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15. Supplementary Notes

Each crash is 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 an on-site investigation of the single-vehicle crash of a 2014 Ford E-350 Type III ambulance that occurred on the roadside of a five-lane, undivided highway. The ambulance was configured with a Type III patient compartment, and the cab was equipped with driver's and passenger's frontal air bags. The vehicle was occupied by a belted 26-year-old male driver, an unbelted 49-year-old female paramedic, and a 76-year-old male patient who was restrained on a Stryker Model 6082 MX-PRO patient cot. The ambulance crew was conducting a non-emergency transport, and the driver was operating the vehicle without emergency lights and siren activated. The ambulance was traveling in an easterly direction in the left through lane when the driver suffered a diabetic episode and lost consciousness. The ambulance departed the right side of the roadway, and the front plane struck the end terminal of a blocked-out, W-beam steel guardrail. The ambulance continued down an embankment and struck several trees and initiated a fall-over one quarter turn rollover into a ditch bank, where the top surface of the patient compartment struck and gouged the embankment. This engagement initiated an end-over type rollover, where the vehicle completed 180 degrees of rotation about its longitudinal axis without ground contact. The ambulance came to rest on its wheels facing west. The driver sustained police-reported "C" (possible) injuries and was transported by ambulance to a hospital, where he was examined and released with no reported injuries. The paramedic sustained police-reported "A" (incapacitating) injuries and was transported by helicopter to a hospital, where she was hospitalized overnight for treatment of her injuries. The patient sustained police-reported "K" (fatal) injuries and was pronounced deceased at the scene of the crash.

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Table of Contents

Special Crash Investigations
Transportation Research Center
On-Site Ambulance Crash Investigation
Case Number: IN18005
Vehicle: 2014 Ford E-350 Type III Ambulance
Location: Ohio
Crash Date: March 2018

Background

This report documents an on-site investigation of the single-vehicle crash that involved a 2014 Ford E-350 Type III ambulance (Figure 1). This investigation was initiated by the National Highway Traffic Safety Administration in April 2018 through NHTSA's Office of Emergency Medical Services (EMS) and assigned to the Indiana University Transportation Research Center. The crash occurred in Ohio in March 2018 during daylight and was investigated by a local police agency. The vehicle was inspected, and the driver and manager of the ambulance service were interviewed in April 2018.

Figure 1. The damaged 2014 Ford E-350 ambulance

This crash occurred on the roadside of a five-lane, undivided highway. The Ford was configured with a Type III patient compartment, and the cab was equipped with driver and passenger frontal air bags. The vehicle was occupied by a belted 26-year-old male driver, an unbelted 49-year-old female paramedic, and a 76-year-old male patient who was restrained on a Stryker Model 6082 MX-PRO patient cot. The ambulance crew was conducting a non-emergency transport, and the driver was operating the vehicle without emergency lights and siren activated. The ambulance was traveling east in the left through lane when the driver suffered a diabetic episode and lost consciousness. The ambulance departed the right side of the roadway, and its front plane struck the end terminal of a blocked-out, W-beam steel guardrail. The ambulance continued down an embankment and struck several trees and initiated a fall-over one quarter turn rollover into a ditch bank, where the top right corner of the patient compartment struck and gouged the embankment. This engagement initiated an end-over type rollover, where the vehicle completed 180 degrees of rotation about its lateral axis without ground contact. The ambulance came to rest on its wheels facing west. The driver sustained police-reported "C" (possible) injuries and was

transported by ambulance to a hospital, where he was examined and released with no report of injuries. The paramedic sustained police-reported "A" (incapacitating) injuries and was transported by helicopter to a hospital, where she was hospitalized overnight for treatment of her injuries. The patient sustained police-reported "K" (fatal) injuries and was pronounced deceased at the scene of the crash. The ambulance was towed from the crash scene due to damage.

Emergency Medical Service, Personnel, Driver Training, and History

The ambulance service had been in operation since 1986. It provided emergency and non-emergency transport service to a 300-square-mile area with a population density of approximately 614 people per square mile. The ambulance service operated 18 ambulances and was a contract operation. The ambulance company screened its drivers' records prior to employment and provided an 8-hour classroom driving course, as well as defensive driving, obstacle course maneuvering, and on-the-job driver training. This was taught by existing ambulance staff. No re-certifications were required.

The driver was certified as an ambulance driver and emergency medical technician (EMT). He received his driver training through the ambulance company's training program. He had been employed with the ambulance service for 18 months and worked on a full-time basis. His normal work shift was 24 hours. The driver stated that he went to bed at approximately 2200 hours on the night before the crash and woke at 0500 hours. He did not work the day prior to the crash and began working at 0700 hours on the day of the crash. The driver had a long history of Type 1 diabetes and was prescribed Humalog and Levemir to regulate his glucose. The paramedic also worked for the ambulance service on a full-time basis. She did not work the day prior to the crash and began working at 0700 hours on the day of the crash. No known driving citations were issued as a result of this crash.

Summary

Crash Site

This crash occurred during the afternoon on a five-lane, undivided U.S. highway. The weather conditions were cloudy, north winds at 32 km/h (20 mph), a temperature of 1.7 °C (35 °F), and dew point of -5.5 °C (22 °F), according to local weather reports. The roadway was straight and traversed in an east/west direction. There were two through lanes in each direction and a bi-directional center left turn lane. Each lane was approximately 3.1 m (10.2 ft) wide. The roadway pavement markings consisted of solid white edge lines, broken white lane lines, solid/broken yellow bi-directional turn lane lines, and white bi-directional left turn arrows. The roadway surface was bituminous with a positive 3% negative grade in the eastbound direction. A narrow paved and stone shoulder bordered the eastbound lane. The south roadside consisted of a level grass area that transitioned to a wooded area with a negative slope and a drainage ditch. A W-beam guardrail system protected the eastbound traffic flow from the wooded area and the ditch area. The posted speed limit was 80 km/h (50 mph). The crash diagram is included at the end of this report.

Pre-Crash

The ambulance crew was conducting a non-emergency transport of a 76-year-old patient from one medical facility to another. The vehicle was traveling east in the left through lane without the emergency siren and lights activated. The driver suffered an episode of hypoglycemia due to his Type 1 diabetes and lost control of the vehicle. Witnesses stated that the ambulance was swerving in both eastbound lanes prior to departing the south road edge (Figure 2). The vehicle's Event Data Recorder (EDR) reported the vehicle's speed range as 87.0 km/h (54.1 mph) to 88.0 km/h (54.7 mph) from -5.0 to -1.5 sec prior to algorithm enable (AE).

Figure 2. East view of the ambulance's approach to roadway departure

The antilock braking system (ABS) was reported as engaged at -1.0 sec and the speed range from -1.0 to 0.0 sec as reported from 84.0 km/h (52.2 mph) to 58.0 km/h (36.0 mph). The ambulance departed the south shoulder and entered the grass roadside in a tracking mode. The departure angle was approximately 10 degrees. Police documented 25.0 m (82.0 ft) of rotating dual right rear marks on the grass roadside and 12.8 m (42.0 ft) of left rear tire marks as the vehicle tracked to impact with the guardrail end terminal.

Crash

The front plane, right aspect of the ambulance struck the end terminal of the guardrail system (Event 1, Figure 3). The force direction on the ambulance was in the 12 o'clock sector. The EDR reported the maximum longitudinal and lateral delta Vs as -39.90 km/h (-24.79 mph) and 8.26 km/h (5.13 mph). These values were recorded at 300 and 294 milliseconds of AE respectively. The WinSMASH program could not be used to calculate a delta V as the Event 1 impact was with a yielding object that was out of scope for the program and there was overlapping damage. The frontal air bags did not deploy and the retractor pretensioners did not actuate. The impact kinked the first section of W-beam 180 degrees and kinked the second section of W-beam 90 degrees. The left aspect of the undercarriage overrode the displaced end terminal and approximately 4.6 m (15.1 ft) of W-beam. During this engagement, the undercarriage directly contacted the back side of the wood posts. In all, five break-away wood posts were fractured.

