

CRASH DATA RESEARCH CENTER

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**CALSPAN ON-SITE CHILD RESTRAINT SYSTEM CRASH INVESTIGATION
SCI CASE NO: CA10018**

VEHICLE: 2002 FORD RANGER

LOCATION: FLORIDA

DATE: MAY, 2010

Contract No. DTNH22-07-C-00043

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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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<i>16. Abstract</i> <p>This on-site investigation focused on the rollover crash of a 2002 Ford Ranger pickup truck and the injuries sustained by a 2-year-old female restrained within a forward-facing Child Restraint System (CRS) secured in the front right position of the vehicle. The Ford was equipped with redesigned frontal air bags that did not deploy during the rollover crash. The unrestrained 25-year-old male driver of the Ford was ejected through the vehicle's backlight during the rollover sequence and was fatally injured. The crash occurred on the southbound lanes of an interstate highway during the early morning hours after the southbound Ford drifted into the center median. The driver of the vehicle responded to the errant trajectory by steering to the right (clockwise) and in the process overcorrected. The Ford reentered the highway and the wheel rim of the left front tire contacted the asphalt road surface. The contact tripped the vehicle into a left side leading rollover. The Ford rolled across the southbound lanes, onto the west roadside, struck a light pole and came to rest on its top. The driver was ejected during the last stage of the rollover sequence and came to rest 18.6 m (61 ft) south of the vehicle. The child remained restrained within the CRS and came to rest inverted in the vehicle. She was removed from the CRS by the first responders and transported to a pediatric trauma center for evaluation. She was treated for minor soft tissue hand injury and released. The investigating police officer examined the installation of the CRS while the vehicle was still at the scene. The officer stated that the CRS was loosely restrained by the vehicle's 3-point safety belt. He also reported that the switchable retractor was in the emergency locking mode.</p>			
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CALSPAN ON-SITE CHILD RESTRAINT SYSTEM CRASH INVESTIGATION
SCI CASE NO: CA10018
VEHICLE: 2002 FORD RANGER
LOCATION: FLORIDA
DATE: MAY, 2010

BACKGROUND

This on-site investigation focused on the rollover crash of a 2002 Ford Ranger pickup truck and the injuries sustained by a 2-year-old female restrained within a forward-facing Child Restraint System (CRS) secured in the front right position of the vehicle. **Figure 1** is a front right oblique view of the vehicle. The Ford was equipped with redesigned frontal air bags that did not deploy during the rollover crash. The unrestrained 25-year-old male driver of the Ford was ejected through the vehicle's backlight during the rollover sequence and was fatally injured. The crash occurred on the southbound



Figure 1: Front right oblique view of the Ford Ranger.

lanes of an interstate highway during the early morning hours after the southbound Ford drifted into the center median. The driver of the vehicle responded to the errant trajectory by steering to the right (clockwise) and in the process overcorrected. The Ford reentered the highway and the wheel rim of the left front tire contacted the asphalt road surface. The contact tripped the vehicle into a left side leading rollover. The Ford rolled across the southbound lanes, onto the west roadside, struck a light pole and came to rest on its top. The driver was ejected during the last stage of the rollover sequence and came to rest 18.6 m (61 ft) south of the vehicle. The child remained restrained within the CRS and came to rest inverted in the vehicle. She was removed from the CRS by the first responders and transported to a pediatric trauma center for evaluation. She was treated for minor soft tissue hand injury and released. The investigating police officer examined the installation of the CRS while the vehicle was still at the scene. The officer stated that the CRS was loosely restrained by the vehicle's 3-point safety belt. He also reported that the switchable retractor was in the emergency locking mode.

This crash was identified by the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) through an Internet media search. The notification was forwarded to the Calspan Special Crash Investigations (SCI) team on May 12, 2010. Calspan SCI initiated follow-up research of the crash on the same day and contacted the investigating police department. Cooperation was established and details regarding the crash circumstances

were obtained. The Ford was located at a tow yard in close proximity to the crash site and the CRS was within the vehicle. The on-site investigation was conducted May 14, 2010.

