August 12, 2024 Highway Investigation Report HIR-24-05

Rear-End Collision Between Combination Vehicle and Medium-Size Bus

Williamsburg, Virginia
December 16, 2022

Abstract: On Friday, December 16, 2022, about 1:36 a.m. eastern standard time, a truck-tractor in combination with a semitrailer, operated by Triton Logistics Incorporated, was traveling east on Interstate 64 (I-64) near Williamsburg, Virginia, when it crashed into the rear of a slower-moving medium-size bus, operated by Futrell's Party Adventures, LLC. The bus was traveling about 20–25 mph, while the truck was traveling about 65–70 mph. The truck driver did not brake or take any evasive action while approaching the slower-moving vehicle. As a result of the crash, 3 bus occupants died, 9 sustained serious injuries, and 11 sustained minor injuries. The truck driver also sustained serious injuries. Safety issues identified in this investigation include the inadequate safety culture of the truck motor carrier, the need for federal requirements for commercial vehicle collision avoidance systems, and the inadequate safety management and oversight of the bus carrier. The NTSB issues new safety recommendations to the Federal Motor Carrier Safety Administration, the Commonwealth of Virginia, Triton Logistics Incorporated, and the Commercial Vehicle Safety Alliance. The NTSB also reiterates recommendations to the National Highway Traffic Safety Administration and the Federal Motor Carrier Safety Administration.

Contents

Figures

Acronyms and Abbreviations

ACC	adaptive cruise control
ADAS	advanced driver assistance systems
AEB	automatic emergency braking
BASICs	Behavior Analysis and Safety Improvement Categories
CDL	commercial driver's license
CFR	*Code of Federal Regulations*
CVSA	Commercial Vehicle Safety Alliance
DMV	Department of Motor Vehicles
DOT	Department of Transportation
ECM	engine control module
ELD	electronic logging device
eRODS	Electronic Record of Duty Status
FCW	forward collision warning
FMCSA	Federal Motor Carrier Safety Administration
HOS	hours of service
ISS	Inspection Selection System
MCMIS	Motor Carrier Management Information System
NAFMP	North American Fatigue Management Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
RDH	Riverside Doctor's Hospital Williamsburg
RRMC	Riverside Regional Medical Center

SMS	Safety Measurement System
SWRMC	Sentara Williamsburg Regional Medical Center
VDOT	Virginia Department of Transportation
YCFLS	York County Fire & Life Safety

Executive Summary

What Happened

On Friday, December 16, 2022, about 1:36 a.m. eastern standard time, a truck-tractor in combination with a semitrailer (combination vehicle), operated by Triton Logistics Incorporated, was traveling east on Interstate 64 (I-64) near Williamsburg, York County, Virginia, when it crashed into the rear of a slower-moving medium-size bus, operated by Futrell's Party Adventures, LLC. Both vehicles were traveling in the right eastbound lane. In the 5 seconds before the crash, the bus was traveling at a speed of about 20 to 25 mph, while the combination vehicle was traveling between 65 and 70 mph with cruise control activated. The speed limit on I-64 is 70 mph. The truck driver, the sole occupant in the combination vehicle, did not brake or take any evasive action as he approached the slower-moving bus. During the collision with the truck-tractor, the roof and sidewalls of the bus separated from the rest of the vehicle, exposing the occupant compartment. After the collision, the bus rotated counterclockwise around the front of the truck-tractor, crossed over the left eastbound lane, and breached the eastbound median guardrail. The truck-tractor continued forward on a southeast trajectory relative to the roadway, across the travel lanes, shoulder, and median. As a result of the crash, 3 bus occupants died, 9 sustained serious injuries, and 11 sustained minor injuries. The truck driver also sustained serious injuries.

What We Found

We found that the truck driver's lack of response to the slow-moving vehicle in his travel lane was due to fatigue from excess driving time and lack of sleep opportunity. The truck's motor carrier, Triton Logistics Incorporated, created fictitious driver accounts for its vehicles' electronic logging device systems that enabled drivers to operate beyond federal regulations, creating an opportunity for fatigued driving. The ability to track data entry in the electronic logging device software could increase accountability and transparency and deter motor carriers from making false entries aimed at circumventing hours-of-service regulations.

We found that a comprehensive fatigue management program can reduce fatigue-related crash risk and improve safety by, for example, educating drivers; had Triton had such a program, the driver may not have been operating the truck while fatigued. In addition, inward-facing video enhances the effectiveness of driver coaching programs and can reduce instances of violations of carrier safety policies.

Advanced vehicle technologies, including automatic emergency braking and adaptive cruise control, were available as standard equipment for this truck-tractor; however, the carrier opted not to purchase these systems. We found that the collision may have been avoided or its severity lessened had these systems been installed on the truck-tractor. Because commercial vehicle customers can elect not to purchase collision avoidance systems, even those that are considered standard equipment, federal requirements are necessary to increase widespread deployment of this technology.

We found that the slow speed of the bus increased the severity of the collision and may have been due, in part, to a partially blocked prescreen fuel filter. The bus carrier lacked appropriate safety management practices, as demonstrated by the poor maintenance and improper registration of the bus and use of an improperly licensed driver. In addition, the Commonwealth of Virginia did not provide safety guidance to new motor carrier licensees, increasing the likelihood that new carriers could operate without knowledge of safety regulations and best practices.

The National Transportation Safety Board determines that the probable cause of the Williamsburg, Virginia, crash was the truck driver's fatigue, due to excessive driving time and limited sleep opportunity, which resulted in his lack of response to the slow-moving bus ahead. Contributing to the truck driver's fatigue was the motor carrier, Triton Logistics Incorporated, which created fictitious driver accounts in the electronic logging device system and enabled drivers to operate their vehicles for hours in excess of federal regulations. Contributing to the severity of the crash was the operation of the bus at a significantly slower speed than other highway traffic.

What We Recommended

As a result of this investigation, we issued six new safety recommendations and reiterated three recommendations. We recommended that the Federal Motor Carrier Safety Administration revise federal regulations to require providers of electronic logging devices to create and produce an audit log, to include date, time and editor for driver logins, driver's license numbers, and active driver list changes. We recommended that the Commonwealth of Virginia provide new intrastate motor carrier licensees with safety guidance such as proper license class, drug- and alcohol-testing requirements, fatigue management, vehicle maintenance, and safe commercial vehicle operation. We also recommended that Triton Logistics Incorporated implement a process to regularly verify the accuracy of driver records of duty status, implement a fatigue management program to educate its drivers and other employees about fatigue, and proactively use onboard video event recorder information, including inward- and forward-facing video, to enhance driver training/coaching. Finally, we recommended that the Commercial Vehicle Safety Alliance inform its members of this crash, including the potential consequences of false log information.

We reiterated Safety Recommendation H-15-5 to the National Highway Traffic Safety Administration to complete the development and application of performance standards and protocols for the assessment of forward collision avoidance systems in commercial vehicles, and Safety Recommendation H-22-3 to require that all buses and trucks over 10,000 pounds gross vehicle weight rating be equipped with onboard video event recorders. Finally, we reiterated Safety Recommendation H-22-4 to the Federal Motor Carrier Safety Administration to provide guidance to motor carriers to proactively use the onboard video event recorder information to aid in driver training and ensure driver compliance with regulatory rules essential for safe operation.

1 Factual Information

1.1 Crash Narrative

On Friday, December 16, 2022, about 1:36 a.m. eastern standard time, a combination vehicle was traveling eastbound on Interstate 64 (I-64) near Williamsburg, York County, Virginia, when it crashed into the rear of a slower-moving medium-size bus.[1] The combination vehicle, a 2022 Freightliner Cascadia truck-tractor in combination with a 2020 Great Dane semitrailer, was operated by Triton Logistics Incorporated (Triton). The medium-size bus was a 2000 Eldorado operated by Futrell's Party Adventures, LLC (Futrell's), and was carrying 23 occupants. Both vehicles were traveling in the right eastbound lane. The weather was clear and the roadway was wet from earlier precipitation. The conditions were dark and no highway lighting was present in the vicinity of the crash. The posted regulatory speed limit was 70 mph.

In the 5 seconds before the crash, the bus was traveling at a speed of about 20 to 25 mph, while the combination vehicle was traveling between 65 and 70 mph with cruise control in use.[2] The bus had not recently entered I-64 from an on-ramp or changed lanes just before the collision, nor was it slowing to exit the interstate. Forward-facing video from the combination vehicle showed that the rear lights of the bus were illuminated and visible before the crash. As the vehicles reached mile marker 240, the combination vehicle struck the rear of the bus. Electronic data from the truck-tractor showed that the truck driver did not brake or take any evasive action to avoid the crash.[3] After the initial rear-end impact in the right lane, the bus was redirected leftward across the center and left travel lanes toward the center median, while rotating counterclockwise around the front of the truck-tractor. The front of the bus struck and breached the eastbound median guardrail during its counterclockwise rotation. In the collision sequence, the roof and sidewalls of the bus separated from the rest of the vehicle, exposing the occupant compartment. The bus came to rest in the median, facing north. The combination vehicle continued forward on an angled trajectory relative to the roadway, across the travel lanes, and breached the eastbound median guardrail. It then continued across the median and came to rest against the back of the westbound roadway median guardrail (see figures 1 and 2).

[1] (a) Visit ntsb.gov to find additional information in the public docket for this NTSB accident investigation (case number HWY23MH004). Use the CAROL Query to search safety recommendations and investigations. (b) At the location of the crash, vehicles in the eastbound lanes travel in a southeast direction, and vehicles in the westbound lanes travel in a northwest direction.

[2] See sections 1.4.1.5 and 1.4.2.5 for more details on how the vehicle speeds were determined.

[3] See section 1.4.1.5 for additional information.

Figure 1. Eastbound view of final rest positions of the bus and combination vehicle (Source: Virginia State Police with annotations by the NTSB).

Figure 2. Westbound view of the combination vehicle's final rest position (Source: Virginia State Police).

Figure 3 shows a diagram of the postimpact travel of each vehicle relative to the physical evidence.

Figure 3. Depiction of the postimpact paths of travel for the truck and bus relative to physical evidence as overlaid atop the scene (orthomosaic image).

1.2 Injury Outcome, Occupant Protection, and Emergency Response

1.2.1 Injury Outcome

As a result of the crash, all of the bus occupants were ejected. Three of them died, 9 sustained serious injuries, and 11 sustained minor injuries. The approximate seating locations and injury severity of the bus occupants are shown in figure 4. Exact orientation and posture for each occupant was not known. The truck driver, who was the sole occupant of the combination vehicle, sustained serious injuries.

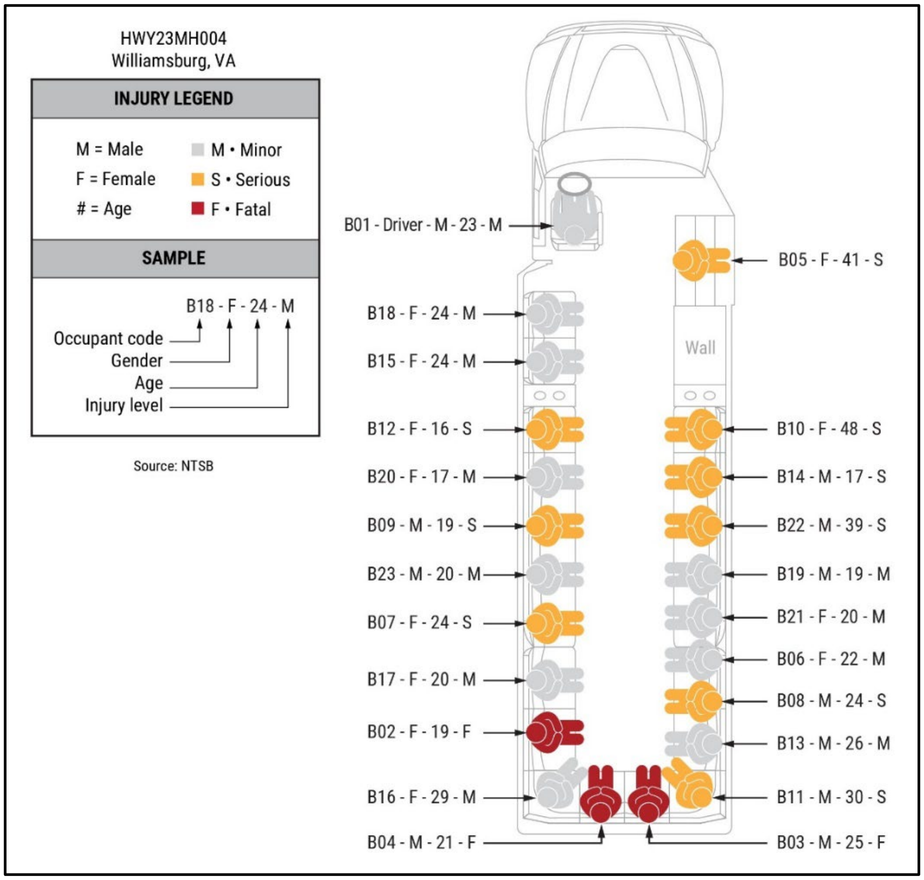

Figure 4. Seating locations and injury severity sustained by bus occupants.

1.2.2 Occupant Protection

The passenger compartment of the bus consisted of a perimeter- or "limousine-style" seating arrangement. None of the passenger seats were equipped with seat belts or other passenger restraint systems. The bus driver's seat belt was not functional.[4] The bus driver provided a written statement to Virginia State Police, stating that he was not wearing his seat belt while operating the bus. All bus occupants were ejected during the crash.

In the postcrash examination of the combination vehicle, the NTSB found the truck driver's lap/shoulder belt intact and in the buckled position. The seat belt was free to extend and retract, and nothing indicated that the seat belt had been in use by

[4] The bus driver's seat belt release mechanism was missing. In addition, the lower portion of the belt—which should be connected to the manufacturer's lower anchor point by a hex bolt—was disconnected. The seat belt was free from any crash-related damage, indicating that the belt was disconnected before the crash.

the truck driver during the collision sequence. Although buckled, the position of the seat belt was consistent with being buckled behind the driver.

1.2.3 Emergency Response

Nine 911 calls were made and routed to various first responder agencies; the first call was received at 1:38 a.m. First responders began arriving on scene within about 5 minutes of the first call. The Virginia State Police, York County Fire & Life Safety (YCFLS), James City County Fire Department, and Williamsburg City Fire Department responded to the crash, which was determined by the YCFLS incident commander to be a mass-casualty event. Triage identified three fatalities.[5] Medical transportation, including seven ambulances and two mass-casualty buses, transported most of the injured persons to three area hospitals. One occupant left the scene before the first responders arrived and later self-presented at Riverside Doctor's Hospital Williamsburg (RDH) with serious injuries. The closest Level 2 Trauma Center was Riverside Regional Medical Center (RRMC), located about 25 miles southeast of the collision site.[6] The six most severely injured occupants arrived at RRMC between 2:30 and 2:56 a.m. Other surviving occupants were transported to Sentara Williamsburg Regional Medical Center (SWRMC) and RDH, with arrival times between 2:23 and 3:08 a.m. Four of the occupants who were initially taken to SWRMC and RDH were later transferred to RRMC due to the extent of their injuries.

