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CRASH DATA RESEARCH CENTER

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GENERAL DYNAMICS ON-SITE AMBULANCE CRASH INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

CASE NO. CA03-004

VEHICLE – 1997 FORD E-350 TYPE III AMBULANCE

LOCATION - STATE OF KENTUCKY

CRASH DATE – JANUARY 2003

Contract No. DTNH22-01-C-17002

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

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

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16. Abstract This on-site investigation focused on the crashworthiness issues and occupant protection systems of a chassis cab/box body Type III ambulance unit. The vehicle was a 1997 Ford E-350 that was equipped with a Horton ambulance body. The ambulance was occupied by a 27-year-old male driver, a 47-year-old female patient care provider (PCP) with an Emergency Medical Technician (EMT) certification, and a 30-year-old male PCP with a Paramedic certification. The ambulance was transporting a 75-year-old female patient to a local hospital with its emergency lights and siren activated on a two-lane roadway. The driver of the ambulance attempted to pass a tractor-trailer that was slowing in the westbound lane. The tractor-trailer initiated a left turn in front of the ambulance and the driver of the ambulance braked and steered right to avoid the collision. The ambulance departed the right roadside, ramped up a hillside, tipped onto its left side and came to rest on the roadway. The driver of the ambulance was restrained by the manual 3-point lap and shoulder belt and sustained minor abrasions and contusions. The female PCP was unrestrained and was displaced in the patient compartment during the crash. She sustained a separated left shoulder and multiple contusions as a result of contact within the patient compartment. The male PCP sustained a hyper-extended right knee and multiple arm and leg contusions as a result of bracing and contact with interior surfaces of the patient compartment. He also sustained a contusion to the back of the head from contact with the displaced cardiac monitor/defibrillator. The patient was displaced forward out of the ambulance cot restraints onto the floor and was redirected as the ambulance tipped over. The patient expired due to a medical condition. A report from a Medical Examiner stated that the patient's death was not a result of the crash.			
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TABLE OF CONTENTS

GENERAL DYNAMICS ON-SITE AMBULANCE CRASH INVESTIGATION
TECHNICAL SUMMARY REPORT
CASE NO. - CA03-004
SUBJECT VEHICLE - 1997 FORD E-350 TYPE III AMBULANCE
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BACKGROUND

This on-site investigation focused on the crashworthiness issues and occupant protection systems of a chassis cab/box body Type III ambulance unit **(Figure 1)**. The vehicle was a 1997 Ford E-350 that was equipped with a Horton ambulance body. The ambulance was occupied by a 27-year-old male driver, a 47-year-old female patient care provider (PCP) with an Emergency Medical Technician (EMT) certification, and a 30-year-old male PCP with a Paramedic certification. The ambulance was transporting a 75-year-old female patient to a local hospital with its emergency lights and siren activated on a two-lane roadway. The driver of the ambulance attempted to pass a tractor-trailer that was slowing in the westbound lane. The tractor-trailer initiated a left turn in front of the ambulance and the driver of the ambulance braked and steered right to avoid the collision. The ambulance departed the right roadside, ramped up a hillside, tipped onto its left side and came to rest on the roadway. The driver of the ambulance was restrained by the manual 3-point lap and shoulder belt and sustained minor abrasions and contusions. The female PCP was unrestrained and was displaced in the patient compartment during the crash. She sustained a separated left shoulder and multiple contusions as a result of contact within the patient compartment. The male PCP sustained a hyper-extended right knee and multiple arm and leg contusions as a result of bracing and contact with interior surfaces of the patient compartment. He also sustained a contusion to the back of the head from contact with the displaced cardiac monitor/defibrillator. The patient was displaced forward out of the ambulance cot restraints onto the floor and was redirected as the ambulance tipped over. The patient expired due to a medical condition. A report from a Medical Examiner stated that the patient's death was not a result of the crash.

Figure 1. Damaged 1997 Ford E-350/Horton Ambulance

NHTSA's Special Crash Investigation Division was alerted to the crash through an Emergency Medical Service web site. The news link was e-mailed to the General Dynamics SCI team. The SCI team initiated telephone follow-up with the investigating police agency and the ambulance service. Cooperation was established with both agencies and an on-site investigation was initiated. This investigation was conducted by SCI in conjunction with the Center for Disease Control's (CDC) National Institute of Occupational Safety and Health (NIOSH).

SUMMARY

Crash Site

This single-vehicle crash occurred on an east/west two-lane state roadway during the nighttime hours of January 2003. At the time of the crash, it was dark and the asphalt roadway surface was wet from previous rain. The crash occurred on a straight and level section of the roadway as westbound traffic exited a left curve. The roadway was configured with one travel lane in each direction separated by a broken yellow centerline at the crash site. The centerline east of the crash site was configured with a solid yellow line for eastbound traffic and a broken yellow line for westbound traffic. The roadway was bordered by narrow asphalt shoulders and commercial businesses on the south side. The north roadside consisted of a shallow drainage ditch that measured 1.6 m (5.2') in width and 50.8 cm (20.0") deep at the center aspect and a treed hillside. A warning sign was present on the north roadside adjacent to the ambulance's final rest position indicating a three-phase traffic signal was present west of the crash site. The posted speed limit for the east/west roadway was 72 km/h (45 mph). The scene schematic is included as **Figure 20** at the end of this report.