SUMMARY

Vehicle Data - 2002 Ford Ranger

The 2002 Ford Ranger was manufactured in January 2001 and was identified by the Vehicle Identification Number (VIN): 1FTYR10U82T (production sequence deleted). The 4x2 regular-cab pickup was configured on a 283 cm (111.5 in) wheelbase and had a Gross Vehicle Weight Rating (GVWR) of 2,359 kg (5,200 lb). The vehicle was equipped with the base model trim. The power train consisted of a 3.0-liter, V-6 engine linked to a 5-speed manual transmission. The brakes were a front disc/rear drum system with 4-wheel anti-lock. The pickup was equipped with a three-passenger split bench seat (60/40 left side wide). A narrow center seat position adjusted forward and aft with the driver seat. The center console flipped rearward and also served as the back rest for the center position. The manual restraints consisted of 3-point lap and shoulder belts in the outboard positions and a center lap belt. The outboard positions were equipped with buckle pretensioners. The Ford Ranger was equipped with redesigned driver and front right passenger air bags. An OEM manual cut-off switch was available to suppress the deployment of the front right passenger. The switch was mounted in the lower center aspect of the instrument panel. The switch was in the “Air Bag Off” position at the time of the crash. The vehicle’s recommended tire size was P235/75R15 with a cold tire pressure of 207 kPa (30 PSI) front and 241 kPa (35 PSI) rear. The vehicle was equipped with Prodigy H/T P235/75R15 tires mounted on OEM alloy wheels. The specific tire data at the time of the SCI inspection was as follows:

Tire	Measured Pressure	Tread Depth	Damage
LF	Tire flat	8 mm (10/32)	Tire debaded, Rim deformed and abraded
LR	207 kPa (30 PSI)	7 mm (9/32)	Axle fractured, Wheel separated, Rim abraded
RF	207 kPa (30 PSI)	8 mm (10/32)	Rim deformed
RR	Tire flat	7 mm (9/32)	Tire debaded, Rim abraded

Crash Site

The crash occurred during the morning hours of May 2010. At the time of the crash, it was dark and the weather was not a factor. The road surface was dry. The crash occurred on the southbound lanes of a 2-lane, divided, limited-access, interstate highway. The respective north/south lanes were separated by a depressed grass median. At the crash site, there was a large radius right curve and an entrance ramp onto the interstate on the west roadside. There was

a negative grade along the pre-crash trajectory of the Ford. **Figure 2** is a look back view at the crash site of the Ford's roadside departure. The west roadside terrain sloped away from the travel lanes to a wide drainage area located approximately 15 m (50 ft) west of the road. The Ford came to rest on its top at the base of the slope. **Figure 3** is a look back at the crash site from the final rest area of the Ford. An overhead light pole supported by a concrete base was located along the Ford's rollover trajectory. The speed limit was 105 km/h (65 mph). **Figure 19**, at the end of this report, is a schematic of the crash.



Figure 2: Look back view of the crash site at the roadside departure of the Ford.



Figure 3: Look back view from the final rest area of the Ford along its rollover trajectory

Crash Sequence

Pre-Crash

The 2002 Ford Ranger was southbound, driven by the unrestrained 25-year-old male. The 2-year-old female was restrained within a forward-facing CRS and secured in the front right position of the Ford. The vehicle departed the left side of the interstate and entered the center median. The driver reacted to the vehicle's errant trajectory by steering clockwise (right) in an attempt to regain the road. In the process of the steering maneuver, the driver overcorrected and the vehicle began to yaw clockwise. Diverging tire marks in the median identified during the SCI scene inspection evidenced the vehicle's off-road trajectory, **Figure 4**. The total length of the off-road travel was approximately 98 m (322 ft). As the Ford reentered the southbound travel lane, the left front tire rolled under and exposed the rim to the pavement.



Figure 4: View of the Ford's yaw marks as the vehicle reentered the travel lane.

