TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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GENERAL DYNAMICS ON-SITE AMBULANCE CRASH INVESTIGATION
CASE NO: CA02-028
VEHICLE: 1999 FORD E-350 SUPER DUTY VAN CHASSIS W/WHEELED COACH TYPE III AMBULANCE BODY
LOCATION: NEW JERSEY
CRASH DATE: JULY 2002

Contract No. DTNH22-01-C-17002

Prepared for:

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

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

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

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. CA02-028	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle General Dynamics On-Site Ambulance Crash Investigation Vehicle: 1999 Ford E-350 Chassis Location: State of New Jersey		*5. Report Date*: October 2004 *6. Performing Organization Code*	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Transportation Sciences Crash Data Research Center Advanced Engineering Services A General Dynamics Company P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00410.0000.0049 *11. Contract or Grant No.* DTNH22-01-C-17002	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		*13. Type of Report and Period Covered* Technical Report Crash Date: July 2002 *14. Sponsoring Agency Code*	
15. Supplementary Note On-site investigation of the crashworthiness and occupant protection systems of a Type III ambulance.			
16. Abstract This on-site crash investigation focused of the crashworthiness and occupant protection systems of a Wheeled Coach Type III ambulance and the injury severity of the occupants of the patient compartment. This unit consisted of a 1999 Ford E-350 Super Duty van chassis that was equipped with the Ford Ambulance Preparation Package and the box-type ambulance body. The ambulance was occupied by a 19-year old male driver with an Emergency Medical Technician (EMT) certification and a Class D driver's license (both New Jersey State issued), a 35-year old male EMT who was seated on the left side CPR seat in the patient compartment, and an emotionally distressed 40-year old female patient who was seated on the right side bench seat. The driver was restrained by the manual 3-point lap and shoulder belt system while the EMT and the patient were restrained by the manual lap belts. The driver was operating the ambulance with the overhead emergency lights and siren activated, although the patient's transport was non-emergency. On an approach to a four-leg intersection, the driver slowed for a stop sign and proceeded into the intersection. A 1997 Ford Crown Victoria taxicab was traveling on the intersecting street. The ambulance entered the intersection and was struck by the taxicab on the left rear area of the patient compartment. The ambulance subsequently struck a parked vehicle and overturned onto its right side, before striking a second parked car. The damage rating for the three impacts was minor. None of the occupants of the ambulance were injured in the crash. The EMT seated in the patient compartment sustained a facial and elbow abrasion as he unbuckled the safety belt and fell onto the right side of the patient compartment post-crash. All three occupants were transported to a local hospital by protocol where they were examined for possible injury and released.			
17. Key Words Intersection crash Patient compartment Manual lap belts		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 19	*22. Price*

Table of Contents

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BACKGROUND

This on-site crash investigation focused of the crashworthiness and occupant protection systems of a Wheeled Coach Type III ambulance and the injury severity of the occupants of the patient compartment. This unit consisted of a 1999 Ford E-350 Super Duty van chassis that was equipped with the Ford Ambulance Preparation Package and the box-type ambulance body **(Figure 1)**. The ambulance was occupied by a 19-year old male driver with an Emergency Medical Technician (EMT) certification and a Class D driver's license (both New Jersey State issued), a 35-year old male EMT who was seated on the left side CPR seat in the patient compartment, and an emotionally distressed 40-year old female patient who was seated on the right side bench seat. The driver was restrained by the manual 3-point lap and shoulder belt system while the EMT and the patient were restrained by the manual lap belts. The driver was operating the ambulance with the overhead emergency lights and siren activated, although the patient's transport was non-emergency. On an approach to a four-leg intersection, the driver slowed for a stop sign and proceeded into the intersection. A 1997 Ford Crown Victoria taxicab was traveling on the intersecting street. The ambulance entered the intersection and was struck by the taxicab on the left rear area of the patient compartment. The ambulance subsequently struck a parked vehicle and overturned onto its right side, before striking a second parked car. The damage rating for the three impacts was minor. None of the occupants of the ambulance were injured in the crash. The EMT seated in the patient compartment sustained a facial and elbow abrasion as he unbuckled the safety belt and fell onto the right side of the patient compartment post-crash. All three occupants were transported to a local hospital by protocol where they were examined for possible injury and released.

Figure 1. Overall view of the involved ambulance.

NHTSA notified the General Dynamics Special Crash Investigation team of the crash on July 8, 2002. Cooperation was established with the investigating police agency that was responsible for the investigation of the crash and the organization of the ambulance service. The on-site investigation was scheduled for July 11. The on-site investigation involved the inspection and documentation of the involved ambulance and crash site, interviews with the supervisor of the ambulance service, and interviews with the ambulance driver and EMT. The other vehicles could not be location for inspection.

SUMMARY

Crash Site

The crash occurred at a four-leg intersection of two one-lane, one-way city streets during nighttime hours. Overhead lights mounted on utility poles illuminated the streets and the intersection. At the time of the crash, the weather conditions were clear and dry. The ambulance was traveling in an easterly direction on a local street on approach to the intersection. Parallel parking was permitted at both curb lines and buildings bordered the sidewalks. A stop sign regulated eastbound traffic flow through the intersection. The taxi cab was traveling in a southerly direction of the intersecting roadway. Curbside parking was permitted on this roadway, which reduced traffic flow to one lane. Immediately prior to the intersection, parking was prohibited which allowed two lanes of southbound traffic at the intersection. Southbound traffic flow was not controlled at the intersection. The asphalt road surfaces were smooth and worn from heavy traffic volume. The asphalt composition did not contain a high amount of aggregate. There were no defects at the crash location and the posted speed limits were 40 km/h (25 mph).

