National Transportation Safety Board

Washington, DC 20594

Highway Accident Brief

Collision Between Passenger Train and Refuse Truck at Active Grade Crossing, Crozet, Virginia, January 31, 2018

Accident Number:	HWY18MH005
Accident Type:	Train and refuse truck collision at active grade crossing
Location:	Lanetown Road at Buckingham Branch Railroad, milepost 195.85, near Crozet, Albemarle County, Virginia
Date and Time:	January 31, 2018, about 11:16 a.m. eastern standard time
Vehicle 1:	2018 Freightliner refuse truck
Operator 1:	Time Disposal, LLC
Vehicle 2:	Amtrak train P923-31 (Congressional Special Train)
Operator 2 (railroad):	Buckingham Branch Railroad
Operator 2 (train):	Amtrak
Fatalities:	1
Injuries:	9

Crash Description

On Wednesday, January 31, 2018, about 11:16 a.m., a 2018 Freightliner refuse truck operated by Time Disposal, LLC, was traveling south on Lanetown Road near Crozet, Virginia. The truck was occupied by a 30-year-old driver and two passengers, who were en route to help another crew collect refuse. The truck's route required traversing a highway–railroad grade crossing on Lanetown Road, at railroad milepost 195.85 of the Buckingham Branch Railroad (BBR).[1] The grade crossing is located on a curved segment of the track and is equipped with an active warning system consisting of flashing warning lights, bells, and gate arms that lower at a train's approach.

At the same time, a chartered passenger train operated by Amtrak, comprising two locomotives and eight cars, which had departed Washington, DC, earlier that morning, was traveling west toward the crossing (figure 1) at a recorded speed of 60 mph.[2] The train engineer

[1] The grade crossing is on the North Mountain Subdivision of the BBR Richmond & Alleghany Division.

[2] On the way to its destination of White Sulphur Springs, West Virginia, the train had made a stop in Charlottesville, Virginia, about 20 minutes before the crash. The speed of the train is based on the lead locomotive's event data recorder.

stated in a postcrash interview that when the grade crossing on Lanetown Road came into view, he saw the warning lights flashing and the refuse truck drive around the lowered gate arms, but he believed the truck had sufficient time to clear the tracks. The engineer reported that he saw the truck stop on the tracks and remain stationary; after determining that the truck was not moving, the engineer put the train into emergency braking.