Figure 3. Area of impact with end terminal

The ambulance continued approximately 10 m (32.8 ft) down the -10% grade and ran over numerous small saplings, measuring 3-8 cm (1.2-3.1 in) in diameter (Event 2). The front plane then struck and fractured a 12 cm (4.7 in) diameter PVC marker post that was anchored vertically in the ground (Event 3, Figure 4). The vehicle continued an additional approximately 28 m (91.9 ft) to the bottom of the embankment where a small creek flowed northwest to southeast. The front plane, center aspect struck and fractured two closely spaced trees (Event 4) resulting in direct contact to the bumper face. The grade of the vehicle's travel path at this point was -16%, and there was an approximately 1 m (3.3 ft) drop-off from the embankment to the ditch bank. The ambulance remained on its wheels as it traversed the embankment. Due to the slope of the embankment, the ambulance initiated a fall-over rollover event (Event 5) involving one-quarter turn.

Figure 4. Area of PVC pipe impact

The right-side tires of the ambulance were in the ditch as the left side tires remained in contact with the embankment. The front right corner of the cab and the top right corner of the patient compartment struck and wedged into the ditch bank (Event 6), interrupting and tripping the ambulance into a "cartwheel" type, end-over-end continuation of the rollover. During the end-over-end, the unit rotated 180 degrees about its longitudinal axis without ground contact before coming to final rest on its wheels facing west with its right wheels in the ditch (Figure 5).

Figure 5. Police photo showing impact of upper/right-front corner of the patient compartment into ditch bank and the ambulance at final rest

The patient cot remained secured in the antler bracket and rail clamp. The patient slid forward and partially out of the cot restraints during the crash. According to the paramedic, he was lying partially on the floor and was unresponsive.

Post-Crash

Police, emergency medical, and rescue services responded to the scene. A passerby assisted the driver out of the vehicle through the left front door. He sustained police reported "C" (possible) injuries and was transported by ambulance to a hospital, where he was treated and released. The paramedic came to rest lying in the stairwell of the right-side door of the patient compartment. She was removed by emergency personnel through the back doors and, due to perceived serious injury, was transported by helicopter to a hospital, where she was hospitalized overnight for treatment of her injuries. She stated that the patient was partially off the cot with his head on her legs and that he was unresponsive. She further stated that the cot remained locked in place and that passersby removed it in an attempt to assist with rescue efforts. The patient sustained serious (AIS 3 level) injuries and expired at the crash scene. His body was transported to the county coroner for autopsy.

A heavy-duty tow truck was called to the scene to remove the ambulance. The tow service first cabled the vehicle and winched it on its right plane to secure chains to the undercarriage. The ambulance was then rolled back onto its wheels and was lifted in an upright position over the guardrail and placed on the road surface before being towed from the scene. The ambulance was towed to an ambulance service facility, where it was inspected for this investigation.

2014 Ford E-350 Type III Ambulance

Description

The Ford E-350 ambulance consisted of a van-based cutaway chassis and a Type III ambulance body. The chassis, manufactured as an incomplete vehicle in June 2014, was identified by Vehicle Identification Number 1FDWE3FS2EDxxxxxx. The patient compartment, manufactured by Wheeled Coach Industries in May 2015, was a certified "Star of Life Ambulance." The specified wheelbase was 351 cm (138.2 in). The Ford was powered by a 6.8 liter, V-10 gasoline engine with a dual-wheel rear-drive axle. The gross vehicle weight rating was 5,216 kg (11,500 lb) with gross axle weight ratings of 2,087 kg (4,600 lb) front and 3,538 kg (7,800 lb) rear. The service brakes were power-assisted 4-wheel disc with ABS. The vehicle manufacturer's recommended tire size was LT225/75R16 for the front and rear tires with a recommended cold tire pressure of 448 kPa (65 PSI) on the front and 414 kPa (60 PSI) on the rear tires. At the time of the crash, the ambulance was equipped with Michelin LTX M/S tires of the recommended size. All tires were in good condition at the time of the crash.

The cab of the ambulance was configured with two box-mounted bucket seats with integrated head restraints and fold-down center armrests. An aftermarket ambulance console was mounted between the seats that housed the emergency lights and siren switches and radio communication equipment. Safety equipment consisted of dual-stage driver and passenger frontal air bags and manual 3-point lap and shoulder seat belts with retractor pretensioners.

The Type III ambulance patient compartment was manufactured in May 2015 by Wheeled Coach Industries. The chassis/patient compartment was a body-on-frame configuration. The patient compartment was constructed of an all aluminum body with a one-piece seamless roof. Three exterior access compartments were located on each side of the unit with two rear out-swing patient loading doors and a right-side door for crew members. All side compartment doors and the access door were hinged at the forward aspects. Emergency lighting was present on the front, back, and both side planes at the top surfaces.

The interior of the patient compartment was configured with a rear-facing captain's chair at the forward aspect of the unit and a right side-mounted, inward facing bench seat. The captain's chair was box-mounted with an adjustable seat track, an integrated 3-point lap and shoulder seat belt, and a child restraint system integrated into the backrest. The bench seat was equipped with three lap belts.

The interior left wall was configured with a series of cabinets with clear sliding doors. A counter area provided a work space and flat surface to place monitoring equipment. An oxygen port and controls for interior lighting and HVAC were located above the counter space. The forward wall right aspect contained dual doors concealing a storage compartment with HVAC vents above.

Exterior Damage

Exterior Damage Event 1: The ambulance sustained front plane damage during the impact with the end terminal. The front bumper, grille, and radiator were directly damaged (Figure 6). The direct contact damage began 43 cm (16.9 in) left of the right front bumper corner and extended 37 cm (14.6 in) to the left. Maximum residual crush was 19 cm (7.5 in), occurring 10 cm (3.9 in) right of center of the front plane. The collision deformation classification (CDC) was 12FZEN2.

Figure 6. Front plane damage

As the ambulance traveled down the embankment, the front plane struck and overrode numerous small diameter saplings (Event 2). These impacts were distributed across the front plane and did not produce direct contact damage or residual crush. During these engagements, the front plane struck and fractured the PVC marker post (Event 3). Again, no residual damage resulted to the vehicle. CDCs for these events were 12FDE91 and 12FRE91, respectively, with U representing no residual damage.

The center front aspect of the ambulance struck and fractured two trees (Event 4) as it traversed the embankment (CDC: 12F9EN1). These closely spaced tree impacts produced damage to the bumper that was located immediately right of the centerline and immediately left of the vehicle's endplane centerline. These tree impacts, along with the frontal impact with the guard rail end terminal (Event 1), were overlapping and resulted in a combined Field L of 168 cm (66.1 in). The crush profile documented at bumper level was as follows: C1 = 7 cm (2.8 in), C2 = 0 cm, C3 = 13 cm (5.1 in), C4 = 19 cm (7.5 in), C5 = 0 cm, and C6 = 0 cm.

Due to the slope of the embankment, the ambulance initiated a fall-over type rollover involving one-quarter turn (Event 5) as the tires remained in contact with the ditch and embankment. The CDC for this event was 00RDAO2.

