The physical

Figure 3: On-scene trajectory view of the yaw marks.

evidence of the yaw marks was observed crossing the painted lane lines and was documented. **Figure 4** is a trajectory view of the Ford taken during the SCI inspection. The figure depicts the right front and right rear tire marks crossing the center line during the fully developed yaw.

Figure 4: View of the yaw marks.

Crash

The Ford departed the west road edge. The vehicle had rotated approximately 86 degrees counterclockwise relative to its northbound travel direction. As the vehicle departed the road, the front right passenger reported that he released his safety belt and moved toward the center of the vehicle. The vehicle travelled down the roadside embankment with a right side leading attitude and contacted several small diameter trees and a deteriorated fence post with the right side plane. These impacts did not affect the vehicle's dynamics. The Ford travelled approximately 19.2 m (63 ft) along its northwest trajectory to the base of the embankment at which time its right side tires furrowed and the vehicle tripped into a right side leading roll. As the vehicle was nearing the completion of the first quarter turn, the Ford Explorer impacted the hardwood tree with its roof.

The impact with the tree occurred over the Explorer's second row. The force of the impact resulted in severe roof intrusion into the second row. The impact force located aft of the vehicle's center of gravity initiated a clockwise rotation of the Ford around the tree. The Ford rotated approximately 160 degrees clockwise, rebounded from the tree and up-righted. It came to rest on its wheels facing north 4.6 m (15 ft) from the tree impact. During the post-impact rotation, the left side plane of the Ford contacted and uprooted a 5 cm (2 in) diameter tree.

Post-Crash

The front right passenger exited the vehicle through the front right window. The driver released her safety belt and reached back into the second row for the 4 month old female. The driver removed the 4 month old from the CSS and handed her out to the male passenger. The driver then exited the vehicle through the front right window. The 8 year old right rear passenger was trapped within the vehicle under the intruded roof.

The driver took the infant from the passenger and carried her up to the road. During this time a passerby had notified the first responders via the 9-1-1 system. Emergency personnel and the police arrived. Due to the severity of the infant's injuries the County Medical Examiner was also called. The 4 month old infant was pronounced deceased at the scene and was transported to a funeral home in the CSS. The vehicle's right A-pillar through D-pillars were cut in order to remove the 8 year old from the vehicle. The 8 year old was transported to a pediatric trauma center and was hospitalized in the intensive care unit. The driver was transported to a local hospital for minor injuries. The front right passenger sustained abrasions and contusions to his lower extremities but declined medical treatment.

1998 Ford Explorer

Exterior Damage

The Ford Explorer sustained contact damage to its right, top and left planes as a result of the crash. **Figure 5** is a front right oblique view of the Explorer. The right plane sustained minor body panel deformation to the right fender as a result of the small tree/brush contacts. The fender was deformed over a 53 cm (21 in) length that began at the right front axle location and extended rearward. The maximum deformation in this region measured 4 cm (1.5 in). A 10 cm (4 in) region of the right rear quarterpanel was deformed to 6 cm (2.25 in) depth as a result of contact to a fence post. This deformation was located 50 cm (19.5 in) aft of the rear axle. A 55 cm (21.5 in) area of the right side plane sustained 14 cm (5.5 in) of induced vertical crush as a result of the roof impact. This area began 3 cm (1 in) forward of the right rear axle.

Figure 5: Front right oblique view of the Ford.

During the first quarter-turn of the rollover, the Explorer impacted the tree with its roof. The direct contact to the tree began 71 cm (28 in) aft of the header and extended rearward 91 cm (36 in). The roof crush was biased to the right side of the vehicle. The right bias of the crush indicated the vehicle had not completed the first quarter-turn prior to the impact. The vertical crush of the right roof rail was documented during the SCI inspection. Refer to **Figure 6**. A reference line was established 69 cm (27 in) above and parallel to the sill. The crush of the roof rail was measured from the D-pillar to the A-pillar relative to the reference line. The Field L was 175 cm (69 in). The crush profile was as follows: C1 = 6 cm (2.5 in), C2 = 30 cm (12.0 in), C3 = 41 cm (16.0 in), C4 = 28 cm (11.0 in), C5 = 10 cm (4.0 in), C6 = 10 cm (4.0 in). The maximum lateral and vertical crush were located at the right C-pillar and measured 43 cm (17 in) and 41 cm (16 in), respectively. The extension of the base of the front right window sill (beltline) was used as a reference.