1.3 Highway Factors

1.3.1 General Roadway Description

In the area of the crash, I-64 consisted of three eastbound and three westbound travel lanes. Each of the travel lanes was about 12 feet wide. The paved shoulders adjacent to the right and left travel lane were each about 14 feet wide. At mile marker 240, the eastbound roadway was straight with a 2.96% uphill grade. A 36-foot-wide median separated the eastbound travel lanes from the westbound travel lanes (figure 5). A strong-post, blocked-out, W-beam guardrail was continuous along

[5] Occupants were triaged using a simple triage and rapid treatment method for mass-casualty incidents, which uses a color-coding system to quickly identify and label the patient's apparent medical condition.

[6] *Trauma centers* are classified into different levels based on the presence of patient care resources. A Level 2 trauma center is able to initiate definitive care for all injured patients.

the left shoulder in both the eastbound and westbound direction of travel.[7] The total height from the pavement surface to the top of the W-beam rail element was about 30 inches, which conformed to the American Association of State Highway and Transportation Officials (AASHTO) *Roadside Design Guide* (AASHTO 2011).

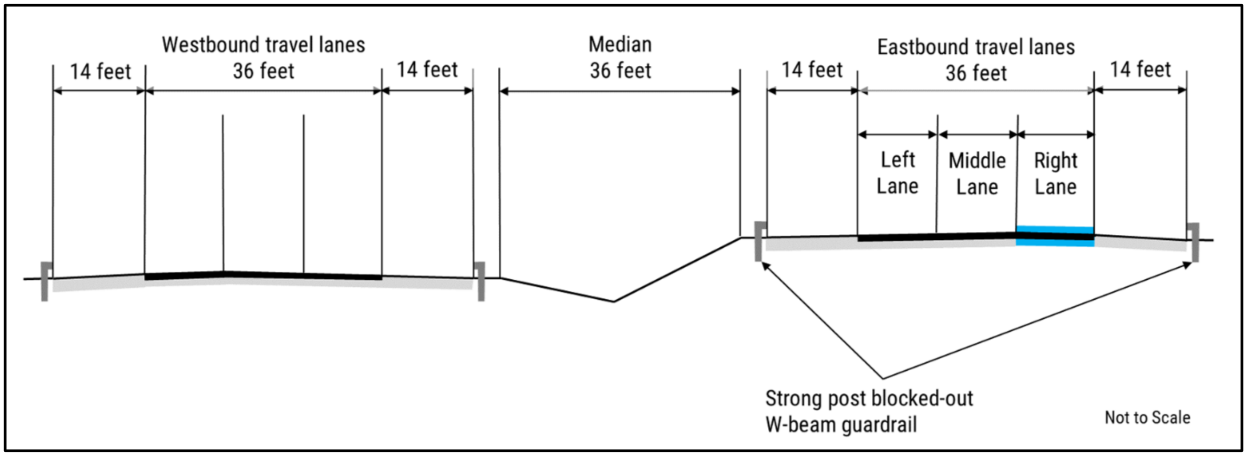

Figure 5. Cross-section of I-64 at the crash location. The collision occurred in the eastbound right lane (highlighted in blue).

No highway lighting was present, nor was it required. The NTSB observed conditions at the crash site on December 19, 2022, near the same time as the crash, and found that the reflective materials on highway signs and pavement were visible.

As determined by the Virginia Department of Transportation (VDOT), the average daily traffic volume on I-64 in both the eastbound and westbound directions was 68,360 vehicles per day in 2021.[8] About 93% were passenger vehicles and the remaining 7% were buses and trucks of varying sizes. Examination of the 5-year crash history—from 2018 to 2022—for the roadway within a mile of the crash location revealed 42 crashes, one of which was fatal.[9] The posted regulatory speed limit in the crash area was 70 mph. The Code of Virginia, section 46.2-877, states that "no person shall drive a motor vehicle at such a slow speed as to impede the normal and reasonable movement of traffic."[10] The roadway did not have a posted minimum

[7] The guardrail was considered a test level 3 (TL-3)-compliant barrier system in accordance with the AASHTO *Manual for Assessing Safety Hardware*. The guardrail conformed with guidelines set by the National Cooperative Highway Research Program (NCHRP) that are based on average daily traffic and median width. See NCHRP Research Report 996.

[8] In 2021, VDOT completed an interstate improvement project that included widening this section of I-64 from four lanes to six for about 21 miles.

[9] According to the police report, a fatal crash occurred on May 8, 2022, in which a vehicle traveling eastbound on I-64 at a high rate of speed ran off the road to the left and struck the median barrier; then ran off the road to the right and struck the guardrail twice.

[10] See the Code of Virginia, Va. Code Ann. Section 46.2-877 (1989), at the following link: [46.2-877.](46.2-877.)

speed limit and VDOT did not have any record of a minimum speed limit being established or requested on interstate- or state-maintained highways, although VDOT has the authority to establish such speed limits based on determinations that slow speeds on part of a highway consistently impede traffic movement. The NTSB reviewed the collision area's crash history from 2018 through 2022 and did not find any incident in which "driving too slowly" or similar reason was listed as a contributory factor.

1.4 Vehicle Factors

1.4.1 Combination Vehicle

1.4.1.1 General Description

The combination vehicle consisted of a 2022 Freightliner Cascadia truck-tractor and 2020 Great Dane semitrailer. The truck-tractor was equipped with a Detroit Diesel DD15 455-horsepower engine, a Detroit 12-speed automatic transmission, and pneumatic drum brakes with an antilock braking system. The semitrailer was a 53-foot-long, van-style semitrailer. The combination vehicle had a registered weight of 80,000 pounds. At the time of the crash, the semitrailer was loaded with 46,353 pounds of cargo. An exemplar truck-tractor and the crash-damaged one are shown in figure 6.

Figure 6. Exemplar truck-tractor (left; source: Vanguard Truck Center). Crash-damaged truck-tractor (right).

The truck-tractor was not equipped with advanced driver assistance systems (ADAS), nor did federal regulations require it to be.[11] Since 2015, Daimler Trucks North America (Daimler) has provided the Detroit Assurance® Safety Suite as an optional feature on all new Freightliner Cascadias and, since 2018, has marketed it as a standard feature. The Detroit Assurance® Safety Suite included forward collision warning (FCW), automatic emergency braking (AEB), and adaptive cruise control

[11] *Advanced driver assistance systems* are technologies designed to increase the safety of driving a vehicle. These include, but are not limited to, forward collision avoidance systems, lane-keeping assist systems, driver monitoring systems, and adaptive cruise control.

(ACC), among other features. Although marketed by Daimler as standard equipment, Triton requested that Daimler deliver the 2022 truck-tractor without collision avoidance technology. As a result, Triton received a cost discount on its truck order, which included this truck.[12] Triton told the NTSB that the owner and several of the drivers had field-tested an earlier version of the equipment, and they did not like its performance.

1.4.1.2 Damage

Figure 7 shows the postcrash damage to the truck-tractor and semitrailer. The truck-tractor sustained significant damage to its front end with damage trailing along the left side. The hood and front bumper were missing and the bumper guard was bent and creased in multiple locations. The full width of the windshield was shattered.

Figure 7. Postcrash photographs showing the front of the truck-tractor (left) and the front left of the semitrailer (right).

The front portion of the semitrailer was missing along with the fifth wheel kingpin, upper fifth wheel plate, and landing gear. The damage sustained by the combination vehicle was consistent with a frontal impact with the rear of the bus and a sudden stop, which caused the cargo inside the semitrailer to propel forward and break through the forward bulkhead.

1.4.1.3 Mechanical Inspection

A postcrash examination of the truck-tractor's steering, brakes, suspension, and electrical systems was conducted. The lower steering arm was found to be bowed, consistent with crash-induced damage. The steering remained functional even with this damage. No pre-existing or crash-related damage was noted to the

[12] The order for this truck-tractor was placed in 2020 and included a total of 10 vehicles, all of which were purchased without collision avoidance technology.

suspension system for either the truck-tractor or semitrailer. The truck-tractor was equipped with a dual pneumatic brake system with drum brakes on all axles. The brake system sustained damage to the brake hose connections and air lines, consistent with the crash. The electrical system remained intact except for the main power supply cable to the vehicle control electronics, which had been severed. The headlamps and turn signals were destroyed in the collision, but the forward-facing video showed that, leading up to the crash, the headlamps were functional and illuminated. The rear turn signals, brake lamps, and tail lamps remained intact and were functional. Three tires exhibited crash damage; the remaining tires and all wheels were undamaged.

1.4.1.4 Maintenance and Recalls

After Triton obtained the truck-tractor, the vehicle had one annual safety inspection conducted on April 25, 2022, and the record listed no defects. The latest annual safety inspection report for the semitrailer, conducted on October 4, 2022, also listed no defects. Triton conducted regular maintenance on its truck-tractors, including the crash-involved vehicle. The manufacturer had issued two recalls for this model of truck-tractor, pertaining to replacement of the aluminum battery cables and exhaust pipe. No records indicated that either was replaced on the crash-involved truck-tractor.

1.4.1.5 Electronic Data

The truck-tractor was equipped with multiple control modules for engine management and vehicle operations. The engine was controlled by a Detroit Diesel engine control module (ECM). The primary function of the ECM is to control the engine's performance, fuel efficiency, and emissions based on various engine and sensor inputs. The ECM can record diagnostic trouble codes associated with engine and/or sensor faults, which may then activate warnings on the dashboard. Also, the ECM is capable of capturing vehicle speed, engine speed, and other parameters during triggered events.[13] Recovered event data related to this crash included a total of 120 seconds of data, reported at 1-second intervals. The data showed that the truck-tractor traveled at speeds between 65 and 70 mph during the 2 minutes before the collision. Cruise control was engaged during this timeframe. Minor variations in engine load, engine speed (revolutions per minute or RPM), and vehicle speed were recorded in the final seconds leading up to the crash. The ECM recorded no braking action before impact, and the recorded vehicle speed just before the collision was 65.5 mph.

In addition, the truck-tractor was outfitted with components of a fleet management system manufactured by Samsara, Inc., that included a Samsara CM31

[13] The systems did not record steering angle data.

forward-facing high-definition camera connected to a gateway module. The gateway module provided telematics cellular communication and included a global navigation satellite system receiver. As part of a subscription service, Samsara provided an internet-based dashboard through which motor carriers could access data transmitted from their vehicles when certain event thresholds were met. For this crash, Triton provided a time series event record containing data, including time, location, global positioning system speed, and ECM speed, which was reported at 1-second intervals. The Samsara event record data, which were time-stamped and correlated with the video, also indicated a speed of about 65 mph at the time of the crash.

The NTSB obtained about 3 minutes of forward-facing video leading up to the crash.[14] As shown in figure 8, about 5 seconds before the collision, the combination vehicle was traveling in the right lane and then, about 2 seconds before striking the bus, began to drift toward the right shoulder. Portions of the two headlamp beam patterns can be seen reflecting from the road surface ahead of the vehicle. Roadway lane lines, roadside reflectors, and right roadside barriers all reflect sufficient light to be clearly seen and identified. Similarly, some aspects of the bus, which was also traveling in the right lane, can be seen ahead of the truck. The most salient features of the bus included rearward lighting and the reflectorized surface of the registration plate. The rearward lighting on the bus included two outboard tail lamps mounted near mid-vertical height, two outboard clearance lamps mounted near the roof line, and three center identification lamps mounted near the roof line and mid-width of the vehicle. As the combination vehicle approached the slower-moving bus, other vertical surfaces at the rear of the bus increasingly reflected light from the truck's headlamps.

[14] The video was reviewed to determine the truck driver's ability to maintain lane positioning. See section 1.5.1.2 for more details.

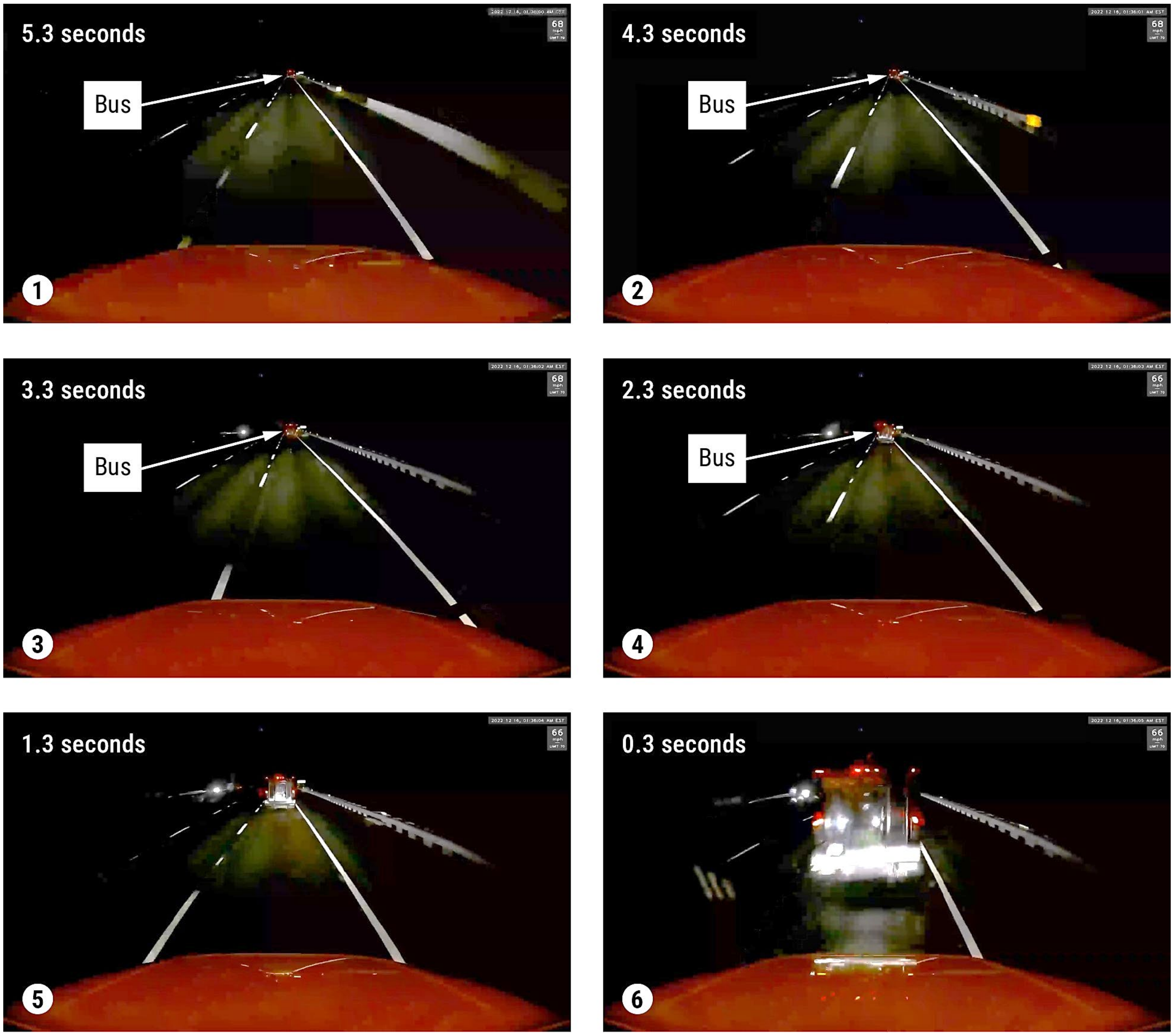

Figure 8. Video still-shots from the truck-tractor's forward-facing camera. Annotations indicate the time to collision, in seconds.

