CRASH DATA RESEARCH CENTER
Calspan Corporation
Buffalo, NY 14225

CALSPAN ON-SITE AMBULANCE CRASH INVESTIGATION
SCI CASE NO: CA09005

VEHICLE: 1998 FORD E350 TYPE III AMBULANCE
LOCATION: SOUTH CAROLINA

CRASH DATE: FEBRUARY, 2009

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

1. Report No. CA09005	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle Calspan On-Site Ambulance Crash Investigation Vehicle: 1998 Ford E350 Type III Ambulance Location: South Carolina		*5. Report Date*: April 2009 *6. Performing Organization Code*	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Calspan Corporation Crash Data Research Center P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00500.0000.0034 *11. Contract or Grant No.* DTNH22-07-C-00043	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		*13. Type of Report and Period Covered* Technical Report Crash Date: February 2009 *14. Sponsoring Agency Code*	
15. Supplementary Note An investigation of a multiple event crash involving a 1998 Ford E350 Type III ambulance.			

16. Abstract

This investigation focused on the crash dynamics and injury sources surrounding the single-vehicle crash of a 1998 Ford E350 Type III ambulance that was involved in a multiple event crash sequence. The ambulance was occupied by a 56 year old restrained male driver, a 45 year male paramedic and a 51 year old male patient. The paramedic and patient were riding in the patient compartment of the ambulance. The patient was recovering from serious burn injuries sustained in a traffic crash that occurred in November 2008. He was being transported from a Georgia Burn Center to an acute care specialty hospital closer to his North Carolina home at the time of the crash. The crash occurred during the daylight hours in clear weather conditions. The Ford ambulance was eastbound on a three-lane divided interstate. The respective travel lanes were separated by a concrete barrier wall. The driver lost consciousness due to an adverse reaction to prescription medication he was taking. The vehicle departed the right side of the interstate and traversed the road side striking a highway sign and sideswiping a brush/tree line. The driver steered back to the left and over-corrected causing the ambulance to reenter and cross the eastbound lanes to an impact with the center barrier. The frontal air bags deployed as a result of the barrier impact. The concrete barrier redirected the vehicle back to the right and the ambulance came to rest straddling the inboard traffic lanes. The driver was not injured. The paramedic sustained minor soft tissue injuries as a result of the crash. The 51 year old patient sustained life-threatening injuries and died approximately two hours after transport to a Level 1 Trauma Center. The Trauma Center was located approximately 16 km (10 miles) from the crash site.

17. Key Words Road side departure Frontal crash Type III ambulance Patient compartment Bariatric cot…..Fatal injuries		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 19	*22. Price*

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BACKGROUND

This investigation focused on the crash dynamics and injury sources surrounding the single-vehicle crash of a 1998 Ford E350 Type III ambulance that was involved in a multiple event crash sequence. **Figure 1** is a front left oblique view of the Ford. The ambulance was occupied by a 56 year old restrained male driver, a 45 year male paramedic and a 51 year old male patient. The paramedic and patient were riding in the patient compartment of the ambulance. The patient was recovering from serious burn injuries sustained in a traffic crash that occurred in November 2008. He was being transported from a Georgia Burn Center to an acute care specialty hospital closer to his North Carolina home at the time of the crash. The crash occurred during the daylight hours in clear weather conditions. The Ford ambulance was eastbound on a three-lane divided interstate. The respective travel lanes were separated by a concrete barrier wall. The driver lost consciousness due to an adverse reaction to prescription medication he was taking. The vehicle departed the right side of the interstate and traversed the road side striking a highway sign and sideswiping a brush/tree line. The driver steered back to the left and over-corrected causing the ambulance to reenter and cross the eastbound lanes to an impact with the center barrier. The frontal air bags deployed as a result of the barrier impact. The concrete barrier redirected the vehicle back to the right and the ambulance came to rest straddling the inboard traffic lanes. The driver was not injured. The paramedic sustained minor soft tissue injuries as a result of the crash. The 51 year old patient sustained life-threatening injuries and died approximately two hours after transport to a Level 1 Trauma Center. The Trauma Center was located approximately 16 km (10 miles) from the crash site.

Figure 1: 1998 Ford E350 Type III ambulance.

This crash was identified by the National Highway Traffic Safety Administration's (NHTSA's) Office of Emergency Medical Services (OEMS) on February 5, 2009. The OEMS asked the Crash Investigation Division (CID) of the NHTSA to initiate further investigation of the crash through the Special Crash Investigation (SCI) program. The Calspan SCI team initiated follow-up investigation and established cooperation with the ambulance service. The ambulance was relocated to its base of operations in Georgia and was available for inspection. The on-site scene and vehicle inspections took place February 18 and 19, 2009.

SUMMARY

VEHICLE DATA

1998 Ford E350 Ambulance

The 1998 Ford E350 chassis was manufactured as an incomplete vehicle in June 1998 and was identified by the Vehicle Identification Number (VIN): 1FDXE40FXWH (production sequence deleted). The Ford E350 was configured on a 401 cm (158 in) wheelbase with a dual rear axle. It had a Gross Vehicle Weight Rating (GVWR) of 6,373 kg (14,050 lb). The odometer read 304,436 km (189,173 miles) at inspection. The power train consisted of a 6.8 liter/V-10 diesel engine linked to a four-speed automatic transmission. The service brakes were a front disc/rear drum system without antilock. The manufacturer's recommended tire size was LT225/75R16. The recommended cold tire pressure was 448 kPa (65 PSI) front and 552 kPa (80 PSI) rear. The ambulance was equipped with Uniroyal LT245/75R16 tires and the specific data measured at the time of the SCI inspection was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	Tire flat	9 mm (11/32 in)	Yes	Sidewall cut/ Tire debeaded
LR inner	Unknown	8 mm (10/32 in)	No	None
LR outer	Unknown	8 mm (10/32 in)	No	None
RF	331 kPa (48 PSI)	10 mm (12/32 in)	No	None
RR inner	414 kPa (60 PSI)	9 mm (11/32 in)	No	None
RR outer	124 kPa (18 PSI)	6 mm (8/32 in)	No	None

