

**CRASH DATA RESEARCH CENTER**

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**CALSPAN ON-SITE AMBULANCE CRASH INVESTIGATION**

**SCI CASE NO: CA08034**

**VEHICLE: 2005 FORD E450 CHASSIS  
HORTON CUSTOM AMBULANCE MODULE**

**LOCATION: DELAWARE**

**CRASH DATE: JUNE, 2008**

Contract No. DTNH22-07-C-00043

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

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

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## CALSPAN ON-SITE AMBULANCE CRASH INVESTIGATION

SCI CASE NUMBER: CA08034

VEHICLE: 2005 FORD E450 CHASSIS / HORTON CUSTOM AMBULANCE MODULE

LOCATION: DELAWARE

CRASH DATE: JUNE 2008

### BACKGROUND

This on-site investigation focused on an ambulance crash that involved a Horton custom ambulance module mounted on a 2005 Ford E450 chassis. This Type III ambulance was involved in a single-vehicle, multiple event crash that resulted in the death of two of the occupants in the patient compartment, including a 31-year-old female Paramedic seated on the right sided bench seat and an 82-year-old female patient positioned on the stretcher. The two remaining occupants, a 47-year old male Emergency Medical Technician (EMT) seated on the left side of the patient compartment and a 34-year-old male EMT operating the vehicle, were injured.



Figure 1: Right front oblique view of the ambulance.

The Basic Life Support (BLS) ambulance was operating in a non-emergency mode with the crew of three Emergency Medical Services (EMS) providers and patient. En route to their destination facility, the right side of the vehicle departed the right edge of the roadway. The ambulance was subsequently involved in a multiple event crash with two large diameter trees and two utility boxes that resulted in severe damage and integrity loss to the patient compartment. The 47-year-old EMT and the patient were fully ejected during the crash sequence.

Notification of this crash was received by the Calspan Special Crash Investigations (SCI) team on August 18, 2008 from the National Highway Traffic Safety Administration (NHTSA). The SCI team initiated telephone follow-up with State EMS management and gained cooperation from the insurance company and the ambulance service to inspect the vehicle and conduct the on-site investigation. The on-site investigation took place on August 21, 2008 and involved the inspection and documentation of the vehicle, damage, occupant positions, portals of ejection, occupant restraint availability, patient compartment configuration, and injury sources. In addition, the crash site was inspected and documented, and pertinent parties were interviewed.

## SUMMARY

### *Crash Site*

This crash occurred on a two-lane roadway during nighttime hours. Weather conditions at the time of the crash were overcast with rain, a temperature of 19 degrees Celsius (66 Fahrenheit), and westerly winds of 11 km/h (7 mph) (Source: *Weather Underground wunderground.com*). The bituminous roadway was straight and level with a posted speed limit of 64 km/h (40 mph). The ambulance was traveling northbound in the 3.6 m (12 ft) wide travel lane, which was supported by a 3.1 m (10 ft) east shoulder.



**Figure 2:** Overall view of the crash scene.

The roadway was bordered by tree lines on both sides. A large 70 cm (27.5 in) diameter oak tree was centered 1.4 m (5 ft) from the edge of the east shoulder, leaning toward the roadway at an approximate 15-degree angle. This tree was the point of the first and most severe impact. A pair of utility boxes was located 36.3 m (119 ft) and 39 m (128 ft) north of the large oak tree, respectively. The first was 1.3 m (4 ft) from the edge of the shoulder and was the point of the second impact. The second was 0.9 m (3 ft) from the edge of the shoulder and was the point of the third impact. The point of final impact was a 46 cm (18 in) diameter pine tree that was located 45.1 m (148 ft) from the oak tree and 2.1 m (7 ft) from the edge of the shoulder. Roadway markings included a double solid yellow centerline and white fog lines that delineated the shoulders. **Figure 2** is an northbound trajectory view of the crash scene. The crash schematic is attached as **Figure 14**.

### *Vehicle Data*

#### *2005 Ford E450 Chassis*

The ambulance chassis was a 2005 Ford E450, manufactured in February 2005 and identified by the Vehicle Identification Number (VIN): 1FDXE45P95H (production sequence deleted). The electronic odometer reading at the time of SCI inspection was unknown. The Ford was manufactured as an incomplete chassis with the ambulance prep package(**Figure 3**) incorporating a two-door



**Figure 3:** Cab of the Ford chassis.

cutaway cab configured for a driver and front right passenger with an open rear frame prepared for secondary manufactured body mounting.

The chassis had a 401 cm (158 in) wheelbase. This 4x2 dual-wheel rear drive platform was powered by a 6.8-liter, 10-cylinder diesel engine linked to a 5-speed automatic transmission. The service brakes were power-assisted hydraulic four-wheel discs with anti-lock.

The manufacturer’s recommended tire size was 225/75R16E front and rear with cold tire pressures of 450 kPa (65 PSI) and 550 kPa (80 PSI), respectively. At the time of SCI inspection, all tires were the recommended size mounted on OEM steel wheels, with the following data:

<b>POSITION</b>	<b>MAKE/MODEL</b>	<b>TIN NUMBER</b>	<b>PRESSURE</b>	<b>TREAD</b>	<b>DAMAGE</b>
LF	Firestone Transforce HT	8XIL THO	FLAT	8 mm (10/32”)	None
RF	Firestone Transforce HT	WIIL THO 3007	352 kPa (51 psi)	9 mm (11/32”)	None
LR Outer	Michelin LTX	Unknown	545 kPa (79 psi)	4 mm (5/32”)	None
LR Inner	Unknown	Unknown	548 kPa (80 psi)	6 mm (7/32”)	None
RR Outer	Firestone Transforce HT	WIIL THO 1008	538 kPa (78 psi)	9 mm (11/32”)	None
RR Inner	Unknown	Unknown	514 kPa (75 psi)	6 mm (7/32”)	None