1.4.2 Bus

1.4.2.1 General Description

The medium-size bus was built in two stages. The first stage consisted of an International 3400 chassis, manufactured in May 2000. The second stage of the bus was an Eldorado National Company Aero Elite 320 bus body manufactured in November 2000. The bus was equipped with a 190-horsepower International Elect T444E diesel engine, an automatic AT545 four-speed transmission, and air over hydraulic disc brakes. As manufactured, the bus had a gross vehicle weight rating of

21,440 pounds and a passenger-carrying capacity of 33.[15] A precrash photo of the bus is shown in figure 9.

Figure 9. Precrash photo of the bus. (Source: Daily Press)

At the time of the crash, the seating configuration consisted of a driver's seat and perimeter seating without defined seating positions in the passenger compartment (see figure 10). The seating configuration observed in the bus was modified from the original vehicle design. Although the build documents were no longer available, the two floor seat tracks observed in the floorboard of the bus and the two seating rails along the sides of the vehicle are consistent with forward-facing seating and inconsistent with a perimeter-seating configuration. The original forward-facing seating arrangement was modified and the perimeter-seating arrangement was installed, though no paperwork regarding the modifications was available. Due to a lack of documentation and records from the vehicle owner, it is unknown where or when the seating modifications were made. The perimeter seating did not anchor into either floor seat track or attach to either side seat rail as designed. Instead, the seat pans were affixed to a custom frame that was welded to a metal

[15] (a) *Gross vehicle weight rating* is the total maximum weight that a vehicle is designed to carry when loaded, including the weight of the vehicle itself plus fuel, passengers, and cargo. The GVWR for this bus was specified in the VIN decode. (b) The maximum passenger capacity for the Aero Elite 320 as reported in the original product literature was 33 passengers; however, that number was for a non-perimeter-seating configuration.

extension, which in turn appeared to have been welded to the inboard C-channel of the seat rail as a connection or anchor point.

Figure 10. Overhead view of the bus, showing the reconstructed seating arrangement.

1.4.2.2 Damage

The bus sustained catastrophic rear damage from the collision with the combination vehicle. The frame rails on the chassis were bent to the right, with the rear of the right frame rail crushed in a forward direction. The rearmost frame crossmember was displaced forward and broken. The bus body compartment, including the roof and sidewalls, completely separated from the vehicle chassis (see figure 11). On the left side, the sidewall, seat rail, and all passenger seating detached from the chassis. On the right side, the seat rail and one bench seat remained intact; the remaining seats and the sidewall skin detached from the rail. Additional damage was sustained at the front due to the subsequent contact with the guardrail. Both sides of the front bumper were displaced rearward. The windshield was shattered and had separated from the upper part of the window frame.

Figure 11. Postcrash photo showing the bus from the rear.

1.4.2.3 Mechanical Inspection

The NTSB examined the bus's steering, brakes, and suspension. The steering system was intact and functional. The right shock absorber on the rear axle was bent forward due to the rear impact, but no other damage to the suspension system was found. No pre-existing or crash damage was noted to the brakes. One tire sustained crash damage but no pre-existing defects were noted to any of the tires or wheels.

The electrical system was compromised due to the crash; thus, the NTSB was unable to test it. The forward-facing video from the truck provided evidence that the tail lamps on the rear of the bus were illuminated before impact.

Although the fuel system did not show any damage or leaks, the NTSB disassembled the fuel system to assess whether a mechanical issue contributed to the low speed of the bus. No issues with the fuel pump assembly or fuel line were found. The fuel filter, fuel bowl, and remaining fuel appeared clean and free of debris. The engine was equipped with a paper element fuel filter assembly and a wire screen mesh prescreen element assembly. The prescreen element, between the fuel tank and the fuel pump, was designed to filter out larger debris down to 25 microns coming from the fuel tank; it was about 50% clogged with debris. A clogged fuel filter reduces the amount of fuel delivered to the fuel pump and can cause several issues such as difficulty starting, engine misfires, stalling, or reduced power.

Regarding the bus body, the postcrash examination revealed notable corrosion to various metal portions of the bus's frames, rails, and undercarriage. The NTSB also discovered rotting wood throughout the vehicle's floor and roof. Weld failures occurred where the seat frame metal extensions were welded to the seat rails, allowing all seats and seat frames to be ejected from the vehicle except for one bench seat pan and frame. The only seat that remained had weld failures present as well.

1.4.2.4 Maintenance and Recalls

Before the current owner took possession of the bus in September 2020, maintenance records from the previous vehicle owner indicated that between August and November 2019, the engine had multiple issues, including loss of power due to low coolant levels and stalls necessitating replacement of various parts.

In October 2020, the bus failed a Virginia State Police mechanical inspection due to defects with the brakes, headlamps, signal lamps, steering, and suspension. Repairs were conducted and the bus passed a follow-up inspection. The current owner did not provide any other preventive or corrective maintenance records from November 2020 onward. The NTSB located evidence showing that, in December 2021, the bus passed the Virginia State Police inspection with no defects noted. Further, investigators found no active recalls either through the manufacturer or in the National Highway Traffic Safety Administration (NHTSA) recall database.

The *Engine Operation and Maintenance Manual* for the T444E diesel engine provided the following maintenance schedule for fuel filter cleaning and replacement: clean prescreen filter every 10,000 miles, 350 hours, 1,000 gallons of fuel, or 6 months (whichever occurs first); and change the fuel filter and prescreen elements every 20,000 miles, 700 hours, 2,000 gallons of fuel, or 12 months (whichever occurs first). Although maintenance records state that an oil and oil filter change was done in 2020, no records show fuel filter cleaning or replacement by either the current or previous owner.

1.4.2.5 Calculated Bus Speed

The bus was not equipped with any recording devices (such as a camera or ECM) to determine speed or driver actions before the crash. The truck-tractor's forward-facing video, recorded by the Samsara telematics system, provided sufficient imagery to determine the speed of the bus, using a commercially available camera-tracking software. To calculate the bus speed, the three-dimensional location and orientation of the camera at every frame was determined relative to landmarks in the scene, and then the position of the bus on the roadway was determined. The precision of the bus speed calculation improved as the bus filled more of the video field of view while the combination vehicle closed the separation gap. At impact, the bus was traveling between 20 and 25 mph.[16]

1.5 Driver Factors

1.5.1 Truck Driver

1.5.1.1 Licensing, Experience, Health, and Toxicology

The 61-year-old driver of the combination vehicle held an Alabama Class "A" commercial driver's license (CDL) with a tank vehicle endorsement and a corrective lenses restriction. His license was issued in September 2022 and was due to expire in June 2026. He had about 16 and a half years of experience driving commercial vehicles. In that time, he had been employed by about 20 motor carriers. He had worked for Triton Logistics Incorporated twice—from October 2020 to August 2021, and then from April 2022 to the date of the crash. In the 3 years before the crash, he had no convictions on his driving record.

In September 2022, during his medical exam required by US Department of Transportation (USDOT) regulations, the truck driver reported no medical conditions. He was subsequently issued a 2-year medical certificate.[17] When interviewed by the NTSB, he described his health as good. He stated that he had been prescribed eyeglasses and was wearing them at the time of the crash.

The driver, as an interstate commercial driver, was subject to the drug and alcohol testing requirements of the Federal Motor Carrier Safety Administration (FMCSA) as specified in Title 49 *Code of Federal Regulations* (*CFR*) Part 382. The truck driver underwent two pre-employment controlled-substance tests with his current employer; both test results were negative. The truck driver did not undergo the postcrash drug and alcohol testing required by FMCSA regulations. Triton included a letter in its files that stated that, due to the driver being hospitalized awaiting surgery and his cell phone being left in the truck after the crash, Triton was unable to arrange for tests to be administered within the required timelines. Postcrash toxicology testing was performed by the Virginia Department of Forensic

[16] Uncertainty for the bus speed calculation was ±5 mph.

[17] Per requirements of 49 *Code of Federal Regulations* 391.45.

Science at the request of the Virginia State Police, and no ethanol or other tested-for substances were detected in the truck driver's blood specimen.[18]

1.5.1.2 Precrash Activities

To determine the truck driver's activities leading up to the crash, the NTSB used data from the truck's electronic logging device (ELD), his cell phone records, and his interviews. The crash trip originated in St. Louis, Missouri, on the afternoon of December 14 (2 days before the crash) and had a destination of Chesapeake, Virginia. The day of the crash was the truck driver's seventh consecutive day on duty.[19]

When interviewed by the NTSB, the driver stated that he did not keep to a specific sleep pattern but would stop driving when he felt tired. He preferred to drive at night. He stated that he had slept for about 5 hours shortly before the crash and that when he began driving on the morning of December 16 he felt "a hundred percent." He also stated that he consumed energy drinks in the days before the crash.[20]

The NTSB estimated the truck driver's sleep opportunities in the 3 days before the crash (see figure 12). Sleep opportunities were determined when the driver was logged off duty or in the sleeper berth and there was no cell phone activity.[21] Additionally, periods of only 30 minutes were not counted as sleep opportunities. It should be noted that sleep opportunity periods are not necessarily time *used* for rest. In the 3 days before the crash, the truck driver had a total of 7.5, 4, and 7 hours available for sleep. However, the available sleep opportunities were brief and non-consecutive throughout the day, each lasting between 1 and 5 hours.

---

[18] As part of the Virginia State Police postaccident toxicology testing, both the bus driver and truck driver had their blood screened for ethanol, methanol, acetone, isopropanol, cocaine/benzoylecgonine, opiates, oxycodone/oxymorphone, methamphetamine/MDMA, phencyclidine, fentanyl, methadone, barbiturates, benzodiazepines, carisoprodol/meprobamate, zolpidem, buprenorphine/norbuprenorphine, cannabinoids, diphenhydramine/cyclobenzaprine, dextromethorphan, tramadol, tricyclic antidepressants, and amphetamine/MDA. The truck driver's blood specimen was also screened for alkaline-extractable drugs.

[19] For additional details on the truck driver's work schedule, see section 1.6.1.4.

[20] Many different types of supplements were found in the truck-tractor, including energy-boosting products, but none were associated with impairment and the evidence was insufficient as to whether they were used precrash.

[21] For more information about sleeper berths in truck-tractors, see 49 *CFR* 393.76—Sleeper berths.

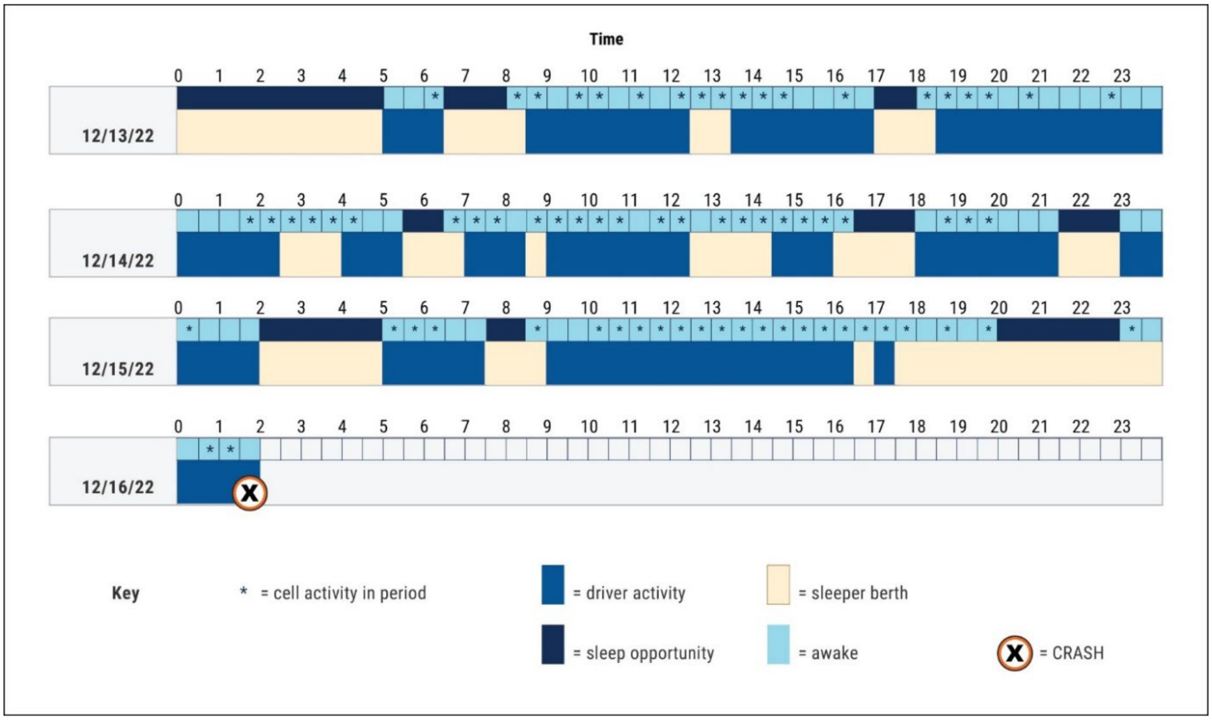

Figure 12. The truck driver's sleep opportunities in the 3 days before the crash.

Footage from the truck-tractor's forward-facing video showed that in the 3 minutes before the crash, the combination vehicle repeatedly drifted over into the shoulder area and then back into the right lane. Specifically, the vehicle crossed the white shoulder line nine times. A still-shot from the forward-facing video is shown in figure 13.

Figure 13. Still-shot from the forward-facing video, showing the combination vehicle crossing the white shoulder line in the 3 minutes leading up to the crash.

In the 3 days before the crash, records for the truck driver's cell phone show several instances of cell phone activity occurring during driving time. However, around the time of the crash, records showed data activity but no call or text activity.[22]

1.5.2 Bus Driver

1.5.2.1 Licensing, Experience, and Toxicology

The 23-year-old bus driver held a Virginia Class "D" non-commercial driver's license, which was suspended at the time of the crash. He first obtained his driver's license in 2017. His license was most recently issued in December 2021 and was due to expire in August 2028. His Virginia Driver History Record showed only the subject crash. His license was suspended in August 2022 for "insurance monitoring."[23] The bus driver was an occasional (fill-in) driver for Futrell's. He did not hold a CDL or passenger endorsement despite needing both to legally operate a vehicle capable of carrying 16 or more passengers, as required by the Virginia Commercial Driver's License Act.[24] He also had not been medically certified to operate commercial vehicles as required by Virginia law.[25] The NTSB could not locate any information related to training the bus driver may have received for his non-commercial license, and Futrell's did not have a training program.

