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Special Crash Investigations On-Site Ambulance Crash Investigation Vehicle: 2016 Ford E-350 Type III Ambulance Location: Georgia Crash Date: June 2017

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

16. Abstract

This report documents the on-site investigation of a 2016 Ford E-350 Type III ambulance, which experienced a single-vehicle run-off-road crash that resulted in the fatality of a 55-year-old male patient who was being transported in a non-emergency mode. A belted 21-year-old female driver operated the ambulance at the time of the crash, with the patient and an unbelted 29-year-old male EMT in the patient compartment. The crash occurred overnight while the patient was being transported from a nursing facility to local hospital. The driver stated to the police that she had fallen asleep, which resulted in the right roadside departure of the ambulance. The vehicle then struck a large tree on the roadside, rotated clockwise, and rolled three quarter turns left-side-leading before coming to rest on its right plane. The patient was displaced from the cot during the crash and suffered traumatic head injuries that resulted in his death at the crash site. Both crewmembers were transported by other ambulances to a local hospital for treatment of reported non-capacitating (B-level) injuries.

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BACKGROUND

This report documents the on-site investigation of a 2016 Ford E-350 Type III ambulance (**Figure 1**) that had a single-vehicle run-off-road crash resulting in the fatality of a 55-year-old male patient being transported in a non-emergency mode. A belted 21-year-old female driver operated the ambulance at the time of the crash, with the patient and an unbelted 29-year-old male emergency medical technician (EMT) in the patient compartment. The crash occurred during overnight hours while the patient was being transported from a nursing facility to local hospital. The driver stated to the police that she had fallen asleep, which resulted in the right roadside departure of the ambulance. The vehicle then struck a large tree on the roadside, rotated clockwise, and rolled three left-side-leading quarter turns before coming to rest on its right plane. The patient was displaced from the cot during the crash and suffered traumatic head injuries that resulted in his death at the crash site. Both crewmembers were transported by other ambulances to a local hospital for treatment of reported non-capacitating (B-level) injuries.

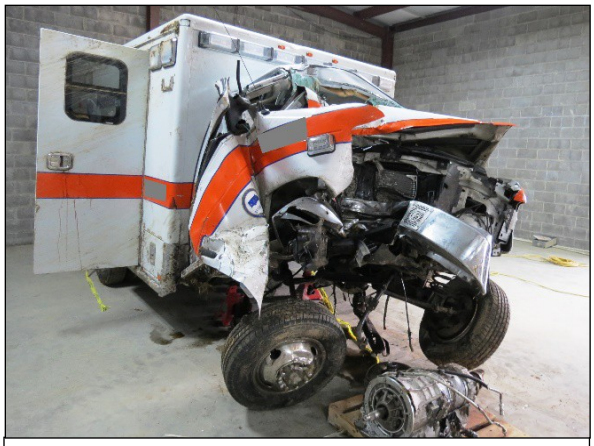


Figure 1. Right front view of the 2016 Ford E-350 Type III ambulance.

This crash was identified by the Office of Emergency Medical Services of the National Highway Traffic Safety Administration. Notification was then forwarded to NHTSA's Crash Investigation Division (CID) and assigned to the Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc., for on-site investigation in June 2017. The SCI team established cooperation with the investigating law enforcement agency, and the on-site portion of this investigation took place during June 2017. The on-site activities consisted of inspections of the ambulance and crash site. Due to pending criminal and civil legal actions, the agency owner of the ambulance refused to cooperate or provide any information for this investigation. Attorney intervention on the agency's behalf refused to allow a hands-on inspection of the patient compartment or wheeled cot, thus permitting a visual inspection only. The inspection of the vehicle therefore consisted of exterior damage measurements, documentation of intrusions into the cab, an evaluation of the manual and supplemental restraint systems in the cab, and a visual inspection of the patient compartment and its contents.

The SCI investigator was not authorized to enter or move items in the patient compartment for the visual inspection and documentation process. However, the agency agreed to allow the SCI investigator to image event data recorder (EDR) data from the Ford's restraints control module (RCM). This was performed using the Bosch Crash Data Retrieval software and tool. Following inspection of the vehicle, the crash site was photographed and documented using a total station mapping system. Attempts to interview the EMS crewmembers were denied.

SUMMARY

Crash Site

The crash occurred on a four-lane roadway overnight. Environmental conditions reported by the National Weather Service in the vicinity at the time of the crash included clear skies with a temperature of 22 ºC (71 ºF), 100-percent relative humidity, and calm winds. A Nikon Nivo 5+M total station mapping system and photographs were used to document the crash site during the SCI inspection. A crash diagram is included at the end of this report.

Figure 2. South-facing view depicting the roadway configuration and the ambulance's pre-crash trajectory.

The multi-lane roadway was oriented in the north/south direction with a left curve for southbound traffic. The radius of the curve measured 742 m (2,435 ft). Respective travel directions were separated by a double yellow centerline. The two southbound lanes measured 3.5 m (11.5 ft) wide and were separated by broken white lines, with a solid white line delineating the travel lanes from the 1.3 m (4.2 ft) wide shoulder. A continuous, full-width rumble strip was cut into the surface of the shoulder. **Figure 2** depicts a southbound view of the roadway for the ambulance's pre-crash travel trajectory. The speed of traffic on the multi-lane roadway was controlled by a posted limit of the 72 km/h (45 mph).

A local road intersected the apex of the curve from the west. The primary roadway progressed along a 1.6-percent downgrade in the southbound direction beginning in the area of the intersection. The west roadside consisted of an expansive grass area that was populated with large diameter trees dispersed approximately 30 m (100 ft) apart. A tree in the roadside located 10.5 m (34.4 ft) from the west edge line of the multi-lane roadway and 28.2 m (92.5 ft) south of the intersecting local road was the focal point of impact. The tree was fractured and uprooted by the associated impact forces. All evidence of the tree was removed at the time of the SCI crash site inspection.

Ambulance Agency, Crew, and Transport Description

The ambulance agency declined to participate in the SCI investigation and refused to provide any information to the SCI investigator concerning its operational procedures, certification requirements, training programs, or employee schedules. A statement released by the agency to the media reported that all drivers were required to complete eight hours of emergency vehicle

operations training, be supervised in the field for 48 hours, and be recertified every year. A review of the agency's website revealed that it is a multi-tiered medical transport service not associated with any particular medical treatment center and was capable of providing EMS care at both the basic life support (BLS) and advanced levels (ALS). The agency performs emergency response, mutual aid, inter-facility transfers, private requests, and specialty transports over multiple response areas in Georgia and Tennessee, using a variety of fleet ambulances and emergency response vehicles. It employs an all-career staff of management, support personnel, drivers, dispatchers, and EMTs of varying levels of care.

The SCI investigator's attempts to interview the involved EMS crewmembers were refused by the EMS agency, citing pending criminal and civil legal concerns. Specifics concerning the driver and the events leading up to the crash were documented by the investigating law enforcement agency and became public news in the weeks following the crash through statements released to the media by the driver's attorney. From these multiple sources, the SCI investigator determined the following summarized circumstances concerning the driver and the incident transport.

The 21-year-old-female driver of the ambulance reported to her assigned work shift at 1900 hours during the evening prior to this overnight crash. She was scheduled to a work a 12-hour shift, and had been on-duty for 9 hours when the crash occurred. The driver was credentialed as an advanced emergency medical technician (AEMT). Of note, she also held secondary employment. It is unknown if she had completed a work shift for her secondary employer prior to the start of this assigned shift. The driver discovered at some point in the days preceding the crash that she was 5 weeks pregnant after experiencing illness and fatigue. As a result, she had stopped consuming the caffeinated beverages that she ordinarily had relied upon to help her maintain her alertness while on-duty. She also had a history of long QT syndrome (LQTS), a condition of repolarization of the heart that has been known to cause sudden and uncontrollable arrhythmias, potentially resulting in fainting, seizures, or sudden death.[1] The driver had experienced at least one episode related to her LQTS condition during the prior year (specific time/place unknown).

No specifics were available concerning the 29-year-old male EMT, his work schedule, or his levels of training/certification.

The involved EMS crewmembers had been dispatched to respond to an area nursing facility to transport the 55-year-old male patient to a hospital. The patient was a morbidly obese individual with history of heart disease and deep vein thrombosis, who was to be transported from the nursing facility to a regional medical facility for care. The transport was executed in a non-emergency mode, without the use of emergency warning lights or siren. The hospital was 66.8 km (41.5 mi) south of the nursing facility. This distance was estimated to take approximately 54 minutes of total travel time. The crash occurred after the ambulance had traveled without incident for 63 km (39 mi), approximately 45 minutes into the trip. No specifics concerning the on-duty shift activities of the EMS crew prior to the incident transport were available.

Pre-Crash

The EMS crew arrived at the nursing facility and located the patient. They transferred him onto the bariatric-wheeled ambulance cot and placed him in the ambulance. The male EMT assumed

[1] National Heart, Lung, and Blood Institute. (n.d.). Long QT Syndrome (Webpage/portal). Retrieved from http://www.nhlbi.nih.gov/health-topics/long-qt-syndrome

care of the patient and seated himself unbelted on the right-facing bench seat in the patient compartment, though he later moved to the captain's chair during travel. The female took the driver's seat and used the available seat belt system for manual restraint. The ambulance then began the non-emergency transport of the patient to the hospital.