The interior of the chassis was configured with two box-mounted deluxe high back captain’s chairs with integrated head restraints and manual seat track and recline adjustment features. Both seating positions were equipped with 3-point lap and shoulder safety belts for manual restraint. A folding armrest was on the inboard side of both seats. The steering wheel featured tilt adjustment, though its position was unknown. A center console with an array of switches and communications equipment related to the ambulance’s emergency response activities was mounted below the instrument panel’s stereo and climate controls. At the console’s rear aspect, immediately between the two seats, was a 32 cm (12.5 in) long storage bin. It was 34 cm (13.5 in) deep and divided into three equidistant sections across its 42 cm (16.5 in) width.

***Ambulance Weight/Payload***

The Ford chassis was placarded by its manufacturer to have a Gross Vehicle Weight Rating (GVWR) of 6,373 kg (14,050 lb). This was distributed as Gross Axle Weight Ratings (GAWR) of 2,087 kg (4,600 lb) front and 4,286 kg (9,450 lb) rear. The manufacturer of the Horton ambulance module had placarded the Type III ambulance with a vehicle weight/payload sticker. This declared that the curb weight of the overall vehicle was 4,545 kg (10,019 lbs). The curb weight at the axle locations was 1,845 kg (4,067 lb) front and 3,395 kg (7,704 lb) rear. The actual payload of the vehicle was 1,829 kg (4,031 lb). Optional equipment specified for this custom ambulance was 795 kg (1,752 lb), which resulted in a total remaining usable payload of 1,034 kg (2,279 lb). The estimated weight of the EMS equipment and supplies on-board the



ambulance at the time of the crash was 410 kg (900 lb). The ambulance was not overloaded at the time of the crash.

### *Horton Custom Ambulance Module*

The ambulance module (**Figure 4**) was manufactured by Horton Emergency Vehicles Company and was identified as Ambulance type/model F553B-IIISD. This alphanumeric designation represents a Ford van chassis with Horton's Model 553 constructed as body style B, a Type III ambulance. Overall dimensions of the ambulance module were 430 cm (169 in) in length, 226 cm (89 in) in height, and 244 cm (96 in) in width.



**Figure 4:** Left rear oblique view of ambulance module.

The module was made of welded construction framework of 5 cm (2 in) square, 3 mm (1/8 in) thick aluminum box tubing with 5 mm (3/16 in) aluminum exterior body paneling. The roof was made of ladder frame construction with six major lateral frame rails and two lateral side rails, welded and reinforced by gussets. The left and right sides were constructed of similar aluminum framework with identical aluminum exterior paneling, joined with reinforced butt-joint welds. The floor was ladder aluminum frame construction with 1 cm (1/2 in) composite flooring with fiber reinforcement and rubber matting. The four corners of the ambulance module were the major seams of the aluminum paneling and framework, which were held together by 9 cm (3.5 in) extruded aluminum beams. The ambulance module was affixed to the chassis, and bolted to the B-pillars and roof crossbeam of the cab. There were five 8 mm (5/16 in) bolts in each B-pillar, spaced equidistant upward beginning 20 cm (8 in) above the floor. There were six equidistant spaced bolts in the roof crossbeam.

### *Exterior*

At the front corner of the left side was a tall rectangular storage compartment for the large on-board oxygen tank. A shoreline power connection was located immediately aft of the oxygen tank compartment. Below the shoreline power connection was a mid-height two-door storage compartment with an adjustable shelf. Above the rear axle was a shallow pullout storage drawer, aft of which was the fuel tank filler cap. Another mid-



**Figure 5:** Left exterior of the ambulance module.



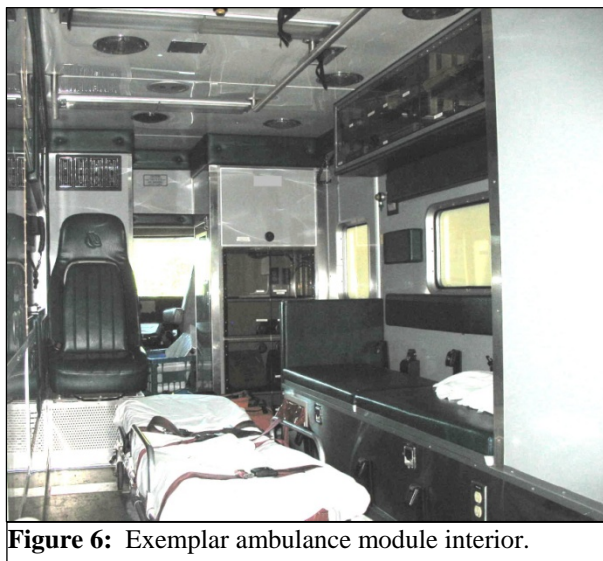
height two-door storage compartment occupied the rear corner. The left exterior side of the ambulance is depicted in **Figure 5**.

On the right side were two compartments and a passenger access door. Glazing consisted of a square window centered in the upper portion of the access door and a rectangular window aft of the access door above the wheel-well. Immediately forward of the access door was a tall rectangular compartment with roll out battery storage in the bottom. Another tall rectangular compartment was at the rear corner, and served as storage for backboards and other equipment. At the rear was a large 157 cm (62 in) tall by 127 cm (50 in) wide two-door opening. These doors opened toward either side of the body to allow for the easy loading and unloading of the patient compartment. A square window was centered toward the top of each door.

