



NTSB/HAR-21/02

November 17, 2021

# Collision between Sport Utility Vehicle and Medium-Size Bus Transporting Adult Passengers with Disabilities and Special Needs

Belton, South Carolina

December 17, 2019

**Abstract:** This report discusses the December 17, 2019, collision of a sport utility vehicle (SUV) with a medium-size bus, occupied by a driver and 7 passengers, 2 of whom were seated in wheelchairs, on US Highway 76 (US-76) in Belton, South Carolina. The SUV accelerated to a speed of about 75 mph, then crossed the center line and collided with the left side of the bus, intruding into the bus just behind the driver. The unbelted SUV driver was ejected and fatally injured. A lap-belted bus passenger seated in the intrusion area sustained fatal injuries. The remaining bus occupants sustained minor to serious injuries. The safety issues identified in this report are driver distraction due to cell phone use while driving, and the need for improvements to wheelchair securement training. As a result of this investigation, the National Transportation Safety Board makes one new safety recommendation to the National Association of State Directors of Developmental Disabilities Services, reiterates recommendations to the 50 states, the District of Columbia, and manufacturers of portable electronic devices, and changes the classification of a recommendation to the National Highway Traffic Safety Administration.

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## Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ACDSNB	Anderson County Disability and Special Needs Board
ADA	Americans with Disabilities Act
CDL	commercial driver's license
EDR	event data recorder
EEG	electroencephalogram
GVWR	gross vehicle weight rating
GPS	global positioning system
LDP	lane departure prevention
LDW(s)	lane departure warning (system)
MRI	magnetic resonance imaging
NASDDDS	National Association of State Directors of Developmental Disabilities Services
NCAP	New Car Assessment Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SCDDSN	South Carolina Department of Disabilities and Special Needs
SCHP	South Carolina Highway Patrol
SUV	sport utility vehicle
UMTRI	University of Michigan Transportation Research Institute
WTORS	wheelchair tie-down and occupant restraint systems

## Executive Summary

### What Happened

On Tuesday, December 17, 2019, about 3:30 p.m. eastern standard time, a sport utility vehicle (SUV) was traveling east on US Highway 76 (US-76) in Belton, South Carolina. The posted speed limit was 45 mph. Meanwhile, a medium-size bus—occupied by a driver and 7 passengers, 2 of whom were seated in wheelchairs—was traveling west on US-76 at a speed of about 45 mph. According to a witness following behind the SUV, it was traveling erratically across the lanes. Shortly before the crash site, the SUV accelerated to a speed of about 75 mph and, about 1–2 seconds before the impact, crossed the center line and subsequently collided with the left side of the bus, intruding into the bus just behind the driver. The unbelted SUV driver was ejected and fatally injured. A lap-belted bus passenger seated in the intrusion area sustained fatal injuries. The remaining bus occupants sustained minor to serious injuries.

### What We Found

Leading up to the crash, the driver of the SUV had engaged in a 16-minute phone call with a friend that ended less than a minute before the collision. During that conversation, the SUV driver received two incoming calls that she did not answer. She ended the first phone call and placed a call on her cell phone to the incoming number. The driver's outgoing call went to voicemail. Following this call, several incoming calls went unanswered.

Cell phone use—including talking and placing or receiving calls while driving—is a nationally recognized cause of driver distraction. Cell phone use may be manually, visually, and cognitively distracting to the driver. Prohibiting the use of cell phones and other portable electronic devices for calls or texting while driving can decrease the number of distracted driving-related crashes. Cell phone technology, such as Do Not Disturb modes, can lessen the distraction of incoming calls or texts to drivers.

During the postcrash examination of the bus, we found that the occupant restraints used to secure the wheelchair occupants were severely twisted. Additionally, postcrash placement of the wheelchairs suggested that they had been improperly secured to the bus. Improper positioning of the wheelchair securement straps and twisting of the webbing of the belt system for the wheelchair occupants can increase their risk of injury.

Further investigation revealed that training in how to secure wheelchairs for transportation had been only a small part of the defensive driving session for the bus driver. Following communication with the NTSB, the bus transportation provider improved its wheelchair securement training. It is critical that drivers and others responsible for securing wheelchairs and their occupants in vehicles do so properly to limit potential injury.

We determined that the probable cause of this crash was the SUV driver's loss of control of her vehicle due to distraction from cell phone use, resulting in the SUV crossing into the opposite travel lane and colliding with the medium-size bus. Contributing to the severity of the crash was the excessive speed of the SUV.

## What We Recommended

As a result of this investigation, we recommended that the National Association of State Directors of Developmental Disabilities Services inform its members of the circumstances of this crash and advise them to ensure that their employees receive annual training in securing wheelchairs and their occupants for transportation.

We also reiterated a recommendation to the 50 states and the District of Columbia to (1) ban the nonemergency use of portable electronic devices (other than those designed to support the driving task) for all drivers; (2) use the National Highway Traffic Safety Administration model of high visibility enforcement to support these bans; and (3) implement targeted communication campaigns to inform motorists of the new law and enforcement, and to warn them of the dangers associated with the nonemergency use of portable electronic devices while driving.

Finally, we reiterated a recommendation to manufacturers of portable electronic devices (Apple, Google, HTC, Lenovo, LG, Motorola, Nokia, Samsung, and Sony) to develop a distracted driving lock-out mechanism or application for portable electronic devices that will automatically disable any driver-distracting functions when a vehicle is in motion, but that allows the device to be used in an emergency; install the mechanism as a default setting on all new devices and apply it to existing commercially available devices during major software updates.

We also classified from “Open—Acceptable Response” to “Open—Unacceptable Response” Safety Recommendation H-15-40, which asked the National Highway Traffic Safety Administration to develop, and require compliance with, a side-impact protection standard for all newly manufactured medium-size buses, regardless of weight.



## 1. Factual Information

### 1.1 Crash Narrative

On Tuesday, December 17, 2019, about 3:30 p.m. eastern standard time, a 2015 Chevrolet Equinox sport utility vehicle (SUV), occupied by a 53-year-old female driver, was traveling east on US Highway 76 (US-76) in Belton, South Carolina.<sup>1</sup> In that area, US-76 is a two-lane roadway with the west and east travel lanes divided by a double yellow centerline. The posted speed limit is 45 mph. Meanwhile, a 2009 14-passenger Goshen Coach medium-size bus built on a Ford E350 cutaway chassis, occupied by a 27-year-old female driver and 7 passengers, and operated by the Anderson County Disabilities and Special Needs Board (ACDSNB), was traveling west on US-76 at a vehicle-recorded speed of about 45 mph. The weather conditions were cloudy, and the roadway was dry. According to a witness driving behind the SUV, about 100 yards before the collision, the SUV accelerated to about double its previous speed (investigators later confirmed that the speed was about 75 mph). The SUV departed the eastbound travel lane while in an approximate 3° curve, crossed into the westbound travel lane, and collided with the front left corner of the bus. The unbelted SUV driver was ejected and fatally injured. The bus driver was restrained with a lap/shoulder belt, and five rear-seated bus passengers were restrained with lap-only belts. Two wheelchair-bound passengers were restrained by lap/shoulder belts, and the wheelchairs were attached in the left and right rear securement locations in the rear of the bus. As a result of the crash, one of the lap-belted occupants seated behind the driver was partially ejected and fatally injured, and the bus driver and six remaining passengers sustained minor to serious injuries.<sup>2</sup>

### 1.2 Crash Scene

According to a witness traveling behind the SUV, about 20–30 seconds before the crash, the vehicle traveled fully into the wrong (opposite) travel lane, back into its travel lane, then back into the opposite travel lane, off the pavement, and into the grass before returning to its travel lane.<sup>3</sup> The witness said that as the SUV returned to its travel lane, which he estimated took place about 100 yards from the crash site, the SUV accelerated to a high rate of speed. The witness, attempting to get the vehicle's license plate number, sped up to close to 80 mph. About 2 seconds before impact, the SUV moved into the opposite travel lane and subsequently collided with the bus. The event data recorder (EDR) on the bus showed that the bus driver decreased accelerator pedal pressure about 1 second before impact and

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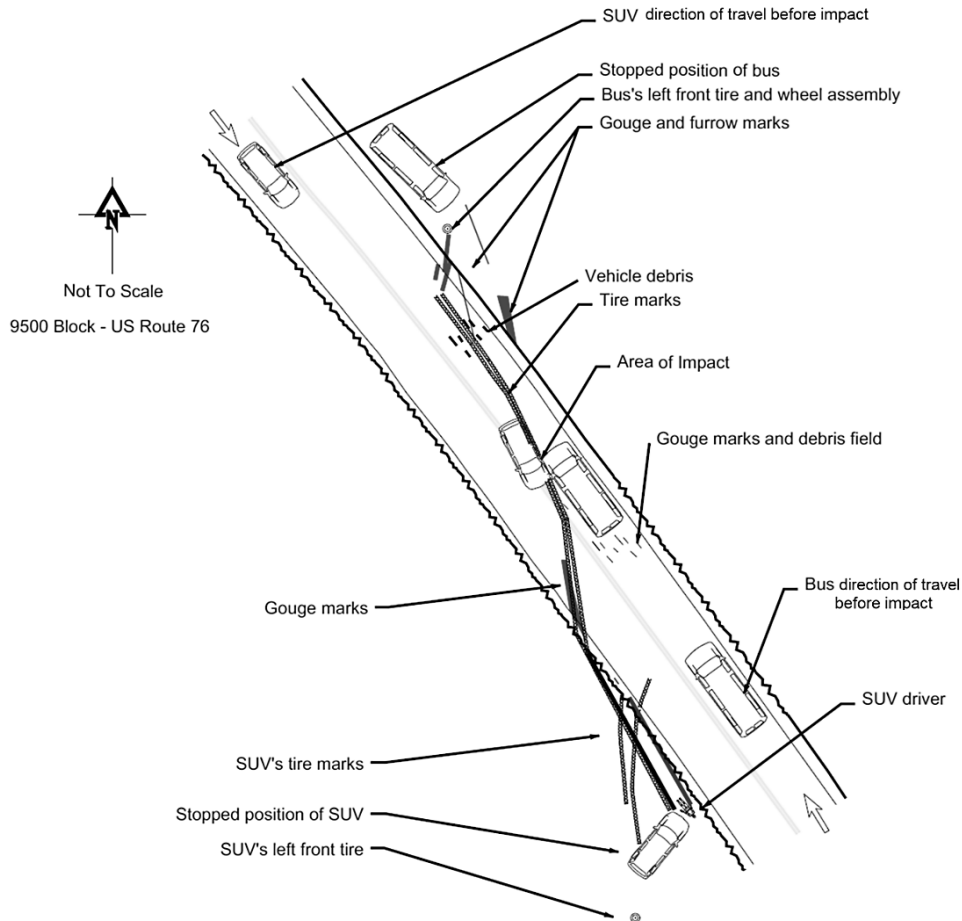
<sup>1</sup> All times cited in the report are eastern standard time.