The patient compartment of the ambulance was manufactured by American Emergency Vehicles in June 1999. The Type III compartment bore the model designation Trauma Hawk WDF G17. The curb weight of the ambulance was listed as 4,305 kg (9,490 lb). The ambulance could carry a payload of 2,068 kg (4,560 lb) inclusive of 136 kg (300 lb) of specified optional equipment. The patient compartment had a typical layout with a double rear door for cot loading, a three passenger bench seat along the right side, a right side entry door, a rear facing paramedic seat behind the driver and multiple cabinets for storage.

AMBULANCE COMPANY AND PERSONNEL

The involved ambulance company was based in Georgia and provided facility based medical transport. This company was not a 9-1-1 emergency responder. The company had been in business approximately 14 years and operated a fleet of ten ambulances.

The driver of the ambulance was a 56 year old male. He was a retired truck route driver and had been employed by the ambulance company for approximately five months. He had been an Emergency Medical Technician (EMT) since 1973. The driver's normal work schedule was Monday through Friday, 0830 to 1730 hours. He worked a normal shift the day prior to the crash without complications and had slept approximately eight hours. He felt well rested. He arrived at work at approximately 0730 hours on the day of the crash.

The driver had a reported height and weight of 170 cm (67 in) and 97 kg (214 lb). He had a 12 year history of diabetes and had been taking insulin approximately two years. He was also taking prescription medication for high blood pressure and for a prostate condition. Four days prior to the crash, the driver received a prescription change for his blood pressure medication. The prescription drug combination caused the driver to lose consciousness which precipitated the road side departure crash.

The paramedic seated in the patient compartment was a 45 year old male with a height and weight of 178 cm (70 in) and 95 kg (210 lb). He was employed full time by the ambulance company and it was his only job. He worked a rotating 24 hour shift. The day of the crash was his first shift back after 48 hours off-duty. He arrived at work at approximately 1030 hours on the day of the crash. He was seated in the rear facing seat behind the driver and was unrestrained.

PATIENT AND TRANSPORT DETAILS

The crash occurred during the transport of the 51 year old male recuperating burn patient. He was being transferred from a Georgia Burn Center to an acute care specialty hospital closer to his North Carolina residence. He had an estimated height and weight of 191 cm (75 in) and 132 kg (290 lb). He was being transported on a Stryker MX-Pro bariatric cot. The patient was involved in a traffic crash in November of 2008 and had suffered serious burns to his trunk and lower extremities. The burns had required multiple skin grafts and were healing without complications. The patient's autopsy report indicated that he recently had a myocardial infarction and suffered from cardiomegaly and acute pericarditis. During the transport, the patient's heart was monitored and he was being ventilated through a tracheotomy.

CRASH SITE

This single-vehicle, multiple event crash occurred during the daylight hours of February 2009. At the time of the crash, the weather was clear. The crash occurred on a three-lane, divided east/west interstate highway. The road had a negative three percent grade in the eastbound direction. The respective traffic lanes were separated by a "Jersey style" concrete median barrier. The eastbound traffic lanes measured 3.7 m (12 ft) in width. A 2 m (6 ft) section of the barrier was identified as the point of impact. The inboard shoulder adjacent to the barrier was an estimated 1.2 m (4 ft) in width. The outboard shoulder measured 3.1 m (10.2 ft) wide. A 1.5 m (4.9 ft) wide rumble strip was cut into the shoulder. The grassy terrain outboard the shoulder had a 20 percent negative grade to the south. A highway sign located 6.8 m (22.3 ft) south of the pavement was positioned along the vehicle's off-road trajectory. The sign board measured 5.6 m x 1.7 m (18.5 ft x 5.6 ft) and was supported by three breakaway I-beam posts. The I-beam posts were 5.3 m (17.3 ft) in height. A brush/scrub tree line located 8.3 m (27.2 ft) south of the road was also contacted during the crash sequence. The interstate speed limit was

Figure 2: Trajectory view at the road side departure.

96 km/h (60 mph). **Figure 2** is an eastbound view at the ambulance's roadside departure. The ambulance departed the interstate 269 m (883 ft) prior to the point of impact with the median barrier.

CRASH SEQUENCE

Pre-Crash

The driver and paramedic picked up the patient during the morning hours on the day of the crash. They departed the Burn Center and were approximately one hour into their trip when the paramedic asked the driver to pull off the highway. The patient was reportedly uncomfortable and the paramedic needed assistance resituating the patient on the cot. The driver exited the interstate and stopped at a gas station/convenience store. The driver assisted the paramedic in repositioning the patient. During the stop, the driver tested his blood sugar level and found it to be normal. Both individuals purchased some food for the trip and returned to the vehicle.

The ambulance reentered the interstate and was traveling east in the outboard lane. Approximately 2 km (1 mile) into the continuation of their trip, the driver lost consciousness (due to a medication reaction) and relinquished control of the ambulance. The ambulance traversed the shoulder, across the rumble strips and departed the pavement at a shallow angle estimated at five degrees. The trajectory of the ambulance was evidenced by rolling tire marks through the grass that were documented at the time of the SCI inspection. Along the vehicle's trajectory, all six tire imprints were visible in the soft soil of the road side terrain.