The driver operated the ambulance southbound in the right lane of the rural highway during dark overnight hours. She ultimately became fatigued and began to fall asleep. Data imaged from the Ford's EDR reported that the ambulance's speed was 106.0 km/h (65.9 mph) at 5 seconds prior to algorithm enable (AE). Consistent pre-crash speed and engine parameters, combined with the "On" status of the speed control telltale reported by the imaged EDR data, indicated that the driver was operating the vehicle with the cruise control active.

Figure 3. South-facing view of the ambulance's tire marks through the roadside.

The ambulance maintained a straight trajectory and began to drift right at the onset of the left curvature. It departed its travel lane and crossed onto the shoulder, where its tires overrode the rumble strips. The vehicle then departed the roadway, without input from the sleeping driver. Tire marks in the soil/grass surface of the roadside evidenced the ambulance's roadside departure and trajectory, which correlated to an angle of departure of approximately 5 degrees. The SCI review of the imaged EDR data indicated that the ambulance departed the roadway and traversed the roadside for approximately 3 seconds leading up to the tree impact.

Figure 4. South-facing view of the ambulance's tire marks from the local road toward the point of impact.

Physical evidence documented by the SCI investigator at the crash site included 95.6 m (313.7 ft) total length of tire marks from the vehicle. This consisted of 57.2 (187.7 ft) of tire marks from the roadway edge through the grass leading up to the intersecting local road, 11.0 m (36.1 ft) of tire marks across the intersecting local road, and an additional 27.4 m (89.9 ft) of tire marks through the grass roadside leading up to the impacted tree. A time-distance evaluation using EDR-reported pre-crash speeds equated to approximately 3 seconds of travel time, which correlated to the time between the road departure and the tree impact.

Figure 3 depicts the ambulance's tire marks through the roadside following the initial roadside departure, while **Figure 4** depicts the tire marks leading from the intersecting road toward the point of impact. In the images, evidence cones distinguish the right (yellow) and left (blue) tire marks.

The SCI investigator noted that the tire marks observed at the crash site progressed along a left-arching trajectory that resembled the left-curvature of the roadway, despite the near straight line departure of the vehicle from the roadway. This suggested that the driver may have provided a left (counterclockwise) steering input during the vehicle's off-road trajectory in an attempt to regain the roadway. This conclusion was supported by the imaged pre-crash data, which also indicated that the driver perceived and reacted to the vehicle's errant trajectory during the latter stage of the pre-crash recording. A momentary input was provided to the accelerator at the 1.5-second pre-crash interval, followed by a change in the service brake status to "On" at the 0.5-second pre-crash interval. A slight reduction in the vehicle's speed and engagement of the anti-lockbrakes accompanied the braking status change. The EDR-reported speed of the vehicle at time zero was 87.0 km/h (54.1 mph), which was likely an inaccurate representation of the vehicle's center of mass speed due to the off-road circumstances.

Crash

The first crash event occurred as the front plane/right aspect of the ambulance impacted the hardwood tree on the roadside. Although the tree had been sheared and displaced from its original location as a result of the impact, all of its remnants had been cleared prior to the SCI crash site inspection. An area of bare soil was all that remained to evidence the location of the impact (**Figure 5**).

Figure 5. South-facing view of the location of the tree and focal impact for the Ford.

Crash forces were in the 12 o'clock sector for the ambulance, which crushed the frontal structure of the vehicle and sheared the tree. Portions of the tree remained engaged in the crush profile of the front plane and were dragged by the vehicle. The right offset of the impact forces induced a clockwise rotation to the ambulance about its vertical axis as its center of mass continued in a southerly direction.

Figure 6. Image of the overturned ambulance at final rest from a southwest-facing perspective (obtained from an online news source).

The vehicle rotated approximately 30 degrees clockwise and its left side tires began to furrow into the soft grass/soil surface of the roadside. Coupled with the dynamics from the tree impact, an instability was created by the lateral drag force on the left side tires with respect to the vehicle's center of mass. This tripped the ambulance into a left side leading rollover (Event 2). The vehicle rolled onto its roof and then onto its right side, completing 3- quarter turns over an estimated distance of 18.6 m (61.0 ft) from the initiation of roll to the center of mass' final rest position. During the rollover trajectory, the ambulance continued to rotate approximately 80-degrees ckockwise about the vertical axis. The vehicle came to final rest on its right plane, facing in a northwesterly direction (**Figure 6**).

Post-Crash

The driver unbuckled her manual seat belt system and crawled through the left door window opening to exit the overturned vehicle. Several passing motorists observed the crash and stopped to offer assistance, observing the driver lying on the grass near the overturned ambulance. The emergency response system was notified of the crash via multiple cellular telephone calls. Law enforcement, EMS, and fire department personnel responded to the crash site. Passers-by opened the rear doors of the patient compartment and assisted the EMT out of the overturned ambulance. Arriving emergency personnel observed the patient lying unresponsive on the right wall of the patient compartment, with the wheeled ambulance cot on top of him. He was evaluated by EMS personnel and, absent of vital life signs, pronounced deceased at the crash site.

The driver and EMT were transported by ambulances to the emergency room of a local hospital for treatment. The driver was admitted to the hospital for treatment of several fractures, while the EMT was treated for his injuries and released. A coroner summoned to the scene declared the patient deceased and removed his body from the crash site. No autopsy was performed. Following the on-scene police investigation, the ambulance was recovered and towed from the scene to one of the ambulance agency's facilities. It remained at that facility under direction of the investigating law enforcement agency at the time of the SCI inspection.

2016 FORD E-350

Description

The Ford E-350 (**Figure 7**) was a cutaway chassis identified by the Vehicle Identification Number 1FDWE3FS2GDxxxxxx. It was manufactured as an incomplete vehicle in September 2015 and equipped with the manufacturer's "Ambulance Prep Package." An electric odometer reading could not be determined due to inoperability. The vehicle's powertrain consisted of a 6.8 liter, V-10, gasoline engine linked to a 4-speed, automatic transmission. The dual rear-wheel drive chassis was built on a 351 cm (138 in) wheelbase. The manufacturer's recommended tire size was LT225/75R16 front and rear, with cold tire pressures of 448 kPa (65 PSI) front and 414 kPa (60 PSI) rear. All tires were Michelin Defender LTX M/S of the recommended size and had ample tread. The force of the crash displaced and deformed the front axle and drive shaft. There was no damage to the rear tires or displacement of the rear axle.

Figure 7. Left front oblique view of the Ford Type III ambulance at the time of the SCI inspection.

The Ford's cab was equipped with cloth-surfaced, forward-facing bucket seats that had adjustable seat backs with integral head restraints. At the time of the SCI inspection, the driver's seat was adjusted to a middle track position with the seat back slightly reclined. Occupant protection features included 3-point lap and shoulder seat belts with buckle pretensioners and a frontal air bag system that consisted of dual-stage air bags for the driver and front right passenger positions. Both buckle pretensioners actuated and both frontal air bags deployed as a result of the crash.

Type III Ambulance Patient Compartment
The Ford's chassis was completed during secondary manufacturing in October 2015. During this process, a Type III patient compartment that had been manufactured in September 2011 by American Emergency Vehicles, Inc., was affixed to the new Ford chassis. Emergency services operations equipment, such as warning lights, sirens, and radio communications, were installed in the cab and about the exterior of the vehicle.

This installation was classified as a "remount" project, where the patient compartment module from an ambulance whose chassis has exceeded its usable lifetime is recycled by being reconditioned and mounted onto a new vehicle chassis. Electronics and other systems in the patient compartment and about its exterior are updated or replaced in this process. It should be noted that the Remount manufacturing practice has been the topic of debate for some time among EMS organizations and professionals, ambulance vehicle manufacturers, and ambulance accreditation committees.

As of late 2017, the Commission on Accreditation of Ambulance Services (CAAS) was still working on discussing the issue of remount manufacturing, and had not yet published standard documentation.[2] NHTSA has collaborated with the CAAS in this effort.

The patient compartment was equipped as a mobile emergency medical care unit, configured for the seating of up to four total occupants. This included a rear-facing captain's chair at the forward aspect of the patient compartment, a two-occupant left-facing bench seat on the right side, and a centralized rear-facing wheeled ambulance cot. A pass-through to the cab of the ambulance was located adjacent to the captain's chair positon. There were multiple cabinets and a counter area mounted to the left wall of the interior. The layout included double rear-entry doors for cot loading and a single right entry door. Interior cabinets were constructed of plywood and aluminum components of varying thicknesses, bonded together using a variety of glue, wooden pegs, and metallic screws. Surfaces were covered with a laminate finish, and all cabinets were outfitted with clear polymer sliding doors. Aluminum corner bead and plastic were used for edge trim. Fiberglass and foam insulation provided thermal and acoustic protection from the environment.

Vehicle Weight/Payload
The Ford chassis was placarded by its manufacturer with a gross vehicle weight rating of 5,216 kg (11,500 lb). This was distributed as gross axle weight ratings of 2,087 kg (4,600 lb) front and 3,538 kg (7,800 lb) rear. The secondary manufacturer had affixed a label in the patient compartment of the ambulance which declared that the curb weight of the vehicle was 4,105 kg (9,050 lb). Specified options to the vehicle increased its curb weight by an additional 252 kg (555 lb). The total useable payload of the vehicle, including the weight of equipment, cargo, and occupants, was 860 kg (1,895 lb).

