

**TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER**

Veridian Engineering
Buffalo, NY 14225

**VERIDIAN ON-SITE AMBULANCE CRASH INVESTIGATION
SCI TECHNICAL SUMMARY REPORT**

VERIDIAN CASE NO. CA02-009

VEHICLE - 2000 FORD E-350 TYPE III AMBULANCE

LOCATION - STATE OF KENTUCKY

CRASH DATE - MARCH 2002

Contract No. DTNH22-01-C-17002

Prepared for:

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

DISCLAIMER

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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

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

TECHNICAL REPORT STANDARD TITLE PAGE

<p>1. <i>Report No.</i> CA02-009</p>	<p>2. <i>Government Accession No.</i></p>	<p>3. <i>Recipient's Catalog No.</i></p>	
<p>4. <i>Title and Subtitle</i> Veridian On-site Ambulance Crash Investigation Vehicle: 2000 Ford E-350 Type III Ambulance Location: State of Kentucky</p>		<p>5. <i>Report Date:</i> December 2002</p>	
		<p>6. <i>Performing Organization Code</i></p>	
<p>7. <i>Author(s)</i> Crash Data Research Center</p>		<p>8. <i>Performing Organization Report No.</i></p>	
<p>9. <i>Performing Organization Name and Address</i> Transportation Sciences Crash Data Research Center Veridian Engineering P.O. Box 400 Buffalo, New York 14225</p>		<p>10. <i>Work Unit No.</i> C00410.0000.0024</p>	
		<p>11. <i>Contract or Grant No.</i> DTNH22-01-C-17002</p>	
<p>12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590</p>		<p>13. <i>Type of Report and Period Covered</i> Technical Report Crash Date: March 2002</p>	
		<p>14. <i>Sponsoring Agency Code</i></p>	
<p>15. <i>Supplementary Notes</i> On-site investigation of a frontal crash involving a 2000 Ford E-350 Type III ambulance and a 1995 Mitsubishi Eclipse. The crash resulted in severe damage to both vehicles, moderate injuries to the occupants in the ambulance, and the death of the Mitsubishi's driver.</p>			
<p>16. <i>Abstract</i> 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 2000 Ford E-350 that was equipped with an ambulance body. The ambulance was being operated by a crew of two and was transferring a patient in a non-emergency mode to a regional hospital. The driver was an unrestrained 22-year-old male state-certified Emergency Medical Technician (EMT), and the patient care provider (PCP) was a 37-year-old male state-certified Paramedic. The PCP was unrestrained on the center position of the side bench seat in the patient compartment. The 34-year-old male patient was restrained in a supine position on the ambulance cot with his head slightly elevated, and the patient's 41-year-old brother, was restrained on the rear-facing attendant's seat. The ambulance was involved in an offset head-on collision with a 1995 Mitsubishi Eclipse driven by a 17-year-old male. The severe impact resulted in the deployment of the frontal air bags in both vehicles. The Eclipse was redirected rearward and came to rest 31.8 m (104.3') rear of the point of impact on the roadside. The ambulance overturned onto its left side, slid in a forward direction, and came to rest on the roadway. The ambulance driver sustained a forehead contusion and a right leg contusion. He exited the ambulance through the right front door window opening. The PCP loaded the front right interior shelves and sustained a loss of consciousness, a right parietal/occipital scalp laceration, a right maxillary sinus fracture, a right occipital scalp contusion, a nasal fracture, a laceration of the right cheek/nose, and a right thigh contusion. He also sustained a left occipital intraparenchymal hemorrhage, a left occipital brain contusion a result of the shelf contact. He rebounded into the opposite side interior cabinetry which resulted in a left forearm abrasion and a left hand laceration. The patient's brother sustained minor internal injuries from the lap belt and assisted the patient out of the rear of the ambulance. The patient and his brother left the scene with family members who were following the ambulance in a non-contact vehicle. They were transported to a regional hospital. The driver of the ambulance and PCP were transported by ambulance to a regional hospital. The driver was treated and released and the PCP was admitted two days for treatment. The 17-year-old male driver of the Mitsubishi sustained critical injuries and expired 10 hours following the crash.</p>			
<p>17. <i>Key Words</i> Ambulance Redesigned Air bags</p>		<p>18. <i>Distribution Statement</i> General Public</p>	
<p>19. <i>Security Classif. (of this report)</i> Unclassified</p>	<p>20. <i>Security Classif. (of this page)</i> Unclassified</p>	<p>21. <i>No. of Pages</i> 29</p>	<p>22. <i>Price</i></p>

TABLE OF CONTENTS

BACKGROUND	1
SUMMARY	2
Crash Site	2
Pre-Crash	2
Crash	3
Post-Crash	5
VEHICLE DATA - 2000 Ford E-350 Ambulance	6
VEHICLE DAMAGE	9
Exterior Damage - 2000 Ford E-350 Ambulance	9
Interior Damage - 2000 Ford E-350 Ambulance	10
Exterior Damage - 1995 Mitsubishi Eclipse	14
MANUAL RESTRAINT SYSTEM - 2000 Ford E-350 Ambulance	14
FRONTAL AIR BAG SYSTEM - 2000 Ford E-350 Ambulance	16
OCCUPANT DEMOGRAPHICS - 2000 Ford E-350 Ambulance	17
Driver	17
Driver Injuries	17
Driver Kinematics	17
Patient Compartment Right Side Bench Seat Passenger (PCP)	18
Patient Compartment Right Side Bench Seat Passenger (PCP) Injuries	18
Patient Compartment Right Side Bench Seat Passenger (PCP) Kinematics	19
Patient Compartment Rear-Facing Attendant's Seat Passenger	21
Patient Compartment Rear-Facing Attendant's Seat Passenger Injuries	21
Patient Compartment Rear-Facing Attendant's Seat Passenger Kinematics	21
Patient Compartment Cot Passenger (Patient)	22
Patient Compartment Cot Passenger (Patient) Injuries	22
Patient Compartment Cot Passenger (Patient) Kinematics	23
SCENE SCHEMATIC	24
APPENDIX A - McCoy Miller 138SSB Type III Ambulance Specifications	25
APPENDIX B - Patient Compartment Schematics	30

**VERIDIAN ON-SITE AMBULANCE CRASH INVESTIGATION
SCI TECHNICAL SUMMARY REPORT
VERIDIAN CASE NO. CA02-009
SUBJECT VEHICLE - 2000 FORD E-350 TYPE III AMBULANCE
LOCATION - STATE OF KENTUCKY
CRASH DATE - MARCH 2002**

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 2000 Ford E-350 that was equipped with an ambulance body. The ambulance was being operated by a crew of two and was transferring a patient in a non-emergency mode to a regional hospital. The driver was an unrestrained 22-year-old male state-certified Emergency Medical Technician (EMT), and the patient care provider (PCP) was a 37-year-old male state-certified Paramedic. The PCP was unrestrained on the center position of the side bench seat in the patient compartment. The 34-year-old male patient was restrained in a supine position on the ambulance cot with his head slightly elevated, and the patient's 41-year-old brother, was restrained on the rear-facing attendant's seat. The ambulance was involved in an offset head-on collision with a 1995 Mitsubishi Eclipse driven by a 17-year-old male. The severe impact resulted in the deployment of the frontal air bags in both vehicles. The Eclipse was redirected rearward and came to rest 31.8 m (104.3') rear of the point of impact on the roadside. The ambulance overturned onto its left side, slid in a forward direction, and came to rest on the roadway. The ambulance driver sustained a forehead contusion and a right leg contusion. He exited the ambulance through the right front door window opening. The PCP loaded the front right interior shelves and sustained a loss of consciousness, a right parietal/occipital scalp laceration, a right maxillary sinus fracture, a right occipital scalp contusion, a nasal fracture, a laceration of the right cheek/nose, and a right thigh contusion. He also sustained a left occipital intraparenchymal hemorrhage, a left occipital brain contusion a result of the shelf contact. He rebounded into the opposite side interior cabinetry which resulted in a left forearm abrasion and a left hand laceration. The patient's brother sustained minor internal injuries from the lap belt and assisted the patient out of the rear of the ambulance. The patient and his brother left the scene with family members who were following the ambulance in a non-contact vehicle. They were transported to a regional hospital. The driver of the ambulance and PCP were transported by ambulance to a regional hospital. The driver was treated and released and the PCP was admitted two days for treatment. The 17-year-old male driver of the Mitsubishi sustained critical injuries and expired 10 hours following the crash.



Figure 1. Damaged Type III 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 Veridian SCI team. The Veridian SCI team initiated telephone follow-up with the investigating police agency and the County EMS coordinator. 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 two-vehicle crash occurred during the nighttime hours on a two-lane U.S. route. At the time of the crash, it was dark with no roadway illumination. The driver of the ambulance stated that the temperature was approximately 4 degrees Celsius (40 degrees Fahrenheit) and the weather was clear and windy. The concrete roadway surface was dry. The east/west two-lane roadway was straight and consisted of one travel lane in each direction separated by a dashed yellow centerline and bordered by gravel shoulders. The U.S. route had an approximate three percent negative westbound grade that began at a hillcrest 395 m (1295') east of the scene. At the crash site, a two-lane local roadway intersected the U.S. route in a T-configuration on the south side. A stop sign was located on the southeast corner for traffic turning onto the U.S. route. The posted speed limit for the roadway was 89 km/h (55 mph). The scene schematic is included as **Figure 32**.

