

CRASH DATA RESEARCH CENTER
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CALSPAN ON-SITE ROLLOVER CRASH INVESTIGATION
SCI CASE NO.: CA08030

VEHICLE: 2007 FORD F250 PICKUP TRUCK

LOCATION: NORTH CAROLINA

CRASH DATE: JUNE 2008

Contract No. DTNH22-07-C-00043

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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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.

TECHNICAL REPORT STANDARD TITLE PAGE

<p>1. <i>Report No.</i> CA08030</p>	<p>2. <i>Government Accession No.</i></p>	<p>3. <i>Recipient's Catalog No.</i></p>	
<p>4. <i>Title and Subtitle</i> Calspan On-Site Rollover Crash Investigation Vehicle: 2007 Ford F250 Pickup Truck Location: North Carolina</p>		<p>5. <i>Report Date:</i> September 2010</p>	
		<p>6. <i>Performing Organization Code</i></p>	
<p>7. <i>Author(s)</i> Crash Data Research Center</p>		<p>8. <i>Performing Organization Report No.</i></p>	
<p>9. <i>Performing Organization Name and Address</i> Calspan Corporation Crash Data Research Center P.O. Box 400 Buffalo, New York 14225</p>		<p>10. <i>Work Unit No.</i></p>	
		<p>11. <i>Contract or Grant No.</i> DTNH22-07-C-00043</p>	
<p>12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590</p>		<p>13. <i>Type of Report and Period Covered</i> Technical Report Crash Date: June 2008</p>	
		<p>14. <i>Sponsoring Agency Code</i></p>	
<p>15. <i>Supplementary Note</i> An investigation of the multiple event crash of a 2007 Ford F250 pickup truck.</p>			
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<p>17. <i>Key Words</i> Rollover Partial Ejection Restrained Occupants Moderate Injury</p>		<p>18. <i>Distribution Statement</i> General Public</p>	
<p>19. <i>Security Classif. (of this report)</i> Unclassified</p>	<p>20. <i>Security Classif. (of this page)</i> Unclassified</p>	<p>21. <i>No. of Pages</i> 12</p>	<p>22. <i>Price</i></p>

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SCI CASE NO.: CA08030**

**VEHICLE: 2007 FORD F250 PICKUP TRUCK
LOCATION: NORTH CAROLINA
CRASH DATE: JUNE 2008**

BACKGROUND

This on-site investigation focused on the barrier impact/rollover crash dynamics of a 2007 Ford F250 pickup truck (**Figure 1**) and the injury sources for the 24-year-old male driver, 25-year-old male front right passenger, and a 27-year-old male second row left passenger. The crash occurred when the driver of the Ford swerved left to avoid an unknown non-contact vehicle that was encroaching into his lane. The Ford crossed the westbound travel lanes and struck the center median barrier with its front plane. The Ford was redirected where it subsequently tripped and rolled over onto its left plane. The non-contact vehicle also crossed the westbound travel lanes and struck the concrete barrier ahead of the Ford; however, this vehicle continued its westbound travel and fled the crash site. During the rollover event, the driver and second row left occupant were partially ejected through their respective door glazing openings. All three occupants of the Ford sustained minor to moderate severity injuries and were transported to a local trauma center. The driver and second row left passenger were hospitalized for three days. The Ford's front right passenger was treated and released.



Figure 1: Left front oblique view of the 2007 Ford F250 pick-up truck

The Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) identified this crash and forwarded the crash information to the Calspan Special Crash Investigation (SCI) team on August 1, 2008. Calspan SCI initiated a follow-up investigation and established cooperation with the vehicle's insurance carrier and determined that the Ford was available for inspection at a vehicle salvage facility. On August 5, 2008, the CID subsequently assigned an on-site investigation of this crash to the SCI team due its interest in rollover crashes involving late model year vehicles. The on-site portion of the investigation was conducted on August 13, 2008, which consisted of an inspection of the Ford and crash the site. The hospital medical records were obtained and at incorporated into this report at a later date.

SUMMARY

Crash Site

This crash occurred during the nighttime hours of June 2008, on the westbound portion of an east/west physically divided interstate roadway. The interstate consisted of four bituminous-surfaced travel lanes in each direction. The environmental conditions were clear and the asphalt road was dry. The pre-crash westbound lanes contained a large radius right curve leading up to the crash site. The travel lanes were physically separated by a double concrete median barrier system. Landscape shrubs filled the area between the concrete barriers. The north roadside consisted of a paved shoulder that contained a W-beam guardrail system. The posted speed limit was 97 km/h (60 mph). Due to heavy traffic at the time of the SCI scene inspection, narrow shoulders and limited sight distance, the SCI investigator was not able to exit his vehicle and conduct a physical inspection of the crash site. The Crash Schematic is included as **Figure 8** of this report.

