On-Site Ambulance Crash Investigation
SCI Case Number DS14016
Vehicle: 2013 Leader Type II Mercedes-Benz Sprinter Ambulance
Location: California
Crash Date: April 2014

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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 be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

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

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The focus of this investigation is the vehicle-to-vehicle impact with the subsequent rollover of a 2013 Leader Type II Mercedes-Benz Sprinter ambulance.

16. Abstract

The focus of this investigation is the vehicle-to-vehicle impact with the subsequent rollover of a 2013 Leader Type II Mercedes-Benz Sprinter ambulance. This two-vehicle crash occurred in April 2014 in the State of California. The crash site was within the intersection of a north/south roadway and an east/west roadway. The intersection was controlled by three-phase traffic signals. The Mercedes chassis was configured with a forward cab and rear patient compartment equipped for the treatment of medical emergencies in a mobile environment. The ambulance was traveling eastbound with no emergency lights or siren activated. The three occupants in the ambulance included the driver, an EMT, and a patient. The ambulance was being driven by a restrained 20-year-old male. One unrestrained EMT, a 20-year-old male, was assisting a patient in the back of the ambulance. The patient was a 51-year-old female who was being transported under legal custody as a psychiatric patient. She was strapped to the ambulance cot. Additionally, she was held in place with soft restraints to her extremities. The other vehicle was a 2005 Lincoln Town Car. According to the police account, the Lincoln entered the intersection in the path of the ambulance. The crash occurred when the front of the ambulance impacted the right side of the Lincoln and the ambulance subsequently overturned. All four occupants from both vehicles were transported to local hospitals for treatment. The ambulance was declared a total loss by the insurance company and then bought back by the ambulance company. The Lincoln was towed from the scene due to damage.

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BACKGROUND

The focus of this investigation is the vehicle-to-vehicle impact with subsequent rollover of a 2013 Leader Type II Mercedes-Benz Sprinter ambulance (**Figure 1**). All three occupants of the ambulance were injured. The crash was identified by a Dynamic Science, Inc. crash investigator from a news report. Notification was forwarded to the Special Crash Investigations (SCI) group of the National Highway Traffic Safety Administration (NHTSA) on April 21, 2014. NHTSA's Office of Emergency Medical Services (OEMS) was contacted and the team was instructed to pursue this case on April 22, 2014. The SCI team contacted the investigating police agency and obtained the police report. Cooperation to inspect the vehicle was obtained and the inspection took place on June 6, 2014. The vehicle is not supported by the Bosch Crash Data Retrieval tool, but SCI did obtain a copy of the ZOLL Road Safety data report for this event. This is discussed later in this report.

Figure 1. 2013 Mercedes-Benz Sprinter ambulance

This two-vehicle crash occurred in April 2014 in the State of California. The crash site was within the intersection of a north/south roadway and an east/west roadway. The intersection was controlled by three-phase traffic signals. The Mercedes chassis was configured with a forward cab and rear patient compartment equipped for the treatment of medical emergencies in a mobile environment. The ambulance was traveling eastbound with no emergency lights or siren activated. The three occupants in the ambulance included the driver, an EMT, and a patient. The ambulance was being driven by a restrained 20-year-old male. One unrestrained EMT, a 20-year-old male, was assisting a patient in the back of the ambulance. The patient was a 51-year-old female who was being transported under legal custody as a psychiatric patient. She was strapped to the ambulance cot. Additionally, she was held in place with soft restraints to her extremities. The other vehicle was a 2005 Lincoln Town Car. The Lincoln entered the intersection in the path of the ambulance. The crash occurred when the front of the ambulance impacted the right side of the Lincoln and the ambulance subsequently overturned.

All four occupants from both vehicles were transported to local hospitals for treatment. The ambulance was declared a total loss by the insurance company and then bought back by the ambulance company. The Lincoln was towed from the scene due to damage. On-scene photos were obtained to conduct a partial inspection of the Lincoln.