Vehicle Data – Ambulance

Chassis/Cab

The involved ambulance consisted of a 1999 Ford E-350 Econoline Super Duty chassis cab **(Figure 2)** that was equipped with the Ford Ambulance Preparation Package and a Wheeled Coach Type III ambulance body. The chassis was equipped with a 7.3-liter diesel engine linked to a four-speed automatic transmission with a column mounted transmission selector lever. The vehicle's braking system consisted of power-assisted four-wheel disc brakes with rear wheel anti-lock. The unit was manufactured on a 350.5 cm (138.0") wheelbase. The Ford chassis was manufactured on 11/98 and was identified by the following Vehicle Identification Number (VIN): 1FDWE30F2XH (production number deleted). The E-350 was equipped with Cooper SRMII Radial LT light truck tires mounted on OEM alloy wheels. All tires, including the dual tires mounted on the rear drive axle were LT225/75R16. The specific tire data for the vehicle is identified in the following table. It should be noted that the rear tire pressures could not be obtained due to the configuration of the valve stems.

Figure 2. Quarter view of the E-350 chassis,

Position	Measured Tread Depth	Measured Pressure	Damage
LF	7.1 mm (9/32”)	483.4 kPa (70.5 PSI)	None
RF	7.9 mm (10/32”)	387.4 kPa (56.5 PSI)	None
LR – Outer	3.1 mm (4/32”)	Unknown	Circumferential abrasions to outer bead of wheel
LR – Inner	7.9 mm (10/32”)	Unknown	None
RR – Outer	5.6 mm (7/32”)	Unknown	Circumferential abrasions to outer bead of wheel
RR - Inner	7.9 mm (10/32”)	Unknown	None

The interior of the Ford E-350 chassis cab was configured with box mounted, high-back bucket seats for the two outboard-seated positions. Power equipment consisted of power windows and door locks. The vehicle was equipped with a tilt steering wheel that consisted of five adjustment positions. The driver’s restraint system consisted of a continuous loop, 3-point lap and shoulder belt with a sliding latch plate and an emergency locking retractor (ELR) with a belt sensitive locking feature. The D-ring was adjustable and was set to the full-down position. There was no loading evidence to the belt system. The buckle was equipped with a pretensioner that did not fire. The front right position was not occupied at the time of the crash. The front right belt system was the same as the driver’s; however, the retractor was dual mode with ELR and automatic locking retractor (ALR) functions. The E-350 was equipped with redesigned frontal air bags for the driver and right passenger positions. The air bags and pretensioners did not activate as a result of the minor severity impacts.

Patient Compartment - Exterior

The exterior of the patient compartment measured 375.9 cm (148.0”) in length and 219.7 cm (86.5”) in height. The unit was mounted on the chassis cab with interior access from the back of the cab of the E-350 to the patient compartment and exterior access through right side and rear doors.

Figure 3. Left side view of the patient compartment.

The left exterior side of the patient compartment contained four compartments **(Figure 3)**. The forward compartment housed the oxygen cylinders. This compartment was accessed by a forward hinged door that was 41.9 cm (16.5”) in width and 151.1 cm (59.5”) in height. Internally, the compartment was equipped with two floor mounts that were 11.4 cm

(4.5”) in diameter to position the portable oxygen cylinders. These positioned the cylinders on 15.2 cm (6.0”) centers. Located 34.3 cm (13.5”) above the floor was a double C-shaped band with thumbscrew adjustments to restrain the cylinders. Mounted on the right wall of this compartment were two vertical rails that were equipped with two ratchet straps used to secure the upper end of the primary oxygen cylinder. These straps were 2.5 cm (1.0”) wide and approximately 4.8 mm (3/16”) in thickness. It should be noted that the cylinders were removed prior to the SCI investigation and that no leakage was reported.

Adjacent to and aft of the oxygen compartment was a compartment with a forward hinged door that measured 95.3 cm (37.5) in height and 87.3 cm (34.4”) in width. This compartment housed a “Sharps” container and was placarded with a Caution Infectious Waste label. In addition to the “Sharps” container, this compartment housed cervical spine collars, backboard supports and a fire extinguisher. This compartment remained intact, without damage throughout the crash. The door remained closed and operational.

Located aft of the rear axle were two 195.6x38.1 cm (77.5x15.0”) opposing doors that latched to the center of the opening. Although these doors were within the initial impact zone, the doors remained closed and operational. Internally, two shelves were positioned at the upper aspect of the compartment that housed an assortment of bandages and gauze.

The back of the patient compartment was equipped with the primary doors for loading patients into the ambulance. These outboard hinge doors were 146.1 cm (57.5”) in height and contained two 34.3x55.9 cm (13.5x22.0”) windows located in the upper third of the doors. The doors remained closed and were operational post-crash. Located below the doors was a hinged aluminum step bumper. The recessed step platform measured 17.8x118.1 cm (7.0x46.5”). This section of the bumper was not damaged, although the left aspect of the bumper was deformed by the displacement of the corner post.