The ambulance departed the highway in a tracking mode and traveled 89 m (292 ft) along the roadside. At this point in its trajectory, the ambulance began to off-track due to the 20 percent cross slope of the embankment. The rear tires began tracking outside (down slope) of the front tires. **Figure 3** is a trajectory view of the ambulance depicting the onset of the off tracking 100 m (328 ft) from the road departure. Two schematics of the crash are attached to the end of this report. **Figure 19** is an overall crash schematic. **Figure 20** is a larger scale schematic depicting the impact sequence.

Figure 3: Trajectory view of the ambulance 100 m (328 ft) from road departure.

Crash

The front right corner of the ambulance impacted the highway sign post (Event 1) that was located 140 m (459 ft) east of the roadside departure. The sign post was located 6.8 m (22.3 ft) south of the pavement edge. Refer to **Figure 4**. Deformation to the post was noted 109 cm to 135 cm (43 in to 53 in) above its base and a blue paint transfer was evident throughout the area. The transfer corresponded to the blue detail paint of the ambulance cab. As the ambulance continued forward, the post pocketed in the right fender immediately forward of the A-pillar. The base of the post separated from its mounting points and the post contacted and deformed the upper aspect of the patient compartment along the right side plane (Event 2). A brush/scrub tree line was located 14 m (46 ft) east of the sign and 8.6 m (28.2 ft) south of the road. The right side plane of the patient compartment contacted and was abraded by the trees in swiping contact

(Event 3) as the ambulance continued east. The contact length to the tree line measured 13 m (43 ft). At this point, the ambulance was off-tracking approximately 20 degrees (rotated CCW) and traveling parallel to the interstate (**Figure 5**). As the vehicle continued to the east, the ambulance then began to climb the cross slope.

Figure 4: Trajectory view at the highway sign and tree line impacts.

Figure 5: Trajectory view at the tree line contact.

Over the next 65 m to 75 m (213 ft to 246 ft), the ambulance ascended the cross slope and reentered the highway. Although he had no recollection of the crash, the driver applied a left steer and may have accelerated in order to redirect the trajectory of the vehicle. Without these driver inputs, the ambulance would have continued down the cross slope of the embankment. The ambulance returned to the asphalt shoulder and travel lanes road 238 m (782 ft) from its initial departure. As the front tires contacted the pavement, the combination of the steering angle and the sudden increase in friction at the tire/pavement interface increased the CCW rotation rate of the ambulance. The ambulance reentered the road in a CCW yaw; the rear tire sets crossed over and were tracking outside the front tire sets. The vehicle's trajectory was in a northeast direction. **Figure 6** is an on-scene police image of the vehicle's yawing trajectory. This tire evidence had partially eroded due to the traffic flow at the time of the SCI inspection.

Figure 6: Yawing trajectory at the highway reentry.

The ambulance traversed the traffic lanes and the front left aspect of the vehicle impacted the center barrier (Event 4). The orientation of the front of the ambulance to the barrier resulted in an 11 o'clock direction of force to the Ford. The left frame member deformed inboard and the

left tire/wheel fractured at the suspension. The left front tire/wheel deformed rearward and inboard under the center of the vehicle as the ambulance mounted the center barrier and was redirected to the right. The front of the ambulance disengaged from the barrier with a southeast trajectory. The left rear aspect of the patient compartment contacted the barrier (Event 5) and was abraded as the vehicle slid to rest. The ambulance came to rest straddling the inboard traffic lane 16 m (52 ft) from the impact. **Figure 7** is a view of the vehicle's final rest.

Figure 7: On-scene police image of the final rest of the ambulance

The severity of the barrier impact (delta V) calculated by the Damage Algorithm of the WINSMASH model was 20 km/h (12 mph). The longitudinal and lateral delta V components were -17 km/h (-11 mph) and 10 km/h (6 mph), respectively. This calculated value under-estimated the severity of the crash due to the use of only the residual crush profile. The residual bumper crush did not reflect the energy absorbed during the frame deformation or suspension damage. The delta V of the barrier impact was in the range of 32 to 40 km/h (20 to 25 mph) based on SCI field experience.

Post-Crash

The driver's first recollection was a passer-by pounding on the left front window. The driver regained his thoughts, released his seat belt and opened the left door. The driver ran to the back of the ambulance and opened the rear doors. The paramedic was calling for assistance. The patient had partially separated from the cot. He was reportedly on his left side still within the cot's restraints. The driver entered the patient compartment and began assisting the paramedic with the ventilator. The patient was alert and gave positive indications to the driver and paramedic that he was not seriously injured.

The police and a local ambulance service responded to the scene. The patient was removed from the ambulance via a spine board and transferred to another ambulance. He was transported to a regional trauma center. He arrived in the Emergency Room and was examined approximately 33 minutes post-crash. The patient was responsive, had no complaints and denied chest and/or abdominal pain. He was then transferred to trauma services for further inpatient care. Over the course of the next 60 minutes the patient's condition rapidly deteriorated. He was pronounced deceased 175 minutes post-crash of undetected spleen and liver lacerations that resulted in uncontrolled intra-abdominal bleeding. The hospital records of trauma service were not available for review. An autopsy was conducted which identified the intra-abdominal lacerations.

The driver and paramedic were also transported by ground ambulance. The driver sustained minor cheek abrasions due to contact with the deployed driver air bag. However, he was hospitalized for ten days as the issues relating to his unconsciousness, blood pressure, and

medications were evaluated. The paramedic sustained a facial, scalp and lower extremity contusions and was treated and released.