Crash

The left front wheel contacted the road surface and tripped the vehicle into a left side leading rollover (Event 1). The Ford rolled across the interstate highway and departed the right side of the road. A series of gouge marks were dispersed across the traffic lanes and evidenced the vehicle's trajectory. **Figure 5** is a view of the Ford's roll trajectory. The right side of the Ford impacted the concrete base and fractured the frangible mount of a light pole (Event 2). At the time of the impact the Ford was in a non-horizontal attitude. The Ford then rolled down the shallow embankment and came to rest on its top. The vehicle rolled a total of 10-quarter turns over a distance of approximately 82 m (270 ft). The driver was ejected through the backlight during the later stages of the rollover. He came to rest 18.6 m (61 ft) south the Ford's final rest location.



Figure 5: Roll trajectory of the Ford.

Post-Crash

The police and ambulance personnel responded to the crash site. The ejected driver was pronounced deceased at the scene. The 2-year-old female was found within the CRS suspended by the harness straps. She was removed from the CRS and transported by ground ambulance to a regional trauma center for evaluation. She was treated for a minor soft tissue injury and released from the Emergency Department on the day of the crash. The Ford Ranger sustained disabling damage and was towed from the crash site.

2002 Ford Ranger

Exterior Damage

The exterior damage to the Ford Ranger was consistent with a multiple quarter turn rollover event. The vehicle's two side planes, top plane and the all wheels/tires exhibited damage from multiple ground impacts (**Figures 6 and 7**). The scratch pattern on the vehicle's roof was bi-directional indicative of rotation during the multiple ground contact rollover event. The body panels exhibited isolated areas of abrasion and deformation attributed to the rollover. Both doors could be opened and closed; however, their operation was impeded by deformation. The backlight and both side window glazings disintegrated during the rollover. The windshield was fractured by the exterior forces of the crash.



Figure 6: Left front oblique view of the Ford.



Figure 7: Right front oblique view of the cab.

The left front wheel rim was abraded and fractured over 60 percent of its circumference. The left front tire was debanded. The left rear axle fractured and the tire/wheel had separated. The axle fractured immediately outboard the wheel bearing. The leaf springs of the suspension were deformed. The axle fracture and suspension damage occurred due to ground contact during the rollover. The leaf springs of the right rear suspension were also deformed and the right rear tire was debanded. The right wheelbase dimension was reduced 19 cm (7.5 in).

Figures 8 and 9 are front and back views of the greenhouse depicting the deformation of the roof. The pillars and side rails deformed inboard as the roof crushed down. The roof was crushed down over both the driver and front right passenger seat positions and had deformed in the shape of an inverted V. The headliner/roof was in contact with the head restraints of both outboard seats. The maximum vertical crush of the backlight header measured 21 cm (8.1 in). The deformed roof increased the size of the ejection portal for the driver through the backlight. **Figure 10** is a view of the right roof side rail and the location of the maximum vertical and lateral deformation. The maximum vertical and lateral side rail deformation of the side rail was 33 cm (13.0 in) and 12 cm (4.6 in), respectively. The Collision Deformation Classification (CDC) of the rollover was 00TDDO5.

There was an isolated region of damage to the right side plane that was related to the impact with the light pole and concrete base. The damaged region was located within the rollover damage at the junction of the cab and pickup bed (right B-pillar area). The damaged region measured approximately 20 cm x 61 cm (8 in x 24 in), length by height. The maximum lateral crush measured approximately 10 cm (4 in). The overlapping damaged regions hampered exact measurements. The CDC of Event 2 was 00RZAN2.



Figure 8: Front view of the roof deformation.



Figure 9: Back view of the roof and backlight header deformation

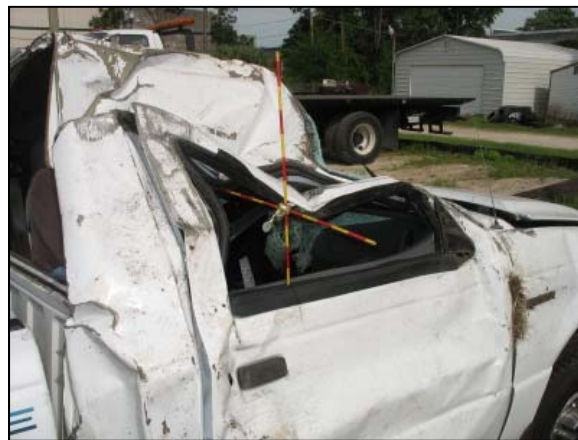


Figure 10: View of the maximum vertical and lateral deformation at the right roof side rail.