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 204 kg (450 lb). The combined total weight of the vehicle's occupants was at least 327 kg (720 lb), but likely was

[2] CAAS News. (2017, August 1). "Rethinking Remounts – Developing a national standard for ambulance remounts." Retrieved from www.caas.org/2017/08/01/rethinking-remounts-developing-a-national-standard-for-ambulance-remounts.

not more than 454 kg (1,000 lb). The total payload of the vehicle was therefore no more than 658 kg (1,450 lb). It was the SCI investigator's assessment that the ambulance was operating in its specified payload capacity and weight rating at the time of the crash.

Exterior Damage: Cab

The cab of the Ford sustained severe damage as a result of the tree impact (Event 1). Direct contact damage began at the centerline and extended 51 cm (20 in) to the right, the estimated approximate diameter of the tree. The force of the impact deformed the structures of the front bumper and engine compartment, which wrapped around the tree into a U-shaped pattern. The maximum depth of the pattern (less freespace) measured 132 cm (52.0 in).

Figure 8. Overhead view of the Ford ambulance depicting the frontal damage.

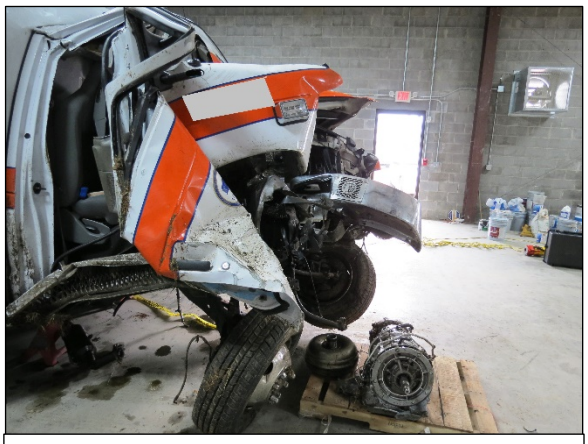


Figure 9. Right side view of the Ford depicting the deformation.

Figures 8 and 9 are overhead and right-side views depicting the deformation of the Ford, respectively. The residual crush profile measured along the bumper beam was as follows: C1 = 20 cm (7.9 in), C2 = 100 cm (39.4 in), C3 = 130 cm (51.2 in), C4 = 130 cm (51.2 in), C5 = 110 cm (43.3 in), and C6 = 100 cm (39.4 in). Direct contact and deformation were noted at the windshield header from the sheared/uprooted tree. The right A-pillar was crushed rearward into a near-vertical orientation. The left front door remained closed during the crash events and would not re-latch post-crash due to deformation, while the right front door was crushed by the exterior deformation that resulted in a stress overload of the latch and caused an integrity loss. There was no damage to the cab attributable to the rollover event. The Collision Deformation Classification (CDC) assigned to the Ford for the front tree impact damage pattern was 12FZEW5.

The crash severity (delta-V) of the tree impact was calculated using the barrier algorithm of the WinSMASH program. The total delta-V was 54 km/h (33 mph), with a longitudinal component of -54 km/h (-33 mph) and a lateral component of 0 km/h (0 mph). Although this calculated value is in general agreement with the EDR-reported delta-V, it is still classified as borderline due to the vehicle's type/characteristics.

Exterior Damage: Patient Compartment

The patient compartment of the Type III ambulance (**Figure 10**) was manufactured by American Emergency Vehicles. This particular patient compartment was removed from an older chassis

and remounted onto the 2016 Ford E-350 chassis during October 2015. Placarding in the compartment indicated it was originally built during December 2011. The all-aluminum patient compartment had overall length x width x height dimensions of 481 x 226 x 180 cm (189 x 89 x 71 in).

Figure 10. Left-side view of the AEV Type III patient compartment.

The interior layout of the patient compartment included double-rear doors for cot loading, a two-passenger bench seat along the right side, a right-side entry door, a rear-facing captain's chair against the forward wall, and multiple cabinets for storage along the left and right walls. The structural integrity of the patient compartment remained intact throughout the crash sequence. Exterior damage from the rollover (Event 2) was limited to minor deformation to the front header, with surface scratches and debris embedded in the joints of its construction. The header was dented immediately right of the longitudinal centerline from presumed contact with a tree branch during the initial impact. A 60 x 60 cm (24 x 24 in) area at the left rear corner of the roof was deformed less than 5 cm (2 in) as a result of ground contact during the rollover. The entire surface of the right plane was dirt-scuffed in a diagonal pattern, indicative of the rotation of the ambulance as it rolled onto its right side and slid to final rest. The CDC assigned to the ambulance for the rollover damage was 00RDAO2.

Event Data Recorder

The 2016 Ford E-350 Cutaway was equipped with a restraints control module (RCM) designed for the diagnostics, sensing, and control of the vehicle's supplemental restraint systems (air bags and pretensioners). The RCM also had EDR capabilities. The EDR data was imaged at the time of inspection by the SCI investigator using the Bosch CDR tool via a direct- to-module connection and software version 17.4. Electrical power was supplied externally. The data was later re-read using version 19.0, included at the end of this report as **Appendix A**.

This RCM monitored bi-directional acceleration (longitudinal and lateral) data. It did not have roll-sensing capabilities. The EDR component in this RCM had the capacity to store two events, with the capability to distinguish two different 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. Deployment events became locked in the module's memory and could not be overwritten. Non-Deployment events were events which met the threshold to record data, but the severity of the event was not enough to require air bag deployment. Non-Deployment events could be overwritten by subsequent events. A 5-second pre-crash buffer, populated with vehicle performance and operational data, was linked to each recorded event.

The imaged EDR data contained one locked frontal deployment event, designated the "First Record." Analysis of the recorded event was consistent with the circumstance of the tree impact (SCI Event 1). The EDR data was imaged by the SCI investigator on Ignition Cycle 3,780.

First Record

The imaged data indicated that this event was recorded on Ignition Cycle 3,778. At the time of the event, no Diagnostic Trouble Codes (DTCs) were present. The air bag warning lamp in the instrument cluster was "Off" (not illuminated), and the front right air bag suppression switch was "not active." The driver's seat belt was "Buckled." The speed control telltale in the instrument cluster was "On."

The maximum recorded longitudinal and lateral delta-V's for the First Record event were -44.23 km/h (-27.48 mph) at 284 milliseconds and -10.03 km/h (-6.23 mph) at 75 milliseconds. A field in the data labeled "Key-On Timer," which represented the length of time that the vehicle's electrical system was energized (i.e. Ignition on), had a value of 5,940 seconds. Equivalent to 1 hour and 39 minutes, it was consistent with the duration of the ambulance's pre-crash travel. The EDR data was completely written to memory. Pre-crash buffer data 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
-5.0	106.0 (65.9)	2,100	0	Off	Not engaged
-4.5	106.0 (65.9)	2,100	0	Off	Not engaged
-4.0	106.0 (65.9)	2,100	0	Off	Not engaged
-3.5	106.0 (65.9)	2,100	0	Off	Not engaged
-3.0	106.0 (65.9)	2,100	0	Off	Not engaged
-2.5	106.0 (65.9)	2,100	0	Off	Not engaged
-2.0	105.0 (65.2)	2,100	0	Off	Not engaged
-1.5	100.0 (62.1)	2,100	33	Off	Not engaged
-1.0	111.0 (69.0)	2,200	0	Off	Not engaged
-0.5	101.0 (62.8)	2,000	0	On	Not engaged
0	87.0 (54.1)	1,700	0	On	Engaged

The pre-crash data indicated that the driver of the ambulance may have been operating the vehicle on Cruise Control (based on the illuminated condition of the Speed Control Telltale and the recorded constant speed and engine parameters leading up to the -2.5-second pre-crash interval). Reconstruction of the crash determined that the ambulance departed the roadway approximately three seconds prior to the tree impact. The driver perceived and reacted to the vehicle's errant trajectory during the later stage of the pre-crash recording, as was evidenced by the changing state of the vehicle's speed, accelerator pedal position and the brake application prior to the crash (AE). The reported speed at the -1.0-second interval appeared to be an inaccurate value in relation to the time history of the other reported speeds and in its representation as the vehicle's center of mass speed. The reported vehicle speed is derived from a measurement of the transmission tail-shaft rotation. For the purposes of the reconstruction, the speed at the -1.0-second interval was assumed to be 101 km/h (62.5 mph).

Interior Damage: Cab

The cab of the ambulance sustained severe damage from the Event 1 tree impact that consisted of catastrophic intrusion into the front row right occupant space and moderate intrusion into the driver's space. The left A-pillar was displaced rearward 10 cm (4.0 in), which had resulted in the rearward displacement of multiple components including: the instrument panel by approximately 15 cm (5.9 in), the steering column by 10 cm (3.9 in) and the windshield header by 10 cm (3.9 in).

Rearward displacement of the engine and transmission prior to their separation had displaced the engine cowling laterally to the left, which had compressed the toe pan approximately 15 cm (5.9 in). As a result of this intrusion, the SCI investigator observed that the accelerator pedal overlapped the brake pedal. **Figure 11** is an overall view of the intrusion and damage to the driver's area of the ambulance's cab.