Pre-Crash

The 22-year-old male driver had worked 16 hours the previous day at a different ambulance service, slept for approximately 8 hours, and had been on-duty for approximately 17.5 hours of his 24-hour shift at the time of the crash. The driver stated that he had been studying during the early part of the shift, had taken a few short naps, and had driven the ambulance on six emergency calls prior to the crash. The driver did not have a CDL license, although a CDL license was not required for this class vehicle. He had six years of general driving experience and a year and a half of ambulance driving experience.

The PCP had also been on-duty for approximately 17.5 hours of his 24-hour shift at the time of the crash. He was seated on the center position of the right side bench seat in the patient compartment and was initially restrained by the automatic locking retractor (ALR) lap belt. A semi-automatic cardiac defibrillator that weighed 9 kg (20 lb) was vertically restrained by the lap belt to the right of the PCP and an unrestrained soft-shell medical kit was positioned on the bench seat to his left. The PCP had removed the lap belt to adjust the HVAC controls on the opposite wall of the patient compartment during the transport and did not re-engage the restraint after being re-seated.

The 35-year-old patient was restrained to the ambulance cot by three adjustable straps at the chest, abdomen, and leg. He was positioned supine with his head elevated approximately 40 degrees from horizontal and covered with a hospital blanket under the restraints. Prior to the crash, the patient was stable and had one intravenous (IV) line in his right wrist. According to the PCP, the patient was alert and relaxed during the transport. There was no oxygen in use at the time of the crash.

The patient's brother was riding in the rear-facing attendant's seat located in the front left aspect of the patient compartment. The PCP advised the patient's brother to utilize the manual restraint prior to the

transport and he was restrained at the time of the crash by the lap belt with an automatic locking retractor (ALR).

The driver was operating the ambulance westbound on the two-lane U.S. route in a non-emergency mode (**Figure 2**). The emergency warning devices were not in operation. The driver stated that the low-beam headlights were in use and there were no distractions within the ambulance. The driver said that he exited a right curve that was located approximately 1.6 km (1.0 miles) east of the crash site and did not detect any headlights from any approaching vehicles. He stated that he noted the speedometer read 89 km/h (55 mph) as the ambulance entered the curve. He subsequently detected headlights approaching from the opposite direction and realized that the ambulance had crossed the centerline. The ambulance driver steered right in an attempt to avoid the collision. A witness following behind the ambulance stated that he did not see any brake lights illuminate on the ambulance as it crossed the centerline.



Figure 2. Westbound approach for the ambulance

A 17-year-old male was operating the 1995 Mitsubishi Eclipse eastbound on the U.S. roadway (**Figure 3**). The driver detected the ambulance encroaching into the eastbound lane and braked and steered left in an attempt to avoid the collision. A right front tire mark that measured 8.8 m (28.9') was present in the Mitsubishi's pre-crash trajectory. The mark began in the center of the eastbound lane, curved slightly toward the centerline, and ended at the point of impact.



Figure 3. Eastbound approach for the Mitsubishi Eclipse

Crash

The Ford E-350 ambulance impacted the Mitsubishi Eclipse in an offset head-on configuration. The impact resulted in severe damage to both vehicles. The principal direction of force was in the 12 o'clock sector for both vehicles. After the initial engagement, the ambulance rotated slightly clockwise (CW) as it crushed the front right aspect of the Mitsubishi. The damage and trajectory algorithm of the WinSMASH program computed impact speeds and delta-V's based on the vehicles' respective crush profiles and post-impact trajectories (The final rest position of the ambulance was estimated for WinSMASH based on a non-rollover assumption to final rest. The drag factor between the left side of the ambulance body and the road surface was significantly lower than the drag factor between the tires and the road surface, which resulted in a longer slide-to-stop distance). The calculated impact speed for the ambulance was 84.6 km/h (52.6 mph) and the calculated impact speed of the Mitsubishi was 87.0 km/h (54.1 mph). The total delta-V for the Ford ambulance was 39.0 km/h (24.2 mph) and the total delta-V for the Mitsubishi Eclipse was 125.0 km/h (77.7 mph). The barrier equivalent speeds for the ambulance and Mitsubishi were 52.1 km/h (32.4

mph) and 108.3 km/h (67.3 mph), respectively. The Ford E-350 ambulance was equipped with an Event Data Recorder. The EDR module was removed from the vehicle during the vehicle inspection and forwarded through NHTSA to Ford/Siemens to be downloaded. The Field Event Analysis Report received from Ford/Siemens stated that in this crash, the EDR was only able to record the first 20 milliseconds. It was suspected that the battery feed to the EDR was lost before the recording was complete. Therefore, lateral acceleration and delta-V were not available. The Field Event Analysis Report results are summarized as follows in **Figure 4** :

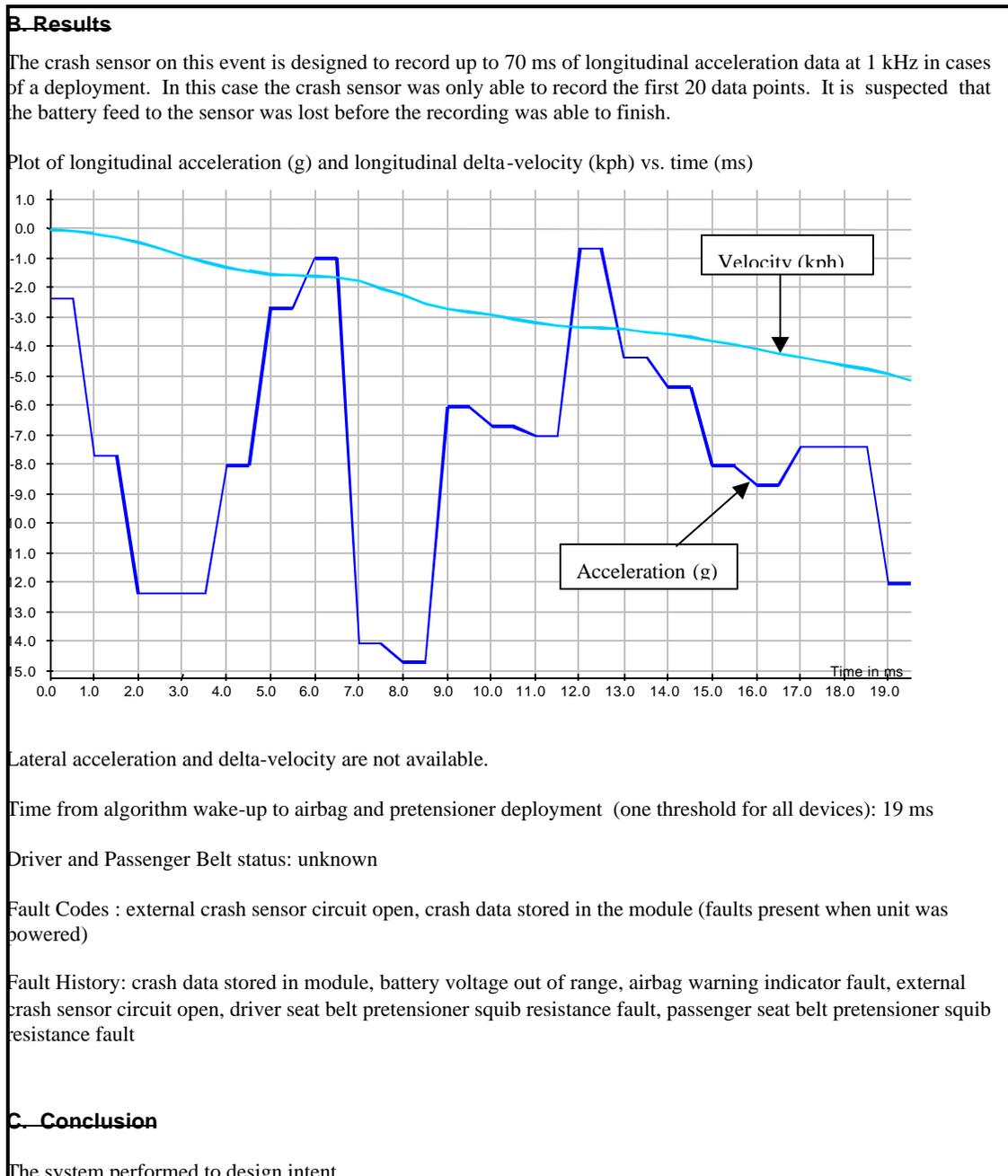


Figure 4. Results of the EDR download for the Ford E-350 ambulance

The ambulance initiated a slight CW yaw after engaging the Mitsubishi. The forward velocity of the ambulance combined with the CW rotation and high center of gravity, caused it to roll onto its left side and slide forward on the roadway to final rest. Based on gouges on the road surface, the ambulance rolled onto its side 8 m (26') west of the point of impact. The sustained contact between the left side of the ambulance body and the road surface overcame the initial CW rotation and the ambulance slowly rotated CCW to final rest on its left side. The left front door opened as a result of the initial impact due to latch/striker overload. The trailing edge of the door was heavily abraded from contact with the road surface. The ambulance came to rest 44 m (145') from the initial point of impact and had slid a total distance of 36 m (118'). The disproportionate weight of the ambulance relative to the weight of the Mitsubishi resulted in the rearward displacement of the Mitsubishi 31.8 m (104.3'). The Mitsubishi rotated approximately 40 degrees in a counterclockwise (CCW) direction across the westbound lane from the point of impact and came to rest off the north roadside.