Interior Damage

The interior of the Ford sustained moderate severity intrusion as a result of the crash. There were no identified points of occupant contact. The measured intrusions are listed in the table below:

Position	Component	Intrusion	Direction
1 st Row Left (Driver)	Windshield header	11 cm (4.2 in)	Vertical
	Roof side rail	14 cm (5.5 in)	Vertical
	A-pillar	13 cm (5.0 in)	Vertical
	Roof above seat	27 cm (10.5 in)	Vertical
	B-pillar	10 cm (4.1 in)	Lateral
	Roof side rail	11 cm (4.4 in)	Lateral

Position	Component	Intrusion	Direction
1 st Row Right	Windshield header	23 cm (9.2 in)	Vertical
	Roof side rail	25 cm (10.0 in)	Vertical
	A-pillar	17 cm (6.7 in)	Vertical
	Roof above seat	32 cm (12.5 in)	Vertical
	B-pillar	17 cm (6.7 in)	Lateral
	Roof side rail	17 cm (6.5 in)	Lateral

The driver seat was located in a rear-track position that measured 5 cm (1.8 in) forward of full rear. The seat back was reclined 5 degrees. The left roof side rail was in contact with the seat's integral head restraint. The horizontal distance from the seat back to the driver air bag module measured 43 cm (17.0 in). This measurement was taken 41 cm (16.0 in) above the seat bight.

During the rollover, the OEM radio separated from the instrument panel and became captured between the steering wheel rim and the deformed left A-pillar, (**Figure 11**). The captured radio had jammed the steering wheel rim, which restricted rotation of the wheel. The wheel rim was rotated 90 degrees CW.



Figure 11: View of the left interior depicting the displaced radio and jammed steering wheel rim.

The front right seat was located in a rear-track position that measured 1 cm (0.5 in) forward of full rear. The seat back angle measured 30 degrees aft of vertical. The deformed right roof side rail and roof were in contact with the integral head restraint. The horizontal distance from the seat back to the vertical face of the instrument panel measured 79 cm (31.0 in). This measurement was taken 30 cm (12.0 in) above the seat bight. The interior trim covering the right A-pillar and roof side rail partially detached at the side rail and was in the front right occupant space.

Manual Restraint Systems

The driver's restraint consisted of continuous loop webbing, a sliding latch plate, adjustable D-ring and an Emergency Locking Retractor (ELR). The D-ring was adjusted to the full-up position. The safety belt system was equipped with a buckle pretensioner. The webbing was in the stowed position at initial inspection. Examination of the latch plate revealed evidence of historical use. There was no crash-related evidence of use observed on the latch plate, D-ring or webbing. The buckle pretensioner did not actuate. Based on the observations of the inspection, the driver was unrestrained at the time of the crash.

The front right restraint consisted of continuous loop webbing, a sliding latch plate, adjustable D-ring and a switchable Automatic Locking/ELR. The D-ring was adjusted to the full-up position. The belt system was equipped with a buckle pretensioner that did not actuate during the crash. The latch plate exhibited indications of historical use. There was minor polishing of the friction surface. The webbing was stowed on the retractor at the time of the inspection. Examination of the webbing revealed it was loaded and creased in the lap section over a 53 cm (21 in) length from its interaction with forward-facing belt path of the CRS. An Energy Management Loop (EML) in the webbing was located immediately above the outboard floor anchor. Refer to **Figures 12 and 13**. The stitching in the webbing had released. The release of the EML increased the webbing length approximately 8 cm (3 in). The manufacturer's label on the webbing indicated that the belt system had to be replaced.



