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ON-SITE AMBULANCE CRASH INVESTIGATION

CASE NUMBER - IN10036
LOCATION - ILLINOIS
VEHICLE - 2004 FORD E350 TYPE III AMBULANCE
CRASH DATE - October 2010

Submitted:

April 13, 2011

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

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

Technical Report Documentation Page

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16. *Abstract*

The focus of this on-site investigation was the damage to the patient compartment of a 2004 Ford E350 Type III Ambulance and the reconstruction of the crash. The ambulance was driven by a restrained 66-year-old male. An unrestrained 52-year-old paramedic was attending to a 52-year-old patient who was secured on a patient cot in the patient compartment. The ambulance was on a non-emergency run and was operating without emergency lights and siren. The ambulance was traveling north on a 2-lane, undivided, rural state highway at night during clear and dry weather conditions. A 1999 Chevrolet C1500 Silverado pickup truck was traveling east on a rural roadway at a high rate of speed when the driver applied hard braking as she approached the intersection. The Chevrolet rotated counterclockwise and its right side plane impacted the left side plane of the ambulance (event 1). The ambulance rotated counterclockwise and departed the east side of the roadway where it rolled over, right side leading, four quarter turns (event 2). The initial impact to the ambulance displaced the left side wall of the patient compartment and it separated from the vehicle during the rollover. The paramedic and the patient were both ejected from the patient compartment during the rollover. The ambulance driver, patient, and paramedic were transported by ambulance to a hospital. The driver was treated in the emergency room for minor injuries and released. The patient was treated in the emergency room and transferred to a trauma center. The paramedic was pronounced deceased.

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IN10036

The focus of this on-site investigation was the damage to the patient compartment of a 2004 Ford E350 Type III Ambulance (**Figure 1**) and the reconstruction of the crash. This crash was brought to our attention by the National Highway Traffic Safety Administration (NHTSA) on October 13, 2010 through an on-line news article. The crash had initially been suggested as of potential interest to NHTSA by this contractor on October 12, 2010. This investigation was assigned October 21, 2010. The crash involved the ambulance and a 1999 Chevrolet Silverado pickup truck. The crash occurred in October, 2010, at 2311 hours, in Illinois and was investigated by the Illinois State Police. The ambulance, the Chevrolet, and an exemplar ambulance were inspected on October 27, 2010. The crash scene was inspected on October 27-28, 2010. The driver of the ambulance and a first responder were interviewed at the crash scene on October 28, 2010. The director of operations of the ambulance company was interviewed on November 2, 2010. This report is based on the police crash report, vehicle inspections, crash scene inspection, exemplar ambulance inspection, interview information, occupant kinematic principles, and evaluation of the evidence.

Figure 1: The damaged 2004 Ford E350 Type III ambulance

AMBULANCE COMPANY AND PERSONNEL

The ambulance service was operated by the county government and was staffed by volunteers. The ambulance service had been in operation for 34 years and provided emergency transfer and 9-1-1 service to a rural county. The service operated a fleet of 6 ambulances and did not have a specific driver training requirement for their ambulance drivers.

The driver of the ambulance was a 66-year-old male. He was a basic Emergency Medical Technician (EMT) and had been a volunteer with the ambulance service for approximately 34 years. He was primarily a driver for the ambulance service. He had completed a certified emergency vehicle operators course and a "behind the wheel" driving course at approximately the age of 58. On the day of the crash, he had worked a full day at his normal job and was on-call for the ambulance service the evening of the crash. He had slept six to eight hours the night before the crash. The driver stated during the SCI interview that at the time of the crash the ambulance was operating without the emergency lights and siren.

The paramedic was a 52-year-old male. He had been a paramedic with the ambulance service for approximately 27 years. The paramedic was unrestrained and seated in an unknown location in the patient compartment. The driver stated that the paramedic was probably administering intravenous fluids to the patient.

The patient was a 52-year-old male who was complaining of pain. He had been involved in a crash on a 4-wheel all-terrain vehicle several days prior to this crash. The patient was restrained on a Stryker 6500 Power Pro XT patient cot.

CRASH CIRCUMSTANCES

Crash Environment: This crash occurred at night in the 4-leg intersection of a 2-lane, undivided, state highway and a 2-lane, undivided, rural roadway. The weather was clear and dry and the there was no artificial lighting. The ambulance was traveling on the state highway, which traversed in a north-south direction. The Chevrolet was traveling on the rural roadway, which traversed in an east-west direction. The state highway was level bituminous and bordered by 1.2 m (3.9 ft) wide gravel shoulders. The northbound lane was 3.9 m (12.8 ft) in width, while the southbound lane was 3.3 m (10.8 ft) in width. The roadway pavement markings consisted of solid white edge lines and a broken yellow center line. The rural roadway was bituminous with 1 m (3.3 ft) wide grass shoulders. The roadway was 5.3 m (17.4 ft) in width and was controlled by a stop sign at the intersection. There were no roadway pavement markings. The grade of the rural roadway was positive 1.6% to the east. The speed limit for both vehicles was 89 km/h (55 mph). The Crash Diagram is on page 17 of this report.

Figure 2: Approach of the ambulance northbound to the intersection

Figure 3: Approach of the Chevrolet eastbound at the onset of the skid marks

Pre-Crash: The ambulance was traveling north on the state highway (**Figure 2**) at a driver estimated speed of 89-93 km/h (55-58 mph). The emergency lights and siren were not activated. The Chevrolet was traveling east (**Figure 3**) at a high rate of speed and the 37-year-old female driver applied hard braking as she approached the intersection. The vehicle rotated counterclockwise as it skidded 66 m (216.5 ft) to impact with the ambulance. At the point of impact, the Chevrolet had rotated counterclockwise 85 degrees from its initial easterly heading. The calculated speed of the Chevrolet at the onset of the braking skid

Figure 4: Location of impact viewed from the northbound approach of the ambulance

marks was 134 km/h (83 mph). The Chevrolet driver's blood alcohol concentration was 0.17 mg/dl. The driver of the ambulance stated that he did not see the Chevrolet until he was almost at the intersection. He estimated that he had approximately 1 sec to react and was unable to take any avoidance actions.