SUMMARY

Crash Site

The crash site was within the intersection of a north/south local road and an east/west local road. The eastbound leg of the intersection consisted of two eastbound through lanes, a marked left turn lane, and two westbound through lanes (**Figure 2**). The asphalt roadway was straight with a positive 2 percent grade. The speed limit was 72 km/h (45 mph). The southbound leg consisted of a marked right turn lane, a southbound through lane, a marked left turn lane, and two northbound through lanes **(Figure 3**). The asphalt roadway was straight with a positive 3percent grade. The speed limit was 64 km/h (40 mph). It was dark at the time of the crash with spot illumination by streetlights. The weather at the nearest reporting station was 16° C (60° F), humidity 82 percent, visibility 10 km (6 miles), and the winds were calm. A Crash Diagram is included at the end of this technical report on page 12.

Figure 2. Eastbound approach, 2013 Mercedes-Benz Sprinter ambulance

Figure 3. Southbound approach, 2005 Lincoln Town Car

Pre-Crash

The Mercedes ambulance was traveling eastbound with no emergency lights or siren activated at approximately 72 km/h (45 mph). The ambulance organization is a private company that provides 24 hour/7 days a week service to both emergency and non-emergency calls as contracted to private and government agencies. The service is Commission on Accreditation Services (CASS) accredited. The ambulance was transporting a psychiatric patient from one facility to another. The driver and rear compartment care giver were both certified as EMTs and were full-time employees. They both had completed a 40 hour EVOC first responder vehicle course using the National Safety Council guidelines/curriculum. They began a 24-hour shift at 1900 hours on the previous day and had been on duty for approximately 9-1/2 hours. Their last shift was completed three days earlier. The Lincoln was traveling southbound at an unknown speed. The traffic signal phase was green for the ambulance and red for the Lincoln. Prior to impact, the driver of the ambulance braked and steered to the right in an attempt to avoid the collision.

Crash

As the Lincoln entered the intersection in the path of the ambulance was impacted on the right side by the front of the ambulance (Event 1). The Missing Vehicle algorithm of the WinSMASH program calculated a Total Delta-V of 14 km/h (9 mph) for the ambulance. The longitudinal and lateral velocity changes were -11 km/h (-7 mph) and 9 km/h (6 mph), respectively. The program calculated a Total Delta-V of 24 km/h (15 mph) for the Lincoln. The longitudinal and lateral velocity changes were -12 km/h (-7 mph) and -21 km/h (-13mph), respectively. The Lincoln was

displaced to the south and rotated in a clockwise direction before coming to rest facing west in the south leg of the intersection. The ambulance rotated clockwise, tripped, and rolled one quarter-turn onto its left side (Event 2). The vehicle continued rotating on its left side until coming to rest facing north in the right turn lane in the south leg of the intersection (**Figure 4**).

Post-Crash

The police-reported injury levels for all occupants are described as follows. The driver of the ambulance sustained "B" (Other visible) type injuries and was transported to a local hospital where he was treated and released. The rear compartment EMT sustained "A" (Severe) type injuries and was transported to a local hospital where he was admitted and hospitalized. The patient sustained "C" (Complaint of pain) type injuries and was transported to local hospital for examination. The driver of the Lincoln sustained "B" (Other visible) type injuries and was transported to a local hospital where she was treated and released. Both vehicles were towed due to damage. The ambulance was declared a total loss by the insurance company. It was salvaged and then bought back by the ambulance company. The Lincoln was towed from the scene due to damage.

Figure 4. 2013 Mercedes-Benz Sprinter ambulance, looking south (on scene photo)

2013 LEADER TYPE II LI MERCEDES-BENZ SPRINTER AMBULANCE

Description

The ambulance was a 2013 Mercedes-Benz Sprinter 2500 van type chassis manufactured in November 2012 and identified by the Vehicle Identification Number (VIN): WD3PE7CC4D5xxxxxx. The vehicle mileage is unknown. The chassis was completed during secondary manufacturing by Leader Industries as a Type II ambulance. The placard identifying the date of secondary manufacture was located on the interior B-pillar but it could not be accessed due to the jammed left front door. The chassis was a rear-wheel drive platform powered by a Mercedes-Benz OM642 3.0-liter 6-cylinder diesel engine linked to an automatic transmission.