All four exterior sides of the ambulance body were equipped with emergency warning and auxiliary lighting. A large blue emergency light-bar spanned the top of the front, while clear scene lights and red emergency lights were mounted at the upper corners of the rear and side planes. Blue and red emergency lights were mounted on the rear plane, while standard tail, brake, and marker light assemblies were mounted on all sides as required.

### ***Interior***

The interior of the ambulance body incorporated three separate seats, a countertop, comfort controls, the patient stretcher, and numerous storage cabinets and compartments. Due to severe damage to the right side of the case vehicle's ambulance module, an exemplar patient compartment right side interior is depicted in **Figure 6**. On the right side was the bench seat and passenger access door. Storage for Personal Protective Equipment (PPE) gloves was located above the access door. To the rear of the access door was the split-lid bench seat above the wheel-well, which incorporated under-seat bulk storage. Lap belts were available to accommodate three passengers on the bench seat. A large cushion was on the wall above, serving as the seatback for the bench seat. There was also a side window, forward of which was an oxygen port mounted to the wall aft of the access door. At the rear corner was the interior intrusion of the large exterior storage compartment.



**Figure 6:** Exemplar ambulance module interior.

The middle of the patient compartment was for the removable wheeled patient stretcher. The parent rescue squad had installed a Stryker Model 6500 Power Pro XT (Serial #070339040) with

a Ferno anchoring system (Serial #808344). The anchoring system consisted of a forward antler bracket that straddled the wheels and frame at the head of the stretcher, with a rail clamp that secured the rear aspect of the stretcher. When loaded into the ambulance, an anchor pin located on the foot of the stretcher would insert into the rear bracket of the clamp and activate the spring-loaded mechanism, which would lock the stretcher in place for transit.

Immediately forward of the stretcher was the rear-facing “Captain’s Chair”. This seating position provided the occupant with a view of the entire patient compartment and access to the ambulance module controls, with close proximity to the driver to enable crew coordination and communication. It also placed the patient’s head area immediately in front of the occupant, with respect to the stretcher, and thus was the best location to manage the patient’s airway during pre-hospital care. The Captain’s Chair seat could be adjusted forward or backward with positive stops. A lap belt was available for manual restraint, while a head restraint was integrated into the top of the seatback. Also integrated into the seatback was a Child Restraint System (CRS) with an accompanying 5-point safety harness. To the right of the Captain’s Chair was the center pass-through to the cab. To the immediate right of the pass-through were four stacked shelves with clear polymer doors for the stowage of large EMS bags and BLS equipment. The bulkhead provided the placement of the heating and air conditioning unit and the associated vents. A locking cabinet was located in the upper right corner.

The left side of the patient compartment served primarily for the stowage of EMS supplies required for patient care. A large counter was located immediately to the left of the Captain’s Chair. Mounted on the left wall above the countertop were oxygen, suction, and electrical outlets. An onboard suction unit was mounted in a metal bracket affixed to the counter, connected to the vacuum outlet on the wall. An overhang above served as the control center for the patient compartment, with an array of switches for lighting, a thermostat, radio volume controls, and electrical power controls. Above this overhang was a pair of side-by-side 36 cm (14 in) tall by 74 cm (29 in) long compartments with clear polymer swing-open doors. Immediately aft of the countertop and control center was the 79 cm (31 in) wide cardiopulmonary resuscitation “CPR” seat, with a two-piece seatback and a manual restraint lap belt attached to the wall. This seat is so named as its location at the patient’s chest area with respect to the stretcher places the occupant in a prime position to perform CPR. The remainder of the left wall space consisted of large storage compartments with clear sliding doors.



**Figure 7:** Left interior of patient compartment.

## ***Crash Sequence***

### ***Pre-Crash***

The two EMTs were 21 hours into their 24-hour shift. Their day had been relatively routine and consisted of completing a mechanical check and supply inventory of the ambulance, eating meals, random relaxation breaks at the station, and five previous calls.

The pair responded to their sixth call at a nearby nursing home, where they were joined by a Paramedic from the countywide EMS department who was to provide Advanced Life Support (ALS) back-up. The patient required a higher level of care than the BLS care capabilities of the two EMTs, and as such, the Paramedic accompanied the 47-year-old in the patient compartment to attend to the patient while the 34-year-old drove. En route to their destination, responsibilities associated with patient care had led the Paramedic to be seated unrestrained in the center of the left-facing bench seat and the EMT was seated unrestrained in the right-facing CPR seat. The conscious patient was unrestrained on the stretcher to facilitate the rendering of pre-hospital care. The driver was operating the ambulance northbound on a state road familiar to him, and had traveled 7 km (4.4 mi) from the location of the EMS call. The driver alleged that a deer jumped from the wooded area on the left side of the roadway and entered the travel path of the ambulance. He responded by entering into an avoidance maneuver by steering the vehicle over the fog line and onto the right shoulder to avoid a collision with the animal. This caused the departure of the right side of the ambulance from the bituminous surface of the shoulder, and placed the ambulance on a trajectory toward the roadside wooded area.

### ***Crash***

The first impact occurred when the front right corner area of the cab of the ambulance impacted the large diameter oak tree. The front right corner of the ambulance was crushed and displaced rearward by the 12 o'clock direction of force. The upper right corner of the protruded frontal plane of the ambulance module impacted the angled tree. As the ambulance engaged the tree, the module sustained severe integrity loss as the right side of the module separated full-height from its front right corner rearward to the forward edge of the right rear exterior storage compartment.