In the postcrash toxicology testing, conducted by the Virginia Department of Forensic Science at the request of the Virginia State Police, no ethanol or other tested-for substances were detected in the bus driver's blood specimen.[26]

---

[22] Cell phone use was determined from cell phone company records, not from data downloaded from the cell phone. Because the data did not come directly from the cell phone, the NTSB could not determine if data activity indicated active use of the cell phone by the driver.

[23] The Commonwealth of Virginia requires all motor vehicles licensed or subject to registration in Virginia to be covered by a minimum level of insurance or for the owner of the vehicle to pay an uninsured motor vehicle fee. If an uninsured vehicle is operated without insurance or payment of the fee, both the owner and operator of the vehicle are guilty of a Class 3 misdemeanor. If such operation is discovered, the licenses of the owner and operator and the registration of the vehicle may be suspended. The term "insurance monitoring" means that the bus driver was found to have owned or operated an uninsured vehicle by one of the four ways in which Virginia monitors vehicle insurance. See the Code of Virginia, Va. Code Ann. Section 46.2-707 (2014), at the following link: § 46.2-707, and the Virginia DMV's Insurance Monitoring Methods.

[24] See the Code of Virginia, Va. Code Ann. Section46.2-341.1 (1989), at the following link: 46.2-341.1.

[25] See the Code of Virginia, Va. Code Ann. Section19 VAC 30-20-80 (2023), at the following link: 19VAC30-20-80.

[26] See section 1.5.1.1, footnote 18, for a list of tested-for substances.

1.5.2.2 Precrash Activities

The owner of the bus company told the NTSB that, on the day of the crash, the bus was not being operated in commerce but rather for personal use. The bus was transporting the owner's family and friends to a social event in Richmond, Virginia, and the owner did not charge anyone for the trip. Therefore, the owner considered the crash trip to not be in commerce. The bus had transported its passengers from Norfolk, Virginia, to Richmond earlier that evening and was returning them home to Norfolk when the crash occurred. One passenger reported in a police interview that during the outbound trip to Richmond, two vehicles swerved around the bus. The return trip began around midnight.

The NTSB determined the bus driver's sleep opportunities in the 2 days before the crash, using his cell phone records.[27] His approximate sleep opportunities are shown in figure 14. During those 2 days, he had a total of about 21.5 and 14.5 hours of available sleep opportunity, in segments between 1 and 13 hours long.

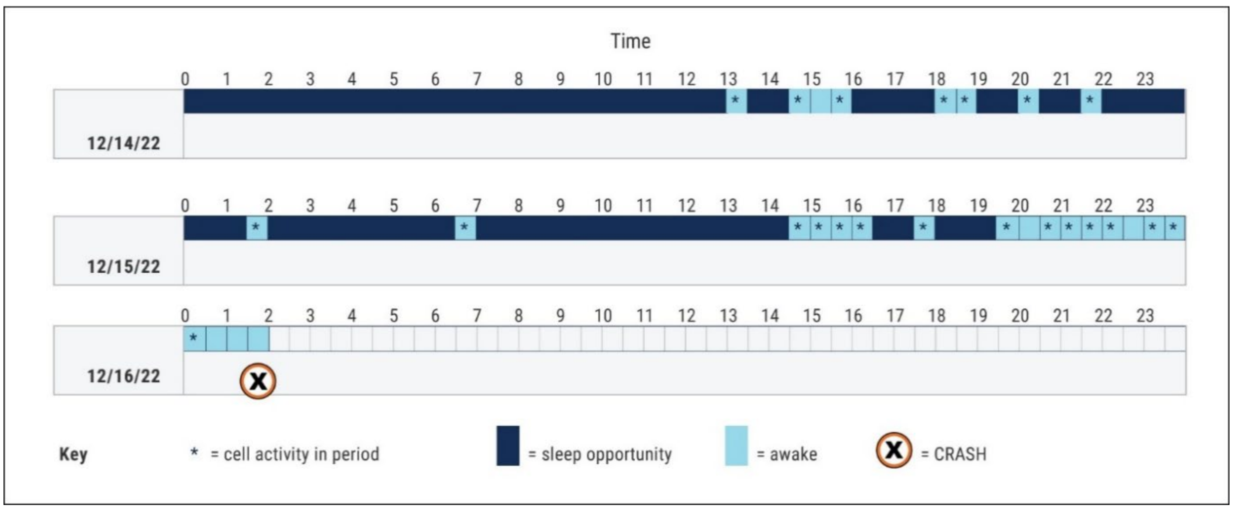

Figure 14. Bus driver's sleep opportunities in the 2 days before the crash.

Records for the bus driver's cell phone showed no call or text activity around the time of the crash. In addition, the forward-facing video from the combination vehicle showed no indication of poor lane maintenance on the part of the bus driver in the moments leading up to the crash.

When interviewed by the Virginia State Police, the bus driver stated that the bus was traveling about 40 mph when struck. However, when interviewed later by the

[27] Only 2 days of cell phone activity information was available for the bus driver.

NTSB, he said the speed was about 50 mph. He also said that he had not noticed any issues with the vehicle operation.[28]

1.6 Motor Carrier Factors

1.6.1 Triton Logistics Incorporated

1.6.1.1 General Overview

The combination vehicle was owned and operated by Triton Logistics Incorporated, which originally started as a carrier in 2011.[29] The current owner acquired the company in 2013. According to the FMCSA's Motor Carrier Management Information System (MCMIS), Triton was issued USDOT number 2255842 and was registered as an interstate "For-Hire" carrier of general freight and other non-hazardous materials loads. Per Triton's most recent Motor Carrier Identification Report (form MCS-150) preceding the crash, the carrier operated 247 power units and 272 trailers, and employed 167 drivers.

1.6.1.2 Carrier Policies

Triton had many procedures and policies in effect at the time of the crash. These included rules of conduct for drivers, a formal written orientation procedure, postcrash procedures, a drug and alcohol policy, a ban on cell phone use and texting, and a roadside inspection rewards and penalties program. The carrier had an established controlled substance and alcohol testing program per 49 *CFR* Part 382 and provided the NTSB copies of its annual drug and alcohol testing for the past four quarters. Triton also had an established hiring process, with pre-approval requirements for drivers: minimum age of 23, a minimum of 2 years commercial driver's license experience, no more than three prior accidents or a series of accidents and violations agreed on by the carrier and the insurance company. The carrier did not have a stand-alone fatigue management policy and did not schedule routes to manage fatigue. Triton drivers could choose when to drive (for example, they could choose to drive overnight rather than during the day). In addition, drivers were paid by the mile.

Triton had the speed of all its truck-tractors electronically governed at 69 mph. In addition, Triton used Samsara as the provider for its forward-facing video system and fleet management system. Samsara provided the carrier with email alerts for certain events, including speeding, violation of traffic signs and signals, and harsh driving—including harsh acceleration, turning, and braking. The carrier's safety

[28] The bus driver did not consent to an interview with the NTSB until 8 months after the crash.

[29] See the Triton Logistics, Inc., website.

group—consisting of a claims manager, human resources manager, and safety administrator—would evaluate the events and coach and/or discipline the driver, if necessary. Triton officials told the NTSB that the crash-involved driver had only two alerts from the Samsara system since his hire date: one for harsh braking and one for unsafe following distance. The driver had been warned about these events as they were his first unsafe driving alerts that Samsara reported. Samsara also provided a "safety dashboard" to show driver performance information, based on the risk factors listed above (including speeding, harsh driving, following distance, and violation of traffic signals). At the time of the collision, the crash-involved driver's Samsara dashboard score was ranked above the average driver, according to carrier officials.

Title 49 *CFR* Part 395 required the carrier to install and maintain an ELD to track drivers' hours of service (HOS). An ELD is a device or technology that automatically records a driver's driving time and facilitates the accurate recording of a driver's HOS. At the time of the crash, Triton used an electronic tablet-based ELD with RoadStar LLC as the provider.[30] Triton employed an HOS manager, who described his team's oversight duties as follows:

- checking driver logs to make sure they were completed with all mandatory information;
- ensuring drivers were not in violation overnight and that they were notified and stopped in time;
- ensuring drivers did not abuse the personal conveyance allowance; and
- ensuring no one drove with an unplugged or broken ELD.

1.6.1.3 Federal Oversight

The FMCSA has oversight responsibility for interstate motor carriers. The agency operates the Compliance, Safety, Accountability (CSA) system to improve safety of large trucks and buses.[31] In addition, the Safety Measurement System (SMS) uses a motor carrier's data from roadside inspections, state-reported crashes, and the

[30] RoadStar was self-certified and listed on the FMCSA's approved device list.

[31] For more information, see What is CSA? Factsheet (dot.gov). Federal Motor Carrier Safety Administration, March 2016. FMCSA-14-001.

Federal Motor Carrier Census to quantify performance in seven Behavior Analysis and Safety Improvement Categories (BASICs).[32]

At the time of the crash, the CSA system displayed an alert for Triton in the "unsafe driving" BASIC.[33] The SMS profile also showed that at the time of the crash, Triton's driver out-of-service rate was 2.5% and its vehicle out-of-service rate was 17.1%. The national averages are 6% and 21.4%, respectively.

Since becoming a carrier, Triton had not been subject to an on-site FMCSA comprehensive compliance review. The carrier was subject to an off-site New Entrant Safety Audit on April 10, 2013, and, based on that audit, successfully exited the New Entrant Program.[34] Triton had also been subject to a focused compliance review in 2018 as a result of a recently hired driver who had tested positive for marijuana use at a previous carrier.[35]

Postcrash, the FMCSA conducted an on-site focused review of Triton, which found violations, including making or permitting a driver to make a false report regarding duty status (49 *CFR* 395.8[e][1]) and requiring or permitting a property-carrying commercial motor vehicle driver to drive more than 11 hours (49 *CFR* 395.8[a][3][i]). As a result of the postcrash focused review, the FMCSA assigned Triton a conditional safety rating.[36]

---

[32] Seven safety categories, referred to as Behavior Analysis and Safety Improvement Categories (BASICs), reflect the types of regulatory violations: (1) Unsafe Driving, (2) Hours of Service (HOS) Compliance, (3) Driver Fitness, (4) Controlled Substances and Alcohol, (5) Vehicle Maintenance, (6) Hazardous Materials Compliance (if applicable), and (7) Crash Indicator. A carrier's rating for each BASIC depends on its number of adverse safety events, the severity of its violations or crashes, and when the adverse safety events occurred. Carriers are compared to a peer group of other carriers with a similar number of inspections using a percentile rating of 0 to 100, with the 100th percentile indicating the worst performance. Intervention threshold levels for each BASIC depend on the inherent risk of the category, as well as the carrier type. When a carrier is above a threshold level in a BASIC, it is considered to be in an "alert" status. For details, see Safety Measurement System (dot.gov).

[33] Triton had been in an alert status in this category since December 2021, according to the FMCSA's MCMIS system.

[34] At the time of the 2013 New Entrant audit, Triton had one driver, one vehicle, and different owners.

[35] At the time of the 2018 review, Triton had 92 drivers, 102 truck-tractors, and 119 semitrailers.

[36] *Conditional* safety rating means a motor carrier does not have adequate safety management controls in place to ensure compliance with the safety fitness standard that *could* result in occurrences listed in 49 *CFR* 385.5 (a) through (k). See also Appendix B to 49 *CFR* 385 for an explanation of the safety rating process.

1.6.1.4 Crash-Involved Driver's Hours of Service

On the day of the crash, Triton provided the NTSB with ELD data pertaining to the crash. Examination of the ELD data showed that the truck driver was operating in a driver/codriver arrangement. The data contained identifying information, driver's license numbers, and logins for two drivers. However, the driver and codriver information was very similar: the driver's license number and state (Alabama) were the same for the driver and codriver. The driver's login was his last name followed by his first name and the number 2 with no spaces; the codriver's login was the same with the addition of letters "tl" at the end of the driver's login.[37] Subsequently, Triton edited the alleged codriver's license information to reflect a Virginia license number before uploading the ELD data to the FMCSA's Electronic Record of Duty Status (eRODS) system on December 19, 2022.[38] The codriver login and other information was not changed. Triton officials stated that the change to the codriver license number was made due to the carrier reviewing and editing improper information.

The crash-involved driver told the Virginia State Police that he had dropped off his codriver at a truck stop just before the crash. However, after further investigation of available evidence, the NTSB found that the person who the crash-involved truck driver had told Virginia State Police was his codriver was no longer a Triton employee and had been dismissed on December 8, 2022, 8 days before the crash. The NTSB conducted a phone interview with the alleged codriver, who stated that he did not know the crash-involved driver and had never occupied the truck with him or driven long-distance trips for Triton. Instead, he had been a local driver based at Triton's Virginia location and did not routinely use an ELD.[39]

During his interview, the truck driver stated that Triton had instructed that if he exceeded his allowable driving hours, he was to stop, call the Triton HOS department by cell phone, and Triton personnel would log him out of the ELD and log in a new driver. He could then continue driving. The truck driver told investigators that his ELD would show his information, but any additional hours would be attributed to another driver. In addition, both the NTSB and FMCSA spoke to four former Triton drivers who had been identified by roadside inspection notes as drivers who had recently dropped off codrivers at truck stops. All four indicated that Triton had provided them a similar process to use when they were out of allowable driving hours.

---

[37] As an example, the crash-involved driver's login was "lastfirst2" and the codriver's login was "lastfirst2tl," where "lastfirst" was the same for both drivers.

[38] The FMCSA's eRODS is a system used by safety officials to locate, open, and review output files transferred from ELDs.

[39] Short-haul drivers operating within a 150 air-mile radius of their normal work location are not required to use an ELD, per 49 *CFR* 395.1.

Triton's HOS manager stated that his team was responsible for creating driver ELD logins (the drivers could not do that themselves), but he denied creating additional logins for drivers to use, stating that might have been "a mistake." In a phone conversation with the NTSB, Triton's chief executive officer also could not explain the discrepancy associated with the inaccurate login of a codriver.

At the time of the crash, the ELD was functioning and connected to the truck-tractor and showed accurate driving and stopped times, location, and other telematics information. The data from the ELD (that is, both the driver and codriver hours) are shown in figure 15 (note that the figure shows the time in central standard time, whereas the crash occurred in the eastern time zone).