1998 FORD E350 AMBULANCE

Exterior Damage

The 1998 Ford E350 ambulance sustained impact damage to the right, front, and left planes as a result of the multiple event crash sequence. The right plane/sign post impact (Event 1) resulted in a direct contact damage pattern that began on the leading aspect of the fender 53 cm (21 in) forward of the right front axle and extended rearward 109 cm (43 in) ending at the mid-aspect of the A-pillar. **Figure 8** is a right view of Ford's cab damage. A pocketing of the sign post into the fender occurred within this damage region above the level of the right front tire. The length of the pocketed deformation measured 53 cm (21 in) and the maximum lateral crush was 10 cm (4 in). The Collision Deformation Classification (CDC) of this impact was 12-RFHW2

The leading vertical edge of the patient compartment, at its junction with the cab, then struck the sign post (Event 2). This contact region began 137 cm (54 in) above the ground and extended to the top of the compartment. The contact then continued rearward along the top aspect of the box to the back plane. Several regions of body damage resulted with a maximum lateral deformation of 2 cm (1 in). The CDC of this contact was 12-RZGS1. **Figure 9** is a right side view of the patient compartment.

Figure 8: Right view of the Ford cab.

Figure 9: Right side plane damage.

The right side plane of the patient compartment also sustained surface abrasions as a result of contact to the tree line (Event 3). The abrasions began 225 cm (88.5 in) rearward of the right front axle and extended 339 cm (133 in) to the back plane. The CDC of this contact was 12-RZAS1

The front plane of the ambulance sustained 65 cm (25.5 in) of direct contact damage as a result of the center barrier impact (Event 4). The direct contact began 24 cm (9.5 in) left of center and extended to the left front bumper corner. The combined width of the direct and induced damage extended across the entire 178 cm (70 in) undeformed end width. **Figure 10** is a front left oblique view of the damage. The residual crush profile, measured along the front bumper, was

as follows: C1 = 34 cm (13.4 in), C2 = 14 cm, (5.5 in), C3 = 0, C4 = 0, C5 = 0, C6 = 5 cm (2 in). The force of the angular impact deformed the left frame rail inboard 23 cm (9 in) at the body mount located aft of the left front wheel opening. The left front suspension completely fractured and separated at its attachment to the frame. The left front tire and wheel was forced rearward and inboard. The cab's structure forward of the B-pillar was shifted to the right approximately 23 cm (9 in). The front left door remained closed during the crash. The door was forced open by the driver during his exit. The right front door was jammed closed by compression. The roof of the cab was buckled above the driver's position. The windshield was completely fractured. The left window glazing was intact. The right window glazing had disintegrated but was held in place by an after-market window tint. The right wheelbase measurement was unchanged. The CDC of the impact was 11-FYEW3.

Figure 10: Front let oblique view of the Ford.

The rear aspect of the ambulance's left side plane contacted the center barrier during the later stages of the crash sequence as the vehicle traveled to final rest (Event 5). Horizontal body panel abrasions were noted to the left rear corner. The abrasions measured approximately 15 cm x 51 cm (6 in x 20 in) length by height. The abrasions and deformation prevented the door of the small compartment at that location from opening. **Figure 11** is a left exterior view of the ambulance. The CDC of this contact was 12-LBES1.

Figure 11: Left side view.

Interior Damage

Inspection of the passenger compartment of the ambulance was unremarkable. There was no intrusion or interior damage associated with the exterior crash force. There was no observed evidence of interior occupant contact points.

The box-mounted driver seat was adjusted to the full rear track position. The seat track travel measured 19 cm (7.5 in). The seat back was reclined 10 degrees aft of vertical. The horizontal distance from the seat back to the driver air bag module in the center of the steering wheel measured 63 cm (24.8 in). The anti-submarine angle of the seat cushion measured 10 degrees. The two-spoke, tilt steering wheel was adjusted to the center position. There was no deformation of the steering wheel rim. There was no separation of the steering column's shear capsules.

Safety Belt System

The 1998 Ford E-350 was equipped with manual 3-point lap and shoulder safety belts for the two seating positions. The driver's safety belt was configured with continuous loop webbing, a sliding latch plate, a height adjustable D-ring, an Emergency Locking Retractor (ELR), and a buckle mounted pretensioner. The D-ring was adjusted 3 cm (1 in) below the full-up position at the time of the SCI inspection. The buckle pretensioner had actuated evidenced by buckle stalk compression. The pretensioner actuated as a result of the median barrier impact. The webbing was stowed in the retractor upon initial inspection. Examination of the webbing and latch plate revealed historical use consistent with the age of the vehicle. Minor frictional abrasions were noted on the hardware of the latch plate consistent with use at the time of the crash.

The front right safety belt was configured with continuous loop webbing, sliding latch plate, height adjustable D-ring, a switchable ELR/Automatic Locking Retractor (ALR) and a buckle pretensioner. The front right seat was not occupied during the crash. The right buckle pretensioner had also actuated during the barrier impact.

Frontal Air Bag System

The 1998 Ford E-350 was equipped with a redesigned frontal air bag system for the driver and front right positions. As a result of the median barrier impact, the frontal air bag system deployed. The driver's air bag was conventionally located in the center of the steering wheel hub and was concealed by two cover flaps. The top cover flap measured 19 cm (7.5 in) in height and 13 cm (5 in) in width. The lower cover flaps measured 6 cm (2.5 in) in height and 13 cm (5 in) width. The driver's air bag membrane measured 61 cm (24 in) in diameter in its deflated state. The air bag contained two tethers at the 12 and 6 o'clock positions and was vented by two vent ports at the 11 and 1 o'clock positions. There was no damage or occupant contact points present on the air bag membrane.