Vehicle Data

2007 Ford F250

The case vehicle was a 2007 Ford F250 Lariat Super-Duty pickup truck. The Ford was identified by the Vehicle Identification Number (VIN): 1FTSW21P57E (production number deleted). The manufacturer's label and date of manufacture could not be accessed as the left front door was jammed shut. The digital odometer reading was unknown due a lack of electrical power. The Ford was powered by a 5.4-liter turbo-diesel, V8 engine linked to a 5-speed automatic transmission with four-wheel-drive and was configured on a 397 cm (156.2 in) wheelbase. The braking components consisted of power-assisted front and rear disc brakes with anti-lock and electronic brake force distribution systems. The Ford's OEM 5-spoke alloy wheels were outfitted with Goodyear Wrangler AT/S, LT275/65R20 tires. Based on the OEM specifications, the installed tires were an optional size. The vehicle manufacturer recommended front and rear cold tire pressure for the optional size tires was 448 kPa (65 PSI). The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Tire Pressure	Measured Tread Depth	Tire/Wheel Damage
Left Front	Tire Flat	2 mm (3/32 in)	Cut in outer sidewall
Left Rear	331 kPa (48 PSI)	2 mm (3/32 in)	Sidewall scuffing
Right Front	345 kPa (50 PSI)	4 mm (5/32 in)	None
Right Rear	352 kPa (51 PSI)	2 mm (3/32 in)	None

The interior of the Ford was configured with leather surfaced five-passenger seating. The front bucket seats were separated by a center console and equipped with integrated head restraints. The second row seat was a split bench (60/40) design and contained forward folding seatbacks with two outboard adjustable head restraints that were located in the full-down position. The right rear seatback was found in the fold-down position. The manual safety belt system

consisted of 3-point lap and shoulder belts for the four outboard positions and a second row center lap-only belt. The vehicle was equipped with redesigned frontal air bags for the driver and front right passenger.

Crash Sequence

Pre-Crash

The 24-year-old male driver of the Ford was operating the vehicle westbound on an interstate roadway in the outboard lane (**Figure 2**). A non-contact vehicle was traveling ahead of the Ford in the same lane. As both vehicles traveled forward, the non-contact vehicle began to slow down and the driver of the Ford then changed lanes to the left in order to pass the non-contact vehicle. In the process of the passing maneuver, the non-contact vehicle also changed lanes to the left. The driver of the Ford observed the non-contact vehicle's encroachment and performed an evasive maneuver by initiating a left steering input. This action resulted in the Ford paralleling the non-contact vehicle's leftward trajectory as the Ford maintained its speed and relative distance from the encroaching vehicle. Both vehicles crossed the width of the roadway and each vehicle departed the south side of the travel lanes onto the paved shoulder area.



Figure 2: Westbound pre-impact travel path of the Ford

Crash

The driver of the Ford maintained his evasive trajectory until the left aspect of the vehicle's front plane impacted the center concrete barrier (Event 1), **Figure 3**. This initial event resulted in moderate frontal damage with a resultant direction of force in the 12 o'clock sector. As the Ford's front bumper deformed, it exposed the left front wheel which contacted the concrete barrier. This contact cut and deflated the left front tire and damaged the left front suspension components. Additionally, this impact resulted in the deployment of the frontal air bag system. The damage algorithm of the WinSMASH program was used to calculate the severity of the impact (delta-V). The total delta-V was 23 km/h (14.3 mph) with longitudinal and lateral components of -23 km/h (-14.3 mph) and 4 km/h (2.5 mph).



Figure 3: Depicts the contact evidence to concrete barrier wall from the Ford's first event

As the crash sequence developed, the Ford was redirected by the impact forces until its trajectory was parallel with the length of the concrete barrier in a continuous engagement. This resulted in the left side of the Ford contacting the barrier in a side-swiping configuration. As the front left aspect of the Ford disengaged from the barrier the left front rim bead contacted the asphalt road surface and tripped the Ford into a left side leading one-quarter turn rollover event (Event 2). While on its left side the Ford slid approximately 33 meters (108 feet) to final rest. During the rollover, the window glazings of the left doors disintegrated which resulted in the partial ejection of the driver and second row left occupant.