Secondary manufacturing of the vehicle consisted of installation of the patient compartment module and installation of emergency services operational equipment (warning lights, sirens, and radio communications). Completed as a Type II certified ambulance, the vehicle was configured with a forward cab and rear patient compartment equipped for the treatment of medical emergencies in a mobile environment (**Figure 5**).

Figure 5. Exemplar patient compartment, 2013 Mercedes-Benz Sprinter ambulance

The Mercedes' cab was configured for the seating of two occupants, with forward-facing box-

mounted seats that featured manual seat track and seat back recline adjustments integrated into the seat backs. Three-point lap and shoulder safety belts were available for manual restraint and adjustable head restraints. The cab's seats were divided by a center console that integrated communications equipment and an array of switches related to the ambulance's emergency response and operational activities. Within the patient compartment module was seating for up to three crew members as well as the patient. This included a high back attendant seat at the forward plane facing rearward, a two-passenger bench seat on the right plane, and a centrally located single occupant cot. The attendant seat was configured with a lap and shoulder belt. The squad bench was configured with lap belts. Two additional female seat belt buckles were bolted to the side of the bench seat for use to restrain a back board or a spine board on the bench to act as a secondary litter. A cargo safety net was located at the head end of the squad bench.

The patient compartment had interior dimensions of 275.0 cm (108.2 in) in length, 172.0 cm (67.7 in) in width, and 195.0 cm (76.7 in) in height. There was a single step at the rear of the ambulance. Double-wide rear doors (122.0 cm/48.0 in) served for the loading and unloading of the cot, as well as entry for the crew. There was also a sliding occupant access door at the forward aspect of the right side.

Vehicle Weight, Payload, and Tire Data

The Mercedes chassis was placarded with a Gross Vehicle Weight Rating (GVWR) of 3,878 kg (8,550 lbs). This was distributed as Gross Axle Weight Ratings (GAWR) of 1,801 kg (3,970lbs) front and 2,431 kg (5,360lbs) rear. The Gross Cargo Weight Rating (GCWR) was 6,146 kg (13,550 lbs). A tire and loading placard from an exemplar vehicle indicated the combined weight of occupants and cargo should never exceed 821 kg (1,810 lbs).

The vehicle manufacturer's recommended tire size was LT245/75R16 with recommended cold tire pressures of 320 kPa (46 psi) front and 480 kPa (70 psi) rear. At the time of the SCI inspection, the vehicle was equipped with BF Goodrich T/A tires of the recommended size on the front and Continental Vanco Four Seasons tires of the recommended size on the rear. Specific tire data was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Tire Flat	11 mm (14/32 in)	No	Sidewall cut
LR	448 kPa (65 psi)	5 mm (6/32 in)	No	None
RR	421 kPa (61 psi)	5 mm (6/32 in)	No	None
RF	386 kPa (56 psi)	10 mm (13/32 in)	No	None

ZOLL Road Safety System

The ambulance was equipped with a ZOLL Road Safety System. The system is an on-board hardware/software package that continually detects and proactively corrects unsafe driving behaviors, including aggressive cornering, hard braking, excessive acceleration, and speeding. Data is automatically uploaded from the ambulance to the system base. The system administrator sets

parameters that should not be exceeded. As a driver approaches known parameters, the system will sound an alert. If the driver exceeds a parameter for a set time, a notification is sent to the system administrator. The system settings and driver performance reports are accessible via PCs and mobile web-based devices. The system was operating at the time of the crash and SCI obtained a copy of a system report. The following data is estimated from trace data in one and five second increments.

