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Special Crash Investigations: On-Site Ambulance Crash Investigation; Vehicle: 2012 Freightliner M2 Type I Ambulance; Location: Missouri; Crash Date: July 2020

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Each crash represents a unique sequence of events, and generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicles or their safety systems. This report and associated case data are based on information available to the Special Crash Investigation team on the date this report was published.

16. Abstract

This report documents the on-site investigation of the multi-event crash of a 2012 Freightliner M2 Type I ambulance and a 1999 Jeep Grand Cherokee that resulted in serious injuries to the ambulance's unbelted 27-year-old male paramedic, its 61-year-old male unbelted driver, and its 48-year-old male patient that was restrained to a Stryker patient cot system. The Jeep and Freightliner were traveling north on a four-lane divided interstate highway when the front of the Jeep struck the left rear corner of the Freightliner ambulance (Event 1). The impact redirected the Freightliner off the west roadside, where the right plane struck a guardrail end terminal (Event 2) and the front plane struck a median cable barrier (Event 3). This caused the ambulance to roll over one-quarter turn (Event 4), right-side leading. The Jeep continued north on the highway and struck the east and west guardrails (Events 5 and 6) with the back and front planes. The ambulance was transporting the patient without its emergency warning lights or siren in use at the time. Following the crash, all three occupants were transported by ambulances to hospitals for treatment.

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Special Crash Investigations
On-Site Ambulance Crash Investigation
Case Number: CR20024
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Background

This report documents the on-site investigation of the multi-event crash involving a 2012 Freightliner M2 Type I ambulance (Figure 1) and a 1999 Jeep Grand Cherokee that resulted in police-reported A-level (incapacitating) injuries to the ambulance's unbelted 27-year-old male paramedic, its 61-year-old male unbelted driver, and its 48-year-old male patient restrained to a Stryker patient cot system. The paramedic was attending to the patient at the time of the crash. The Jeep and Freightliner were traveling in the northbound lanes of a four-lane divided interstate highway when the front plane of the Jeep struck the left rear corner of the Freightliner ambulance (Event 1). The impact redirected the ambulance off the west roadside where the right plane struck a guardrail end terminal (Event 2) and the front plane struck a median cable barrier (Event 3). This caused the vehicle to roll over one-quarter turn (Event 4), right-side leading. The Jeep continued north on the highway and struck the east and west guardrails (Events 5 and 6) with the back and front planes.

The ambulance was transporting the patient without its emergency warning lights or siren in use at the time of the crash. Following the crash, all three occupants were transported by ambulances to hospitals for treatment.

Figure 1. Forward-right oblique view of the 2012 Freightliner M2 Type I ambulance at the time of the SCI inspection

This crash was identified by the National Highway Traffic Safety Administration in October 2020, which assigned the investigation to the Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc. Both vehicles were located, and permission to inspect was obtained in October 2020. The on-site portion of this SCI investigation occurred in October 2020. On-site activities included an inspection of the Freightliner to examine and document the exterior and interior damage, identify occupant contacts, and evaluate the supplemental and manual restraint systems. An inspection of the Jeep documented its exterior damage. Additionally, the crash site

was documented by photographs and a total station mapping system. An interview of the ambulance agency's staff was conducted during the on-site investigation.

Ambulance Agency, Personnel, Driver Training, and Transport Description

The municipal ambulance agency was a multi-tiered medical transport service not associated with any particular medical treatment facility. It was capable of providing all levels of emergency medical services (EMS) care, from basic life support (BLS) to advanced (ALS) critical care. The ambulance agency covered an area of 181 square miles and performed public emergency response, inter-facility transfers, and specialty transports using a fleet of 14 Type I ambulances.

The ambulance agency employed career professionals who consisted of administrative staff, support personnel, dispatchers, and emergency medical technicians (EMTs) of varying levels of care. The agency maintained its equipment and operated in compliance with all Missouri Department of Public Safety regulations. The ambulance agency required its employees who operated vehicles to complete emergency vehicle operations training. The involved driver had taken the training many times, with his last certification in 2019 from in-house training. It should be noted that the driver was also an instructor for the in-house training given to all drivers in that ambulance agency. The driver had been certified since 1980.

The EMS personnel primarily were scheduled on 48-hour shift rotations with 96 hours off between shifts. The involved driver had been on his 48-hour shift for 32 hours at the time of the crash with no reported issues concerning fatigue. The EMT in the patient compartment was part-time and had come on duty at 0730 hours the morning of the crash.

The ambulance agency has a fatigue policy that allowed employees to take extended breaks for rest and/or leave work early at their request if the medical professional starts feeling fatigued. Management encouraged its employees to take advantage of this benefit and self-reported that they have employees who use this policy. The ambulance agency reported that the authorization of an employee to use the fatigue policy is at the discretion of the duty officer and that they have never had issues with personnel using this policy.

Summary

Crash Site

The crash occurred in the interchange of a four-lane interstate highway during the afternoon hours. Reported weather conditions in the locale included partly cloudy conditions and a temperature of 30 ºC (86 ºF).