<sup>2</sup> Additional information can be found in the public docket for this accident investigation (case number HWY20FH001) by accessing the accident docket link: [Search Docket - Docket Management System \(nts.gov\)](https://www.nts.gov/search-docket). For information about our safety recommendations, use the CAROL Query for Safety Recommendations: <https://data.nts.gov/carol-main-public/basic-search>.

<sup>3</sup> Although the witness could not remember exactly where he first saw the SUV, he recalled seeing it after passing a traffic signal located about 1.5 miles from the crash site.

applied the brake between 0.5 second before impact and the time of impact.<sup>4</sup> The EDR on the SUV did not register any braking input before the collision.

The left front of the SUV struck the front left side of the bus at an angle with maximum intrusion just behind the bus driver's seat and into the passenger compartment. Gouge and tire marks were found in the westbound lane at the crash site (see figure 1). Both the bus and the SUV rotated counterclockwise, with the bus coming to rest off the paved roadway on the side of the westbound lane and the SUV coming to rest off the paved roadway along the eastbound lane.



**Figure 1.** Crash scene diagram. (Source: Original diagram provided by the South Carolina Highway Patrol. Enhanced by the NTSB)

<sup>4</sup> Both the SUV and the bus were equipped with an EDR as part of the restraint system; investigators were therefore able to confirm details such as speed. The South Carolina Highway Patrol removed the EDRs from both vehicles, downloaded the data, and provided reports to the NTSB.

### 1.3 Injuries

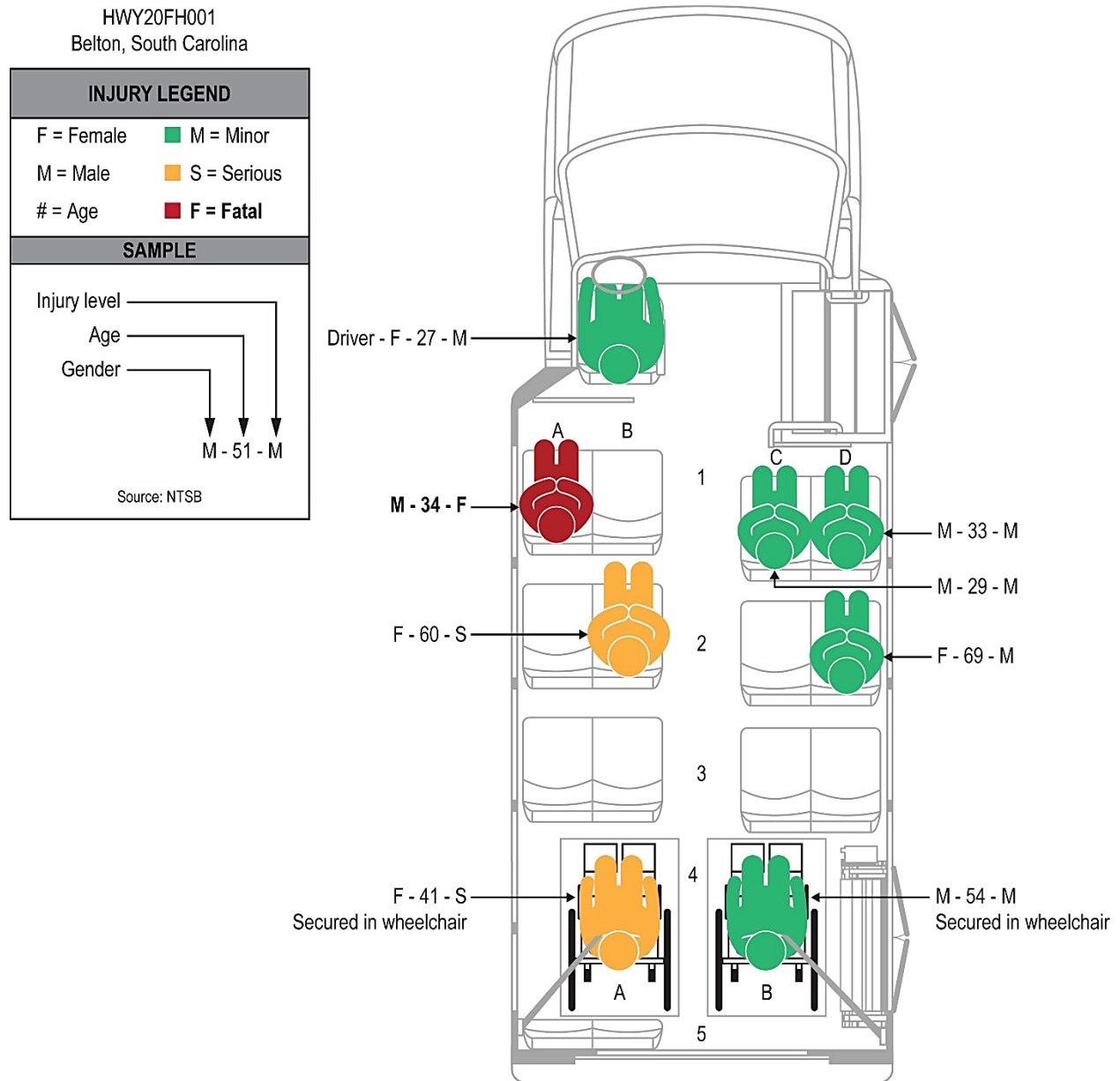
The driver of the SUV was fully ejected from the vehicle, and emergency responders found her conscious, partially underneath the SUV's front left bumper. She experienced cardiac arrest while being transported from the crash site and was declared deceased at the medical center.

The bus driver sustained minor injuries. The passenger seated behind the bus driver in the window seat was partially ejected and sustained fatal injuries; he was declared deceased on-scene. Another passenger seated on the left (driver) side of the bus was seriously injured, sustaining a fractured left arm, fractured right thumb, and forehead laceration. Three passengers seated on the right (passenger boarding side) side of the bus sustained minor injuries, including bruises, abrasions, and lacerations. The passenger in a wheelchair seated on the left side of the bus was seriously injured, including a fracture to the right leg, cervical and lumbar spinal fractures, and fractures to the right ribs and a pneumothorax. The passenger in a wheelchair seated on the right side of the bus sustained minor injuries, including a laceration to his scalp. Injury information is shown in table 1 and figure 2.

**Table 1.** Injury severity of SUV driver and bus occupants.

Injury Severity <sup>a</sup>	Fatal	Serious	Minor	None	Total
SUV driver	1	0	0	0	1
Bus driver	0	0	1	0	1
Bus passengers	1	2	4	0	7
Total	2	2	5	0	9

<sup>a</sup> Note: Title 49 *Code of Federal Regulations* 830.2 defines fatal injury as any injury that results in death within 30 days of the accident, and serious injury as any injury that (1) requires hospitalization for more than 48 hours, commencing within 7 days from the date of injury; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burn affecting more than 5 percent of the body surface.



**Figure 2.** Bus seating chart.

## 1.4 Restraint Use

### 1.4.1 SUV Driver

The EDR data from the SUV stated that the driver lap/shoulder belt was “not buckled.” The EDR data also showed that the driver’s airbag deployed from the steering wheel, the outboard torso airbag deployed from the driver seat back, and the side curtain airbags along both sides of the vehicle deployed. As stated previously, the driver was ejected from the SUV.

### 1.4.2 Bus driver and passengers

The bus driver was wearing a lap/shoulder belt, and the driver airbag deployed from the steering wheel. The bus was equipped with lap-only belts in the rear passenger seating positions. The bus was also equipped with two wheelchair securement positions. According to the bus driver, the five passengers seated in bus seats had secured their lap belts at the start of the trip, and she had checked the belts to make sure they were properly fastened.

Two passengers were secured in their personally owned wheelchairs in a forward-facing position at the rear of the bus, one on the left side and one on the right side.<sup>5</sup> The bus driver said she secured the wheelchairs in the rear of the bus using the 4-point wheelchair tie-down system and the bus's 3-point (lap/shoulder belt) wheelchair occupant restraint system. See section 1.11 for additional information on wheelchair securement.

According to a witness, following the crash, the wheelchairs were found strapped to the bus with the occupants strapped to the wheelchairs. The witness said the wheelchairs had flipped forward and their occupants were upside down with the wheelchairs on top of them. The webbing for both of the lap/shoulder belts at the wheelchairs positions was found severely twisted during the postcrash examination of the bus (see figure 3).



**Figure 3.** Lap/shoulder belts used to restrain the wheelchair occupants. Left, the twisted shoulder restraint for the wheelchair occupant on the left side of the bus. Right, close-up view of the shoulder restraint for the wheelchair occupant on the right side of the bus.

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<sup>5</sup> Neither wheelchair met, nor was required to meet, voluntary standards for use in a motor vehicle. ANSI/RESNA WC19 is a voluntary standard for designing, testing, and labeling a wheelchair for use as a seat in a motor vehicle. ISO 7176-19 is an international standard. Wheelchairs that meet this standard have passed tests to withstand collisions under certain conditions.

Both wheelchairs sustained crash damage and displayed visible signs of loading. The wheelchair that had been secured on the left side of the bus sustained damage to the left side of the seat frame. The weld at the vertical frame member and the horizontal frame member was separated. The hinge plates of the footrest were found partially unhinged. The left-hand pusher of the wheelchair secured on the right side was bent aft almost 45° (see figure 4).