Figure 7. Maximum vertical crush occurred at the right windshield header

During the rollover, the front-right aspect of the Ford and the top right aspect of the patient compartment struck and gouged the ditch bank (Event 6). The impact to the Ford deformed the steel bumper and fractured the right headlamp assembly and damaged the right front fender and hood. Mud was present in the inner fender area, on top of the wiper cowl, and at the upper right A-pillar. The A-pillar and side rail separated and the windshield header was buckled. The top right aspect of the patient compartment struck and gouged the embankment. Mud and deformation to the top right corner area was present with scratches and mud transfer on the forward third of the roof. The maximum vertical crush was 8 cm (3.1 in) occurring at the right windshield header (Figure 7). There was no lateral crush to the roof. The CDC for this Event 6 impact was 00FRAE9. The patient compartment is outside the scope of CDC.

The Event 6 embankment impact tripped the ambulance into an end-over-end rollover. The ambulance completed 180 degrees of rotation about its lateral axis before coming to rest on its wheels facing in a westerly direction, nearly opposite of its initial heading. There was no ground contact during the end-over-end rollover; therefore, this dynamic event was outside the scope of CDC.

There were multiple isolated dents and scrapes to the exterior of the ambulance as it traveled through a heavily wooded area of branches, vines, small diameter trees, and brush. These could not be separated into singular events.

Event Data Recorder

The ambulance's EDR was imaged with version 17.7 of the Bosch Crash Data Retrieval software and reported with version 19.5.2. Electrical power was supplied with an external battery, and the data were imaged with a direct connection to the restraints control module (RCM). The EDR reported two unlocked events (non-deployments), and the records for both were complete. The report is attached at the end of this report as Appendix A.

The EDR was capable of storing two deployment events. Deployment events cannot be overwritten or cleared from the RCM. Data from events which do not qualify as deployable events can be overwritten by subsequent events.

System Status at Event (First Record): There were no diagnostic faults present prior to the start of the first event, the frontal air bag warning lamp was "Off," and the driver's seat belt status was "Buckled." The maximum longitudinal and lateral acceleration was recorded as -39.90 km/h (-24.79 mph) and 8.26 km/h (5.13 mph), respectively and occurred 300 msec and 294 msec after AE.

System Status at Event (Second Record): There were no diagnostic faults present prior to the start of the second event, the frontal air bag warning lamp was "Off," and the driver's seat belt status was "Buckled." The maximum longitudinal and lateral acceleration was recorded as -7.53 km/h (–4.68 mph) and 7.42 km/h (4.61 mph), respectively, and occurred 150 msec and 287 msec after AE.

Figure 8. Occupant contact to cabinet located at front right of the patient compartment

Interior Damage

Interior Damage: The interior of the ambulance cab sustained moderate damage from intrusion to the passenger compartment. The most severe intrusions involved the right roof and windshield header which intruded vertically and laterally, 10 cm (3.9 in) and 7 cm (2.8 in), respectively. No discernable occupant contacts were noted. Both front doors remained closed and operational.

The windshield glazing was 100-percent fractured with bond separation at the center aspect of the windshield header. The left door glazing was disintegrated.

Patient Compartment: Inspection of the patient compartment revealed minor damage from intrusion. The right-side door was intruded 6 cm (2.4 in), but it remained closed and operational. Two of the three-piece glazing for this door was disintegrated during the crash.

The left door of the supply cabinet located at the front right of the patient compartment was deformed from contact by the paramedic (Figure 8). The HVAC vent grille located above the cabinet was also fractured, displaced, and scuffed with fabric transfers. Scuffing was present on the yellow grab bar mounted to the right-side exterior door.

Manual Restraint Systems

The two front-seat positions of the cab were equipped with 3-point lap and shoulder seat belts with sliding latch plates and emergency locking retractors (ELR). Both retractors were equipped with pretensioners that did not actuate.

The driver was restrained by his lap and shoulder seat belt based on the EDR-reported status of the seat belt as "Driver Buckled." The driver also stated during the interview that he was belted. Inspection of the driver's seat belt assembly revealed no discernable evidence of loading.

The patient compartment's rear facing captain's chair was equipped with an integrated lap and shoulder seat belt. This seat position was not occupied during the crash.

The right-side bench seat in the patient compartment was equipped with three lap belts that were secured to the side wall. Inspection of these seat belts revealed little historical usage and no discernable evidence of loading. The paramedic had been seated on the bench seat attending to the patient and had just stood up prior to the crash; therefore, she was not belted.

Patient Cot

The cot that was used to transport the patient was a Stryker REF Model 6082 MX-PRO (Figure 9), Serial Number 040440xxx. It was an X-frame design with a maximum capacity of 295 kg (650 lbs). It was 205 cm (80.7 in) in length and 58 cm (22.8 in) in width and had a height range of 34 cm (13.4 in) to 95 cm (37.4 in). The backrest could be adjusted from 2-73 degrees from horizontal. It was equipped with shoulder, chest, hip, and knee restraints, all of which were secured to the frame of the cot.

Figure 9. Image depicting the Stryker cot at the time of the SCI inspection

The paramedic reported to the police that the cot was secured to the floor prior to transport of the patient. The antler bracket secured the head of the cot by restraining the undercarriage using the wheel frames as anchor points. The rail clamp was located at the back left of the patient compartment and secured the cot to the floor. The SCI inspection revealed no abnormalities of the patient cot, restraints, or the antler clamp. The rail clamp was found to be jammed in the open position. The paramedic stated that the cot was forcibly removed by passersby as they attempted

to help her and the patient, indicating that the status of the rail clamp was probably related to the removal of the cot.

According to the statements made to the police and interview data, the patient was secured to the cot by the shoulder, chest, hip, and knee restraints, with the backrest elevated to a slight angle. The paramedic stated that immediately prior to the crash she removed the shoulder straps in order to remove the patient's coat so his blood pressure could be taken; therefore, the patient was only restrained by the lateral straps. She further stated that the patient slid partially out of the remaining restraints during the crash. It was confirmed by the police indication that the patients' pants were pulled down to the knees. She stated that he came to final rest on the floor, with his head on her feet.

Supplemental Restraint Systems

The ambulance was equipped with dual-stage frontal air bags and retractor pretensioners for the front-row seating positions. Neither the air bags deployed nor the pretentioners actuated during the crash.

2014 Ford E-350 Type III Ambulance Occupants

Driver Demographics

Age/Sex:	26 years/male
Height:	165 cm (65 in)
Weight:	50 kg (110 lb)
Eyewear:	Glasses
Seat type:	Bucket seat
Seat track position:	Between forward-most and middle positions
Manual restraint usage:	Lap and shoulder belt
Usage source:	EDR, vehicle inspection
Air bags:	Frontal, not deployed
Alcohol/drug data:	Police reported none
Egress from vehicle:	Exited with some assistance through driver's door
Transport from scene:	Ambulance
Medical treatment:	Treated and released

Driver Injuries

Injury No	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	None	N/A	N/A	N/A

Source: emergency room records.

Driver Kinematics

The driver was seated with the seat track adjusted to a forward position. He was restrained by the 3-point lap and shoulder belt with the D-ring adjusted to a mid position. At impact with the end terminal, the driver initiated a forward trajectory and loaded the seat belt webbing as the ELR retractor locked. The seat belt prevented him from contact with frontal components. He was displaced forward and right and engaged the locked belt webbing as the vehicle translated to a non-horizontal trajectory down the embankment and struck the trees and the ditch bank. During the end-over-end rollover, the seat belt secured the driver in his position and prevented him from interior contact and potential injury. As a precautionary measure, the driver was transported to a local hospital, where he was evaluated and released.