Figure 12: View of the reconstructed pre-crash condition of the EML.



Figure 13: View depicting the deployed EML.

Frontal Air Bag System

The Ford was equipped with redesigned frontal air bags in the driver and frontal right passenger positions. The air bags did not deploy in the crash. The driver air bag was located in the center hub of the steering wheel rim. The front right passenger air bag was a mid-mount design located in the right aspect of the instrument panel. The front right passenger air bag was configured with a cut-off switch in order to suppress the deployment of the air bag. The switch was mounted in the lower aspect of the center instrument panel. The switch was turned to the “Air Bag Off” position (**Figure 14**).



Figure 14: View of the air bag cut-off switch.

Child Restraint System

The 2-year-old female was restrained in a forward-facing mode within a Cosco Scenera S CRS that was secured in the front right position (**Figure 15**). The CRS was manufactured on April 10, 2008 and was identified as Model No. 22123-DDZ, Serial No. WC C 660693. The CRS was a convertible seat designed for both rear-facing and forward-facing use. In the forward-facing mode the seat was compatible with children over 1 year of age weighing 10 - 18 kg (22 - 40 lb) and 85 - 110 cm (34 - 43 in) in height. Infants less than 1 year of age and less than 16 kg (35 lb) were required to be rear-facing.



Figure 15: View of the CRS reconstructed into the front right seat position.

The CRS was found loose within the vehicle's front row at the time of the SCI inspection. The adjustable foot was in the extended position required for forward-facing use. The 5-point harness straps were routed through the top slots and had been adjusted (post-crash) to the fully slack position. The at-crash harness adjustment was unknown. There was no crash related evidence on the harness straps. Both harness straps were roped in the buckle clips (**Figure 16**). The strap was twisted a single turn as it passed under the bottom of the shell.



Figure 16: View of the harness straps roped within the buckle clips.

Examination of the complete harness system revealed that the harness adjustment strap of the CRS was unconventionally routed. The adjustment strap was attached to the harness at the splitter plate and then was unconventionally routed through the adjustment foot (**Figure 17**). The adjustment strap should have been routed along the perimeter of the shell. The fit of the harness straps was adjusted by pulling the end of the adjustment strap located at the front of the shell. Tension on the adjustment strap would have pulled on the adjustable foot of the CRS and effected the tension placed on the harness straps.



Figure 17: View of the improperly routed adjustment strap.

The fabric covering the shell was removed and the shell was examined for stress marks. A single stress mark was located at the inboard aspect of the forward-facing belt path. The stress mark was caused by an interaction with the vehicle’s safety belt during the crash. The examination of the rest of the CRS shell was unremarkable.

The CRS was repositioned in the front right seat. **Figure 18** is a left interior view of the repositioned CRS. For reference, the horizontal distance from the seat bight of the CRS to the instrument panel measured 58 cm (23.0 in). The vertical distance from the CRS seat bight to the intruded roof measured 62 cm (24.5 in). The vertical clearance from the top the CRS shell to the intruded roof measured 9 cm (3.5 in). The partially detached interior trim is visible in the image.



Figure 18: Left interior view of the repositioned CRS.

Driver Demographics/Data

Age/Sex:	25-year-old/Male
Height:	175 cm (69 in)
Weight:	125 kg (275 lb)
Seat Track Position:	Rear-track
Restraint Use:	None
Restraint Usage Source:	SCI interior inspection, PAR
Mode of Transport From Scene:	Deceased prior to transport
Type of Medical Treatment	None, Fatal injuries

Driver Injury

Injury	Injury Severity (AIS 2005)	Injury Source
Multiple rib fractures; right anterior 2-4, posterior 6-8 and 12, posteriolateral 10	Severe (450213.4,1)	Ground
Multiple rib fractures; left posterior 6-8 and 12	Serious (450203.3,2)	Ground
Bilateral lung contusions	Serious (441410.3,3)	Ground