The trafficway traversed in a general north-south direction with two bituminous through lanes in each direction separated by a wide grassy median and cable barrier (Figure 2). The lanes were 4.0 m (13.1 ft) wide. The northbound roadway curved to the left with a radius of 1,142 m (3,746.7 ft) and was positively sloped at 3 percent. The roadway was slightly superelevated, but due to safety concerns from high traffic, a measurement was not obtained. It was also bordered by bituminous shoulders with rumble strips and metal guardrails. Roadway markings consisted of a solid white edge line, a dashed white lane line, and a solid yellow median line. The posted speed limit was 113 km/h (70 mph). The roadway surface was dry at the time of the crash. A crash diagram is included at the end of this report.

Figure 2. North-facing view of the roadway and pre-crash approach of the Jeep

Pre-Crash

The following pre-crash specifics were substantiated from the evidence gathered during the SCI investigation, from statements made by the ambulance agency's managerial staff during the interviews, and a review of the law enforcement documentation of the crash. Prior to the crash, the ambulance was transporting the patient to a local hospital for approximately 7 minutes in non-emergency mode with steady lights and no siren. The driver was not restrained by the available 3-point lap and shoulder seat belt system. The unbelted paramedic occupied the middle aspect of the bench seat in the patient compartment. The patient was secured to the cot system with his upper body elevated approximately 45 degrees.

The ambulance was traveling north in the right lane at police-reported speeds from 96 km/h (60 mph) to 104 km/h (65 mph). The Jeep was traveling north in the left lane. Witnesses interviewed by the police stated that the Jeep had almost struck them as they were traveling. The police crash

report (PAR) stated that the driver of the Jeep was operating the vehicle while impaired at the time of the incident.

Crash

The Jeep crossed into the right lane, and the Jeep's front bumper, right aspect struck the back bumper, left aspect of the ambulance (Event 1). The impact induced a counterclockwise rotation to the ambulance and redirected it toward the left lane and off the west roadside. The right plane of the ambulance, patient compartment area, struck the end terminal of the W-beam guardrail (Event 2, Figure 3). The ambulance continued off the roadway, and the front plane struck the cable barrier (Event 3, Figure 4). This impact caused the ambulance to roll over, right-side leading, one-quarter turn (Event 4). The ambulance came to final rest facing south, partially in the left southbound travel lane.

Figure 3. Northeast view of the guardrail struck by the right plane of the ambulance

Figure 4. Eastward view of the cable barrier struck by the ambulance resulting in the one-quarter overturn onto its right side

After the impact with the ambulance, the Jeep continued north in the right lane. The Jeep rotated counterclockwise and struck the W-beam guardrail with its rear bumper on the east side of the roadway (Event 5). The Jeep then traveled across the two lanes and struck the W-beam guardrail with its front plane on the west edge of the roadway (Event 6) where it came to final rest.

Post-Crash

Witnesses to the crash contacted the local emergency response system. The local fire department, law enforcement, and EMS personnel responded, and several passersby stopped to offer assistance. The ambulance agency reported that a few passersby opened the rear patient compartment doors and cut the patient free from the cot system and removed him from the patient compartment. The paramedic was lying on the rear right patient compartment door when emergency personnel arrived. Emergency personnel removed the windshield to allow the driver to exit the cab under his own power. EMS providers removed the ambulance's paramedic. All occupants of the ambulance were taken to local hospitals, where they were evaluated. They all sustained incapacitating (A-level) injuries. The Jeep driver sustained non-incapacitating (B-level) injuries and was transported by ambulance to a local hospital. Her level of treatment is unknown. The local police did request a toxicology report on the driver of the Jeep that returned a positive result for alcohol. The results of the toxicology report are unknown and were not listed in the police report.

A local recovery service removed the ambulance and Jeep from the crash scene. Both vehicles were towed to a local yard. The ambulance was later moved to a salvage yard by its insurer. The Jeep remained at the local yard owned by the recovery service.

2012 Freightliner M2 Ambulance

Description

The ambulance, a 2012 Freightliner M2 chassis manufactured in January 2012, was identified by the Vehicle Identification Number 1FVACVDU5CDxxxxxx. The chassis was completed during the secondary manufacturing in November 2012 with a Type I ambulance body (Figure 5). The chassis was a dual rear-wheel drive platform powered by a Cummins 6.7-liter diesel engine linked to a 4-speed automatic transmission.

Figure 5. Right-front oblique image of the 2012 Freightliner M2 Type I ambulance

The secondary manufacturing of the vehicle consisted of the installation of the Medtec patient compartment module and the installation of emergency services operational equipment (warning lights, sirens, and radio communications). Completed as a Type I certified "Star of Life" ambulance, the vehicle was configured with a forward cab and rear patient compartment equipped for the treatment of medical emergencies in a mobile environment. A placard confirmed that the Medtec Type I ambulance conformed to Federal Specifications KKK-A-1822F in effect on the date of manufacture. This refers to the U.S. General Services Administration's (GSA) standard for minimum specifications, test parameters, and criteria for design, performance, equipment, and appearance of ambulances in order to display the six-pointed blue star with Rod of Asclepius (Star of Life).

The Freightliner's cab was configured for the seating of two occupants with forward-facing seats that featured manual seat tracks, seatback recline, and height adjustments. Three-point lap and shoulder seat belt systems were available for manual restraint, and head restraints were integrated into the seatbacks. There were no available supplemental restraints.

The patient compartment was equipped with a rear-facing, high-back, pedestal-mounted seat at the forward end, a three-passenger bench seat parallel to the right wall, and a centrally located single-occupant patient cot and mount. The rear-facing seat was equipped with an integrated lap and shoulder seat belt. The bench seat was equipped with lap belts only.