Post-Crash

Police and rescue personnel responded to the crash site. The rescue personnel cut the A-pillars and deflected the roof upward during their extrication efforts. All three occupants sustained minor to moderate severity injuries, were assisted from the vehicle and were transported to a regional trauma center. The driver and second row left passenger were hospitalized for three days. The front right passenger was treated and released. The Ford was towed from the crash site and consequently deemed a total loss by the insurance company. The vehicle was moved to a regional vehicle salvage facility where it was inspected during this SCI investigation.

2007 FORD F250

Exterior Damage

The exterior of the Ford sustained moderate damage to the front (**Figure 4**) and left side planes (**Figure 5 and 6**) as a result of the multiple event crash. The first impact (Event 1) occurred to the left aspect of the front plane. The direct damage width measured 50 cm (19.7 in) and began 41 cm (16.1 in) left of the vehicle centerline and extended to the front left bumper corner. The maximum crush measured 40 cm (15.7 in) and was located on the left corner of the front bumper. A crush profile was measured at the bumper level with the following results: C1 = 40 cm (15.7 in), C2 = 23 cm (9.1 in), C3 = 7 cm (2.8 in), C4 = 2 cm (0.8 in), C5 = 2 cm (0.8 in), C6 = 0 cm. The Ford's left wheelbase was reduced by 25 cm (9.8 in). The Collision Deformation Classification (CDC) for this event's direct damage was 12FLEW2.



Figure 4: Overall view of the frontal damage

The Ford's engagement with the barrier wrapped around the left front corner as the vehicle was redirected and the barrier contact extended along the entire length of the left plane. The 86 cm (34 in) height of the abrasion pattern across the left doors was consistent with the height of the barrier. The direct damage consisted of surface abrasions with minimal lateral deformation.

Scuffing was observed on the sidewall of the left rear tire due to the barrier contact. The left doors were jammed shut.

As the forward aspect of the Ford disengaged from the barrier, the left front rim contacted the pavement and tripped the vehicle into a one-quarter turn rollover. The rollover event (Event 2) resulted in longitudinally oriented abrasions along the left side plane that extended vertically to a height of 190 cm (75 in) at the roof side rail. Heavy abrasions were noted to the forward side of the left mirror mount. Minimal lateral deformation to the body panels was noted. There did not appear to be lateral deformation of the greenhouse; the post-crash extrication damage to the A-pillars and roof hampered any meaningful measurements. The pickup truck's frame aft of the cab was deformed laterally to the right evidenced by the 15 cm (6 in) left-side gap between the cab's aft wall and the pickup bed. The gap between the cab and bed on the right was closed. The CDC for this event was 00LDAO3.



Figure 5: View of the Ford's left side damage.



Figure 6: View of the Ford's left side damage.

Interior Damage

The interior of the Ford sustained moderate damage attributed to minor occupant contact, passenger compartment intrusions, frontal air bag deployment, and post-crash extrication damage. A 6 cm x 5 cm (2.5 in x 2 in) scuff mark was noted on the glove box door. It was located 6 cm (2.3 in) right of the glove box centerline and 48 cm (19 in) above the floor. The transfer case shift lever was found in a deformed condition from a possible front right passenger contact. **Figure 7** depicts the interior evidence at the Ford's left roof area. Two small scuff marks were observed at the upper aspect of the left B-pillar and grab handle. Post-crash



Figure 7: Left roof area of the Ford.

body fluid was noted on the upper left B-pillar and along the left roof side rail at the both driver and second row left positions. During the extrication efforts, rescue personnel cut the A-pillars and deflected the roof upward and rearward, which creased the headliner at the midpoint of the roof.

The driver seat was located in a mid to rear-track position that measured 7 cm (2.8 in) forward of full-rear. The seatback was reclined 15 degrees aft of vertical. The horizontal distance from the seat to the driver air bag module measured 60 cm (23.5 in). The two-spoke tilt steering wheel rim was in the full-up position. There was no steering wheel rim deformation or steering column compression. The front right seat was adjusted in a mid to rear-track position that measured 6 cm (2.5 in) forward of full-rear. The seatback was reclined 25 degrees aft of vertical. The horizontal distance from the seatback to the vertical face of the instrument panel measured 91 cm (36.0 in).