**Figure 4.** Wheelchairs damaged in the collision. Left, the wheelchair that was positioned on the bus's left side. Right, the wheelchair positioned on the bus's right side.

## 1.5 Emergency Response

The Anderson County Sheriff's Department was notified of the crash through the 911 system at 3:31 p.m. The Friendship Volunteer Fire Department was dispatched at 3:34 p.m. and arrived 10 minutes later; the Belton Volunteer Fire Department was dispatched at 3:39 p.m. and arrived 4 minutes later. The Anderson County Sheriff's Department notified the South Carolina Highway Patrol (SCHP) at 3:35 p.m., and their units arrived at 4:02 p.m. The Anderson County Emergency Management office dispatched its mobile Incident Command vehicle with scene lighting and additional resources to assist the SCHP. Six ambulances responded to the scene, the first arriving at 3:43 p.m. In total, nine agencies assisted with the response.<sup>6</sup>

The bus driver and five passengers were transported from the crash site to Prisma Health Greenville Memorial Hospital (26 miles away) and AnMed Health Medical Center (11 miles away) by 4:32 p.m. One bus occupant was transported by a parent to AnMed Health Medical Center. The SUV driver was declared deceased after being transported to AnMed Health Medical Center. The fatally injured bus passenger was declared deceased on-scene.

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<sup>6</sup> Agencies include South Carolina Highway Patrol, Friendship Volunteer Fire Department, Honea-Path EMS, Belton Volunteer Fire Department, MedShore Ambulance, Anderson County Sheriff, Anderson County Fire Department, Anderson County Office of Emergency Management, and South Carolina Department of Transportation.

## 1.6 Vehicle Information

### 1.6.1 2015 Chevrolet Equinox SUV

#### 1.6.1.1 General

The 2015 Chevrolet Equinox SUV 1LT trim had a gross vehicle weight rating (GVWR) of 3,758 pounds and was equipped with a six-speed automatic transmission, a 2.4-liter engine, antilock braking system, and hydraulic disc brakes on all four wheels.<sup>7</sup> The last recorded mileage was 47,312 miles. Maintenance records indicated that the vehicle was last serviced on July 19, 2019. Forward collision warning, lane departure warning, or rear park assist were not available for this vehicle trim level.

The National Highway Traffic Safety Administration (NHTSA) safety recall database indicated no safety-related recalls that would have affected the SUV, including the tires.<sup>8</sup> The NHTSA defect investigation database revealed one active and one inactive defect investigation related to windshield wiper transmission failures.<sup>9</sup>

#### 1.6.1.2 Damage

The SUV sustained significant contact damage to the left front axle area and the entire left side (see figure 5). The front left fender, driver door, and rear left passenger door (including the roof siderail, the A, B, and C pillars, and windows) were torn off during the collision event. The damage to the driver door destroyed the left side curtain airbags. The hood was pushed rearward, and the windshield was destroyed by impact forces. The vehicle's retractable sunroof was found in the open position (see figure 6). Investigators found no damage to the right front and rear passenger doors, nor to the right side and rear windows.

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<sup>7</sup> The *gross vehicle weight rating* is the maximum operating weight of a vehicle as specified by the manufacturer including the vehicle's chassis, body, engine, engine fluids, fuel, accessories, driver, passengers, and cargo.

<sup>8</sup> <https://www.nhtsa.gov/recalls>, accessed on December 21, 2019.

<sup>9</sup> <https://www.nhtsa.gov/vehicle/2015/CHEVROLET/EQUINOX/SUV/AWD#investigations> accessed December 23, 2019.



**Figure 5.** Crash-damaged SUV.





**Figure 6.** Top view of damaged SUV with open sunroof.

The driver's seatback was deformed rearward and resting against the rear seat cushion. The driver's side outboard torso airbag, located on the driver seat back, deployed in the crash. The driver's footwell space, accelerator, and brake pedal were displaced rearward into the driver seat position. The emergency brake pedal and attaching hardware were embedded into the side of the bus. The left front tire and wheel assembly was displaced and shifted aft. Due to the collision damage, functional tests of the steering, brake, and electrical systems could not be performed, but no evidence suggested any precrash defects or disrepair to these systems.

### **1.6.1.3 Event Data Recorder**

The EDR data (table 2) showed that, during the 5 seconds before the crash, the SUV was traveling at a constant speed of 75 mph. The cruise control was not active and there was no indication of braking. The EDR also recorded a 40-mph maximum longitudinal velocity change and a 9-mph maximum lateral velocity change (from left to right) during the collision. Steering angles were not recorded on the EDR.

**Table 2.** SUV EDR data.

Times (sec)	Vehicle-recorded speed mph [km/h]	Accelerator pedal, % full (accelerator pedal position)	Service brake (brake switch circuit state)	Engine rpm	Engine throttle, % full (throttle position)
-5.0	75 [120]	21	Off	2,176	51
-4.5	75 [120]	21	Off	2,176	51
-4.0	75 [120]	22	Off	2,176	53
-3.5	75 [120]	22	Off	2,176	55
-3.0	75 [120]	19	Off	2,176	40
-2.5	75 [120]	19	Off	2,176	42
-2.0	75 [120]	17	Off	2,176	43
-1.5	75 [120]	17	Off	2,240	39
-1.0	75 [120]	14	Off	2,176	35
-0.5	75 [120]	14	Off	2,176	36

## 1.6.2 2009 14-Passenger Goshen Coach Medium-Size Bus

### 1.6.2.1 General

The medium-size bus was manufactured in two stages. Ford was the first-stage manufacturer of the cab and chassis, completed in December 2008. The second-stage manufacturer was Goshen Coach, Inc., which completed the final build in January 2009 when the Ford cab and chassis were equipped with a Goshen 14-passenger medium-size bus body. Once built to completion, the bus GVWR was 12,500 pounds.

The side paneling of the bus was made of wood, and the underlying structure consisted of 1.875-inch insulation between spot-welded, 1-inch-square, 16-gauge tubular steel. Behind the driver were three rows of two-person Freedman model BV (“big van”) Foldaway Featherweight midback passenger seats equipped with lap-only belts.<sup>10</sup> The bus body was also configured with Americans with Disabilities Act

<sup>10</sup> A BV Foldaway seat is designed to be mounted with bolts only to the floor. In comparison, an AM (“aisle maker”) Foldaway seat is mounted to the floor and the wall.

(ADA) wheelchair-accessible bus equipment, beginning with the fourth row seating location reserved for wheelchairs on the left and right sides.<sup>11</sup> A single row of two-person Featherweight flip seats for the fifth row was attached to the backwall on the left side for use when no wheelchairs were being transported.

ACDSNB maintenance records indicated that the bus had undergone regularly scheduled, routine maintenance. The NHTSA safety recall and defect investigation database did not contain any safety-related recalls or any defect investigations specific to the crash-involved bus.

### 1.6.2.2 Damage

The bus sustained contact damage to the left side, including damage to the steering, brake, and electrical systems. The initial point of contact was in the area of the left front fender and wheel. The contact damage continued down the left fender and driver's door. Intrusion into the rear passenger compartment occurred directly behind the driver seat at the B-pillar extending to the forward edge of the second window (see figure 7). The window frames and glazing on the left side of the bus at the first and second rows of passenger seating were missing, exposing both rows of passenger seating. Damage to the left side of the bus ended just before the rear bumper.



**Figure 7.** Wide-angle-lens photo of the crash-involved bus, with damage visible to the left side beginning at the front wheel.

<sup>11</sup> Title 49 *Code of Federal Regulations* Part 38.

Due to the collision, the left front axle assembly fractured and the left rear axle, including the rear dual wheel, detached from the rear-end housing. The collision damage precluded functional checks to the steering, brake, and electrical systems, but there was no indication of any malfunction leading up to the crash.

The right side of the bus had no visible damage. The passenger loading door near the front was intact and operative during the postcrash inspection. The ADA wheelchair lift door was also undamaged.

### 1.6.2.3 Event Data Recorder

The bus's EDR captured data for 5 seconds before impact reported in 0.5-second intervals.<sup>12</sup> The data indicated that, during that time, the bus traveled at a constant speed of 45–46 mph. As shown in table 3, at the recorded time of 0.5 seconds before AE, the accelerator pedal position percentage dropped from 21 percent to zero. At time zero, the status of the service brake indicator changed from “off” to “on,” meaning that the bus driver applied the brakes within 0.5 seconds of the crash. Antilock braking system activity, stability control, and traction control information is also collected by the EDR but reported as non-engaged.

**Table 3.** Bus EDR data.

Times (sec)	Vehicle-recorded speed mph [km/h]	Accelerator pedal, % full	Service brake, on/off	Engine rpm
- 5.0	45.4 [73.0]	32	Off	1,500
- 4.5	45.4 [73.0]	32	Off	1,500
- 4.0	45.4 [73.0]	32	Off	1,500
- 3.5	46.0 [74.0]	32	Off	1,500
- 3.0	46.0 [74.0]	27	Off	1,500
- 2.5	46.0 [74.0]	20	Off	1,500
- 2.0	46.0 [74.0]	18	Off	1,500
- 1.5	46.0 [74.0]	20	Off	1,500
- 1.0	45.4 [73.0]	21	Off	1,500
- 0.5	45.4 [73.0]	0	Off	1,500
0.0	44.7 [72.0]	0	On	1,600

<sup>12</sup> The time of impact is approximated by the point where an acceleration threshold is met and the module begins the airbag deployment process. This is referred to as *algorithm enabled* deployment or AE.

The bus was equipped with a global positioning system (GPS)-based fleet tracking system that recorded parameters transmitted once per minute and included location, speed, event, date, and time. A hard-braking event was shown with a recorded time of 3:31 p.m.