Figure 6: Right side view depicting the roof deformation.

The left front fender sustained minor damage during the post-impact rotation to final rest due to contact with small diameter trees. The deformation began 20 cm (8 in) forward of the left front axle and extended rearward 69 cm (27 in). The maximum crush measured 4 cm (1.5 in). The left door panel and hood exhibited scratches indicative of the off-road travel through the brush. The left B-pillar and C-pillar deformed outboard (leftward) due to the non-horizontal crash force. The C-pillar buckled.

The overall length and wheelbase dimensions of the vehicle did not change as a result of the crash. The left door was opened by extrication. The right door was jammed shut. The windshield was fractured by the exterior crash force and all the side windows glazings had disintegrated. The Collision Deformation Classifications (CDC's) of the exterior damage are summarized in the table below:

Impact Description	Collision Deformation Classification (CDC)
Right plane impact to brush	03-RFEW1
Right plane impact to fence post	03-RBEN1
Rollover	00-T9999
Tree Impact	00-TPDW4
Left plane impact to tree	09-LFEW1

1998 Ford Explorer

Interior Damage

The interior damage to the Explorer consisted of intrusion of the right plane and roof, deployment of the frontal air bags and occupant contacts to the roof. The vehicle sustained severe roof intrusion into the second row as a result of the crash. The measured intrusions are noted in the following table:

Position	***Component***	***Intrusion***	***Direction***
Row 1 Right	A-pillar	25 cm (10.0 in)	Lateral
Row 1 Right	Right roof side rail	18 cm (7 in)	Vertical
Row 2 Right at B-pillar	Right roof side rail	8 cm (3.0 in)	Vertical
Row 2 Right at C-pillar	Right roof side rail	69 cm (27 in)	Vertical
Row 2 Right	B-pillar	48 cm (19 in)	Lateral
Row 2 Right	C-pillar	56 cm (22 in)	Lateral
Row 2 Right at B-pillar	Right side panel	17 cm (6.5 in)	Lateral
Row 2 Right at C-pillar	Right side panel	4 cm (1.5 in)	Lateral
Row 2 Right	Roof	76 cm (30 in)	Vertical
Row 2 Center	Roof	67 cm (26.5 in)	Vertical
Row 2 Left	Roof	64 cm (25 in)	Vertical
Row 2 Left at C-pillar	Left roof side rail	57 cm (22.5 in)	Vertical
Cargo area at D-pillar	Right side panel	9 cm (3.5 in)	Lateral
Cargo area at D-pillar	Right roof side rail	5 cm (2 in)	Lateral

The driver seat was restricted in a mid-track position. The position of the driver seat measured 17 cm (6.5 in) forward of full rear referenced to the front right passenger seat. The seat back was reclined 12 degrees aft of vertical. The horizontal distance from the seat back to the center hub of the steering wheel rim measured 38 cm (15 in). There were no occupant contact points noted to the knee bolster.

The front right passenger seat was adjusted to a rear track position that measured 1 cm (0.5 in) forward of full rear. The seat back was reclined 20 degrees aft of vertical. The seat back was also deformed 30 cm (12 in) forward from contact with the intruding roof and deformed over a

46 cm x 36 cm (18 in x 14 in) area. The horizontal distance from the seat back to the face of the instrument panel measured 76 cm (30 in).

The two passenger second row seat was a 60/40 split bench (left side wide). The head restraints in the second row were adjusted to the full down position. The upper outboard aspect of the right rear seat exhibited a pattern of blood evidence that measured 13 cm (5 in) in width. It was loaded by the occupant and deformed rearward due to the intrusion of the roof and right side pillars. The deformation of the seat measured 5 cm (1.8 in) with reference to the left rear seat. The angle of the deformed seat back measured 34 degrees aft of vertical. Although the right rear occupant contacted the intruding roof during the crash sequence, the headliner exhibited no obvious contact point(s). The residual height of the roof measured 36 cm (14 in) above the right rear seat bight.