The passenger compartment intrusions are listed in the following table:

Location	Component	Magnitude	Direction
Left Front	Toe pan	8 cm (3 in)	Longitudinal
Left Front	Instrument panel	9 cm (3.5 in)	Longitudinal
Left Front	Side panel forward of A-pillar	13 cm (5 in)	Lateral
Left Front	Door, forward lower quadrant	3 cm (1 in)	Lateral
Left Front	Roof side rail	5 cm (2 in)	Lateral
Left Rear	C-pillar	4 cm (1.5 in)	Lateral

Manual Safety Belt Systems

The Ford was equipped with manual 3-point lap and shoulder safety belts for the four outboard seating positions and a 2-point lap belt in the center rear position. The safety belt systems were not equipped with pretensioners. The driver's safety belt consisted of a sliding latch plate, adjustable D-ring that was in the full-down position and an Emergency Locking Retractor (ELR). The driver was restrained at the time of the crash, which was supported by loading evidence on the belt system. This evidence consisted of subtle frictional abrasions to the latch plate, D-ring and loading creases in the webbing, located 93 cm (36.8 in) above the floor anchor.

The front right safety belt was configured with a sliding latch plate, a switchable ELR/Automatic Locking Retractors (ALR) and an adjustable D-ring that was located in the full-down position. The front right passenger utilized the safety belt during the crash evidenced by subtle frictional abrasions to the latch plate and D-ring and loading creases in the webbing, located 92 cm (36.3 in) above the floor anchor.

The second row left safety belt was equipped with an ELR/ALR, fixed D-ring and a sliding latch plate. Examination of the safety belt system revealed subtle frictional evidence of use on the

latch plate. Based on the SCI examination of the Ford’s safety belt systems, the second row left passenger was restrained at the time of the crash.

Frontal Air Bag System

The Ford was equipped with a redesigned frontal air bag system, which deployed as a result of the median barrier impact (Event 1). The driver’s air bag was located within the steering wheel hub and was concealed by a single cover flap. The cover flap measured 20 cm x 13 cm (7.8 in x 5 in), height x width. There was no evidence of occupant contact to the flap. A large section of the air bag had been cut out and removed post-crash for unknown reasons. This missing section could not be located during the SCI inspection. The remaining portion of the air bag was free of damage and occupant contact points.

The front right air bag was a mid-mount design, incorporated into the front right instrument panel. This air bag was equipped with a single flap that measured 36 cm (14 in) in width and 18 cm (7 in) in height. There was no evidence of occupant contact to the flap. The front right air bag had also been cut out and removed from the Ford post-crash.

Occupant Demographics/Data

Driver

Driver Age/Sex: 24-year-old/Male
 Height: Unknown
 Weight: 77 kg (170 lbs)
 Seat Track Position: Mid to rear-track position
 Manual Safety Belt Use: 3-point lap and shoulder belt
 Usage Source: Vehicle inspection
 Egress from Vehicle: Assisted by EMS
 Mode of Transport from Scene: Ambulance to a regional trauma center
 Type of Medical Treatment: Hospitalized for three days

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Comminuted bilateral anterior maxillary fractures extending to the ridge, displacement of bilateral maxillary incisors	Moderate (250612.2,3)	Ground
Fractured front upper teeth, canines, and incisors	Minor (251404.1,8)	Ground
Large laceration through the right side of the upper lip extending to the right cheek approximately 5 cm (2 in) exposing teeth	Minor (290602.1,8) (290602.1,1)	Ground

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Closed head injury, NFS	Minor (160402.1,0)	Ground
Avulsion laceration to the right ala of the nose, NFS	Minor (290600.1, 4)	Ground
Multiple scalp lacerations, NFS	Minor (190600.1,9)	Ground
Multiple scalp abrasions, NFS	Minor (190202.1,9)	Ground
Multiple facial abrasions, NFS	Minor (290202.1,9)	Ground
Significant left lateral shoulder abrasion with exposed muscle and foreign matter found in the abrasion	Minor (790800.1,2)	Ground
Right forearm abrasions, NFS	Minor (790202.1,1)	Deploying driver air bag

Source = Hospital records

Driver Kinematics

The 24-year-old male driver was seated in a mid to rear-track position and was restrained by the manual 3-point lap and shoulder belt system. At impact with the median barrier, the locking mode of the retractor engaged and the frontal air bags deployed. The deploying air bag contacted the driver's right forearm, which resulted in a right forearm abrasion. The driver initiated a forward trajectory and loaded the safety belt webbing as evidenced by the subtle frictional abrasions on the latch plate and creases in the webbing. The driver rode down the frontal crash forces as the Ford's left side began to engage the south side of the barrier wall. During the continuous engagement with the concrete barrier, the restrained driver remained within his front left seating position.

