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SPECIAL CRASH INVESTIGATIONS

CASE NO.: CR14057

ON-SITE AMBULANCE CRASH INVESTIGATION

VEHICLE: 2011 FORD E350 TYPE III AMBULANCE
AMBULANCE BODY: WHEELED COACH CITIMEDIC PLUS VII

LOCATION: OHIO

CRASH DATE: AUGUST 2014

Contract No. DTNH22-12-C-00269

Prepared for:

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

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

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16. Abstract This on-site ambulance crash investigation focused on the multiple event/rollover crash of a 2011 Ford E350 Type III ambulance. The crash resulted in the complete separation of the ambulance's right plane and the corresponding ejection of the cot, a 56-year-old male patient partially restrained to the cot in a Fowler's position, and a 30-year-old male Emergency Medical Technician (EMT) seated unrestrained in the rear-facing captain's chair. The completely ejected patient sustained fatal injuries and was pronounced deceased at the scene. At the time of the crash, the ambulance was driven by a restrained 30-year-old female. The ambulance drifted right and departed an interstate roadway, where it impacted several objects and then rolled multiple quarter turns off of an embankment. The Ford was equipped with a frontal air bag system and safety belt pretensioners, though neither system deployed/actuated in the crash. Both Emergency Medical Services (EMS) personnel were transported by other ambulances to a local hospital for the treatment of police-reported non-incapacitating (B-level) injuries.			
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BACKGROUND

This on-site ambulance crash investigation focused on the multiple event/rollover crash of a 2011 Ford E350 Type III ambulance (**Figure 1**). The crash resulted in the complete separation of the ambulance's right plane and the corresponding ejection of the cot, a 56-year-old male patient partially restrained to the cot in a Fowler's position, and a 30-year-old male Emergency Medical Technician (EMT) seated unrestrained in the rear-facing captain's chair. The completely ejected patient sustained fatal injuries and was pronounced deceased at the scene. At the time of the crash, the ambulance was driven by a restrained 30-year-old female. The ambulance drifted right and departed an interstate roadway, where it impacted several objects and then rolled multiple quarter turns off of an embankment. The Ford was equipped with a frontal air bag system and safety belt pretensioners, though neither system deployed/actuated in the crash. Both Emergency Medical Services (EMS) personnel were transported by other ambulances to a local hospital for the treatment of police-reported non-incapacitating (B-level) injuries.

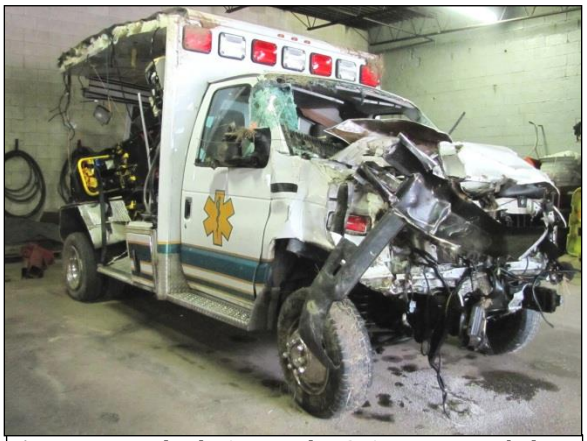


Figure 1: Involved 2011 Ford E-350 Type III ambulance at the time of the SCI inspection.

The crash was identified by the Special Crash Investigations (SCI) team through an internet news source on August 20, 2014. The notification was forwarded to the SCI group of the National Highway Traffic Safety Administration (NHTSA) and subsequently assigned for on-site investigation on the same day. The SCI team initiated telephone contact with the investigating law enforcement agency and secured cooperation to conduct the on-site investigation, which occurred on August 21-22, 2014. The on-site investigation involved the documentation of the ambulance, the cot and its fastening system, and the crash site. In addition, the Ford's Event Data Recorder (EDR) was imaged during the vehicle inspection process using the current version of the Bosch Crash Data Retrieval (CDR) software and tool. Medical record data was obtained for the patient through the medical examiner. An attorney representing the driver refused to allow an interview. The local hospital refused to release the EMS providers' medical records associated to their respective post-crash evaluation and treatment.

CRASH SUMMARY`

Crash Site

The crash occurred on the southbound portion of a divided, limited-access roadway during nighttime hours. According to weather reports, conditions at the time of the crash were clear skies with a temperature of 11.7 °C (53.1 °F), 5.6 km/h (3.5 mph) southerly winds, and 86% relative humidity. The bituminous roadway surface was dry. Southbound traffic utilized three 4.0 m (13.1 ft) wide lanes that were delineated by single dashed white lines. A 1.1 m (3.6 ft) left shoulder supported the southbound lanes from a broad grass median that divided the northbound and southbound portions of the roadway. A 3.0 m (9.8 ft) wide shoulder supported the southbound travel lanes to the west. Speed was regulated by a posted limit of 113 km/h (70 mph). In the area of the crash, an additional 5.4 m (17.7 ft) wide exit interchange lane departed the southbound portion at an approximate 5-degree angle. The exit ramp curved right and progressed west away from the limited-access roadway.

Figure 2: Southbound trajectory view of the ambulance's pre-crash travel path.

A grass swale was located between the exit ramp and southbound portion. Within the swale were a large "Exit" sign, single yellow polymer delineator stake, and a business/services designation sign. As the exit ramp curved west away from the limited-access roadway, the swale transitioned to a large depressed area with steep embankments. A W-beam guardrail with 15x20 cm (6.0x8.0 in) breakaway wooden posts and an energy absorbing end treatment served to protect the exit ramp traffic from the steep, negatively-sloped embankment. Scattered within the broad depressed area between the exit ramp and the limited-access roadway were several trees and other vegetation of varying species and diameter, though the majority of the area was open. A Crash Diagram is included on **Page 26** of this technical report.

Ambulance Agency, Crew, and Transport Description

The private ambulance agency was a multi-tiered medical transport service not associated with any particular medical treatment center, capable of providing a wide array of EMS care and medical transportation. It employed a variety of all career staff (non-volunteer), including vehicle operators, dispatchers, management, and EMS providers, who ranged from basic-level EMTs to certified Critical Intensive Care Paramedics (CICP). The agency itself was the largest EMS, GT, and wheelchair van service provider within its geographic area.

Prior to the crash, the private ambulance agency had received a request for a non-emergent, inter-facility transfer, designated as a General Transport (GT). The specific request was for a Basic Life Support (BLS) transport of the 56-year-old male patient from a local hospital to a different medical facility for mental health evaluation and care not available at the local hospital.

The distance of the GT was approximately 241 km (150 mi), which would have required roughly 2 hours and 30 minutes of travel time to complete. The private agency dispatched the involved ambulance with the 30-year-old female and 30-year-old male EMTs to transport the patient. No specific information concerning the background, experience, or training certifications of the involved EMS providers or their work shift time were available. According to the private ambulance agency, although usage of manual restraint for the driver was a procedural requirement, there was no standing protocol for restraint of crew within the patient compartment. However, the agency required that the entire multi-point harness system, inclusive of the shoulder straps and multiple lateral straps, be used for restraint of the patient on the wheeled ambulance cot.

Pre-Crash

The private ambulance and crew arrived at the local hospital and retrieved the patient. They assisted in seating him on the cot in a Fowler's position (the back/head portion of the cot partially reclined to an approximate 45-60 degree angle). The crewmembers then restrained him to the cot using all of the lateral straps of the multi-point harness system, without usage of the shoulder straps. The cot was then wheeled to the awaiting ambulance and loaded into the patient compartment, then secured into position using the fastening system. The male EMT situated himself unrestrained within the rear-facing captain's chair. The female EMT assumed the vehicle operator's position and utilized the lap and shoulder safety belt system for manual restraint.

Approximately 1 hour and 30 minutes after departing the local hospital, the ambulance was traveling south on the limited-access roadway. It had completed approximately 137 km (85 miles) of the trip. The driver operated the ambulance in the far right lane and was using vehicle's cruise control to maintain speed. In her statement to the law enforcement agency, the driver reported the cruise control setting to be 113 km/h (70 mph). According to the data imaged from the Ford's EDR during the vehicle inspection process, the vehicle's pre-crash speed was a consistent 118 km/h (73.3 mph) for the entire pre-crash buffer data sample.

Although the ambulance was equipped with a Global Positioning Satellite (GPS) mapping system, it was not functioning on the day of the crash. Based on the driver's statement to the law enforcement agency, it became necessary to assess the duration of the trip and determine the remaining distance and travel time. She retrieved her cellular telephone device to use its built-in mapping application with GPS technology, and as a result relinquished control of the vehicle. The ambulance began to drift right from its travel lane and unintentionally entered the exit lane of the approaching exit interchange ramp. It is likely that the coincident location of the exit ramp and corresponding void in the rumble strips affected the driver's ability to recognize the vehicle's errant trajectory. That is, the vehicle continued on the exit ramp without the driver realizing that she was no longer within the travel lanes.

Figure 3: South facing view of the ambulance's errant trajectory onto the exit interchange ramp.

Due to the engagement of the cruise control, the ambulance maintained its travel speed as the exit ramp increasingly curved away from the limited-access roadway. The ambulance passed through the gore and departed the roadway into the swale between the exit ramp and the multi-lane roadway. **Figure 3** depicts the trajectory of the ambulance from a pre-crash approach view. There was no evidence at the scene of any avoidance steering or braking action by the driver, an observation which was confirmed through a review of the Ford's pre-crash buffer data within the imaged EDR report. As the ambulance's left tires entered the swale, its front plane approached multiple objects.

Crash

The first crash event occurred as the front plane of the Ford impacted the yellow polymer delineator stake within the swale between the exit interchange ramp and the southbound portion of the limited-access roadway. This impact was of insignificant magnitude and did not affect or alter the ambulance's errant trajectory. **Figure 4** depicts the ambulance's crash event path from the location of the Event 1 impact within the swale. The second crash event occurred as the front plane of the Ford impacted the energy absorbing terminal of the W-beam guardrail. Associated forces deflected the end treatment along the guardrail, as designed, which deformed the guardrail and sheared multiple support posts as the ambulance maintained its forward trajectory. Due to the momentum of the ambulance with respect to its mass and speed, it maintained its forward trajectory unaltered and experienced continuous engagement with the deforming guardrail.

Figure 4: Crash event travel path of the ambulance viewed from the Event 1 impact location.