Post-Crash

The 22-year-old driver of the ambulance exited the vehicle under his own power through the right front door window opening. He attempted to call for help on a cellular telephone but the telephone did not operate properly. Family members of the patient stopped their vehicle behind the ambulance and opened the rear doors of the patient compartment. The patient's brother assisted the patient out of the ambulance cot and both crawled out of the ambulance on their hands and knees. The ambulance driver walked around the rear of the vehicle and noted that the patient and his brother had exited the ambulance through the rear doors. The ambulance driver also noticed an engine compartment fire on the Mitsubishi and returned to the forward aspect of the patient compartment to get a fire extinguisher. Two trucks that were not involved in the crash stopped on the roadway and provided additional fire extinguishers and the family members of the patient assisted in extinguishing the fire. The ambulance driver advised the family members to transport the patient and his brother in the family members' vehicle to a regional hospital. The patient was admitted for treatment and the patient's brother did not seek treatment until several days after the crash. The ambulance driver returned to the rear of the ambulance and saw the unconscious PCP laying across the left side cabinetry, called his name and summoned him to exit the ambulance. The PCP regained consciousness and exited the rear of the ambulance. The ambulance driver treated the PCP at the rear of the ambulance until rescue personnel arrived. The ambulance driver was transported to a regional hospital and treated and released after approximately seven hours. The PCP was also transported to a regional hospital and admitted for treatment.

The 17-year-old male driver of the Mitsubishi Eclipse was critically injured as a result of the crash. Rescue personnel removed the roof of the Mitsubishi to facilitate the removal of the driver. He was transported by ambulance to a regional hospital and admitted for treatment. He expired approximately 10 hours following the crash.

VEHICLE DATA - 2000 Ford E-350 Ambulance

The 2000 Ford E-350 ambulance was identified by the Vehicle Identification Number (VIN): 1FDSE35F8YH (production sequence omitted). At the time of the vehicle inspection, the odometer read 88,140 km (54,769 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 140 liter (37 gal) fuel tank, dual 110-amp alternators, dual batteries, a limited-slip rear axle, front and rear disc brakes, and a 3-speed automatic transmission with overdrive. Other features included a tilt steering wheel, cruise control, electronic stereo radio, heavy duty air conditioning, dual electronic horns, and original equipment manufacturer (OEM) low-mount RV style mirrors with convex mirrors. The ambulance was configured with 41 x 18 cm (16 x 7") wheels, LT245/75R16 Goodyear Wrangler HT tires and full wheel covers. All tires exhibited moderate tread wear.



Figure 5. Close-up view of silicone caulk bead on the right aspect of the windshield

The windshield was configured with a rubber gasket that surrounded 100 percent of the laminate which was bonded to the opening. During the vehicle inspection, it was noted that minimal bonding agent existed on the gasket or the vehicle. Beads of silicone caulk that measured approximately 5 - 8 cm (2 - 3") in length were found on the rubber gasket and windshield frame on the lower right A-pillar (**Figure 5**), both upper A-pillars, and at the juncture of the right windshield header and left A-pillar. It appeared that the OEM windshield had been replaced prior to the receipt of the ambulance from the supplier. There was concern that the methods used to install the windshield may have contributed to significant bond separation that violated the integrity of the windshield.

The Ford E-350 ambulance package was produced by McCoy Miller. The ambulance model was a Medic 138SSB Type III. The patient compartment dimensions measured 351 x 213 x 168 cm (138 x 84 x 66"). The ambulance was configured with two rear entry doors with an opening that measured 137 x 145 cm (54 x 57"), and a single entry door on the right front aspect that measured 79 x 179 cm (31 x 70"). The entry doors had paddle type latches equipped with interior and exterior accessible locks. The ambulance had three exterior compartments on the left side and two exterior compartments on the right front aspect. 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. The emergency lighting/siren specifications are also included in **Appendix A** at the end of this report.

The forward exterior compartment on the left aspect (**Figure 6**) 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 on top of a 3.8 cm (1.5") hat channel that was welded to the bottom of the compartment. Two sets of heavy-duty straps that measured 5.1 cm (2") in width with ratchet adjustments were attached to 27.9 cm (11.0") wide brackets to secure the tank upright in the cabinet. The brackets were located 27.9 cm (11.0") and 52.1 cm (20.5") above the bottom of the cabinet, respectively. A third set of straps was located 73.7 cm (29.0") above the bottom of the cabinet and was configured with a locking latch plate and spring-release buckle. Creases were present on the heavy-duty straps from the ratchet-style clasp, but there was no evidence of loading on the straps.



Figure 6. Forward compartment for oxygen cylinder

The interior of the patient compartment (**Figure 7**) was configured with six halogen dome lights, one incandescent bar light, and one stepwell light that was activated with the side door. The interior was also configured with a heater/air conditioner, three-speed ventilation fan, and a static vent located over the side entry door. A non-padded 163 cm (64") long stainless steel assist rail was located on the ceiling above the ambulance cot area and 25 cm (10") assist rails were located on each entry door and on the forward right aspect of the patient compartment. Most of the interior cabinetry consisted of sliding 0.5 cm (0.2") thick plexiglass doors configured with full-length aluminum pull handles. Each cabinet with plexiglass doors was configured with a 3.2 cm (1.3") wide aluminum trim picture frame with 45 degree angles at the corners. Three columns and three rows of cabinets with plexiglass doors were located along the left wall on the center and rear aspect and measured 41.9 cm (16.5") in depth. The entire cluster of cabinets on the left wall of the ambulance measured 165 cm (65") in width and 118 cm (47") in height. Additional cabinets with plexiglass doors were located over the work space area on the forward aspect of the left wall and over the bench seat on the right wall. The specific cabinet locations are illustrated in the ambulance interior schematic in **Appendix B**.



Figure 7. View of patient compartment interior

A Stryker Model cot fastener system was installed in the ambulance. The fastening system consisted of a front “antler” bracket mounted to the left aspect of the floor (**Figure 8**) that secured the front wheels of the cot and a rear spring-loaded fastener rail mounted on the lower left wall (**Figure 9**) that fastened directly to the cot frame. The ambulance cot was a Stryker Model 6091 EZ-PRO 2 aluminum cot (**Figure 10**). The cot was rated for a maximum weight of 228 kg (500 lb). The ambulance cot measured 210.8 cm (83.0") in length and 58.4 cm (23.0") in width. It was configured with three sets of harness straps for the chest, hips, and legs and was also configured with a four-point shoulder harness restraint. The articulated backrest elevated to a maximum of 75 degrees from horizontal.



Figure 8. Front “antler” bracket



Figure 9. Fastener rail



Figure 10. Stryker ambulance cot

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. The front seat tracks were jammed. Both front seats were adjusted to the full-rear position. The driver’s seat back was reclined approximately 20 degrees from vertical at the time of the vehicle inspection.

The seating in the patient compartment of the ambulance was configured with a single rear-facing attendant’s seat mounted on a wood base with a storage cabinet in the forward left position. A three-person bench seat was located along the right wall with dual split lids that were configured with ratchet-style hold opens. A longitudinal storage space with open access from the rear was located under the inboard aspect of the bench seat and measured 176.5 cm (69.5") in longitudinally, 10.2 cm (4.0") laterally, and 55.9 cm (22.0") in height for storage of a scoop stretcher. Additional storage space was located under the split bench seat lids.

VEHICLE DAMAGE

Exterior Damage - 2000 Ford E-350 Ambulance

The 2000 Ford E-350 ambulance sustained severe frontal damage as a result of the impact with the Mitsubishi Eclipse (**Figure 11**). The direct damage on the bumper began 8.9 cm (3.5") inboard of the front left corner and extended laterally 160.0 cm (63.0") to the front right corner. The combined direct and induced damage measured 148.6 cm (58.5") from bumper corner to bumper corner. The right side of the bumper separated from the right frame rail which resulted in understatement of the bumper crush. The front right bumper corner was located 18.0 cm (7.1") forward of the leading edge of the frame. The maximum crush on the bumper was located at C6 at the front right corner and measured 85.7 cm (33.8"). Crush measurements were also documented along the lower radiator support. The maximum crush along the lower radiator support was located at C5 and measured 78.1 cm (30.8"). Six crush measurements were taken along the front bumper and were as follows: C1 = 0.0 cm, C2 = 23.2 cm (9.1"), C3 = 53.3 cm (21.0"), C4 = 75.9 cm (29.9"), C5 = 83.2 cm (32.8"), C6 = 85.7 cm (33.8"). The right wheelbase was shortened by 78.1 cm (30.8"). The right front tire was deflated and restricted due to its rearward displacement. The right front wheel exhibited a dent to the outer bead that measured 17.8 x 3.8 cm (7.0 x 1.5").