## 1.7 Highway Information

### 1.7.1 General

The crash occurred in the 9500 block of US-76, near milepost 27.45 and about 0.70 mile east of Belton, South Carolina. US-76 is an asphalt-paved, two-lane highway with 11-foot-wide lanes in each direction. There is a 1-foot-wide double yellow center line without rumble strips separating the two travel lanes. The 2-foot-wide shoulders are delineated from the travel lanes by a solid white stripe, and rumble strips are milled into the pavement. The posted speed limit at the crash location is 45 mph, and the average daily traffic count from 2010 to 2019 was 6,400 vehicles per day. US-76 was originally surveyed and constructed in 1928. The pavement was last resurfaced in 2004, and the shoulder-line rumble strips were added to both shoulders in 2009.

As the SUV traveled southeast on US-76 on a slight 1-percent upgrade section of roadway, it entered a 261-foot-long right-hand curve with a radius of about 1,910 feet (or about 3°) and superelevation of 4.5 percent. The curve had no horizontal line-of-sight restrictions, and the alignment, curve radius, and superelevation met design specifications.<sup>13</sup>

### 1.7.2 Crash History

Thirty-five crashes were reported along a 1.5-mile-long segment (from milepost 26.8 to 28.3) between January 1, 2010, and September 30, 2019.<sup>14</sup> Most of these crashes involved rear-end collisions and run-off-road crashes. No head-on collisions were reported during this period. Of the 35 crashes, one was a fatal rollover crash, eight crashes resulted in injury, and 26 involved property-only damage.

## 1.8 Driver Information

### 1.8.1 SUV Driver

The 53-year-old female SUV driver held a class D South Carolina driver's license issued in 2017 and valid until 2027.<sup>15</sup> During the 10 years preceding the crash, her driving record showed no traffic violations or crash involvement; however, her record indicated she was involved in crashes in 1998, 1999, and 2006. According to the 2006 crash report, the driver had a run-off-road crash and subsequently struck a utility

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<sup>13</sup> American Association of State Highway and Transportation Officials (AASHTO). 2018. *A Policy on Geometric Design of Highway and Streets* (7th edition). Washington, DC: AASHTO.

<sup>14</sup> Data provided by the South Carolina Department of Transportation.

<sup>15</sup> In South Carolina, a class D driver license allows the holder to drive noncommercial passenger vehicles, such as cars and trucks, which do not exceed 26,000 pounds GVWR.

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pole. The contributing circumstance to the crash was coded as a medically related event. Her husband said she had experienced a seizure and, on the advice of her doctor, stopped driving for 6 months.

### **1.8.1.1 Medical Conditions**

According to medical records, the SUV driver had a history of seizures since 1993 when a benign tumor in her brain was diagnosed and removed. Her 2015–2016 neurology medical records documented her typical seizures as episodes during which she remained aware and able to speak and move but experienced déjà vu and a “fizzy” body sensation lasting 5 seconds or less, with other people sometimes noticing drooling, slurred speech, or brief shaking of a limb. According to medical records, an electroencephalogram (EEG) in 2011 had been normal, and her brain magnetic resonance imaging (MRI) in 2015 had shown no tumor regrowth. In August 2016, she reported to her neurologist that she had the best seizure control she had ever experienced, with only one seizure in the preceding year, and in January 2019 she told her primary care provider that she had not had a seizure since at least March 2018. No seizure episodes were documented in the driver’s 2017–2019 records from her primary care provider. According to medical records, the driver was prescribed phenytoin to control her seizures, and the prescribed dose of this medication had not changed since 2015.

The SUV driver’s medical records also showed that she had a long-term history of anxiety and depression treated with medication. At her last primary care visit in November 2019, the driver said she had been experiencing numerous symptoms of anxiety and depression that had been interfering with her daily life. No records indicated that she had suicidal thoughts. The driver had a prescription for duloxetine to treat her anxiety and depression. This medication had first been prescribed to her in August 2019, and its dosage had not changed since November 2019.

### **1.8.1.2 Toxicology**

The South Carolina Law Enforcement Division’s Forensic Services Laboratory tested the SUV driver’s vitreous fluid for a selection of drugs and alcohols. None were detected. The Federal Aviation Administration Forensic Sciences Laboratory tested blood from the SUV driver. Phenytoin was detected at 7.89 µg/mL. Duloxetine was detected but not quantified.

### **1.8.1.3 Driver Activities Before the Crash**

On the day of the crash, the SUV driver worked as a substitute teacher. According to the school induction coordinator, the SUV driver and she visited for about 30 minutes after the teaching day. The coordinator stated she was not aware of any kind of physical or mental problems that would have affected the SUV driver before the latter departed the school. The coordinator also stated that no one had ever reported the SUV driver as having any such issues while performing classroom instruction duties.<sup>16</sup>

Cell phone records show a call from the SUV driver’s phone at 3:13:01 p.m. (see table 4) that lasted for 16 minutes and 19 seconds, ending at 3:29:20 p.m. She was speaking to a long-time friend who, when interviewed by the NTSB, stated that the SUV driver had called her when she was leaving work to talk

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<sup>16</sup> The school induction coordinator was responsible for recruiting new teachers. Although she was interviewed in her professional capacity, the coordinator stated she was also a friend of the SUV driver.

about an event that had upset her. According to the friend, the phone call was interrupted twice by incoming calls, and after the second call, the SUV driver said she had to end their call and return the call of the person trying to reach her. Cell phone records show incoming calls at 3:23:31 p.m. and 3:29:19 p.m. from the same number. The SUV driver did not answer these calls.

At 3:29:36, the SUV driver initiated a phone call to the number of the incoming phone calls, but the call went to voicemail. Several postcrash calls came to the SUV driver's phone beginning at 3:30:48 p.m.

**Table 4.** Summary of SUV driver's cell phone activity.

Time (EST)	Call Type	Elapsed Time (MM:SS)
3:13:01	Outgoing from SUV driver's number	16:19
3:23:31	Incoming	0:00
3:29:19	Incoming	0:00–0:02
3:29:36	Outgoing from SUV driver's number	0:02
	Crash occurred	
3:30:48	Incoming	0:00
3:30:50	Incoming	0:00
3:31:26	Incoming	0:00
3:32:40	Incoming	0:00
3:34:16	Incoming	0:00
3:35:14	Incoming	0:00
3:37:12	Incoming	0:00
3:39:22	Incoming	0:00
3:42:14	Incoming	0:07

The SUV was equipped with an infotainment system allowing vehicle occupants to connect a cell phone to operate it "hands free" through the infotainment controls. In addition to being operated by pushbuttons, knobs, display menus, and steering wheel controls, the infotainment system could be connected to a cell phone through "Bluetooth" technology and facilitated operation through voice commands. If voice commands were not used, then the operator would either dial the phone manually or use the system display panel to place a call. According to the owner's manual, the voice command

would not work in situations with excessive background noise.<sup>17</sup> The owner's manual also warned, "When using a cell phone, it can be distracting to look too long or too often at the screen of the phone or the infotainment system. Taking your eyes off the road too long or too often could cause a crash resulting in injury or death. Focus your attention on driving." According to the SUV driver's husband, she used the infotainment console to permit hands-free use of the cell phone. It was not possible to conclusively determine how the cell phone was being used at the time of the crash (handheld or hands-free).

### **1.8.2 Bus Driver**

The 27-year-old female bus driver held a class D driver's license issued by the South Carolina Department of Motor Vehicles.<sup>18</sup> Her current license was issued in 2016 and valid until 2023. Her driving record for the last 10 years indicated that she had three driving violations while operating a personal vehicle.<sup>19</sup>

The bus driver had been employed with ACDSNB for about 3 years. She had completed a mandatory defensive driver training course to drive the agency vehicles. The driver performed other caregiver daily tasks at the ACDSNB in addition to driving the bus.

The SChP did not drug test the bus driver given the on-scene evidence. In addition, she was not subject to US Department of Transportation-pertinent drug testing because she was not required to have a commercial driver's license (CDL).<sup>20</sup> Moreover, ACDSNB policy requires a driver to be judged at fault in an accident before postaccident drug testing is conducted. In her interview with the NTSB, the bus driver stated she was well rested, in good health, and not taking any medications that would have affected her driving at the time of the crash.<sup>21</sup> She typically went to bed around 8:30 p.m. or 9:00 p.m. and would get up around 4:45 a.m. or 5:00 a.m.

The bus driver said she had dropped off one passenger and was going to Belton to drop off another passenger. She said she saw the SUV coming into the bus's lane and "felt just like I had a second to react." She said she was not on her cell phone at the time of the crash.

## **1.9 Bus Transportation Provider**

The bus was operated by the ACDSNB, located in Anderson, South Carolina. The mission of the ACDSNB is to assist people with disabilities and their families in the Anderson County area. It provides both

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<sup>17</sup> The NTSB noted that the sunroof of the SUV was open at the time of the crash. It was not determined if wind noise from the open sunroof would have interfered with voice commands.

<sup>18</sup> The bus driver was not required to have a CDL to operate a 14-passenger bus. A class C CDL is required to operate any single vehicle, or combination of vehicles, that either is designed to transport 16 or more passengers, including the driver, or is used to transport hazardous materials.

<sup>19</sup> Speeding in April 2010, accident in February 2017, and speeding in May 2019.

<sup>20</sup> Title 49 *Code of Federal Regulations* 382.303.

<sup>21</sup> Investigators interviewed the bus driver on December 19, 2019.



residential and adult day services. At the time of the crash, ACDSNB operated 34 vehicles and employed 29 people who also performed driving tasks.

Much of the funding of the ACDSNB comes through the South Carolina Department of Disabilities and Special Needs (SCDDSN).<sup>22</sup> The SCDDSN plans, develops, coordinates and funds services for persons with disabilities and special needs. It also provides operational oversight to county boards and contractors that it funds by establishing personnel, safety, vehicle use, and training policies and requirements. Postcrash, the ACDSNB provided the NTSB with policy documents on driver licensing, hiring, qualification standards, vehicle operational policies, and employee drug testing policies. Training certification records were also provided. The ACDSNB policies were consistent with the requirements of the SCDDSN.