Injury	Injury Severity (AIS 2005)	Injury Source
Cerebrum subarachnoid hemorrhage, at the bilateral inferior posterior occipital lobes, upper right parieto-occipital and at each upper bilateral mid-parietal area	Moderate (140693.2,1) (140693.2,2)	Ground
Partial anterior vertebral disc fracture at C6/7 without spinal cord injury	Moderate (650299.2,6)	Ground
Sternum fracture, partial horizontal fracture at the level of 3 rd rib	Moderate (450804.2,4)	Ground
Multiple lacerations of the right lobe of the liver, 400 ml moderate hemoperitoneum	Moderate (541820.2,1)	Ground
Shallow laceration of the anterior hilum of the left kidney, 2cm long partial thickness w/local hemorrhage	Moderate (541622.2,2)	Ground
Small serosal contusion of the anterior cecum	Moderate (540810.2,8)	Ground
Small subgaleal hemorrhage at the left parieto-occipital area	Minor (110402.1,6)	Ground
Laceration of the right eyebrow	Minor (210602.1,1)	Ground
Nose contusion	Minor (210402.1,4)	Ground
Right and left cheek abrasions	Minor (210202.1,1) (210202.1,2)	Ground
Right and left cheek contusions	Minor (210402.1,1) (210402.1,2)	Ground
Forehead abrasions, left and right aspects	Minor (210202.1,7)	Ground
Shallow horizontal lacerations of the upper central back	Minor (410602.1,6)	Ground
Broad area of abrasions of the upper central back and multiple diagonal sliding-type abrasions across the back	Minor (410202.1,6)	Ground
Broad area of contusion of the upper central back	Minor (410402.1,6)	Ground
Multiple chest abrasions, whole region	Minor (410202.1,0)	Ground

Injury	Injury Severity (AIS 2005)	Injury Source
Multiple, bilateral upper extremity abrasions	Minor (710202.1,3)	Ground
Multiple, bilateral lower extremity abrasions	Minor (810202.1,3)	Ground

Source of injury data: Medical Examiner's Report of Autopsy

Driver Kinematics

The 25-year-old unrestrained driver of the Ford allowed the vehicle to depart the left side of the interstate. The vehicle entered the center median and the driver over-reacted to the errant trajectory by steering CW (right). The Ford entered a CW yaw and tripped into a left side leading rollover as it reentered the highway.

The repeated roof/ground contacts during the 10-quarter turn rollover deformed the greenhouse vehicle's structure. The pillars and roof side rails deformed inboard. The central aspect of the roof deformed vertically upward and increased the size of the ejection portal through the backlight. During the course of the rollover, the unrestrained driver was displaced from the driver seat. He traveled between the front seat backs and was ejected through the backlight. The driver impacted the ground and sustained fatal multiple blunt force injuries. He was pronounced deceased at the scene of the crash.

Child Passenger Demographics/Data

Age/Sex:	2-year-old/Female
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Rear-track
Restraint Use:	5-point harness of a CRS
Restraint Usage Source:	SCI interior inspection, PAR
Mode of Transport From Scene:	Assisted from the vehicle and transported by ground ambulance to a pediatric trauma center for evaluation
Type of Medical Treatment	Treated and released

Front Right Child Passenger Injury

Injury	Injury Severity (AIS 2005)	Injury Source
Right hand laceration, NFS	Minor (710600.1,1)	Interior trim

Source: Police reported

Front Right Child Passenger Kinematics

The 2-year-old female was restrained by the 5-point harness of a CRS in the front right position. During the rollover sequence, the front right retractor locked the vehicle's safety belt system. The child loaded the harness straps of the shell with her chest and began to ride down the force of the crash. During the course of the rollover, the combined loading of the child and CRS caused the EML of the safety belt to release.

During the deformation of the roof, the interior trim covering the right A-pillar and roof side rail partially detached. The child sustained a hand laceration as a result of contact with the trim. The child's head remained below the level of the shell and did not contact the intruding roof based on her injury outcome and the lack of contact evidence to the roof above and surrounding her seat position.