Paramedic Demographics

Age/sex:	49 years/female
Height:	175 cm (69 in)
Weight:	54 kg (120 lb)
Eyewear:	Unknown
Seat type:	Inward-facing bench seat on right side of patient compartment
Seat track position:	N/A
Manual restraint usage:	None
Usage source:	Vehicle inspection/ambulance manager interview

Air bags:	None available
Alcohol/drug data:	None
Egress from vehicle:	Removed due to perceived serious injuries through the back doors
Transport from scene:	Helicopter
Medical treatment:	Hospitalized one day

Paramedic Injuries

Injury No	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Non-displaced right greater tuberosity fracture of humerus	751151.2	Other interior object: grab bar on right door of the patient compartment	Probable
2	Puncture wound to right lower leg	810602.1	Unknown	Probable
3	Abrasion to right shoulder	710202.1	Other interior object: supply cabinet located at the front right of the patient compartment	Probable
4	Abrasion to right elbow	710202.1	Other interior object: supply cabinet located at the front right of the patient compartment	Probable

Source: hospital records.

Paramedic Kinematics

The paramedic was initially seated in the patient compartment on the right-side crew bench seat attending to the patient. She stood up to move toward the passageway between the cab and patient compartment when she sensed the driver losing control of the vehicle. The impact with the terminal head displaced her forward into the supply cabinet located at the front, right side of the patient compartment. The contact displaced the left door of the cabinet inward. As the ambulance traversed the embankment and translated to a non-horizontal attitude, the paramedic was displaced to the front right corner of the patient compartment resulting in abrasions of the right upper extremity. Her head or shoulder probably contacted and displaced the overhead vent louver. Scuff and fabric transfers were present on the louver. At impact with the embankment, she probably contacted the grab bar on the right door of the patient compartment. This rigid component was scuffed and was the probable source of her right humerus fracture. The paramedic was displaced forward and into the right-front corner of the patient compartment as the vehicle initiated and completed the end-over-end roll maneuver. She came to rest on the floor of the patient compartment at the stairwell of the right-side door with the patient partially resting on her legs. The paramedic was removed from the patient compartment by EMS and was transported by helicopter to a medical center, where she was hospitalized overnight.

Patient Demographics

Age/sex:	76 years/male
Height:	180 cm (69 in)
Weight:	95 kg (210 lbs)
Eyewear:	Unknown
Seat type:	Lying on ambulance cot with backrest slightly elevated
Seat track position:	N/A
Restraint usage:	Secured by hip and knee lateral cot restraints
Manual usage source:	Ambulance service owner interview
Air bags:	None available
Alcohol/drug data:	None
Egress from vehicle:	Fatal in patient compartment
Transport from scene:	Medical examiner
Medical treatment:	None

Patient Injuries

Injury No	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Left anterior 6th rib fracture, lateral left 5-9 rib fractures, posterior left 5-12 rib fractures	450211.3	Other interior object: Vertical wall of forward cabinet	Possible
2	Right posterior 4, 6-12 rib fractures	450203.3	Other interior object: Vertical wall of forward cabinet	Possible
3	Fracture of sternum	450804.2	Other interior object: Vertical wall of forward cabinet	Possible
4	5 cm laceration to right lobe of liver	54182+2.2	Other interior object: Lateral cot restraint	Possible
5	Left clavicle fracture, mid 1/3	750621.2	Other interior object: Vertical wall of forward cabinet	Possible
6	6 in. left parietal laceration down to bone	110604.2	Other interior object: Vertical wall of forward cabinet	Possible
7	1 ¼ in. posterior occipital scalp laceration	110602.1	Other interior object: Vertical wall of forward cabinet	Possible
8	2 x 1 in. contusion to left front temporal scalp	110402.1	Other interior object: Leading edge of right bench seat wall	Possible

Injury No	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
9	Left parietal and temporal subgaleal hemorrhage 10 x 20 cm with underlying muscle hemorrhage	110402.1	Other interior object: Vertical wall of forward cabinet	Possible
10	Occipital subgaleal hemorrhage 2 x 2 cm	110402.1	Other interior object: Vertical wall of forward cabinet	Possible
11	Right parietal subgaleal hemorrhage 3 x 2 cm	110402.1	Other interior object: Vertical wall of forward cabinet	Possible
12	Occipital vertex region 1 ½ x 1 in. Abrasion	110202.1	Other interior object: Vertical wall of forward cabinet	Possible
`13	1 cm contusion to right tongue	243401.1	Self-inflicted	Possible
14	4 x 2 in. abrasion to left neck	310202.1	Unknown	Unknown
15	4 x 2 in. abrasion to posterior neck	310202.1	Unknown	Unknown
16	Hemorrhage overlying C7-T1; Right mid-back has 3 ½ in. contusion	410402.1	Other interior object: Vertical wall of forward cabinet	Possible
17	1 x 1 ½ in. contusion to right upper abdomen; 1 ½ x 1 in. contusion to right lower abdomen	510402.1	Other interior object: Lateral cot restraint	Possible
18	Left arm has two 1 in. tears	710602.1	Unknown	Unknown
19	Left forearm has two 1 in. tears	710602.1	Unknown	Unknown
20	Right forearm has small skin tears	710602.1	Unknown	Unknown
21	2 x 2 in. skin tear dorsal right hand	710602.1	Unknown	Unknown
22	Left arm contusion	710402.1	Unknown	Unknown
23	Left forearm contusion	710402.1	Unknown	Unknown
24	Right forearm contusion	710402.1	Unknown	Unknown

Injury No	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
25	Left lower leg 3 in. curved skin tear	810602.1	Other interior object: Lateral cot restraint	Possible
26	Right buttock 4 x 1 in. contusion	810402.1	Other interior object: Cot mattress	Possible
27	Right leg 1 x ¼ in. abrasion	810202.1	Other interior object: Lateral cot restraint	Possible
28	Left thigh 1 x ¼ in. abrasion	810202.1	Other interior object: Lateral cot restraint	Possible
29	Left knee 3 x ¾ in. abrasion	810202.1	Other interior object: Lateral cot restraint	Possible

Source: autopsy report (internal).