**Figure 8:** Tree struck by right front of ambulance.

The offset right impact initiated a clockwise (CW) rotation. The ambulance continued on its northbound trajectory for 36.3 m (119 ft) as it rotated approximately 250 degrees CW. The second impact occurred as the ambulance impacted



the first utility box. Gouge marks in the shoulder surface from the right front wheel identified the angle of the vehicle at impact. The ambulance maintained its CW rotation for approximately another 40 degrees and impacted the second utility box. After continuing to maintain its northbound trajectory and CW rotation for another 6.1 m (20 ft), the right side of the ambulance module struck the large diameter pine tree.

The occupants of the CPR seat and stretcher were ejected from the patient compartment through the gaping right-sided integrity loss of the module as the ambulance completed its final 160 degrees of CW rotation. The vehicle came to rest 8.6 m (28 ft) from the final impact location, facing eastward, and perpendicular to the roadway.

The final rest position was evidenced by rear axle tire location markings painted on the road surface by local police, located 53.7 m (176 ft) from the point of the initial impact. Total CW rotation of the ambulance during the crash sequence was 450 degrees. The ejected occupants came to rest on the roadway within the ambulance's travel path, between its final impact and final rest positions.

### ***Post-Crash***

Emergency response to the scene included local police, fire, and EMS. The EMT driver of the ambulance exited without assistance. The ejected EMT was ambulatory at scene. Both were transported via ground ambulance to a local hospital for the treatment of non-life-threatening injuries. The Paramedic, who remained within the patient compartment during the crash sequence, was unconscious and had to be removed by emergency response personnel. She was transported via ground ambulance to a local hospital, where she was pronounced deceased upon arrival. The patient, who had a valid Do No Resuscitate (DNR) order, was pronounced deceased at scene. The ambulance was towed from scene.

### ***Vehicle Damage***

#### ***2005 Ford Chassis - Exterior***

The front of the ambulance sustained moderate damage from the crash. There was rearward crush to the bumper, grille, hood, and right fender. The fiberglass hood had a fracture to its right aspect. The right headlight assembly had disintegrated, and the right mirror was sheared mid-support stalk. Bark and other debris were embedded within the cast aluminum emergency siren speaker box mounted on the right bumper corner, as well as the forward aspect of the right front fender and the remnants of the right mirror support stalk.



**Figure 9:** Damage to Ford chassis.

Scratching and abrasions from contact with the bark of the trees covered the protruding edges of the front right body panels. Five lug nut caps on the right front wheel were bent or separated. The windshield glazing was shattered in a spider web pattern, right laterally offset from centerline. Integrity loss to the cab was limited to the disintegration of the right front glazing.

Direct contact damage extended 15 cm (6 in) inboard from the front right bumper corner. The direct and induced damage Field L extended across the entire bumper width from corner to corner. The residual crush measured along the bumper was as follows: C1 = 7 cm (3 in), C2 = 2 cm (1 in), C3 = 1 cm (0.5 in), C4 = 1 cm (0.5 in), C5 = 3 cm (1 in), and C6 = 11 cm (4.5 in). Maximum crush was located on the right bumper corner at C6. Severe damage was sustained by the ambulance module from this event, and is summarized in a latter section designated as such. The Collision Deformation Classification associated with this event was 12FRAE9.

Damage from the second, third, and fourth impacts was overlapping, and could not be separated by event. At the time of SCI inspection, the right wheelbase had lengthened by 4 cm (1.5 in) to 405 cm (159.5 in), and the left was subsequently shortened by 1 cm (0.5 in) to 400 cm (157.5 in). This deflection was attributed to the first engagement with the large diameter oak tree. There was also damage to the rear bumper, which was deflected upward with grass and mud embedded underneath. This was reported to have been induced during post-crash removal and towing activities.

### ***Interior***

Occupant contact in the cab was limited to the front left occupant position. An area of scuffing was found on the knee bolster 76-83 cm (30-32.5 in) left of center, located 38-43 cm (15-17 in) below the top of the instrument panel.

A second area of knee bolster scuffing was found 46-52 cm (18-20.5 in) left of center, 47-51 cm (18.5-20 in) below the top of the instrument panel. The Heating, Ventilating, and Air Conditioning (HVAC) vent outboard of the steering column was fractured at its lower aspect. The end of turn signal stalk on the left side of the steering column was fractured and missing. These contacts are highlighted by yellow markings in **Figure 10**.



**Figure 10:** Left front occupant position.

### ***Horton Custom Ambulance Module***

The ambulance module sustained severe exterior and interior damage from the crash. Direct contact damage from the first impact extended along the forward roof rail from the front right corner extending 48 cm (19 in) inboard and extending downward 104 cm (41 in). There was also direct damage on the right aspect of the protruding light bar. The upper right corner was folded

inward 51 cm (20 in). The majority of the right side of the ambulance module was separated. There was a gaping hole extending full-height from the front right chassis cab seam to rear of the right rear axle.



**Figure 12:** Frontal view of ambulance.



**Figure 11:** Integrity loss to right side of ambulance module.

**Figure 11** depicts a frontal view of the ambulance (note damage to the module on the right side in relation to the left), while **Figure 12** shows the severe integrity loss to the right side.

Along its upper aspect, the right roof side rail was torn completely away from the roof framework from the front right corner rearward to 31 cm (12 in) forward of the rear axle, a length of 279 cm (110 in). The second of the six major roof frame rails, with respect to the front of the module, was crushed rearward approximately 76 cm (30 in) at its right aspect.

The forward four of the six major roof frame rails were fully exposed on the right side of the roof, having separated from the roof side rail at their gussets. The paneling of the roof was crushed rearward on its right side and exhibited a distinct U-shaped fold pattern from direct engagement with the large diameter oak tree.