The patient compartment had six exterior storage compartments (three on each side) and three occupant access doors (one right, two rear). The exterior compartments served for the storage of and curbside access to large emergency medical equipment and supplies, such as backboards, stair-chairs, trauma dressing kits, splints, oxygen cylinders, and roadside safety equipment. Two

rear doors served for the loading and unloading of the cot system, as well as entry/exit for medical personnel. There was also an access door at the forward aspect of the right side.

Vehicle Weight/Payload

The Freightliner chassis was placarded by its manufacturer with a gross vehicle weight rating (GVWR) of 8,164 (18,000 lb). This was distributed as gross axle weight ratings (GAWR) of 3,628 kg (8,000 lb) front and 4,536 kg (10,000 lb) rear. A vehicle weight/payload certification sticker was located on the interior surface of the forward-most exterior compartment door, placarded by the manufacturer Medtec ambulance module. It declared that the curb weight of the overall vehicle after the secondary manufacturing was 6,549 kg (14,440 lb). The curb weight at the axle locations was 2,857 kg (6,300 lb) front and 3,692 kg (8,140 lb) rear. According to the vehicle's placard, the calculated actual payload of the completed vehicle was 1,614 kg (3,560 lb). Based on experience and knowledge of EMS equipment and typical ambulance configuration, the estimated combined weight of the equipment and supplies on-board the ambulance at the time of the crash was a minimum 431 kg (725 lb). Based on those calculations, the vehicle's placard, and average weight of occupants the ambulance was not operating in excess of its available payload capacity at the time of the crash. At the ambulance's date of manufacture, the minimum available payload allowed by the KKK-A-1822F specifications was 816 kg (1,800 lb).

The vehicle manufacturer's recommended tire size was 245/70R19.5 with a recommended cold tire pressure of 758 kPa (110 PSI) for the front and rear tires. At the time of the SCI inspection, the vehicle was equipped with Bridgestone R238 tires of the manufacturer's recommended size on the front-axle positions and Continental HDR tires of the manufacturer's recommended size on the rear-axle positions. Specific tire data at the time of the SCI inspection were as follows:

Position	Tire Identification Number	Measured Tread Depth	Restriction	Damage
LF	Y7RX 37H 1917	8 mm (10/32 in)	No	None
LR inner	Unknown	Unknown	No	None
LR outer	A393 1YW 3219	12 mm (15/32 in)	No	None
RR outer	Unknown	9 mm (12/32 in)	No	None
RR inner	Unknown	Unknown	No	None
RF	Y7RX 37H 1917	8 mm (10/32 in)	No	None

Exterior Damage

The direct damage for the Event 1 (Jeep) impact began at the left rear bumper corner and extended to the right 12 cm (4.7 in) (Figure 6) and wrapped onto the left plane with deformation at the sill level. The WinSMASH program could not be used to determine delta V since the vehicle was out of the scope for the program. The truck deformation classification (TDC) assigned to this impact was 06DLLN1.

The direct damage for the Event 2 (guardrail end terminal) impact measured 59 cm (23.2 in) and was located just above the right axle position (Figure 7). A crush profile was not obtained due to the vehicle being out of the scope of the program as it is an altered heavy-duty truck. The TDC assigned to this right plane impact was 04RBEWB.

The direct damage for the Event 3 (cable barrier) impact extended across the entire frontal plane. The direct damage consisted of full width abrasions to the steel bumper with overlapping crush at the right corner from the subsequent rollover event (Figure 8). The WinSMASH program could not be used to determine delta V since this vehicle was out of the scope for the program. The TDC assigned to this frontal plane impact was 01FDEW1.

Figure 6. Left-rear oblique view of the 2012 Freightliner depicting the Event 1 damage

Figure 7. Right-plane view of the 2012 Freightliner depicting the damage sustained from Event 2 and Event 4

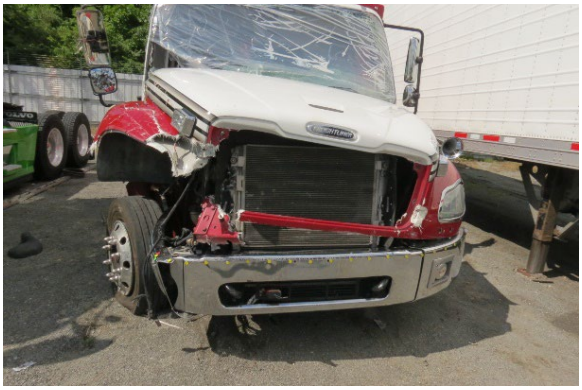


Figure 8. Front-plane view of the 2012 Freightliner depicting the Event 3 damage

The damage resulting from Event 4 (rollover) extended across the entire right plane of the vehicle and was evidenced by surface scratching, broken emergency lights, and a displaced framing of the patient compartment. The TDC assigned to this rollover event was 00RDAOA.

Interior Damage

The interior of the Freightliner cab sustained minor damage during the crash. There were no intrusions observed; however, the windshield glazing was cracked during impact but remained in place. Post-crash, the windshield glazing was removed to allow the driver to exit the cab.

Occupant contacts were identified on the roof above the driver's seating position and the storage compartment above the driver's sun visor. Additionally, a speaker mounted to the front-center left aspect of the windshield header had separated from its mount (Figure 9). The driver struck the right upper A-pillar and the right door quarter window and frame with his head. The quarter window was disintegrated, and the frame was deformed. There was blood spatter on the front right aspect of the roof with blood on the pillar from where the driver likely came to final rest.