ACDSNB employees who drove clients received about 2 weeks of pre-employment training and in-service training every 3 years. Specifically, drivers completed an 8-hour defensive driving class. Drivers also completed a 90-minute driver assessment segment that covered how to operate the ADA lift and the wheelchair tie-down and occupant restraint systems (WTORS), as well as several other driving-focused topics such as vehicle control. According to the ACDSNB driver training supervisor, new bus drivers were also shown “at the vehicle” how to operate the wheelchair lift and WTORS. The bus driver completed the training in 2017 when she began with ACDSNB; there was no recurrent training requirement for operating the WTORS.

## 1.10 Weather and Astronomical Data

Weather data for December 17, 2019, were obtained from the Greenville-Spartanburg International Airport, about 24 miles northeast of the crash site. At 3:26 p.m., the conditions were reported as wind from the southwest at 9 mph, light rain, a temperature of 62°F, a dew point of 59°F, and humidity at 90 percent.<sup>23</sup> According to the National Oceanic and Atmospheric Administration solar calculator, for the crash location on December 17, 2019, sunrise was at 7:31 a.m. and sunset was at 5:22 p.m.<sup>24</sup> At 3:35 p.m., the sun was at an angle of 225° from true north, with an elevation in the sky of 17° above the horizon. At this location, the sun would have been to the right of the SUV as it traveled south on US-76.

## 1.11 Additional Information

### 1.11.1 Wheelchair securement

Proper positioning of the WTORS for wheelchair occupants is essential for the safety of the wheelchaired passenger. The wheelchair securement system in the 2009 medium-size bus involved in

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<sup>22</sup> (a) SCDDSN receives grant monies from the Federal Transit Administration, Medicare, Medicaid, and private funding. (b) <https://ddsn.sc.gov/>.

<sup>23</sup> Although the weather report showed rain at the weather reporting station, the localized weather at the crash site was cloudy, not raining, and the roadway was reported as dry.

<sup>24</sup> <https://www.esrl.noaa.gov/gmd/grad/solcalc/>.

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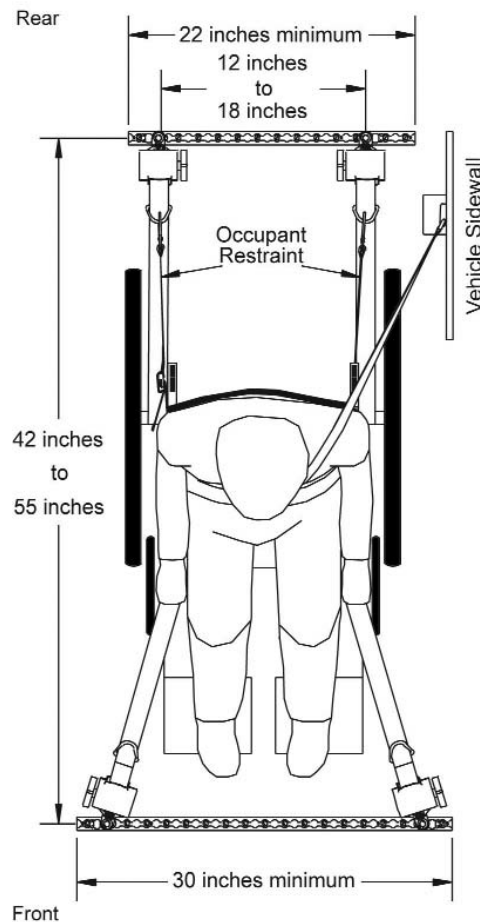
the crash was manufactured by Sure-Lok. According to Sure-Lok, a properly secured wheelchair requires two separate restraint systems (figure 8).<sup>25</sup> A wheelchair restraint keeps the wheelchair secured to the vehicle with tie-down retractor straps in four locations (two at the front and two at the rear). The tie-down straps are anchored to the bus floor in tracks at one end, and at the opposite end of the strap is a hook that is attached to the wheelchair. Sure-Lok guidance states that the two front retractors/straps should be anchored outside the front wheels and that the two rear retractors/straps should be anchored inside the rear wheels about 12–18 inches apart, as shown in figure 8. The straps should be attached to the wheelchair frame at an approximate 45° angle and in a straight path from the anchor to the wheelchair (straps should not be twisted or crossed). Placing the wheelchair tie-downs at the appropriate locations and angles will help prevent the wheelchair from tipping. The lap/shoulder belts restrain the occupant in the secured wheelchair, like seat belts for vehicle seats. The lap belt portion of the system connects to the track in the flooring. The adjustable shoulder harness attaches to the wall and then crosses over the occupant to connect to the lap belt at the hip.

The wheelchair tie-down system and the occupant restraint system work in conjunction to protect the wheelchair passenger during vehicle operation, such as sharp turns or hard braking, and in the event of a crash. Misuse and improper positioning of the wheelchair securement systems and the lap/shoulder belts places wheelchair passengers at higher risk of injury in a crash (NHTSA 1997).

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<sup>25</sup> (a) [SIP008 \(sure-lok.com\)](https://sure-lok.com). (b) [https://sure-lok.com/wp-content/uploads/pdf\\_downloads/SL\\_Maintenance\\_Decal.pdf](https://sure-lok.com/wp-content/uploads/pdf_downloads/SL_Maintenance_Decal.pdf).

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**Figure 8.** Illustrations showing proper positioning of WTORS with straps at all four corners of the wheelchair and a lap/shoulder belt for the occupant restraint (Source: Sure-Lok)

### 1.11.2 Postcrash Wheelchair Placement

During the postcrash examination of the bus, the NTSB placed the wheelchairs back on the bus to approximate the layout of the WTORS. The examination of the bus's WTORS showed that the wheelchair positioned on the left side of the bus likely had one strap/retractor anchored inside one of the rear wheels, with the other rear strap/retractor anchored on the outside of the other wheel. The front strap/retractors were likely anchored improperly, with one front tie-down strap anchored outside the left front wheel and the other front tie-down strap anchored between the two front wheels. The rear retractors/straps for the wheelchair on the right side of the bus were anchored about 10 inches apart and were close to being centered between the wheels. As for the front tie-down straps, one would likely have been anchored between the wheelchair wheels and the other outside the other wheel. As previously mentioned, the lap/shoulder portions of the occupant restraint system were found severely twisted. The track on the floor of the bus that anchors the securement system was filled with debris and dirt.

### **1.11.3 Postcrash Safety Improvements**

As noted earlier in the report, before the crash, ACDSNB provided its employees with defensive driver training and in-vehicle training that showed new drivers operation of the bus wheelchair lift and securement of a wheelchaired passenger using both the wheelchair tie-down to the vehicle and the lap/shoulder belt for the wheelchair occupant. There was no recurrent training on the use of the WTORS.

Postcrash, NTSB staff communicated with ACDSNB, informing the board of additional on-line training available to staff. On October 21, 2020, ACDSNB informed the NTSB that it is now requiring new drivers to view two videos, one on wheelchair lift operation and one on wheelchair securement. New drivers will also be required to demonstrate to a supervisor correct and safe operation of the WTORS securement system. Additionally, ACDSNB will require this training annually.

## 2. Analysis

### 2.1 Introduction

The SUV, occupied by the 53-year-old female driver, was traveling east on US-76 in Belton, South Carolina. The SUV entered an approximate 3° righthand curve at a vehicle-recorded speed of about 75 mph. About 2 seconds before impact, the SUV crossed into the opposite travel lane and subsequently collided with the left side of the 14-passenger medium-size bus. The SUV driver and one passenger on the bus were fatally injured. The bus driver and six remaining passengers sustained minor to serious injuries.

The analysis portion of this report first discusses factors that could be excluded as causing the crash or contributing to the severity of its outcome. The following safety issues are also discussed:

- Driver distraction due to cell phone use while driving (sections 2.2 and 2.3).
- Need for improvements to wheelchair securement training (section 2.4).

As a result of its analysis, the NTSB determined that the following factors did not cause or contribute to the crash:

- *Mechanical Condition of the SUV* – Postcrash inspection did not reveal any pre-existing mechanical deficiencies with the SUV’s tires, steering, braking, and suspension systems. Inspection of the electrical system was not possible due to collision damage. Maintenance records showed that the SUV was maintained.
- *Mechanical Condition of the Bus* – Postcrash inspection did not reveal any evidence of mechanical issues with the medium-size bus. Records indicated that the bus had undergone routine maintenance.
- *Roadway Design and Maintenance* – The roadway alignment, curve radius, and superelevation met AASHTO design specifications. The pavement was last resurfaced in 2004 and rumble strips were added in 2009. Nearly 10 years of crash data did not reveal any other head-on collisions at the crash location.
- *Bus Transportation Provider Policies* – The hiring, licensing, and operational policies for the ACDSNB were adequate and in compliance with the SCDDSN.
- *Bus Driver* – The bus driver was properly licensed and trained to operate the medium-size bus involved in the crash. She was likely alert and not distracted at the time of the collision. According to the bus driver and a witness, the bus driver had only 1–2 seconds to react to the SUV being in its lane. The EDR from the bus indicated that within a second before the collision, the bus driver stopped pressing the accelerator pedal and within a half-second before the collision, she applied the brakes.
- *Weather/Illumination* – At the time of the crash, it was daylight, and local weather conditions were cloudy without precipitation. The pavement was dry.

The NTSB concludes that none of the following were factors in this crash: (1) mechanical condition of the SUV or bus, (2) the design or maintenance of the roadway, (3) the bus transportation provider policies, (4) the bus driver's actions, and (5) weather or illumination.

The Belton Volunteer Fire Department arrived at the crash site at 3:43 p.m., 4 minutes after being notified of the crash. The SUV driver and the bus occupants were transported to hospitals (26 miles and 11 miles from the crash site) by ambulance (one bus passenger was brought to the hospital by a family member an hour after the crash). The NTSB concludes that the emergency response and transportation of the injured was timely and adequate.