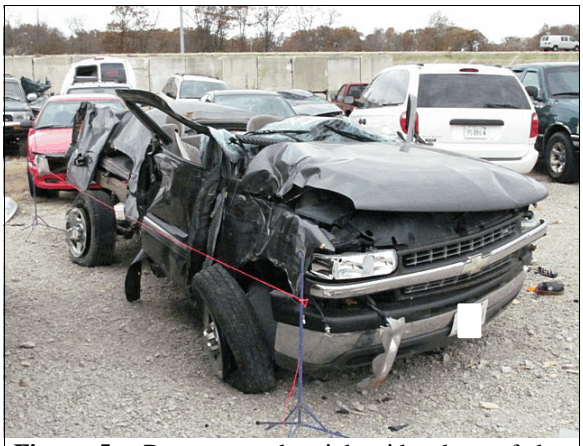

Figure 5: Damage to the right side plane of the Chevrolet from the impact with the left side plane of the ambulance

Figure 6: Damage on the left side plane of the ambulance from the impact with the right side plane of the Chevrolet; arrow shows location of initial contact on the left front door

Crash: The crash occurred within the intersection (**Figure 4**) as the right side plane of the Chevrolet (**Figure 5**) impacted the left side plane of the ambulance (**Figure 6**, event 1). The left side wall of the patient compartment was torn open during the engagement between the two vehicles. The force direction on the ambulance was within the 11 o'clock sector and the calculated total Delta V was 28 km/h (17.4 mph). The longitudinal and lateral velocity changes were -20.8 km/h (-12.9 mph) and 18.8 km/h (11.7 mph), respectively. The calculated impact speeds of the ambulance and the Chevrolet were 92 km/h (57 mph) and 74 km/h (46 mph), respectively. The ambulance rotated counterclockwise approximately 10 degrees and departed the east side of the roadway. It rotated an additional 22 degrees as it traveled 15 m (49.2 ft) down a negative 18% grass covered grade to the bottom of a ditch where the right side wheels furrowed into the soil and the vehicle tripped and rolled over (event 2), right side leading, four quarter turns. The ambulance rolled over up the positive 8% back slope of the ditch and came to final rest on its wheels heading east 50 m (164 ft) north of the impact area. During the rollover, the paramedic and the patient were both ejected through the displaced left side wall of the patient compartment. The paramedic came to final rest near the left front wheel of the ambulance. The patient and cot came to final rest approximately 10 m (33 ft) directly north of the ambulance. The displaced wall of the patient compartment came to final rest approximately 4 m (13 ft) directly south of the ambulance. The Chevrolet came to final rest in the east ditch 15 m (49 ft) north of the impact area.

Post-Crash: The driver exited the vehicle through the left front window glazing, which had disintegrated during the crash. An off-duty EMT who lived near the crash site was the first on–scene. He stated during the SCI interview that at least some of the straps on the patient cot had broken and that the patient was separated from the cot. He was unsure which straps had broken. The driver and the paramedic were transported by ambulance to a hospital. The driver was treated in the emergency room and released. The paramedic was pronounced deceased. The patient was transported to a trauma center. He was treated in the emergency room and transferred to a second

trauma center. The driver and front right passenger of the Chevrolet were transported by air ambulance to a hospital. The driver was hospitalized and the front right passenger was pronounced deceased. Both vehicles were towed from the crash scene due to damage.

CASE VEHICLE

2004 Ford E350 was a rear wheel drive, 2-passenger, 2-door, super duty cutaway van (VIN: 1FDWE35P34H------) manufactured in June of 2004. The ambulance body was manufactured by Wheeled Coach in September 2004. The vehicle was equipped with a 6-liter, V-8 diesel engine, an automatic transmission, and anti-lock brakes. The front row was equipped with box-mounted seats, integral head restraints, lap-and-shoulder safety belts, and driver and front right passenger frontal air bags. The patient compartment had a typical layout with a box-mounted rear-facing seat behind the driver, a three passenger bench seat along the right side with lap safety belts, a single seat with lap safety belt at the middle of the left side, a right side entry door, double rear doors for patient loading, and multiple cabinets along the left side, right side, and front for storage. The specified wheelbase was 351 cm (138 in).

CASE VEHICLE DAMAGE

Exterior Damage Event 1: The ambulance sustained left side plane damage from the impact with the Chevrolet. The direct damage began on the left front door 253 cm (99.6 in) forward of the left rear axle. The direct damage was 43 cm (16.9 in) in length on the left front door and extended onto the left side plane of the patient compartment. The entire left side wall of the patient compartment was torn off the vehicle during the crash. The wall was constructed of sheet aluminum that was attached to a welded aluminum frame by adhesive caulk (**Figure 7**). The frame of the wall was constructed of welded 5 cm x 5 cm (2 in x 2 in) aluminum studs. The inside surface of the wall was constructed of plywood. The wall was insulated with fiberglass. The frame of the wall was welded to the front, back, top, and floor of the patient compartment. All of the left side wall studs broke at their welds on the frames of the front, top (**Figure 8**), back (**Figure 9**), and floor of the patient compartment.

Figure 7: The displaced left side wall of the ambulance

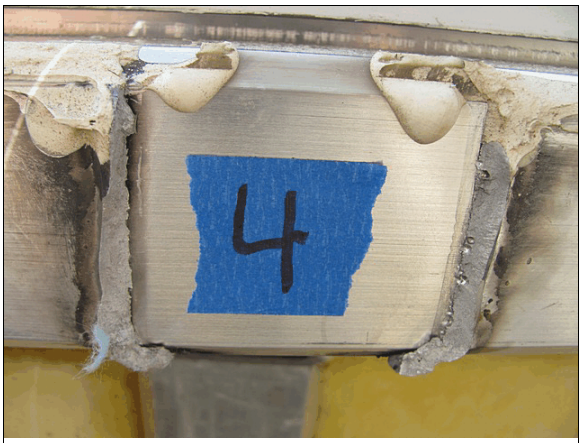

Figure 8: Broken welds of one of the vertical studs at the top horizontal frame member

Damage Classification Event 1: The Collision Damage Classification (CDC) for the left side damage was 11LDAW3 (320 degrees). A

conservation of linear momentum analysis was performed to determine the impact speed and Delta V. The results are presented in the crash section on page 3 of this report. The WinSMASH program could not be used to calculate a Delta V for this impact since no crush stiffness coefficients are available for the patient compartment and no crush profile for the ambulance could be measured.