The right side of the patient compartment was configured with four storage compartments and a door to the patient compartment. The egress door was hinged at the forward aspect and was 80.7 cm (31.8”) in width and 187.4 cm (73.8”) in height. A 49.5x41.9 cm (19.5x16.5”) window was positioned over a 22.9x21.6 cm (9.0x8.5”) sliding window. Although the vehicle rolled onto its right side, these glazing panels remained intact. The door hinge was abraded; however, the door remained closed and operational. Located forward of this door was a 40.6x46.5 cm (16.0x18.3”) compartment door that was hinged at the forward edge. This door was partially jammed by deflection of the external hinge. Located directly above this door, was a 120.1x46.5 cm (47.3x18.3”) door, which concealed a three-shelf compartment. At the time of the SCI inspection, these compartments were empty.

Two additional doors were configured in the body of the patient compartment aft of the rear axle position. A 52.1x64.2 cm (20.5x25.3) door hinged at the forward aspect concealed a compartment that stored road flares. Located immediately behind this compartment was a 195.6x30.5 cm (77.5x12.0”) door that stored backboards. This compartment door was hinged at the forward aspect. Within this compartment was a

series of mounting brackets that were removed from the vehicle prior to this investigation. Both doors aft of the axle position remained closed and operational. There was no intrusion of these compartments or spillage of the contents into the patient compartment.

Patient Compartment - Interior

The interior forward wall of the patient compartment contained a sliding pass-through door that provided a 45.7x121.9 cm (18.0x48.0") access to the cab of the ambulance. This door was open at the time of the crash. Located immediately rearward and to the right of this pass-through was a rear-facing jump seat. This seat was a box mounted high-back bucket seat that was manufactured by Emergency Vehicle Seating (EVS), and was identified as an EVS Hi-BAC Safety Seat, 1700 and 1800 Series. Integrated into the seat back was a child safety seat (CSS) with a 5-point harness system **(Figure 4)**. This CSS was concealed at the time of the crash. The jump seat was equipped with a fixed length adjustable lap belt with an automatic locking retractor.

Figure 4. Jump seat/child safety seat.

The retractor was located on the inboard side of the jump seat. The webbing contained a sewn-on latch plate and spooled 80.2 cm (35.5") out of the retractor. The lap belt was manufactured by Indiana Mills Mfg. Inc. and was identified by the following nomenclature:

F06560
LOT ID# 173762-01
SA28016
iMMi Jan 99

This lap belt system yielded routine usage wear marks; however, this seat was not occupied at the time of the crash.

A top hinged compartment door was located above the rear-facing jump seat. This compartment door measured 74.9 cm (29.5") laterally and 36.8 cm (14.5") in height. The door remained closed and was not damaged in the crash.

A storage cabinet was built into the right aspect of the forward wall. A 44.7x129.5 cm (17.6x51.0") door concealed the cabinet, which contained two shelves. A 21.6x104.1 cm (8.5x41.0") Plexiglas window was centered in the door. Both the door and the glazing panel remained closed and intact. Adjacent to the left of the door, were two metal louvered vent grids. These vents were not damaged and were not contacted by the occupants of the patient compartment during the crash. **Figures 5 and 6** are overall views of the patient compartment.

Figure 5. Overall view of the left interior of the patient compartment.

Figure 6. Overall view of the right interior of the patient compartment.

The left interior of the patent compartment **(Figure 7)** was equipped with a myriad of cabinets, work counter, controls, and the CPR seat. At the forward aspect of the left side interior, two overhead compartments were present. Two sliding Plexiglas doors closed the forward compartment with a total glazing opening of 25.4x99.1 cm (10.0x39.0”). Adjacent aft of this compartment was a hinge door that measured 20.3x29.2 cm (8.0x11.5”). Both compartments remained closed with no damage occurring to the doors or contents. Located below these two compartments were the HVAC controls, two oxygen valves, power outlets, and an access panel to the on board oxygen cylinders. A work counter with a rounded counter edge was positioned below the controls. There was no damage or occupant contact to these components.

Figure 7. Left side interior of the patient compartment.

Located aft of the above-mentioned components, was the CPR seat. The EMT was seated and restrained in this seat at the time of the crash. The CPR seat consisted of a flat cushion that was positioned 50.8 cm (20.0”) above the floor. The seated area of this position was 45.7 cm (18.0”) deep and 58.4 cm (23.0”) wide. A separate back cushion folded flat to form additional counter space if needed. The cutout area above the seat was padded on all three sides. This padded area extended to the full height of the ceiling, which offered padded protection to an occupant of this jump seat. The seat was equipped with a lap belt with an automatic locking retractor.

The rear aspect of the left side interior of the patient compartment consisted of additional counter space and four large compartments that were concealed by Plexiglas sliding

panels. A narrow band of padding was positioned horizontally above these compartments. A rear bulkhead extended from the padded strip to the ceiling of the patient compartment. A small compartment was located in the forward aspect of the bulkhead, immediately aft of the jump seat location. All of these compartments remained closed and without damage. There was no occupant contact evidence on the left side interior.