Time	Data Variable	Value
3:35:00	Vehicle Speed	72 km/h (45 mph)
3:35:00	Engine RPM	1300
3:35:01	Ignition	On
3:35:01	Brake	On
3:35:01	Seatbelt	On
3:35:01	Brake Safe Force	75%
3:35:03	G Force	0.85 g, deceleration
3:35:06	G Force	>1.00 g, right turn

Exterior Damage

Damage to the exterior of the ambulance from the multiple event crash was present on the frontal and left planes.

The ambulance sustained moderate damage to the front plane during the impact with the Lincoln (Event 1). The direct damage began at the left bumper corner and extended 76.0 cm (29.9 in) laterally to the right (**Figure 6)**. The Field L extended from bumper corner to bumper corner and measured 144.0 cm (56.6 in) Six crush measurements were taken at the bumper backing bar level as follows: C_1 = 5.0 cm (1.9 in), C_2 = 2.0 cm (0.8 in), C_3 = 3.0 cm (1.2 in), C_4 = 1.0 cm (0.4 in), C_5 = 0 cm, C_6 = 4.0 cm (1.6 in). The maximum crush was located at C_1. The backing bar/frame rails were shifted 20.0 cm (7.9 in) to the right. The Collision Deformation Classification (CDC) was 71FYEW1.

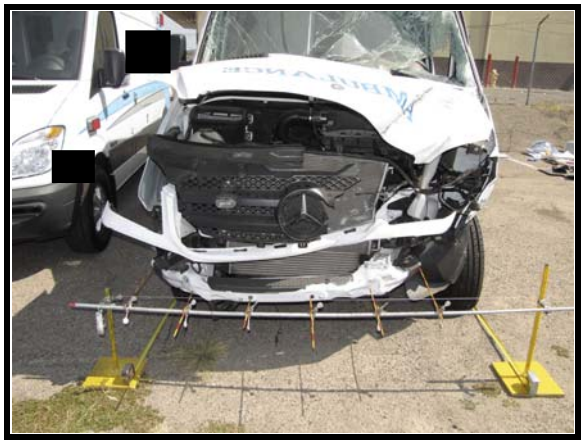

Figure 6. 2013 Mercedes-Benz Sprinter ambulance, frontal damage

The ambulance sustained minor damage to the left plane during the one-quarter rollover (Event 1). The direct damage began at the rear of the patient compartment and extended 258.0 cm (101.5 in)

forward (**Figure 7**). The vertical damage extended from the sill to the roof. The maximum crush was located 13.0 cm (5.1 in) below the roof line and 46.0 cm (18.1 in) forward of the rear of vehicle and measured 8.0 cm (3.1in). The CDC was 00LDAO2.

Figure 7. 2013 Mercedes-Benz Sprint ambulance, left side damage

Interior Damage

The inspection of the interior cab of the vehicle revealed minor damage from occupant contacts and intrusion. There was a minor contact to the driver's door hardware. There was left side intrusion to the forward lower quadrant (1.0 cm [0.4 in]), upper A-pillar (3.0 cm [1.2 in]), and roof rail/upper window frame (3.0 cm [1.2 in]). There was no deformation of the steering wheel rim or compression of the column. There were no deformations to any of the seats. The driver's door was jammed shut. All the other doors remained closed and operational. The windshield was cracked and had sagged due to heat. The left front glazing disintegrated from impact forces.

The interior of the cab and patient compartment had been stripped prior to the SCI inspection. Several interior images were obtained from the ambulance company by SCI. There was a large area of blood located at the aft end of the upper cabinetry along the left side (**Figure 8**).

Figure 8. Interior, 2013 Mercedes-Benz Sprinter (ambulance company photo)

Manual Restraint Systems

The cab of the Mercedes chassis was equipped with manual restraint systems for both seating positions. Each was a 3-point lap and shoulder belt system that consisted of continuous loop webbing with sliding latch plates and with shoulder anchorages adjusted to the full-down position. At the time of the inspection, the safety belts had been cut and partially removed to extract and salvage the seats. The ZOLL system indicated that the driver was restrained. The squad bench lap belts were not used in the crash. A safety net was located at the head end of the squad bench. An examination of the net did not reveal any contacts or damage.