The front right air bag was a top mount design incorporated into the right aspect of the instrument panel. The air bag was concealed by a single cover flap that measured 29 cm (11.5 in) in height and 39 cm (15.5 in) in width. The rectangular shaped air bag membrane measured 91 cm (36 in) in height and 46 cm (18 in) in width. The air bag contained two vent ports on the side panels. The air bag membrane was free of damage and occupant contacts.

PATIENT COMPARTMENT

The exterior panels of the patient compartment sustained minor sideswiping type damage as described in the *Exterior Damage* section of this report. There was no separation of the compartment's panels or intrusion into the compartment's interior. There were three exterior compartments on the left side of the ambulance. The doors of these compartments remained closed during the crash sequence. The compartment doors located forward of the rear axle were operational at the time of the SCI inspection. A 127 cm (50 in) tall H-size oxygen cylinder was located in the compartment immediately aft of the driver and was supplying oxygen to the patient at the time of the crash. The tank was secured in place by a single ratchet style load strap at the mid-upper aspect. The tank remained secured throughout the crash sequence. The left rear compartment door (aft of the rear axle) could not be opened due to the minor body panel deformation that resulted from contact with the center barrier described previously. The right side of the ambulance contained four exterior compartments and an entry door into the patient

compartment. All of the doors remained closed during the crash sequence. All the doors were operational at the time of the SCI inspection, except the small compartment immediately aft of the rear axle. The spring loaded door handle for this compartment separated during the contact with the tree line.

Figures 12 – 14 are interior views of the patient compartment. The compartment was not damaged. The supplies had been off-loaded prior to the inspection. The paramedic seat was located on the forward left side behind the driver's seat. This position was equipped with a non-adjustable, box-mounted rear-facing bucket seat with a lap (only) safety belt. The safety belt consisted of a sewn on latch plate, retractable webbing, and an ALR retractor. The lap belt revealed minor historical use evidence. There was no observed crash related evidence. The paramedic was seated in this position. The remaining food items purchased immediately prior to the crash were observed in the cabinet and on the counter to the right of the seat during the SCI inspection. The left side interior consisted of counter space and multiple hanging cabinets. The cabinets had sliding plexiglass doors with aluminum pull-handles. The right side consisted of a side-facing three-passenger bench seat. The bench was equipped with lap belts.

Figure 12: Rear-facing paramedic seat.

Figure 13: Left interior view.

Figure 14: Right interior bench seat.

At the time of the crash, the cot was secured to the floor of the ambulance for transport. Numerous unsecured items were dislodged by the frontal impact and were displaced about the interior of the compartment. **Figure 15** is an on-scene police image taken of the patient compartment interior at final rest. For unknown reasons, the antler bracket, that secured the forward (head) aspect of the cot, was removed from its floor mount post-crash. The bracket is visible and highlighted in the on-scene police image (figure 15).

At the time of the SCI inspection, the antler bracket was loose on the floor. Only one of the spinner nuts that fastened the bracket to the floor could be found. The antler bracket was not deformed and the floor mounting locations were not damaged. The floor mounted rail clamp that secured the rear (foot) aspect of the cot was in place and operational. There was no floor deformation in the area of the clamp. The clamp remained closed during the crash sequence and the cot remained secured. **Figure 16** is a view of the patient compartment floor area, antler bracket and rail clamp. Post-crash blood evidence from an unknown source was noted on the floor.

Figure 15: On-scene police image of the patient compartment interior.

Figure 16: Floor view of the cot antler bracket and the rail clamp.

PATIENT COT

The cot used to transport the patient in this crash was manufactured by Stryker, Model Number: 6083 MX-PRO; Serial Number: 050739782. **Figure 17** is a view of the cot. This cot was constructed of steel tubing and was designed to be used for bariatric transport. The lower frame of the cot was a scissor design which allowed for height adjustment. The cot measured 183 cm (72 in) in length and 64 cm (25 in) in width. The angle of the back rest was set via a pneumatic adjustment. The specific angle of the back rest at the time of the crash was not known. The paramedic reported the back rest was slightly elevated. The bariatric cot was larger than a standard cot and had a greater weight rating. The standard cot measured 180 cm (71 in) in length and 46 cm (18 in) in width. This Stryker model was capable of transporting a total weight of 726 kg (1,600 lbs) in the lowered position and 386 kg (850 lbs) in its fully raised position. The patient that was transported weighed approximately 132 kg (290 lbs) and was within the weight requirements of the cot.

Figure 17: Stryker bariatric cot.

When secured in the ambulance for transport, the frame work supporting the cot's front wheels nested in the antler bracket that was attached to the ambulance floor. A locking pin attached to the tubular frame between the right wheels was captured by the floor mounted rail clamp. The locking pin measured 3 cm (1 in) diameter and 5 cm (1.8 in) in height. As stated earlier in this report, the cot remained engaged in the antler bracket and the clamp throughout the crash sequence.

The cot contained a two belt system for securing patients. Each restraint consisted of two adjustable length webbings with a locking latch plate. The fixed end of each webbing was attached to the side frame of the cot. The webbings were positioned at the mid and lower aspects of the cot and could be adjusted longitudinally approximately 13 cm (5 in). At these locations, the webbings could be positioned across a patient's torso and lower legs. Examination of the torso belt revealed evidence of historical use (**Figure 18**). The torso belt webbing was creased in multiple areas. The edges of the webbing fabric were frayed from repeated use. Evidence related to its specific use during this crash could not be verified. The evidence of historical use on the lower belt webbing was not as apparent. The cot was not equipped with a shoulder harness system.

