

**TRANSPORTATION SCIENCES
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**OFFICE OF DEFECTS INVESTIGATION
1998 FORD CROWN VICTORIA POLICE INTERCEPTOR REAR IMPACT CRASH**

VERIDIAN CASE NO: CA02-034

LOCATION: NEW YORK

CRASH DATE: AUGUST 2002

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness of the involved vehicle(s) or their safety systems.

TECHNICAL REPORT STANDARD TITLE PAGE

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<p>17. <i>Abstract</i></p> <p>This investigation focused on identifying the cause of a crash induced fire in a 1998 Ford Crown Victoria Police Interceptor and the identification of any associated potential mechanical defect(s). The Ford Crown Victoria was involved in a rear-end crash with a 2002 Chevrolet K2500 pick-up truck towing a 5th wheel gooseneck cattle trailer. The Ford Crown Victoria was stopped on the road straddling the fog line at the time of the crash with his emergency lights illuminated. The 78 year old driver of the Chevrolet failed to recognize that the police vehicle was stopped and braked too late to avoid the crash. The New York State Trooper seated in the Ford struck the posterior aspect of his head on the intruding rear sheet metal and was incapacitated. He was removed from the vehicle by some witnesses to the crash. The Ford Crown Victoria was then consumed by the post-impact fire.</p> <p>The Special Crash Investigations team at Veridian Engineering was notified of the August 2002 crash by the New York State Police. The Veridian SCI team forwarded the notification to the National Highway Traffic Safety Administration's Crash Investigation Division and NHTSA's Office of Defects Investigation. The ODI requested the Crash Investigation Division assign an on-site investigation of the crash to Veridian SCI. The Ford Crown Victoria was stored by the State Police pending the August 20, 2002 on-site inspection. Technical representatives from Ford Motor Company and the New York State Police Crash Reconstruction team participated in the vehicle inspection, in addition to the Veridian SCI investigators.</p>			
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BACKGROUND

This investigation focused on identifying the cause of a crash induced fire in a 1998 Ford Crown Victoria Police Interceptor and the identification of any associated potential mechanical defect(s). The Ford Crown Victoria was involved in a rear-end crash with a 2002 Chevrolet K2500 pick-up truck towing a 5th wheel gooseneck cattle trailer. The Ford Crown Victoria was stopped on the road straddling the fog line at the time of the crash with his emergency lights illuminated. The 78 year old driver of the Chevrolet failed to recognize that the police vehicle was stopped and braked too late to avoid the crash. The New York State Trooper seated in the Ford struck the posterior aspect of his head on the intruding rear sheet metal and was incapacitated. He was removed from the vehicle by some witnesses to the crash. The Ford Crown Victoria was then consumed by the post-impact fire.

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SUMMARY

Crash Site

This two-vehicle crash occurred during the afternoon hours of August, 2002. At the time of the crash, it was daylight and the weather was clear. The road surface was dry. The crash occurred in the outboard northbound lane on a north/south, four lane state highway, **Figure 1**. The roadway was straight and level in the area of the crash with approximately 275 m (900 ft) of sight distance. The travel lanes were bordered by a 2.4 m (8.0 ft) wide shoulder. A shallow ditch was located 4.6 m (15.0 ft) east of the shoulder and had a estimated depth of 0.6 m (2.0 ft). A large area of small diameter trees and brush began



Figure 1: Northbound trajectory view approaching the impact.

approximately 9 m (30 ft) east of the road edge. An overhead utility line crossed the road immediately north of the crash and was hanging down. The height of the downed wires measured approximately 3 m (10 ft) and were being clipped by passing tractor/semi-trailer trucks. **Figures 2 and 3** are views of the post-crash tire and gouge marks and the final rest location of the Ford, respectively.



Figure 2: Post-crash trajectory of the vehicles.



Figure 3: Final rest area of the Ford.