Supplemental Restraint Systems

The ambulance was equipped with frontal air bags for supplemental restraint. Neither air bag deployed during the crash.

Rollover Mitigation

The NHTSA has given the 2012 version of this vehicle model a one star rating on a five star scale.[1] This rating indicates that the vehicle had a Static Stability Factor (SSF) between 0.95 and 1.02, and a greater than 50 percent chance of rollover. The Mercedes' mitigation features consisted of electronic stability control and ABS brakes. The control loss in this crash was the result of impact forces associated with the impact with the Lincoln, which induced a rapid clockwise rotation. After the vehicle rotated approximately 90 degrees, the vehicle tripped on the roadway surface, left side leading. The vehicle rolled one quarter-turn and came to rest on its left side.

Patient Cot

The patient cot was a Rugged MX-PRO Ambulance Cot that was manufactured by Stryker. The cot involved in the crash was undamaged and placed back into service. The ambulance company was unable to locate the involved cot. An exemplar cot was examined (**Figure 9**). The cot was constructed of a tubular aluminum frame with circumferential weld joints and steel hardware fasteners. The X-frame supporting the mattress platform featured manual height adjustment capabilities and the mattress platform featured 0-73 degrees of backrest articulation. Its length was 203 cm (80 in) and the width was 58 cm (23 in). Labeling declared that the load capacity limit of the cot was a maximum of 227 kg (500 lbs). The cot was equipped with two lap belts and one four-point shoulder restraint. The cot was secured in place within the passenger compartment via a 6371 Stryker antler design floor-mount cot fastener system. The system consisted of a forward antler bracket and rearward side mounted locking-clamp mechanism (**Figure 10**). The antler bracket cradled the forward portion (location of the patient's head area) of the cot's frame, while the vertically-oriented locking mechanism clamped around a pin protruding from the cot's lower frame rail. According to interviewees, the cot remained locked in place and the patient remained secured during the crash. There was no reported damage to the cot or the fastening system.

Figure 9. Exemplar Stryker Rugged MX-PRO Ambulance Cot

Figure 10. 6371 Stryker cot fastener system

[1] www.safercar.gov

2013 MERCEDES-BENZ SPRINTER AMBULANCE OCCUPANTS

Driver Demographics

Age/Sex:	20 years/Male
Height:	175 cm (69 in)
Weight:	78 kg (172 lbs)
Eyewear:	None
Seat type:	Box-mounted seat
Seat track position:	Unknown track position
Manual restraint usage:	Lap and shoulder belt
Usage source:	ZOLL report, interview
Air bags:	Driver's air bag available, did not deploy
Alcohol/Drug Data:	None
Egress from vehicle:	Under own power
Transport from scene:	Ground ambulance to a local hospital
Type of medical treatment:	Transported, treated and released

Driver Injuries

Inj. No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Abrasion, right knee	810202.1,1	Lower instrument panel	Certain

Source: Interviewee, police report

Driver Kinematics

The restrained 20-year-old male driver was seated in an upright posture. His right foot was on the brake and he was actively steering to the right. At impact with the Lincoln, the driver was displaced forward and slightly to the left in response to the 11 o'clock direction of force and loaded the safety belt. His right knee contacted the lower instrument panel. As the vehicle began a clockwise rotation, the driver was displaced to the left. The vehicle tripped and began a left-side leading rollover. The driver was displaced to the left and contacted the left door. He remained in his seat immediately after the crash and was able to exit the vehicle under his own power.

Bench Seat Occupant Demographics

Age/Sex:	20 years/Male
Height:	175 cm (69 in)
Weight:	77 kg (170 lbs)
Eyewear:	Unknown
Seat type:	Left facing, bench seat
Seat track position:	Not adjustable
Manual restraint usage:	Lap belt available, not used
Usage source:	Vehicle inspection, police statements
Air bags:	None available
Alcohol/Drug Data:	None
Egress from vehicle:	Removed from vehicle due to moderate injuries
Transport from scene:	Air ambulance to trauma center
Type of medical treatment:	Hospitalized from early morning till later in the evening that same day.