Pre-Crash

The 27-year-old male driver of the ambulance possessed a Commercial Driver's License (CDL), although it was not a state requirement to operate the ambulance. He also completed over 100 hours of defensive driver training, and taught various state-sponsored fire training courses, including an Emergency Vehicle Operations Course (EVOC). The driver had 11 years of general driving experience and 9 years of experience driving ambulances. The driver had responded to the emergency call in his private vehicle and was not "on duty" prior to the emergency transport.

The female PCP was state-certified as an EMT, and had been "on-duty" for 11 hours prior to the emergency call. She was in the last hour of her 12-hour shift. She stated that she had been involved with two previous emergency calls during the earlier part of her shift.

The male PCP was state-certified as a Paramedic with 7 years of experience at the Paramedic level and 5 years of experience at the EMT level. At the time of the crash, he was 32 hours into his 42-hour shift. He stated that his normal shift consisted of 42 hours and that he was well-rested the day of the crash. He also stated that sleeping accommodations were available at the ambulance company, and that the average number of calls per day was three or four. He could not recall the number of previous calls he had taken during his shift.

The driver of the ambulance was operating the vehicle westbound on the two-lane roadway in an emergency mode. He estimated his speed to be 64-72 km/h (40-45 mph) prior to the crash. He stated that there were no distractions in the ambulance and no two-way radio traffic at the time of the crash.

The 75-year-old female patient was lying supine on the ambulance cot and was unresponsive. She was restrained by three lateral straps on the ambulance cot. The ambulance crew stated that prior to the crash, a pulse was present and her breathing was labored. The PCP's had administered oxygen via the on-board oxygen system and were monitoring the patient's heart

rhythm with a Lifepack 10 cardiac monitor/defibrillator. A pulse oximeter was present on the patient's finger. The male PCP had completed the administration of an intravenous line (IV) in the patient's left arm and hung the IV bag on the roof-mounted IV bag holder.

As the ambulance was in the left curve approaching the straight section of the roadway **(Figure 2)**, the driver detected a tractor-trailer ahead in the westbound lane traveling well below the posted speed limit. The tractor-trailer was displaying a left turn signal as it slowed, and the driver of the ambulance thought the truck was slowing to let the ambulance pass. The ambulance driver initiated a passing maneuver and crossed the centerline of the roadway. As the ambulance entered the eastbound lane, the tractor-trailer initiated a left turn into a driveway across the path of the ambulance. The driver of the ambulance braked and steered right in an attempt to avoid the collision. He called out to the occupants in the patient compartment during the avoidance maneuver in an attempt to warn them of the impending crash. The ambulance crossed the centerline, initiated a clockwise (CW) yaw across the westbound lane, and departed the right roadside. It traveled through the shallow ditch and ramped up the hillside. At the time of the scene inspection, there were no pre-crash tire marks or other evidence on the roadway surface.

Figure 2. Westbound approach for the ambulance

Crash

The front wheels of the ambulance furrowed in the hillside and the ditch for approximately 5 m (16'). The furrowing of the wheels and CW yaw caused the ambulance to tip over onto its left side and slide a short distance to final rest on the north roadside **(Figure 3)**. Contact with the road surface was limited to the left side aspect of the ambulance cab and patient compartment.

Figure 3. Area of final rest for the ambulance

Post-Crash

The driver of the ambulance came to rest in the driver's seat. He contacted the dispatcher via the two-way radio in the ambulance and advised them of the crash. He unbuckled the safety belt in an attempt to exit the ambulance cab, and fell into the left front door area due to the position of the ambulance. He stated that the left front window glazing had disintegrated from impact forces, and his legs were stuck under the instrument panel and his upper torso was facing the center of the cab. He was unable to exit the vehicle and rescue personnel removed the roof of the cab to extricate the driver.

The PCP's and patient were assisted out of the patient compartment by rescue personnel. All of the occupants were transported by ambulance to a local hospital.

VEHICLE DATA - 1997 Ford E-350/Horton Ambulance

The 1997 Ford E-350 ambulance was identified by the Vehicle Identification Number (VIN): 1FDKE30F1VH (production sequence omitted). The odometer reading at the time of the vehicle inspection was 121,087 km (75,242 miles). The ambulance was configured with a Ford E-350 Super Duty 4 x 2 cutaway chassis that was equipped with the Ford Ambulance Prep package that included a 7.3 liter, turbo-charged V-8 diesel engine, a single 133 liter (35 gal) fuel tank, front disc and rear drum brakes, a four-speed automatic transmission with overdrive, and original equipment manufacturer (OEM) low-mount RV style mirrors with convex mirrors. The ambulance was configured with LT225/75R16 tires. The tire data for the ambulance is as follows:

Position	**Tire**	**Pressure**	**Tread**
LF	Cooper SRM II	379 kpa (55 psi)	6.4 mm (8/32")
LR (inboard dual)	Unknown	Unknown	0.8 mm (1/32")
LR (outboard dual)	Cooper Discoverer	Unknown	7.1 mm (9/32")
RF	Cooper SRM II	400 kpa (58 psi)	6.4 mm (8/32")
RR (inboard dual)	Unknown	Unknown	2.4 mm (3/32")
RR (outboard dual)	Cooper Discoverer	Unknown	5.6 mm (7/32")