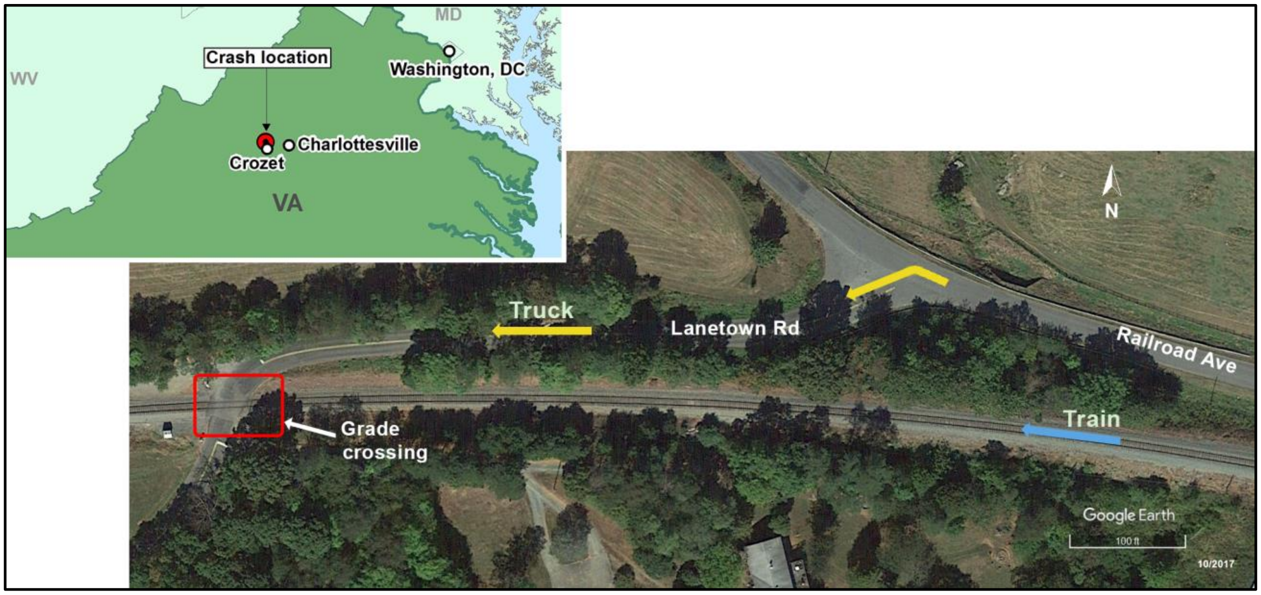

Figure 1. Aerial view of grade crossing and paths of train and truck, with inset map of crash location. (Source: Adapted from Google Earth)

About 3 seconds after the engineer engaged the emergency brake, the train struck the left rear side of the refuse truck, at a speed of 35 mph. The truck rotated counterclockwise, collided with a railroad signal bungalow and a mailbox structure on the southwest corner of the crossing, and came to rest about 26 feet south of the south rail, parallel to the tracks and with the front end against the west edge of Lanetown Road. The truck's hopper—the container into which refuse is loaded—was displaced (figure 2). The train came to a stop 20 seconds later, with the front axle of the lead locomotive derailed.

A police officer traveling in the lead locomotive reported that as the grade crossing came into view, he saw the truck move across the tracks and then stop "with the back end of the truck still hanging over the tracks." The driver of a car that was traveling south on Lanetown Road and had reached the grade crossing reported seeing the refuse truck stopped on the tracks, with the gate arms lowered and the warning lights flashing. The witness stated that within a few seconds of his arrival, he saw a train approach from the east and moments later strike the refuse truck. The witness stated that he did not see the truck move at any point before the impact.

Figure 2. Truck at rest position postcrash, with partial view of displaced hopper.

Injuries and Seat Belt Use

The crash resulted in the death of one truck passenger, serious injuries to the second passenger, and minor injuries to the truck driver. Four train crew members and three train passengers sustained minor injuries. From interviews with the train crew and the first responders, NTSB investigators determined the location of the train employees and the passengers who sustained injuries. Three of the injured train employees were in the lead locomotive, and the fourth was in the first passenger car at the time of the crash. Two of the injured train passengers were in one of the passenger cars, and the third was in one of the café cars.

As a result of the impact with the train and the subsequent rotation of the truck, the two truck passengers were thrown against the interior of the cab, were ejected through the passenger door, and landed on the ground to the right side of the truck. The truck passenger who died was sitting in the center seat position. The passenger who sustained serious injuries was sitting next to the passenger door. The driver was thrown forward and to the right but was not ejected. Although the truck was equipped with seat belts in all three seating positions, an examination of the truck showed that none were in use at the time of the crash.[3] Research by the National Highway Traffic Safety Administration has shown that the risk of fatalities in large vehicles, such as buses, can be reduced by 77 percent if lap/shoulder belts are installed and properly used.[4] The reduced risk is

[3] The driver and the right passenger seat positions were equipped with lap/shoulder belts, while the middle seat was equipped with only a lap belt.

[4] National Highway Traffic Safety Administration, *Fatality Reduction by Safety Belts for Front-Seat Occupants of Cars and Light Trucks, Updated and Expanded Estimates Based on 1986–99 FARS Data*, DOT HS 809 199 (Washington, DC: NHTSA, 2000).

achieved primarily by reducing occupant motion relative to the vehicle and preventing occupants from being ejected, particularly when the survival space is sufficiently retained, as it was in the cab of the refuse truck.[5] Thus, the NTSB concludes that because the cab of the refuse truck retained sufficient survival space, had the truck occupants worn their seat belts, the belts could have kept them in their seats, prevented them from being ejected, and lessened their risk of serious or fatal injury.