The front plane of the ambulance then impacted a small bush (Event 3) growing adjacent to the guardrail. Associated forces uprooted the bush and displaced it along the ambulance's travel path. The minimal severity of the forces associated with the Event 3 impact did not affect or alter the ambulance's trajectory. The left front corner aspect of the ambulance's front plane then impacted the right support stake and right aspect of a business/service designation sign (Event 4). This deformed the right metal support stake and initiated counterclockwise (CCW) rotation to the sign, which resulted in the separation of the sign's breakaway bases.

Similar to preceding events, the Event 4 impact was not of sufficient magnitude to affect or alter the ambulance's trajectory. **Figure 5** depicts the location of the second, third, and fourth impact Events.

Figure 5: Second, third, and fourth crash events within the ambulance's multiple event crash sequence.

Figure 6: Fall-over initiation location for the ambulance's rollover (Event 5) within the embankment/swale area.

The ambulance maintained its forward travel path and deformed the guardrail, which deflected downward. The vehicle then overrode the deformed portion of the guardrail, which snagged on the driveshaft and sheared it from the chassis. The ambulance maintained its forward trajectory and began to negotiate the steep negative embankment of the interchange ramp. Due to the slope of the embankment and the mass of the ambulance, its rear aspect began to translate the downslope and a clockwise (CW) yaw was initiated. An instability was created as the vertical axis of the ambulance's center of mass deviated left from the normal axis with respect to the cross-slope of the embankment. This initiated a fall-over rollover sequence off of the embankment (Event 5). **Figure 6** depicts the rollover initiation location and trajectory of the ambulance, as well as the embankment and broad grass area between the limited-access roadway and the exit interchange ramp.

As the ambulance rolled left side-leading, repetitive contact with the ground resulted in multiple areas of gouging and displacement of the grass and soil surface. Forces associated with the rollover resulted in the fracture of the cot's frame rail and corresponding disengagement from the cot fastening system during the initial four quarter-turns of the rollover. Centrifugal forces subsequently displaced the cot and patient vertically and held the cot and its occupant within the right roof area of the patient compartment as the rollover continued to develop.

The structural integrity of the patient compartment became compromised during the sixth and seventh quarter-turns of the rollover sequence, and its right plane began to separate. Subsequently, the entire right plane of the patient compartment and its components, including the right occupant loading door, right wall, cabinetry, bench seat, and right rear loading door, separated entirely from the ambulance during the eighth and ninth quarter-turns.

Separated components and loose interior objects were projected forward along the ambulance's trajectory by the centrifugal forces of the rollover. The catastrophic integrity loss resultant from the right plane separation also permitted the complete ejection of the cot and patient. The male EMT remained within the patient compartment until the tenth quarter-turn, at which point he, too, was completely ejected through the open right plane of the patient compartment.

During the rollover sequence, the ambulance's front plane struck the branches of a 15 cm (6.0 in) diameter tree (Event 6). Although the branches were sheared by the associated forces, the impact was not of sufficient magnitude to interrupt or alter the ambulance's rollover sequence. The ambulance maintained its rollover and came to final rest with its left plane facing upward (with the open right plane area down) after having completed eleven quarter-turns. The overall distance of the rollover from the initiation point to the final rest position measured 45.0 m (147.6 ft). **Figure 7** depicts a lookback view from the ambulance's final rest position to the rollover path and Event 6 impact location.

Figure 7: Lookback from the ambulance's final rest position to the Event 6 impact and Event 5 rollover path.

The cot contacted the ground and was redirected, causing the patient to separate from the cot. The cot came to final rest approximately 15.0 m (49.2 ft) beyond the ambulance's final rest position, with the patient also coming to final rest within the open grassy area approximately 15.0 m (49.2 ft) southwest of the ambulance's final rest position. The separated right plane and its components came to final rest as a relatively whole unit, approximately 14.0 m (46.0 ft) southeast of the ambulance's final rest position.

Post-Crash

The local emergency response system received multiple communications reporting the crash and dispatched local fire department, EMS, and law enforcement personnel to the scene. Upon the arrival of EMS personnel, the non-responsive patient was pronounced deceased. The ejected male EMT was immobilized on a long spine board with cervical collar and transported to a local hospital by ambulance for evaluation and treatment of police-reported non-incapacitating (B-level) injuries. Firefighters utilized a manual hand saw to cut and remove the Ford's windshield, and they then cut the driver's safety belt webbing. The driver exited the vehicle with some assistance. As a precaution, she was immobilized on a long spine board with cervical collar and then transported to a local hospital by ambulance for evaluation and treatment of police-reported non-incapacitating (B-level) injuries. A local recovery service responded to the scene and towed the ambulance to a local storage facility, where it was held on impound by the law enforcement agency. The cellular telephone device of the driver was seized by the investigating officer. As of the date of this technical report, no charges had been filed against the driver.

2011 FORD E350 TYPE III AMBULANCE

Description

The Ford E350 was a cutaway chassis identified by the Vehicle Identification Number (VIN): 1FDWE3FS5BDxxxxxx. It was manufactured as an incomplete vehicle chassis in June 2011 and was equipped with Ford's Ambulance Prep Package. A placard confirmed that the Ford conformed to all applicable Federal Motor Vehicle Safety Standards (FMVSS) in effect as of its date of manufacture. The Ford's digital odometer reading could not be obtained due to electrical system inoperability. The Ford had a dual-wheel rear axle and was built on a 351 cm (138.0 in) wheelbase. The rear-wheel drive powertrain consisted of a 6.8-liter V-10 gasoline engine that was linked to an electronic 4-speed automatic transmission with overdrive. **Figure 8** depicts the 2011 Ford E350 ambulance at the time of the SCI inspection.

Figure 8: Front left oblique view of the 2011 Ford E350 ambulance at the time of the SCI inspection.

The vehicle manufacturer's recommended tire size was LT225/75R16 front and rear, with recommended cold tire pressures of 415 kPa (60 PSI) for all six tire locations. All visible tires were Goodyear Wrangler SRA of the recommended size, with matching Tire Identification Numbers (TINs) of "PJ1L H5HV." Specific tire data measured at the time of the SCI inspection was as follows:

Position		Measured Pressure	Measured Tread Depth	Restriction	Damage
LF		421 kPa (61 PSI)	6 mm (8/32 in)	No	None
LR	Outer	415 kPa (60 PSI)	6 mm (7/32 in)	No	None
	Inner	Unknown	6 mm (8/32 in)	No	None
RR	Outer	Tire Flat	5 mm (6/32 in)	No	None
	Inner	Unknown	4 mm (5/32 in)	No	None
RF		358 kPa (52 PSI)	6 mm (7/32 in)	No	None

The interior of the Ford's cab was configured for the seating of two occupants. Both seats were forward-facing, box-mounted seats with manual seat track and seat back recline adjustments, and featured integral head restraints. At the time of the SCI inspection, both front seats were adjusted to their rearmost track positions. Occupant protection systems included 3-point lap and shoulder safety belts with buckle pretensioners, as well as driver and front right passenger frontal air bags. Between the two seats and beneath the instrument panel's stereo and climate controls was a center console with an array of switches and communications equipment related to the ambulance's emergency response and operations activities.

The Ford's chassis was completed as a Type III Certified "Star of Life" ambulance during secondary manufacturing by Wheeled Coach Industries, Incorporated of Winter Park, Florida in October 2012. This consisted of the affixation to the Ford's chassis of the Wheeled Coach model "CitiMedic Plus VII" patient compartment and the installation of emergency services operation equipment, such as warning lights, sirens, and radio communications. A placard confirmed that the Wheeled Coach Type III ambulance conformed to the Federal Specifications KKK-A-1822 in effect on its date of manufacture.

Wheeled Coach CitiMedic Plus VII Patient Compartment

The Wheeled Coach patient compartment (**Figure 9**) had overall length x width x height dimensions of 371 cm x 269 cm x 173 cm (146.0 in x 90.0 in x 68.0 in). It was configured for the seating of up to four occupants surrounding a centralized cot for the patient, with numerous wall-mounted cabinets, shelves, and countertops for the storage of medical equipment and supplies. The layout included double-rear entry doors for cot loading and a right side entry door, with multiple exterior storage compartments.

Figure 9: Left side view of the Wheeled Coach Type III patient compartment.

The patient compartment was constructed primarily of 5x5 cm (2.0x2.0 in) square aluminum tubing welded in ladder-frame patterns, with aluminum sheeting covering exterior surfaces. Interior cabinets were constructed of 2 cm (0.75 in) plywood bonded using glue and wooden pegs, with laminate surface finish and Lexan sliding doors. Aluminum corner bead was used for edge trim. Fiberglass and foam insulation provided thermal barrier and sound protection from the outside environment.

The left plane of the patient compartment featured three exterior storage compartments with warning and scene lighting. The storage compartments provided ample space for secured storage of the large on-board oxygen cylinder, vehicle maintenance supplies, and long spine boards. The right plane featured a rear storage compartment for the spare tire, a forward access drawer for the patient compartment's low-voltage (12-V) batteries, and a compartment door for curbside access to an interior EMS supply cabinet.

The interior of the patient compartment was equipped as a mobile emergency medical care unit with a centralized patient cot. The left wall consisted of seven storage cabinets, a recessed storage area for the secured storage of a stair chair, an open countertop, and an array of switches and controls for the patient compartment's lighting and Heating, Ventilation, and Air Conditioning (HVAC).

A rear-facing captain's chair was located immediately right of the countertop, overlooking the head area of the cot (**Figure 10**). The pass-through to the cab was in front of the captain's chair, and a large cabinetry area was located on the right aspect of the front wall. The right wall included the three-passenger bench seat with small overhead storage cabinetry. The cot was positioned rear-facing within the central area of the patient compartment.

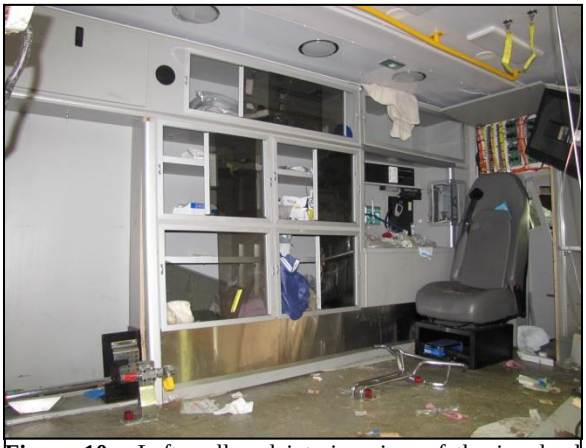


Figure 10: Left wall and interior view of the involved ambulance's patient compartment.