The Ford E-350 ambulance package was produced by Horton Emergency Vehicles. The ambulance model was a 453 Type III. The patient compartment dimensions measured 370 x 216 x 239 cm (146 x 85 x 94"). The ambulance was configured with two rear entry doors with an opening that measured 137 x 119 cm (54 x 47"), and a single entry door on the right front side aspect that measured 76 x 198 cm (30 x 78"). The entry doors had paddle type latches equipped with interior and exterior accessible locks. Two electronic switches in the patient compartment and one on the cab's center console controlled the patient compartment door locks. The ambulance had three exterior compartments on the left side and four exterior compartments on the right side. Each compartment was equipped with a paddle-type locking latch. Compartment specifications are included in **Appendix A** at the end of this report. The ambulance was also equipped with an electronic siren and emergency lighting, which included body warning lights, flashing lights, grille lights, intersection lights, load lights, and scene lights. A center console was present between the front seats, which housed controls for the sirens, emergency lights, and two-way radios. The ambulance specifications are included in Appendix A at the end of this report.

The forward exterior compartment on the left aspect housed an H-size oxygen cylinder that measured 110.5 cm (43.5") in height and 17.8 cm (7.0") in diameter. The H-cylinder was secured with a steel cylinder bottle bracket **(Figure 4)** mounted to the forward aspect of the left front exterior cabinet. The bracket was configured with three heavy-duty steel semi-circular clasps, which were secured to the bracket on the each side by 7.9 mm (5/16”) diameter bolts that measured 10.2 cm (4.0”) in length and wing nuts. The clasps measured 25.4 cm (10.0”) in width, 4.4 cm (1.8”) in height, and the semi-circular diameter measured 17.8 cm (7.0”). The three clasps were located 13.3 cm (5.5”), 50.8 cm (20.0”), and 88.9 cm (35.0”) above the bottom of the bracket, respectively. The volume of oxygen at the time of the crash was not known.

Figure 4. View of oxygen cylinder bracket

The forward compartment on the right aspect of the patient compartment allowed access to the interior shelves and also housed the vehicle batteries in the bottom aspect. A roll-out drawer housed two batteries that were secured by a single aluminum bracket along the top aspect **(Figure 5)**. The drawer measured 42.5 cm (16.8”) in length, 34.9 cm (13.8”) in width, and 27.3 cm (10.8”) in depth. An aluminum cover was secured over the top of the drawer with wing bolts. It was removed post-crash to gain access to the batteries. The drawer was configured with a high-tension spring locking mechanism on the center aspect of the face of the drawer that engaged with a receiver mounted on the interior aspect of the cabinet floor.

Figure 5. View of battery drawer

The opening between the cab and the patient compartment measured 115.6 cm (45.5”) in height and 47.0 cm (18.5”) in width. A 2.5 cm (1.0”) thick door hinged on the right side was found locked in the open position. The door was recessed into the right aspect of the pass-through in the open position. It was locked in the open position by a steel pin-type lock located at the bottom outboard aspect of the door. A second receiver was located on the left aspect of the pass through opening to lock the door in the closed position.

A center-mount Ferno Model 175-4 ambulance cot fastener system was installed in the ambulance. The fastening system consisted of a front "antler" bracket mounted to the center aspect of the floor that secured the front wheels of the cot and a rear spring-loaded fastener rail mounted on the left aspect of the floor that fastened directly to the cot frame. Both the “antler” bracket and fastener rail were detachable and a second set of floor plates were located to the left of the mounting plates in use.

The ambulance cot was a Ferno Model 35-A aluminum cot **(Figure 6)**. The cot was rated for a maximum weight of 228 kg (500 lb) and was designed with eight vertical adjustment positions. Its overall length measured 200.1 cm (79.0”) and overall width measured 61.0 cm (24.0”). The cot was configured with a fully adjustable gas-assist backrest and three sets of lateral harness straps with locking latch plates for the chest, hips, and legs. A 4-point shoulder harness was available for this ambulance cot, but was not affixed to the cot at the time of the crash.

Figure 6. Ferno ambulance cot

The specific cabinet locations for the patient compartment interior **(Figure 7)** are illustrated in the ambulance interior schematic in **Appendix A**. A non-padded stainless steel assist rail was located on the ceiling above the ambulance cot area. The front right side exterior cabinet was accessible from the interior of the patient compartment by four aluminum doors with spring-loaded cam lock closures that were hinged on the bottom aspects. The doors measured 58.4 cm (23.0”) in width and 22.2 cm (8.8”), 22.2 cm (8.8”), 48.3 cm (19.0”), and 45.7 cm (18.0”) in height from top to bottom, respectively. The remaining interior cabinetry consisted of sliding plexiglass doors configured with full-length aluminum pull handles. Each cabinet with plexiglass doors was configured with an aluminum trim picture frame with 45 degree angles at the corners. Two cabinets with plexiglass doors were located along the left wall on the rear aspect and measured 45.7 cm (18.0") in depth. The rear left side cabinets were vertically oriented and the combined measurements were 58.4 cm (23.0") in width and 121.9 cm (48.0") in height. Additional cabinets with plexiglass doors were located forward of the rear cabinets at the top and bottom aspects of the wall. The top cabinet was configured with sliding doors and measured 61.0 cm (24.0”) in width and 30.5 cm (12.0”) in height. An open sheet-metal-constructed shelf that measured 39.4 cm (15.5”) in width, 10.8 cm (4.8”) in height, and 45.7 cm (18.0”) in depth was attached to the bottom aspect of the upper cabinet. The bottom cabinet was hinged at the bottom aspect and constructed of a single aluminum door with a spring-loaded cam lock. The bottom cabinet measured 61.0 cm (24.0”) in width and 30.5 cm (12.0”) in height. Two additional cabinets that measured 111.8 cm (44.0") in width and 30.5 cm (12.0") in height were located over and under the work space area on the forward aspect of the left wall.