The CSS was restrained in a rear-facing mode in the left rear position. The left rear seat back angle measured 27 degrees. The residual height of the roof measured 43 cm (17 in) above the center of the seat cushion, (**Figure 7**). Although, the intruding roof between the B- and C-pillars contacted the CSS and was the source of the infant's head injury, examination of the headliner was unremarkable.

Figure 7: Measurement of the residual roof height above the left rear seat cushion.

1998 Ford Explorer

Manual Restraint Systems

The driver's restraint consisted of a three-point lap and shoulder belt with continuous loop webbing, a sliding latch plate, an adjustable D-ring and an Emergency Locking Retractor (ELR). The D-ring was adjusted to the full down position. Upon initial inspection, the webbing was stowed within the retractor. The retractor operated intermittently due to left B-pillar deformation. The webbing could only be partially extended, approximately 20 cm (8 in). The latch plate exhibited historical use indicators. The driver indicated in her interview that she was restrained by the safety belt at the time of the crash. She further indicated that she sustained a left shoulder abrasion which was attributed to belt use.

The front right restraint consisted of a three-point lap and shoulder belt with continuous loop webbing, a sliding latch plate, an adjustable D-ring and a switchable ELR/Automatic Locking Retractor (ELR/ALR). The D-ring was in the full down position. At the time of the SCI inspection, the webbing of this restraint was stowed and gathered in the D-ring. The front right passenger reported in his interview that he was initially restrained during the vehicle's travel. However, when the driver lost control and the vehicle began to depart the road, the passenger released the safety belt and dove toward the center floor area of the vehicle. As the webbing retracted, the passenger likely loaded the webbing with his arm causing it to gather in the D-ring. He refused medical attention at the time of the crash sustaining only minor lower extremity abrasions and contusions.

The rear right restraint consisted of a three-point lap and shoulder belt with continuous loop webbing, a sliding latch plate, a fixed D-ring and a switchable retractor (ELR/ALR). The passenger was restrained at the time of the crash by the safety belt. The webbing was cut by the first responders 137 cm (54 in) above the anchor. The balance of the webbing had spooled back into the retractor post-crash. The latch plate was still buckled into the receiver at the time of the SCI inspection. There was no crash-related physical evidence observed on the webbing or D-ring surface. The latch plate exhibited historical use and minor abrasions were identified on the friction surface.

The rear left restraint consisted of a three-point lap and shoulder belt with continuous loop webbing, a sliding latch plate, a fixed D-ring and a switchable retractor (ELR/ALR). This webbing was found extended from the retractor upon initial inspection and the retractor was locked. The length of the extended webbing measured 221 cm (87 in). Examination of the webbing was unremarkable for crash related evidence. The latch plate exhibited minor abrasions indicative of historical use. The driver stated during the SCI interview that she had restrained the CSS in the rear left position. The safety belt was positioned through the rear-facing belt path, buckled and the slack was pulled out of the webbing. She then completely extended the webbing and switched the retractor to the automatic locking mode and then fed the webbing back into the retractor. She indicated that she was instructed by the hospital about this procedure and had followed it the morning of the crash. Refer to the *Child Safety Seat Data* section of this report for further detail regarding the CSS installation.

1998 Ford Explorer

Supplemental Restraint Systems

The frontal air bag System in the 1998 Ford Explorer consisted of redesigned driver and front right passenger air bags that deployed as a result of the crash. The driver air bag module was designed in the typical manner and located in the center hub of the steering wheel rim. The driver air bag module had symmetrical H-configuration cover flaps. The height and width of the flaps measured 8 cm x 18 cm (3 in x 7 in), respectively. There was no occupant contact evidence on the cover flaps. The deployed driver air bag measured 66 cm (24 in) in diameter in its deflated state. It was tethered by four internal straps sewn to the face of the bag and vented by ports located in the 11 and 1 o'clock sectors. Post-crash blood evidence was observed in the 6 o'clock sector of the bag.

The front right passenger air bag was a mid-mount design located in the right aspect of the instrument panel. The single cover flap measured 38 cm x 17 cm (14.8 in x 6.8 in), width by height. The face of the deflated bag measured 61 cm x 61 cm (24 in x 24 in), width by height. The air bag was not tethered and was vented by ports located on the side panels of the bag. There was no residual contact evidence on the face of the bag.