The right side interior wall of the patient compartment **(Figure 8)** was configured with the door, a three-position bench seat with underneath storage, an oxygen valve, and overhead compartments. The interior door handle consisted of a 2.5 cm (1.0") diameter stainless steel handrail that measured 68.6 cm (27.0") vertically and 40.6 cm (16.0") horizontally. There was no padding to this handrail. A tempered glass window was positioned within the form of the handrail. This door remained closed and operational post-crash. Located aft of the door was the three-position bench seat. The padded cushion was 6.4 cm (2.5") thick and measured 176.5 cm (69.5") in length and 48.3 cm (19.0") in depth. A fold-down padded armrest was mounted to the sidewall at the forward aspect of the bench seat. This padded armrest was 50.8 cm (20.0") in length and in the down position, was 22.9 cm (9.0") above the bench seat cushion. At the time of the crash, it was in the up position. An oxygen valve was located aft of the armrest. The armrest and valve were contacted by the EMT post-crash as he unbuckled his lap belt and fell into these components. The armrest was not damaged; however, the valve was rotated without leakage. The bench seat backrest measured 130.8 cm (51.5") in length and 43.2 cm (17.0") in height and was attached to the side wall 27.9 cm (11.0") above the cushion. The measured thickness of the backrest was 6.4 cm (2.5").

Figure 8. Right side interior of the patient compartment.

Three lap belts were bolted to the sidewall to restrain side-facing passengers of the patient compartment. The patient was restrained in the center position at the time of the crash. The lap belts were spaced with 38.1 cm (15.0") centers between the anchorage bolts (3/8" diameter, Grade 8) for the latch plate webbing and the automatic locking retractor (ALR). The retractors contained 111.8 cm (44.0") of webbing that spooled onto the ALRs. All three belt system were identified by the following nomenclature:

F06765A
LOT ID# 173762-02
SA28022

The rear wall of the patient compartment consisted of the two loading doors. A 27.9x119.4 cm (11.0x47.0") padded panel was attached to the bulkhead above the doors. Protruding stainless steel handrails formed at 90 degrees were mounted to both doors. The vertical aspect of the rail measured 83.8 cm (33.0") and the lower horizontal rail

measured 22.9 cm (9.0”). These rails were not padded. The doors remained closed during the crash and there was no damage or contact evidence to the doors. They did provide a point of egress for the EMT and the patient post-crash.

The patient cot was manufactured by Ferno and was identified by Model No. 35-A. This unit was rated at a 227 kg (500 lb) capacity and was equipped with six wheeled casters. The cot was equipped with three 5.1 cm (2.0”) wide restraint straps that were positioned at the level of patient’s chest, abdomen, and legs. The cot was secured to the floor of the patient compartment by a single Ferno floor lock that was identified by No. 604002. At the time of the crash, the patient was not positioned on the cot and the cot remained secured to the restraint device.

Vehicle Data - 1999 Ford Crown Victoria

The involved 1999 Ford Crown Victoria was a registered taxicab. The four-door vehicle was a body-on-frame configuration powered by a 4.6-liter V-6 engine linked to a four-speed automatic transmission. The police reported VIN for this vehicle was 2FALP72W1VX (production number deleted). The Crown Victoria taxicab was removed from the towing agency and could not be located for this SCI investigation.

Crash Sequence

Pre-Crash

The ambulance crew was involved in three hospital transports within the first seven hours of their assigned 12-hour shift. The crew received a call to transport a female patient from a halfway residence to a local hospital for evaluation. This patient was not a medical transport. She had refused her prescribed medications and had become irritable. The staff at the facility requested transport for hospital evaluation.

As the ambulance crew arrived at the facility, the patient was assisted into the patient compartment of the ambulance and allowed to sit on the bench seat on the right side of the ambulance. She was seated in the center of three positions and was restrained with the manual lap belt with an automatic locking retractor. The ambulance crew positioned the lap belt and ensured a proper fit around her hips. Because of the reported behavior of the patient, the senior EMT decided that he would ride in the patient compartment with the patient due to his physical size, in the event she became disorderly. This decision called for the second EMT to drive the ambulance. Although he had driven similar ambulance units, this was his first trip driving this ambulance.

Figure 9. Pre-crash trajectory of the ambulance.

The 19-year old driver of the ambulance departed the location of the call and was proceeding in an easterly direction on a one lane, one-way city street **(Figure 9)**. Although the call was not of an emergency medical nature, the driver was proceeding with the

vehicle's overhead emergency lights and siren activated. The driver stated that he was traveling at an estimated speed of 48 km/h (30 mph) on the city street that permitted parallel parking at both curb lines. As he approached the intersection, the driver decelerated to approximately 40 km/h (25 mph) and entered the intersection. Buildings located at the corners of the intersection obscured the driver's view of southbound traffic approaching the intersection. Although a stop sign was present at the mouth of the intersection for eastbound traffic, the ambulance driver proceeded through the regulatory sign without stopping.

A taxicab was proceeding in a southerly direction on the intersecting roadway **(Figure 10)**. The 52-year old male driver and three passengers, assumed to be fares, occupied the taxicab. Buildings at the intersection obstructed the taxi cab driver's view of the approaching ambulance. As the taxicab entered the intersection, the ambulance crossed its path of travel from right to left. The ambulance driver did not initiate avoidance maneuvers and there was no pre-crash evidence (i.e., skid marks) to indicate the driver of the taxicab attempted to avoid the impending crash. The Crash Schematic is attached as **Figure 21**, Page 19.

Figure 10. Pre-crash trajectory of the taxicab.