Figure 18: Historical use evidence observed on the torso belt webbing.

A factory service representative inspected the cot several days post-crash. It was inspected as part of the routine service he provided for the ambulance company. The factory representative did not find any damage to the cot. The cot had been used post-crash by the ambulance company for other patient transport tasks prior to the SCI inspection.

DRIVER DEMOGRAPHICS

Age/Sex:	56 year old / Male
Height:	170 cm (67 in)
Weight:	97 kg (214 lb)
Seat Track Position:	Full-rear track position
Eyewear:	Prescription eyeglasses
Safety Belt Usage:	3-point manual lap and shoulder safety belt
Usage Source:	SCI vehicle inspection
Egress from Vehicle:	Unassisted
Mode of Transport from Scene:	Ground ambulance to a Level 1 trauma center
Type of Medical Treatment:	Hospitalized for 10 days due to complication of his blood pressure medication; not crash related

DRIVER INJURIES

Injury	***Injury Severity (AIS90/Update 98)***	***Injury Source***
Mild right facial abrasions	Minor (290202.1,1)	Deployed driver air bag

Source: Hospitalization Discharge Summary

DRIVER KINEMATICS

The 56-year-old male driver of the ambulance was seated in full rear track position with the seatback slightly reclined and was restrained by the manual lap and shoulder safety belt system. The driver lost consciousness due to a prescription medication reaction and relinquished control of the ambulance. The use of the safety belt helped to maintain the driver's position within the seat. The ambulance departed the right side of the interstate and traveled along the road side embankment. During this trajectory, the ambulance struck a sign post and sideswiped a brush/scrub tree line. These events were minor and did not significantly displace the driver.

At impact with the concrete barrier, the buckle pretensioner actuated and the frontal air bag deployed. The driver was displaced forward as a result of the barrier impact force and loaded the safety belt system. This loading was supported by the frictional abrasions on the latch plate. The driver's face/head engaged the deployed frontal air bag resulting in the identified right facial abrasions. The combination of safety belt usage and frontal air bag deployment prevented the driver from contacting the steering assembly and other forward interior components, thus preventing the driver from further injury.

The driver's first recollection post-crash, was a passer-by pounding on his window. The driver regained his thoughts, unbuckled his safety belt and exited through the left door. He opened the rear doors of the ambulance and entered to assist the paramedic. After transport of the patient, the driver was transported to a trauma center where he was admitted for ten days in order to evaluate and treat his blood pressure complications. He returned to work 28 days post-crash.

PARAMEDIC DEMOGRAPHICS

Age/Sex:	45 year old / Male
Height:	178 cm (70 in)
Weight:	95 kg (210 lb)
Seat Position:	Rear facing seat in patient compartment
Eyewear:	None
Safety Belt Usage:	None
Usage Source:	SCI vehicle inspection
Egress from Vehicle:	Unassisted
Mode of Transport from Scene:	Ground ambulance to a Level 1 trauma center
Type of Medical Treatment:	Treated and released

PARAMEDIC INJURIES

Injury	***Injury Severity (AIS90/Update 98)***	***Injury Source***
Contusion of the central face (nose and mouth)	Minor (290402.1,4)	Interior loose object
Right scalp contusion	Minor (190402.1,1)	Ambulance floor
Right leg contusion (calf to hip)	Minor (890402.1,1)	Ambulance floor

Source: Paramedic interview. There was no record of treatment for this individual at the reported hospital.

PARAMEDIC KINEMATICS

The 45 year paramedic was seated in the rear facing seat behind the driver. He was monitoring and providing care for the patient and had just returned to his seat immediately prior to the crash. He was unrestrained. As the ambulance departed the road, the paramedic initially thought that the driver had taken an exit ramp from the interstate. As he began to realize that the vehicle was off the road, he braced himself and was holding onto the counter and seat attempting in maintain his position. As he looked through the window of the rear doors, he realized the ambulance had returned to the road prior to the barrier impact. Then the impact occurred.

The paramedic responded to the frontal impact force by loading the seat back. The cardiac monitor that was positioned on the counter to his right and forward of his seat was displaced forward and struck his mouth and nose. The contact with this displaced object resulted in the reported contusion.

The deflection of the ambulance along the barrier displaced the paramedic from his seat onto the floor of the ambulance. This contact resulted in contusions to his right scalp and right leg. The paramedic came to rest on the floor on his right side. His head was near the stairs of the side door entry facing the rear of the ambulance. He indicated that his head was in close proximity to the head of the patient.

The paramedic recalled that the patient had slid forward relative to the cot, was leaning to the cot's left side and was partially on the floor. He was still within the restraints of the cot. The paramedic's first actions were to check the patient status, and ensure that the patient's airway was intact. The patient exhibited positive indications that he was not injured as the paramedic and driver proceeded to provide care.

After the patient was removed and transported, the paramedic was transported by ground ambulance to a local hospital treated and released. He was off of work for three weeks.