Child Safety Seat Data

Figure 8 is a front view of the Child Safety Seat (CSS) in use at the time of the crash. The CSS was a Graco Snugride rear-facing infant seat Model No: 7350D0H2, Serial No: JJ0910050936, manufactured September 10, 2005. The CSS without the base was installed in the rear left position of the Ford Explorer, using the vehicle's 3-point lap and shoulder, in a rear-facing mode. The seat was labeled for use by infants that weighed between 2 kg to 10 kg (5 lb to 22 lb) with a height of 74 cm (29 in) or less. The CSS was configured with a 5-point harness system. The harness was routed through the top slots. The harness straps were flat and were not folded over, roped, or creased. The harness retainer clip was present and operational. The two-piece latch plate and buckle assembly operated as designed.

Figure 8: Front view of the Graco Snugride.

The driver installed the CSS within the vehicle by threading the lap and shoulder belt through the cut-outs of the belt path and buckling the latch plate. She indicated that she removed the slack from the webbing, pulling it tight across the shell. She then set the switchable retractor to the automatic locking mode and fed the balance of the webbing back into the retractor. The carrier handle was in the vertical position. The harness retainer clip was over the mid-chest and the harness straps were reported as "snug" on the infant's shoulders. **Figures 9 and 10** are a view of the CSS reinstalled within the Explorer.

Figure 9: Left front oblique view of the reinstalled CSS.

Figure 10: Left rear oblique view.

Inspection of the CSS revealed multiple stressed areas (whitened plastic) and a fracture of the shell. Blood evidence was identified on the right strap, immediately above the retainer clip, **Figure 11**. Reportedly, the infant was bleeding from the right ear indicative of a basilar skull fracture. The shell's carrier handle was jammed in a forward position (toward the foot area of the shell). The intruding roof contacted the (vertically positioned) handle, and caused it to rotate forward (opposite its normal rotation) and become jammed. The fabric covering the CSS shell was removed during the SCI inspection. **Figure 12** is a view of the shell with the fabric

removed. The upper arch of the shell's back was heavily stressed from impact by the intruding roof. The shell was stressed over a 46 cm (18 in) arc length. The infant's head was located in this area and directly contacted the roof. A 25 cm (10 in) long linear fracture was also observed. The shell fractured laterally through the molded cut-outs for the shell's release handle and 6 cm (2.4 in) down the left side to the molded reinforcement below the left harness strap slot. **Figure 13** is a view of the back side of the shell and the fracture line. Additional stress marks were observed to the forward right aspect of the shell in the area of the infant's feet (**Figure 14**). This region of stresses developed as the shell was compressed downward and rearward into the vehicle's seat back by the intruding roof. The examination of the belt path cut-outs was unremarkable for crash related evidence.

Figure 11: Harness straps.

Figure 12: Stress marks and fracture across the arch of the upper shell

Figure 13: Back view of the fractured shell.

Figure 14: Stressed forward left aspect of the shell.

OCCUPANT DEMOGRAPHICS

	Driver	***Front Right Passenger***
Age/Sex:	22 year old / Female	27 year old / Male
Height:	142 cm (56 in)	175 cm (69 in)
Weight:	59 kg (130 lb)	82 kg (180 lb)
Seat Position:	Mid track	Rear track
Manual Restraint Use:	Three-point lap and shoulder	None
Usage Source:	SCI inspection	SCI inspection
Medical Treatment:	Transported to a local hospital, treated and released	Not transported

	Left Rear Passenger	***Right Rear Passenger***
Age/Sex:	4 month old / Female	8 year old / Male
Height:	56 cm (22 in) (est. Medical Examiner)	Unknown
Weight:	Unknown	Unknown
Manual Restraint Use:	Restrained by a five-point harness within an infant child safety seat in a rear-facing mode	Three-point lap and shoulder belt
Usage Source:	SCI inspection	SCI inspection
Medical Treatment:	None, fatally injured	Transported and hospitalized in serious condition

DRIVER INJURY

Injury	***Injury Severity (AIS 98 Update)***	***Injury Source***
Left shoulder abrasion, NFS	Minor (790202.1,2)	Safety belt

Note: the above injuries were identified during an in-person interview with the driver.