Figure 7. View of patient compartment interior

Two cabinets were located over the right side squad bench seat. The combined measurements were 184.2 cm (172.5”) in length and 25.4 cm (10.0”) in height. A second cabinet was located on the rear wall on the right side of the patient compartment, adjacent to the right exit door, and

under the right side upper cabinet. It measured 50.8 cm (20.0”) in width, 30.5 cm (12.0”) in height, and 20.3 cm (8.0”) in depth.

A sharps/waste cabinet **(Figure 8)** was located forward of the leading edge of the squad bench seat that measured 27.3 cm (10.5”) in length, 53.3 cm (21.0”) in width, and 23.5 cm (9.3”) in depth. The cabinet cover was configured with a plastic pull-type latch on the forward aspect and was hinged at the rear aspect, adjacent to the forward edge of the squad bench seat. The inboard aspect was configured with a horizontally oriented spring-hinged plastic flap that measured 8.9 x 16.5 cm (3.5 x 6.5”) and outboard aspect with a circular hole that measured 8.9 cm (3.5”) in diameter. The outboard aspect of the cabinet was used for disposal of used medical items and the used sharps container was under the inboard aspect under the spring-hinged flap.

Figure 8. Sharps/waste cabinet

It was noted that 3.2 cm (1.3”) thick padding was located around the entire perimeter of the patient compartment interior.

Prior to the crash, the Lifepack 10 cardiac monitor/defibrillator was positioned on the shelf above the bottom cabinet which was located on the center aspect of the left wall of the patient compartment. The cardiac monitor/defibrillator was not restrained and was in use to monitor the patient’s heart rhythm.

The seating in the cab of the Ford E-350 ambulance was configured with box-mounted bucket seats with integral head restraints and folding armrests on the inboard aspects. Both front seats were adjusted to the full-rear position.

The seating in the patient compartment of the ambulance was configured with a single rear-facing attendant's bucket seat mounted on a wood base in the forward left position with an adjustable fore and aft seat track position. The technician seat track was adjusted to the full-rear position (rear = toward the forward wall of the patent compartment) in the rear-facing orientation and had a total travel distance of 5.1 cm (2.0”). An HVAC duct panel was located on the forward interior wall above the seat back. A split three-person squad bench seat was located along the right wall with a lid hinged on the forward/outboard aspect. The rear half of the squad bench seat was fixed. Additional storage space was located under the forward half of the squad bench seat. The bench seat lid was secured in the down position in place by a spring-loaded steel clasp on the center aspect of the lid. The lid overhang measured 4.4 cm (1.8”). Three 7.0 cm (2.8”) thick sections of padding were present on the right wall above the bench seat. Each measured 16.5 cm (6.5”) in height and were spaced 12.7 cm (5.0”) apart. The top sections measured 135.9 cm (53.5”) in length and the bottom measured 149.9 cm (59.0”) in length.

A single seating position was located on the center aspect of the left wall of the patient compartment **(Figure 9)**. Commonly called the “CPR seat”, it was configured with a bottom cushion and 3.2 cm (1.3”) thick padding on the outboard side aspects. The padded seat back was located 20.3 cm (8.0”) above the cushion, and was hinged at the bottom aspect, designed to fold onto the outboard padded cushions for use as a shelf. The seat back measured 59.7 cm (23.5”) in width and 40.6 cm (16.0”) in height. It was anchored in the up position by a steel pin-type lock located at the top of the seat cushion at the forward aspect.

Figure 9. Left side "CPR" seat

VEHICLE DAMAGE

Exterior Damage - 1997 Ford E-350/Horton Ambulance

The 1997 Ford E-350/Horton ambulance sustained minor damage as a result of the crash **(Figure 10)**. Both A-pillars were cut by rescue personnel and the roof was folded rearward to facilitate the extrication of the driver. Minor deformation to the front bumper and rear step were a result of towing and removal from the crash scene.

Large amounts of dirt were present on the left front wheel, left side running board, and the left side aspect of the patient compartment. The left front wheel sustained abrasions. The left outside mirror was abraded and rotated counterclockwise (CCW). The forward mount on the top aspect and both bottom mounts for the outside mirror were separated from the exterior door panel. The left front door panel sustained minor induced damage as a result of the lateral mirror frame displacement caused by the left side rollover **(Figure 11)**. Induced damage also resulted from rescue efforts as the left A-pillar and the door window frame was cut.