Vehicle Weight/Payload

The Ford chassis was placarded by its manufacturer with a Gross Vehicle Weight Rating (GVWR) of 5,216 kg (11,500 lb). This was distributed as Gross Axle Weight Ratings (GAWR) front and rear of 2,087 kg (4,600 lb) and 3,538 kg (7,800 lb), respectively. The curb weight of the completed ambulance was 4,244 kg (9,358 lb). A vehicle weight/payload certification sticker placarded by the manufacturer of the Wheeled Coach patient compartment further declared that the total useable payload was 972 kg (2,142 lb). This exceeded the 794 kg (1,750 lb) minimum payload availability allowed by the KKK-A-1822 specifications as of the ambulance's date of manufacture.

During the SCI vehicle inspection, the SCI Investigator estimated the combined weight of the EMS equipment and supplies on-board the involved ambulance to be approximately 431 kg (950 lb). Based on the vehicle's placarded available payload and the SCI Investigator's assessment of the EMS equipment and supplies, the calculated available payload for occupants and personal belongings was 541 kg (1,192 lb). It was therefore concluded that the ambulance was not operating in excess of its available payload capacity at the time of the crash.

Exterior Damage

The SCI inspection of the ambulance identified multiple areas of impact and rollover damage which were directly related to the multiple events of this crash. Any damage associative to the polymer delineator stake (Event 1) impact was overlapped by subsequent events. Although direct contact damage was masked, the non-rigid, small diameter object likely did not result in measurable deformation to the Ford's front plane.

Based on the location of the stake with respect to the Ford's tracking tire marks, the Collision Deformation Classification (CDC) assigned to the ambulance for the Event 1 impact was 12FLEN1. No WinSMASH calculations could be performed for the Event 1 impact due to the minor severity of the event, lack of measurable deformation, and yielded status of the struck object.

Direct contact damage associated with the guardrail (Event 2) was distributed across the Ford's front plane. Although initial engagement was narrow based on the 38 cm (15.0 in) width of the energy absorbing end terminal, prolonged engagement with the deforming guardrail and its posts resulted in damage across the Ford's entire 178 cm (70.0 in) front end width. Frontal components, including the bumper beam, grille, radiator, headlight assemblies, fascia, and hood were deformed rearward by associated contact and crash forces. Damaged frontal components separated in whole or in part during the subsequent crash sequence events. At the time of the SCI vehicle inspection, the metallic front bumper was completely separated from its frame rail mounts.

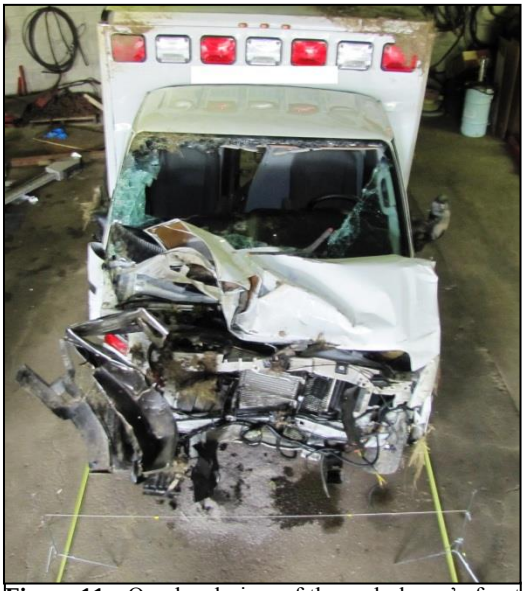


Figure 11: Overhead view of the ambulance's front plane and crush measurements.

Using the documented undamaged cab length, the SCI Investigator obtained damage measurements to the exposed frame rail ends (**Figure 11**). Based on exemplar measurements, no deflection of the frame rail ends resulted from the crash. The CDC assigned to the ambulance for the Event 2 guardrail impact was 12FREW2. No WinSMASH calculations could be performed for the Event 2 impact due to the yielded status of the guardrail and posts and lack of measurable deformation.

Direct and induced contact damage associated with the bush impact (Event 3) was overlapped by subsequent events and not discernable on the Ford's front plane. The occurrence of the impact was only identifiable based on the evidence observed at the crash scene by the SCI Investigator. Based on the location and size of the bush, the impact may not have produced measurable deformation to the vehicle. The CDC assigned to the ambulance for the Event 3 impact was 12FZEN1. No WinSMASH calculations could be performed for the Event 3 impact due to the minor severity of the event, lack of measurable deformation, and yielded status of the struck object.

Based on the location of the Ford's tire marks at the scene with respect to the location of the business/service designation sign, direct contact associated with Event 4 was located on the extreme left front bumper corner, the left front fender, the left side mirror, and the left front corner aspect of the patient compartment. This damage was overlapped by subsequent events during the remainder of the crash sequence. The CDC assigned to the Ford for the Event 4 impact was 12FLAS9. No WinSMASH calculations could be performed for the Event 4 impact due to the minor severity of the event, sideswiping nature of the impact configuration, lack of measurable deformation, and yielded status of the struck object.

Direct contact associated with the estimated 11 quarter-turn rollover (Event 5) was present on all planes of the Ford cab and the Wheeled Coach patient compartment. On the left plane, mud and grass were embedded in various body panel seams and voids, including areas surrounding the left front fender, left front wheel, and left side mirror of the cab, as well as the top left corner, left roof side rail, left sill, left rear wheel, left rear wheel well, and bottom left rear corner of the patient compartment. The top left corner of the patient compartment was deflected at the forward plane joint with the Ford cab. The left rear exterior storage compartment of the patient compartment was jammed shut by deformation sustained at the left rear corner aspect of the patient compartment.

Severe damage and integrity loss was sustained by the ambulance during Event 5. The entire right plane and the right half of the rear plane of the patient compartment separated completely from the vehicle during the eighth and ninth quarter-turns of the rollover. On the ambulance's rear plane, only the left corner aspect, rear header, and left rear loading door remained. The right rear loading door, lower door frame, right rear corner aspect, and rear step bumper were completely separated. **Figure 12** depicts a left rear oblique view of the ambulance and its remaining components. Note the deflection and deformation to the lower left rear corner and sill. The complete separation of the right plane is depicted in **Figure 13**. The separation of the right plane resulted from the fracture of all welded joints of the roof and floor structure to the right plane. Some of the joints were welded circumferentially, while others were spot welded (**Figure 14**).

Figure 12: Left rear oblique view of the ambulance and remaining components.

Figure 13: View of the missing right plane of the ambulance's patient compartment.

Figure 14: Close-up view of the differing joint welds observed along the right roof side rail of the ambulance's patient compartment.

Due to the right plane separation, no right plane rollover crush measurements could be obtained. The Ford's cab did not sustain deformation explicit to the rollover. The only other measureable damage attributable to the rollover was located at the lower left rear corner aspect of the patient compartment, where the maximum lateral deformation measured 11 cm (4.3 in). Due to the separation of the right plane, the estimated CDC assigned to the ambulance for the rollover (Event 5) was 00RDAO99 (*where "99" represents an unknown value*). No WinSMASH calculations could be performed due to the non-horizontal nature of the associated forces.

The Event 6 impact with the tree, which occurred during the final quarter-turns of the rollover sequence, involved the front plane of the ambulance. At the time of the SCI inspection, several small twigs and pieces of tree branch were entangled within frontal components and matched the damaged tree observed during the SCI scene inspection. This damage pattern overlapped damage sustained during earlier, more significant crash events, and as such an accurate residual crush profile could not be obtained. However, based on the direct contact identified and in conjunction with the size of the tree and its location with respect to the final rest position of the ambulance, a CDC of 00FCEN1 was assigned to the Event 6 impact damage. No WinSMASH calculations could be performed for the Event 6 impact due to non-horizontal nature of the forces, lack of measurable deformation, and yielded status of the struck object.

Event Data Recorder

The 2011 Ford E350 was equipped with a Restraints Control Module (RCM) mounted to the floor beneath the driver's seat. It was designed for the diagnostics, sensing, and control of the vehicle's supplemental restraint and air bag systems, and also had EDR capabilities. The RCM's EDR data was imaged using the Bosch CDR tool and software version 13.0.1 via a connection directly to the RCM and using 110-V alternating-current (AC) electricity to power the CDR interface. The imaged RCM data, reported with software version 16.1.1, is included at the end of this technical report as **Attachment A**.

The Ford's RCM monitored bi-directional acceleration (longitudinal and lateral) data. It did not have roll-sensing capabilities. The EDR component within the RCM had the capacity to store up to two events and the capability to distinguish two event types. These events were termed Deployment and Non-Deployment. Deployment events by definition were events which met the threshold required to deploy an air bag device. Deployment events were locked within the RCM's memory and could not be overwritten. Following a Deployment event, the RCM was required to be replaced in conjunction with the vehicle's repair.

Non-Deployment events were events which met the threshold to record data, but the severity of the event was not large enough to require an air bag device deployment. Non-Deployment events were unlocked events and could be overwritten by subsequent events. Associative to each event's recording was a 5-second pre-crash data buffer which, populated with vehicle performance and operational data, was linked to each recorded event.

The imaged EDR data contained two unlocked Non-Deployment events designated the "First Record" and "Second Record." The Non-Deployment events were separated in time by 200 milliseconds. Analysis of the recorded events was consistent with the circumstances of the guardrail impact (SCI Event 2) and its associated prolonged engagement, as the vehicle sheared multiple support posts and deformed the guardrail. The EDR data was imaged on Ignition Cycle 4,773, with both events reported on ignition cycle 4,770.