The NTSB considered whether the SUV driver's history of medical issues, including seizure disorder and anxiety and depression, might have affected her precrash actions. The SUV driver's medical records characterized her seizure disorder as effectively controlled on a prescribed phenytoin regimen that had been stable for years, and her postmortem toxicology showed she had taken phenytoin. Her erratic driving behavior, described by a witness as swerving across the opposite lane of traffic but then returning to the correct traffic lane and maintaining lane following for a period of time, was not consistent with seizure-related impairment or incapacitation, which would likely cause more abrupt and complete loss of vehicle control. Major depression can cause cognitive and psychomotor impairment and can increase crash risk in drivers (Snyder 2013, Hill et al. 2017). It is unknown if the SUV driver's ability to operate her vehicle was affected by her anxiety and depression or how her anxiety and depression might have interacted with other factors such as her ability to switch attention between the driving task and placing a phone call while driving.

As noted, the driver's prescribed medications included phenytoin to treat her seizures and duloxetine to treat her anxiety and depression. Both medications were found in postmortem toxicology testing. She had no changes in her prescribed medication close to the crash date. Phenytoin may cause cognitive and psychomotor impairment and typically carries a warning that users should not drive until they have become accustomed to its effects (Thompson et al. 1981, Gallassi et al. 1987). Data on impairment from duloxetine are limited; users might be advised not to drive until they know how the drug affects them. There is insufficient information to determine whether these medications affected the SUV driver's driving. The NTSB concludes that it is unlikely that the SUV driver's seizure disorder contributed to the crash, and there is insufficient information to determine whether her anxiety and depression or effects of medications used to treat her seizure disorder, anxiety, and depression contributed to her actions leading up to the crash.

## **2.2 SUV Driver Actions**

### **2.2.1 Cell Phone Use**

According to cell phone records, the SUV driver had engaged in a 16-minute cell phone conversation with a friend, which ended less than a minute before the crash. The driver's friend described the conversation as a discussion of an event that had upset the driver. During that conversation, the SUV driver received two incoming calls that she did not answer but ended the first call to respond to. The SUV driver's cell phone records show that she then placed a call on her cell phone, which went to voicemail, just before the crash.

Cell phone use for such activities as calling or texting while driving is a nationally recognized cause of driver distraction. It has been associated with visual (taking eyes off the road), manual (taking hands off the steering wheel) and cognitive (taking mind off driving) distraction (NHTSA 2010). NHTSA estimates that 8.8 percent of drivers were using some type of phone, either handheld or hands-free, at a typical daylight moment in 2019 (NHTSA 2021a). Using a cell phone for calls or texting while driving increases the odds of being involved in a crash or near crash. Visual-manual cell phone behaviors (texting, dialing, browsing, or locating/reaching for/answering) are associated with a higher crash risk (Dingus et al. 2016, Farmers et al. 2015, Owen et al. 2018). In fact, visual-manual cell phone interaction was found to triple drivers' odds of involvement in a road departure crash and increased the drivers' odds of rear-ending the vehicle ahead by more than a multiple of seven (Owen et al. 2018).

Conversation is frequently linked to cognitive distraction while driving, because drivers take their mind off driving or divert attention away from driving to another task (National Safety Council 2012, NHTSA 2013). The National Safety Council highlights the difficulties and limits in performing multiple cognitive tasks simultaneously and describes some of the related performance outcomes, such as failure to notice events in the driving environment, slower reaction time, and difficulty staying in the travel lane. Individual studies as well as a 2018 meta-analysis of cell phone use concluded that conversation using either a handheld or hands-free cell phone resulted in driving performance decrements (Caird et al. 2018, Zhang et al. 2019, Spyropoulou and Linardou 2019). In general, reaction time increased (Caird et al. 2018). In its investigation of a motorcoach collision with a bridge overpass in Alexandria, Virginia, the NTSB concluded that using a hands-free cell phone can impair driving performance.

Voice recognition systems have been introduced into vehicles and cell phones to avoid manual-visual driving decrements from dialing a cell phone; however, they are still more distracting than driving without using any cell phone for calls or texting (Simmons et al. 2017, Strayer et al. 2017, Strayer et al. 2018). NHTSA compared driver performance using handheld phones, portable hand-free phones, and integrated hands-free cell phones and found that tasks that required a high visual-manual demand, like dialing, are linked to performance decrements (NHTSA 2013). NHTSA cautioned that although hands-free interfaces allow for communication by voice, visual-manual tasks are sometimes still required. According to the SUV driver's husband, she used the SUV's infotainment console to permit hands-free use of the cell phone; however, it was not possible to conclusively determine how the cell phone was being used at the time of the crash (handheld or hands-free).

The person who spoke with the SUV driver for 16 minutes before the crash told the NTSB that the conversation was about an event that was upsetting to the driver. A few studies have suggested that the type of conversation can also influence the driver's performance; that is, a more emotionally involving conversation can be more distracting for a driver, including a conversation on a cell phone affect driving performance (Briggs et al. 2011, Dula et al. 2011, Chan and Singhal, 2015). Although the studies have limitations, the Briggs et al. study showed that drivers who were more emotionally involved in a conversation made more driving errors, and Dula et al. showed that study participants in the emotional call condition spent more time speeding and crossed the center line more often.

Regardless of how the SUV driver was using the cell phone (handheld or hands-free), maintaining a conversation on a cell phone, particularly one that may be emotional, and initiating and receiving phone calls while driving, places distracting cognitive, visual, and manual demands on the driver, resulting in

reduced driving performance. The cell phone records indicated that the SUV driver had completed a 16-minute phone call and then made and received phone calls that coincided with the time of the collision. The NTSB concludes that the SUV driver was distracted by the actions of talking, placing, and receiving calls on her cell phone while driving, which led to her crossing into the opposing lane of travel.

Section 2.3 discusses various strategies to prevent cell phone use for calls and texting while driving.

### 2.2.2 Driving Behaviors

According to a witness following the SUV, about 20–30 seconds before the collision, the SUV had traveled into the opposite travel lane, back into its travel lane, then back into the opposite travel lane, off the pavement, and into the grass before returning to its travel lane. About 100 yards before the impact location, the SUV sped up and maintained lane control until 1–2 seconds before the crash, when it crossed over the center line again and subsequently collided with the bus.

Lane departure warning (LDW) systems are designed to monitor lane markings and alert the driver when the vehicle is drifting out of its lane.<sup>26</sup> Similarly, lane departure prevention (LDP) technologies monitor lane markings and warn a driver when the vehicle is drifting out of its lane; additionally, an LDP system will actively intervene using steering, braking, or accelerating (or a combination of those actions) to ensure the vehicle stays in its travel lane.<sup>27</sup> LDW and LDP can be beneficial in preventing roadway departure crashes and head-on collisions (Wang 2019, Cicchino 2018). The effectiveness of LDW and LDP systems depends on several factors, including the visibility of the lane markings on the highway, roadway geometry, the weather, vehicle speed, and the design of the system such as steering intervention, trajectory of the camera, and driver input. Although the lane markings in the vicinity of the Belton crash likely would have been visible to a camera, other factors such as the few seconds (possibly as few as 2 seconds) between the SUV crossing into the opposing lane and colliding with the bus, and the excessive speed of the SUV would influence the effectiveness of LDW.<sup>28</sup> The active intervention of an LDP system might have assisted the SUV driver in keeping her lane if she was not actively steering the vehicle out of the lane. It might also have provided additional feedback to the driver through its steering intervention. The NTSB concludes that although it is unlikely that an LDW system would have prevented this crash, an LDP system that keeps a vehicle from departing its lane may have prevented the crash.

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<sup>26</sup> (a) [Driver Assistance Technologies | NHTSA](#) (b) The American Automobile Association (AAA) identified 19 names used to describe LDW and lane-keep assist systems. In this report, the NTSB uses the term LDW to describe a system that uses technology to alert a driver when the vehicle is on a trajectory to travel out of its lane and the driver must respond with braking or steering input to keep the vehicle in the lane, and the term LKA to describe a system that uses technology to actively keep a vehicle from drifting out of its lane by automatically applying braking or steering input. When referring to a specific vehicle system, it uses the name given to that accessed system. [ADAS-Technology-Names-Research-Report.pdf \(aaa.com\)](#) March 16, 2021.

<sup>27</sup> <https://www.nhtsa.gov/equipment/driver-assistance-technologies>, accessed on August 29, 2021.

<sup>28</sup> The US New Car Assessment Program (NCAP) testing of LDW is conducted at 45 mph (<https://www.govinfo.gov/content/pkg/FR-2015-12-16/pdf/2015-31323.pdf>), and Euro NCAP testing of LDW and LDP is conducted at 72 kph (about 44.7 mph). (<https://cdn.euroncap.com/media/20895/euro-ncap-lss-test-protocol-v10.pdf>).

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In 2015, NHTSA published a request for comments on its plans to upgrade NCAP by incorporating LDW and other advanced crash avoidance technologies into a rating program.<sup>29</sup> The NTSB responded on February 16, 2016, to the request for comments and supported the addition of LDW systems to NCAP.<sup>30</sup> As part of the efforts for the testing and confirmation procedures for LDW systems, NHTSA has established supplemental performance test information of LDP systems.<sup>31</sup> In 2021, NHTSA launched a consumer information campaign to promote LDP systems along with rear automatic braking, blind spot intervention, and automatic high beams.

Lane departure warning and prevention systems were not available for the 2015 Equinox 1 LT trim. Currently, Chevrolet provides as standard equipment an LDP named “Lane Keep Assist with Lane Departure Warning” on the Equinox. The system uses a camera sensor behind the windshield to detect lane lines ahead of the vehicle. If the system senses the vehicle drifting, the lane-keep assist icon will turn amber in color and steer the vehicle back into its lane. If the vehicle continues to drift and the driver does not react, the system will alert the driver with a warning beep. The NTSB is encouraged that LDW and LDP are being developed for passenger vehicles and are being installed as standard equipment. In 2019, AAA noted an increased availability of lane-keeping assistance technology for passenger vehicles (AAA 2019).<sup>32</sup>

When the SUV left its lane and collided with the left side of the bus in an angular, sideswipe motion, it resulted in the loss of two left-side bus body sidewall panels, exposing a 5-foot by 6-foot opening with as much as 11 inches of intrusion into the first two passenger rows. The bus was traveling at a recorded speed of 45 mph at impact, resulting in a closing speed with the 75-mph SUV of 120 mph. In a side-impact crash, near-side occupant injuries are often caused by a reduction of occupant space, direct contact with the struck portion of the vehicle, and inertial movement by the passenger (Arndt and Grzebieta 2003, Rouhana and Foster 1985, Howard et al. 2004, Acierno et al. 2004). The passenger seated in the left window seat of the first row was exposed to the loss of sidewall integrity and suffered injuries from either contact with the SUV or contact with sections of the sidewall that were damaged during the intrusion. Therefore, the NTSB concludes that the SUV struck the medium-size bus at a speed of about 75 mph, causing catastrophic intrusion damage and compromising the survival space of the bus passenger seated in the primary impact and intrusion path of the SUV.