Figure 9. View of the 2012 Freightliner cab interior depicting the broken speaker

Minimal damage was sustained by the interior of the patient compartment during the crash. Due to the lateral forces associated with the rollover, all cabinetry sliding doors on the left were displaced. Additionally, a medical monitor mounted on the left side center counter broke away from its mount and may have contacted one of the occupants.

Slight deformation of the patient compartment module occurred during the rollover. This deformation resulted in the patient compartment module shifting to the left approximately 36 cm (14.2 in) (Figure 10). This shifting also resulted in the rear patient compartment doors becoming jammed. As reported by the ambulance agency, the doors were forced open by passersby.

Figure 10. Leftward shifting of the patient compartment

Multiple contacts were found in the patient compartment that could be attributed to the unbelted paramedic. These included contacts to the center of the roof above the patient cot system, rear wall above the right rear door, right bench rear wall (Figure 11), and right wall above the right patient compartment module window.

Manual Restraint Systems

The cab of the Freightliner chassis was equipped with a 3-point lap and shoulder seat belt system for both seating positions that consisted of continuous loop webbing, sliding latch plates, and fixed upper anchors. The driver's seat belt retracted onto an emergency locking retractor (ELR), while the front right passenger's seat belt retracted onto an ELR/automatic locking retractor (ALR). At the time of the SCI inspection, the driver's seat belt system was intact, operational, and exhibited evidence of historical use (Figure 12). The driver's seat belt was loosely retracted against its respective B-pillar, and there was no evidence of load marks to the webbing, D-ring, or latch plate hardware.

Figure 11. View of the right bench rear wall of the patient compartment where the paramedic contacted with his back

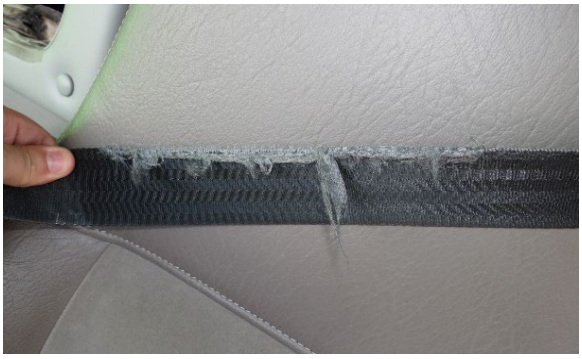


Figure 12. The 2012 Freightliner driver's seat belt evidence of historical use

The patient compartment was equipped with manual seat belt systems at all four seating positions. All manual restraint systems in the patient compartment used continuous loop webbing. The lap belts for the bench seat retracted onto ELRs mounted to the patient compartment wall, and the rear-facing seat was equipped with an integrated 3-point lap and shoulder seat belt. None of these seat belts were in use at the time of the crash.

Patient Cot System

The patient cot system was a Power Pro-XT Ambulance Cot (Figure 13) manufactured by Stryker,[1] serial number 1812003xxxxxx, and was manufactured in December 2018. It was constructed with a tubular aluminum frame with circumferential weld joints and steel hardware fasteners. The X-frame supporting the mattress featured power lift capabilities and had a height range of 36 cm (14.2 in) to 105 cm (41.3 in).

Figure 13. Stryker Power Pro-XT patient cot system that was used during the incident

The backrest could be adjusted via a manually controlled gas-pressure cylinder from 0 to 73 degrees. Similarly, the leg portion could be adjusted from 0 to 15 degrees from horizontal. Overall dimensions of the cot were 58 cm (22.8 in) wide and 206 cm (81.1 in) long. Manufacturer specifications indicated that the cot weighed a total of 57 kg (125 lb) with a maximum weight capacity of 318 kg (700 lb).

The Stryker cot was equipped with a multi-point harness system for manual restraint of its occupant (patient). This multi-point harness system included a lateral leg strap, lateral lap strap, and shoulder/chest harness, in which a pair of shoulder straps buckled into a lateral chest strap. The harness webbing was continuous loop, and all straps included locking latch plates for length adjustment. The ambulance agency has a policy requiring that the patient be securely restrained by all straps when on the cot system. The ambulance agency and police crash report both stated that the patient remained secured to the cot system during the crash sequence and that passersby cut the webbing straps and assisted the patient out of the compartment.

Cot Fastening System

The Stryker cot was secured in place and positioned in the floor of the patient compartment via a Stryker Power-LOAD system (Figure 14). The fastening system consisted of two components, including the bracket/assembly that attached to the cot and a continuous bracket that mounted to the floor of the patient compartment. The continuous bracket that mounted to the patient compartment floor measured 241 cm (95 in) long and was 62 cm (24.5 in) wide. Manufacturer specifications indicated that the complete system weighed a total of 96.5 kg (211.5 lb). The cot was secured to the fastening system with two latches at the head and one at the foot. The floor-mounted bracket guided the cot into and out of the patient compartment of the ambulance. This

[1] Stryker Corporation, Kalamazoo, MI.

latching system secured the cot longitudinally to the floor and restricted the multi-directional movement of the cot during vehicle operation.