DRIVER KINEMATICS

The 22 year old restrained female driver was seated in an upright posture in a mid-track position. The driver lost control of the vehicle after a series of steering maneuvers to avoid an object fallen onto the road. The Ford Explorer yawed counterclockwise off the left side of the road and travelled down a steep embankment.

During this off-road trajectory, the safety belt's retractor locked. The driver likely was bracing with her arms and loaded the safety belt with her torso. As the vehicle tripped and began to roll, the Ford impacted the tree with its roof. The force of the impact caused the driver air bag to deploy. The driver responded to the non-horizontal direction of force by exhibiting a vertical trajectory (with respect to the vehicle) and further loaded the safety belt. She also loaded the deployed driver air bag and rode down the force of the crash. The driver sustained a left shoulder abrasion from safety belt loading. The driver exited the vehicle and removed the 4 month old infant from the CSS and carried her up to the roadside.

FRONT RIGHT PASSENGER INJURY

Injury	*Injury Severity (AIS 98 Update)*	*Injury Source*
Multiple abrasions and contusions to the lower extremities, NFS	Minor (890202.1,3) (890402.1,3)	Lower right instrument panel

Note: the above injuries were identified during the front right passenger interview.

FRONT RIGHT PASSENGER KINEMATICS

The 27 year old male front right passenger was seated in an upright posture in a rear track position. The passenger stated that he was initially restrained by the vehicle's safety belt; however, he reportedly released the belt as the driver lost control. As the vehicle departed the road, the passenger indicated that he attempted to protect himself by moving toward the center of the vehicle and bending over at the waist. Upon impact with the tree, the passenger likely interacted with the deployed front right passenger air bag and instrument panel. He sustained multiple abrasions and contusions to the lower extremities. He exited the vehicle under his own power and denied medical transport.

REAR LEFT PASSENGER INJURY

Injury	*Injury Severity (AIS 98 Update)*	*Injury Source*
Basilar skull fracture, bleeding from the right ear	Serious (150200.3,8)	Intruding roof
Multiple skull fractures to the top and left occipital region with suture separation	Moderate (150400.2,6)	Intruding roof
Dislocation of the left jaw, NFS	Moderate (251604.2,2)	Intruding roof

Note: the above injuries were identified during in-person interview with the Medical Examiner. A copy of the medical examiner's report could not obtained.

REAR LEFT PASSENGER KINEMATICS

The 4-month old infant was restrained by a 5-point harness within the CSS in a rear-facing mode. The CSS (shell without the base) was installed within the vehicle by the three-point lap and shoulder belt routed through the designated belt path. The driver had switched the left rear retractor to the automatic locking mode.

Upon impact, the CSS and infant responded to the non-horizontal direction of the impact force by initiating a vertical trajectory (with respect to the vehicle). The CSS loaded the locked safety belt system and was held in position. The infant loaded the harness straps with her shoulders and began to ride down the impact. The inertia of the infant's head caused the neck to flex and extend. In this manner, the infant's head likely became exposed above the level of the shell to the intruding roof. The roof crushed down impacting the infant's head and the CSS. The CSS was compressed in the seat cushion. The (upright) carrier handle rotated forward and became jammed. The impact from the intruding roof resulted in a fracture of the CSS shell and multiple stresses to the shell. The infant sustained fatal head trauma. She was removed from the vehicle by the driver and carried to the roadside. She was pronounced deceased at the scene and

removed to a funeral home. The Medical Examiner conducted an external examination and identified the aforementioned injuries. No autopsy was conducted.

REAR RIGHT PASSENGER INJURY

Injury	***Injury Severity (AIS 98 Update)***	***Injury Source***
Closed head injury, NFS	Minor (115099.7.0)	Intruding roof.

Note: the above injuries were identified during an in-person interview with the driver.

REAR RIGHT PASSENGER KINEMATICS

The 8 year old right rear passenger was restrained and seated in an upright posture at the time of the impact. As the vehicle departed the road and travelled down the embankment, the safety belt retractor locked. Upon impact, the passenger responded to the non-horizontal force direction by initiated a vertical trajectory with respect to the vehicle and loaded the belt system. Coincident to this trajectory, the roof crushed and intruded into the occupant space. The roof contacted the child's head causing the closed head injury and compressed the child into the seat. The force of the impact deformed the right rear seat back rearward. The child was found unresponsive within the vehicle and was entrapped by the roof deformation. The vehicle's right pillars were cut in order to remove the child. He was transported by ground ambulance and hospitalized in serious condition.