Figure 11. View of frontal damage to the ambulance



Figure 12. Lateral view of frontal damage

The fiberglass hood sustained a complete longitudinal fracture to the right of the centerline and a second longitudinal fracture to the left of the centerline. The right front fender and right front door were crushed and displaced rearward (**Figure 12**). The right front door was also severely deformed and bowed 61.0 cm (24") outward due to rearward displacement. The right sill was deformed rearward and upward. The frame rails and cab of the Ford E-350 was shifted to the right. The forward aspect of the left frame rail was displaced 29.8 cm (11.8") laterally to the right. The forward aspect of the right frame rail was displaced 70.5 cm (27.8") to the right. The lateral shift of the cab resulted in stress overload on the bolts that secured the left rear outboard aspect of the cab to the patient compartment. The stress resulted in a 7.6 cm (3.0") separation of the left rear aspect of the cab from the patient compartment. The Collision Deformation Classification for the impact with the Mitsubishi Eclipse was 12-FDEW-6. The incremented CDC adjusted for the end shift to the right was 72-FDEW-6.

The Ford E-350 ambulance also sustained moderate damage as a result of the rollover onto the left side after the initial impact. The left side rollover damage began 139.7 cm (55.0") rearward of the left rear axle and extended 342.9 cm (135.0") on the body of the ambulance (**Figure 13**). The vertical height of the rollover damage was 214.6 cm (84.5"). The left outside mirror was folded into the door window frame and sustained abrasions on the outboard aspect. The rear edge of the left front door was abraded adjacent to the latch and at the beltline. There was no abrasion damage to the left B-pillar and no damage forward of the left A-pillar. Heavy longitudinal abrasions were noted on the left front corner of the patient compartment and were more pronounced at the top corner and bottom aspect. Vertical corner separation that measured 2.5 cm (1.0") wide between the front and left side panels of the patient compartment occurred 88.9 cm (35.0") below the top aspect. The forward aspect also overlapped the left side aspect at the corner which began at the bottom aspect and extended 90.8 cm (35.8") vertically. Both top front corners of the patient compartment sustained fractures. The top left side rails of the patient compartment were heavily abraded. The left rear wheel sustained a 22.9 cm (9.0") long minor bending of the bead area that measured 1.3 cm (0.5") in maximum depth. The wheel cover was separated and sustained abrasions on the center aspect. The left rear tire was also abraded from the rollover. The CDC for the rollover event was 00-LDAO-1



Figure 13. View of left side rollover damage

Interior Damage - 2000 Ford E-350 Ambulance

The 2000 Ford E-350 ambulance cab sustained severe interior damage as a result of the frontal impact with the Mitsubishi Eclipse. Interior damage to the cab area of the ambulance was attributed to occupant contact and compartment intrusion. The minimal bonding agent (silicone caulk) on the windshield gasket combined with the induced damage as a result of the frontal impact resulted in significant bond separation of the windshield (**Figure 14**). The windshield separation was 100 percent at the right A-pillar, approximately 33 percent on the right side of the windshield header, 100 percent at the left A-pillar, and approximately 30 cm (12") at the bottom left aspect, inboard of the left A-pillar. The significant bond separation provided an avenue for possible occupant ejection. The maximum separation between the windshield frame and the windshield laminate measured approximately 15 cm (6") at the center aspect of the right A-pillar. The entire windshield laminate was stress-cracked. Both the left front and right front glazing were closed prior to impact and disintegrated from impact forces.

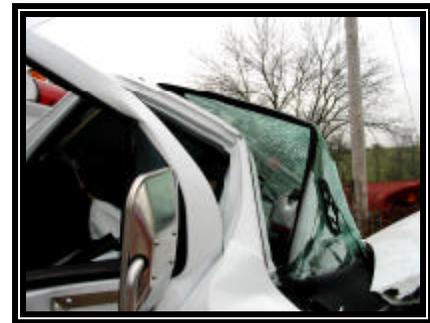


Figure 14. Right side view of windshield bond separation

The driver stated that the left front door was jammed shut at the scene, however, the investigating officer reported that the door was open when the ambulance was uprighted post-crash. The door would not close at the time of the vehicle inspection due to the deformation of the vehicle. The right front door latch released/failed from stress overload. The door was severely deformed due to the rearward displacement of the right A-pillar. The door would not open due to separation of the interior door panel, which was rearward of the interior aspect of the right B-pillar.



Figure 15. View of cab interior

Multiple intrusions in the cab of the Ford E-350 ambulance were noted as a result of the frontal impact (**Figure 15**). The engine shroud/cover was displaced rearward and laterally to the left into the front left position and the front left floor pan was crushed laterally. In the front right occupant space, the entire top and right side aspect of the engine cover/shroud was separated from the body due to deformation. Intrusions are summarized as follows:

Position	Component	Intrusion	Direction
11	Engine shroud/cover	8.9 cm (3.5")	Lateral
11	Left floor pan	3.8 cm (1.5")	Lateral
13	Roof	24.1 cm (9.5")	Vertical
13	Right A-pillar	19.1 cm (7.5")	Longitudinal
13	Right mid-instrument panel (center aspect)	15.9 cm (6.3")	Longitudinal
13	Right mid-instrument panel (right aspect)	18.4 cm (7.5")	Longitudinal
13	Right lower instrument panel	21.6 cm (8.5")	Longitudinal
13	Engine shroud/cover	3.8 cm (1.5")	Longitudinal
13	Right toe pan	38.1 cm (15.0")	Longitudinal

The upper half of the steering wheel rim was deformed approximately 1.9 cm (0.8") forward from occupant loading. The steering column was compressed forward, evidenced by shear capsule displacement. The displacement of the left and right shear capsules measured 0.5 cm (0.2") and 0.2 cm (0.1"), respectively. The knee bolster was scuffed laterally as a result of right knee contact from the driver. The scuff was located 17.1 cm (6.8") inboard of the left edge and measured 20.3 cm (8.0") diagonally in length.

Interior damage to the patient compartment was moderate and attributed to occupant contact. The pass-through door between the patient compartment and cab was fully opened and positioned behind the driver's seat. The inboard roller was off of the door track. The wall panel forward of the rear-facing attendant's seat was constructed of 1.9 cm (0.8") thick Luan plywood with two layers of laminate. The panel was fractured on the inboard side of the attendant's seat 73.7 cm (29.0") above the floor due to occupant loading. The vinyl seat back cushion of the attendant's seat was deformed from the forward loading of the seated occupant (**Figure 16**). The middle aspect of the panel behind the seat back was displaced forward 1.7 cm (0.7") on the outboard side of the attendant's seat from occupant loading. The top left corner of the front pass-through door frame sustained a fracture that measured approximately 3.0 cm (1.2") in length. A second fracture was located 7.0 cm (2.8") above the top right corner of the pass-through door opening.



Figure 16. View of interior damage to the front left area of the patient compartment

The right side forward panel adjacent to the forward edge of the right side door was fractured as a result of a head strike by the PCP (**Figure 17**). Hair and tissue were embedded in the fractured laminate from the occupant. The fracture was located 99.7 cm (39.3") above the floor, inboard and slightly above the front right assist handle and measured 5.1 cm (2.0") vertically. Additional contact from the head strike was located on the 3.8 cm (1.5") wide aluminum face of the top open shelf below and inboard of the panel fracture. A tissue transfer measured 4.4 cm (1.8") in width and 0.6 cm (0.3") in height and was located 7.6 cm (3.0") inboard of the right side wall. A heavy front-to-rear abrasion/scuff and a slight fracture were noted on the inboard edge of the action area on the left wall rear of the attendant's seat from probable contact with the occupant's arm. The abrasion measured 5.1 cm (2.0") in height on the plastic and a total height of 12.7 cm (5.0"). It was located 79.4 cm (31.3") forward of the forward patient compartment panel, and extended 14.6 cm (5.8") longitudinally.



Figure 17. Front right area of the patient compartment showing contacts and damage

Front-to-rear body fluid spatter was present on the left side cabinetry. Many of the plexiglass sliding cabinet doors were fractured from the occupants walking on them to exit the overturned ambulance (**Figure 18**). A large amount of body fluid (blood) and some hair was present on the outer aspect of the top middle cabinet where the PCP came to rest. The fracture in the plexiglass door allowed the body fluid to collect inside the cabinet. The lower rear cabinet was closed during the vehicle inspection, however, a large amount of hair was present inside the cabinet. A dent was present on the aluminum trim cover on the left rear corner of the patient compartment. It was located 105.4 cm (41.5") above the floor and measured 2.5 cm (1.0") in height.



Figure 18. Damaged left side cabinetry

The headliner exhibited a body fluid (blood)-packed hair contact on the center padded rail from the PCP. The contact was located 125.1 cm (49.3") forward of the rear bulkhead and measured 10.2 cm (4.0") in diameter. A second hair contact was located above the final rest position of the PCP 75.6 cm (29.8") forward of the rear bulkhead and 3.8 cm (1.5") inboard of the left side cabinetry.

The forward cushion on the bench seat sustained heavy diagonal rear-to-front scuffs with abrasions on the inboard vinyl face. The damage resulted from contact with the supplies in the right pocket of the PCP's cargo pants as he moved laterally toward the forward aspect of the patient compartment. The scuffs/abrasions measured 39.4 cm (15.5") longitudinally. Three diagonal scuffs with scuffs in between were present on the top outboard aspect of the forward bench seat cushion. The scuffs extended 8.9 cm (3.5") laterally from the rear edge of the cushion. They were located 19.1 cm (7.5") rear of the forward edge of the cushion and measured 26.7 cm (10.5") longitudinally. The scuffs were a result of the Lifepack 10 defibrillator sliding across the vinyl seat cushion.

The Stryker ambulance cot sustained minor damage to the inboard aspect of the frame adjacent to the pneumatic shock on the backrest. The ambulance cot remained engaged with the locking mechanism throughout the crash.