Crash

The frontal area of the taxicab impacted the left rear aspect of the patient compartment of the ambulance. The impact produced sideswipe-type damage to the ambulance. The resultant directions of force were within the 11o'clock sector for the ambulance and most likely within the 2 o'clock sector for the striking taxicab. Although the ambulance experienced a longitudinal crash pulse, the pulse was not sufficient to deploy the vehicle's frontal air bag system or fire the safety belt buckle pretensioners. The damage to the patient compartment involved isolated dents, superficial abrasions, transfers on the rub strips, and dents and abrasions to the left rear hubcap and chrome wheel, and snagging of the left rear corner post.

The momentum of the ambulance directed the vehicle forward as it crossed the mouth of the intersection. The frontal area impacted the rear area of a parked 1991 Dodge Caravan. This Dodge was parked parallel to the south (right) curb line, immediately east of the mouth of the intersection. This impact, although minor in severity, displaced the Dodge forward into the rear of a 1999 Honda Civic that was parked forward of the Dodge. The ambulance rotated across the eastbound travel lane, probably a result of wheel deflection and a counterclockwise steering input by the driver. As a result, the ambulance initiated a lateral rollover onto its right side. The vehicle tipped over due to its high center of gravity and rapid CCW redirection. As the ambulance overturned and slid a short distance to rest, the frontal area impacted the right side of a 1998 Toyota

Corolla that was parked adjacent to the left (north) curb line. There was no distinct contact evidence associated with this impact. This impact displaced the parked Toyota into the rear of a parked 1993 Nissan Quest minivan. The ambulance came to rest on its right side, engaged against the right side of the struck 1998 Toyota.

It should be noted that the patient compartment of the ambulance is outside the scope of the WinSMASH reconstruction program; therefore a velocity change (delta V) was not computed for the initial left side impact.

Post-Crash

Immediately following the crash, the EMT who was riding in the patient compartment of the ambulance, unbuckled his manual lap belt and fell across the width of the ambulance, impacting the right side wall of the patient compartment. Initially he was disoriented with respect to the attitude of the ambulance (on its right side) and its location. He reached for the radio and called his dispatcher and notified him of the rollover crash. The EMT then proceeded to the rear of the patient compartment and opened the rear doors to identify the location of the crash. He returned to the patient compartment and relayed the location to his dispatcher. The dispatcher relayed the crash information to the police department and a squad car was dispatched to the scene. The EMT assisted the patient by unbuckling her lap belt and assisted her from the vehicle, exiting through the rear doors of the patient compartment.

The city police were located approximately three blocks from the crash site as they received the call of the crash. They responded to the crash site, arriving within a minute of notification. As they arrived on-scene, the officers observed the driver belted to his seat position, suspended above the cab as the vehicle rested on its right side. One of the officers opened the left front door and the driver unbuckled his safety belt system. He fell to his right and immediately stood up and crawled out of the opened door and was assisted to the pavement by the officer. Due to the nature of the crash (rollover) and the involvement of city personnel, the driver, EMT, and the patient were transported by additional ambulance units to a local hospital where they were evaluated for injury and released. The ambulance was towed from the crash site to the city garage where it was retained in its crash state. The vehicle was inspected for this investigation at the garage location.

The 1997 Ford Crown Victoria taxicab was towed from the scene due to the frontal damage from its impact with the ambulance. None of its occupants were transported for medical evaluation. The parked 1998 Toyota was towed from the crash site while the Honda, Nissan, and the Dodge were left at the scene following the police investigation. None of these vehicles could be located during this SCI investigation.

Vehicle Damage

Exterior – Ambulance

The ambulance sustained minor severity damage as a result of the initial impact with the Ford Crown Victoria taxicab. The taxicab struck the left rear aspect of the patient compartment **(Figure 11)**. The damage began on the left rear chrome wheel, 21.6 cm

(8.5”) forward of the axle position and extended rearward onto the rubber fender flare, lower portion of the patient compartment aft of the axle, corner post, terminating at the left corner of the aluminum rear bumper. The direct damage length measured 219.7 cm (86.5”). There was no measurable crush to this contact area. The damage to the wheel consisted of an abrasive pattern to the chrome surface with minimal deflection of the wheel bead. The lower aspect of the patient compartment, aft of the axle, was scratched with superficial isolated dents. The bottom aspect of the left rear corner post of the patient compartment was snagged by the Ford as the ambulance continued forward. The snagging deflected the corner post 19.3 cm (7.6”) rearward at the bottom corner and separated the full height of the post from the side and rear sheet metal body panels. The Collision Deformation Classification (CDC) for this impact was 10-LBEW-1.

Figure 11. Left side damage from the initial impact with the taxicab.

The frontal area of the ambulance sustained minor severity damage from the secondary impact with the parked 1991 Dodge Caravan. Subtle white paint transfers were noted to the top surface of the front bumper **(Figure 12)**. These transfers began 11.4 cm (4.5”) left of center and extended laterally 27.9 cm (11.0”), ending 16.5 cm (6.5’) right of the vehicle’s centerline. The composite lower bumper fascia panel was abraded. These abrasions were both vertically and diagonally oriented and began 61 cm (24”) left of center of the license plate and extended 125.7 cm (49.5”) to the right. A horizontally oriented black rubber-type scuffmark was present on the lower bumper fascia and appeared to be underlying the abrasions. This transfer began 78.7 cm (31.0”) left of center and extended 162.6 cm (64.0”) laterally. There was no residual crush to the front bumper. There was no contact evidence or damage to the grille or hood face. The CDC for this damage was 12-FDLW-1.