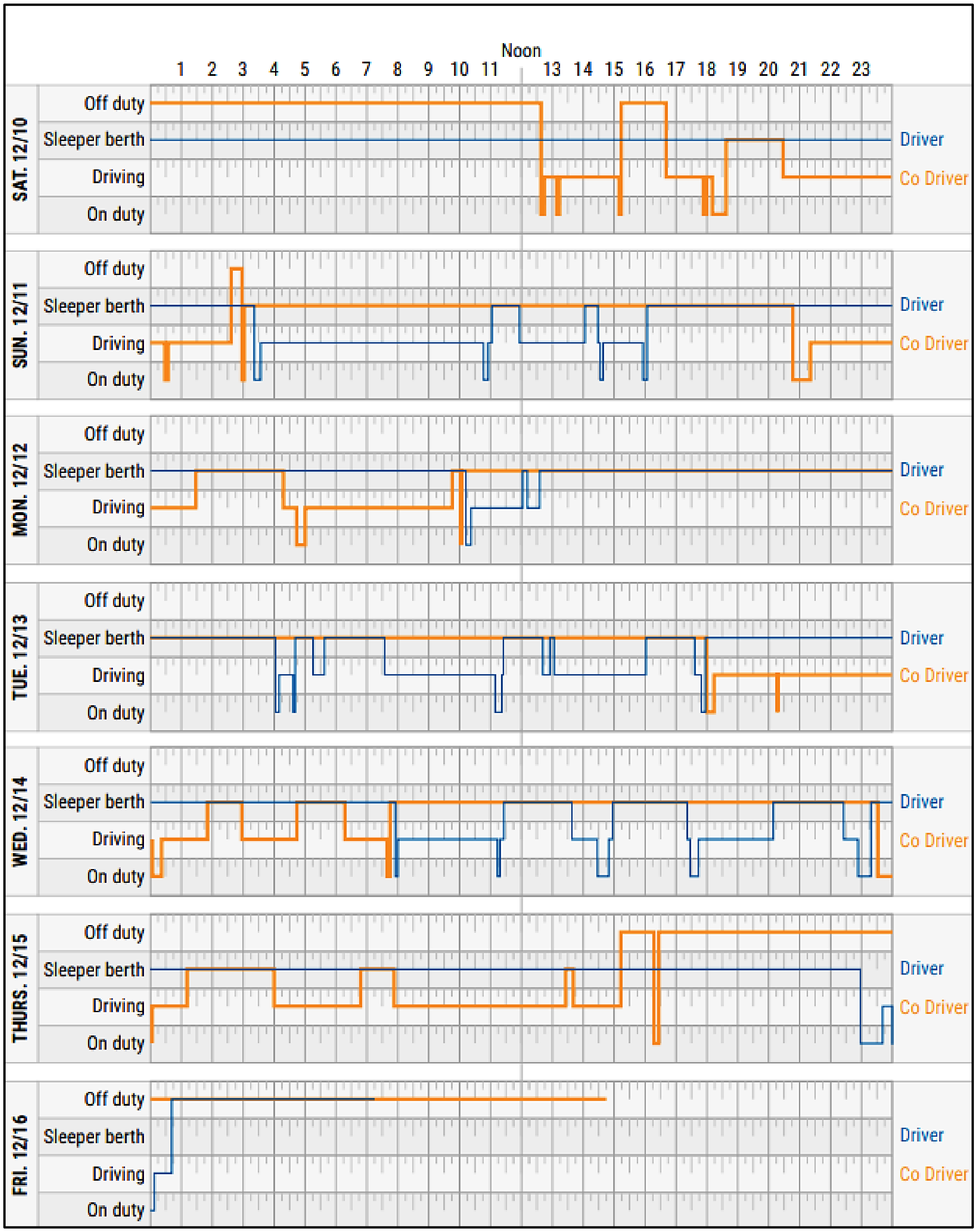

Figure 15. Record of duty status for the crash-involved driver and alleged codriver (times are recorded in central standard time).

1.6.2 Futrell's Party Adventures

1.6.2.1 General Overview

Futrell's Party Adventures, LLC (Futrell's), was first registered as a company in June 2020 and the owner purchased the bus in September 2020. The bus was the company's only vehicle. The bus was registered as a non-commercial passenger vehicle with standard 2-year registration that expired in November 2022. At the time of the crash, the company had operating authority in the Commonwealth of Virginia. Futrell's operated only in Virginia (intrastate). The company was not registered with the USDOT and did not have a USDOT number, nor was it required to have one under Virginia law.

1.6.2.2 Oversight

For intrastate carriers, the states—Virginia in this case—have overall oversight responsibility. The Virginia Department of Motor Vehicles (DMV) issues operating authority to passenger carriers. Under Virginia law, the bus carrier was classified as a contract passenger carrier.[40] To obtain operating authority, carriers must complete an application for a contract passenger carrier; provide evidence of a $25,000 surety bond; be evaluated by a case manager for fitness, including review of any complaints against the carrier; and ensure that the carrier's vehicles have the proper registration. After these steps are taken, a public notice is posted on the DMV website allowing a 2-week comment period. If the application is approved, the carrier would then have to file proof of proper liability insurance.[41]

When granting a new carrier operating authority, the Virginia DMV provided carriers additional information by email, including the Virginia DOT *Motor Carrier Manual*.[42] Information in this manual pertaining to contract passenger carriers consisted of insurance requirements, trip sheets and documentation, bond requirements, operating authority renewal, and causes for operating authority suspension/revocation. The manual had no safety-related information pertaining to driver licensing requirements, vehicle maintenance, or other safety management best practices.

Futrell's applied to the Virginia DMV for operating authority as a contract passenger carrier in the Commonwealth of Virginia and operating authority was granted on November 15, 2022. As of the crash date, Futrell's had not obtained for-

---

[40] See the Code of Virginia, Va. Code Ann. Section 46.2-2000 (2017), at the following link: 46.2-2000.

[41] See Motor Carriers | Virginia Department of Motor Vehicles.

[42] See Motor Carrier Manual (dmv.virginia.gov).

hire vehicle registration and license plates for the bus, although required.[43] When Futrell's was granted operating authority, the Virginia DMV provided the Virginia DOT *Motor Carrier Manual* to the company via email.

The Virginia DMV's law enforcement division would normally conduct a new licensee inspection of a carrier with newly issued operating authority. This inspection is similar to an FMCSA new-entrant audit. The inspection would be conducted 60–90 days from the issuance of the authority. In this case, Futrell's was issued operating authority less than 60 days before the crash, and the new licensee inspection had not been scheduled or conducted.

1.6.2.3 Federal Oversight

The crash trip, being entirely intrastate and not in commerce, was outside the FMCSA's regulatory purview and outside most of the Federal Motor Carrier Safety Regulations. Because the crash trip was not in commerce, the bus driver was not required to have a pre-employment test for controlled substances and alcohol.[44] However, this driver made other trips for Futrell's that were in commerce, which would have required him to have a pre-employment test per 49 *CFR* Part 382 (adopted by Virginia law).[45] Even for a non-commerce trip, the seating capacity of the bus required the bus driver to have a CDL with a passenger endorsement and be medically qualified to operate the vehicle per Virginia law.[46]

Postcrash, the FMCSA contacted the owner of Futrell's to determine if a compliance review was warranted. The owner provided the FMCSA a signed document stating that Futrell's was no longer operating as a passenger carrier and if the company were to re-enter the business, it would educate itself in regulatory and safe operation requirements. The FMCSA did not conduct an investigation or take any enforcement action.

1.6.2.4 Carrier Policies

Futrell's did not have written policies or procedures that normally apply to the passenger-carrying industry. The company did not require the crash-involved bus driver to complete an employment application or take a pre-employment

[43] For more information, see Intrastate Operating Authority Registration - Plate Requirements | Virginia Department of Motor Vehicles.

[44] As noted earlier, the bus was carrying the owner's family and friends.

[45] See the Code of Virginia, Va. Code Ann. Section 19 VAC 30-20-80 (2023), at the following link: 19VAC30-20-80.

[46] See the Code of Virginia, Va. Code Ann. Section 46.2-341.1 (1989), at the following link: 46.2-341.1. The crash-involved bus driver did not have a CDL with passenger endorsement or the medical qualification.

controlled-substance test, nor did the carrier review his driving history. Also, Futrell's did not keep vehicle maintenance records. Although the crash trip was not in commerce, the bus was advertised and used for commercial purposes on other trips.

1.7 Postcrash Actions

As a result of FMCSA enforcement action, Triton paid a fine of $36,170 for violations related to failure to conduct postcrash alcohol testing, falsification of records, and exceeding maximum driving time. In addition, as of the date of this report, Triton's status remains conditional.

Carriers with a conditional safety rating are still able to conduct operations. Due to the results of the postcrash compliance review and subsequent roadside inspections, Triton's Inspection Selection System (ISS) score was elevated from 61 (on a scale of 1–100) at the time of the crash to 97 as of February 23, 2024. The ISS is a screening tool used by roadside enforcement personnel to prioritize carriers and vehicles for roadside inspections. The higher the ISS score, the more likely the vehicle will be selected for roadside inspection.[47]

Since the postcrash compliance review, Triton has had 211 roadside inspections conducted on its vehicles and drivers.[48] Three of these inspections cited false logs as a violation. In the 211 post-compliance review roadside inspections, no codrivers were listed or mentioned in the notes sections.

Triton told the NTSB that the carrier hired outside safety consultants, the Simplex Group, to coach and train Triton's drivers on safety topics, focusing on HOS. According to Triton, Simplex is also providing a dedicated account safety manager to review Triton's ELD records and verify that the HOS team provides sufficient oversight. Triton also changed ELD providers to ensure that there were no errors or issues with account management and user access; however, the NTSB was unable to determine the scope of these changes.

[47] The ISS score is based on several variables, including the overall BASICs score, previous roadside inspections, and driver and vehicle out-of-service rates.

[48] Data obtained from the FMCSA's MCMIS website as of February 23, 2024.

2 Analysis

2.1 Introduction

On Friday December 16, 2022, about 1:36 a.m., a combination vehicle was traveling eastbound on I-64 near Williamsburg, Virginia, when it crashed into the rear of a slower-moving medium-size bus. As a result of the crash, three bus occupants died and 20 were injured; the truck driver was also injured.

The analysis first examines factors that can be excluded as causal or contributory to the crash, and then discusses the truck driver actions (section 2.2). Next, the analysis discusses the following safety issues:

- Inadequate safety culture of the truck motor carrier (section 2.3), which includes the deficient oversight of driver hours of service (section 2.3.1), failure to appropriately manage the risk of driver fatigue (section 2.3.2), and driver monitoring (section 2.3.3),
- Need for federal requirements for commercial vehicle collision avoidance systems (section 2.4), and
- Inadequate safety management and oversight of the bus carrier (section 2.5), which includes maintenance deficiencies that may have contributed to the slow speed of the bus (section 2.5.1) and inadequate state oversight (section 2.5.2).

As a result of our investigation, the NTSB established that the following factors did not cause or contribute to the crash:

- *Highway design, lighting, and minimum speed limits:* The roadway was straight with an upgrade slope that posed no obstructions for drivers traveling in the eastbound direction. Highway lighting was not required on I-64 in the vicinity of the crash. The highway signs and pavement markings were retroreflective and in excellent condition. This location had no prior history of crashes caused by slow-moving vehicles or other evidence of slow speeds consistently impeding the normal and reasonable movement of traffic. Thus, it was reasonable that the area had no posted minimum speed limit sign.
- *Combination vehicle steering, brakes, suspension, tires, wheels, brakes, and electrical systems:* Mechanical inspection of the combination vehicle revealed no pre-existing defects in these systems that would have contributed to the collision.

- *Bus steering, brakes, suspension, tires, wheels, brakes, and electrical systems:* Mechanical inspection of the bus revealed no pre-existing defects in these systems that would have contributed to the collision. In addition, the forward-facing video from the truck provided evidence that all lights on the rear of the bus were illuminated and visible before impact, and therefore the electrical system did not contribute to the crash.

- *Truck driver's health, alcohol or other drugs, training and experience, and cell phone use:* The truck driver was medically qualified. His postcrash toxicological testing did not detect alcohol or other tested-for drugs. He was trained and had experience driving commercial vehicles, and he was not using his cell phone for texting or calls at the time of the crash.

- *Bus driver's health, alcohol or other drugs, cell phone use, and fatigue:* The bus driver's postcrash toxicological testing did not detect alcohol or other tested-for drugs. He was not using his cell phone at the time of the crash and had sufficient sleep opportunities before the crash. Additionally, the forward-facing video from the truck showed no indication of poor lane maintenance on the part of the bus driver that would suggest fatigue.

The NTSB therefore concludes that none of the following were factors in this crash: (1) highway design, lighting, and minimum speed limits; (2) the combination vehicle's steering, brakes, suspension, tires, wheels, brakes, and electrical systems; (3) the bus's steering, brakes, suspension, tires, wheels, brakes, and electrical systems; (4) the truck driver's health, alcohol or other drugs, training and experience, and cell phone use; and (5) the bus driver's health, alcohol or other drugs, fatigue, and cell phone use.

In addition, the first 911 call was received at 1:38 a.m., and first responders began to arrive on scene within about 5 minutes of that call. Occupants were triaged efficiently and timely, and effective medical transportation was provided to three area hospitals. The NTSB concludes that the emergency response was timely and adequate.

2.2 Truck Driver Actions

2.2.1 Driver Hours of Service

The investigation revealed that the truck driver was logging hours under a fictitious codriver account in the ELD system. Doing so enabled him to drive many more hours than allowed by law without appearing to violate the HOS regulations. The NTSB used the data from the ELD (that is, both the driver and codriver hours) to determine the crash-involved driver's true HOS record from midnight on Saturday

December 10, 2022, to the date and time of the crash, because the hours attributed to the codriver were also driven by the crash-involved driver. In the 6 days leading up to the crash, the truck driver was on duty a total of about 7.75, 17.75, 9, 14.5, 14, and 12 hours each day (for a total of about 75 hours). Per 49 *CFR* 395.3, the HOS limits for drivers of property-carrying vehicles include:

- the 14-hour rule—a driver may not drive after a period of 14 consecutive hours after coming on-duty following 10 consecutive hours off-duty;
- the 11-hour rule—a driver may drive a maximum of 11 hours during the 14-hour period; and
- the 70-hour rule—a driver shall not drive after having been on duty 70 hours in any period of 8 consecutive days.

Leading up to the crash, the truck driver had exceeded the 14-hour rule and the 11-hour rule four and three times, respectively. At the time of the crash, the truck driver had also exceeded the 70-hour rule by more than 4 hours in a period of 7 consecutive days.

2.2.2 Driver Fatigue

Forward-facing video from the truck-tractor showed the vehicle repeatedly drifting to the right, out of its lane and into the right shoulder in the 3 minutes leading up to the crash. Five seconds before the crash, the truck was positioned in the right lane and then, about 2 seconds before striking the bus, began to drift toward the right shoulder. The video showed no evidence of steering consistent with an evasive maneuver. Although the truck-tractor's cruise control generally maintained the speed, minor variations in engine load, engine speed (revolutions per minute or RPM), and vehicle speed in the final seconds leading up to the crash appeared consistent with changes in the vertical grade of the roadway (that is, engine load and RPM increased while ascending a grade, as speed decreased). Further, the electronic data did not record any active braking in the moments before the crash. Thus, neither the video imagery nor electronic data indicated an evasive driver response before impact.