The right passenger access and right forward storage compartment doors were separated completely from the ambulance module. The right side exterior body paneling spanning from the access door to the rear storage compartment, including the right rear glazing above the rear axle, was crushed rearward to the forward edge of the rear storage compartment and separated at its upper and lower seams. Exterior fascia, trim, and molding were sheared and had separated full-height from the ambulance module, from the right front corner to the forward edge of the rear storage compartment. The lower frame rail was bent upward from the forward corner to the rear axle. Portions of the frame rails of the floor were exposed, exhibiting rearward shift at their right aspects.



Interior damage was extensive due to the integrity loss on the right side. The entire stack of compartments in the forward right corner of the patient compartment was sheared away on all sides, as depicted in **Figure 13**. The corresponding forward wall that separated the patient compartment from the cab and contained the center pass-through was separated on the right side.

The wall-mounted seatback of the left-facing three-passenger bench seat was also separated as a direct result of the integrity loss. The seat cushion of the bench seat was angled downward on its outboard edge.



**Figure 13:** Forward right corner of patient compartment.

The left wall was buckled inward toward its center, and the forward upper aspect was intruded laterally. This induced damage was attributed to the compromised integrity of the framework structure, which resulted from the direct framework shear on the right side. The left rear backlight glazing was disintegrated by occupant contact from the Paramedic bench seat occupant. Interior contact points and fluid transfers could not be separated by event, nor attributed to specific occupants.

### ***Manual Safety Belt Systems***

The Ford chassis was equipped with manual 3-point lap and shoulder safety belts for both front occupant positions. The driver's belt was equipped with a sliding latch plate, an Emergency Locking Retractor (ELR), and a buckle pretensioner. The front right belt system was equipped with a sliding latch plate, an Automatic Locking Retractor (ALR) and ELR, and a buckle pretensioner. The driver was not restrained by the manual safety belt, evidenced by a lack of loading on the latch plate, D-ring, or belt webbing.

All seats in the patient compartment of the ambulance module were equipped with manual safety belt restraints. The Captain's Chair was equipped with a manual lap belt. Integrated into the seatback was a stow-away CRS with accompanying 5-point safety harness. The CPR seat was equipped with a lap belt, anchored on the left wall. The bench seat was equipped with three manual lap belts, anchored on its support structure. None of these belts were utilized at the time of the crash.

The patient stretcher was equipped with manual shoulder, chest, lap, and leg safety restraint straps. The ambulance crew reported to the SCI team that at the time of the crash the patient was semi-Fowler, a medical position where the head of the stretcher is reclined between 45 and 60 degrees to optimize comfort and improve breathing in immobile patients. The crew also reported that the patient was unrestrained at the time of the crash as to avoid interference with her



prehospital care. This was confirmed during SCI inspection by a lack of loading evidence on the stretcher’s safety strap systems.

***Air Bag System***

The Ford chassis was equipped with an advanced two-stage frontal air bag system that consisted of a steering wheel hub-mounted driver air bag and a mid-instrument panel-mounted front right passenger air bag. The frontal air bags did not deploy.

***Occupant Data***

***Driver Demographics***

Age / Sex: 34-year-old / Male  
 Height: 180 cm (71 in)  
 Weight: 113 kg (250 lbs)  
 Seat Track Position: Full-rear  
 Safety Belt Usage: Unrestrained  
 Usage Source: SCI vehicle inspection  
 Egress from Vehicle: Exited without assistance  
 Type of Medical Treatment: Transported by ground ambulance to a local hospital for treatment of minor injuries

***Driver Injuries***

<b>INJURY</b>	<b>INJURY SEVERITY (AIS 90/Update 98)</b>	<b>INJURY SOURCE</b>	<b>CONFIDENCE LEVEL</b>
Scalp laceration	Minor (190600.1,9)	A-pillar grab handle	Possible

*Source: Interview with CPR seat occupant*

***Driver Kinematics***

The driver of the ambulance was seated unrestrained in a full-rear track position. No evidence of loading on the belt system components was found. The driver responded to the frontal impact event by initiating a forward trajectory. His knees contacted the knee bolster, evidence by scuffing and deformation to the bolster panel.

As the vehicle engaged the tree and initiated its rotation, his left hand deflected off of the turn signal stalk and contacted the left HVAC vent. The driver contacted the steering wheel hub with his torso, and he loaded the left door panel as the vehicle rotated. His head contacted the A-pillar grab handle. These contacts resulted in minor scalp lacerations. He then rebound into the seatback and against the inboard armrest as the vehicle made its final impact event and rotated to rest.

The driver exited the vehicle without assistance. He was transported from the scene by EMS ground ambulance to a local hospital where he received treatment for minor injuries.

***CPR Seat Passenger Demographics (Occupant #2)***

Age / Sex: 47-year-old / Male  
 Height: 190 cm (75 in)  
 Weight: 104 kg (230 lb)  
 Seat Track Position: Right-facing, non-adjustable  
 Safety Belt Usage: Unrestrained  
 Usage Source: SCI vehicle inspection  
 Egress from Vehicle: Ejected during crash sequence  
 Type of Medical Treatment: Transported by ground ambulance to a local hospital for treatment of minor injuries; hospitalized for 3 days