First Record

At the time of this Non-Deployment event, no Diagnostic Trouble Codes (DTCs) were present. The Air Bag Warning Lamp within the instrument cluster was not illuminated (Off). The driver's safety belt was "Buckled." The speed control telltale, relating to the activation status of the vehicle's cruise control, was indicated "On." A field within the data labeled the Key-On Timer represented the length of time that the vehicle's electrical system was energized (i.e. Ignition On). The Key-on Timer value was 13,630 seconds. The EDR data was completely written to memory. The pre-crash buffer associated with the First Record is listed in the following table:

Time sec	Speed km/h (mph)	Engine RPM	Accelerator Pedal	Service Brake Status	ABS Activity	Stability Control
-5.0	118.0 (73.3)	2,500	0%	Off	Non-engaged	Non-engaged
-4.5	118.0 (73.3)	2,500	0%	Off	Non-engaged	Non-engaged
-4.0	118.0 (73.3)	2,500	0%	Off	Non-engaged	Non-engaged
-3.5	118.0 (73.3)	2,500	0%	Off	Non-engaged	Non-engaged
-3.0	118.0 (73.3)	2,500	0%	Off	Non-engaged	Non-engaged
-2.5	118.0 (73.3)	2,500	0%	Off	Non-engaged	Non-engaged
-2.0	118.0 (73.3)	2,500	0%	Off	Non-engaged	Non-engaged
-1.5	119.0 (73.9)	2,500	0%	Off	Non-engaged	Non-engaged
-1.0	118.0 (73.3)	2,500	0%	Off	Non-engaged	Non-engaged
-0.5	118.0 (73.3)	2,500	0%	Off	Non-engaged	Non-engaged
0	118.0 (73.3)	2,500	0%	Off	Non-engaged	Non-engaged

The pre-crash data is indicative of the vehicle maintaining a constant travel speed in relation to the driver's use of the cruise control system. It also provides further insight into and verification of the driver's lack of response or avoidance attempt prior to the crash. The maximum recorded longitudinal delta-V associated with the First Record event was -20.70 km/h (-12.86 mph), which occurred at 300 milliseconds after Algorithm Enable (AE). The maximum recorded lateral delta-V was 3.22 km/h (2.00 mph) and occurred at 217 milliseconds after AE. Although the magnitude of the longitudinal delta-V appears significant, it should be noted that it occurred over a long duration in time and thus likely did not surpass air bag system deployment criteria threshold. An analysis of the Second Record revealed that the front safety belt buckle pretensioners were actuated by the RCM for the First Record, however, their presence and status was not reported by any fields within the EDR report.

Second Record

The Non-Deployment data recorded within this event was consistent with the First Record data. The Air Bag warning Lamp was "Off," and the Driver Safety Belt was "Buckled," and the speed control telltale was "On." A DTC, represented by the nomenclature "B0090-93" and relating to the driver's safety belt system, was reported for the Second Record. The presence of this DTC confirmed buckle pretensioner actuation by the RCM for the First Record. The Second Record, with respect to each record's AE, occurred 200 milliseconds after the First Record and contained pre-crash buffer data identical to the First Record. The maximum recorded longitudinal delta-V associated with the Second Record was -5.86 km/h (-3.64 mph), which occurred at 203 milliseconds after AE. The maximum recorded lateral delta-V was 7.45 km/h (4.63 mph) and occurred at 264 milliseconds after AE. The low magnitude of the delta-V likely did not surpass air bag system deployment criteria threshold.

Interior Damage

Ford Cab

The cab of the ambulance was inspected for occupant contact, intrusion, and crash related damage. There was no observed evidence of interior occupant contact points, the absence of which was attributed to the driver's use of the available manual safety belt system. It was noted that the AS1 laminated windshield glazing had been removed by emergency response personnel to obtain entry to the ambulance's cab and provide a means of egress for the driver. **Figure 15** depicts the driver's seat position within the ambulance's cab at the time of the SCI vehicle inspection.

Figure 15: Left-facing view of the ambulance's cab and the driver's seating position.

It is probable that the windshield glazing was fractured by crash forces prior to its post-crash removal. Remaining glazing of the Ford's cab remained intact and both front doors were closed and operational.

Wheeled Coach CitiMedic Plus VII Patient Compartment

The interior of the patient compartment sustained crash-related damage that was attributable to integrity loss and occupant contact. There was no evidence of any intrusion into the patient compartment; however, intrusion of objects within the physical environment was made possible during the later stages of the crash sequence relative to the integrity loss sustained. Left side cabinetry was separated along major joint seams as a result of the overall induced deflection of the patient compartment's structure.

The majority of the EMS supplies originally contained within the left side cabinetry prior to the crash was released from within their respective cabinets during the rollover sequence and ejected following separation of the joint seams and displacement of the sliding polymer doors. The collapsible stair chair that was strapped against the wall within the left rear corner of the patient compartment's interior became dislodged during the crash sequence and was also ejected during the rollover. All other EMS equipment and supplies within the interior of the patient compartment, including those within the cabinetry at the right front corner aspect, were ejected following the integrity loss of the right plane. **Figure 16** depicts the interior of the patient compartment at the time of the SCI vehicle inspection.

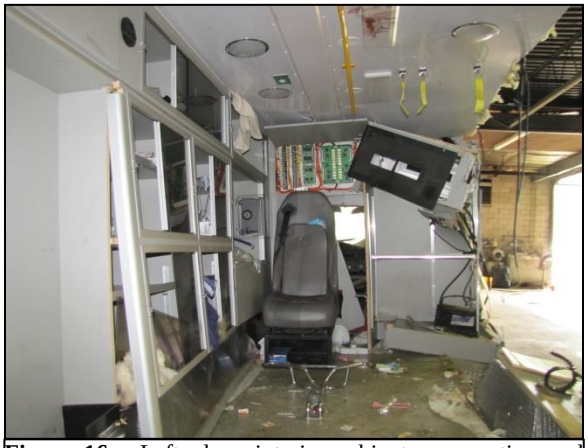


Figure 16: Left plane interior cabinetry separation and patient compartment damage.

Figure 17: Separated right plane of the patient compartment and its components.

Cabinetry and the HVAC unit mounted to the forward wall of the patient compartment also became separated during the rollover sequence. All right plane cabinetry, including the bench seat, remained affixed to the separated right plane. **Figure 17** depicts the separated right plane of the patient compartment. Note separated components, including the right side occupant loading door, right rear loading door, bench seat, right rear wheel well, right rear exterior compartment, and interior cabinetry components.

Occupant contact damage was located on the roof of the patient compartment's interior and was attributable to contact and loading from the displaced patient during the rollover crash event sequence. This contact and loading consisted of the deformation of the yellow aluminum hand rail mounted to the roof structure and large blood splatter on the roof's surface (**Figure 18**). The blood splatter displayed high velocity characteristics and was accompanied by a smear that extended from its origin location on the roof laterally toward the open right plane.

Figure 18: Deformed hand rail and blood on the roof structure of the patient compartment attributable to contact from the patient.

The blood splatter and smear were consistent with the patient having contacted the hand rail and roof components with his head and then remaining engaged with the roof structure as he initiated and completed his ejection path. There was no discernable contact evidence identified during the SCI vehicle inspection that could be associated with the male EMT's kinematics.

Manual Restraint Systems

Ford Cab

The manual restraints for the driver and front right passenger positions consisted of 3-point lap and shoulder safety belts with buckle pretensioners. Both safety belt systems utilized continuous loop webbing with sliding latch plates and adjustable D-rings. The driver's manual restraint was equipped with an Emergency Locking Retractor (ELR), while the front right passenger's manual restraint was equipped with a switchable ELR/Automatic Locking Retractor (ALR). Both adjustable D-rings were in their full-height positions.

The driver's safety belt webbing had been cut by emergency response personnel in order to assist the driver from the overturned vehicle following the crash. The cut was located 170 cm (67.0 in) from the lower anchor (**Figure 19**). All remaining webbing above the cut location had retracted and was concealed by the retractor within the polymer B-pillar fascia. No crash-related occupant loading or contact damage could be identified on the cut portion of the safety belt webbing. At the time of the SCI inspection, the driver's sliding latch plate remained engaged within the buckle. There were minor loading abrasions identified within the belt path on the latch plate.

Figure 19: Left-facing view of the ambulance's cab and the driver's seating position.

Based on the inspection of the driver's safety belt system, and in conjunction with a review of the data imaged from the Ford's EDR, it was apparent that the driver's safety belt system was in use by the driver for manual restraint at the time of the crash. The absence of interior points of contact and driver injury was consistent with her use of the manual restraint. There was no loading evidence present on the front right safety belt system; however, the front right seat was unoccupied at the time of the crash.

Wheeled Coach CitiMedic Plus VII Patient Compartment

The interior of the patient compartment was equipped with manual lap safety belt systems for all three bench seat positions, as well as a 3-point lap and shoulder safety belt for the captain's chair. All three lap belts utilized continuous loop webbing with sewn latch plates and ELR retractors, and their components were mounted to the right wall of the patient compartment. They displayed little-to-no evidence of historical use.

The captain's chair safety belt system also had an ELR with continuous loop webbing and utilized a sliding latch plate. The retractor was integrated into the seat back, while the lower anchor and buckle were mounted to the swivel base. The captain's chair was further equipped with a 5-point harness that was integrated into a folding flap within the seat back. At the time of the SCI inspection, the ELR was locked (**Figure 20**) and the webbing was devoid of crash-related occupant loading evidence. In conjunction with the male EMT's ejection, it was apparent that the captain's chair safety belt system was not in use at the time of the crash.

Figure 20: Locked ELR of the captain's chair safety belt system at the time of the SCI inspection.

Supplemental Restraint Systems

The ambulance was equipped with a frontal air bag system that provided supplemental inflatable restraint for the driver and front right passenger. This system consisted of dual-stage air bags that were mounted within the steering wheel hub and top right instrument panel, respectively. The vehicle was not subject to the advanced air bag portion of FMVSS No. 208; therefore, the air bag system was not Certified Advanced 208-Compliant (CAC). Both air bags were installed by the manufacturer and had not required any service or maintenance prior to the incident crash.

The frontal air bags did not deploy during the multiple event crash sequence. Based on a review of the imaged EDR data, the longitudinal delta-V severity associated with the recognized frontal crash events likely did not surpass deployment threshold. Because the Ford was not equipped with side impact or Inflatable Curtain (IC) air bags, nor did it have roll sensing capabilities, no deployment of any air bag systems would be expected in relation to the rollover crash event.

Patient Cot and Fastening System

Description

The patient cot (**Figure 21**) was a 6500 Power-PRO XT Power Ambulance Cot that was manufactured by Stryker, serial number (S/N): 13074xxxx. Based on this serial number, it was manufactured in July of 2013. 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 power raise/lower capabilities with infinite height positions between a minimum of 36 cm (14.0 in) and a maximum of 105 cm (41.5 in).

Figure 21: Stryker 6500 Power-PRO XT cot at the time of the SCI inspection.