Pre-Crash

The NYS Trooper involved in the crash was assigned the task of monitoring the downed utility line and assisting in traffic control. At the time of the crash, he had been on-scene approximately 2 hours. The Trooper parked the 1998 Ford Crown Victoria Police Interceptor straddling the northbound fog line and had activated its emergency lights. He was seated in the Ford and would exit the vehicle when a tractor/semi trailer approached the scene. He would then direct those larger vehicles into the inboard lane in order to avoid the overhead wires. Passenger cars and pick-up trucks were not a threat to the wires and the officer remained in the vehicle as they passed. The 2002 Chevrolet K2500 pick-up truck was northbound hauling a loaded gooseneck cattle trailer. The Chevrolet was driven by a 78 year old male. The driver failed to recognize that the Ford was stopped and reacted too late to avoid the impact. The Trooper was seated in the vehicle at the time of the crash and had no recollection of seeing the approaching Chevrolet.

Crash

The front plane of the Chevrolet struck the rear plane of the Ford in a 12/6 o'clock impact configuration. The northbound momentum of the Chevrolet caused it to then override the rear aspect of the Ford as it was accelerated forward. The vehicles remained in sustained contact and traveled north approximately 36 m (120 ft) at which time the vehicles began to depart the eastside of the road. The Ford separated from the Chevrolet by a counterclockwise rotation and came to rest facing southeast in the roadside ditch approximately 56 m (183 ft) north of the point of impact. The Ford was reportedly on fire as the vehicles separated, as reported by witnesses to the crash. A small puncture to the Ford's fuel tank from contact with the left rear sway bar support bracket was identified during the vehicle inspection. The Chevrolet continued its northeastward trajectory and came to rest in an area of brush and small diameter trees approximately 73 m (240 ft) north of the impact.

A pattern of gouge marks attributed to the front and rear suspensions of both vehicles identified the point of impact. The post-crash trajectory of the Ford was identified by rear tire skid marks and a long gouge located centrally between the rear tire skids. As a result of the impact, the differential input shaft and the drive shaft of the Ford fractured, **Figure 4**. The gouge mark was attributed to contact from the steel flange at the end of the drive shaft, as the Ford was forced down by the override. This contact was the probable source of the fire's ignition. The outer diameter at the end of the drive shaft was ground down from the contact.



Figure 4: Drive shaft deformation.

Scuff marks attributed to the Chevrolet's left front tire and the left trailer tires, respectively, identified the trajectory of the Chevrolet. As the Chevrolet departed the road, the front cross member bottomed out in ditch as it continued to final rest.

Post-Crash

The Trooper exhibited a rearward trajectory and contacted the intruding sheet metal with the posterior aspect of his head. He sustained two large posterior scalp lacerations and was incapacitated as a result of the head contact. Six witnesses to the crash stopped and assisted the police officer from the vehicle. They reportedly had to fight the fire with fire extinguishers during their rescue. The officer was transported and admitted to a local hospital for treatment of his head injury. He was hospitalized for approximately 22 hours. The driver of the Chevrolet was able to exit the vehicle under his own power. He was reportedly transported to a local hospital with a reported broken nose as his primary injury.

1998 FORD CROWN VICTORIA

The 1998 Ford Crown Victoria, **Figure 5**, was identified by the partial Vehicle Identification Number (VIN): 2FAFP71W5WX (Production sequence deleted). The VIN plate at the left forward aspect of the windshield was partially destroyed by the fire. The State Police reported the vehicle's odometer had recorded approximately 175,424 km (109,000 miles). The 4-door, body-on-frame, sedan was equipped with the Police Interceptor Package. A class II trailer hitch with a 3.2 cm (1-1/4 in) receiver was mounted between the frame rails below the rear bumper.



Figure 5: Left side view of the Ford.

Exterior Inspection

The rear plane of the vehicle sustained severe impact damage that extended across its entire 142.2 cm (56.0 in) end-width. The damage was indicative of an override with the above bumper damage biased to the left side and extending longitudinally forward to the left B-pillar. The left rear door was crushed against the B-pillar and the left C-pillar was crushed forward within 18 cm (7 in) of the left B-pillar. The left front door was jammed shut. The right rear door was fully intact and was jammed shut due to the deformation of the vehicle's frame. The right front door was operational and was used to remove the injured Trooper. The trunk space collapsed and its contents crushed forward due to the impact. The deformation extended forward through the rear occupant space, forward to approximately the front seat backs. The fire consumed everything that was combustible in the vehicle and it was a total burn, **Figure 6**.