***CPR Seat Passenger Injuries (Occupant #2)***

<b>INJURY</b>	<b>INJURY SEVERITY (AIS 90/Update 98)</b>	<b>INJURY SOURCE</b>	<b>CONFIDENCE LEVEL</b>
Concussion (no LOC)	Minor (160402.1,0)	Upper storage compartment	Certain
Scalp contusion	Minor (190402.1,9)	Upper storage compartment	Certain
Scalp laceration	Minor (190600.1,9)	Upper storage compartment	Certain
Right forehead abrasions	Minor (290202.1,7)	Roadway	Probable
Left eye contusion	Minor (297402.1,2)	Upper storage compartment	Probable
Left flank contusion	Minor (590402.1,2)	Countertop, lower storage compartment	Certain
Bilateral knee contusions	Minor (890402.1,3)	Roadway	Probable
Right flank abrasion	Minor (590202.1,1)	Roadway	Probable
Left flank abrasion	Minor (590202.1,2)	Countertop, lower storage compartment	Certain
Large mid back contusion	Minor (690402.1,4)	Roadway	Probable
Left shoulder and elbow contusion	Minor (790402.1,2)	Ambulance module patient compartment control array	Probable
Back abrasions	Minor (690202.1,9)	Roadway	Probable
Bilateral knee and lower leg lacerations	Minor (890602.1,3)	Roadway	Possible
Bilateral knee and lower leg abrasions	Minor (890202.1,3)	Roadway	Possible

*Source: Medical Records*

***CPR Seat Passenger Kinematics (Occupant #2)***

The CPR seat occupant was seated unrestrained in the right-facing non-adjustable single bench-type seat. The occupant responded to the frontal impact event by initiating a forward trajectory. He contacted the compartment wall forward of the seat cushion, countertop, and overhead storage compartment, resulting in minor injuries to his head and left side. He then rebounded against the seatback mounted on the wall as the ambulance rotated.

As the ambulance engaged the pine tree during the final impact, the CPR seat occupant initiated a forward trajectory with respect to his right-facing orientation. He was separated from his seat, traveled over the stretcher, and was ejected from the patient compartment through the large integrity loss of the right side of the ambulance module.

The CPR seat occupant landed within the roadway and slid to rest between the final impact pine tree and the ambulance's final rest position. This ejection resulted in further minor injuries, including abrasions and lacerations from the road surface. The CPR seat occupant was ambulatory at scene. He was transported by EMS ground ambulance to the local hospital where he was hospitalized for three days for the treatment of minor severity injuries.

***Bench Seat Passenger Demographics (Occupant #3)***

Age / Sex: 31-year-old / Female  
 Height: 175 cm (69 in)  
 Weight: 85 kg (187 lb)  
 Seat Track Position: Left-facing, non-adjustable  
 Safety Belt Usage: Unrestrained  
 Usage Source: SCI vehicle inspection  
 Egress from Vehicle: Removed by emergency response personnel due to unconsciousness  
 Type of Medical Treatment: Transported by ground ambulance to local hospital where she was pronounced deceased upon arrival

***Bench Seat Passenger Injuries (Occupant #3)***

<b>INJURY</b>	<b>INJURY SEVERITY (AIS 90/Update 98)</b>	<b>INJURY SOURCE</b>	<b>CONFIDENCE LEVEL</b>
Transection of the aorta (1.7 cm distal to the origin of the subclavian artery) moderate hemorrhage in the mediastinum	Critical (420216.5,4)	Intrusion of storage compartments	Certain
Bilateral lung lacerations (with blood loss > 20% by volume) multiple lacerations with the largest measuring 5cm x 0.7cm, 300 cc of blood in the right pleural cavity, 900 cc's on the left	Critical (441456.5,3)	Intrusion of storage compartments	Certain
Bilateral flail chest (including right ribs 1 thru 8 and left ribs 1 thru 10) fractured both posteriorly and anteriorly	Critical (450266.5)	Intrusion of storage compartments	Certain
Complex liver lacerations (with the largest measuring 12cm x 7.5cm, the left lobe of the liver was almost completely transected)	Critical (541828.5,1)	Intrusion of storage compartments	Certain

Spleen lacerations (two deep lacerations measuring 7cm x 1 cm and 6.8 cm x 1cm extending outward from the hilum , also a 9cm x 5cm laceration)	Severe (544226.4,2)	Intrusion of storage compartments	Certain
Gallbladder laceration (involving the common bile duct)	Severe (541226.4,7)	Intrusion of storage compartments	Certain
Generalized subdural hemorrhage	Severe (140442.4,6)	Intrusion of storage compartments	Certain
Subarachnoid hemorrhage over the posterior cerebellum	Serious (140466.3,6)	Intrusion of storage compartments	Certain
Cervical disarticulation between the 5 <sup>th</sup> and 6 <sup>th</sup> vertebrae (the anterior surfaces gape open 0.9cm)	Moderate (650216.2,6)	Intrusion of storage compartments	Certain
T12 fracture NFS (there is anterior inferior displacement of the thoracic spine)	Moderate (650416.2,7)	Intrusion of storage compartments	Certain
L1 fracture NFS (there is posterior superior displacement of the lumbar spine)	Moderate (650616.2,8)	Intrusion of storage compartments	Certain
Right clavicle fracture (through and through)	Moderate (752200.2,1)	Intrusion of storage compartments	Certain
Scalp contusion (over 8cm x 3cm on right side and on top of head, 10cm x 3 cm)	Minor (190402.1,5)	Intrusion of storage compartments	Certain
Left scalp laceration ( 2.5cm x 1cm jagged laceration, entire thickness)	Minor (190602.1,2)	Left rear door	Certain
Right pectoral muscle tear	Minor (490602.1,1)	Intrusion of storage compartments	Probable
Right posterior forearm lacerations (superficial lacerations 12 x 0.2 cm, perpendicular to this, 5 cm x 0.32 cm and a 9 cm x 0.4 cm laceration, along with 11 small scratch abrasions over a 3 cm x 4 cm area)	Minor (790602.1,1)	Intrusion of storage compartments	Certain
Bilateral forearm and hand abrasions	Minor (790202.1,3)	Intrusion of storage compartments	Probable
Bilateral hand contusions	Minor (790402.1,3)	Intrusion of storage compartments	Probable
Left forearm abrasion on the anterior aspect (5 cm x 0.2 cm) located 7.2 cm above the wrist	Minor (790202.1,2)	Left rear door	Possible
Left chest abrasion (on the superior left breast, 7cm horizontal by 0.5 cm vertical)	Minor (490202.1,2)	Left rear door	Possible
Neck abrasion (below the left mandible, 1.4 cm horizontal by 0.4 cm vertical)	Minor (390202.1,2)	Left rear door	Probable