Figure 14. Image of an exemplar patient cot secured to the Stryker Power-LOAD cot fastening system

Cot and Fastener System Damage

There was minimal damage to the patient cot system as a result of the crash. Damage to the patient cot system was evident on a plate located under the padding (Figure 15). This damage was determined, as per an interview with the ambulance agency, to be from a belt strap that was routed through the lower left hole in the plate.

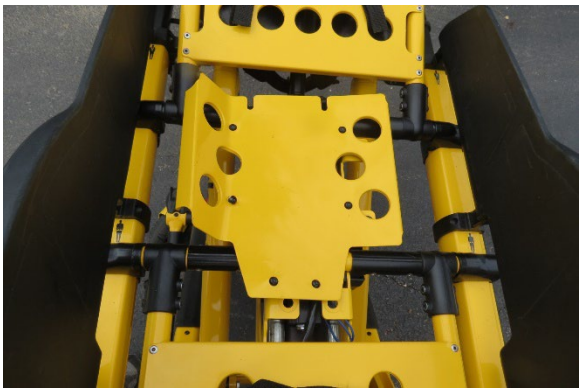


Figure 15. Image of the damaged plate on the patient cot

The floor-mounted Power-LOAD system had no evidence of damage to it as a result of this crash. There was no discernable structural damage to the brackets or attachment points of the fastener system as a result of the crash.

2012 Freightliner M2 Occupants

Driver Demographics

Age/sex:	61 years/male
Height:	180 cm (71 in)
Weight:	83 kg (183 lb)
Eyewear:	Unknown
Seat type:	Bucket seat with integrated head restraint
Seat track position:	Rearmost
Manual restraint usage:	None
Usage source:	Vehicle inspection
Air bags:	Not equipped
Alcohol/drug data:	None
Egress from vehicle:	Exited with assistance
Transport from scene:	Ambulance to a Level II trauma center
Type of medical treatment:	Hospitalized for 5 days; transferred to rehab

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	L1 burst fracture, unstable, extension into canal	650636.3	Isolated IPC Roof – Roof or convertible top	Possible
2	L1 transverse process fractures bilaterally; vertical fracture extending through spinous process of L1	650617.2	Isolated IPC Roof – Roof or convertible top	Possible
3	Major scalp laceration – greater than 10 cm, midline from crown to occiput with staples	110604.2	Isolated IPC Right side – Right side window frame	Certain
4	Scalp laceration, left parietal, unknown length, requiring staples	110600.1	Isolated Right side – Right A-pillar	Probable
5	Right clavicle fracture, medial aspect	750621.2	Isolated Roof – Roof or convertible top	Possible
6	Closed head injury, NFS	100099.9	Isolated IPC Right side – Right A-pillar	Probable
7	Scalp contusion, top of head	110402.1	Isolated Right side – Right side window frame	Probable
8	Scalp abrasions, top of head	110202.1	Isolated Right side – Right side window frame	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
9	Several small areas of ecchymosis on face	210402.1	Isolated Right side – Right A-pillar	Probable
10	Several small areas of abrasions on face	210202.1	Isolated Right side – Right side window glass	Possible

Source: hospital records.

Driver Kinematics

The driver was seated in a rear track position and was not restrained by the available 3-point lap and shoulder seat belt system. At impact with the Jeep (Event 1), the driver initiated a rearward trajectory in response to the rear impact. He then was displaced to his right as the ambulance rotated counterclockwise and struck the end terminal of the W-beam guardrail and the cable guardrail systems (Events 2 and 3). These events probably displaced him from his seat as he began to travel across the interior of the Freightliner. At this time, the ambulance began to roll in a right-side leading event (Event 4). The right plane struck the ground as the vehicle slid to final rest. In response to the rollover, the driver's left scalp area struck the right upper A-pillar, and the midline of his scalp struck the right door quarter window and window frame. The glazing was disintegrated, and the window frame deformed. As a result of these contacts, the driver sustained sutured lacerations of the scalp with an underlying closed head injury and soft tissue injuries of the face and scalp. As his head contacted the pillar area, his torso probably rotated upward with respect to the cab. His right shoulder area struck the roof, causing a clavicle fracture. His lower back probably struck the roof, causing a burst fracture of L1 with transverse process fractures. The driver came to rest inside the cab on the right side against the door and roof areas. Passersby cut the windshield to assist the driver from the vehicle. He was transported by ambulance to a hospital, where he was admitted for treatment of his injuries.

Paramedic Demographics

Age/sex:	27 years/male
Height:	178 cm (70 in)
Weight:	84 kg (185 lb)
Eyewear:	Unknown
Seat type:	Right side-mounted bench seat
Seat track position:	Fixed
Manual restraint usage:	None
Usage source:	Vehicle inspection
Air bags:	Not equipped
Alcohol/drug data:	None
Egress from vehicle:	Removed from vehicle due to perceived serious injuries
Transport from scene:	Helicopter to a local Level 1 trauma center
Type of medical treatment:	Hospitalized for 24 days; transferred to rehab