The Ford subsequently tripped into a left side leading one-quarter turn rollover event. The left plane of the Ford impacted the ground, which disintegrated the left side glazing. The driver's head and left side of his upper body were partially ejected through the left front door glazing opening and contacted the ground which resulted in the bilateral maxillary fracture, the closed head injury and the multiple soft tissue injuries. He was extricated from the Ford and transported to a trauma center where he was admitted for treatment. He was discharged three days post-crash.

Front Right Passenger

Age/Sex: 25-year-old/Male
Height: Unknown
Weight: Unknown
Seat Track Position: Mid to rear-track position
Manual Safety Belt Use: 3-point lap and shoulder belt
Usage Source: Vehicle inspection
Egress from Vehicle: Assisted by EMS
Mode of Transport from Scene: Ambulance to a regional trauma center
Type of Medical Treatment: Treated and released

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Left trapezium fracture (at the ulnar aspect)	Moderate (752002.2,2)	Unknown
3 cm (1.2 in) forehead laceration	Minor (290602.1,7)	Unknown
Left hip abrasion	Minor (890202.1,2)	Safety belt buckle
Left knee abrasion	Minor (890202.1,2)	Transfer case shift lever

Source = Emergency room records

Front Right Passenger Kinematics

The 25-year-old male front right passenger was seated in a mid to rear-track position and was restrained by the manual 3-point lap and shoulder belt system. The median barrier impact activated the inertial-locking safety belt retractor and deployed the frontal air bags. The front right passenger initiated a forward trajectory and loaded the safety belt webbing as evidenced by the frictional abrasions to the latch plate, D-ring and creases in the webbing. The passenger's right lower extremity contacted and scuffed the glove box door. This contact did not result in an injury. The passenger rode down the frontal crash forces as the Ford's left side began to engage the south side of the barrier.

The Ford initiated a rollover event completing one-quarter turn onto its left side. The front right passenger was displaced laterally to the left during the rollover event. His left hip contacted the safety belt buckle resulting in a hip abrasion and the left knee was abraded by contact to the transfer case shift lever. During the crash sequence the front right passenger sustained a forehead laceration and a left trapezium fracture. The source of these injuries was not identified. He was transported to a trauma center where he was treated and released.

Second Row Left Passenger

Age/Sex: 27-year-old/Male
 Height: Unknown
 Weight: Unknown
 Seat Track Position: Non-adjustable
 Manual Safety Belt Use: 3-point lap and shoulder belt
 Usage Source: Vehicle inspection
 Egress from Vehicle: Assisted by EMS
 Mode of Transport from Scene: Ambulance to a regional trauma center
 Type of Medical Treatment: Hospitalized for three days

Second Row Left Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Closed head injury with loss of consciousness	Moderate (160202.2,0)	Ground
Right 2 nd metacarpal fracture	Moderate (752002.2,1)	Left B-pillar
Left eyelid laceration, (complex, on inferior orbital region) just below left eye	Minor (297602.1,2)	Ground
Superficial laceration to the right eyelid	Minor (297602.1,1)	Ground
Epistaxis	Minor (251090.1,4)	Ground
Left cheek laceration, NFS	Minor (290600.1,2)	Ground
Right lateral cheek laceration (1.5 cm vertical)	Minor (290602.1,1)	Ground
Multiple face contusions, NFS	Minor (290402.1, 9)	Ground
Multiple scalp contusions, NFS	Minor (190402.1, 9)	Ground
Multiple face abrasions (entire face)	Minor (290202.1,0)	Ground
Multiple scalp abrasions, NFS	Minor (190202.1,9)	Ground
Chest abrasions (whole anterior)	Minor (490202.1,0)	Ground
Left arm abrasions (anterior and posterior)	Minor (790202.1,2)	Ground

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Bilateral arm lacerations	Minor (790600.1,3)	Ground
Abdomen abrasions	Minor (590202.1,9)	Safety belt

Source = Hospital records

Second Row Left Passenger Kinematics

The 27-year-old male passenger was seated in the second row left seating position and was restrained by the 3-point lap and shoulder belt system. At impact with the median barrier, the inertial-locking safety belt retractor activated. The passenger initiated a forward trajectory in response to the frontal crash, loaded the locked belt system and began to ride down the force of the impact. The Ford subsequently tripped into a left side leading rollover event. The left plane of the Ford impacted the ground which disintegrated the left rear door glazing. The passenger initiated a left trajectory and was partially ejected through the rear left door's glazing opening resulting in ground contact. His right hand contacted the upper left B-pillar evidenced by the identified scuff mark. This contact resulted in a metacarpal fracture. The ground contact resulted in the reported closed head injury and multiple soft tissue abrasions and lacerations. He was extricated from the vehicle and transported to a trauma center where he was admitted for treatment and discharged three days post-crash.