PATIENT DEMOGRAPHICS

Age/Sex:	51 year old / Male
Height:	191 cm (75 in)
Weight:	132 kg (290 lb)
Seat Position:	Supine on a cot in a rear facing mode, back rest slightly elevated for comfort
Eyewear:	None
Safety Belt Usage:	Two separate manual lap belts; across his abdomen and legs
Usage Source:	Interviews
Egress from Vehicle:	Assisted due to perceived injury
Mode of Transport from Scene:	Ground ambulance to a Level 1 trauma center
Type of Medical Treatment:	Examined in the Emergency Room; then rapidly deteriorated and succumbed to undetected abdominal injuries

PATIENT INJURIES

Injury	***Injury Severity (AIS90/Update 98)***	***Injury Source***
Laceration of the lateral-inferior pleural surface of the right lung's lower lobe, Blood loss greater than 20%; Abdominal cavity is markedly distended containing an estimated 3000 cc of liquid blood; the right pleural cavity contains an estimated 1000 cc, the left pleural cavity 500 cc and the pericardial space an estimated 100 cc	Severe (441436.4,1)	Safety restraint
Parenchymal hemorrhage (contusion) underlying the lung laceration	Serious (441406.3,1)	
Capsular and superficial liver lacerations involving the right lateral superior aspect of the right hepatic lobe	Moderate (541822.2,1)	Safety restraint

Injury	*Injury Severity (AIS90/Update 98)*	*Injury Source*
Large 6 cm horizontal capsular laceration of the spleen extending 1.0 to 1.5 cm into the spleen parenchyma. *Note: the autopsy indicated the spleen laceration was the evident cause of the massive intra-abdominal hemorrhage. The blood loss was captured in the lung laceration code, as blood loss cannot be associated to spleen lacerations under current AIS coding conventions*	Moderate (544222.2,2)	Safety restraint
5.0 cm sub-galeal scalp hematoma in the right temple region	Minor (190402.1,1)	Cot frame
Abrasions and lacerations of the right lateral chest, NFS	Minor (490202.1,1) (490600.1,1)	Safety restraint
Abrasions and lacerations of the right lower abdomen, NFS	Minor (590202.1,1) (590600.1,1)	Safety restraint
Abrasions and lacerations of the left lateral chest, NFS	Minor (490202.1,2) (490600.1,2)	Safety restraint

Source: Autopsy Report

PATIENT KINEMATICS

The patient was lying supine on a bariatric cot that was secured in a rear-facing manner by the antler bracket and floor-mounted rail clamp in the patient compartment of the ambulance. He was on a cardiac monitor and being ventilated through a tracheotomy. The back rest of the cot was slightly elevated to provide comfort and ensure a proper airway. The patient was restrained on the cot by lap type belts across his abdomen and across his lower extremities. The restraints were reported by the paramedic as loose. On the morning of the crash, the patient commented to the paramedic as he was being loaded into the ambulance that he did not want to be strapped down tight due to the healing burn injuries sustained in the previous crash.

During the long off-road trajectory of the crash sequence, the patient shifted to the left side of the cot due to the cross slope of the road side. At impact, the patient initiated a forward trajectory (with respect to the vehicle) in response to the barrier impact force. This kinematic response caused the patient to ramp up the cot's back rest and fall off the left side of the (rear facing) cot. As his torso translated forward under the restraints, the patient loaded the webbing with his abdomen resulting in the soft tissue contusions. A concentrated force was placed on the patient's abdomen due to his unbalanced position on the left side of the cot restraint. As the duration and force of the loading peaked, the restraint caused the lung, liver and spleen lacerations. The patient's head contacted the cot frame resulting in the right scalp contusion.

Following the crash, the patient was removed from the ambulance via a spine board, loaded into another ambulance, and transported by ground to a Level 1 Trauma Center. The patient gave positive indications to the driver and paramedic that he was not injured at the time of his transport to the trauma center. The patient's abdominal injuries caused an undetected traumatic blood loss into the abdominal cavity. The patient was pronounced deceased approximately two hours post crash. His cause of death was listed as a traumatic splenic rupture with a massive intra-abdominal hemorrhage.