Paramedic Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	T7-T8 fracture dislocation with retropulsion of T7 into cord; complete spinal injury	610428.5	Isolated IPC Right side – Other right side object (specify): Right wall of patient compartment	Probable
2	T8 Chance fracture	650440.3	Isolated IPC Right side – Other right side object (specify): Right wall of patient compartment	Probable
3	Bilateral T8 lamina fractures; right T8 transverse process fracture	650417.2	Isolated IPC Right side – Other right side object (specify): Right wall of patient compartment	Probable
4	Rib fractures with flail: right 6-8 posterior-medially and anterior aspects; posterior-medial fractures of right 3, 4, 5, 9 ribs	450212.3	Isolated IPC Right side – Other right side object (specify): Right wall of patient compartment	Probable
5	Left posterior-medial 1st rib fracture	450201.1	Isolated Right side – Other right side object (specify): Right wall of patient compartment	Probable
6	Right hemopneumothorax	442205.3	Isolated IPC Right side – Other right side object (specify): Right wall of patient compartment	Probable
7	Bilateral lung contusions, NFS	441410.3	Isolated IPC Right side – Other right side object (specify): Right wall of patient compartment	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
8	Large posterior mediastinal hematoma, which abuts the esophagus and descending aorta	442208.2	Isolated IPC Right side – Other right side object (specify): Right wall of patient compartment	Probable
9	Pneumomediastinum	442209.2	Isolated IPC Right side – Other right side object (specify): Right wall of patient compartment	Probable
10	T11 end plate fracture	650432.2	Isolated IPC Right side – Other right side object (specify): Right wall of patient compartment	Probable
11	T2 right transverse process fracture	650420.1	Isolated Right side – Other right side object (specify): Right wall of patient compartment	Probable
12	T9 right transverse process fracture	650420.1	Isolated Right side – Other right side object (specify): Right wall of patient compartment	Probable
13	Comminuted mid to distal right clavicle fracture	750671.2	Isolated Right side – Other right side object (specify): Right wall of patient compartment	Probable
14	Displacement of right acromioclavicular joint	770730.2	Isolated IPC Right side – Other right side object (specify): Right wall of patient compartment	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
15	Left 2nd metacarpal fracture at base	752521.2	Unknown	Unknown
16	Left 4th metacarpal fracture at base	752521.2	Unknown	Unknown
17	2 cm head laceration, occipital, left of midline	110602.1	Isolated Right side – Other right side object (specify): Right wall of patient compartment	Probable
18	Small scalp hematoma, occipital	110402.1	Isolated Right side – Other right side object (specify): Right wall of patient compartment	Probable
19	2 cm facial laceration above left eye	210602.1	Unknown	Unknown
20	Ecchymosis to right eyelid	210402.1	Unknown	Unknown
21	Hematoma to right upper chest adjacent to clavicle fracture	410402.1	Isolated Right side – Other right side object (specify): Right wall of patient compartment	Probable
22	Large hematoma adjacent to T8 fracture	410402.1	Isolated Right side – Other right side object (specify): Right wall of patient compartment	Probable
23	Back abrasions	410202.1	Isolated Right side – Other right side object (specify): Right wall of patient compartment	Probable
24	Ecchymosis on right shoulder	710402.1	Isolated Right side – Other right side object (specify): Right wall	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
(Cont.)			of patient compartment	
25	Ecchymosis over right clavicle	710402.1	Isolated Right side – Other right side object (specify): Right wall of patient compartment	Probable
26	Right hip ecchymosis	810402.1	Isolated Right side – Other right side object (specify): Right wall of patient compartment	Probable
27	Left hip ecchymosis	810402.1	Isolated Right side – Other right side object (specify): Right wall of patient compartment	Probable
28	Right knee ecchymosis	810402.1	Isolated Interior – Other interior object(s) (specify): Patient cot	Possible

Source: hospital records.

Paramedic Kinematics

The paramedic was seated on the right bench seat, middle position of the patient compartment, attending to the patient. Although lap belts were available for this position, the paramedic was not belted. At impact with the Jeep, the paramedic was displaced rearward as he responded to the crash forces. This impact caused a counterclockwise rotation to the ambulance as it traversed the travel lanes and departed the left roadside. This rotation probably redirected the paramedic back into, or toward the right bench seat. The subsequent impacts with the guardrails (Events 3 and 4) further displaced the paramedic into this seat area. The rollover and right plane contact with the ground caused the paramedic to impact the right wall of the patient with his back area, leading with his right side. As a result, he sustained thoracic vertebral fractures with a complete spinal cord injury, bilateral posterior-medial rib fractures, right hemopneumothorax, bilateral pulmonary contusions, and a large posterior mediastinal hematoma. Additionally, he sustained a right clavicle fracture, displacement of the right acromioclavicular joint, and soft tissue injuries of the back, shoulder, and hip areas. The paramedic sustained left metacarpal fractures and facial soft tissue injuries from unknown specific sources. Occipital scalp injuries probably occurred from the right wall contact.

Post-crash, the paramedic was found lying against the rear loading doors of the patient compartment. He was removed from the ambulance by medical professionals and transported to a regional trauma center for admission and treatment of his injuries.

Patient Demographics

Age/Sex:	48 years/male
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat type:	Semi-fowler on the patient cot system
Seat track position:	Fixed in cot containment system
Manual restraint usage:	Multi-point harness system
Usage source:	Vehicle inspection
Air bags:	Not equipped
Alcohol/drug data:	Undetermined
Egress from vehicle:	Exited with assistance
Transport from scene:	Ambulance to a Level II trauma center
Type of medical treatment:	Treatment unknown

Patient Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Unknown	Unknown	Unknown	Unknown

Source: hospital records requested but not received.