Figure 12. Frontal damage from the impact with the parked Dodge Caravan.

The right side of the ambulance sustained minor severity damage as a result of the overturn **(Figure 13)**. The damage began on the protruding lug nut caps for the right front wheel. These caps protruded 3.5 cm (1.375") outboard of the hub of the wheel and 10.2 cm (4.0") outboard of the wheel rim bead. Three of the caps were deformed from the ground contact. The diamond plated aluminum running board that extended below the right side sill of the cab was abraded. The damage began on the forward corner post of the patient compartment and extended the full length of the body. The damage consisted of isolated dents and abrasions with asphalt embedded into the protruding door and compartment hinges **(Figures 14 and 15)**. This damage began 204.0 cm (80.3") forward of the right rear axle location and extended 172.2 cm (67.8") rearward to the rear corner post. This rollover damage also extended vertically 219.1 cm (86.5"), covering the full height of the patient compartment. The right door and all storage compartments remained closed during the rollover and remained operational post-crash. The CDC for this overturn event was 00-RDAO-1

Figure 13. Overall view of the right side damage to the patient compartment.

Figure 14. Asphalt embedded into the aft side of the door hinges.

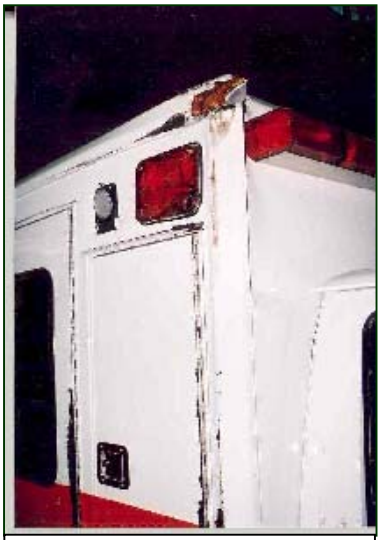

Figure 15. Close-up view of the rollover damage to the top forward corner of the patient compartment.

As the ambulance slid on its right side to final rest, an unknown frontal aspect of the vehicle impacted the right side of the parked 1998 Toyota Corolla. There was no definitive damage noted to the ambulance associated with this event. The CDC for this event was 00-F999-9 (9 = unknown).

Interior – Ambulance

The interior cab (driving compartment) of the ambulance was not damage as a result of the crash. There was no deployment of the frontal air bags and the safety belt pretensioners did not fire. The driver was properly restrained by the manual safety belt system and did not contact interior components.

The patient compartment of the ambulance unit sustained minor damage as a result of occupant contact. This contact damage did not occur during the crash, but occurred post-crash as the EMT unbuckled his manual lap belt system and fell onto the right side wall of the patient compartment. The oxygen valve that was mounted to the right side wall forward of the bench seat was rotated/deflected into the fold down armrest from contact by the EMT **(Figure 16)**. The valve was not damaged and there was no release of oxygen from the valve. This contact resulted in an abrasion to the right face of the EMT. As he came to rest, blood from the abrasion was transferred onto the forward aspect of the padded backrest for the bench seat. The patient was restrained in the center position of the bench seat and did not contact interior components other than the seat back rest. All interior compartments remained closed and were not damaged by the crash forces or occupant contact.

Figure 16. Displaced oxygen valve.

Occupant Demographics

Ambulance Driver

Age/Sex:	19-year old/Male
Height:	167.6 cm (66.0”)
Weight:	54.4 kg (120 lb)
Manual Restraint Usage:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection, driver interview
Seat Track Position:	Mid track (seat track was in full rear position with a seat back recline angle of 23 degrees at the time of the SCI inspection)
Driving Experience:	Automobiles – 3 years, no CDL certification Ambulances – 1 year This ambulance – 1st time driving this vehicle.
Emergency Medical Technician (EMT) Experience:	Full time summer job, received certification in June 2001. He attends college full time and volunteers at another department when attending school.
Eyewear:	Prescription eyeglasses for hyperopia (farsighted)
Egress from Vehicle:	Crawled out of left front door
Type of Medical	

Treatment: Transported by ambulance to a local hospital where he was treated and released. This was a precautionary and routine procedure of the department following a crash.

Driver Work Shift/Rest Cycle

The driver stated that he worked a 12-hour shift on the day prior to the crash, which ended at 0700 hours. Following his shift, the driver returned to his residence and went to sleep. He awoke at 1600 hours, showered and ate a meal. He reported to his assigned shift at 1900 hours, scheduled to work another 12-hour period. During this shift, the driver stated that he and his partner responded to three calls prior to the call that preceded this crash. He noted that he was fully rested at the on-set of his shift and that he was not drowsy during his work shift.