Figure 6: View through the windshield opening of the front interior.

The left rear and right rear body mounts separated from their respective frame locations. The residual location of the left rear mount was 42.0 cm (16.5 in) forward and 36 cm (14 in) above the deformed frame. The right rear mount was located 41 cm (16 in) forward and 29.0 cm (11.5 in) above the deformed frame. The left wheelbase was foreshortened 46 cm (18 in). The right wheelbase lengthened 18 cm (7 in) due frame distortion and rotation of the rear axle.

The residual crush profile of the Ford was measured along the rear bumper and along the trunk line in order to document the override damage. The crush values at these respective elevations were then averaged to develop a composite profile used for analysis. The averaged residual crush profile was as follows: C1 = 118 cm (46 in), C2 = 97 cm (38 in), C3 = 88 cm (35 in), C4 = 72 cm (28 in), C5 = 41 cm (16 in), C6 = 19 cm (7.5 in). The maximum crush at the left rear bumper corner measured 99 cm (39 in). The maximum above-bumper damage (at the location of the left rear tail light) measured 138 cm (54 in). The Collision Deformation Classification (CDC) was 06-BDEW-6. The total Delta V of the Ford calculated by the Damage Algorithm of the WINSMASH model was 45 km/h (28 mph). The longitudinal and lateral components were +45 km/h (+28 mph) and 0 km/h, respectively. The crash configuration was beyond the scope of the WINSMASH model due to the unknown loaded weight of the trailer, however, the results appear reasonable. A Conservation of Momentum and Energy analysis indicated the vehicle's delta V was in the range of +45 to 58 km/h (+28 to +36 mph), based on the Chevrolet's impact speed of 64 to 80 km/h (40 to 50 mph). The WINSMASH analysis was consistent with the analysis by the Conservation Principles. **Figures 7 through 9** are views of the Ford's exterior damage.



Figure 7: Rear view of the Ford.



Figure 8: Left lateral view depicting the maximum deformation.



Figure 9: Right rear deformation.

2002 CHEVROLET K2500 PICK-UP TRUCK

The 2002 Chevrolet K2500 pick-up truck, **Figure 10**, was identified by the Vehicle Identification Number (VIN): 1GCHK24U62F (production sequence deleted). The 3/4 ton, regular cab, 4x4 truck was designed with a 338 cm (133 in) wheelbase and had a gross vehicle weight rating of 4173 kg (9200 lb). The power train consisted of a 5.9 liter V-8 engine linked to a 4-speed automatic transmission. The service brakes were a 4-wheel anti-lock system.



Figure 10: View of the damaged Chevrolet.

The Chevrolet was hauling a gooseneck trailer with two head of cattle at the time of the crash. The trailer

was hitched to the truck by a hitch ball welded to a steel plate. The plate was fastened to the pick-up bed by a four bolt pattern. Upon impact with the Ford, the plate-to-hitch ball weld fractured allowing the trailer to separate from the pick-up truck. The trailer moved forward relative to the pick-up and the trailer coupling penetrated the forward aspect of the pick-up bed. The penetration of the coupling recaptured the trailer and the unit remained attached through the course of the collision to final rest. The State police investigation determined the combined weight of the pick-up truck, trailer and cattle was 5670 kg (12,500 lb). The trailer was not available for inspection.

Exterior Damage

The front plane of the Chevrolet sustained 136.0 cm (53.5 in) of direct contact damage that began 53 cm (21 in) left of the vehicle's center line and extended to the right front bumper corner, **Figure 11**. The combined width of the direct and induced damage extended across the entire 165 cm (65 in) frontal end width. The residual crush profile was as follows: C1 = 0, C2 = 9.0 cm (3.4 in), C3 = 22.0 cm (8.8 in), C4 = 32.0 cm (12.5 in), C5 = 24.0 cm (9.5 in), C6 = 28.0 cm (11 in). The Collision Deformation Classification (CDC) was 12-FDEW-2.