Patient Kinematics

Prior to the crash, the patient was involved in a medical incident, and the two-member ambulance team provided EMS care. This resulted in the immobilization of the male in a supine position, secured to the cot system with the multi-point harness system. Due to the patient's immobilization and restraint status, he remained in the supine position on the cot system throughout the entire crash sequence. On-scene passersby cut the straps of the cot system to assist in removing the patient from the cot system and ambulance as other emergency personnel arrived on scene. He was transported to a local hospital by another ambulance. Although his medical records were requested several times, the records have not been received at the time of this report.

1999 Jeep Cherokee

Description

The 1999 Jeep Grand Cherokee (Figure 16) was a 4-door SUV identified by the VIN 1J4GW68N3XCxxxxxx. It was powered by a 4.7-liter, 8-cylinder gasoline engine. The Jeep had a 269 cm (105.9 in) wheelbase and a reported curb weight of 1,800 kg (3,968 lb). It had seating for five passengers and had 3-point manual lap and shoulder seat belts for all seating positions. The Jeep also had frontal air bags that did not deploy in this crash.

Figure 16. Front-left oblique view of the 1999 Jeep Grand Cherokee

Exterior Damage

The damage attributed to Event 1 (Figure 17) of the crash was located on the right aspect of the front bumper. The direct damage began at the right front bumper corner and extended 57 cm (22.4 in) to the left. The direct damage wrapped around the corner and extended 36 cm (14.2 in) along the right plane. The right fender was crushed and displaced rearward. The right wheelbase was shortened 4 cm (1.6 in). The CDC assigned to this damage pattern was 12FZEW2. An analysis of this corner impact for the crash severity was beyond the scope of the WinSMASH program due to overlapping damage. However, the WinSMASH program was able to produce a barrier equivalent speed (BES) of 15 km/h (9 mph).

Figure 17. Front-plane view of the Event 1 and Event 6 damage sustained by the Jeep

Figure 18. Rear-plane view of the Event 5 damage sustained by the Jeep

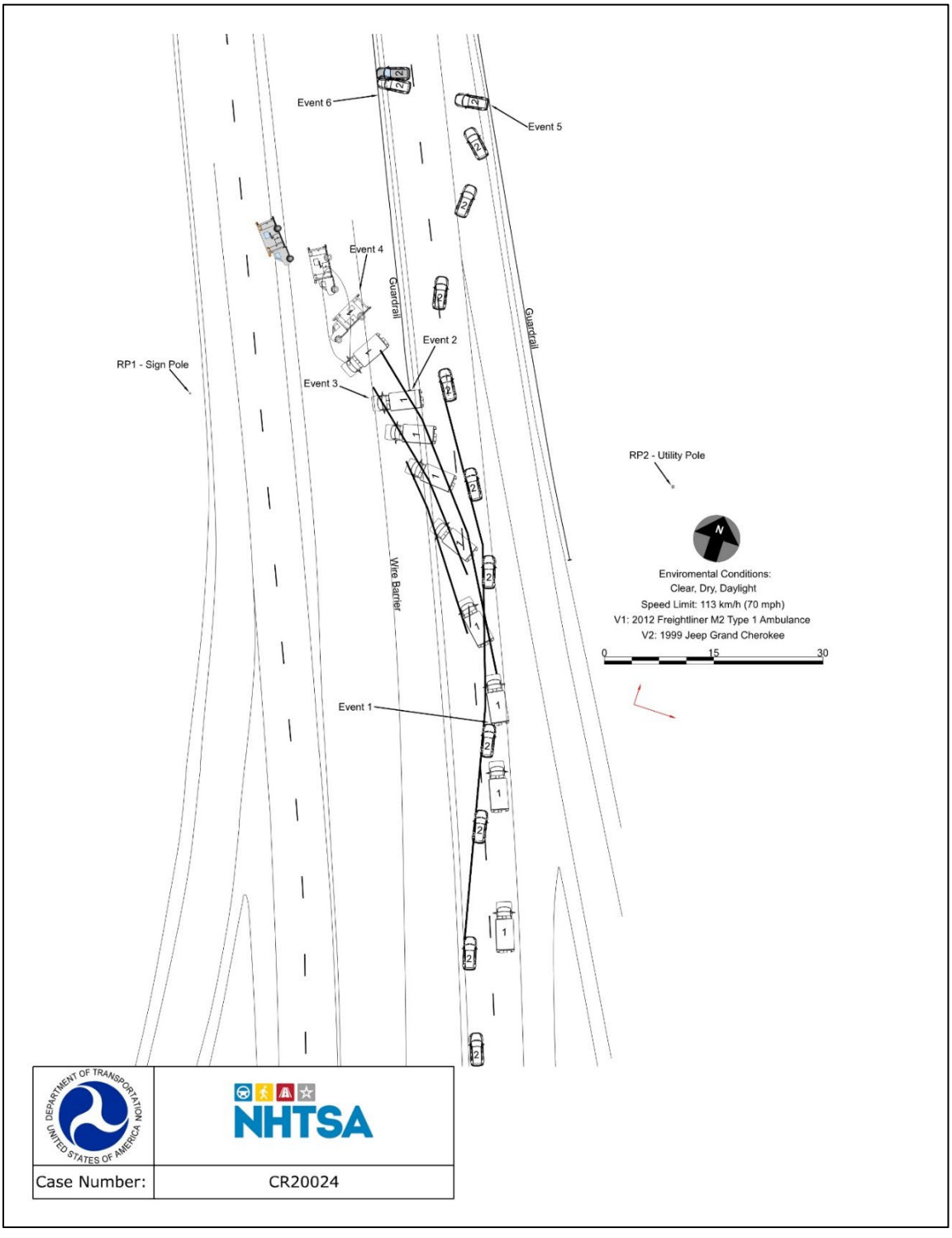
Damage attributed to Event 5 (Figure 18) of the crash was located on the rear plane. The direct damage began at the left rear bumper corner and extended 153 cm (60.2 in) to the right rear bumper corner. The CDC assigned to this damage pattern was 04BDEW1. An analysis of this rear impact for the crash severity was beyond the scope of the WinSMASH program due to no residual crush. However, the WinSMASH program was able to produce a BES of 6 km/h (3 mph).