Left cheek abrasion (lateral aspect, 4 cm vertical by 1 cm horizontal)	Minor (290202.1,2)	Left rear door	Probable
Nose abrasion (right side, triangular shaped 2 x 2 x 1.7 cm, and a 1.3 cm x 0.7 abrasion under the right nostril)	Minor (290202.1,4)	Storage compartments (right side of front wall)	Probable
Right cheek abrasion (0.7 cm x 0.8 cm)	Minor (290202.1,1)	Storage compartments (right side of front wall of patient compartment)	Probable
Center abdomen abrasion (8.3 cm x 0.1 cm)	Minor (590202.1,4)	Left rear door	Possible
Center abdomen laceration (8.3 cm x 0.1 cm)	Minor (590602.1,4)	Left rear door	Possible

*Source: Autopsy report*

### ***Bench Seat Passenger Kinematics (Occupant #3)***

The bench seat occupant was seated unrestrained in the center of the left-facing, non-adjustable bench seat. No loading evidence was found on the belt webbing and latch plate. The occupant responded to the frontal impact event by initiating a forward trajectory. She slid forward on the bench seat and contacted the stack of compartments against the front wall, at the forward right corner of the patient compartment.

As the front right corner of the module engaged the large diameter oak tree and was crushed rearward, the Paramedic was re-directed rearward by the intrusion. This contact resulted in unconsciousness and critical injuries, including the transection of her aorta and bilateral flail chest. She passed over the stretcher and contacted the left rear door, causing further minor injuries. This contact disintegrated the left rear backlight glazing. Gravity forced the Paramedic down onto the floor, between the stretcher and the storage compartments on the left wall. She remained in that location for the remainder of the crash sequence.

The bench seat occupant was found unconscious in the left rear corner of the patient compartment. She was removed from the vehicle by emergency response personnel and transported by EMS ground ambulance to the local hospital, where she was pronounced deceased upon arrival.

***Stretcher Occupant Demographics (Occupant #4)***

Age / Sex: 82-year-old / Female  
 Height: Unknown  
 Weight: Unknown  
 Position: Semi-Fowler's, rear-facing  
 Safety Belt Usage: Unrestrained  
 Usage Source: SCI vehicle inspection, ambulance crew interview  
 Egress from Vehicle: Ejected during crash sequence  
 Type of Medical Treatment: None; Pronounced deceased at scene

***Stretcher Occupant Injuries (Occupant #4)***

<b>INJURY</b>	<b>INJURY SEVERITY (AIS 90/Update 98)</b>	<b>INJURY SOURCE</b>	<b>CONFIDENCE LEVEL</b>
Closed Head Injury	Injured unknown severity (115999.7,0)	Forward wall of patient compartment	Probable
Right hemothorax ( Thoracic cavity injury NFS)	Serious (442202.3,1)	Cardiac monitor	Possible
Left fibula fracture NFS	Moderate (851605.2,2)	Unknown	N/A
Left tibia fracture NFS	Moderate (853404.2,2)	Unknown	N/A
Forehead laceration (2 cm above the right eyebrow) deep laceration in the shape of a boomerang measuring 12.5 cm x 3 cm	Moderate (290604.2,7)	Loose objects within patient compartment	N/A
Left eyelid contusion (upper eyelid, 7cm horizontal x 2cm vertical; lower eyelid, 2cm horizontal by 1 cm vertical)	Minor (297402.1,2)	Loose objects within patient compartment	N/A
Right eyelid contusion ( upper eyelid, 3.5cm horizontal by 1.5cm vertical)	Minor (297402.1,1)	Loose objects within patient compartment	N/A
Right eyelid laceration (1 cm )	Minor (297602.1,1)	Loose objects within patient compartment	N/A
Left cheek laceration (diagonal interrupted laceration measuring 12.5 cm by 1.4 cm)	Minor (290602.1,2)	Deformed aluminum ambulance structure	Possible
Right arm contusions (one 2.5 x 1.5 cm, and one 2 x 2 cm)	Minor (790402.1,1)	Unknown	N/A
Left posterior forearm and hand contusions, (6 x 6 cm on forearm and 6 x 2 cm on hand)	Minor (790402.1,1)	Unknown	N/A
Abdominal contusions (6 scattered contusions, the largest measuring 7.2 x 2.5 cm and the smallest measures 2.5 by 1.5 cm)	Minor (590402.1,0)	Loose objects within patient compartment	N/A
Right chest laceration (superficial below the right breast, measuring 10cm by 0.5 cm)	Minor (490602.1,1)	Cardiac monitor	Possible