Driver Injuries

Injury	***Injury Severity (AIS 90/Update 98)***	***Injury Mechanism***
Not injured	N/A	N/A

Driver Kinematics

The driver was asked by his partner to drive the ambulance during this transport. The EMT determined that due to the mental status and physical size of the patient, it was best that he ride in the patient compartment with her. Therefore, the driver was driving this Type III ambulance for the first time. (He did have experience driving similar units.) As the driver entered the cab of the ambulance, he adjusted the seat to a mid track position, adjusted the interior rear view mirror, and left the door between the cab and the patient compartment open. The driver stated that he was restrained by the manual 3-point lap and shoulder belt system. There was no evidence on the belt system to support belt usage at the time of the crash, however, the vehicle interior lacked occupant contact evidence and the driver reported no injuries. These later factors supported the use of the manual belt system. He was dressed in a blue button-down shirt with a white T-shirt, blue cargo pants, and black boots. This was the standard uniform worn by the ambulance crews. He was also wearing his prescription eyeglasses. **Figure 17** is a view of the driver's compartment.

Figure 17. Interior view of the driver's compartment.

The driver was seated in an upright position with both hands positioned on the steering wheel. At initial impact with the taxicab, the driver probably responded in a forward and left trajectory and loaded the manual belt system. The subsequent impacts with the parked vehicles did not result in significant damage; therefore the driver was not displaced from his restrained position. During the lateral rollover event, the driver moved to his right and was restrained by the belt system as the emergency locking

retractor locked the belt webbing. As the vehicle slid to rest, the driver was supported in his seat by the belt system. The manual belt system restrained the driver and prevented him from contacting interior components, which prevented him from injury.

Immediately following the crash, the driver stated that he was suspended by the belt system and felt that he was in a brief state of shock from the rapid sequence of events during the crash. He further noted that within a minute of the crash, the investigating officers arrived on scene and opened the driver's door. The driver unbuckled his belt system and crawled out of the left front door and was assisted to the road surface by the officer. Although he denied injury, departmental policy required ambulance transport to a local hospital where he was examined for possible injury and released. He returned to his assigned shift on the day following the crash.

Emergency Medical Technician

Age/Sex:	35-year old/Male
Position in Vehicle:	Seated in the CPR seat on the left side of the patient compartment
Height:	167.6 cm (66.0")
Weight:	93 kg (205 lb)
Manual Restraint Usage:	Lap belt
Usage Source:	Vehicle inspection, EMT interview
Emergency Medical Technician (EMT) Experience:	Part-time EMT with 12 years of experience, works as a pathology technician dayshift. He reported to work at 2000 hours for his assigned shift, one hour late due to his late work at his day job.
Eyewear:	Prescription eyeglasses, displaced from face, not damaged
Egress from Vehicle:	Opened and exited rear doors of the patient compartment
Type of Medical Treatment:	Transported by ambulance to a local hospital where he was treated for minor severity injuries and released.

Emergency Medical Technician Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Mechanism
*Abrasion of the right elbow	Minor (790202.1,1)	Right side of patient compartment
*Abrasion adjacent to right eye	Minor (290202.1,1)	Right side of patient compartment

Source- Occupant interview

**The EMT noted that his injuries occurred post-crash as he unbuckled the lap belt and fell onto the right side of the patient compartment.*

Emergency Medical Technician Kinematics

The EMT was seated in the CPR seat on the left side of the patient compartment **(Figure 18)**, opposite of the patient who was being transported to the hospital. The EMT was dressed a blue button-down shirt and a T-shirt, blue cargo pants, and his EMT boots. He was restrained by the manual 2-point lap belt system. Restraint usage was supported by the lack of contact points within the patient compartment and the lack of crash induced injury to the EMT.

Figure 18. CPR seat.

At impact with the taxicab, the EMT probably moved forward and to his left in response to the impact force. Although he was restrained in a side facing jump seat by the lap belt, he was positioned between compartments of the patient compartment interior. These compartments restricted his lateral movement. The subsequent impacts with the parked vehicles did not displace the EMT. As a result of the lateral right side rollover, the EMT moved forward toward the right side of the patient compartment. The lap belt held him in position as the vehicle rolled onto its right side. The EMT did not contact interior components during this event to cause injury. His eyeglasses; however, were displaced from his face.

As the vehicle came to rest, the EMT unbuckled his lap belt and fell across the patient compartment, contacting the fold-down armrest on the right wall of the compartment and the oxygen valve located adjacent to the armrest. This contact resulted in an abrasion to the right of his face. As a result of this abrasion, the EMT bled. He then rolled onto the padded seat back of the patient compartment adjacent to the patient. This resulted in a blood transfer to the padded backrest **(Figure 19)**.

Figure 19. EMT contact to the right side interior and oxygen valve.

The EMT was disoriented within the patient compartment due to the rollover and the unknown location of the vehicle. He stood up and reached for his radio and notified his dispatcher that the unit had rolled over. He proceeded to the rear doors and opened the doors to check the intersection and provided a location of the crash. The EMT then assisted the patient from the vehicle and waited for rescue personnel to arrive on-scene. He was transported to a local hospital where he was evaluated and treated for the facial abrasion. He did not discover the right elbow abrasion until the following day when he showered.

The EMT did not report to work on the day following the crash. He did report on the second day and resumed normal work activities.