Damage attributed to Event 6 (Figure 17) of the crash was located on the front plane. The direct damage extended across the entire front bumper measuring 153 cm (60.2 in). The CDC assigned to this damage pattern was 12FDEW1. The WinSMASH program could not be used to determine delta V since this damage was overlapping to prior damage from the crash sequence.

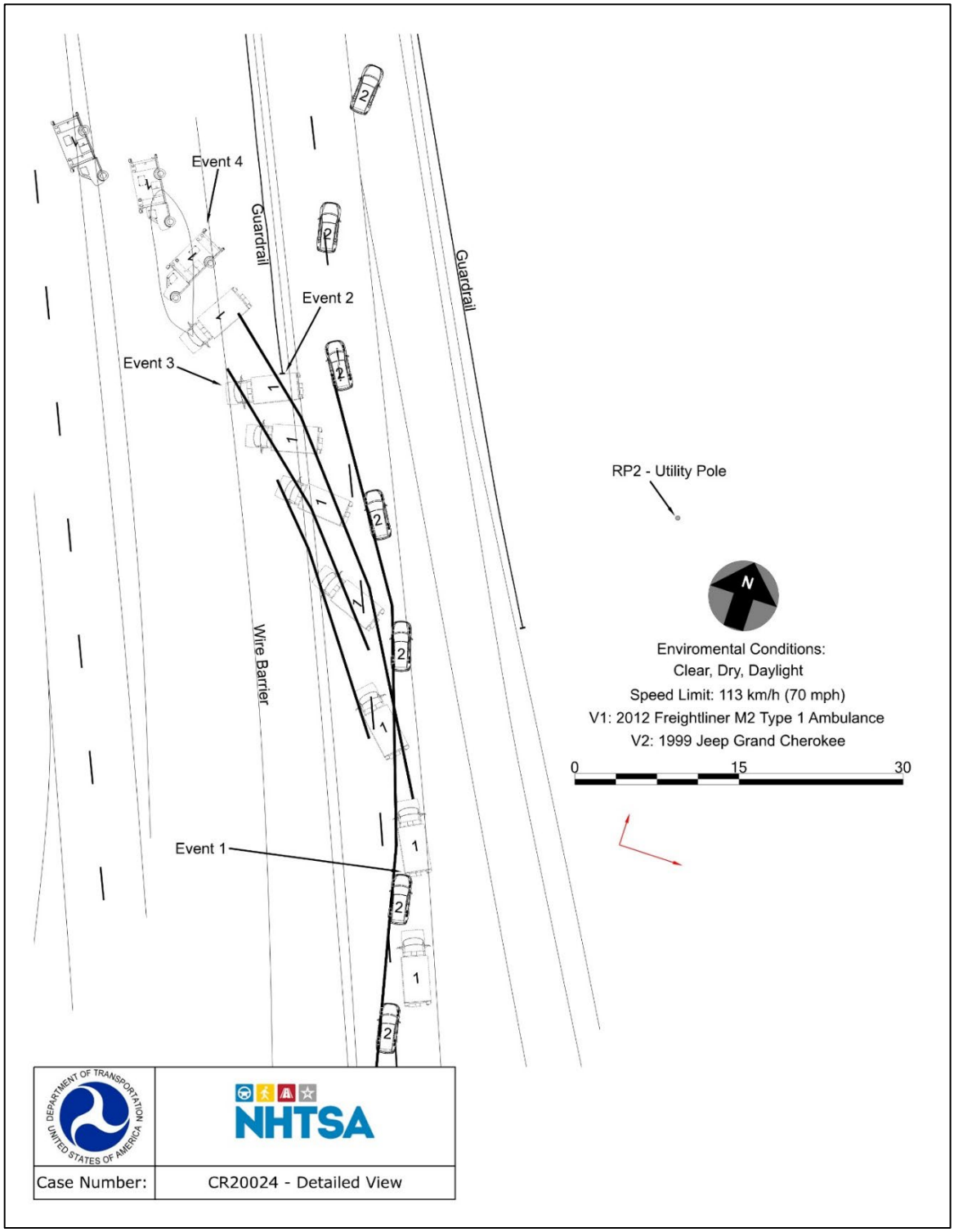
Occupant Data

The Jeep was occupied by a 60-year-old female driver reported by the police to be unbelted. There was no deployment of air bags in the Jeep during the crash sequence. The driver sustained police reported non-incapacitating (B-level) injuries and was transported to a local hospital for treatment. Law enforcement requested a toxicology screening on the driver, which returned a positive result for alcohol.

Crash Diagram



Crash Diagram (A Detailed View)



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