The sliding drawer under the forward aspect of the bench seat was displaced forward as a result of the crash forces (**Figure 19**). The drawer was configured with metal arms on the outboard aspects that slid inside metal rails on the interior of the drawer opening. There was no locking mechanism on the drawer. A 3.1 liter (3.3 quart) sharps container and a 3.8 liter (1 gallon) trash container used for bio-hazardous waste were contained in the drawer. The PCP stated that there was no hazardous waste in the drawer at the time of the crash, however, he could not recall the post-crash status of the sharps container.



Figure 19. View of displaced sliding drawer that housed the sharps container

Exterior Damage - 1995 Mitsubishi Eclipse

The 1995 Mitsubishi Eclipse sustained severe damage as a result of the frontal impact with the Ford E-350 ambulance (**Figure 20**). The front bumper fascia was completely separated at the time of the vehicle inspection. The direct damage on the front bumper fascia started 30.5 cm (12.0") right of center and extended laterally 45.7 cm (18.0") to the front right corner. Direct contact evidence included heavy abrasions and fractures on the fascia. The direct damage along the upper radiator support began at the front left corner and extended 129.5 cm (51.0") laterally to the front right corner. The combined direct and induced damage involved the entire frontal width of the vehicle and measured 66.7 cm (26.3") across the upper radiator support. The maximum crush was located at C6 at the front right corner and measured 171 cm (67") at the upper radiator support. The left frame rail was shifted laterally to the right. The left wheelbase was shortened 9.7 cm (3.8") and the right wheelbase was shortened 90.9 cm (35.8"). The hood was crushed and buckled rearward. The left front fender was pulled inward and the right front fender was crushed rearward (**Figure 21**). The right A-pillar sustained induced rearward displacement, and the roof was buckled. The windshield was fractured from impact forces and the windshield and roof were removed by rescue personnel to facilitate the removal of the driver. The CDC for the impact with the Ford E-350 ambulance was 12-FDEW-8. Due to the crush variance between the bumper beam and the upper radiator support, six crush measurements were averaged between the front bumper beam and the upper radiator support and were as follows: C1 = 53.3 cm (21.0"), C2 = 105.7 cm (41.6"), C3 = 118.5 cm (46.7"), C4 = 127.7 cm (50.3"), C5 = 145.9 cm (57.4"), C6 = 151.5 cm (59.6").



Figure 20. Frontal damage to the Mitsubishi Eclipse



Figure 21. Left side view of the damaged Mitsubishi Eclipse

MANUAL RESTRAINT SYSTEM - 2000 Ford E-350 Ambulance

The front seat positions in the Ford E-350 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, D-ring, or restraint webbing indicative of usage. Both frontal manual restraints were also equipped with buckle pretensioners located on the inboard aspects of the seats (**Figure 22**). Both pretensioners fired as a result of the crash and had uniform piston travel. The cable and crimp nut protruded out of the forward aspects of both barrels 1.6 cm (0.6"). Based on the uniform piston travel and protrusion of the cable out of the barrel,

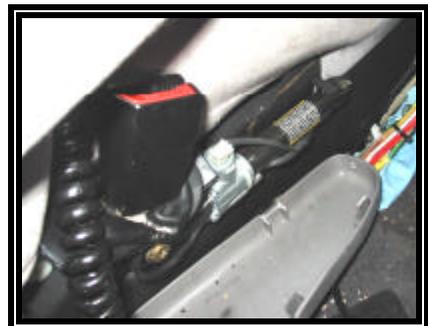


Figure 22. Driver's buckle pretensioner

there did not appear to be any resistance in the driver's manual restraint which also suggests lack of belt usage by the driver. The release button in the left buckle housing was flush with the top aspect of the housing. The release button in the right buckle housing was pulled into the buckle housing 1.0 cm (0.4").

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 model number was: BBLP1164, the part number was: 209SHP, and date of manufacture was April 2000. The retractor and buckle assemblies were vertically mounted on the wall behind each seating position (**Figure 23**). The lower anchor bolts for the retractor and buckle assemblies were mounted approximately 2.5 cm (1.0") above the base of the seats and approximately 5.1 cm (2.0") below the height of the seat cushions. The webbing pull-out measured approximately 127 cm (50") for each belt. The buckle assemblies were mounted with plastic sleeves that measured 15.2 cm (6.0") in height above the anchor bolts. The buckles and webbing extended 15.2 cm (6.0") above the top aspect of the sleeves.



Figure 23. Attendant's seat lap belt

The distance between the center of the retractor assembly and center of the buckle assembly was 26.4 cm (10.4") on the rear-facing attendant's seat. The distance between the retractor assemblies and center of the buckle assemblies on the right side bench seat measured 30.5 cm (12.0") for each of the three seating positions (**Figure 24**). 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 bench seat. Plastic sleeves that measured 18.7 cm (7.4") in height were mounted with a single bolt on the bottom aspects, and the webbing and buckles extended 10.8 cm (4.3") above the sleeves. The forward-most buckle was located 55.2 cm (21.8") rear of the forward edge of the bench seat, and the remaining two buckle assemblies were spaced 49.5 cm (19.5") and 31.1 cm (12.3") apart, respectively.



Figure 24. View of lap belts on the right side bench seat

FRONTAL AIR BAG SYSTEM - 2000 Ford E-350 Ambulance

The Ford E-350 ambulance was equipped with redesigned frontal air bags for the driver and front right passenger positions that deployed as a result of the impact with the Mitsubishi Eclipse. The driver's air bag (**Figure 25**) was housed in the center of the steering wheel with a single cover flap design hinged at the top aspect. The cover flap measured 12.7 cm (5.0") in width at the top aspect and 19.1 cm (7.5") in width at the bottom aspect. The top aspect of the cover flap was contoured to the steering wheel hub and had a longitudinal depth of 5.7 cm (2.5"). The height of the cover flap measured 10.2 cm (4.0"). The driver's air bag measured 61.0 cm (24.0") in diameter in its deflated state. The air bag was tethered by two internal straps that measured 12.7 cm (5.0") wide and were located at the 3 and 6 o'clock aspects. The air bag was vented by two circular ports that measured 2.5 cm (1.0") in diameter and were located at the 11 and 1 o'clock positions and located 7.6 cm (3.0") fore of the peripheral seam. There was no evidence of occupant contact on the air bag membrane and heavy oil transfers were present at the 3 and 6 o'clock positions of the air bag membrane.



Figure 25. Redesigned driver's air bag

The redesigned front right passenger's air bag deployed from a mid-mount module configured with a single cover flap hinged at the top aspect (**Figure 26**). 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. The redesigned front right passenger's air bag measured 45.7 cm (18.0") in width and 43.2 cm (17") in height. The maximum excursion measured approximately 56 cm (22"). The air bag was vented by two 6.4 cm (2.5") diameter ports located at the 3 and 9 o'clock positions on the side panels of the air bag and centered 14.0 cm (5.5") rear of the mid panel flap position. The redesigned front right passenger's air bag was not tethered.



Figure 26. Redesigned front right passenger's air bag

OCCUPANT DEMOGRAPHICS - 2000 Ford E-350 Ambulance

Driver

Age/Sex: 22-year-old male
Height: 175 cm (69")
Weight: 98 kg (215 lb)
Seat Track Position: Full-rear
Manual Restraint Use: Unrestrained
Usage Source: Vehicle inspection
Eyewear: None
Type of Medical Treatment: Transported by ambulance to a regional hospital and treated and released

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Forehead contusion	Minor (290402.1,7)	Left A-pillar
Right lower leg contusion	Minor (890402.1,1)	Knee bolster

Injury source: Hospital records

Driver Kinematics

The 22-year-old driver was seated in an upright posture with the seat track adjusted to the full-rear position. He stated that his right hand was on the steering wheel rim at the 12 o'clock position and his left arm was positioned on the door-mounted arm rest. He was operating the Ford E-350 ambulance in a westbound direction on the two-lane roadway in a non-emergency mode. The driver stated that he was restrained by the manual 3-point lap and shoulder belt, but the interior contact evidence and lack of loading evidence on the manual restraint suggest he was unrestrained. When the driver realized the impending impact, he may have braced as he attempted to avoid the Mitsubishi Eclipse. At impact with the Mitsubishi, the redesigned frontal air bag system deployed and the seat belt buckle pretensioners fired. The driver initiated a forward trajectory and loaded the knee bolster with his right leg, evidenced by a lateral scuff on the bolster and a right lower leg contusion. He loaded through the deployed redesigned driver's air bag and loaded the steering wheel rim, evidenced by deformation to the upper half of the rim and minimal displacement of the shear capsules. He sustained a forehead contusion from probable contact with the left A-pillar. He was redirected to the left as the ambulance rolled onto its left side and the driver's head probably struck the window glazing or the left B-pillar.

The driver exited the ambulance under his own power through the right front door window opening. The driver attempted to call for help on a cellular phone but it did not operate properly. The ambulance driver noticed an engine compartment fire on the damaged Mitsubishi Eclipse, and returned to the ambulance to get the fire extinguisher. He extinguished the fire with assistance from the patient's family members and returned to provide care to the injured PCP. He advised the patient and the patient's brother to continue

on to the hospital in the family member's vehicle as he checked the status of the injured PCP. He was transported by ambulance to a regional hospital where he was treated and released approximately seven hours after the crash.