The forward-facing video showed that the rear lights on the bus were visible before the crash. However, significant differences can exist between the time when a slow-moving lead vehicle becomes visible versus when it is perceived as an immediate hazard (Mortimer and others 2014). The need for an immediate response is based on the change in the perspective of the lead vehicle, which depends on its size and the relative closing speed between the vehicles. Empirical relationships developed from volunteer studies allow calculation of the separation distance between the two vehicles at which a normal driver would interpret the change in size of the vehicle as a hazard requiring a response (Muttart and others 2005). Based on these equations and the closing speed of the combination vehicle (about 44 mph), a typical, unimpaired driver likely could have recognized the bus as a hazard from a distance of about 285 feet, which was about 5 seconds before impact. This would have been sufficient time for an alert driver to initiate either a steering maneuver or a braking response to slow the truck. To avoid the crash using braking alone would have required a deceleration rate near the maximum possible for a loaded combination vehicle operating on dry and level surfaces, which may have been challenging at the time of the crash, given the wet roadway. However, had a braking response been initiated, any speed reduction by the combination vehicle would have served to prevent or mitigate the severity of the crash, increase the time to collision, and possibly allow time for further evasive action such as steering to avoid a crash.

The truck driver's poor lane maintenance and lack of reaction to the bus are consistent with being in a diminished state of alertness, such as while impaired or fatigued. The toxicology results provided no evidence of impairment by alcohol or other tested-for drugs. Additionally, police investigators did not observe any signs of impairment following the crash. Fatigued drivers are susceptible to lapses and performance errors related to slowed reaction time, reduced vigilance, lack of sustained attention, poor lane-tracking ability, and impaired cognitive processing (Babkoff and others 1991, Glenville and others 1978, Lamond and Dawson 1999, Dinges and Kribbs 1991). As an individual becomes increasingly sleep-deprived, sleep propensity increases and the individual may experience microsleeps, as the brain uncontrollably enters a sleep state for a period typically lasting a few seconds. Research has shown that individuals are not good at predicting either their levels of fatigue or the onset of microsleeps before they occur (Boyle and others 2008).

As a result of working excessive hours (about 75 hours in the 7 consecutive days leading up to the crash), the truck driver had insufficient opportunities for sleep, creating a chronic sleep debt.[49] Further, the driver had short and scattered opportunities for rest lasting between 1 and 5 hours in duration. Short and scattered sleep opportunities such as these are not conducive to good sleep quality. Sleep quality refers to the subjective indices of how sleep is experienced, including the feeling of being rested when waking up. Poor sleep quality can negatively affect sleepiness, emotional state, behavior, and cognitive function (Pilcher and others 1997).

In addition, the truck driver's schedule involved sleeping at irregular times, including times when the body's circadian rhythms are geared toward being awake.[50]

[49] *Chronic sleep debt* is the cumulative sleep deficit created when a person obtains less sleep than required over several days.

[50] Systems in the human body follow a set of daily fluctuations, called circadian rhythms. The systems fluctuate in cycles of about 24 hours; affected systems include body temperature, heart rate, blood pressure, hormone excretion, and "sleepiness," among others.

He was also awake at times when his circadian rhythms were geared toward being asleep. The time of the crash, about 1:36 a.m., is when sleepiness tends to be greater and performance capabilities are lower. The NTSB concludes that the truck driver's lack of response to the slow-moving bus in his travel lane was due to his fatigue caused by excessive driving time and limited sleep opportunity.

2.3 Inadequate Safety Culture of the Truck Motor Carrier

A motor carrier's safety culture is reflected in individual and group values, perceptions, and competencies regarding the company's approach to safety management. A good safety culture is supported by a stable framework of policies and oversight mechanisms that establish and maintain appropriate safety risk management. Triton Logistics Incorporated had some policies in place—including reasonable hiring practices and complete driver qualification files, a systemic program for vehicle inspection and maintenance, and an established alcohol and drug testing program.

However, although the carrier had policies regarding driver HOS, this investigation revealed several instances of poor oversight of drivers, failure to enforce company policies, and purposeful actions to overcome HOS limits. The following sections examine Triton's deficient oversight of driver's HOS (section 2.3.1), failure to appropriately manage the risk of driver fatigue (section 2.3.2), and driver monitoring (section 2.3.3).

2.3.1 Oversight of Driver Hours of Service

As noted in section 2.2.1, leading up to the crash, the truck driver had exceeded the federal HOS limits multiple times; these rules are in place to limit a driver's daily on-duty and driving time to help ensure that drivers stay awake and alert. These violations were difficult for an inspector to detect because the ELD was set up in a driver/codriver configuration.

The crash-involved driver and other former Triton drivers told the NTSB that Triton management provided them instructions to follow when they had exceeded their allowable hours. Specifically, the drivers would call in to the carrier's HOS department by cell phone and the carrier would log them into the alternate driver account, which allowed them to continue driving under a false account and circumvent the HOS regulations. Triton's chief executive officer and the HOS manager denied knowing about fictitious logins. However, because drivers were unable to create new ELD logins themselves—only the HOS department had access to that system—Triton staff responsible for oversight of drivers' HOS and compliance with HOS regulations assisted drivers in circumventing these regulations. The NTSB interviewed the person identified in the ELD data as the codriver and learned that he was never a codriver with the crash-involved driver and had been terminated from Triton before the crash. Also, because drivers were paid by the mile, they were financially incentivized to exceed their HOS limits because it allowed them to drive farther and earn more money.

The NTSB concludes that Triton created fictitious driver accounts in the ELD system, which enabled drivers to operate their vehicles for hours beyond those allowable by federal regulations, leading to the drivers driving in a likely fatigued condition, as occurred with the crash-involved driver.

Additional means to oversee driver HOS were available to Triton, but the carrier did not use them. For example, because drivers were paid by the mile, drivers logging excessive hours likely had higher-than-expected paychecks, which should have alerted management. Further, ELD information reflecting two drivers in a single truck should match payroll accounts for those miles. The NTSB recommends that Triton implement a process to regularly verify the accuracy of drivers' records of duty status, such as by cross-referencing other information, such as payroll.

Motor carriers assign ELD user accounts to drivers, which are required to include the driver's name (must match name on driver's license), the driver's license number and issuing state, and a unique ELD username.[51] ELD data concerning the crash trip—obtained from two different sources on two different dates—showed that Triton modified the license number of the alleged codriver in the ELD user account between December 16 and December 19. Triton's intentional modification to the license number may have been done to hide the presence of the fictitious ELD account.

Federal regulations allow drivers and motor carriers to edit and annotate ELD data under certain conditions. For example, there are limitations on which records can be edited, the original data must be retained even when allowed edits are made, and event record history changes must be tracked.[52] However, changes to login information and driver's license numbers are not required to be tracked, nor are carriers required to track who made the change and when. Therefore, the postcrash changes to the ELD data for the crash-involved combination vehicle were not tracked and the Triton personnel who made those changes were not identified. A data tracking system, or audit log, in the ELD software to track these types of edits would create a disincentive for individuals to enter incorrect information or alter records, because any changes would be attributed to that individual. An audit log would assist

[51] See 49 *CFR* 395.22.

[52] Title 49 *CFR* Part 395 Subpart B contains rules intended to promote transparency and reduce fraud during this process.

investigators when conducting compliance reviews and could also be used as another means for motor carriers to provide oversight of driver HOS.

The NTSB concludes that a data-entry tracking history in ELD software can increase accountability and transparency and can deter motor carrier personnel from making false entries aimed at circumventing HOS regulations. The NTSB therefore recommends that the FMCSA revise the ELD requirements in 49 *CFR* Part 395 to require ELD providers to create an audit log that includes:

- date,
- driver login time and who logged them in,
- names of anyone who edited the log,
- driver's license numbers, and
- active driver list changes.

In addition to improved tracking in the ELD software, it is critical that enforcement and oversight officials are aware of the means that some carriers might use to circumvent federal regulations. The Commercial Vehicle Safety Alliance (CVSA), an alliance of commercial motor vehicle safety officials and the industry, plays a key role in carrier and industry oversight by developing inspection procedures and training, and establishing the out-of-service violation criteria for roadside inspections.[53] The NTSB therefore recommends that the CVSA inform its members of the circumstances of the Williamsburg, Virginia, fatal crash caused by the truck driver's fatigue and the creation of fictitious driver accounts in the ELD system by the motor carrier that enabled drivers to operate their vehicles for hours in excess of federal regulations, the importance of comparing driver and employee information to ELD log information during enforcement interventions, and the potential consequences of falsifying ELD log information.

2.3.2 Fatigue Management

In addition to the deficiencies described in section 2.3.1, Triton had no policy focused on fatigue management, did not provide fatigue training to its drivers, and did not schedule drivers' routes with fatigue management in mind. Drivers could choose to drive irregular hours and overnight, and because drivers were paid by the

[53] (a) Although frequently working on behalf of the FMCSA, the CVSA is not part of that or any other federal or state agency. (b) Triton drivers with false log information were identified by roadside inspection notes as drivers who had recently dropped off codrivers at truck stops.

mile, they were incentivized to drive more hours. The carrier also did not have a program to screen for and treat sleep disorders.[54]

Leading up to the Williamsburg crash, the truck driver made several poor choices that may have influenced his fatigue, in addition to operating the truck beyond allowable HOS. He slept at irregular times and remained awake at night; his sleep periods were short, he relied on a subjective feeling of tiredness, and he lacked awareness of circadian rhythms.

Fatigue has long been recognized as a safety issue in the motor carrier industry. One method that motor carriers can use to combat this problem is to implement a fatigue management program, which is a collection of policies, procedures, and information developed to address and reduce the risk of fatigue. It contains fatigue-related information for executives, safety managers, dispatchers, drivers, families, and shippers/receivers. A field study conducted for Transport Canada found that a comprehensive fatigue management program is a promising approach for an efficient and long-term reduction in the experience of fatigue, and can result in improved sleep length and quality, reductions in self-reported fatigue among drivers, and reduction in critical events (nod-offs or close calls) (Smiley and others 2009). The North American Fatigue Management Program (NAFMP), a comprehensive approach to managing the risk of fatigue for commercial vehicle drivers, was developed by the FMCSA and several Canadian transportation organizations.[55] It is a free, voluntary, fully interactive, web-based educational and training program developed to provide truck and bus commercial vehicle drivers, carriers, and others in the supply chain with an awareness of the factors contributing to fatigue and its effect on performance. The NAFMP is currently hosted by the Commercial Vehicle Safety Alliance, which also promotes the program.[56]

The NTSB has investigated many commercial vehicle crashes involving fatigue and has long recognized the value of fatigue management programs for motor carriers. As a result of our investigation into a 2009 crash in Miami, Oklahoma, we recommended that the FMCSA require carriers to adopt fatigue management programs (Safety Recommendation H-10-9). The FMCSA responded that the recommendation would be difficult to implement. Although the FMCSA continued to promote the NAFMP as a voluntary approach to fatigue management, the agency did not mandate fatigue management programs as recommended; therefore, the recommendation was classified Closed—Unacceptable Action in 2017. Even without FMCSA regulation, motor carriers have recognized the importance of having a

[54] Although there is no evidence that a sleep disorder contributed to this crash, screening for and treatment of sleep disorders is part of a good fatigue management program.

[55] For more information, see North American Fatigue Management Program (nafmp.org).

[56] For more information, see CVSA – Commercial Vehicle Safety Alliance.

comprehensive fatigue mitigation strategy. For example, as a result of a 2014 crash in Cranbury, New Jersey, the NTSB recommended that Walmart develop and implement a fatigue management program based on NAFMP guidelines (NTSB 2015a). As a result of improvements by Walmart, Safety Recommendation H-15-22 was classified Closed—Acceptable Action in 2020.

The NTSB concludes that a comprehensive fatigue management program can reduce fatigue-related crash risk and improve safety by, for example, educating drivers about the detrimental effects of irregular sleep patterns, short and scattered sleep opportunities, and driving at night; had such a program been in place at Triton, the driver may not have been operating the truck in a fatigued manner. Therefore, the NTSB recommends that Triton implement a fatigue management program, based on the NAFMP, to educate its drivers and other employees about fatigue, its causes, and its countermeasures.

2.3.3 Driver Monitoring

Safety management of drivers is a key component of safety culture (Short and others 2007). In addition to a stand-alone fatigue management program, onboard video event recorders are a useful tool for motor carriers to proactively manage fatigue and other risky driver behaviors. Inward-facing cameras—available from many providers—provide demonstrated benefits to motor carriers when used as part of driver coaching efforts (Mase and others 2020). As with forward-facing cameras, inward-facing cameras aid crash investigations by documenting the driver's actions before and during the crash. Such cameras can capture cell phone use, steering inputs, seat belt usage, codriver presence, signs of fatigue (such as closed eyes or a nodding head), or the onset of a medical issue. Cameras can also be used in conjunction with driver alerts to warn fatigued drivers. In the Williamsburg crash, an inward-facing camera could have documented head nodding, closed eyes, or other physical signs of driver fatigue, which were likely present. The fleet management system Triton used for driver coaching, which did not include an inward-facing camera, was not able to detect such signs. The truck driver was also not wearing his seat belt—another deficiency that an inward-facing camera would have captured.[57] The NTSB therefore concludes that although Triton used a fleet management system to conduct driver coaching, inward-facing video would enhance the effectiveness of the program and reduce instances of violations of carrier safety policies.

In the NTSB investigation of a 2020 crash that occurred in Mount Pleasant, Pennsylvania, we found that video event recorders on all commercial motor vehicles, in combination with a driver management or coaching program, can assist carriers to identify and address factors in motor carrier operations and driver behavior that

[57] The driver was required by Virginia law and 49 *CFR* 392.16 to wear his seat belt.

increase crash risk (NTSB 2022). Safety Recommendation H-22-3 was issued to NHTSA:

> Require that all buses and trucks over 10,000 pounds gross vehicle weight rating be equipped with onboard video event recorders that record, at a minimum, parametric data associated with the event, such as real clock time, GPS location, and acceleration data, and visibility of the driver's face and of each occupant seating location, visibility of the instrument panel, visibility forward of the vehicle, optimized frame rate, and low-light recording capability.

Although NHTSA is conducting ongoing research on driver monitoring as of the date of this report, the agency has not taken or planned any action to require the recommended onboard video event recorders. As a result, Safety Recommendation H-22-3 is classified Open—Unacceptable Response.

In addition, Safety Recommendation H-22-4 was issued to the FMCSA:

> Provide guidance to motor carriers to proactively use the onboard video event recorder information to aid in driver training and ensure driver compliance with regulatory rules essential for safe operation.