The right A-pillar was displaced approximately 30 cm (11.8 in) rearward at the beltline, associated with deformation of the right door and the release of the latch assembly. This had resulted in occupant compartment integrity loss as the door opened as a result of the first crash event with the tree. The door subsequently became crushed against the cab during the rollover event's first quarter turn. Frontal deformation had crushed the forward cowl which, combined with the A-pillar displacement, resulted in at least 64 cm (25.2 in) of longitudinal intrusion of the right instrument panel. As observed during the SCI inspection, the upper right instrument panel was in contact with the front row right seat back, and the lower right instrument panel was above the front row right seat cushion. Associated with this extensive deformation, the floor had buckled upward approximately 15 cm (5.9 in). **Figure 12** is a lateral view of the damage and intrusion observed to the front row right position of the ambulance's cab.

Figure 11. Damage and intrusion to the driver's area of the ambulance cab.

Figure 12. Catastrophic intrusion and deformation at the front row right position of the ambulance cab.

The AS1 laminated windshield was fully fractured from the frontal impact event, with holing of the glazing at the center aspect and tearing of the laminate along the height of both A-pillars. The windshield sagged onto the upper instrument panel at the time of inspection. Both front door windows were closed at the time of the crash and became disintegrated by the structural deformation to the cab.

Discernable occupant contact in the cab was limited to driver loading of the seat belt system, evidenced by frictional abrasions to the polymer surface of the latch plate. Although the SCI investigator was certain that the driver's knees contacted the intruding/displaced left lower instrument panel (knee bolster), the polymer surface panel was devoid of specific occupant related damage.

Patient Compartment Interior Damage

Damage to the interior of the patient compartment was limited to occupant contact and the displacement of internal objects. There was no intrusion into the interior of the patient

compartment. A lack of cooperation by the ambulance agency and other attorney refusal prevented tha physical inspection of the interior of the patient compartment. Only a visual inspection from the right door opening and rear loading door opening was permitted.

During the crash sequence, the patient translated forward on the wheeled ambulance cot and loaded the mattress platform. This resulted in damage to the cot's frame and caused it to release from its containment system (see **Wheeled Ambulance Cot and Cot Fastening System** discussion). The patient ultimately became displaced on the wheeled ambulance cot, which separated entirely from the cot fastener system. Based on the SCI reconstruction of the crash, visible damage in the patient compartment, and documented injuries sustained by the patient, his head contacted the box-base of the captain's chair during the initial crash event and his forward displacement/partial separation from the wheeled ambulance cot. However, due to an inability of the SCI investigator to enter the patient compartment, no documentation of such contact could be accomplished.

The SCI investigator observed significant blood evidence on the right wall of the patient compartment above the bench seat and on the interior surface of the right door. There was also blood on the ceiling of the interior at the forward aspect of the patient compartment. The blood evidence on the right wall and right door was attributable to the patient, and evidenced his post-crash final rest position in the overturned ambulance. Blood on the roof had droplets extending toward the right plane, indicative that the transfer had occurred post-crash while the vehicle was still overturned. Therefore, the blood on the ceiling likely was not associated with the occupants' crash-sequence kinematics. **Figure 13** depicts the blood on the right wall of the patient compartment. Further contact evidence in the patient compartment evidentiary of the patient's kinematics included separation of the bench seat webbing net and minor deflection of the cabinetry doors at the forward right aspect of the patient compartment (**Figure 14**).

Figure 13. Forward-facing view of the right wall of the patient compartment and the patient's blood evidence.

Figure 14. Left-facing view of the separated webbing net and deflected cabinet (highlighted by yellow circles).

The male EMT's seating position and orientation for this crash enabled his body to ride down the frontal impact event crash forces by distributing his weight against the seat cushion and seat back of the rear-facing captain's chair (**Figure 15**). Due to the soft material comprising the seat, there was no discernable evidence of his kinematic loading or contact relative to the first crash event. It is likely that his head contacted the left wall of the patient compartment adjacent to his seated positon during the rollover. However, the SCI investigator was unable to observe any evidence attributable to such contact during the limited visual inspection.

Figure 15. Left-facing view of the captain's chair in the patient compartment of the ambulance.

Manual Restraint Systems

The Ford's cab was equipped with 3-point lap and shoulder seat belt systems for both seating positions. They used continuous loop webbing with sliding latch plates and adjustable D-rings. The driver's seat belt system retracted onto an emergency locking retractor (ELR), while the front right seat belt used an ELR/automatic locking retractor (ALR). Both were equipped with buckle pretensioners, which actuated during the crash. The adjustable D-rings were observed to be in their respective middle positions. The patient compartment was configured with manual restraint systems for three occupant positions. The rear-facing captain's chair contained an integral 3-point lap and shoulder seat belt system, which consisted of a sliding latch plate and continuous loop webbing. The bench seat was equipped with two multi-point harness systems.

Figure 16. Loading evidence in the belt path of the Ford's driver latch plate.

At the time of the SCI inspection, the driver's seat belt was observed to be stowed in the retractor and resting loosely against the left B-pillar. The webbing spooled freely from the retractor, and although it exhibited historical wear, there was no distinct evidence attributable to driver loading. However, examination of the latch plate revealed frictional abrasions of the polymer surface from the seat belt webbing in the belt path (**Figure 16**). It was apparent that the shortened buckle stalk was indicative of buckle pretensioner actuation. Based on the observations

Figure 17. Deployed driver's frontal air bag in the Ford.

of the SCI investigator, it was determined that the driver was restrained by the manual seat belt system at the time of the crash. These findings were corroborated by the data imaged from the Ford's RCM.

Although law enforcement documentation of the crash indicated that the EMT was restrained by the captain's chair seat belt system, the SCI investigator was not permitted to inspect the system for evidence of usage and loading. The cursory inspection observed that the seat belt system was retracted loosely against the seat back, with no visible evidence of loading.

Supplemental Restraint Systems

The Ford E-350 chassis was equipped with a frontal air bag system for the driver and front passenger positions. The system consisted of dual-stage air bags and seat belt buckle pretensioners. The Ford was equipped with an air bag cut-off switch for the passenger's frontal air bag, and the switch was observed to be in the "on" position at the time of the SCI inspection. Both frontal air bags deployed and both buckle pretensioners actuated as a result of the crash. According to the data imaged from the Ford's RCM, the air bag deployment and pretensioner actuation for all systems occurred at 29.5 milliseconds after AE.

Figure 18. View of the intruded right instrument panel and lack of access to the deployed passenger's frontal air bag in the Ford.

The driver's frontal air bag was concealed in the center hub of the two-spoke steering wheel with a tri-flap module cover. In its deflated state, the deployed air bag (**Figure 17**) was 58 cm (22.8 in) in overall diameter. It was internally tethered via a circular center stitch pattern. Venting was achieved by two 2.5 cm (1.0 in) vent ports located on the back side of the air bag at the 11 and 1 o'clock positions. A small area of blood evidence to the right of the air bag's center stitch pattern was indicative of probable post-crash occupant contact. There was no discernable damage to the deployed driver's air bag.

The passenger's frontal air bag deployed in the unoccupied seat position from its middle instrument panel-mounted module, through the H-configuration covers flaps. The severity of the intrusion at the front right position precluded an inspection of the deployed air bag, as the air bag was entirely concealed between the intruded right instrument panel and the seat back (**Figure 18**).

Figure 19. View of the Stryker bariatric ambulance cot in the ambulance at the time of the visual inspection.

Wheeled Ambulance Cot

The wheeled ambulance cot (**Figure 19**) installed in the Ford ambulance was an MX-Pro Bariatric

Transport Model 6083, manufactured by Stryker. It was identified by the serial number 10114xxxx, indicative that it was manufactured in November 2010. The Stryker cot was constructed of a tubular aluminum frame with circumferential weld joints and steel hardware fasteners. It contained a vinyl-covered mattress pad that was positioned on the aluminum platform of the cot. The X-frame supporting the mattress platform featured manual raise/lower capabilities with height positions between a minimum of 34 cm (13.5 in) and a maximum of 94 cm (37.0 in). The mattress platform itself featured positive backrest angular adjustment between 2- and 73- degrees via a manually controlled gas-pressure cylinder. The leg portion featured 14 degrees of positive angular adjustment. Overall dimensions of the cot were 74 cm (29.0 in) wide and 203 cm (80.0 in) long. Placarding indicated that the cot was rated for a maximum load capacity of 725 kg (1,600 lb) in the flat position and 385 kg (850 lb) with the back-rest in the upright position.

The Stryker cot was equipped with a multi-point harness system for manual restraint of its occupant (patient). This system consisted of a lateral lower extremity strap, a lateral lap/thigh strap, and an upper torso harness which incorporated two shoulder straps that buckled into a lateral chest strap. All of the straps were constructed of fixed length webbing that included either locking latch plates or sewn buckles. At the time of the SCI inspection, the SCI investigator was able to visualize that all straps of the system were unbuckled and hanging loosely from the frame. There appeared to be wear on the exposed surfaces of the webbing, which evidenced habitual historical use. Due to the visual-only nature of the inspection, the SCI investigator was unable to inspect the harness system for evidence of crash-related loading. However, the combination of the ambulance agency's policies and the nature of the transport correlated to a high probability that all of the restraint straps were in use at the time of the crash. Furthermore, the observed damage to the cot's frame and its displacement from the fastening system during the crash further suggest that the occupant was restrained to the cot by the harness system when the crash occurred.