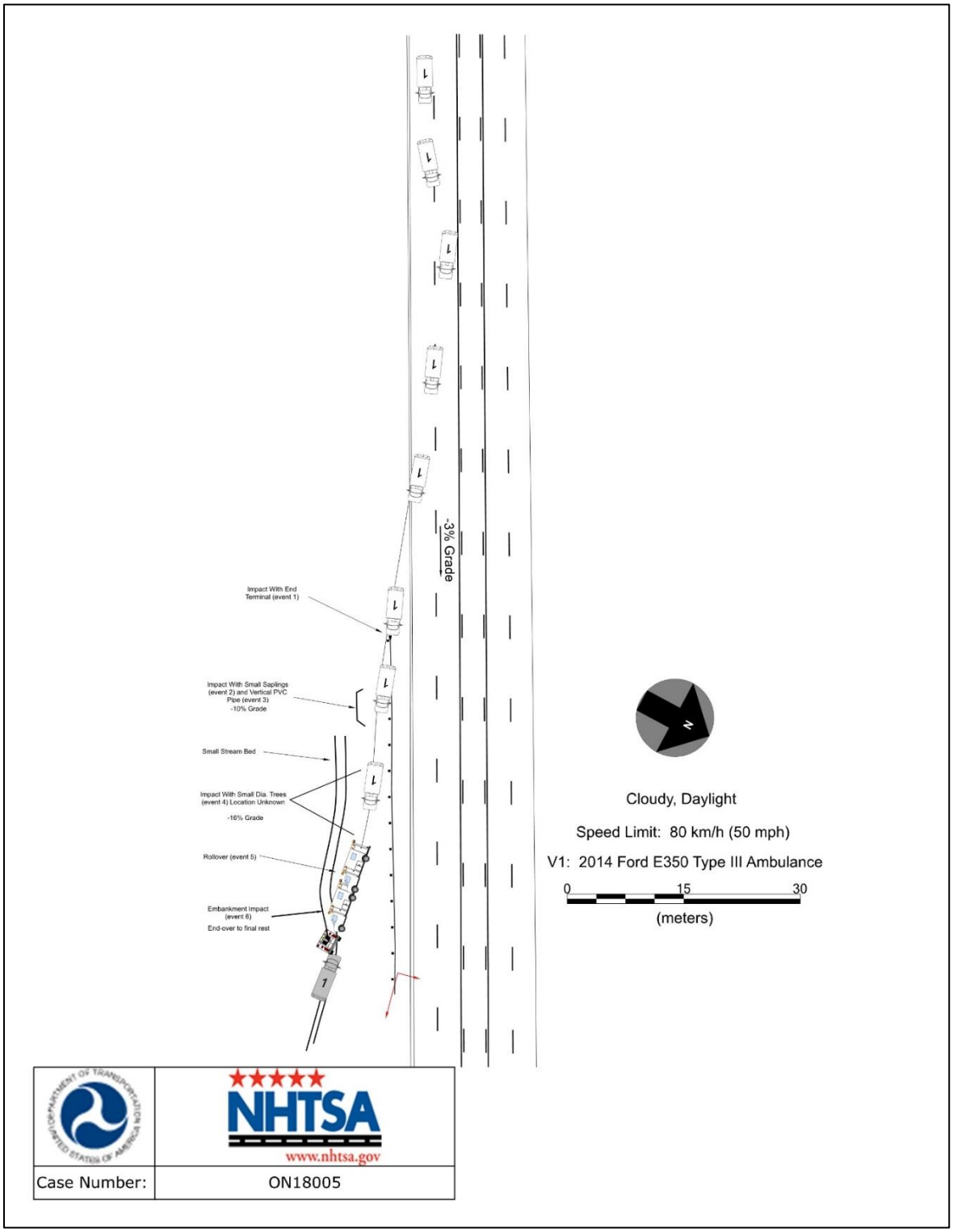
Patient Kinematics

The patient was situated supine on the cot at model minimum uniform crash criteria (MMUCC) position 8, with the cot's head slightly elevated. He was initially restrained to the cot by the shoulder belts mounted at the head of the cot and the chest, hip, and knee lateral restraints attached to the side rails of the cot prior to being loaded into the ambulance. The cot was secured in the patient compartment by the antler bracket and rail clamp. The patient had an oxygen mask applied during the non-emergency transport. While en route to their destination, the paramedic, who was attending to the patient, unbuckled the shoulder restraints to remove his coat and check his blood pressure. The paramedic was standing between the cot and the right-side bench seat.

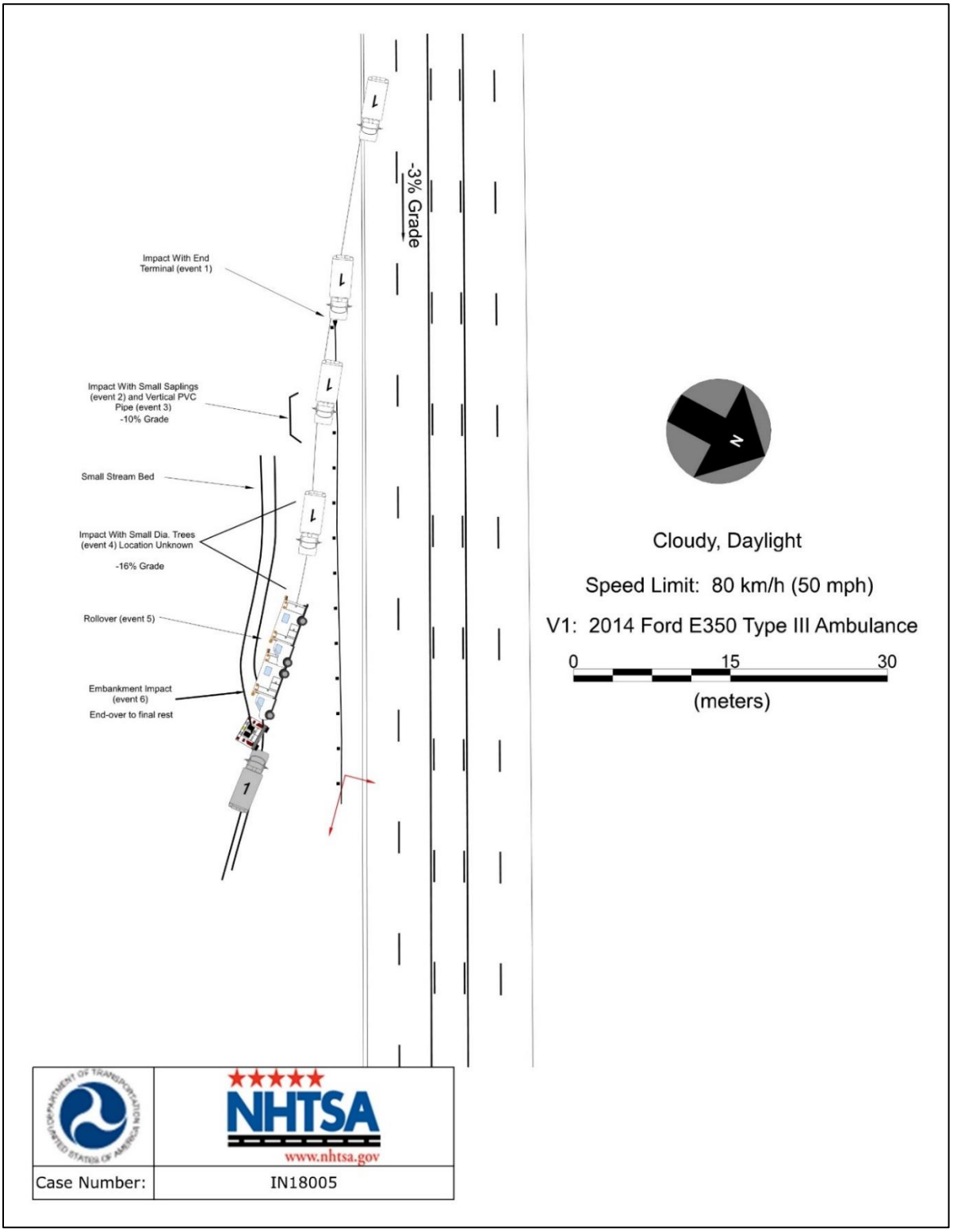
The front-plane impact to the guardrail end terminal displaced the patient forward relative to the cot, as the cot remained secure to the rail and antler bracket. He slid out of the lateral restraints and struck the vertical edge of the front cabinet in the patient compartment. As the ambulance traversed the off-road environment and struck the trees and the embankment, the patient was displaced further forward, which caused his torso to contact the wall as his feet remained engaged with the lateral strap of the cot. He was displaced to his left due to the non-horizontal mode of the ambulance and came to rest in the patient compartment with his head on the lower extremities of the paramedic who was lying in the stairwell area. The patient sustained multiple injuries of the head and torso from contact with the hard surface of the patient compartment wall. Lower leg abrasions, an abdominal contusion, and the liver laceration were attributed to the lateral restraints of the cot.

Passersby stopped to render aid to the occupants and reportedly (forcibly) released the cot from the rail clamp to reach the paramedic and the patient. Emergency medical personnel arrived on scene and removed the paramedic and evaluated the patient. He was determined to be deceased and was pronounced at the scene of the crash.

Crash Diagram



Crash Diagram (An Expanded View)



Appendix A: Event Data Recorder Report for 2014 Ford E-350 Type III Ambulance[1]

[1] The EDR report contained in this technical report was imaged using the current version of the Bosch CDR software at the time of the vehicle inspection. The CDR report contained in the associated Crash Viewer application may differ relative to this report.