Figure 9: Broken welds and separated adhesive caulk on the displaced back wall at the back left corner of the patient compartment

Exterior Damage Event 2: The ambulance sustained damage on both side planes and the top plane during the rollover. The direct damage on the right side plane began at the front of the right fender and extended rearward 43 cm (16.9 in) on the fender. The right side view mirror was broken and grass was embedded in the mirror. The top right corner of the patient compartment was also directly damaged. Scratches were present on the lower right rear side of the patient compartment beginning 96 cm (37.8 in) rear of the right rear axle and extending rearward 74 cm (29 in). The direct damage on the left side plane began at the front of the left fender and extended rearward 193 cm (76 in) to the back of the cab. Ground contact evidence was also present on the displaced left wall of the patient compartment. The direct damage on the top plane involved the roof of the cab and front corners of the patient compartment. The maximum vertical crush was 62 cm (24 in) and occurred on the windshield header 60 cm (23.6 in) left of the top of the right A-pillar. The full width of the roof of the cab, 166 cm (65.4 in), sustained direct damage during the rollover. The maximum lateral crush to the roof structure was 18 cm (7.1 in) and occurred at the top of the right A-pillar.

Damage Classification Event 2: The CDC for the rollover was 00TYDO5. Based on the extent of the roof crush, the severity of the rollover damage was severe.

The vehicle manufacturer's recommended tire size was LT225/75R16. The vehicle was equipped with tires of the recommended size. The ambulance's tire data are presented in the table below.

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	Flat	Flat	448	65	6	8	Debeaded	No	Yes
LR Outside	Flat	Flat	448	65	6	8	Sidewall torn	No	Yes
LR Inside	Flat	Flat	448	65	6	8	Debeaded	No	Yes
RR Inside	152	22	448	65	6	8	None	No	No
RR Outside	Flat	Flat	448	65	6	8	Debeaded	No	Yes
RF	359	52	448	65	6	8	None	No	No

Vehicle Interior: The inspection of the front row revealed a hair transfer on the roof near the left roof side rail from contact by the driver's head. Blood transfers were also located on the roof and left sunvisor above the driver's seat position. There was no discernable evidence of occupant contact located in the patient compartment. There was no deformation of the steering wheel or compression of the energy absorbing steering column.

The left front door was jammed closed during the crash and was forced open at some point following the crash. It would not close at the SCI inspection. The right front door remained closed and operational. The right side entry door for the patient compartment remained closed and operational. The striker on the right rear patient loading door was broken off at its anchor. The left front and right front windows were closed prior to the crash. The left front window glazing was disintegrated from impact forces during the crash. The right front window was undamaged. The windshield was in place and cracked from impact forces and had partially separated from the frame alone the top and right A-pillar. The glazing on the right side entry door of the patient compartment and the patient loading doors was undamaged.

Figure 10: Grass entrapped in the bead of the right rear wheel of the ambulance from engaging the back side of the ditch

ROLLOVER DISCUSSION

The rollover of the ambulance was initiated when the right side wheels furrowed into the ground at the bottom of the ditch. The right rear

wheel (**Figure 10**) sustained the primary load when it entered the channel at the bottom of the ditch and engaged the back side of the ditch (**Figure 11**). The force on the right side wheels was sufficient to trip the vehicle and it rolled over, right side leading four quarter turns up the positive 8% back slope of the ditch and across a distance of 21 m (68.9 ft). During the rollover, the vehicle continued to rotate counterclockwise and it came to final rest heading east.

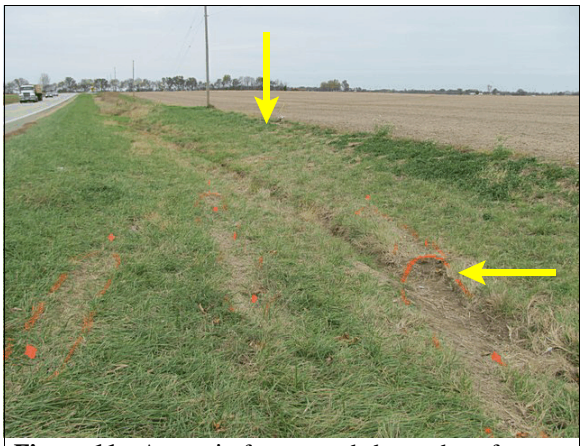

Figure 11: Arrow in foreground shows deep furrow on back side of ditch from right rear wheel of the ambulance; arrow in background shows the final rest location of the ambulance.

AUTOMATIC RESTRAINT SYSTEM

The front row was equipped with driver and front right passenger frontal air bags. The driver's air bag was located within the steering wheel hub and the front right passenger air bag was located within the middle of the right instrument panel. Neither air bag deployed during this crash.

MANUAL RESTRAINT SYSTEM

The front row was equipped with driver and front right passenger lap-and-shoulder safety belts. The driver's safety belt was equipped with continuous loop belt webbing, an adjustable upper anchor that was in the full-down position, a sliding latch plate, and an Emergency Locking Retractor (ELR). The front right safety belt was similarly equipped but had a switchable ELR/Automatic Locking Retractor (ALR).

The inspection of the driver's safety belt assembly revealed historic usage scratches on the latch plate. Load marks were present on the latch plate belt guide. This evidence was consistent with the driver's statement that he was restrained by the lap-and-shoulder safety belt.

PATIENT COMPARTMENT

The patient compartment was configured with storage cabinets on the left side, front, and right side above the crew bench seat. The storage cabinets on the left side were destroyed during the crash. The storage cabinets on the front remained intact. The rear plexiglass sliding door on the right side storage cabinet was displaced off the cabinet. The cabinet was otherwise undamaged. There were four exterior compartments on the right side of the patient compartment. The doors on these compartments were undamaged and remained closed. A storage compartment, which probably housed an H-size oxygen cylinder was located on the left side of the patient compartment immediately behind the driver. The compartment was destroyed during the crash. The door was damaged but the hinges were intact. The oxygen cylinder was not present at the inspection. The remains of two other storage compartments from the left side were also present. One was completely destroyed. The door on the other storage compartment was damaged and the hinges were intact, but the compartment was destroyed. The damage to the left side wall of the

patient compartment was discussed in the exterior damage section for event 1 on page 4 of this report.