Figure 11: Front view of the Chevrolet.

The energy of the impact was primarily managed by the vehicle's structures forward of the radiator support plane and engine cradle. The damaged components included the front bumper, grille, right headlamp assembly, engine cradle and right front suspension. There was a right side bias to the damage pattern due to the slight offset impact orientation of the vehicles. The right wheelbase was reduced 14.7 cm (5.8 in). There was earth and grass embedded in the undercarriage as a result of an impact with the ground during the road side departure. The total Delta V of the Chevrolet calculated by the Damage Algorithm of the WINSMASH model was 22.0 km/h (13.7 mph). The longitudinal and lateral components were -22 km/h (-13.7 mph) and 0 km/h, respectively. The impact speed calculated by the Trajectory Algorithm was 63.0 km/h (39.2 mph). The crash configuration was beyond the scope of the WINSMASH model due to the unknown loaded weight of the trailer, however, the results appear reasonable. This calculated speed was consistent with the 64 to 80 km/h (40 to 50 mph) speed range calculated by the Conservation of Momentum and Energy Principles.

Event Data Recorder

The Chevrolet was equipped with an Event Data Recorder (EDR) integrated into the Sensing Diagnostic Module (SDM) of its Supplemental Restraint System (SRS). Although the impact induced deceleration of the Pick-up was not sufficient to warrant the deployment of the vehicle's SRS, a Near Deployment event was recorded. **Figure 21** at the end of this report is the summary page of the recorded Near-deployment data.

Approximately five seconds prior to the crash, (T-5), the Chevrolet was traveling at a recorded speed of 91 km/h (57 mph). As the driver of the Chevrolet approached the stopped Ford, the driver reacted to the impending crash by applying the brakes at T-4. The brake application was consistent with the speed reduction to 80 km/h (50 mph). At T-3, the vehicle's speed had reduced to 60 km/h (37 mph) and the brakes were off. During this time interval (T-4 to T-3) the impact with the Ford occurred. The force of the impact dislodged the driver's foot from the brake pedal consistent with the brake Off status at that time. At T-1, the Chevrolet had decelerated to a speed of 26 mph and the brakes remained Off. At this time the Chevrolet was departing the right side of the road and bottomed out in the road side ditch. The off road impact caused the non-deployment event to be recorded. The CDC of this impact was 00-UFDW-1.

The EDR only has the capability to record one Near-Deployment event. Should multiple Near-Deployment events occur during a crash sequence, only one event will be stored. It was probable that the vehicle-to-vehicle impact also triggered a Near-Deployment event. However that event was overwritten by the Near-Deployment event caused as the Chevrolet departed the road and bottomed out.

1998 FORD CROWN VICTORIA

Fuel System

The subject vehicle was filled with fuel the day before the crash. During his interview, the Trooper estimated the fuel level was approximately ½ to ¾ full at the time of the crash. The capacity of the fuel tank was 7.2 liters (19 gallons).

Figure 12 is a view of the rear undercarriage of an exemplar Ford Crown Victoria. The front of the vehicle is toward the top of the figure. The fuel tank was located immediately forward of the trunk well and approximately 25 cm (10 in) behind the rear axle. The carry straps securing the tank were attached to the upper and lower aspects of the trunk well. The left sway bar bracket is denoted by the red arrow. **Figure 13** is a right lateral view depicting the distance between the sway bar bracket and the tank.