Although the high speed of the SUV at the time of impact led to damage and intrusion of the bus beyond design standards, the NTSB has previously recommended side-impact protection standards for medium-size buses. Following a Davis, Oklahoma, crash in which a truck-tractor crossed the median and struck the left side of a medium-size bus, the NTSB issued Safety Recommendation H-15-40 for NHTSA to develop, and require compliance with, a side-impact protection standard for all newly manufactured medium-size buses,

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<sup>29</sup> (a) Volume 80 *Federal Register* 78521 (December 16, 2015) <https://www.govinfo.gov/content/pkg/FR-2015-12-16/pdf/2015-31323.pdf>. (b) NCAP rates cars on how they perform in crash tests. It also contains a checklist showing whether a vehicle is equipped with various crash avoidance technologies that meet performance requirements. Included in the list of crash avoidance technologies is LDW systems.

<sup>30</sup> <https://www.regulations.gov/comment/NHTSA-2015-0119-0311>.

<sup>31</sup> <https://www.regulations.gov/document/NHTSA-2006-26555-0135>.

<sup>32</sup> <https://www.aaa.com/AAA/common/AAR/files/ADAS-Technology-Names-Research-Report.pdf>.

regardless of weight (NTSB 2015). In response, on April 12, 2016, NHTSA said it would have to evaluate the construction of medium-size buses and determine the best way to protect bus occupants during a side-impact crash. The NTSB is not aware of any further action that NHTSA has taken in the 5 and a half years since then; therefore, the NTSB classifies Safety Recommendation H-15-40 “Open—Unacceptable Response.”

The unrestrained SUV driver was ejected from the SUV and sustained fatal injuries. Although South Carolina law requires all drivers and occupants to wear a fastened seat belt on public roadways, the EDR indicated that the SUV driver was not wearing her seat belt at the time of the crash. Seat belts are designed to keep occupants secured inside the vehicle. The NTSB concludes that the lack of use of the restraint system contributed to the SUV driver being ejected.

## **2.3 Prevention of Cell Phone Use While Driving**

Elimination of distracted driving for all drivers, including the use of cell phones or portable electronic devices for calls and texting while driving, has been on the NTSB’s Most Wanted List of Transportation Safety Improvements since 2013. The NTSB believes that distracted driving can be prevented through a combination of education, legislation, and enforcement (further discussion in section 2.3.1). Furthermore, the NTSB believes that cell phone technology can also be an effective countermeasure to distracted driving (further discussion in section 2.3.2).

### **2.3.1 Education, Legislation, and Enforcement**

Nearly 20 years ago, the NTSB investigated a multi-vehicle crash near Largo, Maryland, and determined that the probable cause was the combination of inexperience, unfamiliarity with the vehicle, speed, and distraction caused by use of a handheld wireless telephone (NTSB 2003). The NTSB issued four recommendations (H-03-3, H-03-4, H-03-10, and H-03-11) focused on education and a media campaign about the dangers associated with distracted driving and all have been classified “Closed—Acceptable Action.”<sup>33</sup> Additionally, the NTSB issued Safety Recommendation H-03-8, asking the 48 states without cell phone legislation to enact such rules to prohibit holders of learner’s permits and intermediate licenses from using interactive wireless communication devices while driving.<sup>34</sup>

To the National Highway Traffic Safety Administration:

Develop, in conjunction with The Advertising Council, Inc., a media campaign stressing the dangers associated with distracted driving. (H-03-3)

Develop, in conjunction with the American Driver and Traffic Safety Education Association, a module for driver education curriculums that emphasizes the risks of engaging in distracting behavior. (H-03-4)

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<sup>33</sup> Safety Recommendations H-03-3 and H-03-11 were classified “Closed—Acceptable Action” on August 19, 2010.

<sup>34</sup> New Jersey and Maine already had such laws.

To the American Driver and Traffic Safety Education Association:

Develop, in conjunction with the National Highway Traffic Safety Administration, a module for driver education curriculums that emphasizes the risks of engaging in distracting behavior. (H-03-10)

To The Advertising Council, Inc.:

Develop, in conjunction with the National Highway Traffic Safety Administration, a media campaign stressing the dangers associated with distracted driving. (H-03-11)

In 2011, as a result of the NTSB investigation of a multivehicle collision in Gray Summit, Missouri (NTSB 2011), Safety Recommendation H-03-8 was superseded by Safety Recommendation H-11-39 to the 50 states and the District of Columbia:

H-11-39

(1) Ban the nonemergency use of portable electronic devices (other than those designed to support the driving task) for all drivers; (2) use the National Highway Traffic Safety Administration Model of high visibility enforcement to support these bans; and (3) implement targeted communication campaigns to inform motorists of the new law and enforcement, and to warn them of the dangers associated with the nonemergency use of portable electronic devices while driving. (Superseded Safety Recommendation H-03-8)

In February 2021, the NTSB classified Safety Recommendation H-11-39 “Open—Acceptable Response” for South Carolina.<sup>35</sup> The NTSB recognized that South Carolina conducts targeted communication and education campaigns to discourage the use of portable electronic devices for calls and texting while driving but does not use high-visibility enforcement campaigns. Additionally, effective in 2014, South Carolina prohibits the use of handheld wireless communication devices to compose, send, or read a text-based communication while operating a motor vehicle.<sup>36</sup> Since then, legislation has been introduced in the South Carolina Legislature to strengthen the existing law by prohibiting the use of all handheld electronic communication devices by motor vehicle operators, but thus far it has not been enacted.

As of August 2021, 24 states and the District of Columbia prohibit all drivers from using handheld cell phones while driving and 48 states and the District of Columbia ban text messaging for all drivers.<sup>37</sup> A

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<sup>35</sup> The NTSB updated each state on the current classification status of H-11-39 in February 2021. The recommendation is classified “Open—Acceptable Response” for all states except Montana, for which it is classified “Open—Unacceptable Response.”

<sup>36</sup> <https://www.scstatehouse.gov/code/t56c005.php>.

<sup>37</sup> (a) <https://www.ncsl.org/research/transportation/cellular-phone-use-and-texting-while-driving-laws.aspx>. (b) <https://www.iihs.org/topics/distracted-driving/cellphone-use-laws>. (c) Arizona, California, Connecticut, Delaware, Georgia, Hawaii, Idaho, Illinois, Indiana, Maine, Maryland, Massachusetts, Minnesota, Nevada, New

2019 literature review of distracted driving countermeasures concluded that although there are limitations to studies, the majority of studies of all-driver handheld cell phone bans indicate a decrease in handheld cell phone use while driving and also, in some cases, a decrease in the number of fatal and injury crashes (Arnold et al. 2019). The literature review also found that high-visibility enforcement of cell phone and texting bans was associated with a decrease in handheld cell phone use. In April 2021, NHTSA supported National Distracted Driving Awareness Week with a public awareness and enforcement campaign titled “U Drive. U Text. U Pay.”<sup>38</sup>

In 2019, there were 2,895 fatal crashes that involved distraction nationwide. Of these, 387 were fatal crashes involving cell phones (13 percent of all distraction-affected fatal crashes); however, the NTSB notes that the number of cell phone-related crashes is likely underreported (NHTSA 2021b).<sup>39</sup> Results from the 2016 Motor Vehicle Occupant Safety Survey show that of those respondents who kept a cell phone in their vehicle, about 25 percent said that they never talked on the phone while driving and about 20 percent reported they talked on the phone during all or most trips (Diecker and Block, 2020). Furthermore, of those respondents who said that they talked on the phone at least occasionally, two-thirds said they tended to use the phone hands-free. As noted in the previous section, both handheld and hands-free cell phone use while driving reduces driving performance. The NTSB concludes that although most states have prohibited texting while operating a motor vehicle, the risk of a distracted driving crash remains high due to the lack of laws prohibiting the use of any portable electronic device for calls and texting while driving. Therefore, the NTSB reiterates Safety Recommendation H-11-39 to the 50 states and the District of Columbia.

### **2.3.2 Cell Phone Technology**

In 2020, the NTSB investigated a collision of an SUV with a crash attenuator in Mountain View, California, where the driver was distracted by a cell phone game and over-relied on the vehicle’s partial driving automation system (NTSB 2020). In its report, the NTSB discussed Apple’s “Do Not Disturb While Driving” system, which was designed to prevent cell phone users from receiving messages and calls while driving and lets contacts know that the cell phone users are occupied with driving. Further, in the Mountain View report, the NTSB concluded that a technological solution, such as a lock-out function or application that automatically disables highly distracting features of a portable electronic device while driving, is an effective countermeasure for eliminating distraction from portable electronic devices while driving.

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Hampshire, New Jersey, New York, Oregon, Rhode Island, Tennessee, Vermont, Virginia, Washington, and West Virginia prohibit the use of hand-held cell phones while driving for all drivers. (d) Missouri bans text messaging and all other use of hand-held devices while operating a motor vehicle for drivers 21 or younger, and Montana does not have a statewide law restricting use of cell phones in some manner while driving.

<sup>38</sup> <https://www.trafficsafetymarketing.gov/get-materials/distracted-driving>.

<sup>39</sup> NHTSA cites several potential reasons for underreporting of distraction-affected crashes. These include bias with self-reported data elements, lack of evidence to indicate distraction, unavailable witness accounts, or rapidly changing and developing technologies that are not yet captured on police crash reports.