A box-mounted rear-facing seat with a fixed track was located on the forward left side of the patient compartment immediately behind the driver's seat. A galvanized steel strap was located under the box at the back and front. They were bolted to the box and the floor at each corner of the box. The straps were 4 cm (1.6 in) wide and 4 mm (0.2 in) thick. The seat was displaced toward the right side of the patient compartment during the crash. The front strap was bent to the right 17 cm (6.7 in) and the box was broken.

The box-mounted seat was equipped with a lap safety belt. The safety belt was equipped with retractable webbing, an ALR retractor, and a sewn latch plate. The inspection of the safety belt revealed historic usage scratches on the latch plate. There was no evidence of loading on the lap belt.

A box-mounted bench seat was located on the right side of the patient compartment. It was equipped with three lap safety belts, which were bolted to the wall of the patient compartment. Each safety belt was equipped with retractable webbing, an ALR retractor, and a sewn latch plate. Inspection of the safety belt assemblies revealed no evidence of loading.

A single seat with lap safety belt was mounted to the middle left wall of the patient compartment located between the storage cabinets and work shelves. The safety belt consisted of retractable webbing, an ALR retractor, and a sewn latch plate. The safety belt was found bolted to a displaced panel of the wall of the patient compartment. The seat was destroyed. There was no evidence that the safety belt was in use at the time of the crash.

Figure 12: The Stryker 6500 Power Pro XT patient cot

Figure 13: The broken wheel frame on the lift-capable safety bar at the head of the cot

PATIENT COT

The cot that was used to transport the patient was a Stryker 6500 Power Pro XT (**Figure 12**), serial number 081039975. The cot was an aluminum x-frame design and its maximum weight capacity was 318 kg (700 lbs). It was equipped with a 24 volt battery hydraulic lift system. The standard length and width was 206 cm (81 in) and 58 cm (23 in), respectively. Its lowest adjustable position was 36 cm (14 in) and the highest was 105 cm (41 in). No patient restraints were on the cot at the time of the SCI inspection. The ambulance driver stated that the patient was

secured on the cot by the 4-point shoulder restraint and two lower torso restraints.

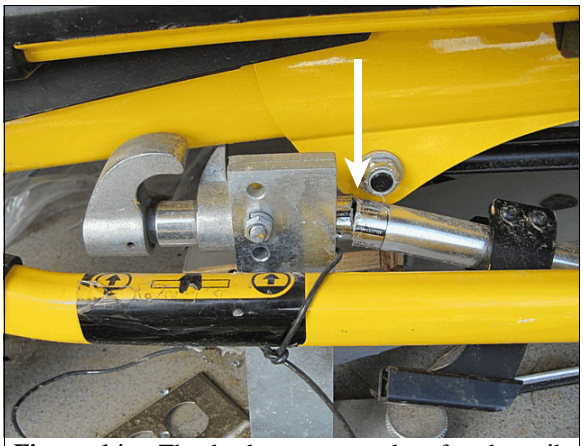

Figure 14: The broken actuator bar for the rail clamp

At the time of the crash, the cot was secured by the ambulance's antler bracket and rail clamp. The antler bracket secures the head of the cot by restraining the undercarriage using the wheel frames as anchor points. The rail clamp secured the frame of the cot. Inspection of the cot revealed that the wheel frame on the lift-capable safety bar at the head of the cot was broken at the end of each frame rail (**Figure 13**). The dimensions of the frame rail were 5 cm x 3 cm (2 in x 1.2 in). The left frame rail was bent 2 cm (0.8 in) to the left, while the right frame rail was bent slightly. A scuff mark 8 cm (3 in) in length was present on the right frame member at the head of the cot. The actuator bar for the rail clamp was fractured (**Figure 14**). The plastic housing on the right grip rail at the foot end controls was also fractured.

The patient and the cot were ejected from the vehicle during the rollover through the displaced left side wall of the patient compartment. The patient cot was placed back in the ambulance following the crash.

CASE VEHICLE DRIVER KINEMATICS

The restrained driver [66-year-old male,173 cm (68 in) and 82 kg (180 lbs)] of the ambulance was seated in an upright posture with his back against the seat back and both hands on the steering wheel at the approximate 10 and 2 o'clock positions. The seat track was located in the rear position and the seat back was slightly reclined. The steering wheel was located between the middle and full-up position. The driver was wearing glasses at the time of the crash.

The left side impact on the ambulance displaced the driver forward and to the left opposite the 11 o'clock direction of force and he loaded the safety belt. The vehicle departed the right side of the roadway and as it rotated counterclockwise into the ditch, the driver was redirected to his right within the safety belt as the vehicle decelerated. When the vehicle rolled over right side leading, the driver was redirected toward the roof. He contacted his head on the intruding roof during the rollover but sustained no head injury. The left front glazing disintegrated during the crash and he sustained abrasions and lacerations on his forehead, lacerations on his right cheek, and abrasions on his left elbow from flying glass fragments. He also sustained an abrasion on the left shoulder from loading the safety belt. He remained restrained in his seat position throughout the rollover and exited the vehicle without assistance through the left front window.