The filler door was located 37.6 cm (14.8 in) aft of the left rear axle and the filler neck was routed through the left rear quarterpanel. The

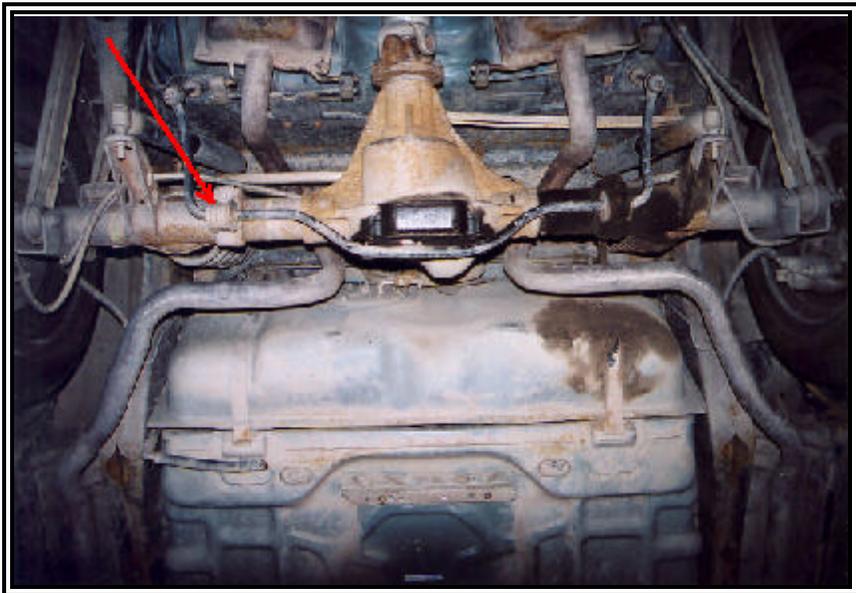


Figure 12: View of the fuel tank and rear axle components of an exemplar Ford Crown Victoria.

filler door was displaced forward 50.3 cm (19.8 in). The residual location of the filler door was 12.5 cm (5.0 in) forward of the post-crash left rear axle location. There was no separation of the filler neck from the tank during the crash, **Figure 14**. Approximately 14.7 cm (5.8 in) of the filler neck remained within the tank. The non-combustible portion of the filler cap was threaded into the neck at the time of the inspection.



Figure 13: Distance between sway bar bracket and the fuel tank.



Figure 14: Filler neck and fuel tank after removal from the vehicle.

The deformation of the fuel tank was biased to its left side. The damaged tank did not have a large reduction in its volume. Two large creases were noted on the left forward side of the tank from direct contact with the left lower shock absorber mount. The creases measured approximately 11.4 cm (4.5 in) in length. No punctures in the tank were identified prior to its removal.

Figures 15 and 16 are overall views of the tank after its removal from the vehicle. A distinct burn pattern was noted on the rear side of the tank (refer to Figure 15). Close inspection of the tank identified a small vertically oriented puncture/cut in the area of the left tank strap on the forward side of the tank. The area in question is highlighted in red in Figure 14. The hole measured 11.1 mm (0.43 in) long by 1.5 mm (0.06 in) wide. **Figures 17 and 18** are progressively closer views of the puncture/cut.

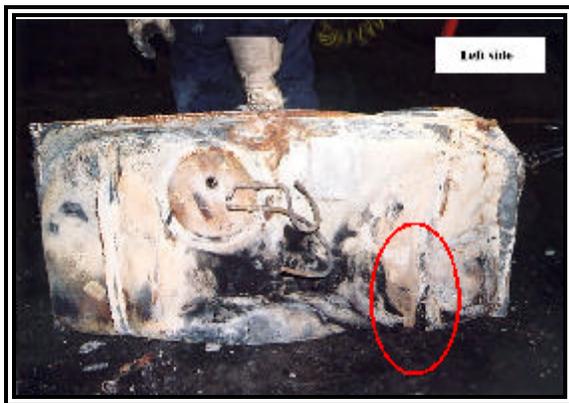


Figure 15: View of the forward side of the tank.



Figure 16: View of the rear side of the tank.



Figure 17: View depicting the location of the puncture/cut on the left side of the tank.