The mattress platform featured 0-73 degrees of positive backrest angular adjustment via a manually controlled gas-pressure cylinder. The leg portion featured 15 degrees of positive angular adjustment. Overall dimensions of the cot were 58 cm (23.0 in) wide and 206 cm (81.0 in) long. The 6500 series Power-PRO XT was equipped with Stryker's Expandable Patient Surface (XPS) armrest rails that folded outward and increased the cot's width in order to accommodate oversize occupants. A placard declared that the load capacity limit of the cot was 318 kg (700 lb). Electrical power for the raise/lower capabilities was supplied by a removable 24-V nickel-cadmium (NiCad) direct current battery, manufactured by DeWalt. When depleted, the battery was removed from its port and placed in a docking station for automatic charging via a 120-V alternating current connection.

The Stryker cot was equipped with a multi-point harness system for manual restraint of its occupant (patient). This system consisted of a lateral leg strap, a lateral lap/thigh strap, and two shoulder straps that buckled into a lateral chest strap. All webbing straps were fixed length and included locking latch plates or sewn buckles. At the time of the SCI inspection, the lateral restraint straps of the cot all remained buckled (**Figure 22**). Both shoulder harness straps were tucked behind the head portion of the mattress. In its buckled position, the leg strap was adjusted to a length that provided 55 cm (21.7 in) of available occupant space. The lap/thigh and chest straps provided 81 cm (31.9 in) and 88 cm (34.6 in), respectively. The comparison value of the buckled lateral straps with all slack removed was 43 cm (16.9 in).

Figure 22: Lateral restraint straps of the Stryker cot at the time of the SCI inspection.

The cot was secured in place within the patient compartment via a Model Stryker Model 6370 Cot Fastener System. It was manufactured in January of 2013 and was identified by the S/N: 13013xxxx. The system consisted of a forward antler bracket and rearward locking rail-clamp mechanism. The antler bracket cradled the forward portion of the cot's frame, while the vertically-oriented locking mechanism secured the pin affixed to the lower frame rail of the cot. Combined, these two components were intended to restrict the lateral and longitudinal movement of the cot within the ambulance.

Cot Damage

The Stryker cot sustained major damage as a result of the multiple-event crash. Initial damage during the crash sequence consisted of deformation sustained by the right lower frame rail due to loading and inertial forces. Those forces exceeded the shear strength load of the aluminum, and the frame rail sheared at the securement location of the locking pin. Following the shear of the tubular aluminum frame rail, the cot became dislodged from the fastening system and was subjected to unrestricted movement within the patient compartment.

During the rollover sequence (Event 5), the cot was displaced vertically and contacted the roof structure of the patient compartment's interior. The foot end and elevated head end of the cot, in conjunction with the patient, loaded and deformed the hand rail. This loading induced deformation to the elevated head portion of the mattress bed.

Following the cot's ejection during the rollover, it struck the ground with sufficient force to deform the left caster at the foot end and bend the frame rails. This was evidenced by gouge marks at the scene that corresponded to soil and grass embedded within the caster. The cot then initiated its own tumbling trajectory, which separated the occupant from the cot and induced further damage. The intravenous (IV) fluid pole fractured at its base and separated from the cot's frame. The SCI Investigator located the IV pole within the grass swale during the scene inspection.

The tumbling trajectory of the cot deformed the telescopic portion of the cot's platform frame beneath the head portion of the mattress bed. The X-frame support legs separated from the cot's platform frame at the foot end of the cot. The mattress bed and platform also appeared deformed. **Figures 23 and 24** depict the damaged cot at the time of the SCI inspection.

Figure 23: Fractured lower frame rail of the Stryker cot at the location of the locking pin.

Figure 24: Separated X-frame support legs at the foot end of the Stryker cot.

Cot Fastening System Damage

During the crash sequence, longitudinal, lateral, and centrifugal forces associated with the crash induced multi-directional movement to the cot. Forces associated with the rollover (Event 5) resulted in deformation to the rail-clamp mechanism of the cot fastening system and the fracture of the cot's frame. The moment force of the cot's loading was transferred to the rail-clamp mechanism via the engagement of the locking pin within the clamp, resulting in the left lateral rotation of the rail-clamp mechanism. At the time of the SCI inspection, the locking pin remained engaged within the clamp mechanism, rotated approximately 30-degrees (**Figures 25 and 26**). There was no apparent deformation or deflection of the forward antler bracket.

Figure 25: Locking pin engaged within the rail-clamp mechanism at the time of the SCI inspection.

Figure 26: Rail-clamp mechanism and locking pin rotated counterclockwise (CCW).

2011 FORD E350 TYPE III AMBULANCE OCCUPANTS

Driver Demographics

Age / Sex:	30 years / Female
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat Type:	Forward-facing box-mounted (MMUCC* Position 1)
Seat Track Position:	Rearmost
Manual Restraint Usage:	3-point lap and shoulder safety belt
Usage Source:	SCI inspection
Air Bags:	Frontal available, not deployed
Alcohol/Drug Involvement:	None
Egress from Vehicle:	Exited vehicle with some assistance
Transport from Scene:	Ambulance to a hospital
Medical Treatment:	Evaluated, treated, and released within 24 hours

** - Based on the Model Minimum Uniform Crash Criteria, Appendix N: Ambulance Diagram*

Driver Injuries

Injury No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Unknown	Unknown	Unknown	Unknown

Source: Medical record requests refused

Driver Kinematics

The 30-year-old female driver was positioned within the driver's seat of the Ford and restrained by the available 3-point lap and shoulder safety belt system. Her restraint usage was determined through a combination of the post-crash condition of the safety belt system and a review of the vehicle's EDR data. The seat was adjusted to a rearmost track position, with the seat back slightly reclined. The driver reported that she was distracted while using a GPS application on her cellular telephone device.

At the onset of the multiple event crash sequence by contact with the polymer delineator stake, the driver became alerted to the vehicle's errant trajectory. The driver did not have sufficient time to respond to the onset of the crash due to the vehicle's speed and proximity to impending objects. At impact with the guardrail, the driver initiated a forward trajectory. The safety belt system's buckle pretensioner actuated, ensuring restriction of the driver's forward movement based on the recognized crash event severity.

She loaded the safety belt system, but remained restrained within the driver's position. Her kinematics were not influenced by the third or fourth SCI crash events, which also likely did not produce injury. As the ambulance fell off of the embankment and began its left side-leading rollover sequence, the driver initiated a left lateral trajectory. The driver's restraint usage maintained her position within the driver's seat as the rollover progressed. The left front glazing remained intact, which prevented the possibility of any degree of ejection of the driver. Although she would have contacted the left door paneling with her left arm, no associated evidence was identifiable during the SCI vehicle inspection.

The driver remained within position through the duration of the rollover (SCI Event 5). The minor severity tree impact (SCI Event 6) was not of sufficient magnitude to affect the driver's kinematics or induce injury.

As the vehicle came to final rest, the driver remained restrained. She became suspended in the overturned vehicle by the safety belt system. Upon the arrival of emergency services personnel, the windshield glazing was cut out and the driver's safety belt webbing was cut. She exited the vehicle with some assistance. As a precaution, the driver was immobilized on a long spine board with cervical collar. She was then transported to a local hospital for evaluation and treatment. The driver's specific injuries remain unknown.

Captain's Chair Occupant Demographics

Age / Sex:	30 years / Male
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat Type:	Rear-facing box-mounted captain's chair (MMUCC Position 3)
Seat Track Position:	Rearmost (with respect to its orientation)
Manual Restraint Usage:	None; 3-point lap and shoulder safety belt system available
Usage Source:	SCI inspection
Air Bags:	None available
Alcohol/Drug Involvement:	None
Egress from Vehicle:	Completely ejected during rollover due to catastrophic integrity loss
Transport from Scene:	Ambulance to a hospital
Medical Treatment:	Evaluated, treated, and released within 24 hours

Captain's Chair Occupant Injuries

Injury No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Unknown	Unknown	Unknown	Unknown

Source: Medical record requests refused

Captain's Chair Occupant Kinematics

The 30-year-old male EMT was positioned unrestrained within the captain's chair inside the patient compartment of the ambulance. Restraint usage was determined through an inspection of the post-crash condition of the captain's chair safety belt system and his completely ejected status. The seat was adjusted to a rearmost track position (with respect to its rear-facing orientation).

For the first four crash events, the EMT initiated a forward trajectory and loaded the seat back of the captain's chair. Due to the relative minor severity of the first frontal impact, he likely did not sustain injury. The EMT's position in the Captain's Chair would have distributed the forces of the guardrail impact (SCI Event 2) across his posterior torso. He likely did not sustain injury from the bush and sign impacts (SCI Events 3 and 4).

At the onset of the rollover sequence (SCI Event 5), centrifugal forces induced a left lateral trajectory to the EMT. Due to his rear-facing orientation, his right flank contacted and loaded the interior cabinetry of the left wall immediately adjacent to his seating position. The location of the EMT to the left of the vehicle's centerline resulted in him remaining within the captain's chair area of the patient compartment for the majority of the rollover sequence. The tree impact (SCI Event 6) was not of sufficient magnitude to affect his kinematics or induce injury. Once the ambulance's rolling trajectory slowed and the force magnitude of the crewmember's mass surpassed the centrifugal forces of the rollover, the EMT responded to gravity and initiated a trajectory toward the ground. At that time, the ambulance had entered its tenth quarter-turn.

The EMT was completely ejected onto the ground through the open right plane as the ambulance completed its rollover and came to final rest. Upon the arrival of emergency services personnel, he was immobilized on a long spine board and transported to a local hospital for evaluation and treatment. His specific injuries remain unknown.