The child came to rest inverted and suspended from the harness straps. She was removed from the CRS by the first responders and transported to a pediatric trauma center for evaluation. She was treated for her hand laceration and released the day of the crash.

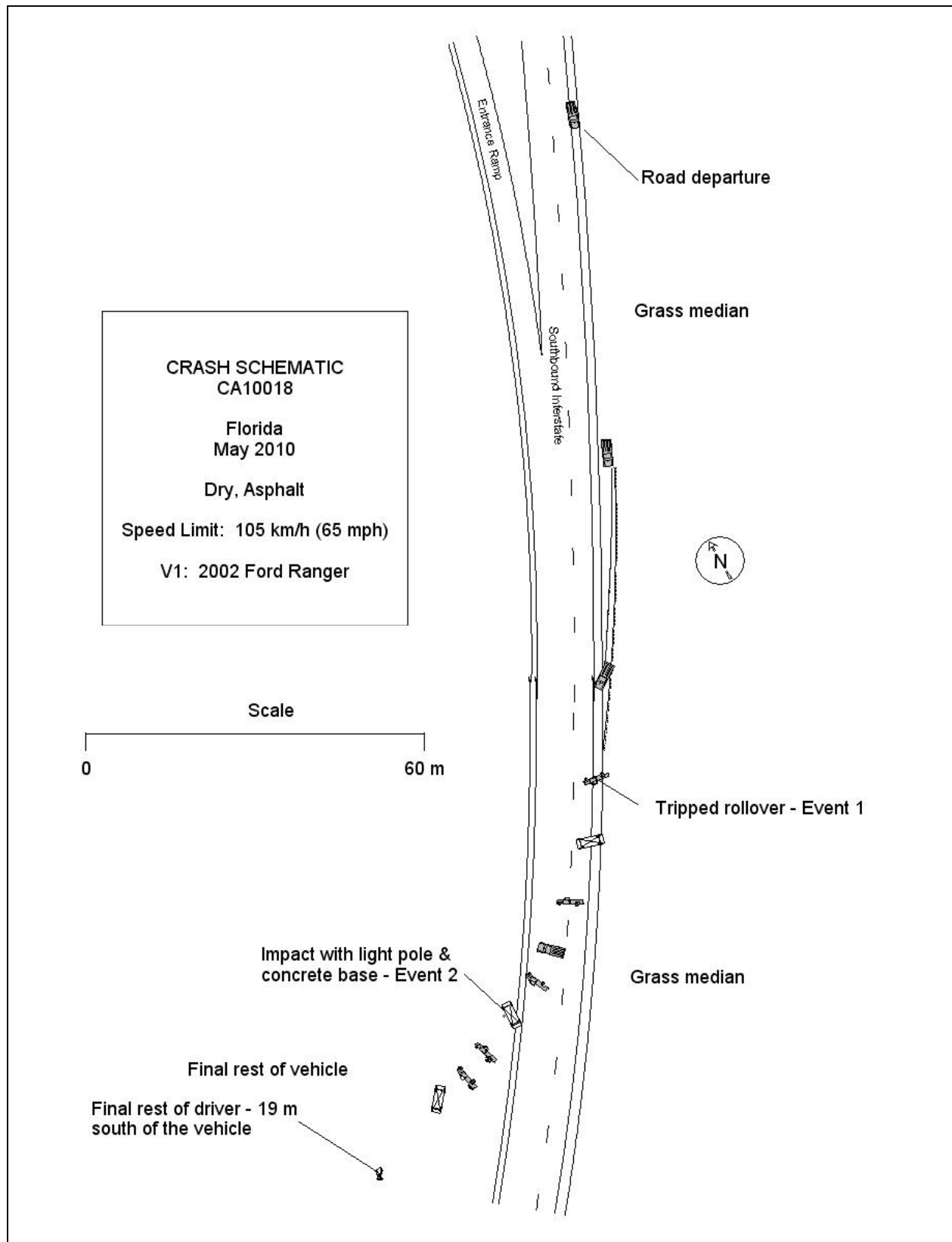


Figure 19: Crash Schematic.