In 2022, the FMCSA informed the NTSB that the agency was taking steps to provide guidance to motor carriers to proactively use the onboard video event recorder information, including forward- and inward-facing video, to aid in driver training. The FMCSA recently released a final report for Phase I of its Tech-Celerate Now program, which promotes adopting ADAS in the commercial motor vehicle industry (Staples and others 2024).[58] In the report, the FMCSA demonstrated a positive increase in both awareness and adoption of onboard monitoring systems, along with other ADAS technologies, following a national outreach campaign for motor carriers. The FMCSA previously told the NTSB that Phase II of the Tech-Celerate Now program, which is ongoing, will include new education and outreach materials that address the recommended carrier guidance on the use of onboard video event recorder information for driver training. As a result, Safety Recommendation H-22-4 is classified Open—Acceptable Response.

The Williamsburg crash provides another example of a commercial vehicle crash in which an inward-facing camera system would have identified unsafe behaviors by the driver (fatigue and lack of seat belt use) that the motor carrier should address to ensure regulatory compliance. It is clear that use of onboard video event recorder information for driver training must include inward-facing video, forward-facing video, and other available data from fleet management systems. Thus, the NTSB reiterates

[58] See Tech-Celerate Now | FMCSA (dot.gov).

Safety Recommendations H-22-3 and -4. The NTSB also recommends that Triton implement a policy to proactively use onboard video event recorder information, including inward- and forward-facing video, to enhance driver training/coaching.

2.4 Need for Federal Requirements for Commercial Vehicle Collision Avoidance Systems

The NTSB has a long history of investigating rear-end collisions that could have been prevented or mitigated by advanced vehicle technologies. For many years, the NTSB has issued recommendations to NHTSA about collision warning systems in commercial trucks and buses to help mitigate or avoid crashes and has updated the recommendations as the technology has matured. For example, in 2001, the NTSB issued Safety Recommendation H-01-6 to NHTSA to complete rulemaking on performance standards for adaptive cruise control and collision warning systems for new commercial vehicles.[59] In 2015, the NTSB published a special investigation report that examined the current state of collision avoidance technologies for preventing rear-end crashes and concluded that these technologies were mature and effective in reducing such crashes (NTSB 2015b). The NTSB issued safety recommendations to passenger vehicle-, truck-, and bus manufacturers to install FCW and AEB systems as standard equipment on their new vehicles (Safety Recommendations H-15-8 and -9).[60] Also as part of that special investigation report, the NTSB recommended that NHTSA:

> Complete, as soon as possible, the development and application of performance standards and protocols for the assessment of forward collision avoidance systems in commercial vehicles. (H-15-5)

Safety Recommendation H-15-5 has been reiterated five times, most recently in our investigation of a multivehicle crash in Phoenix, Arizona (NTSB 2023). Safety Recommendation H-15-5 currently is classified Open—Unacceptable Response, because NHTSA has not addressed collision avoidance systems in commercial vehicles.

The real-world benefits of forward collision mitigation systems in commercial vehicles have been demonstrated. A study by the Insurance Institute for Highway Safety found a 22% reduction in rear-end crashes per miles traveled in trucks equipped with FCW, and this technology provided only a warning when a crash was imminent. An even greater safety improvement—41%—was achieved with AEB, which

[59] Safety Recommendation H-01-6 was classified Closed—Unacceptable Action/Superseded by H-15-5 on June 8, 2015.

[60] Safety Recommendations H-15-8 and -9 are both classified with the overall status Open—Acceptable Response.

actively brakes to avoid rear-end collisions (Teoh 2021). In the European Union, AEB technology is available and, since 2015, mandated on heavy trucks. In 2023, the European New Car Assessment Programme (Euro NCAP) published a plan to, beginning in 2024, rate crash avoidance technologies on heavy trucks.[61]

In 2023, NHTSA and the FMCSA announced a joint notice of proposed rulemaking to require AEB in heavy vehicles.[62] The proposal would require complete avoidance of rear-impact crashes at travel speeds up to about 50 mph without concurrent manual brake application by the driver and up to 62 mph with manual braking application. The NTSB strongly supports the proposed rulemaking and urges NHTSA and the FMCSA to move forward expeditiously, because only a regulation will ensure that all heavy vehicles are equipped with AEB systems.[63]

In the Williamsburg crash, the truck driver was fatigued and demonstrated no active response while approaching the bus; consequently, it is unclear whether a forward collision warning alone would have been effective in reducing the severity of the crash. The truck in this crash was traveling above NHTSA's proposed test speed for conditions without manual braking (about 67 mph versus 50 mph in the NHTSA test), but the speed differential was similar (about 44 mph differential versus 37 mph in the NHTSA test). Thus, an AEB system designed to NHTSA's proposed standards may have been able to slow the vehicle, and either prevent the crash or lessen its severity. AEB was part of the standard collision avoidance package for the 2022 Freightliner Cascadia, which Triton elected not to purchase. The size and flat rear exterior shape of the bus would have provided ideal conditions for use with a forward-looking radar unit (such as in the Detroit Assurance® Safety Suite). Also, radar systems are not dependent on visible light, and thus the effectiveness of a radar system would not have been diminished by the dark conditions present at the time of the crash.

Adaptive cruise control is another technology that may have mitigated the crash and that was available for the 2022 Freightliner Cascadia as part of the collision avoidance package, but not purchased by Triton. ACC keeps the vehicle traveling at a driver-set speed, and it slows the vehicle automatically to maintain a set following distance from the vehicle ahead. The crash-involved truck driver had activated the vehicle's traditional cruise control, which is only able to maintain a set speed and does not reduce that speed based on vehicles ahead. Because the truck driver activated cruise control, it is reasonable to assume he would similarly have activated an adaptive cruise control system had it been available to him. Studies show that drivers favor using ACC systems (NHTSA 2008) and they self-report lower mental

[61] For more information, see Safer Trucks - On the road to Vision Zero (euroncap.com).

[62] For more information, see Docket ID: NHTSA-2023-0023 (Regulations.gov).

[63] For more information, see Docket ID: NHTSA-2023-0023-400.

workload when using ACC, compared with manual driving (de Winter and others 2014). The most current version of Detroit Assurance® Safety Suite, 5.0—which was standard equipment for the crash-involved truck-tractor at its time of purchase—includes the ability to detect and apply full braking for stationary objects, slower-moving vehicles, and pedestrians along with the ability to bring the vehicle to a complete stop while using ACC. Because advanced vehicle technologies such as ACC are not required on heavy trucks, Triton was able to request that its truck-tractors be delivered without that technology.

The NTSB concludes that the collision may have been avoided or the severity reduced if Triton had purchased the standard equipment for the truck-tractor that included collision avoidance systems such as AEB and/or ACC, instead of opting to remove these systems.

The combination vehicle involved in this crash was not purchased with, nor required by federal regulation to have, collision avoidance systems.[64] Because no federal regulation requires trucks to have collision mitigation systems, manufacturers are only voluntarily installing these systems on their vehicles. Daimler has marketed the Detroit Assurance® Safety Suite as a standard feature since 2018. Unlike passenger vehicles being purchased at a car lot, heavy vehicles are exclusively sold using an advanced ordering system, in which purchasers can customize the systems they want to buy. If federal regulation requires certain safety technologies to be installed on vehicles, customers cannot opt out of the technology during the ordering process. By contrast, if a safety technology (such as collision avoidance) is not required by federal regulation, customers can elect to forego it during the ordering process (even if that technology is offered as "standard" by the manufacturer). Triton requested not to have collision avoidance installed during the vehicle build.

This issue is not unique to Daimler trucks. A study funded by the FMCSA found that although several heavy-vehicle manufacturers have voluntarily made AEB "standard" on many new truck models, they also offer "deletion credits" to customers who choose to remove AEB, which provides customers financial incentive to forego the technology and which ultimately reduces voluntary adoption rates (Grove and others 2020).

Therefore, the NTSB concludes that because commercial vehicle customers can choose not to purchase collision avoidance systems, even when marketed by manufacturers as standard equipment, federal requirements are necessary to

[64] The NTSB also advocates for connected vehicle technology, also known as V2X, which may have been beneficial for this crash. However, this technology is not yet widespread and was not available for the subject truck-tractor. For more details, see NTSB 2023.

increase widespread deployment of this technology. Thus, the NTSB reiterates Safety Recommendation H-15-5 to NHTSA.

2.5 Inadequate Safety Management and Oversight of the Bus Carrier

Futrell's Party Adventures did not have policies and oversight mechanisms in place to ensure safe operations. The following sections examine Futrell's lack of appropriate policies and safety management, including inadequate maintenance that may have contributed to the slow speed of the bus (section 2.5.1), and the inadequate oversight by the Commonwealth of Virginia (section 2.5.2).

2.5.1 Safety Management Deficiencies

Futrell's lacked written policies, procedures, and management safety practices normally associated with the passenger-carrying industry. The bus was registered as a non-commercial passenger vehicle, and the owner had not obtained for-hire vehicle registration and license plates for the bus, although required by Virginia law. Futrell's did not require the crash-involved bus driver to fill out an application, take a pre-employment controlled-substance test, or complete training on passenger transportation, nor did the carrier review his driving history. The bus driver did not hold a CDL or a passenger endorsement despite the legal requirement to possess these qualifications to drive the bus. In addition, the bus driver had not completed any training on the safe transportation of passengers and had limited experience driving this bus. In short, Futrell's allowed an improperly licensed and untrained driver to operate the bus at the time of the crash.

In addition, Futrell's did not keep formal maintenance records for the bus. The clogged fuel filter indicates a lack of proper maintenance. According to the *Engine Operation and Maintenance Manual*, the prescreen filter should have been cleaned every 6 months (or 10,000 miles) and replaced every 12 months (or 20,000 miles). The current owner had purchased the bus about 2 years before the crash, and in the intervening time the filter should have been cleaned and replaced. Based on the condition of the filter, it is unlikely that this recommended maintenance was performed.[65]

In addition, the NTSB found notable corrosion on various metal portions of the bus's frame, rails, and undercarriage. We also discovered rotting wood throughout the vehicle's flooring and portions of the roof that were cut during the bus inspection. For this vehicle, the manufacturer recommended maintenance and reapplication of

[65] Maintenance records indicate that the oil and oil filter were changed in October 2020. No records were found showing fuel filter cleaning or replacement.

anti-corrosion barrier treatment to the undercarriage every 6 to 12 months. It is unknown whether this maintenance and reapplication ever occurred. The extensive corrosion on the undercarriage of the vehicle and the lack of anti-corrosion treatment on the various bus components were consistent with the bus owners and operators failing to properly maintain the bus.

The NTSB concludes that Futrell's lacked appropriate management safety practices, as demonstrated by the improper registration of the bus as a personal vehicle, the use of an improperly licensed driver, and the poor maintenance of the bus.

As previously noted, the owner of Futrell's provided the FMCSA with a signed document stating that Futrell's was no longer operating as a passenger carrier, and that if the company were to re-enter the business, it would educate itself in regulatory and safe operation requirements.

In this crash, incompatibilities between the bus and truck-tractor—such as the speed differential and weight difference—resulted in significant damage to the bus body. The severe impact caused the rear, roof, sidewalls, and other vehicle components to separate from the bus, and the occupants no longer had any portion of the occupant compartment structure or substructure to protect them from ejection. The severity of the crash was beyond that of standard crash tests and crashworthiness design standards for any vehicle.

The investigation determined that the wire mesh prescreen fuel filter, which screens the fuel from larger debris before the fuel enters the paper-element filter, was at least 50% blocked. In general, a clogged filter may affect vehicle performance, although the precise effect of the partially clogged filter on the bus in this case could not be quantified. As a result of a partial blockage, whenever the engine demanded more fuel to accelerate, only a portion of the available fuel would be provided, which would reduce power and speed. The NTSB concludes that the bus's slow speed could have been due, in part, to the partially blocked prescreen fuel filter.

A vehicle moving much slower than the prevailing traffic poses a hazard both to other motorists and to the people in the slow-moving vehicle. The slow speed of the bus—20 to 25 mph—compared to the combination vehicle—about 65 mph—resulted in a considerable speed differential in the collision. In crashes, the resultant change in velocity of a vehicle (expressed numerically as "delta-v") and the time during which that change occurs directly correlates with injury severity. In general, the greater the delta-v and the shorter the time during which the change in velocity occurs, the greater the injury severity (Imler and others 2014). The NTSB therefore concludes that the slow speed of the bus on a 70-mph roadway increased the severity of the rear-impact collision by the combination vehicle.

2.5.2 State Oversight

Intrastate motor carriers are exempted from many of the Federal Motor Carrier Safety Regulations, and regulatory oversight by the FMCSA is therefore limited to licensing and controlled substance and alcohol testing. States have overall responsibility for intrastate carriers. Virginia had a process in place for prospective carriers to obtain operating authority, including a new licensee inspection on newly authorized carriers, to be completed after a 60- to 90-day waiting period. However, the information provided to newly authorized carriers in Virginia contained only non-safety information. There was no guidance regarding driver's license requirements, vehicle maintenance, controlled substance and alcohol testing requirements, fatigue management, or other safety-related topics. As such, a carrier like Futrell's likely did not have sufficient information on safety best practices for transporting passengers.

By contrast, Maryland's *Motor Carrier Handbook* contains significant safety information for new carriers, including licensing requirements for intrastate drivers, HOS for intrastate drivers of passenger-carrying vehicles, pre-trip safety inspection of vehicles, safe vehicle operation, and proper preventive maintenance.[66]

The NTSB concludes that the Commonwealth of Virginia did not provide safety guidance to new motor carrier licensees, increasing the likelihood that new carriers could operate in intrastate commerce without knowledge of safety regulations and best practices. Therefore, NTSB recommends that the Commonwealth of Virginia provide new intrastate motor carrier licensees with management safety guidance to include, at a minimum:

- proper license class,
- drug- and alcohol-testing requirements,
- fatigue management,
- vehicle maintenance, and
- safe commercial vehicle operation.

[66] See the state of Maryland's Motor Carrier Handbook (maryland.gov).

3 Conclusions

3.1 Findings

1. None of the following were factors in this crash: (1) highway design, lighting, and minimum speed limits; (2) the combination vehicle's steering, brakes, suspension, tires, wheels, brakes, and electrical systems; (3) the bus's steering, brakes, suspension, tires, wheels, brakes, and electrical systems; (4) the truck driver's health, alcohol or other drugs, training and experience, and cell phone use; and (5) the bus driver's health, alcohol or other drugs, fatigue, and cell phone use.

2. The emergency response was timely and adequate.

3. The truck driver's lack of response to the slow-moving bus in his travel lane was due to his fatigue caused by excessive driving time and limited sleep opportunity.

4. Triton Logistics Incorporated created fictitious driver accounts in the electronic logging device system, which enabled drivers to operate their vehicles for hours beyond those allowable by federal regulations, leading to the drivers driving in a likely fatigued condition, as occurred with the crash-involved driver.

5. A data-entry tracking history in electronic logging device software can increase accountability and transparency and can deter motor carrier personnel from making false entries aimed at circumventing hours-of-service regulations.