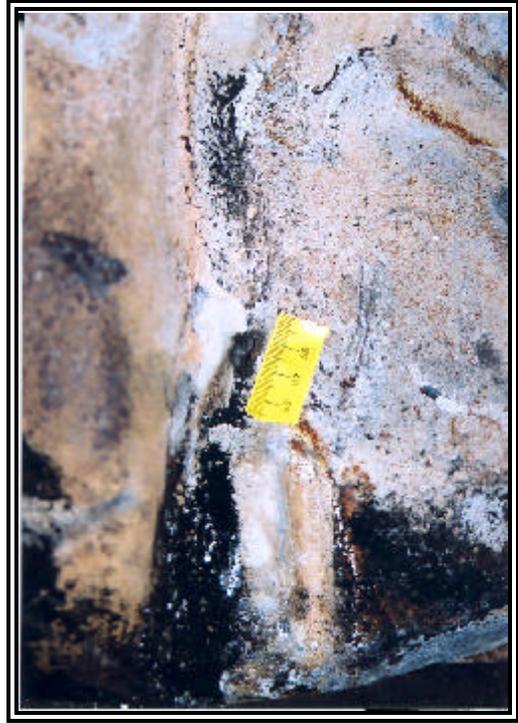


Figure 18: Close-up view of the puncture/cut.

During the deformation of the vehicle, the forward side of the tank contacted the rear axle and left rear sway bar bracket and shock absorber mount. The mechanism that caused the puncture of the fuel tank was contact between the fuel tank, the tank's left carry strap and the left sway bar bracket. Refer to **Figure 19**. Two impressions from the outer edges of the bracket were visible in the tank as a result of the contact. Additionally, the edge of the carry strap in the area of the hole was rolled over and there was a sharp burr. It should be noted, the inboard side (right edge) of the bracket caused the tank puncture. The Technical Safety Bulletin (TSB) issued by Ford on October 21, 2001 addressed grinding the tabs on the outboard (left side) of the bracket (relative to the vehicle). This service was performed on the subject vehicle. The evidence of compliance with the TSB can be seen on the left edge of the bracket in Figure 19.



Figure 19: View of the contact between the tank, carry strap and left rear sway bar bracket.

DRIVER DEMOGRAPHICS

Age/Sex:	47 year old/ Male
Height:	178 cm (70 in)
Weight:	102 kg (225 lb)
Restraint Use:	Unrestrained
Usage Source:	Interview
Medical Treatment:	Transported and hospitalized for approximately 22 hours.

DRIVER INJURIES

<i>Injury</i>	<i>Injury Severity (AIS Update 98)</i>	<i>Injury Mechanism</i>
Closed head injury, awake upon admission, GCS 15, loss of consciousness unknown	Minor (160499.1,0)	Intruding rear body panels
Two lacerations of the occipital-parietal scalp, 5 cm linear and 10 cm angular	Minor (190602.1,6)	Intruding rear body panels
3.5 cm forehead laceration above the left eye	Minor (290602.1,7)	Accessory equipment mounted forward and right of the steering wheel to the top of the instrument panel, probable
Right shoulder contusion	Minor (790402.1,1)	Accessory equipment mounted within the center console, probable
Left shoulder contusion	Minor (790402.1,2)	Steering wheel rim
Left knee contusion	Minor (890402.1,2)	Knee bolster

Injury Source: Hospital Emergency Room Records and Discharge Summary

DRIVER KINEMATICS

Immediately prior to the crash, the Ford Crown Victoria was parked on the road side and the driver was seated unrestrained in the driver seat. Upon impact, the driver initiated a rearward trajectory in response to the 6 o'clock direction of the impact force. The driver loaded the seat back with his torso and was compressed into the seat. The head restraints were reportedly adjusted to the down position. His head/neck probably contacted the head restraint. Due to the magnitude of the impact, the driver probably began to ramp up the seat back. This kinematic pattern further exposed his head to the intruding rear body panels. His head impacted the deformed body panels causing the identified posterior head lacerations. The driver was probably rendered unconscious at this time.

As the stressed seat back and cushion began to unload, the driver rebounded forward. The driver's forward rebound trajectory displaced him into the knee bolster, steering wheel and the accessory components mounted to the top of the instrument panel and within the center console. The driver then slumped back into his seat where he was found by the passer-bys.