IMPORTANT NOTICE: Robert Bosch LLC and the manufacturers whose vehicles are accessible using the CDR System urge end users to use the latest production release of the Crash Data Retrieval system software when viewing, printing or exporting any retrieved data from within the CDR program. Using the latest version of the CDR software is the best way to ensure that retrieved data has been translated using the most current information provided by the manufacturers of the vehicles supported by this product.

CDR File Information

User Entered VIN	1FDWE3FS2ED******
User	
Case Number	
EDR Data Imaging Date	04/17/2018
Crash Date	
Filename	AMBULANCE EDR.CDRX
Saved on	Tuesday, April 17 2018 at 11:25:28
Imaged with CDR version	Crash Data Retrieval Tool 17.7
Imaged with Software Licensed to (Company Name)	NHTSA
Reported with CDR version	Crash Data Retrieval Tool 19.5.2
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
ACM Adapter Detected During Download	Yes
Event(s) recovered	unlocked events

Comments

No comments entered.

The retrieval of this data has been authorized by the vehicle's owner, or other legal authority such as a court order or search warrant, as indicated by the CDR tool user on Tuesday, April 17 2018 at 11:25:28.

Data Limitations

Restraints Control Module Recorded Crash Events:
Deployment Events cannot be overwritten or cleared from the Restraints Control Module (RCM). Once the RCM has deployed any airbag device, the RCM must be replaced. The data from events which did not qualify as deployable events can be overwritten by subsequent events. The RCM can store up to two deployment events.

Airbag Module Data Limitations:

- Restraints Control Module Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced from the point of algorithm wake up. It is not the speed the vehicle was traveling before the event. Note that the vehicle speed is recorded separately five seconds prior to algorithm wake up. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle forward velocity change.
- Event Recording Complete will indicate if data from the recorded event has been fully written to the RCM memory or if it has been interrupted and not fully written.
- If power to the Airbag Module is lost during a crash event, all or part of the crash record may not be recorded.
- For 2011 Ford Mustangs, the Steering Wheel Angle parameter indicates the change in steering wheel angle from the previously recorded sample value and does not represent the actual steering wheel position.

Airbag Module Data Sources:

- Event recorded data are collected either INTERNALLY or EXTERNALLY to the RCM.

  - INTERNAL DATA is measured, calculated, and stored internally, sensors external to the RCM include the following:
    > The Driver and Passenger Belt Switch Circuits are wired directly to the RCM.
    > The Driver's Seat Track Position Switch Circuit is wired directly to the RCM.
    > The Side Impact Sensors (if equipped) are located on the side of vehicle and are wired directly to the RCM.
    > The Occupant Classification Sensor is located in the front passenger seat and transmits data directly to the RCM on high-speed CAN bus.
    > Front Impact Sensors (right and left) are located at the front of vehicle and are wire directly to the RCM.

  - EXTERNAL DATA recorded by the RCM are data collected from the vehicle communication network from various

sources such as Powertrain Control Module, Brake Module, etc.

02007_RCM-RC6_r002

System Status at Time of Retrieval

VIN as programmed into RCM at factory	1FDWE3FS2ED******
Current VIN from PCM	1FDWE3FS2ED******
Ignition cycle, download (first record)	6,667
Ignition cycle, download (second record)	6,667
Restraints Control Module Part Number	BC24-14B321-BD
Restraints Control Module Serial Number	9130880100000000
Restraints Control Module Software Part Number (Version)	BL84-14C028-AB
Left/Center Frontal Restraints Sensor Serial Number	19FDCED5
Left Side Restraint Sensor 1 Serial Number	00000000
Left Side Restraint Sensor 2 Serial Number	00000000
Right Frontal Restraints Sensor Serial Number	00000000
Right Side Restraint Sensor 1 Serial Number	00000000
Right Side Restraints Sensor 2 Serial Number	00000000

System Status at Event (First Record)

Recording Status	Unlocked Record
Complete file recorded (yes,no)	Yes
Multi-event, number of events (1,2)	1
Time from event 1 to 2 (msec)	N/A
Lifetime Operating Timer at event time zero (seconds)	25,670,120
Key-on Timer at event time zero (seconds)	2,455
Vehicle voltage at time zero (Volts)	14.175
Energy Reserve Mode entered during event (Y/N)	No

Faults Present at Start of Event (First Record)

No Faults Recorded

Deployment Data (First Record)

Maximum delta-V, longitudinal (MPH [km/h])	-24.79 [-39.90]
Time, maximum delta-V longitudinal (msec)	300
Maximum delta-V, lateral (MPH [km/h])	5.13 [8.26]
Time, maximum delta-V lateral (msec)	294
Longitudinal Delta-V Time Zero Offset	1.0 ms
Lateral Delta-V Time Zero Offset	1.0 ms

Pre-Crash Data -1 sec (First Record)

Ignition cycle, crash	6,664
Frontal air bag warning lamp, on/off	Off
Frontal air bag suppression switch status, front passenger	Not Active
Safety belt status, driver	Driver Buckled
Brake Telltale	Off
ABS Telltale	Off
Stability Control Telltale	Off
Speed Control Telltale	Off
Powertrain Wrench Telltale	Off
Powertrain Malfunction Indicator Lamp (MIL)Telltale	On

Pre-Crash Data -5 to 0 sec [2 samples/sec] (First Record)

Times (sec)	Speed vehicle indicated MPH [km/h]	Accelerator pedal, % full	Service brake, on/off	Engine RPM	ABS activity (engaged, non-engaged)	Stability control (engaged, non-engaged)	Traction Control via Brakes (engaged, non-engaged)	Traction Control via Engine (engaged, non-engaged)
- 5.0	54.1 [87.0]	18	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 4.5	54.1 [87.0]	18	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 4.0	54.1 [87.0]	18	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 3.5	54.7 [88.0]	18	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 3.0	54.7 [88.0]	18	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 2.5	54.7 [88.0]	18	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 2.0	54.1 [87.0]	19	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 1.5	54.7 [88.0]	18	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 1.0	52.2 [84.0]	70	Off	1,700	engaged	non-engaged	non-engaged	non-engaged
- 0.5	51.6 [83.0]	0	Off	2,200	engaged	non-engaged	non-engaged	non-engaged
0.0	36.0 [58.0]	0	Off	1,900	engaged	non-engaged	non-engaged	non-engaged

Pre-Crash Data -5 to 0 sec [10 samples/sec] (First Record)