Figure 10. Front left view of damaged ambulance

Figure 11. Left front view showing displaced mirror and door damage

The left front corner of the patient compartment outboard of the cab sustained moderate abrasions from the rollover **(Figure 12)**. The abrasions began 62.2 cm (24.5”) from the top aspect of the patient compartment and extended a vertical distance of 153.7 cm (60.5”). The forward corner of the drip rail along the top aspect of the left side of the patient compartment was also abraded **(Figure 13)**. The abrasion measured 1.9 cm (0.8”) in length. The 144.8 cm (57.0”) long diamond plate trim piece that was located on the bottom aspect of the patient compartment, forward of the rear wheel was separated. The aluminum splash guard that was contoured to the rear wheel well was also separated. The Collision Deformation Classification (CDC) for the rollover event was 00-LDAO-1.

Figure 12. View of abrasions on left front corner of the patient compartment

Figure 13. Close up of abrasion on the forward corner of the drip rail

Large amounts of dirt were also present on the right front wheel, the right side running board, and the lower aspect of the right side of the patient compartment **(Figure 14)**. The right front wheel cover was deformed on the center aspect. The rear aspect of the right front fender was deformed slightly at the bottom aspect. The lower diamond plate trim piece aft of the right rear wheel was separated.

Figure 14. Right side view of the ambulance

Interior Damage - 1997 Ford E-350/Horton Ambulance

Interior damage to the cab of the 1997 Ford E-350/Horton ambulance as a result of the crash was minor **(Figure 15)**. Two lacerations were present on the upper interior surface of the left front door armrest that measured 1.9 cm (0.8") and 1.3 cm (0.5"). The interior door damage may have been attributed to extrication efforts, as they were not consistent with occupant contact. The interior trim piece on the left B-pillar was separated. At the time of the vehicle inspection, the plastic trim panel under the front right passenger's air bag cover flap was removed, the center console which contained the emergency radio and warning device switches was removed, and the center engine shroud was removed. The removal of these components was performed post-crash.

Figure 15. Interior view across the cab of the ambulance

Interior damage to the patient compartment of the 1997 Ford E-350/Horton ambulance was moderate, and attributed to occupant contact. The patient had lost control of body functions, which resulted in body substance contact on the left side aspect the patient compartment. Body fluid (blood) was also noted on the left side aspect due to minor bleeding from the patient post-crash.

The aluminum shelf located in the left rear bottom cabinet was displaced on the forward aspect from crash forces. The bolts that secured it into two vertically oriented tracks had separated from the tracks.

The HVAC vent above the rear-facing technician seat was configured with four adjustable plastic louver sets. The left outboard plastic louver set was separated at the time of the vehicle inspection. There was no evidence to suggest occupant contact.

The rear facing technician seat sustained a 3.8 cm (1.5") laceration on the inboard side aspect of the cushion at the seat bight.

The cabinet doors on the front right wall of the patient compartment sustained damage from occupant contact. A 10.2 cm (4.0") section of the aluminum frame around the top door was deformed from occupant contact on the top aspect. A 5.1 cm (2.0") section was deformed on the top right side aspect. The two center cabinet doors on the front right wall of the patient compartment were displaced forward from occupant contact **(Figure 16)**. Both doors were hinged at the bottom aspects and the spring-loaded cam locks were displaced forward past

Figure 16. Close-up of displaced cabinet door

the metal stop brackets. The forward displacement of the second (from the top) cabinet door measured 2.5 cm (1.0”). The forward displacement of the third (from the top) door measured 7.0 cm (2.8”). The bottom cabinet door frame sustained an area of deformation that measured 20.3 cm (8.0”) along the top center aspect.

The IV holder on the right side of the assist rail was deformed from occupant loading. The IV holder was deformed forward and slightly CCW **(Figure 17)**.

A plastic bracket was located on the right wall aft of the right side door 55.9 cm (22.0”) above the bench seat that held an aerosol can of antibacterial cleanser. The bracket was fractured and the aerosol can was displaced as a result of occupant contact.

Figure 17. View of deformed IV bag holder, fractured aerosol can bracket, and deformed cabinetry

The hinged plastic cover of the sharps/waste cabinet forward of the squad bench seat was fractured on the inboard aspect. The fracture measured 10.2 cm (4.0”) in length and was oriented at a 45 degree angle. It began below the spring-hinged flap and extended toward the front inboard corner.

MANUAL RESTRAINT SYSTEM - 1997 Ford E-350/Horton Ambulance

The front seat positions in the 1997 Ford E-350/Horton ambulance were configured with manual 3-point lap and shoulder belts with sliding latch plates. Both manual restraints were configured with adjustable D-rings that were in the full-down positions and had 8.9 cm (3.5") of vertical travel. There was no loading evidence on the driver's latch plate plastic, or D-ring. However, the safety belt webbing exhibited stretching over a total distance of 91.4 cm (36.0”), which began 31.8 cm (12.5”) above the outboard plastic sleeve. An area of multiple small abrasions was located 49.5 cm (19.5”) from the outboard sleeve and extended 17.8 cm (7.0”) along the face of the webbing. Both frontal manual restraints were also equipped with buckle pretensioners located on the inboard aspects of the seats. The pretensioners did not fire as a result of the crash. The driver’s seat belt is shown in **Figure 18**.