Patient Demographics

Age / Sex:	56 years / Male
Height:	170 cm (67.0 in)
Weight:	78 kg (172 lb)
Eyewear:	No
Seat Type:	Rear-facing cot (MMUCC Position 8)
Seat Track Position:	Not applicable
Manual Restraint Usage:	Partially restrained by a multi-point harness system (three lateral restraints (leg, lap, chest) used; shoulder straps available, but not used
Usage Source:	Vehicle and cot inspection
Air Bags:	None available
Alcohol/Drug Involvement:	Yes (Oxycodone, THC, and Diphenhydramine)
Egress from Vehicle:	Completely ejected during rollover due to catastrophic integrity loss
Transport from Scene:	None
Medical Treatment:	Pronounced deceased at the scene by emergency response personnel

Patient Injuries

Injury No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Lacerations of brainstem at level of substania nigra	140212.6,8	Roof	Possible
2	Displaced fractures of ribs with flail chest, bilateral. On left side, anterior aspects ribs 1-7, lateral aspects of 2-5, and posterior aspects of rib 10 are fractured. On right side, anterior aspects of ribs 2-7, lateral aspects of rib 2, posterior aspects of ribs 1-10 are fractured.	450214.5,3	Ground	Possible
3	Bilateral pneumothorax with atelectasis	442203.4,3	Ground	Possible
4	3x1” laceration to upper lobe of left lung	441432.4,2	Ground	Possible
5	Displaced fractures of base of skull	150200.3,8	Roof	Possible
6	Cerebrum lacerations; inferior as well as anterior and superior portions of frontal lobes	140688.3,9	Roof	Possible
7	Displaced fracture of right lamina of thyroid cartilage	340208.3,5	Roof	Possible
8	Vault fracture, multiple; open and displaced	150404.3,9	Roof	Possible

Injury No.	Injury	AIS 2005/08	Injury Source	Confidence Level
9	Maxilla fracture, displaced, NFS	250800.2,9	Roof	Possible
10	Mandible fracture, displaced, NFS	250610.2,9	Roof	Possible
11	Cerebellum, subarachnoid hemorrhage, NFS	140466.2,9	Roof	Possible
12	Fractured bodies of 1st-7th thoracic vertebrae	650430.2,7	Ground	Possible
13	Displaced left tibia fracture	854000.2,2	Ground	Possible
14	Displaced left fibula fracture	854441.2,2	Ground	Possible
15	Displaced fracture of hyoid bone – both sides, associated with moderate hemorrhages	350200.2,5	Roof	Possible
16	Complex 6x3" laceration of left face exposing soft tissue and bone	210604.2,2	Roof	Possible
17	Subgaleal hemorrhage, NFS	110402.1,9	Roof	Possible
18	Displaced left facial fractures	250400.1,2	Roof	Possible
19	Multiple small facial lacerations	210602.1,0	Roof	Possible
20	Multiple small facial abrasions	210202.1,0	Roof	Possible

Source: Autopsy Report

Patient Kinematics

The 56-year-old male patient was within the patient compartment and positioned Fowler's on the Stryker cot. He was restrained by the three lateral straps (leg, lap, and chest) of a multi-point harness system; the available shoulder straps were not used. Restraint use was determined through a combination of the post-crash inspection of the cot and its harness restraint system, as well as the kinematics of the patient during the crash sequence.

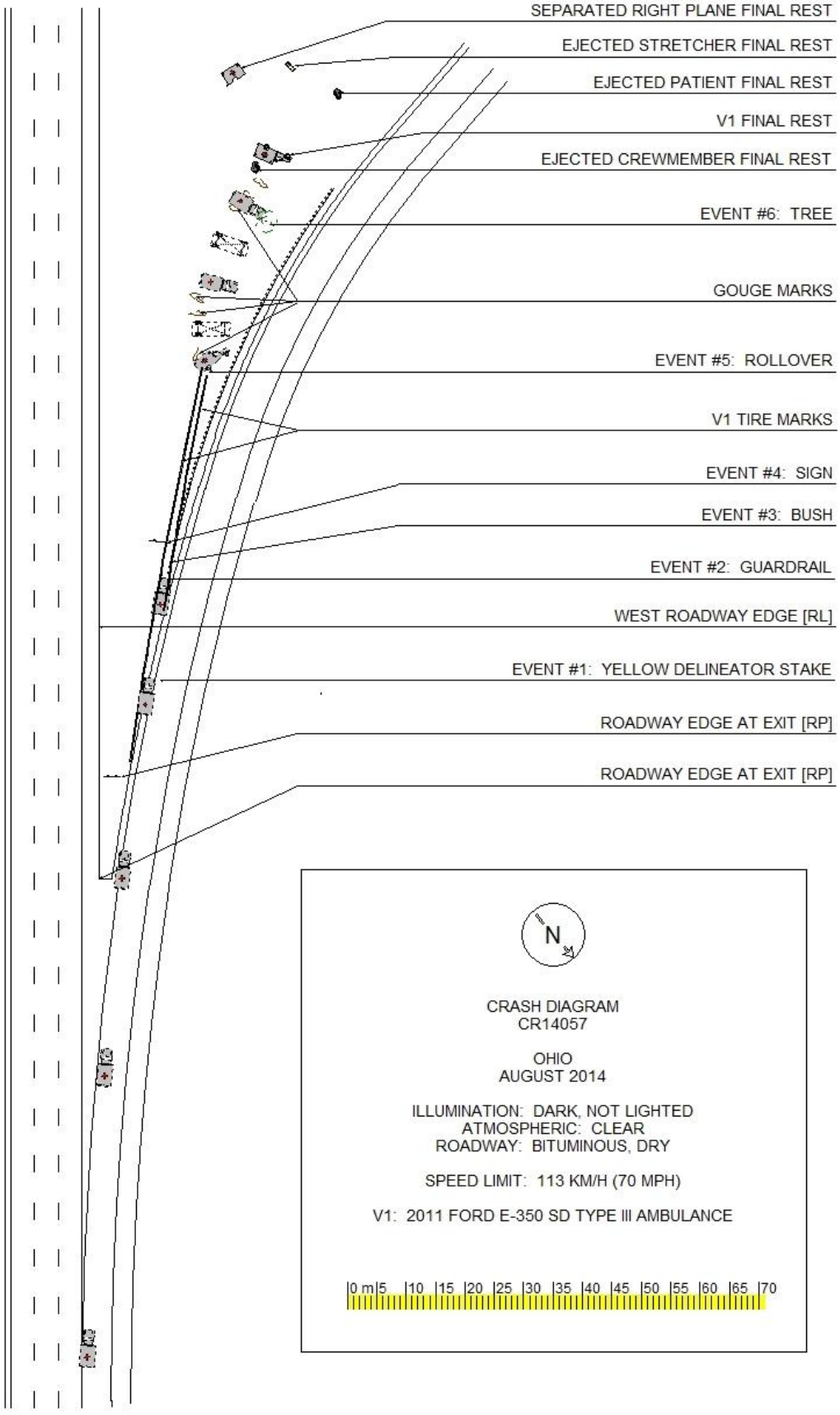
Due to the mass of the ambulance, the polymer delineator stake impact (SCI Event 1) did not initiate the patient's kinematics. However, at the onset of the guardrail impact (SCI Event 2), the patient initiated a forward trajectory. His back loaded the back support of the cot and his body translated slightly forward, thus creating slack within the lateral restraint straps of the harness. The patient remained engaged with the cot during SCI Events 3 and 4.

During the rollover sequence (SCI Event 5), centrifugal and loading forces acting on the cot surpassed the aluminum frame rail's shear strength load and sheared the lower frame rail within the area of the locking pin. Subsequently, the cot became dislodged from the fastening system. The cot and patient then contacted the roof structure of the patient compartment's interior, which resulted in multiple facial and head injuries to the patient and deformed the aluminum hand rail mounted near the roof structure's centerline (*refer to **Figure 18** above*).

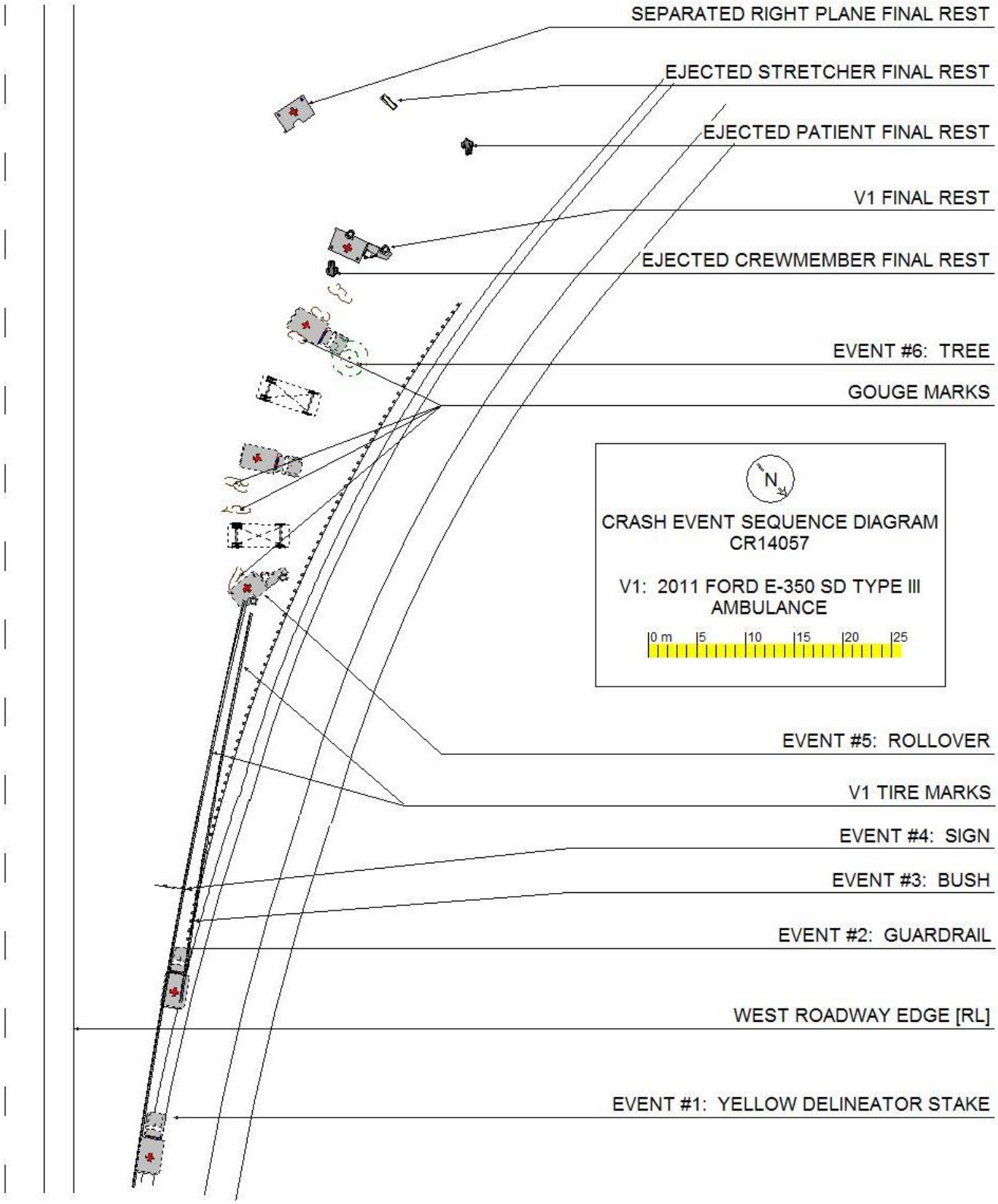
Continued centrifugal forces directed the cot and its occupant right, toward the right roof side rail area. These kinematics were evidenced by the blood transfer observed on the interior surface of the roof structure during the SCI inspection. Following the complete loss of the right plane, the cot and patient were completely ejected during the eighth and ninth quarter-turns. The cot travelled forward of the rolling ambulance and contacted the ground, resulting in the redirection of the cot's trajectory and corresponding separation of the patient from the cot.