Lower abdominal lacerations ( right inguinal area, 2.5cm x 1 cm, and left inguinal area, 8 x 0.5 cm and 7.5 cm x 1 cm)	Minor (590602.1,8)	Unknown	N/A
Right leg laceration (deep over the anteromedial aspect measuring 10.5 cm x 10cm, this reveals the anterior surface of the tibia)	Minor (890602.1,1)	Deformed aluminum ambulance structure	Possible
Right foot laceration (over medial aspect, measuring 4.5 by 1.8cm that extends into the ankle joint which appears to be disarticulated)	Minor (890602.1,1)	Roadway	Possible
Left thigh laceration (mid-anterior aspect measuring 9.5 by 1.5 cm)	Minor (890602.1,2)	Deformed aluminum ambulance structure	Possible

*Source: Non-invasive external medical examination*

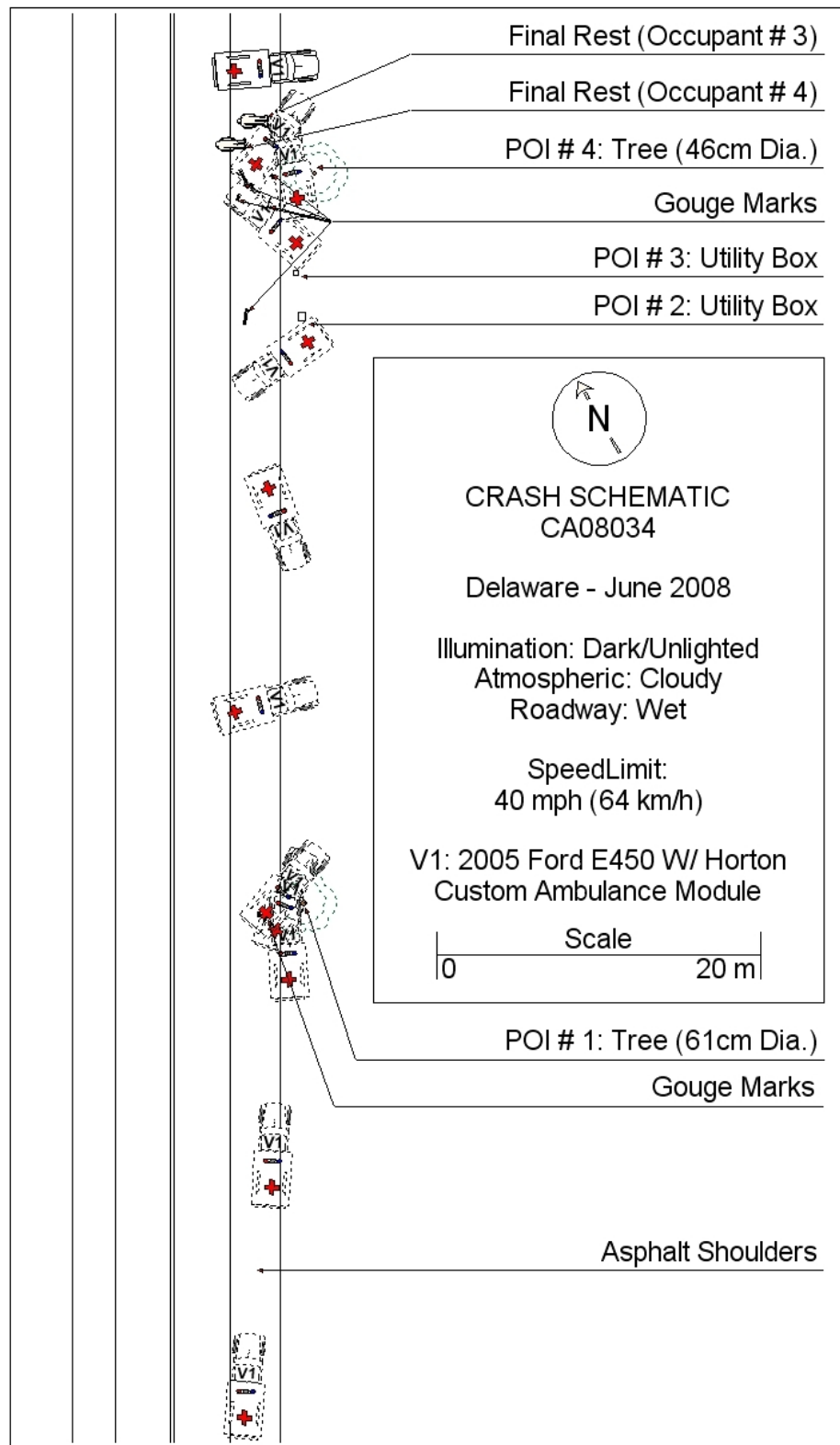
***Stretcher Occupant Kinematics (Occupant #4)***

The patient was positioned semi-Fowler's, unrestrained on the rear-facing stretcher. She responded to the frontal impact event by initiating a forward trajectory. She was separated from the stretcher as she ramped-up the inclined back. Her head and torso contacted the seatback of the Captain's Chair and forward wall of the patient compartment, resulting in a traumatic closed head injury and various minor injuries. As the ambulance module engaged the large diameter oak tree, the patient was redirected rearward by the intrusion. She contacted unspecified loose equipment and supplies and received further moderate severity injury.

After the final impact with the large diameter pine tree, the patient was ejected through the gaping right-sided integrity loss as the vehicle rotated. She landed within the roadway and slid to rest between the final impact pine tree and the ambulance's final rest position. This ejection resulted in minor injuries, including lacerations and contusions.

The stretcher occupant was unconscious in the roadway. Emergency response personnel evaluated her at scene, but no attempts were made to resuscitate her in honor of the DNR. She was pronounced deceased at scene and was not medically transported.





**Figure 14:** Crash schematic.