Figure 18. View of drivers safety belt and buckle pretensioner

The patient compartment seating areas were configured with manual lap belts with ALR's and sewn latch plates. Tags sewn on the webbing indicated that the date of manufacture was July 1995. The retractor and buckle assemblies were vertically mounted on the wall behind each seating position on the squad bench seat and "CPR" seat. The lower anchor bolts for the retractor and buckle assemblies were mounted with a 90 degree steel mounting bracket to the right wall and the base of the seats and approximately 13.3 cm (5.3") below the height of the seat cushions. The buckle assemblies were mounted with plastic sleeves that measured 17.8 cm (7.0") in height above the anchor bolts. The buckles and webbing extended 6.4 cm (2.5") above the top aspect of the sleeves. **Figure 19** illustrates the manual restraints on the squad bench seat.

Figure 19. View of manual restraints on the squad bench seat

The distance between the retractor assemblies and the buckle assemblies on the right side squad bench seat measured 30.5 cm (12.0") for each of the three seating positions. In addition, three buckle assemblies were mounted on the inboard face of the bench and centered vertically between the floor and the cushions to facilitate the restraint of a stretcher on the squad bench seat. Plastic sleeves that measured 17.8 cm (7.0") in height were mounted with a single bolt on the bottom aspects, and the webbing and buckles extended 6.4 cm (2.5") above the sleeves. The forward-most buckle was located 66.0 cm (26.0") rear of the forward edge of the bench seat, and the remaining two buckle assemblies were spaced 55.9 cm (22.0") and 25.4 cm (10.0") apart, respectively.

The retractor assembly and buckle assembly for the box-mounted rear-facing technician seat were mounted behind the seat on top of the box. The buckle assembly was housed in a rigid plastic sleeve that measured 30.5 cm (12.0") in length and was mounted by a single bolt to the inboard aspect of the left wall. The buckle stalk was oriented at a 45 degree angle and the buckle assembly and webbing extended 10.2 cm (4.0") above the sleeve.

FRONTAL AIR BAG SYSTEM – 1997 Ford E-350/Horton Ambulance

The frontal air bag system in the 1997 Ford E-250/Horton ambulance did not deploy as a result of the crash. The driver's air bag was housed in the center of the steering wheel with a single cover flap design hinged at the top aspect. The front right passenger's air bag was configured with a mid-mount module with a single cover flap hinged at the top aspect. The cover flap followed the contour of the upper instrument panel and measured 37.8 cm (14.9") in width and 29.8 cm (11.8") in height. "AIRBAG" was molded into the lower right corner of the cover flap.

OCCUPANT DEMOGRAPHICS - 1997 Ford E-350 Ambulance

Driver

Age/Sex:	27-year-old male
Height:	183 cm (72")
Weight:	137 kg (302 lb)
Seat Track Position:	Full-rear
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection, interview
Eyewear:	Prescription glasses
Type of Medical Treatment:	Transported by ambulance to a local hospital and treated and released

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Left wrist abrasion	Minor (790202.1,2)	Left door interior surface
Right arm abrasion	Minor (790202.1,1)	Driver's seat back
Right shoulder contusion	Minor (790402.1,1)	Left B-pillar
Left knee contusion	Minor (890402.1,2)	Knee bolster
Bilateral thigh contusions	Minor (890402.1,3)	Steering wheel rim

Injury source: Hospital records, interview

Driver Kinematics

The driver was seated in an upright posture with the seat track adjusted to the full-rear position. He was restrained by the manual 3-point lap and shoulder belt. The driver stated that as the ambulance departed the roadside, he was bracing with his arms and legs. As the driver applied the brakes and the ambulance ramped up the hillside in a CW yaw, he initiated a forward and lateral trajectory. The driver loaded the safety belt, which helped to mitigate additional movement in the cab of the ambulance. As the ambulance furrowed into the hillside and tipped over, the driver was redirected to the left and further loaded the safety belt webbing. Although there was no contact evidence on the knee bolster, his left knee probably struck the bolster which resulted in a left knee contusion. His left hand contacted the interior surface of the left front door which resulted in a left hand abrasion. After the ambulance came to rest on the left side, the driver unbuckled the safety belt in an attempt to exit the vehicle. His torso fell onto the interior aspect of the left front door while his legs remained under the instrument panel. As he fell, his thighs contacted the steering wheel rim, which resulted in bilateral thigh contusions and his right arm contacted the driver's seat back resulting in a right arm abrasion. He sustained a right shoulder contusion from contact with the left interior B-pillar after removing the manual restraint. He came to rest with his back against the interior door frame and his legs under the instrument panel.

After the driver's torso was displaced against the left door, he was unable to exit the vehicle. Rescue personnel removed the windshield, cut both A-pillars, and removed the roof to extricate the driver. He was transported by ambulance to a local hospital where he was treated and released.

Patient Compartment Left Side ("CPR") Seat Passenger (PCP)

Age/Sex:	47-year-old female
Height:	155 cm (61")
Weight:	75 kg (165 lb)
Seat Track Position:	Fixed
Manual Restraint Use:	Unrestrained
Usage Source:	Injuries, interview
Eyewear:	None
Type of Medical Treatment:	Transported by ambulance to a local hospital and treated and released. She was admitted the following day.