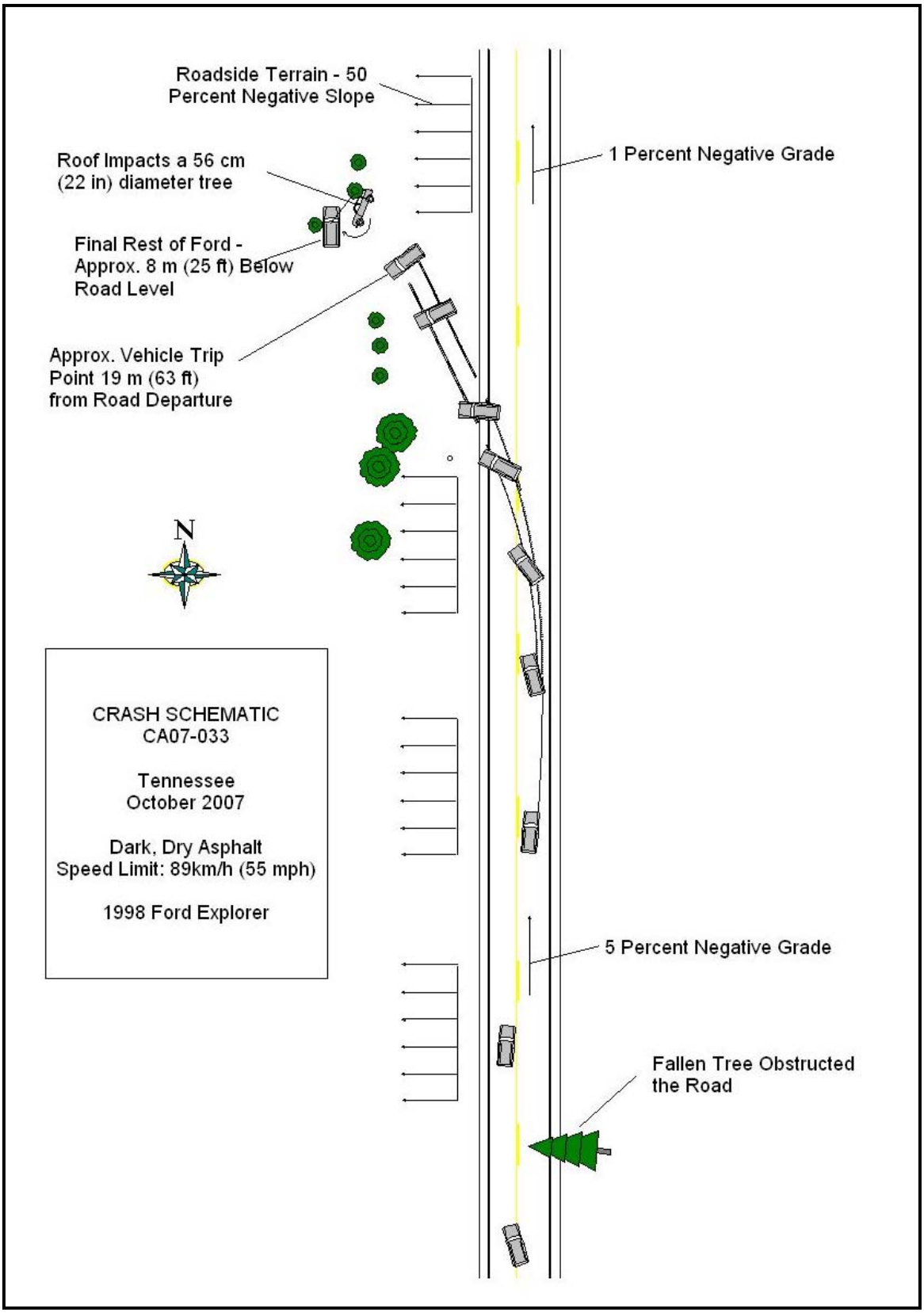

Figure 15: Crash schematic.