Bench Seat Occupant Injuries

Inj. No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Closed head trauma with brief loss of consciousness	161002.2,0	Side interior surface	Probable
2 3 4	Compression fractures: T4, T5, and T6	650416.2,7 650416.2,7 650416.2,7	Side interior surface	Probable
5	2.0 cm (0.8 in) laceration, right forehead	210602.1,1	Side interior surface	Probable
6	Scalp laceration, left lateral	110600.1,2	Side interior surface	Probable
7	Rib fracture, right, 1st rib	450201.1,1	Side interior surface	Probable
8	Bilateral abrasion, lower extremities	810202.1,3	Ambulance cot	Probable

Source: Discharge summary, Radiology reports, History and Physical reports

Bench Seat Occupant Kinematics

The unrestrained 20-year-old male EMT was seated in the left facing bench seat. He was amnesiac to the crash events and it is unknown if he was actively engaged in assisting with patient care. He did not utilize the available lap belt for manual restraint. At impact with the Lincoln, he was displaced forward and to the left into the safety netting. As the vehicle rotated and rolled onto its left side, this occupant was displaced from his seat. His lower legs likely engaged the cot. He continued to the left and contacted the left inner surface of the patient module with his head and chest. He came to rest lying on the left inner surface (**Figure 11**). He was extricated by EMS personnel, transported to a local hospital, and admitted with a Glasgow Coma Score (GCS) of 15. The GCS is a neurological scale that aims to give a reliable, objective way of recording the conscious state of a person for initial as well as subsequent assessment. A patient is assessed against the criteria of the scale, and the resulting points give a patient score between 3 (indicating deep unconsciousness) and either 14 (original scale) or 15 (the more widely used modified or revised scale). This occupant was hospitalized for approximately 15 hours before being released.

Figure 11. Patient compartment, 2013 Mercedes-Benz Sprinter ambulance (on-scene photo)

Cot Occupant Demographics

Age/Sex:	51 years/Female
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat type:	Immobilized longitudinally in supine position on cot
Seat track position:	N/A
Manual restraint usage:	Restrained by torso and leg cot restraints. Extremities restrained by soft restraints.
Usage source:	Interview
Air bags:	None available
Alcohol/Drug Data:	Unknown
Egress from vehicle:	Removed from vehicle by fire department personnel
Transport from scene:	Ground ambulance to a local hospital
Type of medical treatment:	Unknown

Cot Occupant Injuries

According to the police report, this occupant complained of pain to her chest, abdominal area, and right arm.

Cot Occupant Kinematics

Prior to the crash, the 51-year-old female patient was being transported for psychiatric reasons. She was restrained by the lateral cot restraints across her torso and legs. Soft 4-point restraints were being used to restrain her extremities. Due to her restraint status, she remained in her initial supine

position on the cot throughout the entire crash sequence. The cot remained attached to the cot fastener throughout the crash as designed. After the crash, she was extricated by fire department personnel from the back of the vehicle without the cot. The patient was then transported to a local hospital by ground ambulance.

2005 LINCOLN TOWN CAR

Description

The 2005 Lincoln Town Car was identified on the police report. The vehicle was a four-door, rear-wheel drive sedan. The Lincoln was part of a limousine service fleet. The driver was on her way to pick up a client.

Exterior Damage

The Lincoln sustained moderate damage to the right side (**Figure 12**). The estimated CDC was 02RPAW2. It was towed from the scene due to damage.

Figure 12. 2005 Lincoln Town Car, right side damage (on scene photo)

Occupant Data

The Lincoln was being driven by a restrained 26-year-old female. According to the police report, she reported scratches to her lower legs and pain to her right ribs. She was transported by ground ambulance to a local hospital.

CRASH DIAGRAM