Patient Compartment Right Side Bench Seat Passenger (PCP)

Age/Sex: 37-year-old male
 Height: 175 cm (69")
 Weight: 91 kg (200 lb)
 Seat Track Position: Fixed
 Manual Restraint Use: Unrestrained
 Usage Source: Vehicle inspection, interview
 Eyewear: None
 Type of Medical Treatment: Transported by ambulance to a regional hospital and admitted for treatment

Patient Compartment Right Side Bench Seat Passenger (PCP) Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Left occipital intraparenchymal hemorrhage with loss of consciousness < 1 hour	Severe (140638.4,2)	Impact with the assist handle and edge of the Formica wall in the front right aspect of the patient compartment
Left occipital contusion (brain contusion)	Serious (140604.3,2)	Impact with the assist handle and edge of the Formica wall in the front right aspect of the patient compartment
20 cm (8") laceration into muscle on the right parietal/occipital scalp	Moderate (190604.2,1)	Impact with the assist handle and edge of the Formica wall in the front right aspect of the patient compartment
Anterior wall fracture of the right maxillary sinus, slightly depressed	Moderate (250800.2,1)	Impact with the aluminum face of the open top shelf in the front right aspect of the patient compartment
Right occipital scalp contusion	Minor (190402.1,1)	Impact with the assist handle and edge of the Formica wall in the front right aspect of the patient compartment
Nasal fracture with deviation of nasal septum	Minor (251000.1,4)	Impact with the aluminum face of the open top shelf in the front right aspect of the patient compartment

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Laceration of the right cheek/nose	Minor (290602.1,1)	Impact with the aluminum face of the open top shelf in the front right aspect of the patient compartment
Right lumbar area contusion	Minor (590402.1,1)	Impact with Lifepack defibrillator on squad bench seat
Left forearm abrasion	Minor (790202.1,2)	Left side cabinetry
Bilateral knee abrasions	Minor (890202.1,3)	Impact with the aluminum face of the open lower shelf in the front right aspect of the patient compartment
Right thigh abrasion	Minor (890202.1,1)	Compression of the medical supplies/instruments in the right outboard pocket of his cargo pants against his upper leg as he loaded the defibrillator
Right thigh contusion	Minor (890402.1,1)	Compression of the medical supplies/instruments in the right outboard pocket of his cargo pants against his upper leg as he loaded the defibrillator

Injury source: Hospital records

Patient Compartment Right Side Bench Seat Passenger (PCP) Kinematics

The 37-year-old PCP was seated on the right side bench seat in the center position (**Figure 27**). A Lifepack 10 defibrillator unit was restrained vertically on the forward aspect of the bench seat to his right, and an unrestrained soft-sided medical supply bag was on the seat to his left. Prior to the impact, he had been restrained by the lap belt on the bench seat. He got up to adjust the HVAC controls on the left side of the patient compartment. He returned to the seat, but never re-engaged the lap belt. At impact, he initiated a lateral trajectory to his right toward the front of the patient compartment. He loaded the defibrillator as he moved across the bench seat which resulted in a right lumbar area contusion. The medical supplies/instruments in the right outboard pocket of his cargo pants caused abrasions and scuff marks on the vinyl seat cushion and the compression against his upper leg resulted in a right lateral thigh abrasion and contusion.



Figure 27. Photograph depicting pre-crash position of the PCP

He continued forward and struck the assist handle and the edge of the Formica wall with the right aspect of his head which resulted in a fracture of the Formica and hair/tissue deposits in the fracture (**Figure 28**). He sustained a positive loss of consciousness for unknown period of time, a 20 cm (8") laceration on the right parietal/occipital scalp, and a right occipital scalp contusion as a result of the contact with the wall. He also sustained a left occipital intraparenchymal hemorrhage and a left occipital contusion (brain contusion). Based on the contact evidence and injury pattern, it appeared that they were a contre coup injury. His right facial area struck the aluminum face of the open top shelf evidenced by a tissue transfer. He sustained an anterior wall fracture of the right maxillary sinus, a nasal fracture with deviation of nasal septum, and a laceration of the right cheek/nose as a result of the contact with the shelves. His knees struck the aluminum face of the lower open shelf which resulted in bilateral knee abrasions. He rebounded to the left as the ambulance rolled onto its left side and slid to final rest. The PCP contacted the center aspect of the padded headliner evidenced by a body fluid (blood) contact with a hair pattern. He continued the lateral trajectory and impacted the left side cabinetry with his left shoulder which resulted in a left forearm abrasion and a left hand laceration. He came to rest with his head positioned at the top aspect of the left side cabinets approximately 76 cm (30") forward of the rear bulkhead (**Figure 29**).



Figure 28. Photograph depicting head/facial contacts from the PCP



Figure 29. Photograph depicting the final rest position of the PCP's head/face

After the ambulance came to rest, the patient and the patient's brother stepped over the unconscious PCP as they exited the vehicle. The ambulance driver saw the unconscious PCP laying across the left side cabinetry, called his name and summoned for him to exit the ambulance. The PCP regained consciousness and exited the rear of the ambulance. The ambulance driver treated the PCP at the scene, and the PCP was transported by ambulance to a regional hospital and admitted for treatment.

The PCP stated that he had a loss of memory for approximately 30 minutes from immediately prior to the crash to his arrival at the hospital. He was released from the hospital two days following the crash.

Patient Compartment Rear-Facing Attendant’s Seat Passenger

Age/Sex: 41-year-old male
 Height: 175 cm (69")
 Weight: 93 kg (206 lb)
 Seat Track Position: Fixed
 Manual Restraint Use: Lap belt with ALR
 Usage Source: Vehicle inspection, interview, and interview with PCP
 Eyewear: None
 Type of Medical Treatment: Transported from the scene to a regional hospital in a private vehicle and sought treatment several days following the crash

Patient Compartment Rear-Facing Attendant’s Seat Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Kidney contusion	Moderate (541610.2,9)	Lap belt loading
Occipital scalp abrasion	Minor (190202.1,6)	Forward patient compartment wall above the attendant’s seat
Occipital scalp contusion	Minor (190402.1,6)	Forward patient compartment wall above the attendant’s seat

Injury source: Interview

Patient Compartment Rear-Facing Attendant’s Seat Passenger Kinematics

The patient’s brother was seated in the rear-facing attendant’s seat and was restrained by the 2-point lap belt with an ALR. The PCP stated that he advised the occupant to use the lap belt when the transport began. At impact, the rear-facing occupant initiated a rearward trajectory toward the front of the patient compartment and loaded the seat back and front left wall (**Figure 30**). Although there was no identifiable contact, the rear aspect of his head contacted the upper aspect of the forward wall. He sustained an abrasion and contusion on the occipital scalp from the wall contact. The loading to the wall resulted in a fracture of the wall on the left inboard aspect of the pass-through door frame and a fracture in the upper left corner of the door frame. The loading also resulted in 1.7 cm (0.7) of forward displacement at the vertical midpoint of the panel behind the vinyl seat back.

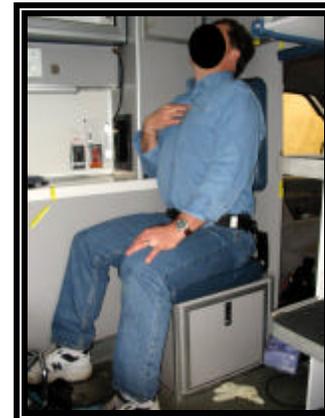


Figure 30. Photograph depicting rearward trajectory of the patient’s brother

He rebounded forward and loaded the manual lap belt and sustained a kidney contusion. A heavy front-to-rear abrasion/scuff and a slight fracture were noted on the inboard edge of the action area on the left wall rear of the attendant’s seat from probable contact with the occupant’s arm as the ambulance rolled onto the left side to final rest (**Figure 31**).



Figure 31. Photograph depicting rebound trajectory of the patient’s brother

The patient’s brother assisted the patient from the ambulance cot and exited the rear of the ambulance under his own power on his hands and knees. Both were transported to a regional hospital in the family member’s vehicle that was following the ambulance. The patient’s brother did not seek medical treatment until several days following the crash for a possible internal injury as a result of seat belt loading. Further injury data could not be obtained due to lack of cooperation with the occupant.

Patient Compartment Cot Passenger (Patient)

Age/Sex: 34-year-old male
 Height: 175 cm (69")
 Weight: 102 kg (225 lb)
 Seat Track Position: Lying supine with torso semi-reclined on ambulance cot
 Manual Restraint Use: Restrained at torso, hips, and legs by straps on the ambulance cot
 Usage Source: Interview with PCP
 Eyewear: None
 Type of Medical Treatment: Transported from the scene in a private vehicle to a regional hospital and was admitted for treatment

Patient Compartment Cot Passenger (Patient) Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Left scalp contusion	Minor (190402.1,2)	Contact with the displaced defibrillator
Left shoulder contusion	Minor (790402.1,2)	Contact with the displaced defibrillator
Left shoulder laceration	Minor (790600.1,2)	Contact with the displaced defibrillator
Left lower leg/ankle abrasion	Minor (890202.1,2)	Loading against the leg/ankle strap on the ambulance cot

Injury source: Interview

Patient Compartment Cot Passenger (Patient) Kinematics

The 35-year-old male patient was restrained on the ambulance cot by three straps at the chest, hips, and legs. His head and torso were elevated approximately 40 degrees from horizontal and a pillow was positioned under his head. He was covered by a hospital sheet that was positioned under the straps. The patient was being transferred between hospitals and also had back surgery approximately two weeks before the crash. The PCP stated that throughout the transport, the patient was conscious, alert, and oriented and that he was also sleeping on-and-off. One intravenous (IV) line had been established at the hospital in the patient's right wrist area. There was no oxygen in use.