Patient Compartment Left Side ("CPR") Seat Passenger (PCP) Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Grade 1 acromioclavicular separation of the left shoulder	Moderate (751230.2,2)	Front right cabinetry of patient compartment
Contusions on left arm, left elbow, and left hand	Minor (790402.1,2)	Front right cabinetry of patient compartment
Right leg contusion	Minor (890402.1,1)	Probable contact with ambulance cot
Left leg contusion	Minor (890402.1,2)	Left side "CPR" seat base

Injury source: Hospital records, interview

Patient Compartment Left Side ("CPR") Seat Passenger (PCP) Kinematics

The 47-year-old female PCP was seated on the left side "CPR" seat at the time of the crash. She was not restrained by the manual lap belt and was assisting the Paramedic PCP with the IV line and a glucose test. As the driver applied the brakes and the ambulance ramped up the hillside, the PCP initiated a forward and lateral trajectory. She was displaced from the seat toward the front right corner of the patient compartment. She struck the front right cabinetry with her left side which resulted in a left shoulder separation, contusions on the left arm, left elbow, and left hand. She stated that occupant-to-occupant contact with the Paramedic PCP occurred during her initial displacement. She rebounded to the left as the ambulance rolled onto its left side, and probably struck the upper cabinetry on the left front aspect, evidenced by hair deposits. She came to rest in the left side "CPR" seat with her left leg twisted under her, and her right leg on the floor, adjacent to the ambulance cot. Her rebound into the seat resulted in a left leg contusion and probable contact with the ambulance cot resulted in a right leg contusion.

The displaced patient came to rest on top of the female PCP. The patient's head came to rest on the shelf forward of the left side "CPR" seat and the patient's torso was on top of the PCP. After

the ambulance came to rest, the PCP checked the patient's vital signs and attempted to administer oxygen, however, oxygen was not flowing to the oxygen mask.

The PCP was assisted out of the ambulance by rescue personnel. She was transported by ambulance to a local hospital and treated and released. She was re-admitted the following day due to crash-related injuries.

Patient Compartment Squad Bench Seat Passenger (PCP)

Age/Sex:	30-year-old male
Height:	201 cm (79")
Weight:	145 kg (320 lb)
Seat Track Position:	Fixed
Manual Restraint Use:	Unrestrained
Usage Source:	Injuries, interview
Eyewear:	None
Type of Medical Treatment:	Transported by ambulance to a local hospital and treated and released

Patient Compartment Squad Bench Seat Passenger (PCP) Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Right knee hyper-extension (sprain)	Moderate (850826.2,1)	Impact forces
Contusion of the posterior scalp	Minor (190402.1,8)	Monitor/Defibrillator
Large lower back contusion	Minor (690402.1,8)	Front right cabinetry of patient compartment
Bilateral arm contusions	Minor (790402.1,3)	Front right cabinetry of patient compartment
Bilateral leg contusions	Minor (890402.1,3)	Front right cabinetry of patient compartment
Multiple contusions, (NFS)	Minor (990400.1,9)	Front right cabinetry of patient compartment

Injury source: Hospital records, interview

Patient Compartment Squad Bench Seat Passenger (PCP) Kinematics

The 30-year-old male PCP was seated on the right side squad bench seat. He was unrestrained. He had initiated an IV line in the patient's left arm and was preparing to secure the IV bag and tape the IV line in place on the patient's arm. Prior to the crash, the driver yelled to the occupants in the patient compartment to warn them of the impending crash. The male PCP stood up, grabbed the roof-mounted assist rail with both hands, and braced his feet against the ambulance cot. As the driver applied the brakes and the ambulance ramped up the hillside, the male PCP initiated a forward trajectory. He sustained a hyper-extension of his right knee from impact forces. He struck the IV bag holder, which was in the down position, evidenced by the deformity

and displacement of the IV bag holder. The IV bag was also displaced and ruptured as a result of the contact. He struck an aerosol spray can of anti-bacterial cleanser, which was mounted on the right wall aft of the side door. The contact fractured the plastic bracket and displaced the aerosol can, which dispensed some of its contents on the interior walls of the ambulance. The PCP continued his forward trajectory and loaded the front right cabinetry of the patient compartment with his right side. His loading displaced the second and third cabinet doors forward past the metal closures and deformed the aluminum frame around the top and bottom doors. The contact with the front right cabinetry resulted in a right shoulder injury, bilateral arm contusions, a lower back contusion, bilateral leg contusions, and multiple other contusions.

The unrestrained cardiac monitor/defibrillator was displaced forward and right. The PCP stated that after he loaded the front right cabinetry, he was struck in the back of the head by the cardiac monitor/defibrillator, which resulted in a contusion of the posterior scalp.

The PCP was redirected left as the ambulance rolled onto its left side, and sustained occupant-to-occupant contact with the displaced female PCP. He came to rest face-down on the left side cabinetry, aft of the left side "CPR" seat. He was removed from the ambulance on a backboard by rescue personnel. He was transported by ambulance to a local hospital where he was treated and released.