6. A comprehensive fatigue management program can reduce fatigue-related crash risk and improve safety by, for example, educating drivers about the detrimental effects of irregular sleep patterns, short and scattered sleep opportunities, and driving at night; had such a program been in place at Triton, the driver may not have been operating the truck in a fatigued manner.

7. Although Triton Logistics Incorporated used a fleet management system to conduct driver coaching, inward-facing video would enhance the effectiveness of the program and reduce instances of violations of carrier safety policies.

8. The collision may have been avoided or the severity reduced if Triton Logistics Incorporated had purchased the standard equipment for the truck-tractor that included collision avoidance systems such as automatic emergency braking and/or adaptive cruise control, instead of opting to remove these systems.

9. Because commercial vehicle customers can choose not to purchase collision avoidance systems, even when marketed by manufacturers as standard equipment, federal requirements are necessary to increase widespread deployment of this technology.

10. Futrell's Party Adventures lacked appropriate management safety practices, as demonstrated by the improper registration of the bus as a personal vehicle, the use of an improperly licensed driver, and the poor maintenance of the bus.

11. The bus's slow speed could have been due, in part, to the partially blocked prescreen fuel filter.

12. The slow speed of the bus on a 70-mph roadway increased the severity of the rear-impact collision by the combination vehicle.

13. The Commonwealth of Virginia did not provide safety guidance to new motor carrier licensees, increasing the likelihood that new carriers could operate in intrastate commerce without knowledge of safety regulations and best practices.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the Williamsburg, Virginia, crash was the truck driver's fatigue, due to excessive driving time and limited sleep opportunity, which resulted in his lack of response to the slow-moving bus ahead. Contributing to the truck driver's fatigue was the motor carrier, Triton Logistics Incorporated, which created fictitious driver accounts in the electronic logging device system and enabled drivers to operate their vehicles for hours in excess of federal regulations. Contributing to the severity of the crash was the operation of the bus at a significantly slower speed than other highway traffic.

4 Recommendations

4.1 New Recommendations

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

To the Federal Motor Carrier Safety Administration:

Revise the electronic logging device (ELD) requirements in Title 49 *Code of Federal Regulations* Part 395 to require ELD providers to create an audit log that includes:

- date,
- driver login time and who logged them in,
- names of anyone who edited the log,
- driver's license numbers, and
- active driver list changes. (H-24-19)

To the Commonwealth of Virginia:

Provide new intrastate motor carrier licensees with management safety guidance to include, at a minimum:

- proper license class,
- drug- and alcohol-testing requirements,
- fatigue management,
- vehicle maintenance, and
- safe commercial vehicle operation. (H-24-20)

To Triton Logistics Incorporated:

Implement a process to regularly verify the accuracy of drivers' records of duty status, such as by cross-referencing other information, such as payroll. (H-24-21)

Implement a fatigue management program, based on the North American Fatigue Management Program, to educate your drivers and other employees about fatigue, its causes, and its countermeasures. (H-24-22)

Implement a policy to proactively use onboard video event recorder information, including inward- and forward-facing video, to enhance driver training/coaching. (H-24-23)

To the Commercial Vehicle Safety Alliance:

Inform your members of the circumstances of the Williamsburg, Virginia, fatal crash caused by the truck driver's fatigue and the creation of fictitious driver accounts in the electronic logging device (ELD) system by the motor carrier that enabled drivers to operate their vehicles for hours in excess of federal regulations, the importance of comparing driver and employee information to ELD log information during enforcement interventions, and the potential consequences of falsifying ELD log information. (H-24-24)

4.2 Previously Issued Recommendations Reiterated in This Report

The National Transportation Safety Board reiterates the following safety recommendations:

To the National Highway Traffic Safety Administration:

Complete, as soon as possible, the development and application of performance standards and protocols for the assessment of forward collision avoidance systems in commercial vehicles. (H-15-5)

This recommendation is reiterated in section 2.4 of this report.

Require that all buses and trucks over 10,000 pounds gross vehicle weight rating be equipped with onboard video event recorders that record, at a minimum, parametric data associated with the event, such as real clock time, GPS location, and acceleration data, and visibility of the driver's face and of each occupant seating location, visibility of the instrument panel, visibility forward of the vehicle, optimized frame rate, and low-light recording capability. (H-22-3)

This recommendation is reiterated in section 2.3.3 of this report.

To the Federal Motor Carrier Safety Administration:

> Provide guidance to motor carriers to proactively use the onboard video event recorder information to aid in driver training and ensure driver compliance with regulatory rules essential for safe operation. (H-22-4)

This recommendation is reiterated in section 2.3.3 of this report.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

JENNIFER HOMENDY Chair	MICHAEL GRAHAM Member
	THOMAS CHAPMAN Member
	ALVIN BROWN Member
	J. TODD INMAN Member

Report Date: August 12, 2024

Appendixes

Appendix A: Investigation

The NTSB received notification of the Williamsburg, Virginia, crash on December 16, 2022, and launched investigators on the same day from the Office of Highway Safety to address highway and vehicle factors, motor carrier operations, human performance, survival factors, and technical reconstruction. The NTSB's Transportation Disaster Assistance Division and Office of Research and Engineering participated in the investigation.

The FMCSA, the Virginia State Police, and the VDOT were parties 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 Federal Motor Carrier Safety Administration:

H-24-19

Revise the electronic logging device (ELD) requirements in Title 49 *Code of Federal Regulations* Part 395 to require ELD providers to create an audit log that includes:

- date,
- driver login time and who logged them in,
- names of anyone who edited the log,
- driver's license numbers, and
- active driver list changes.

Information that addresses the requirements of 49 *United States Code* 1117(b), as applicable, can be found in section 2.3.1 Oversight of Driver Hours of Service. Information supporting (b)(1) and (b)(2) can be found on pages 34–36; (b)(3) is not applicable.

To the Commonwealth of Virginia:

H-24-20

Provide new intrastate motor carrier licensees with management safety guidance to include, at a minimum:

- proper license class,
- drug- and alcohol-testing requirements,
- fatigue management,
- vehicle maintenance, and
- safe commercial vehicle operation.

Information that addresses the requirements of 49 *United States Code* 1117(b), as applicable, can be found in section 2.5.2 State Oversight. Information supporting (b)(1) and (b)(2) can be found on page 45; (b)(3) is not applicable.

To Triton Logistics Incorporated:

H-24-21

Implement a process to regularly verify the accuracy of drivers' records of duty status, such as by cross-referencing other information, such as payroll.

Information that addresses the requirements of 49 *United States Code* 1117(b), as applicable, can be found in section 2.3.1 Oversight of Driver Hours of Service. Information supporting (b)(1) and (b)(2) can be found on pages 34–36; (b)(3) is not applicable.

H-24-22

Implement a fatigue management program, based on the North American Fatigue Management Program, to educate your drivers and other employees about fatigue, its causes, and its countermeasures.

Information that addresses the requirements of 49 *United States Code* 1117(b), as applicable, can be found in section 2.3.2 Fatigue Management. Information supporting (b)(1) and (b)(2) can be found on pages 36–38; (b)(3) is not applicable.

H-24-23

Implement a policy to proactively use onboard video event recorder information, including inward- and forward-facing video, to enhance driver training/coaching.

Information that addresses the requirements of 49 *United States Code* 1117(b), as applicable, can be found in section 2.3.3 Driver Monitoring. Information supporting (b)(1) and (b)(2) can be found on pages 38–40; (b)(3) is not applicable.

To the Commercial Vehicle Safety Alliance:

H-24-24

Inform your members of the circumstances of the Williamsburg, Virginia, fatal crash caused by the truck driver's fatigue and the creation of fictitious driver accounts in the electronic logging device (ELD) system by the motor carrier that enabled drivers to operate their vehicles for hours in excess of federal regulations, the importance of comparing driver and employee information to ELD log information during enforcement interventions, and the potential consequences of falsifying ELD log information.

Information that addresses the requirements of 49 *United States Code* 1117(b), as applicable, can be found in section 2.3.1 Oversight of Driver Hours of Service. Information supporting (b)(1) and (b)(2) can be found on pages 34–36; (b)(3) is not applicable.

References

AASHTO (American Association of State Highway and Transportation Officials). 2011. *Roadside Design Guide*, 4th Edition, pp. 6–10.

Babkoff, H., T. Caspy, Y. Hishikawa, and M. Mikulincer. 1991. "Subjective Sleepiness Ratings: The Effects of Sleep Deprivation, Circadian Rhythmicity and Cognitive Performance." *Sleep*, vol. 14, pp. 534–539. https://doi.org/10.1093/sleep/14.6.534

Boyle, L., J. Tippin, A. Paul, and M. Rizzo. 2008. "Driver Performance in the Moments Surrounding a Microsleep." *Transportation Research Part F: Traffic Psychology and Behaviour*, vol. 11, no. 2, pp. 126–136. https://doi.org/10.1016%2Fj.trf.2007.08.001

De Winter, J., R. Happee, M. Martens, and N. Stanton. 2014. "Effects of Adaptive Cruise Control and Highly Automated Driving on Workload and Situation Awareness: A Review of the Empirical Evidence." *Transportation Research Part F: Traffic Psychology and Behaviour*, vol. 27, Part B, pp. 196–217. https://doi.org/10.1016/j.trf.2014.06.016

Dinges, D. and N. Kribbs. 1991. "Performing While Sleepy: Effects of Experimentally Induced Sleepiness," in T. Monk, ed., *Sleep, Sleepiness, and Performance* (Chichester, UK: John Wiley & Sons, 1991), pp. 98–128.

Glenville, M., R. Broughton, A. Wing, and R. Wilkinson. 1978. "Effects of Sleep Deprivation on Short Duration Performance Measures Compared to the Wilkinson Auditory Vigilance Task." *Sleep*, vol. 1, no. 2, pp. 169–176. https://doi.org/10.1093/sleep/1.2.169

Grove, K., M. Camden, A. Krum, and R. Hanowski. 2020. *Research and Testing to Accelerate Voluntary Adoption of Automatic Emergency Braking on Commercial Vehicles*. FMCSA-RRT-18-013. US Department of Transportation. Federal Motor Carrier Safety Administration, 2020.

Imler, S., M. Heller, C. Raasch, H. Watson, and K. Zhao. 2014. "The Effect of Rear Impact Collision Delta-V and Restraint Status on Injury Outcome." SAE Technical Paper 2014-01-0524. https://doi.org/10.4271/2014-01-0524

Lamond, N. and D. Dawson. 1999. "Quantifying the Performance Impairment Associated with Fatigue." *Journal of Sleep Research*, vol. 8, no. 4, pp. 255–262. https://doi.org/10.1046/j.1365-2869.1999.00167.x

Mase, J., S. Majid, M. Mesgarpour, M. Torres, G. Figueredo, and P. Chapman. 2020. "Evaluating the Impact of Heavy Goods Vehicle Driver Monitoring and Coaching to Reduce Risky Behaviour." *Accident Analysis & Prevention*, vol. 146, 105754. https://doi.org/10.1016/j.aap.2020.105754

Mortimer, R., E. Hoffmann and A. Kiefer. 2014. "The Psychological and Accident Reconstruction 'Thresholds' of Drivers' Detection of Relative Velocity," SAE Technical Paper 2014-01-0437. https://doi.org/10.4271/2014-01-0437

Muttart, J., W. Messerschmidt, and L. Gillen. "Relationship Between Relative Velocity Detection and Driver Response Times in Vehicle Following Situations." SAE technical paper 2005-01-0427.

NHTSA (National Highway Traffic Safety Administration). 2008. *Use of Advanced In-Vehicle Technology by Young and Older Early Adopters: Survey Results on Adaptive Cruise Control Systems*. DOT HS 811070 (Washington, DC: NHTSA).

NTSB (National Transportation Safety Board). 2023. *Multivehicle Collision Involving a Milk Tank Combination Vehicle and Stopped Traffic Queue, Phoenix, Arizona, June 9, 2021*. NTSB/HIR-23/04 (Washington, DC: National Transportation Safety Board, 2023). HIR-23-04

_____. 2022. *Multivehicle Crash Near Mt. Pleasant Township, Pennsylvania, January 5, 2020*. NTSB/HIR-22/01 (Washington, DC: National Transportation Safety Board, 2022). HIR-22-01

_____. 2015a. *Multivehicle Work Zone Crash on Interstate 95, Cranbury, New Jersey, June 7, 2014*. NTSB/HAR-15/02 (Washington, DC: National Transportation Safety Board, 2015). HIR-15-02

_____. 2015b. *The Use of Forward Collision Avoidance Systems to Prevent and Mitigate Rear-End Crashes*. NTSB/SIR-15/01 (Washington, DC; National Transportation Safety Board, 2015). SIR-15-01

Pilcher J.J., D.R. Ginter and B. Sadowsky. 1997. "Sleep Quality versus Sleep Quantity: Relationships between Sleep and Measures of Health, Well-Being and Sleepiness in College Students." Journal of Psychosomatic Research, vol. 42, no. 6, pp. 583–596.

Short, J., L. Boyle, S. Shackelford, B. Inderbitzen and G. Bergoffen. *The Role of Safety Culture in Preventing Commercial Motor Vehicle Crashes*. Vol. 14. Transportation Research Board, 2007.

Smiley, A., T. Smahel, D. Boivin, P. Boudreau, J. Remmers, M. Turner, M. Rosekind, K. Gregory. 2009. *Effects of a Fatigue Management Program on Fatigue in the*

Commercial Motor Carrier Industry. Human Factors North, Inc., prepared for Transportation Development Centre of Transport Canada. Microsoft Word - Final FMP Report - August 20, 2009.doc (nafmp.org).

Staples, B., J. Chang, N. Schweikert, D. Murray, C. Evans, A. Leslie, M. Camden, R. Braswell, K. Grove, T. Weakley, A. King. 2024. *Accelerating the Adoption of Advanced Driver Assistance Systems (ADAS): "Tech-Celerate Now" Phase 1*. FMCSA-RRT-22-004. US Department of Transportation. Federal Motor Carrier Safety Administration, 2024. https://rosap.ntl.bts.gov/view/dot/73052/dot_73052_DS1.pdf.

Teoh, Eric R. "Effectiveness of Front Crash Prevention Systems in Reducing Large Truck Real-World Crash Rates." 2021. *Traffic Injury Prevention*, vol. 22, no. 4, pp. 284–289.

For more detailed background information on this report, visit the NTSB Case Analysis and Reporting Online (CAROL) website and search for NTSB accident ID HWY23MH004. Recent publications are available in their entirety on the NTSB website. Other information about available publications also may be obtained from the website or by contacting –

National Transportation Safety Board
Records Management Division, CIO-40
490 L'Enfant Plaza, SW
Washington, DC 20594
(800) 877-6799 or (202) 314-6551

Copies of NTSB publications may be downloaded at no cost from the National Technical Information Service, at the National Technical Reports Library search page, using product number PB2024-100114. For additional assistance, contact–

National Technical Information Service
5301 Shawnee Rd.
Alexandria, VA 22312
(800) 553-6847 or (703) 605-6000
NTIS website