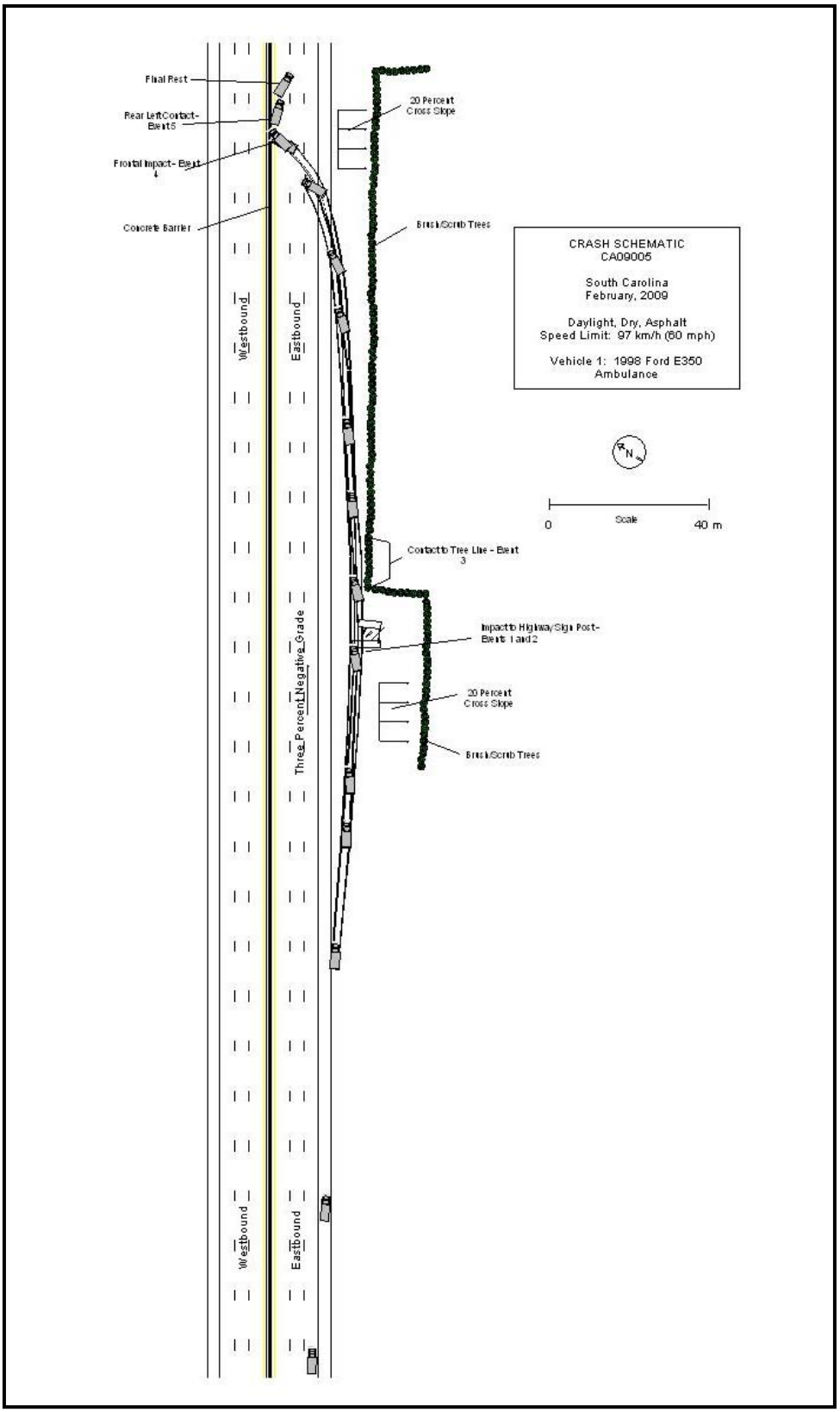

Figure 19: Overall schematic of the crash.

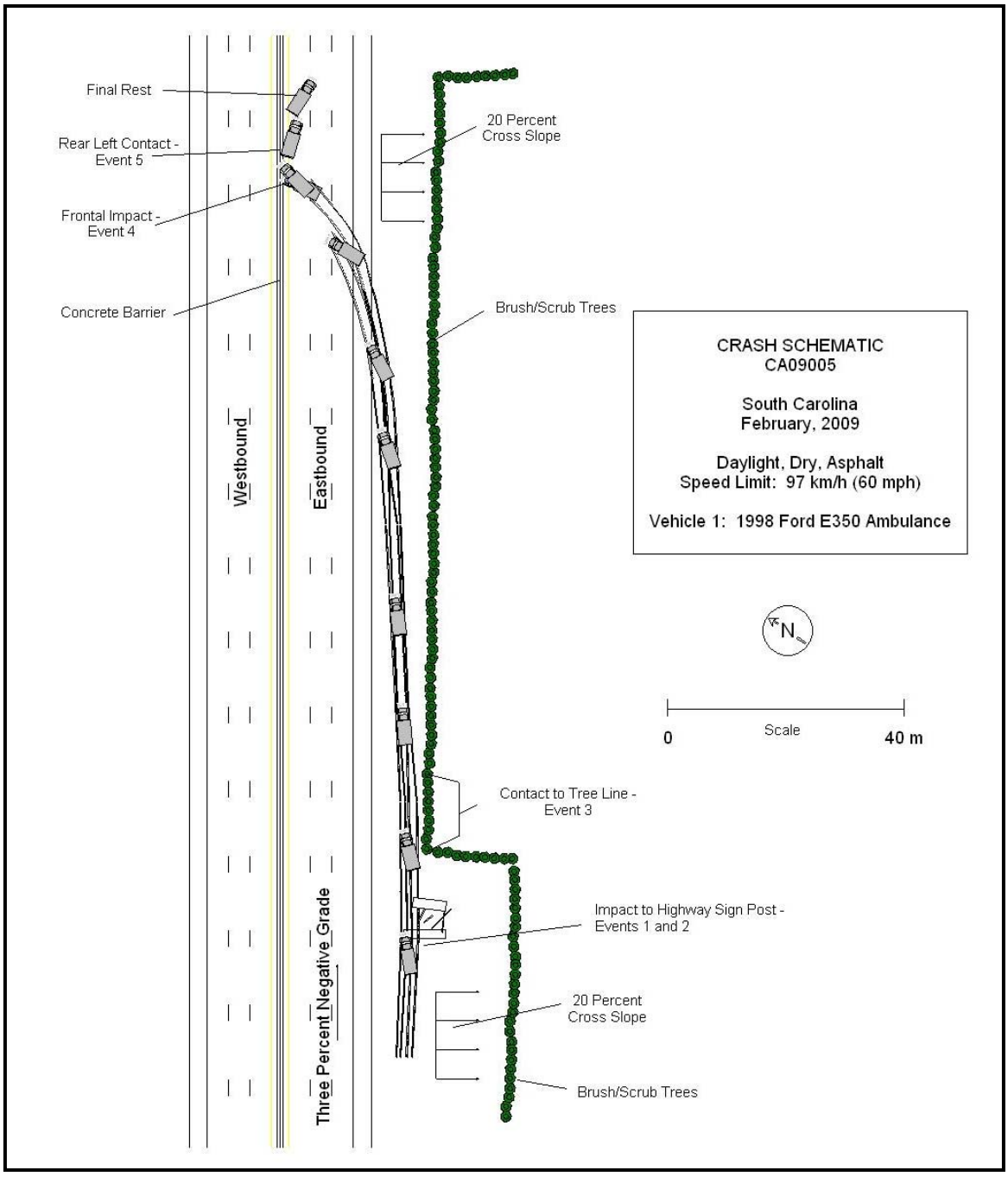

Figure 20: Schematic of the Impact Sequence.