Cot Damage

The patient cot sustained visible damage attributable to occupant loading in relation to the crash sequence. During the crash, the occupant responded toward the front crash force and the back of his torso compressed against the mattress platform and the back support. This translated a minor loading force into the cot's frame as the occupant slid forward along the mattress. As the occupant slid forward and his head and upper torso extended off of the head-end of the cot, his shoulders engaged the multi-point harness systems' straps.

Figure 20. View of the sheared section of the lower right frame rail with locking pin.

The combined forces of the occupant's mass and his loading of the harness system and cot created a loading force at the locking pin and locking clamp mechanism. The moment of these forces overloaded the retaining capabilities of the clamp and exceeded the shear strength of the tubular

aluminum frame. The clamp was forced open, and the right frame rail of the cot sheared in multiple sections. Two of the fractures were located near the locking pin mounting location and created a separated fragment approximately 30 cm (11.8 in) long, which was observed to be lying loosely on the floor beneath the cot at the time of the SCI inspection (**Figure 20**). Overall, the entire cot appeared to be skewed and bent in several directions (**Figure 21**). The side rails were deformed forward, and there were compression bends on the forward aspect of the mattress platform. The backrest was depressed and compressed forward and downward, visibly deformed beyond the designed normal/restitute limit. It was evident to the SCI investigator that the wheeled ambulance cot experienced significant loading by its occupant during the crash sequence.

Figure 21. Overall view of the visibly deformed wheeled ambulance cot from the rear of the ambulance at the time of the SCI inspection.

Cot Fastening System

The Stryker ambulance cot was secured in place and positioned in the floor of the patient compartment via a Stryker Model 6371 Cot Fastener System. It was manufactured in September 2006 and was identified by the serial number 06094xxxx. The system consisted of a forward antler bracket mounted to the floor and a rear locking rail-clamp mechanism mounted on the floor to the right of the left wall of the patient compartment (**Figure 22**). The antler bracket cradled the forward portion of the cot's frame, while the vertically-oriented locking clamp mechanism secured the locking pin that was 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 in the ambulance during transport.

Figure 22. Rail clamp of the Stryker cot fastener system in the ambulance.

Based on the visual inspection, the antler bracket appeared to have remained engaged to its floor mount. The SCI investigator was unable to determine if the antler bracket was deformed as it was partially concealed by debris in the patient compartment. The rail clamp was in its opened position and appeared to be slightly angulated downward, indicative that it likely released during the crash as a result of forward loading by the locking pin as a result of forward compression by the occupant's loading of the cot. It was apparent that the system did not withstand the forces of the crash or retain the wheeled ambulance cot from unrestricted movement.

2016 FORD AMBULANCE OCCUPANTS

Driver Demographics

Age/sex:	21 years/female
Height:	162 cm (64 in)
Weight:	63 kg (138 lb)
Eyewear:	None
Seat type:	Box-mounted bucket seat with integral head restraints
Seat track position:	Middle
Manual restraint usage:	3-point lap and shoulder belt
Usage source:	Vehicle inspection, imaged RCM data
Air bags:	Driver's frontal air bag available, deployed
Alcohol/drug data:	None
Egress from vehicle:	Exited unassisted
Transport from scene:	Ambulance to a local hospital
Type of medical treatment:	Admitted for one day

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Pelvic ring fractures: Mildly displaced S2 vertebral body fracture; Mildly displaced fracture of the right sacral ala; Non-displaced fracture of the left sacral ala	856151.2	Left lower instrument panel	Certain
2	Contusion to right hip	810402.1	Intruded center stack/ center lower instrument panel	Certain
3	Contusion to left hip	810402.1	Left door panel (*RUQ)	Certain
4	Abrasions to right hip	810202.1	Intruded center stack/ center lower instrument panel	Certain

Source: Hospital records.
** RUQ: Rear upper quadrant.*

Driver Kinematics

The 21-year-old female driver of the ambulance was seated in a mid-track position, with the seat back slightly reclined. She used the 3-point lap and shoulder seat belt for manual restraint. Seat belt usage was determined from frictional abrasions on the polymer surface of the latch plate attributable to driver loading identified during the SCI inspection, in conjunction with a review of the data imaged from the Ford's RCM that recorded the driver belt status as "buckled." In the days preceding the crash, the driver had identified after experiencing repetitious morning sickness and headaches that she was five weeks pregnant. Pursuant to that discovery, she had

ceased her otherwise routine intake of highly caffeinated beverages that she ordinarily relied upon to aid her in maintaining her alertness when she worked overnight shifts. The driver also had a pre-existing medical condition of LQTS, with her most recent episode in the previous year.

The driver reported to the investigating law enforcement agency that she had succumbed to her fatigue while operating the ambulance southbound and fell asleep. As the roadway began to curve left, the vehicle continued on a straight trajectory and departed the roadway, without avoidance input by the driver. Although her specific position remains unknown, the driver remained restrained by the seat belt system as the vehicle traversed off-road. Undulation of the vehicle through the roadside ultimately alerted the driver, though she was unable to provide substantial avoidance input prior to the crash.

At impact with the large diameter tree, the driver initiated a forward trajectory in response to the 12 o'clock direction of impact forces. The frontal air bag system deployed and the seat belt pretensioners actuated. She loaded the seat belt system, evidenced by the frictional abrasions observed in the belt path of the latch plate. This restricted the driver's displacement, and her face contacted the deployed air bag as her head flexed forward. The driver's knees and lower extremities contacted the intruding left lower instrument panel and center stack/lower instrument panel. The Energy associated with the loading of her lower extremities with the lower instrument panel was transmitted through the driver's femurs, which produced an unspecified fracture of her pelvis and sacrum. Further intrusion of interior components exacerbated the driver's loading of the deployed air bag.

As the vehicle rotated and initiated the left side-leading rollover sequence, the driver remained restrained by the seat belt system. This held the driver in the driver's seat position during the rollover crash, and prevented her displacement about the vehicle's interior. The driver's left arm, left flank, and left hip contacted the left door panel at the on-set of the 1st quarter turn, and she contacted the intruded center stack/lower instrument panel with her right hip during the 3rd quarter turn and as the vehicle came to final rest. These dynamics and contacts produced soft tissue injuries to her hips.

The driver unbuckled her seat belt system and climbed out of the cab through the opening created by the disintegration of the left front glazing. Once cleared of the vehicle, she laid down on the grass surface and awaited the arrival of emergency response personnel. Passers-by who stopped at the crash site mistakenly presumed that she had been ejected from the vehicle during the crash. She was treated on scene and transported by ambulance to a local hospital, where she was admitted for further treatment of her injuries. In the weeks after the crash, the driver suffered a miscarriage of her pregnancy. According to her legal counsel, a medical doctor had indicated that the miscarriage was a direct result of abdominal trauma sustained in the crash.

Captain's Chair Occupant Demographics

Age/sex:	29 years/male
Height:	Unknown
Weight:	64 kg (141 lb)
Eyewear:	Unknown
Seat type:	Rear-facing captain's chair in patient compartment
Seat track position:	Not applicable

Manual restraint usage:	Integrated 3-point lap and shoulder seat belt system available; none used
Usage source:	Vehicle inspection, medical records
Air bags:	None available
Alcohol/drug data:	None
Egress from vehicle:	Assisted from vehicle by passing motorists
Transport from cene:	Ambulance to a local hospital
Type of medical treatment:	Treated and released

Captain's Chair Occupant Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Acute head injury with loss of consciousness, NFS	161002.2	Right patient compartment wall	Probable
2	7 cm laceration to right lower leg	810602.1	Frame of wheeled ambulance cot	Probable
3	Contusion to right knee	810402.1	Backrest of wheeled ambulance cot	Probable
4	Contusion to left knee	810402.1	Backrest of wheeled ambulance cot	Probable
5	Contusion to right thigh	810402.1	Left patient compartment wall	Probable
6	Contusion to left thigh	810402.1	Right patient compartment wall	Possible
7	Abrasion to left forehead	210202.1	Right patient compartment wall	Probable
8	Abrasion to left shoulder	710202.1	Right patient compartment wall	Probable

Source: Emergency room records.

Captain's Chair Occupant Kinematics

The 29-year-old male EMT was seated in the rear-facing captain's chair at the forward aspect of the patient compartment. There were no positional adjustments available for this seat position. According to law enforcement documentation of the crash, the EMT was restrained by the available integrated 3-point lap and shoulder seat belt system. However, medical record documentation indicated that the driver had stated to treating medical personnel that he was not belted at the time of the crash.

At impact with the tree, the EMT responded to the frontal impact force with a rearward trajectory (with respect to his rear-facing orientation). His posterior loaded the seat back and seat cushion of the captain's chair, and his head probably engaged the integral head restraint. This distributed the crash forces over a large body-surface area, providing the occupant with a substantial ride-down of the crash forces. This reduced the likelihood of serious injury in relation to his kinematic response. However, during the frontal crash, the EMT's lower extremities were contacted by the wheeled ambulance cot's frame and backrest. This resulted from the kinematic

response of the patient and associated forward response/displacement of the wheeled ambulance cot as the patient translated forward. Soft tissue injuries were sustained by the EMT's lower extremities.