At the time of the crash, the rear-facing patient initiated a rearward trajectory toward the front of the patient compartment and loaded the ambulance cot. The patient's left ankle sustained an abrasion from loading against the leg/ankle strap on the ambulance cot. The cot remained in position in the locking mechanism. The loading resulted in slight deformation to the ambulance cot near the frame adjacent to the pneumatic shock on the backrest. The patient was redirected to the left as the ambulance rolled onto its left side. The defibrillator had become displaced within the lateral belt system and struck the patient on the left side. The patient sustained a left scalp contusion, a left shoulder contusion, and a left shoulder laceration. The patient's brother assisted the patient out of the ambulance cot and out the rear of the ambulance. Both were transported from the scene in a family vehicle to a regional hospital. The patient had a complaint of back pain and was admitted for treatment. Further injury data could not be obtained due to lack of cooperation with the occupant.

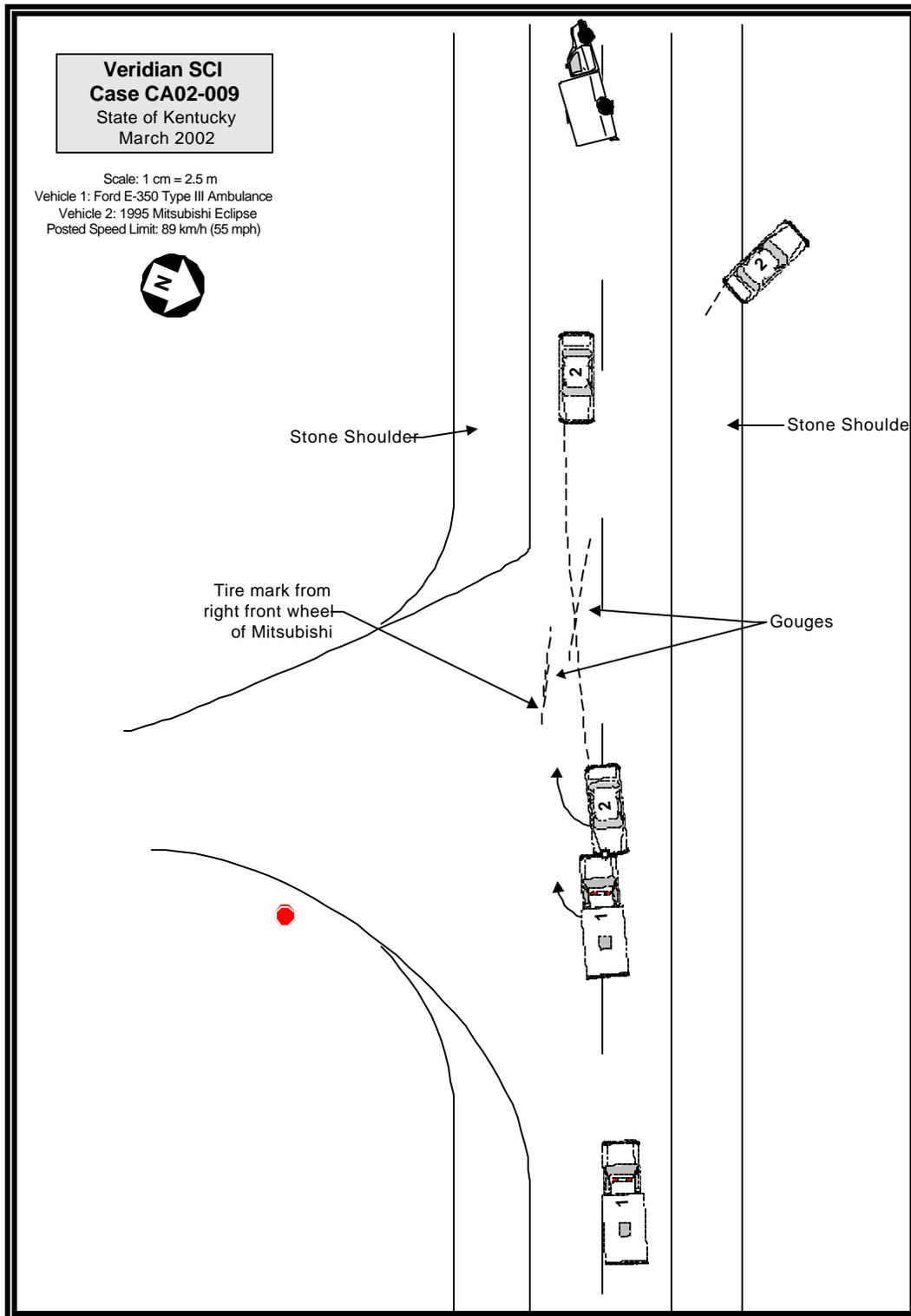


Figure 32. Scene schematic

Appendix A: McCoy Miller 138SSB Type III Ambulance Specifications

(downloaded from www.mccoymiller.com)

CHASSIS

2000 FORD E-350 RV Cutaway, 138" Wheelbase, 9,600# GVWR, Single rear wheel, 80" CA, 7.3L DI Turbo-Charged Diesel (444 CID), Dual 110-amp Motorcraft alternators, Auxiliary Powertrain Control (APC) module, Dual batteries (1500 CCA total), 4.10:1 limited-slip rear axle, 4600# front axle, 6084# rear axle, 3-speed auto transmission w/overdrive, Tilt steering, Cruise control, AM/FM electronic stereo radio w/clock, Single fuel tank-37 gal., Heavy duty air conditioning/cooling, LT245/75Rx16E tires, Dual electric horns, Light & Convenience Group, Ambulance Builder's Prep Package - 47A, OEM low-mount RV style mirrors with bolt on convex mirrors, full-wheel covers, spare tire, jack and tools shipped loose with unit.
Minimum Standard Payload -1,500 lbs.

BODY FEATURES Dimensions: 138" x 84" x 66" Interior headroom

COMPARTMENT LATCHES: Locking paddle type.

ENTRY DOOR LATCHES: Paddle type, locking, inside & outside

EXTERIOR COMPARTMENTS:

COMPARTMENT #1: 14" X 66" X 13 ¼"

MATERIAL: Walls & ceiling = .100 diamondplate

Floor = .125 diamondplate

SHELVES = NONE

DIVIDERS = NONE

LIGHTS = [2] - [1] for compartment open function and [1] for O2 light function

HOLD-OPEN DEVICE = Cam over spring

DOOR VENTS = [2] - [1] Exterior cast aluminum and [1] expanded metal interior

COMPARTMENT VENTS = [2] Black plastic

REFLECTORS = NONE

ADD'T ITEMS = 1 ½" hat channel welded to bottom of compartment under O2 storage location

COMPARTMENT #2: 36" X 39" X 13 ¼"

MATERIAL: Walls & ceiling = .100 diamondplate

Floor = .125 diamondplate

SHELVES = [1] adjustable

DIVIDERS = NONE

LIGHTS = [2] – [1] above and [1] below adjustable shelf

HOLD-OPEN DEVICE = Cam over spring

DOOR VENTS = NONE

COMPARTMENT VENTS = [2] Black plastic

REFLECTORS = NONE

ADD'T ITEMS = NONE

COMPARTMENT #3: 22" X 77 ½" X 10 ¼"

MATERIAL: Walls & ceiling = .100 diamondplate

Floor = .125 diamondplate

SHELVES = NONE

DIVIDERS = NONE

LIGHTS = [1] in ceiling

HOLD-OPEN DEVICE = Cam over spring

DOOR VENTS = NONE

COMPARTMENT VENTS = [2] Black plastic

REFLECTORS = NONE

ADD'T ITEMS = NONE

COMPARTMENT #5: [1]-15 ½" & [1]-7" X 47" X 27" (Upper ALS section) 22" X 13" X 13 ¼" (Lower battery section)

MATERIAL: Walls & ceiling = .090 flat aluminum

Floor = .125 flat aluminum

SHELVES = NONE

DIVIDERS = NONE

LIGHTS = NONE

HOLD-OPEN DEVICE = Cam over spring

DOOR VENTS = NONE

COMPARTMENT VENTS = [2] Black plastic

REFLECTORS = NONE

ADD'L ITEMS = Sweep-out floor, roll-out tray in lower section for a 750CCA battery

DOOR SWITCHES: Magnetic switches installed at top of all doors.
DRIP RAILS: Extruded aluminum installed over compartment openings. Secured with double sided tape.
FUEL FILL GUARD: Cast aluminum
LICENSE PLATE BEZEL: Cast aluminum with [2] lights mounted in center of rear kickplate below rear doors.
REAR ENTRY DOORS: 54"x 57"
REAR ENTRY DOOR HOLD-OPENS: Cast aluminum "Grabber" style
REAR STEP BUMPER: Steel framework (2"x 3" tube) with .100 diamondplate cover pods for outside corners and a 6" aluminum flip-up open grate center section.
RUB RAILS: .100 Aluminum diamond-plate.
SIDE ENTRY DOOR: 31"x 70" with cam over spring hold-open
STONE GUARDS: Front and rear 11" up, .100 aluminum diamond-plate.
THRESHOLDS: 20 gauge stainless steel installed at bottom of all door openings. Secured with double sided tape.
UNDERCOATING In accordance with chassis manufacturer's recommendations.
WHEELWELL TRIM: Black Rubber
WINDOWS: (1) Slider in side entry door 19.5"H x 17.5"W, dark tint.
WINDOWS: (1) Fixed in each rear entry door 19.5"H x 17.5"W, dark tint.