As a result of the Mountain View investigation, the NTSB issued Safety Recommendation H-20-8 to manufacturers of portable electronic devices (Apple, Google, HTC, Lenovo, LG, Motorola, Nokia, Samsung, and Sony) to develop a distracted driving lock-out mechanism or application for portable electronic devices that will automatically disable any driver-distracting functions when a vehicle is in motion, but that allows the device to be used in an emergency; install the mechanism as a default setting on all new devices; and apply it to existing commercially available devices during major software updates. Thus far, the NTSB has received initial responses from Apple and Google. In Apple's June 2020 response, the company indicated that in addition to its Do Not Disturb feature, it has created Siri Eyes Free and CarPlay to allow drivers access to a subset of features of the cell phone without having to physically touch it. Google responded in June 2020, stating that it has a Do Not Disturb mode that, when enabled, will turn off communication, and that the company was improving its voice-activated systems by adding a Driving Mode to Google Assistant. Accordingly, in December 2020, the NTSB classified Safety Recommendation H-20-8 with respect to Apple and Google "Open—Acceptable Response."

The NTSB recognizes that there are limitations to lock-out systems or Do Not Disturb mechanisms available today because these systems are not automatically enabled and drivers can override them to initiate a phone call (Reagan and Cicchino 2020). However, a properly engaged lock-out system can prevent distraction from incoming phone calls. The NTSB concludes that the cell phone lock-out systems available on the market today would not have prevented the SUV driver from initiating a call and engaging in a conversation but could have prevented the distraction from and self-induced pressure to return the incoming calls. Further, the NTSB concludes that a well-designed and properly engaged cell phone lock-out system is an effective countermeasure in reducing cell phone-related distracted driving crashes. Therefore, the NTSB reiterates Safety Recommendation H-20-8.

## **2.4 Wheelchair Securement**

Although the wheelchairs had been secured to the bus with ADA-compliant securement systems, witnesses at the crash scene indicated that both wheelchairs and their occupants were found flipped forward. The wheelchairs and their occupants were restrained. Postcrash examination revealed improper anchoring of the wheelchair front and rear securement straps/retractors for both wheelchairs. Further, the occupant lap/shoulder belts for both wheelchair positions were found severely twisted, reducing the belts' ability to perform properly in a crash.

The University of Michigan Transportation Research Institute (UMTRI) investigated motor vehicle crashes involving occupants seated in wheelchairs and concluded that a primary reason for serious to fatal occupant injuries was the lack of use and/or proper positioning of a lap/shoulder belt restraint system (Schneider 2016). A study of wheelchairs on paratransit vehicles found a higher nonuse or misuse of the occupant restraints than for the wheelchair securement system (Frost 2018).

Manufacturers of the wheelchair restraint systems highlight in their instruction and training that any twisted or damaged wheelchair occupant restraints or wheelchair securement straps can compromise the entire securement system. The NTSB concludes that improper positioning of the wheelchair securement straps and the twisting of the webbing on the lap/shoulder belts used by the wheelchair occupants increased their risk of injury.

As discussed earlier in the report, ACDSNB wheelchair securement training was combined in a day of training with defensive driving, and the ACDSNB did not provide recurrent training on the WTORS before the crash. Following the crash, the ACDSNB began to provide WTORS training that is supplemented with additional securement training videos and required to be conducted annually. The NTSB is aware of various training resources: manufacturers of wheelchair securement systems provide training in virtual and in-person formats, and UMTRI maintains a website on wheelchair transportation safety that contains information on transportation safety, industry standards, and research targeted to consumers, manufacturers, prescribers, and transporters.<sup>40</sup>

The National Association of State Directors of Developmental Disabilities Services (NASDDDS) is an organization of state agencies that provides services to children and adults with intellectual and developmental disabilities and their families.<sup>41</sup> As part of its mission, the NASDDDS assists member state agencies with analyzing federal statutory and regulatory policies that affect people with disabilities and has the ability to disseminate information on state-of-the-art programs and service delivery practices. Because the NASDDDS has the means to distribute relevant information to state disability agencies, the NTSB recommends that the NASDDDS inform its members of the circumstances of this crash and advise them to ensure that their employees receive annual training in securing wheelchairs and their occupants for transportation.

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<sup>40</sup> The UMTRI website was developed with funds from NHTSA, the National Institute on Disability Independent Living and Rehabilitation Research, and a group called “The Friends of the University of Michigan Hospitals,” [Publications - WC Transportation Safety \(umich.edu\)](#).

<sup>41</sup> The South Carolina Department of Disabilities and Special Needs is a member agency of NASDDDS.

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## 3. Conclusions

### 3.1 Findings

1. None of the following were factors in this crash: (1) mechanical condition of the sport utility vehicle or bus, (2) the design or maintenance of the roadway, (3) the bus transportation provider policies, (4) the bus driver's actions, and (5) weather or illumination.
2. The emergency response and transportation of the injured was timely and adequate.
3. It is unlikely that the sport utility vehicle driver's seizure disorder contributed to the crash, and there is insufficient information to determine whether her anxiety and depression or effects of medications used to treat her seizure disorder, anxiety, and depression contributed to her actions leading up to the crash.
4. The driver of the sport utility vehicle was distracted by the actions of talking, placing, and receiving calls on her cell phone while driving, which led to her crossing into the opposing lane of travel.
5. Although it is unlikely that a lane departure warning system would have prevented this crash, a lane departure prevention system that keeps a vehicle from departing its lane may have prevented the crash.
6. The sport utility vehicle struck the medium-size bus at a speed of about 75 mph, causing catastrophic intrusion damage and compromising the survival space of the bus passenger seated in the primary impact and intrusion path of the sport utility vehicle.
7. The lack of use of the restraint system contributed to the driver of the sport utility vehicle being ejected.
8. Although most states have prohibited texting while operating a motor vehicle, the risk of a distracted driving crash remains high due to the lack of laws prohibiting the use of any portable electronic device for calls and texting while driving.
9. The cell phone lock-out systems available on the market today would not have prevented the driver of the sport utility vehicle from initiating a call and engaging in a conversation but could have prevented the distraction from and self-induced pressure to return the incoming calls.
10. A well-designed and properly engaged cell phone lock-out system is an effective countermeasure in reducing cell phone-related distracted driving crashes.
11. Improper positioning of the wheelchair securement straps and the twisting of the webbing on the lap/shoulder belts used by the wheelchair occupants increased their risk of injury.

### **3.2 Probable Cause**

The National Transportation Safety Board determines that the probable cause of the Belton, South Carolina, crash was the SUV driver's loss of control of her vehicle due to distraction from cell phone use, resulting in the SUV crossing into the opposite travel lane and colliding with the medium-size bus. Contributing to the severity of the crash was the excessive speed of the SUV.



## 4. Recommendations

### 4.1 New Recommendations

As a result of this investigation, the National Transportation Safety Board makes the following new safety recommendation.

**To the National Association of State Directors of Developmental Disabilities Services:**

Inform your members of the circumstances of this crash and advise them to ensure that their employees receive annual training in securing wheelchairs and their occupants for transportation. (H-21-4)

### 4.2 Previously Issued Recommendations Reiterated in This Report

The National Transportation Safety Board reiterates the following safety recommendations.

**To the 50 States and the District of Columbia:**

(1) Ban the nonemergency use of portable electronic devices (other than those designed to support the driving task) for all drivers; (2) use the National Highway Traffic Safety Administration model of high visibility enforcement to support these bans; and (3) implement targeted communication campaigns to inform motorists of the new law and enforcement, and to warn them of the dangers associated with the nonemergency use of portable electronic devices while driving. (H-11-39)

**To Manufacturers of Portable Electronic Devices (Apple, Google, HTC, Lenovo, LG, Motorola, Nokia, Samsung, and Sony):**

Develop a distracted driving lock-out mechanism or application for portable electronic devices that will automatically disable any driver-distracting functions when a vehicle is in motion, but that allows the device to be used in an emergency; install the mechanism as a default setting on all new devices and apply it to existing commercially available devices during major software updates. (H-20-8)

### 4.3 Previously Issued Recommendations Classified in This Report

The National Transportation Safety Board classifies the following safety recommendation.

**To the National Highway Traffic Safety Administration:**

Develop, and require compliance with, a side-impact protection standard for all newly manufactured medium-size buses, regardless of weight. (H-15-40)

Safety Recommendation H-15-40, which was previously classified “Open—Acceptable Response,” is hereby classified “Open—Unacceptable Response.”

**BY THE NATIONAL TRANSPORTATION SAFETY BOARD**

**JENNIFER HOMENDY**

Chair

**MICHAEL GRAHAM**

Member

**BRUCE LANDSBERG**

Vice Chairman

**THOMAS CHAPMAN**

Member

**Report Date: November 17, 2021**

## Appendixes

### Appendix A: Investigation

The National Transportation Safety Board was notified of the Belton, South Carolina, crash on December 17, 2019, and dispatched a limited investigative team to the site. The NTSB established groups to investigate survival and vehicle factors, and a combined group to investigate human performance, motor carrier operations, and highway factors.

The South Carolina Highway Patrol was a party to the investigation.

## Appendix B: Consolidated Recommendation Information

Title 49 *United States Code* 1117(b) requires the following information on the recommendations in this report.

For each recommendation—

(1) a brief summary of the Board’s collection and analysis of the specific accident investigation information most relevant to the recommendation;

(2) a description of the Board’s use of external information, including studies, reports, and experts, other than the findings of a specific accident investigation, if any were used to inform or support the recommendation, including a brief summary of the specific safety benefits and other effects identified by each study, report, or expert; and

(3) a brief summary of any examples of actions taken by regulated entities before the publication of the safety recommendation, to the extent such actions are known to the Board, that were consistent with the recommendation.

### To the National Association of State Directors of Developmental Disabilities Services:

#### H-21-4

Inform your members of the circumstances of this crash and advise them to ensure that their employees receive annual training in securing wheelchairs and their occupants for transportation.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section sections [1.4 Restraint Use](#), [1.11 Additional Information](#), and [2.4 Wheelchair Securement](#). Information supporting (b)(1) can be found on pages 4–6, 17–20, and 29–30; (b)(2) can be found on pages 29–30; and (b)(3) is not applicable.

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