The patient tumbled onto the grass and soil surface, and then slid to final rest within the swale area 15.0 m (49.2 ft) southwest of the ambulance. This induced multiple further injuries, and probably exacerbated or compounded the severity of injuries already sustained by the patient. Upon the arrival of emergency services personnel, the unresponsive patient was declared deceased at the scene. His body was transported to a local facility for autopsy.

CRASH DIAGRAM



CRASH EVENT SEQUENCE DIAGRAM



Attachment A

2011 Ford E350 Event Data Recorder (EDR) 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	1FDWE3FS5BD******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	CR14057_V1_ACM.CDRX
Saved on	Thursday, August 21 2014 at 13:11:33
Collected with CDR version	Crash Data Retrieval Tool 13.0.1
Reported with CDR version	Crash Data Retrieval Tool 16.1.1
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 Thursday, August 21 2014 at 13:11:33.

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	1FDWE3FS5BD******
Current VIN from PCM	1FDWE3FS5BD******
Ignition cycle, download (first record)	4,773
Ignition cycle, download (second record)	4,773
Restraints Control Module Part Number	BC24-14B321-BD
Restraints Control Module Serial Number	3109205100000000
Restraints Control Module Software Part Number (Version)	BL84-14C028-AB
Left/Center Frontal Restraints Sensor Serial Number	147043D4
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)	19,735,530
Key-on Timer at event time zero (seconds)	13,630
Vehicle voltage at time zero (Volts)	14.256
Energy Reserve Mode entered during event (Y/N)	No
Time Driver Front Satellite Sensor Lost Relative to Time Zero (msec)	5.5

Faults Present at Start of Event (First Record)

No Faults Recorded

Deployment Data (First Record)

Maximum delta-V, longitudinal (MPH [km/h])	-12.86 [-20.70]
Time, maximum delta-V longitudinal (msec)	300
Maximum delta-V, lateral (MPH [km/h])	2.00 [3.22]
Time, maximum delta-V lateral (msec)	217
Longitudinal Delta-V Time Zero Offset	1.5 ms
Lateral Delta-V Time Zero Offset	1.5 ms

Pre-Crash Data -1 sec (First Record)

Ignition cycle, crash	4,770
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	On
Powertrain Wrench Telltale	Off
Powertrain Malfunction Indicator Lamp (MIL)Telltale	Off

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	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 4.5	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 4.0	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 3.5	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 3.0	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 2.5	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 2.0	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 1.5	73.9 [119.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 1.0	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 0.5	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
0.0	73.3 [118.0]	0	Off	2,500	non-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
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- 1.5	Invalid
- 1.4	Invalid
- 1.3	Invalid
- 1.2	Invalid
- 1.1	Invalid
- 1.0	Invalid
- 0.9	Invalid
- 0.8	Invalid
- 0.7	Invalid
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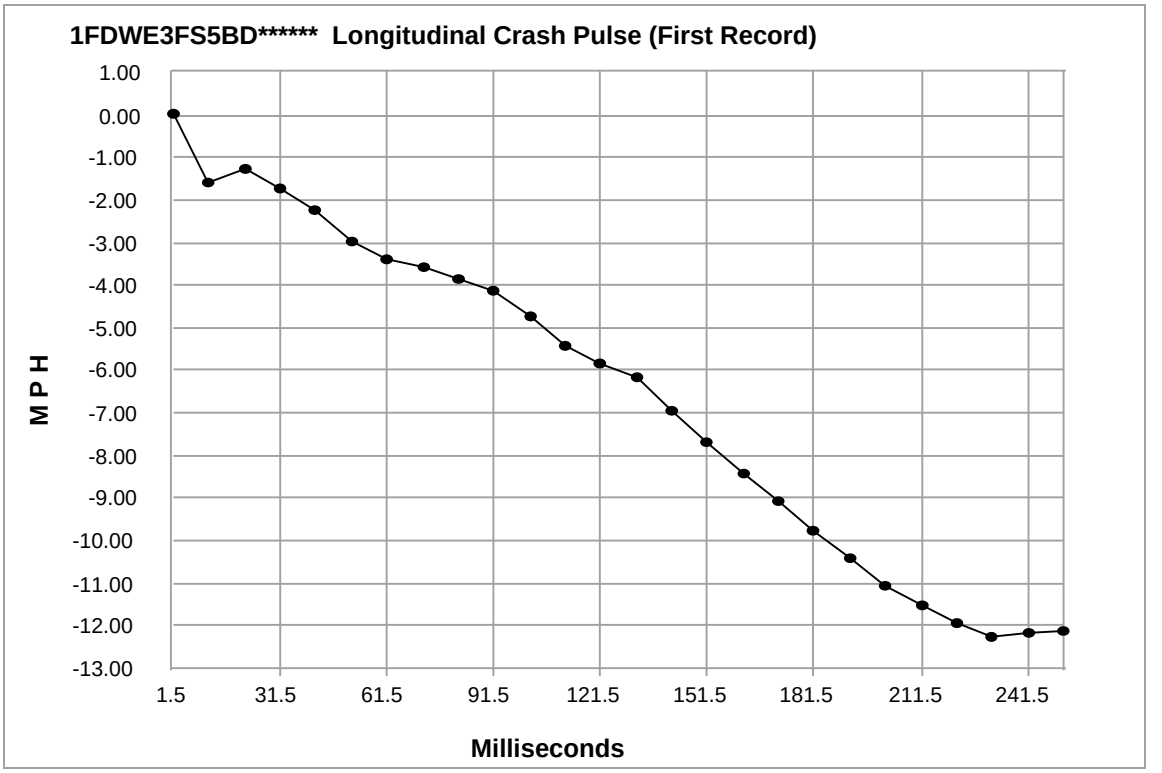
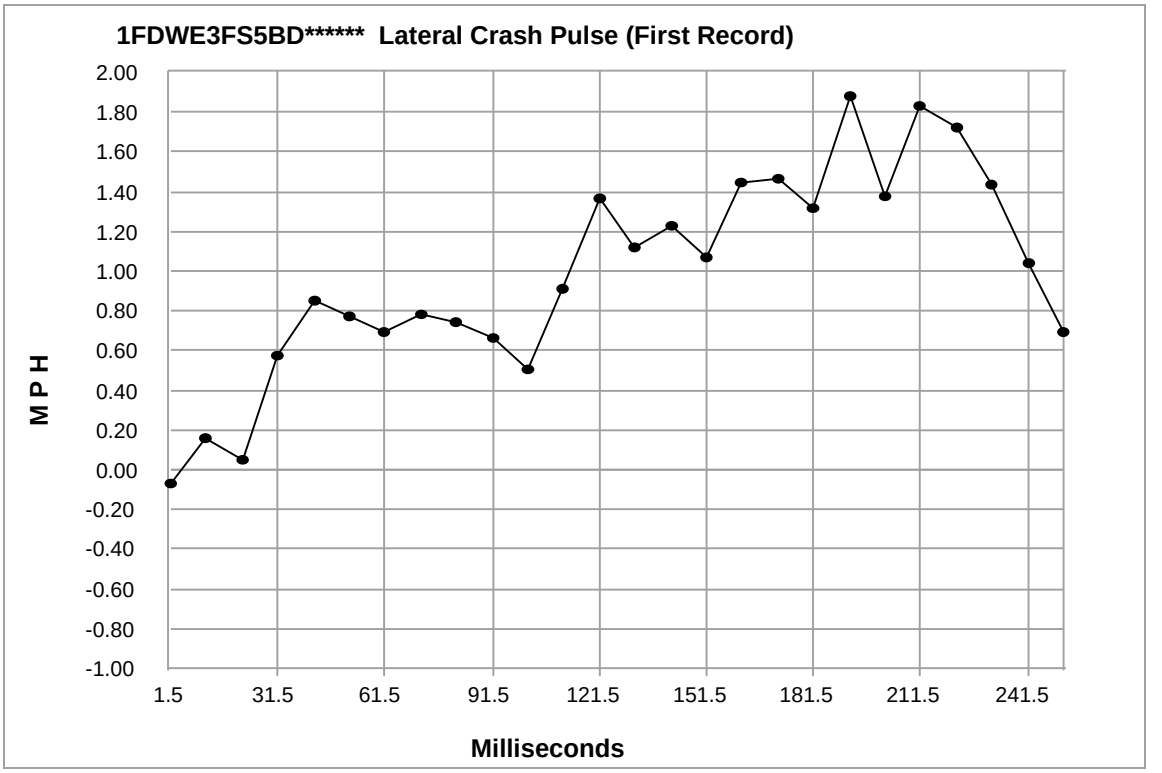
- 0.5	Invalid
- 0.4	Invalid
- 0.3	Invalid
- 0.2	Invalid
- 0.1	Invalid
0.0	Invalid



Longitudinal Crash Pulse (First Record)

Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
1.5	0.02	0.04
11.5	-1.59	-2.55
21.5	-1.27	-2.05
31.5	-1.74	-2.80
41.5	-2.24	-3.60
51.5	-2.96	-4.77
61.5	-3.41	-5.48
71.5	-3.57	-5.74
81.5	-3.86	-6.22
91.5	-4.14	-6.67
101.5	-4.75	-7.64
111.5	-5.44	-8.75
121.5	-5.85	-9.42
131.5	-6.18	-9.95
141.5	-6.95	-11.18
151.5	-7.68	-12.36
161.5	-8.41	-13.54
171.5	-9.05	-14.57
181.5	-9.76	-15.71
191.5	-10.41	-16.75
201.5	-11.06	-17.79
211.5	-11.52	-18.55
221.5	-11.96	-19.25
231.5	-12.24	-19.70
241.5	-12.17	-19.59
251.5	-12.13	-19.52