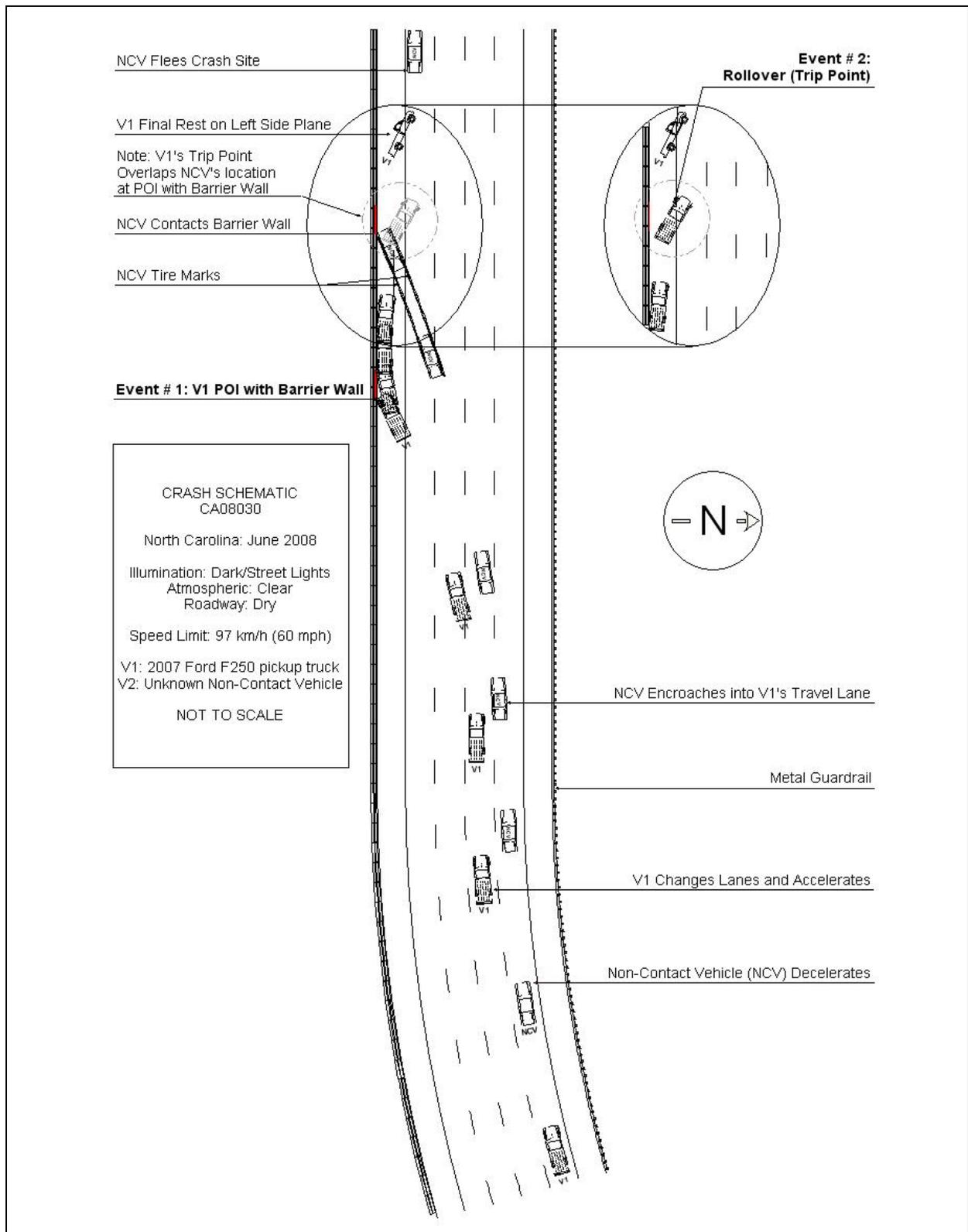


Figure 8: Crash Schematic