The driver was transported by ambulance to a hospital where he was treated in the emergency room and released. The driver's injuries and injury sources are presented in the table below.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Lacerations, 0.5 cm (0.2 in) on forehead, midline, along hairline; no sutures required	minor 210600.1,7	Noncontact injury: flying glass, left front glazing	Certain	Emergency room records
2 3	Abrasions (excoriations) and contusions, small, to forehead	minor 210202.1,7 210402.1,7	Noncontact injury: flying glass, left front glazing	Certain	Emergency room records
4	Lacerations on left cheek, not further specified	minor 210600.1,2	Noncontact injury: flying glass, left front glazing	Certain	Interviewee (same person)
5	Abrasion on left shoulder, not further specified	minor 710202.1,2	Torso portion of safety belt system	Certain	Interviewee (same person)
6	Abrasions (excoriations), mild, on left elbow, not further spec-ified	minor 710202.1,2	Noncontact injury: flying glass, left front glazing	Probable	Emergency room records

CASE VEHICLE OTHER ROW PASSENGER, PARAMEDIC KINEMATICS

The unrestrained paramedic [52-year-old male, 170 cm (67 in) and 68 kg (150 lbs)] was seated in an unknown location within the patient compartment. He was attending to the patient.

The impact with the Chevrolet displaced the paramedic forward and to the left. As the ambulance rotated counterclockwise through the grass, the paramedic was redirected to the right as the vehicle decelerated. He was redirected toward the roof as the vehicle began to rollover right side leading. During the rollover, the paramedic was ejected from the patient compartment through the displaced left side wall of the patient compartment. He sustained subdural and subarachnoid hemorrhages from contacting the ground. Also following his ejection, the roof of the vehicle contacted him, which caused fractures of posterior ribs 1-12 with bilateral hemothoraces, fractured sternum, fractures of thoracic vertebrae T_4 and T_5, fractured left clavicle and scapula, and a fracture through the left sacroliliac joint. He also sustained multiple abrasions and contusions. The paramedic came to final rest near the left front wheel of the ambulance.

CASE VEHICLE OTHER ROW PASSENGER, PARAMEDIC INJURIES

The paramedic was transported by ambulance to a hospital. He sustained critical injuries and was pronounced deceased at the hospital. The table below presents the paramedics's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Hemorrhage, subdural, diffuse, mild, not further specified	serious 140650.3,9	Ground	Probable	Autopsy
2	Hemorrhage, subarachnoid, right lateral parietal lobe	moderate 140694.2,1	Ground	Probable	Autopsy
3	Hemothoraces, bilateral, 500 ml, not further specified with atelectasis (collapsed) both lungs; no pneumothorax or pulmonary contusions	serious 442200.3,3	Exterior of occupant's motor vehicle: roof	Probable	Autopsy
4	Fractured posterior ribs, bilaterally: 1st through 12th, with	serious 450203.3,3	Exterior of occupant's motor vehicle: roof	Probable	Autopsy
5	left side flail chest, not further specified	450211.3,2			Emergency room records
6	Fracture, transverse, sternum, not further specified	moderate 450804.2,4	Exterior of occupant's motor vehicle: roof	Probable	Autopsy
7	Fracture, displaced, T_5 vertebral body, with	moderate 650430.2,7	Exterior of occupant's motor vehicle: roof	Probable	Autopsy
	diastasis between T_4 and T_5 of 1.3 cm (0.5 in)				Emergency room records
8	Fracture left distal clavicle, without significant displacement	moderate 750731.2,2	Exterior of occupant's motor vehicle: roof	Probable	Autopsy
9	Fracture through left sacroiliac joint with separation of pubis symphysis	Serious 856161.3,4	Exterior of occupant's motor vehicle: roof	Probable	Autopsy
10	Fracture left scapula through inferior portion, transversely and comminuted	moderate 750951.2,2	Exterior of occupant's motor vehicle: roof	Probable	Emergency room records
11	Abrasions, brush type, over right side of face from hairline to chin	minor 210202.1,1	Ground	Probable	Autopsy
12	Contusions (ecchymosis) with swelling to forehead, not further specified	minor 210402.1,7	Ground	Probable	Emergency room records
13	Contusion left chest, not further specified	minor 410402.1,2	Exterior of occupant's motor vehicle: roof	Probable	Emergency room records
14	Contusion abdomen, not further specified	minor 510402.1,9	Exterior of occupant's motor vehicle: roof	Probable	Emergency room records

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
15	Abrasions anterior right shoulder, not further specified	minor 710202.1,1	Ground	Probable	Autopsy
16	Contusion left hip, not further specified	minor 810402.1,2	Exterior of occupant's motor vehicle: roof	Possible	Emergency room records
17	Abrasions left knee, not further specified	minor 810202.1,2	Ground	Possible	Autopsy
18	Abrasion right ankle, not further specified	minor 810202.1,1	Ground	Possible	Autopsy

CASE VEHICLE OTHER ROW PASSENGER, PATIENT KINEMATICS

The patient [52-year-old male,178 cm (70 in) and 56 kg (123 lbs)] was restrained supine on the patient cot by the 4-point shoulder harness and two lower torso restraints. His head was positioned toward the front of the ambulance.

The impact with the Chevrolet probably displaced the patient forward and he loaded the restraints on the patient cot. During the rollover, the cot separated from the antler bracket and rail clamp and was ejected through the displaced left side wall of the ambulance. The patient sustained subdural, subarachnoid, and intraventricular hemorrhages of the brain and a brain contusion from contacting the ground. He also sustained a fracture of the third cervical vertebrae, bilateral rib fractures with pneumothorax and hemopneumothorax, fractures of the ninth and tenth thoracic verebrae, and contusion of the mesentery also from contacting the ground. The patient and cot came to final rest approximately 10 m (33 ft) directly north of the ambulance. The person that found the patient reported that at least some of the restraints on the cot had broken, (he was unsure which restraints had broken) and the patient was separated from the cot.