Lateral Crash Pulse (First Record)

Time (msec)	Delta-V, lateral (MPH)	Delta-V, lateral (km/h)
1.5	-0.07	-0.11
11.5	0.15	0.25
21.5	0.05	0.09
31.5	0.58	0.93
41.5	0.85	1.37
51.5	0.77	1.24
61.5	0.69	1.11
71.5	0.79	1.27
81.5	0.74	1.19
91.5	0.66	1.07
101.5	0.51	0.81
111.5	0.91	1.46
121.5	1.36	2.19
131.5	1.12	1.80
141.5	1.23	1.98
151.5	1.07	1.72
161.5	1.45	2.33
171.5	1.47	2.37
181.5	1.32	2.12
191.5	1.88	3.02
201.5	1.37	2.21
211.5	1.83	2.95
221.5	1.73	2.78
231.5	1.44	2.32
241.5	1.04	1.67
251.5	0.69	1.11

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)	19,735,530
Key-on Timer at event time zero (seconds)	13,630
Vehicle voltage at time zero (Volts)	14.094
Energy Reserve Mode entered during event (Y/N)	No
Time Driver Front Satellite Sensor Lost Relative to Time Zero (msec)	Data lost prior to event

Faults Present at Start of Event (Second Record)

B0090-93

Deployment Data (Second Record)

Maximum delta-V, longitudinal (MPH [km/h])	-3.64 [-5.86]
Time, maximum delta-V longitudinal (msec)	203
Maximum delta-V, lateral (MPH [km/h])	4.63 [7.45]
Time, maximum delta-V lateral (msec)	264
Longitudinal Delta-V Time Zero Offset	1.5 ms
Lateral Delta-V Time Zero Offset	1.5 ms

Pre-Crash Data -1 sec (Second Record)

Ignition cycle, crash	4,770
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	On
Powertrain Wrench Telltale	Off
Powertrain Malfunction Indicator Lamp (MIL)Telltale	Off

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	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 4.5	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 4.0	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 3.5	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 3.0	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 2.5	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 2.0	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 1.5	73.9 [119.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 1.0	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
- 0.5	73.3 [118.0]	0	Off	2,500	non-engaged	non-engaged	non-engaged	non-engaged
0.0	73.3 [118.0]	0	Off	2,500	non-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
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- 1.2	Invalid
- 1.1	Invalid
- 1.0	Invalid
- 0.9	Invalid
- 0.8	Invalid
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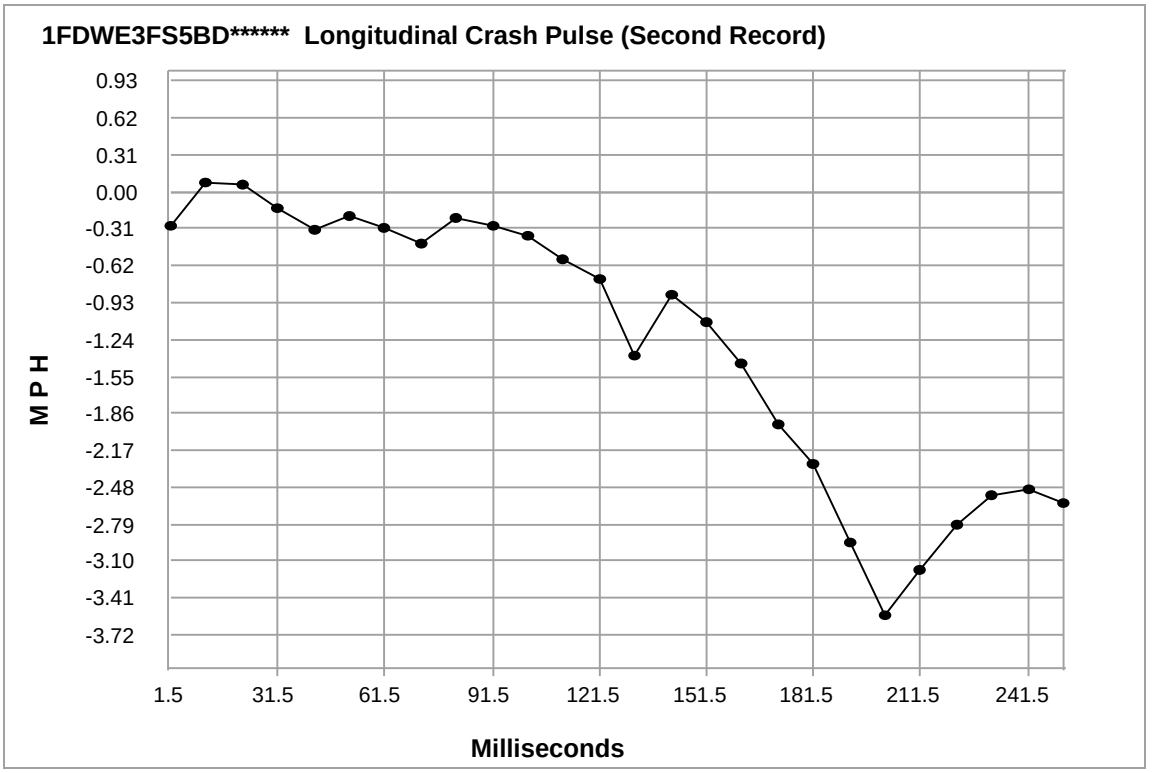
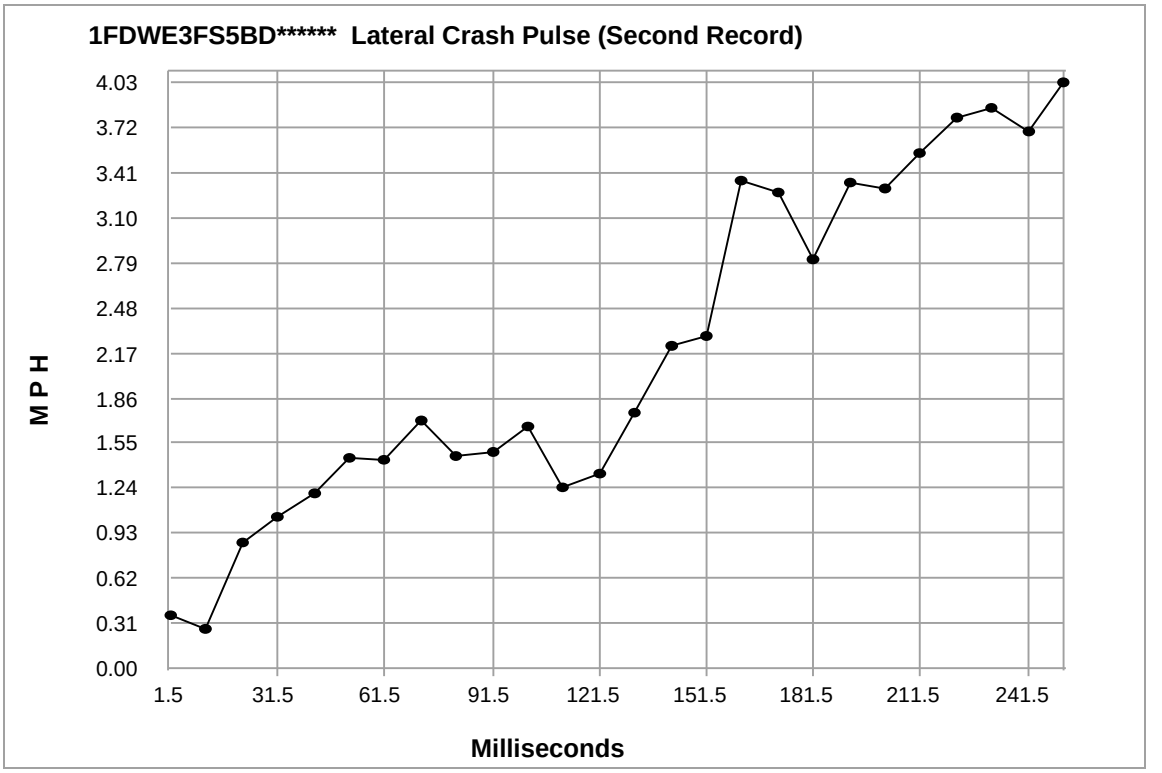
- 0.3	Invalid
- 0.2	Invalid
- 0.1	Invalid
0.0	Invalid



Longitudinal Crash Pulse (Second Record)

Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
1.5	-0.29	-0.46
11.5	0.08	0.12
21.5	0.07	0.11
31.5	-0.14	-0.23
41.5	-0.32	-0.52
51.5	-0.21	-0.33
61.5	-0.31	-0.50
71.5	-0.43	-0.69
81.5	-0.22	-0.35
91.5	-0.29	-0.47
101.5	-0.36	-0.58
111.5	-0.57	-0.91
121.5	-0.72	-1.17
131.5	-1.37	-2.21
141.5	-0.87	-1.40
151.5	-1.09	-1.76
161.5	-1.44	-2.32
171.5	-1.95	-3.14
181.5	-2.28	-3.67
191.5	-2.94	-4.73
201.5	-3.56	-5.73
211.5	-3.17	-5.10
221.5	-2.80	-4.50
231.5	-2.55	-4.11
241.5	-2.49	-4.01
251.5	-2.61	-4.21



Lateral Crash Pulse (Second Record)

Time (msec)	Delta-V, lateral (MPH)	Delta-V, lateral (km/h)
1.5	0.36	0.58
11.5	0.27	0.43
21.5	0.86	1.38
31.5	1.04	1.67
41.5	1.20	1.93
51.5	1.45	2.34
61.5	1.43	2.31
71.5	1.70	2.74
81.5	1.46	2.34
91.5	1.49	2.39
101.5	1.67	2.68
111.5	1.24	2.00
121.5	1.33	2.15
131.5	1.76	2.83
141.5	2.22	3.57
151.5	2.28	3.67
161.5	3.35	5.40
171.5	3.28	5.27
181.5	2.82	4.53
191.5	3.34	5.38
201.5	3.30	5.31
211.5	3.54	5.70
221.5	3.79	6.09
231.5	3.85	6.20
241.5	3.69	5.94
251.5	4.03	6.49

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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Event Record 1

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Event Record 2

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