ELECTRICAL FEATURES

ANTENNA COAX: (1) Run from ceiling of module to behind driver seat
BACK UP ALARM: 97 decibel rating with momentary cut-off switch.
DUAL OEM BATTERIES: 1500 CCA total [1] under hood and [1] in compartment #6 on rollout tray.
MASTER ON-OFF BATTERY SWITCH: Cole Hersee, mounted on driver's seatbase.
GAUGES: Ammeter and voltmeter, digital readout located on front switch control panel
INVERTER: Prewire only for Vanner 1050TUL inverter in compartment #2 with 2ga. power and ground wires with a 4-conductor control cable. If a different inverter is specified check option specification for proper wiring requirements.
SHORELINE: 115V, 20 amp. with mating plug.
115 RECEPTACLES: (2) Duplex lighted hospital grade with GFI protection, (1) in action area and (1) in ALS cabinet.
POWER DISTRIBUTION BOARD: Installed in cabinet over walk-through
ELECTRONIC CONTROL MODULE: Installed in cabinet over walk-through with main distribution board
FRONT CONTROL SWITCH PANEL: Mounted on engine cover with ABS console.
REAR CONTROL SWITCH PANEL: Mounted in action area
12-VOLT DC OUTLETS: (2) For Laerdal style plugs, (1) in action area and (1) in ALS.

EXTERIOR LIGHTING AND MISC. EQUIPMENT(EMERGENCY AND DOT)

I.C.C. LIGHTS: (10) lights with chrome guards. (5) amber installed on front of body and (5) red installed on rear of body.
MARKER LIGHTS: (2) lights – one on each side of body installed towards rear of body.
TAILLIGHTS: Trucklite Super 40 lights with black rubber gaskets.
BODY WARNING LIGHTS: (10) Whelen 97 series halogens, (2) red front corners, (1) clear front center, (2) red each side, (2) red on rear in upper corners, (1) amber centered over rear doors.
FLASHER: Whelen AF6016A dual mode solid state.
GRILLE LIGHTS: (2) Whelen 73 series red halogen mounted in front grille
INTERSECTION LIGHTS: (2) Whelen 73 series red halogen beams w/flanges

LOAD LIGHTS: (2) Whelen Optiscene 97 series over rear doors with internal optics 26 degree.
SCENE LIGHTS: (2) Whelen Optiscene 97 series (1) each side with internal optics 13 degree.
SIREN: Whelen WS-295HFRS w/remote located in front switch console.
SIREN SPEAKERS: Whelen Longhorn speaker with (2)-100 watt drivers.

INTERIOR LIGHTING

ACTION AREA LIGHT: (1) 12" incandescent bar light in action area.
DOME LIGHTS: (6) halogen lights, (2) rows of three with each side switched separately, dual intensity.
SPOTLIGHT: (1) Optronics hand-held 200,000-CP, hard-wired to engine cover. Mounting hardware shipped loose for customer installation after delivery.
STEPWELL LIGHT: (1) Inside stepwell activated with side door.

ENVIRONMENTAL

HEATER/AIR CONDITIONER: Combination heater/air conditioner with thermostat in patient compartment.
VENTILATION: 3-speed power fan located at the top of the street side rear wall, see prints.
ASPIRATOR: (1) Rico RS-4X disposable aspirator, hard plumbed to 12V electric vacuum pump, aspirator collection jar located in action area.
OXYGEN CYLINDER BRACKET: Set of heavy-duty straps with ratchet adjustment, system will accommodate either "H" or "M" size cylinder, located in compartment #1.
OXYGEN OUTLETS: (2) In action area with Ohio quick disconnects.
OXYGEN WRENCH: (1) Tethered in oxygen compartment.
VACUUM PUMP: Thomas 12VDC, mounted on formed aluminum bracket with rubber isolators and installed on back wall of compartment #2.
STATIC VENT, Fresh air intake: Located over side entry door with cast aluminum exterior cover and black plastic adjustable interior cover.

PATIENT HANDLING

ASSIST RAIL: (1) 64" Stainless steel ceiling assist rail over cot area.
ASSIST HANDLE: (4)-10", (1) on each entry door, (1) on ALS cabinet
POST & WHEEL CUPS: For #11 stretcher on squad bench.
COT MOUNT: Femo Model 175-1 installed for specified cot. If no cot is specified mount will be shipped loose for dealer/customer installation after delivery.

CABINETS & HARDWARE (See attached drawing for specific cabinet dimensions)

ACTION AREA: Flat switch panel with ABS plastic on lower action area wall.
ALS CABINET: (2) fixed shelves for 747-kit storage, open shelf for monitor/defibrillator and upper cabinet with hinged Plexiglas door.
CEILING: ¼" Plywood covered with ¼" foam and wrapped with white vinyl. All accessory holes (ie: lights, IV holders, fluorescent lights) are reinforced with ¼" plywood backers.
DOOR PANELS: 1/8" Plywood covered with ½" foam and wrapped with vinyl. Secured to door with screws covered with matching buttons.

INSULATION: Fiberglass batts installed in walls and ceiling except in forward right corner (ALS CABINET LOCATION) where 5/16" Reflectix insulation is used. Reflectix installed in top section of ALS for heat/ac unit, on ceiling above cabinet, and down front wall of body behind cabinet.

KICKPLATES: .063 diamondplate installed at bottom of entry doors. 7"high on rear doors and 16" high on side entry door.

HAZARDOUS WASTE & SHARPS DISPOSAL: 3.3-quart sharps container with a one gallon trash container in a slide-out drawer on end of squad bench.

IV HOLDERS: (2) Dual bottle, Swing-down style, (1) each over cot and squad bench, chest area, w/Velcro retaining straps.

LABELS: (2) "NO SMOKING" signs, (1) in cab, (1) in patient compartment (2) "FASTEN SEAT BELT" signs, (1) in cab, (1) in patient compartment.

PLEXIGLAS DOORS: All Plexiglas to be 3/16" (.1875") thick, clear. All sliding doors to have full-length aluminum pull handles.

REFLECTORS:(3) 3" reflectors – one installed on each entry door on lower outside corner.

SEAT BELTS: (4) Sets of automotive-style lap belts, in addition, (3) restraint belts on squad bench face for stair chair or stretcher.

SQUAD BENCH: Dual split lids with ratchet-style hold opens. Rear-facing vertical slot for scoop stretcher.

STREETSIDE CABINETS: Standard Mini Medic layout with full wall TECHNICIAN SEAT: Wood base with storage.

UPHOLSTERY: Thermal-formed seamless vinyl using 3" foam.

WALK-THROUGH DOOR: Sliding door with Plexiglas view window, which slides behind driver's seat.

PAINT, DECALS, LETTERING

PAINT STRIPING: SEE PAINT OPTIONS

STAR OF LIFE DECALS: Reflective blue Scotchlite with white border:

(2) SOL, 4" on hood.

(2) SOL, 12" on rear.

(2) SOL, 16", (1) each side.

(1) STAR, 32", on roof.

(1) AMBULANCE, 4" mirror image on hood.

(3) AMBULANCE, 6", (1) on each side and rear.

All decals are shipped loose with unit unless otherwise specified

FUEL

DIESEL: Fill tank on unit at time of delivery from factory.

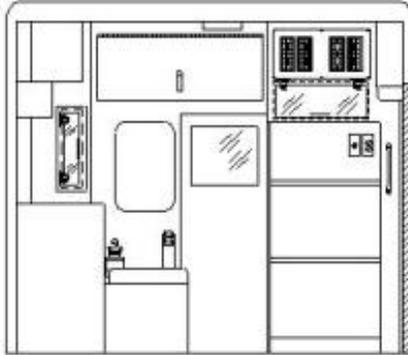
NOTE: With the exceptions of paint striping and standard required patient handling equipment as defined in the specification, a vehicle built to the above requirements meets the intent of KKK-A-1822 Revision D.

Due to on-going product improvement and the changing requirements of the ambulance industry, McCoy Miller reserves the right to change this specification and the related product without prior notice and without any obligation to change prior products or parts.

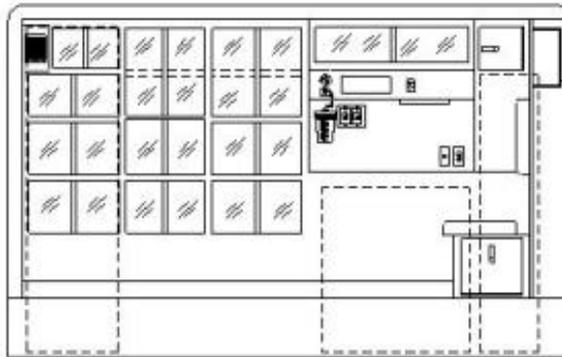
Appendix B: Patient Compartment Schematics

(downloaded from www.mccoymiller.com)

**Forward
aspect:**



**Left side
aspect:**



**Right side
aspect:**