CASE VEHICLE OTHER ROW PASSENGER, PATIENT INJURIES

The patient was transported by ambulance to a trauma center where he was treated in the emergency room. He was transferred to a second trauma center and admitted for treatment of his injuries. He was hospitalized for 55 days.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Hemorrhage, subdural, small, in anterior falx[1], along left frontoparietal and occipital lobes, and along tentorium; developed bilateral subdural hygromas[1]	severe 140654.4,3	Ground	Probable	Hospitalization records
2 3	Hemorrhage, intraventricular, small, within occipital horns of lateral ventricles and 4th ventricle with worsening dilation suspicious for hydrocephalus	severe 140677.4,1 140677.4,2	Ground	Probable	Hospitalization records
4	Contusion, small, hemorrhagic, right frontal lobe, not further specified	serious 140606.3,1	Ground	Probable	Hospitalization records
5	Hemorrhage, small, subarachnoid, in basal cistern and left ambient cistern[2]	moderate 140693.2,2	Ground	Probable	Hospitalization records
6	Fracture C_3, non-displaced, right transverse processes	moderate 650220.2,6	Ground	Probable	Hospitalization records
7	Fractured ribs bilaterally, with some displacement and suboptimal specificity[3]	serious 450203.3,3	Ground	Probable	Hospitalization records

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[1] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
falx (falks) pl. ***fal'ces***: a sickle-shaped organ or structure; used as a general term in anatomical nomenclature to designate such a structure.
f. ce'rebri, f. of cerebrum: the sickle-shaped fold of dura mater that extends downward in the longitudinal cerebral fissure and separates the two cerebral hemispheres.
hygroma (hi-gro'ma) pl hygromas: a sac, cyst, or bursa distended with a fluid.
subdural h.: a collection of fluid in the subdural space resulting from liquefaction of a subdural hematoma.

[2] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
cistern (sis'tern): a closed space serving as a reservoir for fluid; see also *cisterna*.
ambient c.: cisterna ambiens.
basal c.: cisterna interpeduncularis.
interpeduncular c.: cisterna interpeduncularis.
cisterna (sis-ter'na)* pl. *cister'nae: a cistern -- a closed space serving as a reservoir for lymph or other body fluid, especially one of the enlarged subarachnoid spaces containing cerebrospinal fluid.
c. am'biens: the subarachnoid space surrounding the midbrain; it connects the cisterna venae magnae cerebri with the cisterna interpeduncularis. Called also *c. mesencephalicum*.
c. basa'lis: c. interpeduncularis.
c. interpeduncula'ris: interpeduncular cistern -- a dilatation of the subarachnoid space between the cerebral peduncles; called also *basal cistern*.
c. mesencepha'licum: c. ambiens.

[3] For example: fractured bilateral 1st ribs with mild displacement; fractured left 2nd rib with mild displacement and comminution; multiple right rib fractures; massively deformed chest with obvious bilateral rib fractures.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
8	Pneumothorax, small, right lung[4]	moderate 442202.2,1	Ground	Probable	Hospitalization records
9	Hemopneumothorax with 100 ml of air and blood[5]	serious 442200.3,1	Ground	Probable	EMS treatment record
10	Fracture, burst, comminuted, T_{10} vertebrae with complete compromise/encroachment[6] of spinal canal posteriorly, paraplegia, and anterolisthesis, 10 mm (0.4 in), of T_{10} over T_{11}	critical 640428.5,7	Ground	Probable	Hospitalization records
11	Fractures, bilaterally, T_{10} posterior elements, not further specified	moderate 650417.2,7	Ground	Probable	Hospitalization records
12	Fracture T_9 posterior elements, bilaterally, not further specified	moderate 650417.2,7	Ground	Probable	Hospitalization records
13	Contusion, mesenteric, and hemoperitoneum, not further specified	moderate 542010.2,8	Interior object: cot straps	Probable	Hospitalization records
14	Hematoma, large, superior right scalp near vertex	minor 110402.1,1	Ground	Probable	Hospitalization records
15	Laceration right temporal scalp, not further specified	minor 110600.1,1	Ground	Probable	Emergency room records
16	Contusion, large, across abdomen, including left flank from stretcher straps	minor 510402.1,0	Interior object: cot straps	Probable	EMS treatment record
17	Contusion (strap mark) tracking from left chest wall to right lower flank	minor 410402.1,4	Interior object: cot straps	Probable	Emergency room records
18	Abrasion right flank, not further specified	minor 510202.1,1	Ground	Probable	Emergency room records
19	Abrasions, scattered, on central back, not further specified	minor 410202.1,6	Interior object: cot surface	Probable	Emergency room records
20	Abrasion anterior right shoulder, not further specified	minor 710202.1,1	Interior object: cot straps	Probable	Emergency room records

[4] Depending upon which medical record one reads, the right pneumothorax was basal or apical.

[5] The hemothorax was reported by the transferring EMTs and was diagnosed at the initial medical facility where a right chest tube was inserted to drain the wound.

[6] Spinal canal was compressed 3-4 mm (0.12 to 0.16 in) because of retropulsion. The following term is defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
retropulsion (ret"ro-pul'shen): 1. a driving back.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
21	Abrasion anterior proximal thigh, not further specified	minor 810202.1,1	Ground	Probable	Emergency room records
22	Contusion, large, left lateral thigh	minor 810402.1,2	Ground	Probable	EMS treatment record
23	Contusions bilateral knees, not further specified	minor 810402.1,3	Ground	Probable	EMS treatment record

OTHER VEHICLE

The 1999 Chevrolet C1500 Silverado was a rear wheel drive, 3-passenger, 2-door, regular cab pickup truck (VIN: 1GCEC14T0XE------). The specified standard equipment included a 5.3-liter, V8 engine, a 4-speed automatic transmission, 4-wheel anti-lock brakes, and driver and front right passenger frontal air bags.

Exterior Damage: The Chevrolet sustained direct damage to the entire left side during the impact with the ambulance. The direct damaged began 74 cm (29 in) forward of the right front axle and extended 530 cm (208.7 in) down the right side. Crush measurements were taken at the mid-door level and the maximum residual crush was 56 cm (22 in) occurring at C_3. The table below presents the Chevrolet's right side crush profile

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	530	56	530	0	52	56	20	21	21	-20	-20
in		208.7	22.0	208.7	0.0	20.5	22.0	7.9	8.3	8.3	-7.9	-7.9

Damage Classification: The CDC for the right side damage was 05RDAW4 (140 degrees). A conservation of linear momentum analysis was performed and the calculated total Delta V was 64 km/h (39.7 mph). The longitudinal and lateral velocity changes were 47.3 km/h (29.4 mph) and -43.0 km/h (-26.7 mph), respectively. The calculated impact speed was 74 km/h (46 mph).