Patient

Age/Sex:	40-year old/Female
Position in Vehicle:	Seated in an upright attitude in the center position of the bench seat on the right side of the patient compartment
Height:	172.7 cm (68.0”)
Weight:	68 kg (150 lb)
Manual Restraint Usage:	Lap belt
Usage Source:	Driver/EMT interview, vehicle inspection
Egress from Vehicle:	Assisted out rear doors by the EMT
Mode of Transport From Scene:	Ambulance
Type of Medical Treatment:	Examined at local hospital for possible injury and transferred to the hospital for evaluation (purpose of initial transport)

Patient Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanisms
Not injured	N/A	N/A

Source – Driver an EMT Interviews

Patient Kinematics

The patient was seated in a normal seated position on the side facing bench seat on the right side of the patient compartment. She was not a medical transport; therefore she was allowed to sit on the bench seat by the ambulance crew. The patient was restrained by the manual lap belt in the center of the three bench seat positions **(Figure 20)**. At impact with the taxicab, the patient moved to her right and forward with respect to her left side facing position. She loaded the manual lap belt webbing. The secondary collisions with the parked vehicles did not displace her from her initial position. The lap belt with the automatic locking retractor, held her in position. During the rollover event, the patient loaded the right wall and padded backrest of the patient compartment. There was no evidence of occupant contact at her position and she was not reported as injured. She came to rest lying on her back against the padded backrest, restrained by the lap belt.

Figure 20. Bench seated position of the patient.

Following the release of his manual lap belt, the EMT came to rest forward (right of the patient) of the patient against the right wall of the patient compartment. The EMT reported that he did not contact the patient. As he regained his orientation within the vehicle, the EMT unbuckled the patient's lap belt and assisted her from the vehicle through the rear doors. The EMT noted that the patient was very vocal following the crash; however, she was not injured. As a precautionary measure, the patient was transported to a local hospital and examined for possible injury. She was transferred to another department of the hospital for evaluation, the purpose of her initial transport.

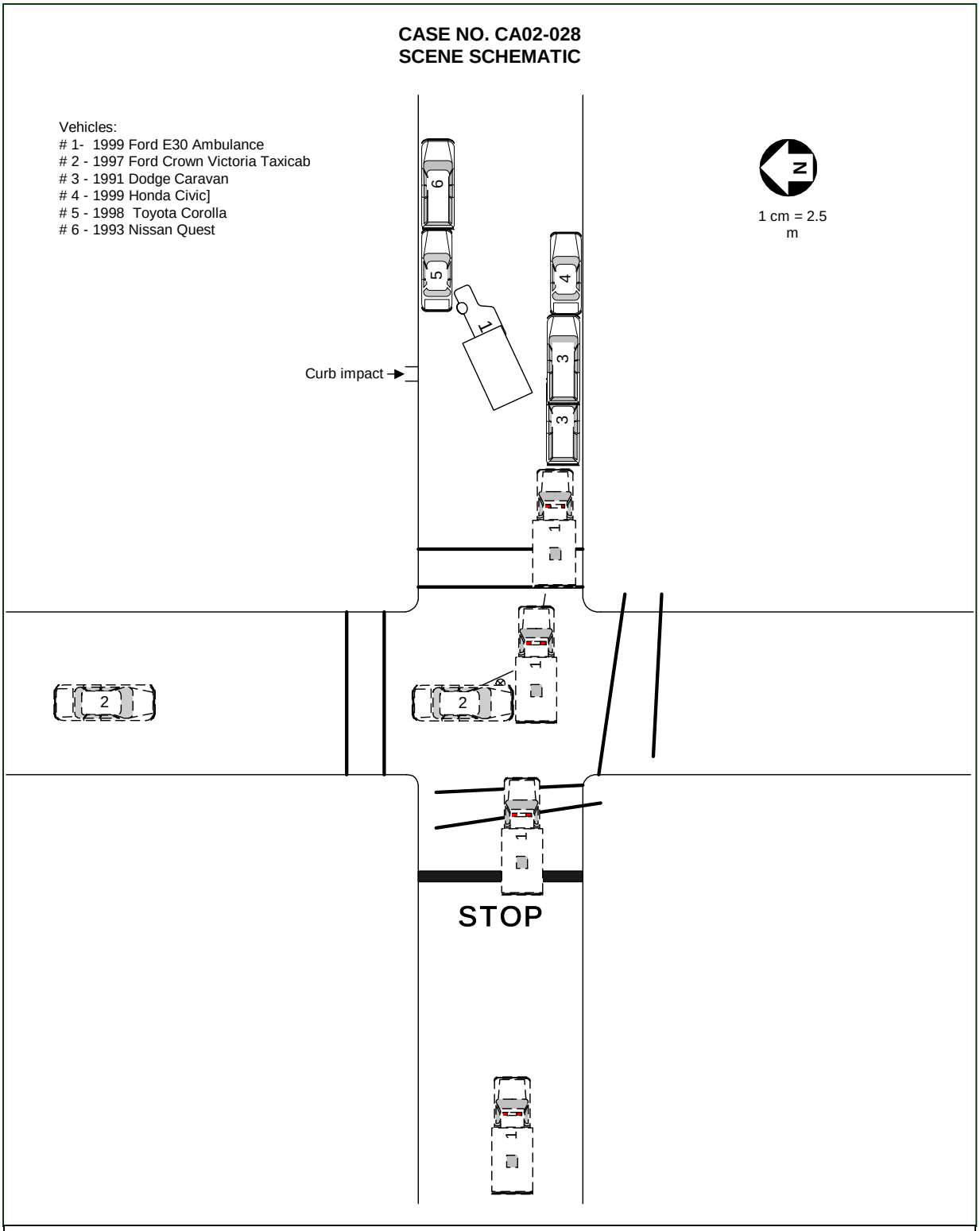

Figure 21. Crash Schematic