During the rollover event, the EMT occupant responded to his right in relation to the left side-leading forces. His right arm and torso contacted the left wall of the patient compartment. A fracture to the composite paneling was present in this area, presumably evidentiary of contact by the EMT's right shoulder and correlating to his right shoulder abrasion.

As the ambulance came to rest on its right side, the EMT was directed to his left by the force of gravity and displaced toward the right side of the patient compartment. He abruptly contacted the right wall of the patient compartment, which probably resulted in an acute head injury with loss of consciousness, the right shoulder contusion and other soft tissue injuries. Of note, it is likely that the EMT was contacted by displaced medical supplies and/or equipment during the crash sequence and as the vehicle came to final rest.

The EMT was able to exit the vehicle under his own power through the rear loading doors after the crash. He was evaluated at the scene and transported by ambulance to a local hospital, where he received treatment and was released within hours of the crash.

Wheeled Ambulance Cot Occupant Demographics

Age/sex:	55 years/male
Height:	Unknown
Weight:	272 kg (600 lb)
Eyewear:	Unknown
Seat type:	Lying supine on the bariatric ambulance cot
Seat track position:	Fixed
Manual restraint usage:	Lateral straps and shoulder straps
Usage source:	Ambulance protocol
Air bags:	None available
Alcohol/drug data:	Not tested
Egress from vehicle:	Removed by firefighters and the coroner
Transport from scene:	Coroner
Type of medical treatment:	None, deceased at scene

Wheeled Ambulance Cot Occupant Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Open skull fracture with brain matter exuding from fracture site, NFS	150406.4	Vertical edge of the storage compartments at the forward wall of the patient compartment	Probable
2	Large laceration of the frontal scalp, NFS	110600.1	Vertical edge of the storage compartments at the forward wall of the patient compartment	Probable

Source: Coroner's Report, external only (not an invasive autopsy).

Wheeled Ambulance Cot Occupant Kinematics

The patient was lying supine on the bariatric ambulance cot, which was secured in position into the patient compartment by the forward-mounted antler bracket and the floor- mounted rail clamp. Based on the observations of the SCI investigator, the patient was likely restrained to the cot by a multi-point harness system. This included the use of the lateral straps positioned at the level of the lower legs, thighs and lap, with shoulder straps buckled into the lap buckle.

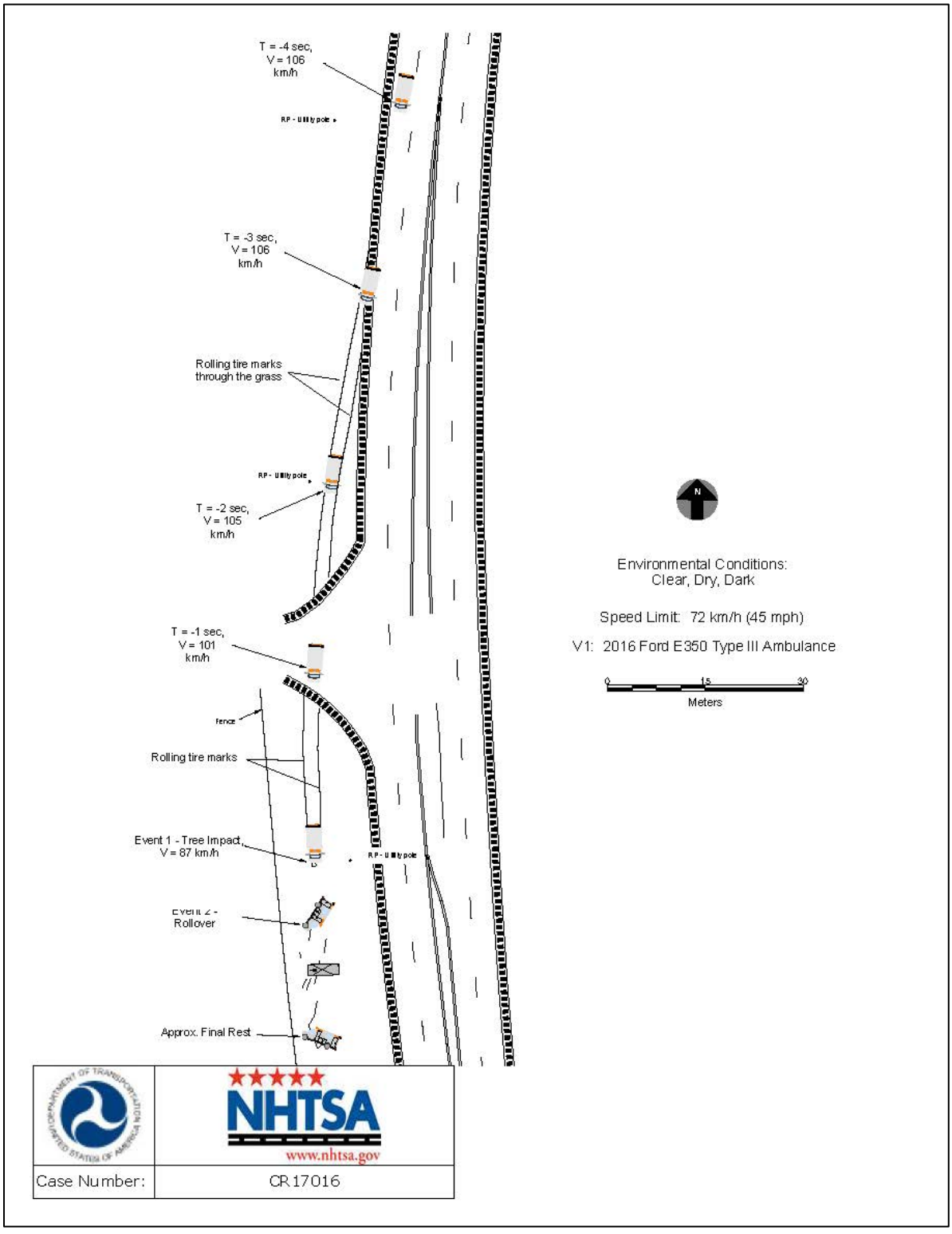
At impact with the tree, the patient and the cot initiated a forward trajectory in response to the frontal crash forces. The patient slid forward from his supine position on the mattress as the cot loaded the antler bracket. The patient maintained his forward momentum and his head and shoulders slid forward off the cot, extending toward the EMT and the captain's chair seat position. This was because the design of the shoulder straps created slack that allowed for forward motion of the patient before his shoulders engaged the straps. Simultaneously, the forces associated with the patient's loading of the cot and the translation of their combined mass exerted a force on the locking clamp mechanism.

This caused the locking clamp to release, while the strength load of the cot's aluminum frame was surpassed and its right frame rail fractured. The cot and patient were then able to maintain their forward displacement without restriction. The combination of cot movement and the forward translation of the patient allowed his head to impact the mount of the captain's chair and the cabinetry/wall at the forward aspect of the patient compartment. This contact resulted in the identified laceration of the scalp and the open skull fracture with exuding brain matter. His left arm/shoulder probably contacted the compartment door of the stacked cabinets, deflecting the bottom hinged door forward.

As the ambulance initiated the rollover (Event 2), the patient's upper torso had slid nearly entirely out from beneath the upper straps of the harness system. His lower extremities remained engaged with the lateral straps that had been positioned at his waist area. During the rollover, the patient and cot moved about the interior unrestricted. It is likely that he contacted the roof at the forward aspect of the patient compartment, before being directed against the right wall at the end of the sequence.

At final rest of the ambulance, the patient was lying face down on the right wall, above the bench seats and on the interior surface of the right-side door. These areas of contact were evidenced by pooled blood and blood smears. The cot was resting on top of the patient, with his lower extremities entangled in the lateral straps of the cot. Emergency response personnel found the patient absent of vital life signs, with a head injury indicative of obvious death. A coroner was summoned to the crash scene to remove his body from the vehicle and conduct an external examination. No autopsy was performed.

CRASH DIAGRAM



APPENDIX A:
2016 Ford E350 Event Data Recorder Report[3]

[3] 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	1FDWE3FS2GD******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	CR17016_V1_ACM.CDRX
Saved on	
Imaged with CDR version	Crash Data Retrieval Tool 17.4
Imaged with Software Licensed to (Company Name)	Company Name information was removed when this file was saved without VIN sequence number
Reported with CDR version	Crash Data Retrieval Tool 19.0
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
ACM Adapter Detected During Download	Yes
Event(s) recovered	locked frontal event

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 .