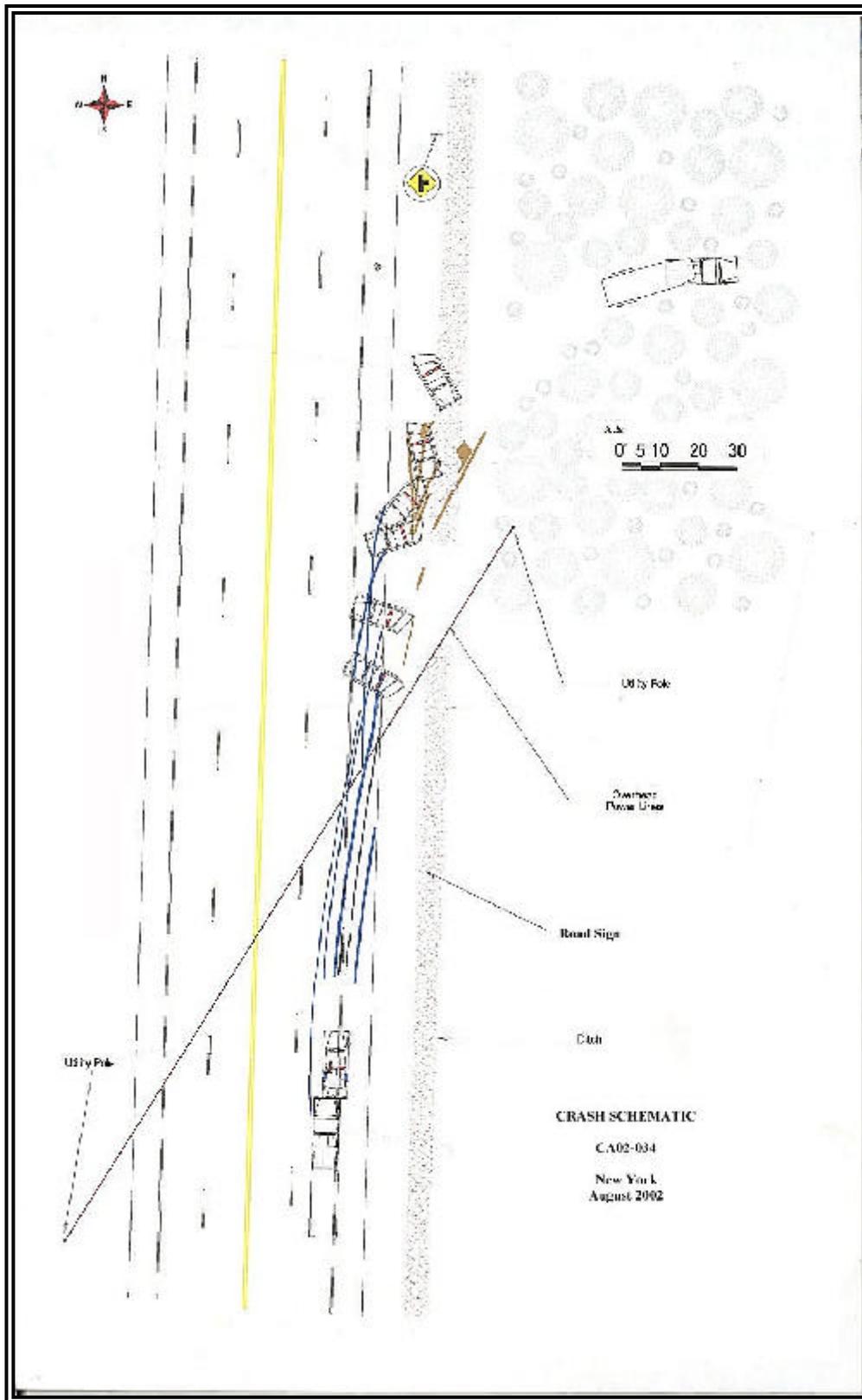


Figure 20: Crash schematic.