Times (sec)	Steering Wheel Angle (degrees)
- 5.0	Invalid
- 4.9	Invalid
- 4.8	Invalid
- 4.7	Invalid
- 4.6	Invalid
- 4.5	Invalid
- 4.4	Invalid
- 4.3	Invalid
- 4.2	Invalid
- 4.1	Invalid
- 4.0	Invalid
- 3.9	Invalid
- 3.8	Invalid
- 3.7	Invalid
- 3.6	Invalid
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- 3.2	Invalid
- 3.1	Invalid
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- 1.2	Invalid
- 1.1	Invalid
- 1.0	Invalid
- 0.9	Invalid
- 0.8	Invalid
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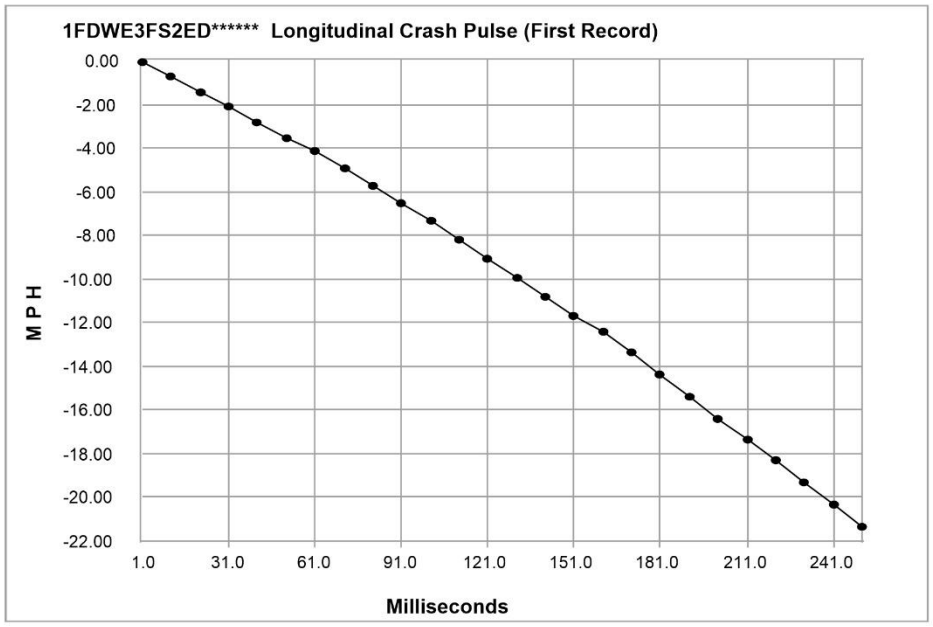
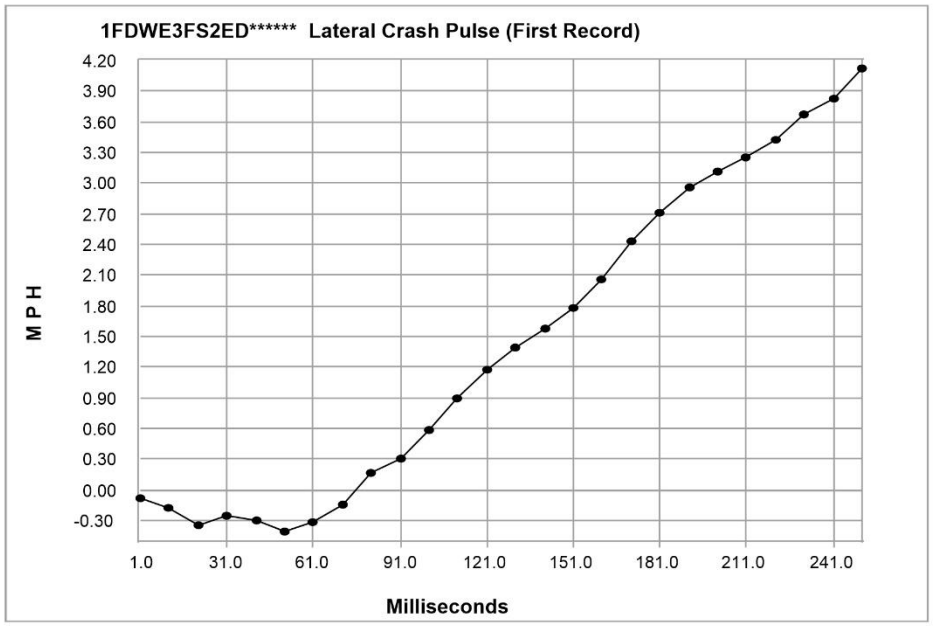
- 0.3	Invalid
- 0.2	Invalid
- 0.1	Invalid
0.0	Invalid



Longitudinal Crash Pulse (First Record)

Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
1.0	-0.08	-0.13
11.0	-0.74	-1.20
21.0	-1.42	-2.29
31.0	-2.11	-3.40
41.0	-2.85	-4.59
51.0	-3.54	-5.70
61.0	-4.17	-6.72
71.0	-4.97	-8.00
81.0	-5.74	-9.24
91.0	-6.56	-10.56
101.0	-7.35	-11.83
111.0	-8.21	-13.21
121.0	-9.11	-14.66
131.0	-9.96	-16.03
141.0	-10.79	-17.37
151.0	-11.68	-18.80
161.0	-12.42	-19.99
171.0	-13.36	-21.49
181.0	-14.41	-23.19
191.0	-15.39	-24.76
201.0	-16.42	-26.42
211.0	-17.35	-27.92
221.0	-18.27	-29.40
231.0	-19.34	-31.12
241.0	-20.30	-32.67
251.0	-21.33	-34.33



Lateral Crash Pulse (First Record)

Time (msec)	Delta-V, lateral (MPH)	Delta-V, lateral (km/h)
1.0	-0.08	-0.13
11.0	-0.17	-0.27
21.0	-0.35	-0.56
31.0	-0.25	-0.40
41.0	-0.31	-0.49
51.0	-0.40	-0.65
61.0	-0.32	-0.51
71.0	-0.14	-0.22
81.0	0.16	0.26
91.0	0.31	0.50
101.0	0.58	0.93
111.0	0.90	1.45
121.0	1.18	1.89
131.0	1.40	2.25
141.0	1.58	2.55
151.0	1.78	2.87
161.0	2.06	3.32
171.0	2.43	3.90
181.0	2.71	4.37
191.0	2.95	4.75
201.0	3.11	5.00
211.0	3.25	5.23
221.0	3.42	5.51
231.0	3.67	5.90
241.0	3.83	6.17
251.0	4.13	6.64

System Status at Event (Second Record)

Recording Status	Unlocked Record
Complete file recorded (yes,no)	Yes
Multi-event, number of events (1,2)	2
Time from event 1 to 2 (msec)	200
Lifetime Operating Timer at event time zero (seconds)	25,670,120
Key-on Timer at event time zero (seconds)	2,455
Vehicle voltage at time zero (Volts)	13.932
Energy Reserve Mode entered during event (Y/N)	No

Faults Present at Start of Event (Second Record)

No Faults Recorded

Deployment Data (Second Record)

Maximum delta-V, longitudinal (MPH [km/h])	-4.68 [-7.53]
Time, maximum delta-V longitudinal (msec)	150
Maximum delta-V, lateral (MPH [km/h])	4.61 [7.42]
Time, maximum delta-V lateral (msec)	287
Longitudinal Delta-V Time Zero Offset	0.5 ms
Lateral Delta-V Time Zero Offset	0.5 ms

Pre-Crash Data -1 sec (Second Record)

Ignition cycle, crash	6,664
Frontal air bag warning lamp, on/off	Off
Frontal air bag suppression switch status, front passenger	Not Active
Safety belt status, driver	Driver Buckled
Brake Telltale	Off
ABS Telltale	Off
Stability Control Telltale	Off
Speed Control Telltale	Off
Powertrain Wrench Telltale	Off
Powertrain Malfunction Indicator Lamp (MIL)Telltale	On

Pre-Crash Data -5 to 0 sec [2 samples/sec] (Second Record)

Times (sec)	Speed vehicle indicated MPH [km/h]	Accelerator pedal, % full	Service brake, on/off	Engine RPM	ABS activity (engaged, non-engaged)	Stability control (engaged, non-engaged)	Traction Control via Brakes (engaged, non-engaged)	Traction Control via Engine (engaged, non-engaged)
- 5.0	54.1 [87.0]	18	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 4.5	54.1 [87.0]	18	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 4.0	54.7 [88.0]	18	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 3.5	54.7 [88.0]	18	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 3.0	54.7 [88.0]	18	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 2.5	54.1 [87.0]	19	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 2.0	54.7 [88.0]	18	Off	1,800	non-engaged	non-engaged	non-engaged	non-engaged
- 1.5	52.2 [84.0]	70	Off	1,700	engaged	non-engaged	non-engaged	non-engaged
- 1.0	51.6 [83.0]	0	Off	2,200	engaged	non-engaged	non-engaged	non-engaged
- 0.5	36.0 [58.0]	0	Off	1,900	engaged	non-engaged	non-engaged	non-engaged
0.0	30.4 [49.0]	0	Off	1,600	engaged	non-engaged	non-engaged	non-engaged