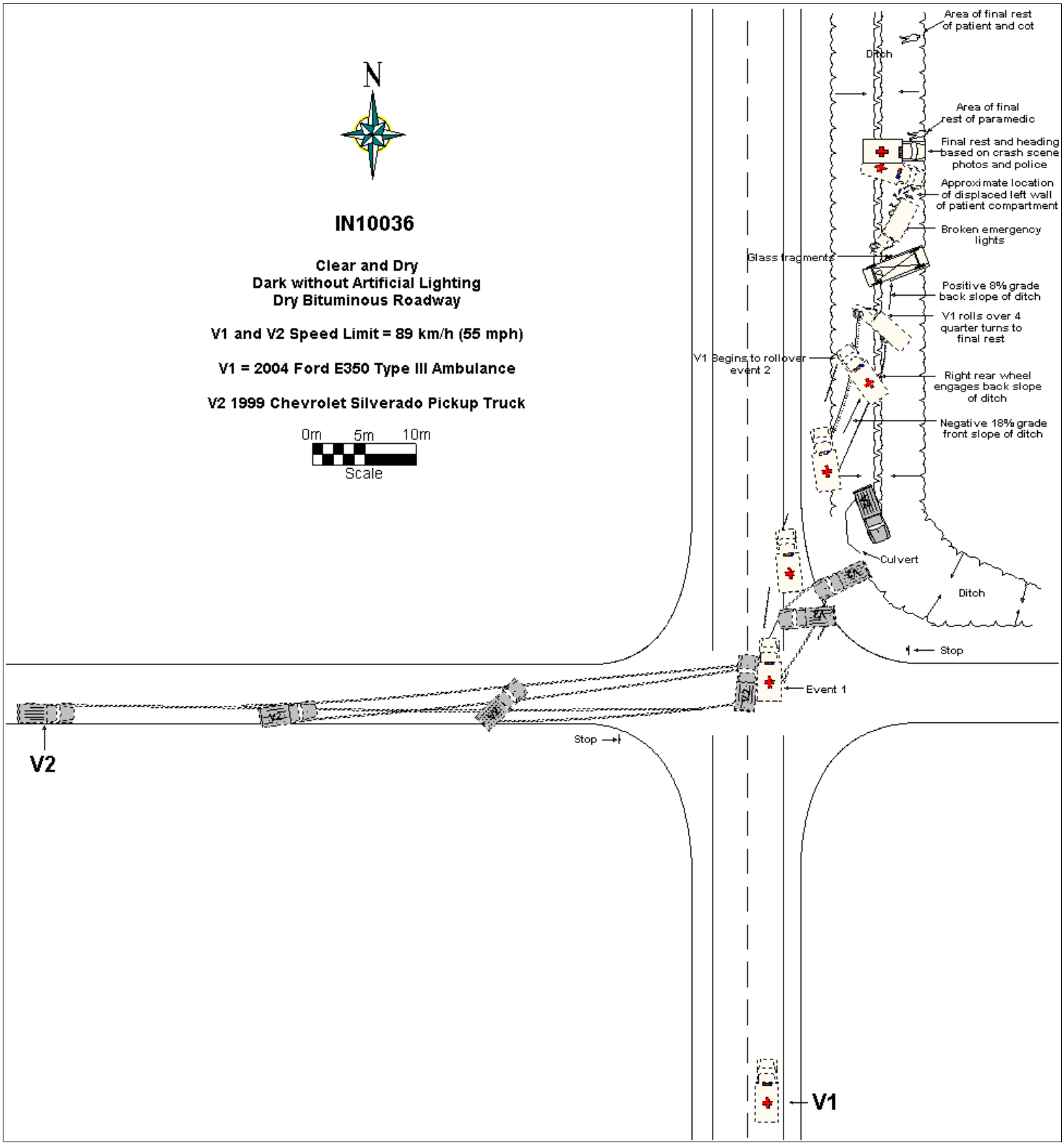
The vehicle manufacturer's recommended tire size was P235/75R16 or optional size P255/70R16. The Chevrolet was equipped with the optional size tires. The vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	Flat	Flat	241	35	5	6	Bead separation	Yes	Yes
LR	214	31	241	35	2	3	None	No	No
RR	Flat	Flat	241	35	2	3	Sidewall cut, bead separated	No	Yes
RF	Flat	Flat	241	35	5	6	None	Yes	Yes

Event Data Recorder: The air bag control module, which contains the Event Data Recorder (EDR) was removed by the police. They imaged the data using the Bosch Crash Data Retrieval tool and version 3.5 of the software. A copy of the EDR report was provided to this contractor. The EDR reported a non-deployment event. No pre-crash data was reported. The EDR reported the SIR warning lamp status as "Off" and the driver's safety belt switch circuit status as "Unbuckled." The front right passenger's SIR suppression switch circuit status was reported as "Air bag suppressed." The time from algorithm enable (AE) to maximum recorded velocity change was 12.5 msec. The maximum recorded velocity change was -0.35 km/h (-0.22 mph). The EDR report is attached at the end of this report[7].

Other Vehicle's Occupants: According to the police crash report, the driver of the Chevrolet (36-year-old female) and the front right passenger (45-year-old male) were not restrained by their lap-and-shoulder safety belts. Neither frontal air bag deployed during the crash. The driver and front right passenger were transported by air ambulance to a hospital. The driver sustained police-reported A (incapacitating) injuries and was hospitalized. The front right passenger sustained critical injuries and was pronounced deceased at the hospital.