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	1FDWE3FS2GD******
Current VIN from PCM	1FDWE3FS2GD******
Ignition cycle, download (first record)	3,780
Ignition cycle, download (second record)	N/A
Restraints Control Module Part Number	BC24-14B321-BD
Restraints Control Module Serial Number	9160365400000000
Restraints Control Module Software Part Number (Version)	BL84-14C028-AB
Left/Center Frontal Restraints Sensor Serial Number	1B7F6F3D
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	Locked 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)	26,251,795
Key-on Timer at event time zero (seconds)	5,940
Vehicle voltage at time zero (Volts)	13.527
Energy Reserve Mode entered during event (Y/N)	Yes
Time Driver Front Satellite Sensor Lost Relative to Time Zero (msec)	16.5

Faults Present at Start of Event (First Record)

No Faults Recorded

Deployment Data (First Record)

Frontal airbag deployment, time to first stage deployment, driver (msec)	29.5
Pretensioner (buckle) deployment, time to fire, driver (msec)	29.5
Frontal airbag deployment, time to first stage deployment, front passenger (msec)	29.5
Pretensioner (buckle) deployment, time to fire, right front passenger (msec)	29.5
Maximum delta-V, longitudinal (MPH [km/h])	-27.48 [-44.23]
Time, maximum delta-V longitudinal (msec)	284
Maximum delta-V, lateral (MPH [km/h])	-6.23 [-10.03]
Time, maximum delta-V lateral (msec)	75
Left or center front, satellite Sensor discriminating deployment	Yes
Left or center, front satellite Sensor safing	Yes
Right, front satellite sensor discriminating deployment	Yes
RCM, front sensor discriminating deployment	Yes
RCM, front sensor safing	Yes
Longitudinal Delta-V Time Zero Offset	8.0 ms
Lateral Delta-V Time Zero Offset	8.0 ms

Pre-Crash Data -1 sec (First Record)

Ignition cycle, crash	3,778
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	65.9 [106.0]	0	Off	2,100	non-engaged	non-engaged	non-engaged	non-engaged
- 4.5	65.9 [106.0]	0	Off	2,100	non-engaged	non-engaged	non-engaged	non-engaged
- 4.0	65.9 [106.0]	0	Off	2,100	non-engaged	non-engaged	non-engaged	non-engaged
- 3.5	65.9 [106.0]	0	Off	2,100	non-engaged	non-engaged	non-engaged	non-engaged
- 3.0	65.9 [106.0]	0	Off	2,100	non-engaged	non-engaged	non-engaged	non-engaged
- 2.5	65.9 [106.0]	0	Off	2,100	non-engaged	non-engaged	non-engaged	non-engaged
- 2.0	65.2 [105.0]	0	Off	2,100	non-engaged	non-engaged	non-engaged	non-engaged
- 1.5	62.1 [100.0]	33	Off	2,100	non-engaged	non-engaged	non-engaged	non-engaged
- 1.0	69.0 [111.0]	0	Off	2,200	non-engaged	non-engaged	non-engaged	engaged
- 0.5	62.8 [101.0]	0	On	2,000	non-engaged	non-engaged	non-engaged	non-engaged
0.0	54.1 [87.0]	0	On	1,700	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
- 3.5	Invalid
- 3.4	Invalid
- 3.3	Invalid
- 3.2	Invalid
- 3.1	Invalid
- 3.0	Invalid
- 2.9	Invalid
- 2.8	Invalid
- 2.7	Invalid
- 2.6	Invalid
- 2.5	Invalid
- 2.4	Invalid
- 2.3	Invalid
- 2.2	Invalid
- 2.1	Invalid
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- 1.4	Invalid
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- 1.1	Invalid
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- 0.8	Invalid
- 0.7	Invalid
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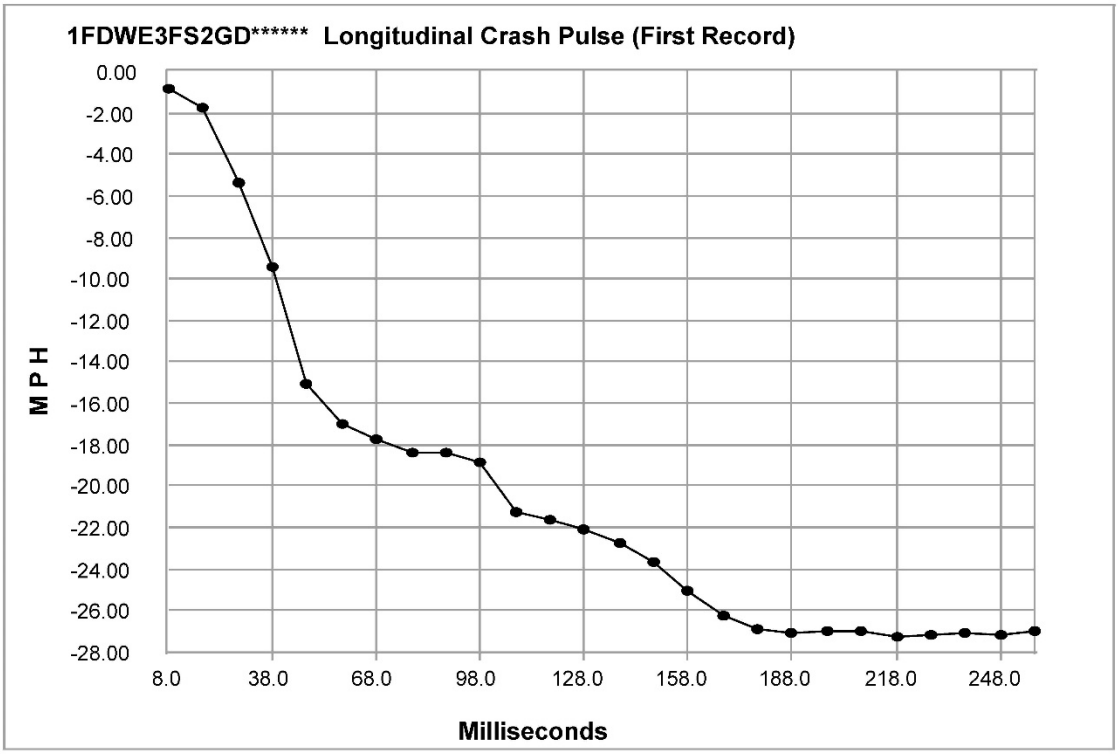
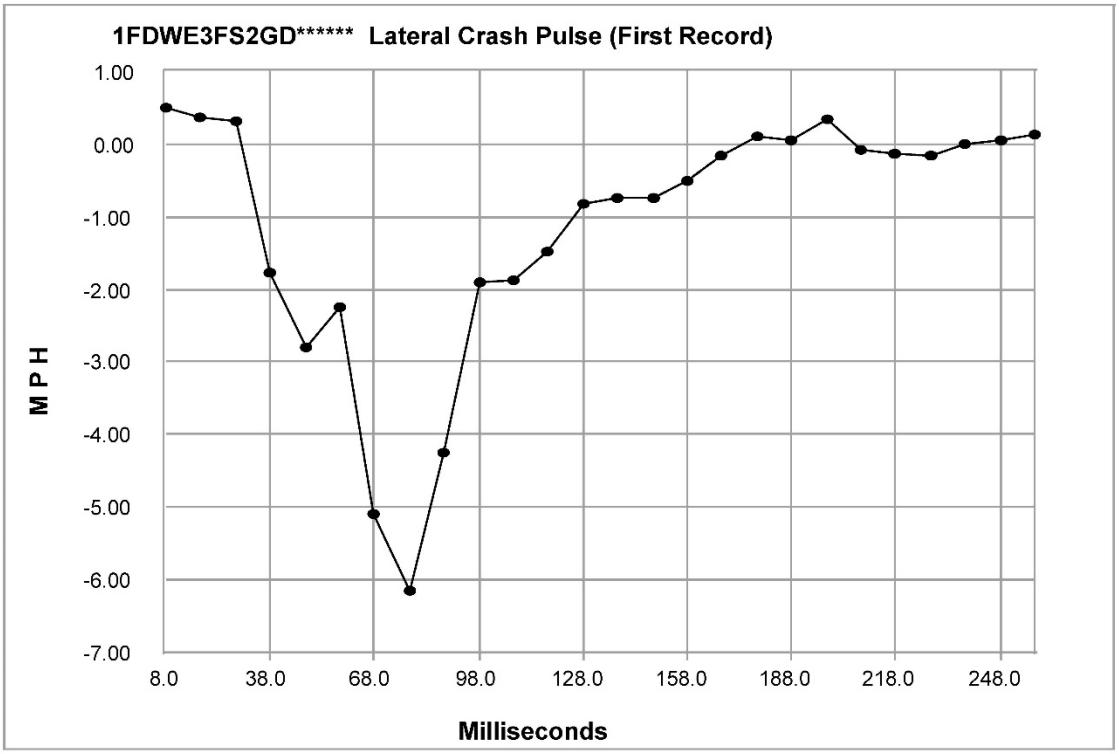
- 0.5	Invalid
- 0.4	Invalid
- 0.3	Invalid
- 0.2	Invalid
- 0.1	Invalid
0.0	Invalid



Longitudinal Crash Pulse (First Record)

Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
8.0	-0.86	-1.39
18.0	-1.76	-2.84
28.0	-5.31	-8.55
38.0	-9.43	-15.18
48.0	-15.05	-24.22
58.0	-17.03	-27.41
68.0	-17.72	-28.52
78.0	-18.42	-29.64
88.0	-18.35	-29.53
98.0	-18.86	-30.34
108.0	-21.25	-34.20
118.0	-21.58	-34.73
128.0	-22.12	-35.60
138.0	-22.77	-36.64
148.0	-23.68	-38.10
158.0	-25.03	-40.29
168.0	-26.21	-42.18
178.0	-26.87	-43.25
188.0	-27.08	-43.59
198.0	-26.98	-43.41
208.0	-26.98	-43.41
218.0	-27.26	-43.86
228.0	-27.21	-43.79
238.0	-27.09	-43.59
248.0	-27.13	-43.66
258.0	-26.99	-43.43



Lateral Crash Pulse (First Record)