Patient (on ambulance cot)

Age/Sex:	75-year-old female
Height:	Approximately 152 cm (60")
Weight:	Approximately 41 kg (90 lb)
Seat Track Position:	Fixed (ambulance cot)
Manual Restraint Use:	Lateral straps on legs, hips, and chest
Usage Source:	Interview with PCP's
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a local hospital and where she expired

Patient (on ambulance cot) Kinematics

The 75-year-old female patient was lying on the ambulance cot in a supine position. She was restrained by three lateral straps positioned across her legs, hips, and chest. There were no shoulder harnesses in use on the ambulance cot. The patient was clothed in a single cotton gown and was en route to the hospital due to her critical status. She was unresponsive, was having respiratory distress, and had lost control of body function prior to transport.

As the driver braked and the ambulance ramped up the hillside, the patient initiated a forward trajectory and slid out of the lateral restraints and fell off the ambulance cot. She fell onto the floor of the ambulance and was redirected to the left as the ambulance rolled onto its left side. She came to rest on top of the female PCP on the left side workspace area. The patient was removed from the ambulance by rescue personnel. She was transported by ambulance to a local

hospital where she expired. Reports from a Medical Examiner stated that the patient's death was not related to the crash.

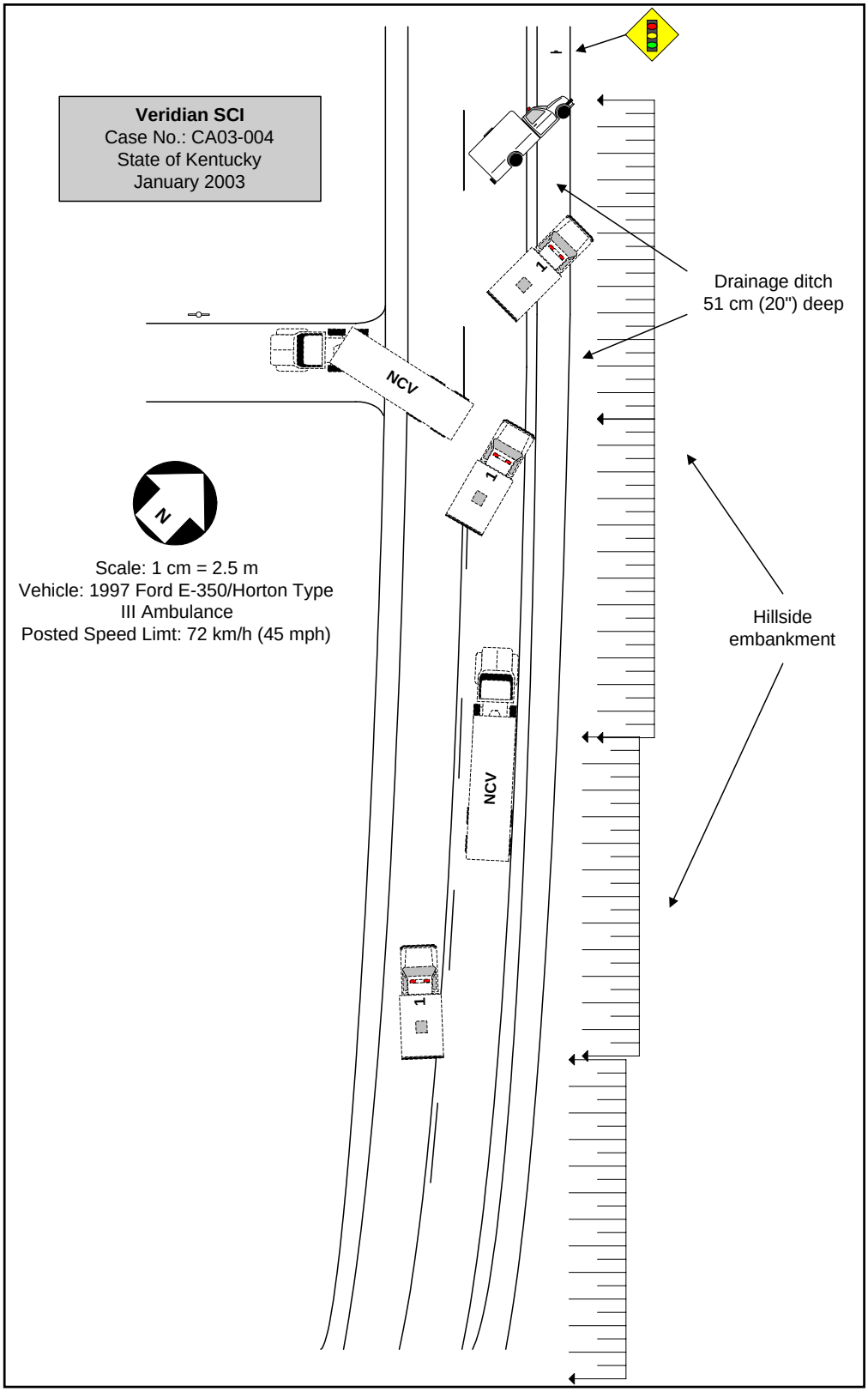

Figure 20. Scene schematic

APPENDIX A – 1997 HORTON MODEL 453 AMBULANCE SPECIFICATIONS