[7]Please note that for confidentiality purposes, pages 3 and 4 are not included with the EDR report


N
IN10036
Clear and Dry
Dark without Artificial Lighting
Dry Bituminous Roadway
V1 and V2 Speed Limit = 89 km/h (55 mph)
V1 = 2004 Ford E350 Type III Ambulance
V2 1999 Chevrolet Silverado Pickup Truck
0m 5m 10m
Scale
Area of final rest of patient and cot
Ditch
Area of final rest of paramedic
Final rest and heading based on crash scene photos and police
Approximate location of displaced left wall of patient compartment
Broken emergency lights
Glass fragments
Positive 8% grade back slope of ditch
V1 rolls over 4 quarter turns to final rest
V1 Begins to rollover event 2
Right rear wheel engages back slope of ditch
Negative 18% grade front slope of ditch
Culvert
Ditch
Stop
Event 1
Stop
V2
V1

Event Data Recorder Report 1999 Chevrolet Silverado

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	1GCEC14T0XE[redacted]
User	Trooper [redacted]
Case Number	[redacted]
EDR Data Imaging Date	11/10/2010
Crash Date	[redacted]
Filename	1GCEC14T0XE[redacted]
Saved on	Wednesday, November 10 2010 at 07:49:01
Collected with CDR version	Crash Data Retrieval Tool 3.5
Reported with CDR version	Crash Data Retrieval Tool 3.5
EDR Device Type	airbag control module
Event(s) recovered	Non-Deployment

Comments

Desktop download performed at [redacted] using cable 02002888. The SDM was provided by [redacted]

Data Limitations

Recorded Crash Events:

There are two types of Recorded Crash Events. The first is the Non-Deployment Event. A Non-Deployment Event records data but does not deploy the air bag(s). The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded longitudinal velocity change. This event will be cleared by the SDM, after approximately 250 ignition cycles. This event can be overwritten by a second Deployment Event, referred to as a Deployment Level Event, if the Non-Deployment Event is not locked. The data in the Non-Deployment Event file will be locked, if the Non-Deployment Event occurred within five seconds before a Deployment Event. A locked Non Deployment Event cannot be overwritten or cleared by the SDM. The second type of SDM recorded crash event is the Deployment Event. The SDM can store up to two different Deployment Events, if they occur within five seconds of one another. If a Deployment Level Event occurs within five seconds after the Deployment Event, the Deployment Level Event will overwrite any non-locked Non-Deployment Event. Deployment Events cannot be overwritten or cleared by the SDM. Once the SDM has deployed an air bag, the SDM must be replaced.

Data:

-SDM Recorded Vehicle Longitudinal Velocity Change reflects the change in longitudinal velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Longitudinal Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. The SDM records the first 300 milliseconds of Vehicle Longitudinal Velocity Change after Algorithm Enable. The maximum value that can be recorded for Vehicle Longitudinal Velocity Change is 56 MPH. Velocity Change data is displayed in SAE sign convention.
-Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit.
-The Time between Non-Deployment and Deployment Events is displayed in seconds. If the time between the two events is greater than five seconds, "N/A" is displayed in place of the time.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded. An indication of a loss of power would be if the ignition cycles at the event is recorded as zero. Data recorded after that may not be reliable, such as Time Between Non-Deployment and Deployment Events, Driver Belt Switch Circuit Status, and Passenger SIR Suppression Switch Circuit Status.
-All data should be examined in conjunction with other available physical evidence from the vehicle and scene.

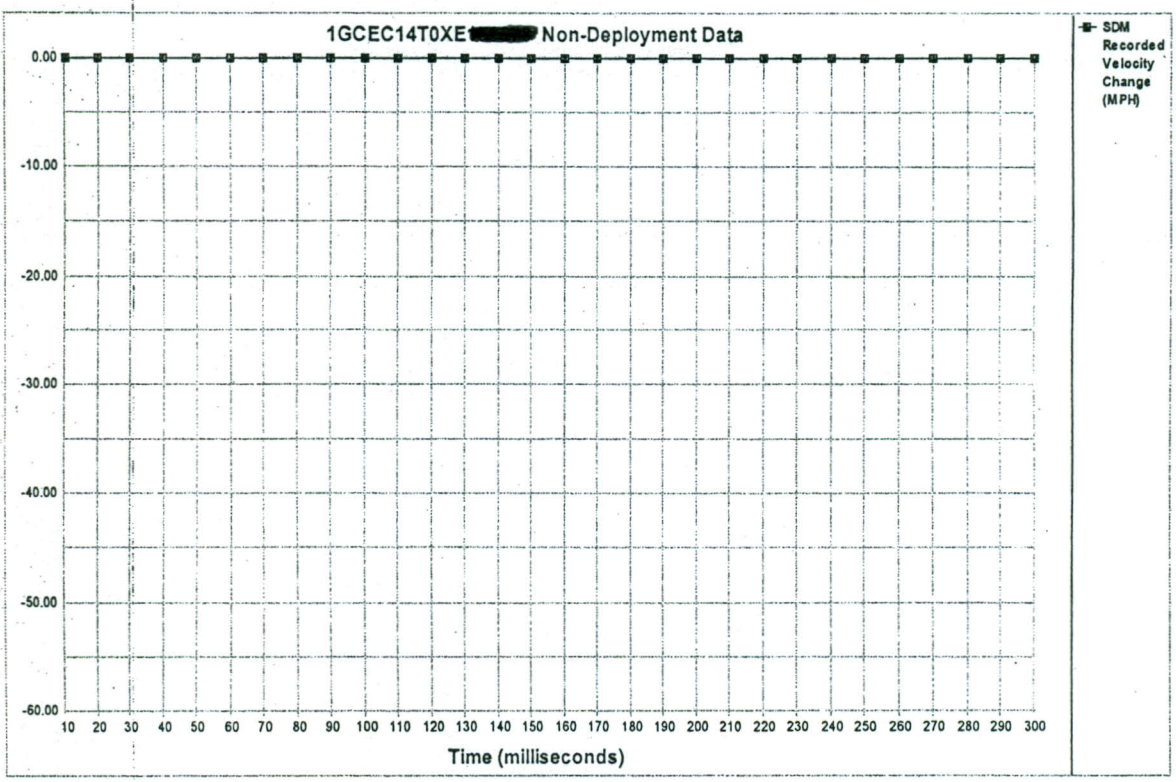
Data Source:

All SDM recorded data is measured, calculated, and stored internally, except for the following:
-The Driver's Belt Switch Circuit is wired directly to the SDM.
-The Passenger Front Air Bag Suppression Switch Circuit is wired directly to the SDM.

01033_SDMRSDD_r001

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger SIR Suppression Switch Circuit Status (if equipped)	Air Bag Suppressed
Ignition Cycles At Non-Deployment	20160
Ignition Cycles At Investigation	20161
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	12.5
Maximum SDM Recorded Velocity Change (MPH)	-0.22
A Deployment was Commanded Prior to this Event	No



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00