Pre-Crash Data -5 to 0 sec [10 samples/sec] (Second Record)

Times (sec)	Steering Wheel Angle (degrees)
- 5.0	Invalid
- 4.9	Invalid
- 4.8	Invalid
- 4.7	Invalid
- 4.6	Invalid
- 4.5	Invalid
- 4.4	Invalid
- 4.3	Invalid
- 4.2	Invalid
- 4.1	Invalid
- 4.0	Invalid
- 3.9	Invalid
- 3.8	Invalid
- 3.7	Invalid
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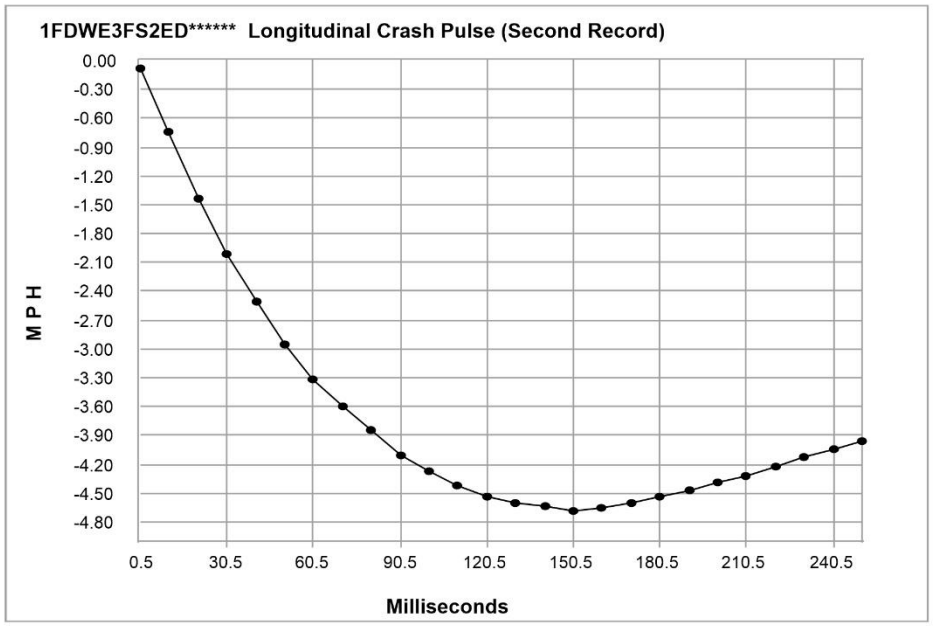
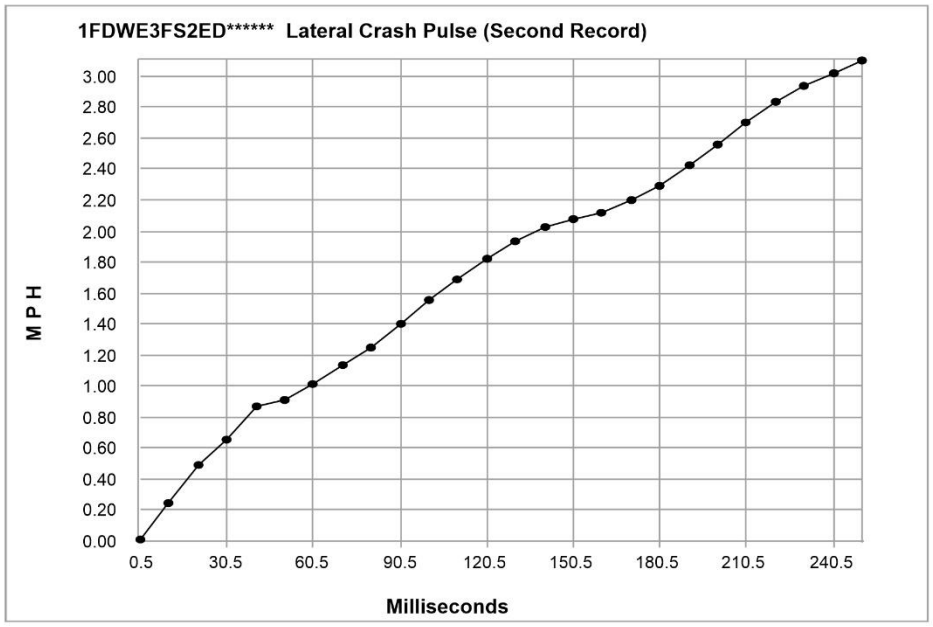


Longitudinal Crash Pulse (Second Record)

Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
0.5	-0.08	-0.13
10.5	-0.74	-1.20
20.5	-1.44	-2.31
30.5	-2.02	-3.24
40.5	-2.51	-4.05
50.5	-2.96	-4.76
60.5	-3.31	-5.33
70.5	-3.60	-5.80
80.5	-3.85	-6.20
90.5	-4.10	-6.60
100.5	-4.28	-6.88
110.5	-4.43	-7.13
120.5	-4.54	-7.30
130.5	-4.60	-7.41
140.5	-4.64	-7.47
150.5	-4.68	-7.53
160.5	-4.65	-7.49
170.5	-4.60	-7.40
180.5	-4.54	-7.31
190.5	-4.47	-7.19
200.5	-4.39	-7.06
210.5	-4.32	-6.95
220.5	-4.23	-6.81
230.5	-4.13	-6.65
240.5	-4.04	-6.50
250.5	-3.95	-6.36



Lateral Crash Pulse (Second Record)

Time (msec)	Delta-V, lateral (MPH)	Delta-V, lateral (km/h)
0.5	0.01	0.02
10.5	0.24	0.39
20.5	0.50	0.80
30.5	0.65	1.05
40.5	0.86	1.39
50.5	0.91	1.47
60.5	1.02	1.64
70.5	1.14	1.83
80.5	1.25	2.02
90.5	1.40	2.25
100.5	1.55	2.50
110.5	1.69	2.72
120.5	1.82	2.92
130.5	1.94	3.12
140.5	2.03	3.26
150.5	2.08	3.34
160.5	2.12	3.41
170.5	2.20	3.53
180.5	2.29	3.69
190.5	2.42	3.90
200.5	2.56	4.11
210.5	2.70	4.35
220.5	2.84	4.57
230.5	2.93	4.72
240.5	3.02	4.86
250.5	3.10	4.99

Hexadecimal Data

Data that the vehicle manufacturer has specified for data retrieval is shown in the hexadecimal data section of the CDR report. The hexadecimal data section of the CDR report may contain data that is not translated by the CDR program. The control module contains additional data that is not retrievable by the CDR system.

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00 00 00 00

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39 31 33 30 38 38 30 31 30 30 30 30 30 30 30 30

42 4C 38 34 2D 31 34 43 30 32 38 2D 41 42 00 00 00 00 00 00 00 00 00 00

19 FD CE D5 00 00 00 00 00 00 00 00 00 00 00 00

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31 46 44 57 45 33 46 53 32 45 44 2A 2A 2A 2A 2A 2A 00 00 00 00 00 00 00
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Event Record 1


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82 BF 25 00 EC C1 25 00 1D C4 25 00 DF C6 25 00 90 C9 25 00 69 CC 25 00 28 CF
25 00 23 D2 25 00 48 D5 25 00 3C D8 25 00 23 DB 25 00 3A DE 25 00 CD E0 25 00
0B E4 25 00 B5 E7 25 00 1B EB 25 00 B2 EE 25 00 EC F1 25 00 22 F5 25 00 D9 F8
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Event Record 2

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DOT HS 813 133
July 2021

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

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