Time (msec)	Delta-V, lateral (MPH)	Delta-V, lateral (km/h)
8.0	0.49	0.79
18.0	0.36	0.58
28.0	0.31	0.50
38.0	-1.78	-2.86
48.0	-2.79	-4.49
58.0	-2.25	-3.62
68.0	-5.10	-8.21
78.0	-6.17	-9.93
88.0	-4.25	-6.83
98.0	-1.90	-3.06
108.0	-1.87	-3.01
118.0	-1.49	-2.40
128.0	-0.82	-1.32
138.0	-0.75	-1.21
148.0	-0.73	-1.18
158.0	-0.51	-0.83
168.0	-0.15	-0.24
178.0	0.10	0.16
188.0	0.04	0.07
198.0	0.34	0.55
208.0	-0.07	-0.11
218.0	-0.13	-0.21
228.0	-0.17	-0.27
238.0	0.00	0.01
248.0	0.05	0.08
258.0	0.12	0.19

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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42 43 32 34 2D 31 34 42 33 32 31 2D 42 44 00 00 00 00 00 00 00 00 00 00

39 31 36 30 33 36 35 34 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

1B 7F 6F 3D 00 00 00 00 00 00 00 00 00 00 00 00

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Event Record 1

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5A 00 31 BF 5A 00 9C C1 5A 00 05 C4 5A 00 CB C3 5A 00 8B C5 5A 00 DF CD 5A 00 06
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29 E2 5A 00 C9 E1 5A 00 CA E1 5A 00 C2 E2 5A 00 9C E2 5A 00 2D E2 5A 00 52 E2 5A
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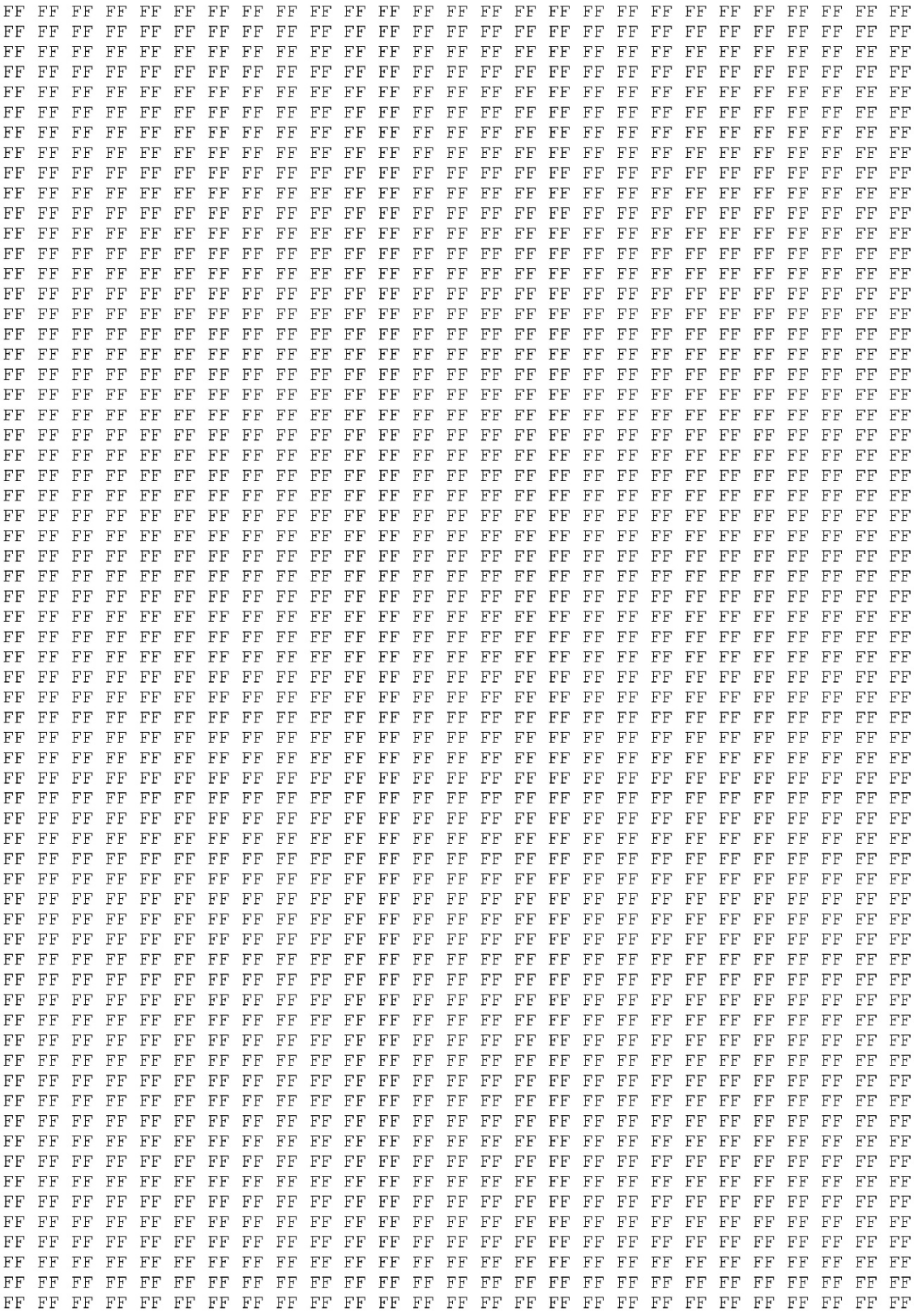

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Event Record 2
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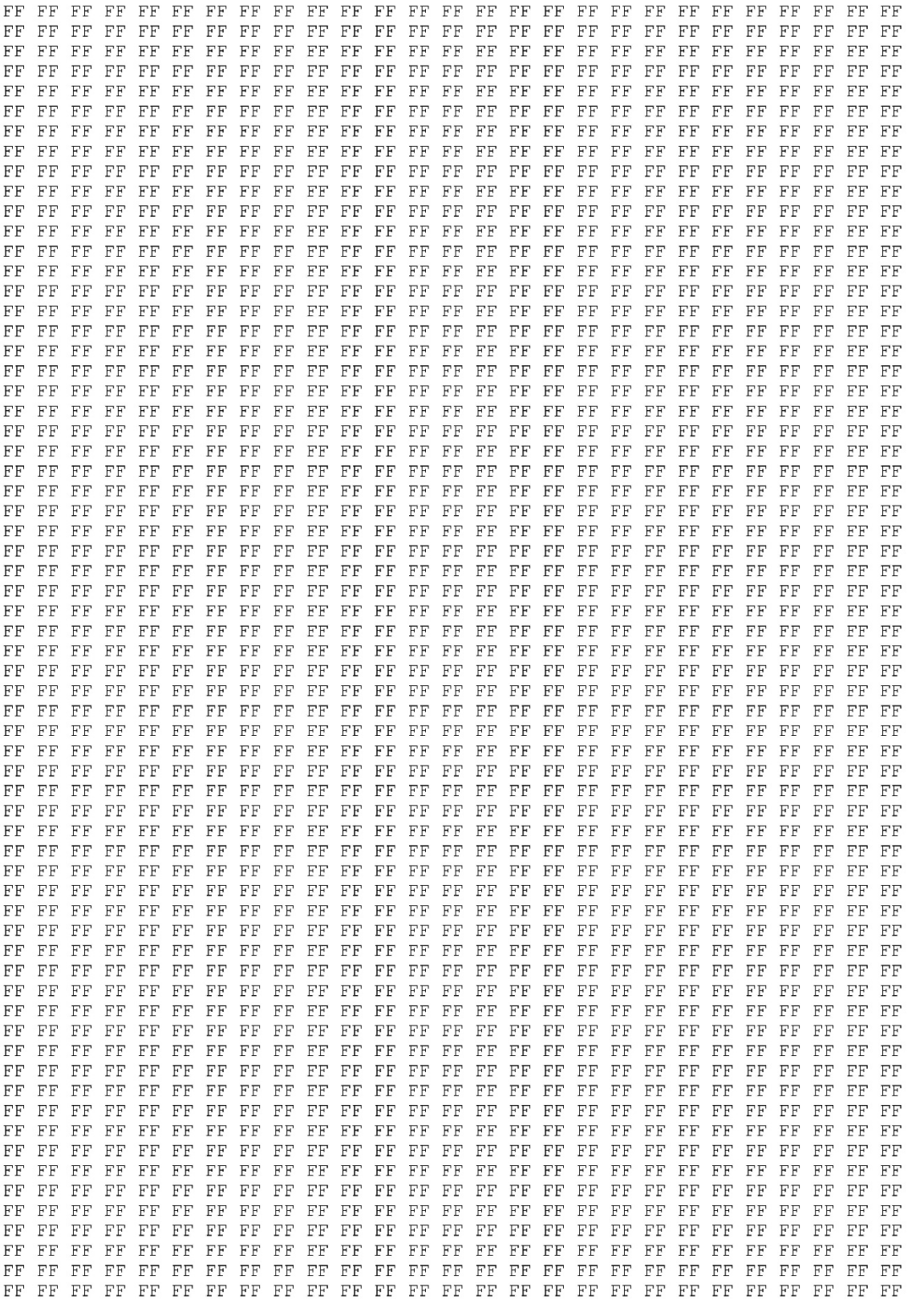

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DOT HS 812 857
January 2020

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

14502-120219-v1a