Seat belt advocacy has been a recurring topic of NTSB outreach since the agency's inception.[6] One facet of the NTSB's multipronged approach includes advocating legislation requiring the use of seat belts. Most recently, in 2015, the NTSB issued Safety Recommendation H-15-42 to the 50 states, the District of Columbia, and Puerto Rico: "Enact legislation that provides for primary enforcement of a mandatory seat belt use law for all vehicle seating positions equipped with a passenger restraint system."[7] The overall status of this recommendation, as well as its individual status for the Commonwealth of Virginia, is "Open—Await Response."

States with primary enforcement laws for seat belt use have consistently exhibited higher use rates. In 2017, seat belt use in the 34 states with primary enforcement was 91 percent, compared with 82 percent in the rest of the country.[8] Although Virginia has adopted Federal Motor Carrier Safety Administration regulations requiring commercial motor vehicle drivers and front seat passengers to use seat belts, the effectiveness of those regulations would be strengthened by enacting a state primary enforcement seat belt law. Thus, the NTSB reiterates Safety Recommendation H-15-42 to the Commonwealth of Virginia.

Emergency Response

The road foreman of engines, who was in the lead locomotive at the time of the crash, informed the BBR dispatcher of the crash at 11:16 a.m.[9] The Albemarle County emergency communication center received the first 911 call at 11:17 a.m. Agencies responding to the scene included the following:

- Albemarle County Police Department (ACPD); its unit was the first to arrive on scene at 11:20 a.m.
- West Albemarle Rescue Squad; its first ambulance arrived on scene at 11:23 a.m.

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[5] For additional information, see "Refuse Truck—Damage" section.

[6] The first recommendation pertaining to seat belts was issued after a 1968 crash in Baker, California (National Transportation Safety Board, *Interstate Bus–Automobile Collision, Interstate Route 15, Baker, California, March 7, 1968*, SS-H-3 [Washington, DC: NTSB, 1968]). The NTSB recommended that the Federal Highway Administration determine the necessity of regulations to require the installation of seat belts in passenger-carrying vehicles (Safety Recommendation H-68-18).

[7] National Transportation Safety Board, *Truck-Tractor Semitrailer Median Crossover Collision With Medium-Size Bus on Interstate 35, Davis, Oklahoma, September 26, 2014*, HAR-15/03 (Washington, DC: NTSB, 2015).

[8] National Highway Traffic Safety Administration, *Seat Belt Use in 2017—Use Rates in the States and Territories*, DOT HS 812 546 (Washington, DC: NHTSA, 2018).

[9] The road foreman of engines supervises the train engineer and is in charge of enforcing rules and regulations.

- Crozet Volunteer Fire Department; its first engine arrived on scene at 11:26 a.m. The senior officer on the engine assumed the role of incident commander, declared a mass casualty incident, and requested a medevac unit.

Other agencies responding to the scene included two from Charlottesville, Virginia—which is about 12 miles from Crozet and has a mutual aid agreement with the town—and several from the neighboring communities of Ivy, Hollymead, and Earlysville. Those agencies provided emergency medical service units, resources, and staff. The seriously injured truck passenger was transported to a local hospital by medevac helicopter. Ambulances transported the truck driver, three train passengers, and one train crew member to local hospitals. The other train crew members were treated at the scene.

NTSB investigators interviewed first responders about their procedures for grade-crossing emergencies. Although staff from the volunteer fire department had never participated in railroad-related training drills and lacked knowledge of the procedures for notifying the railroad in the event of a grade-crossing emergency, those deficiencies did not diminish the emergency response, which was timely and appropriate.

BBR, along with Operation Life Saver, Inc., sponsors community rail safety events, and in conjunction with Amtrak, every 2 years holds rail safety training courses for emergency responders. BBR organized one such safety course in September 2017 in Augusta County, Virginia—the neighboring county—but because of a miscommunication, no representatives from Albemarle County agencies attended. In March 2018, after the crash in Crozet, BBR organized a rail safety training course at the ACPD and invited local first responders.[10] In addition, as part of a community outreach campaign, BBR published safety advertisements in area newspapers, sponsored television advertisements, and hosted community meetings on rail safety.

Highway–Railroad Grade Crossing

Traffic Characteristics

At the request of NTSB investigators, the Virginia Department of Transportation conducted a traffic count for Lanetown Road north and south of the grade crossing over 5 days, starting on March 14, 2018. The count recorded a daily traffic flow of 1,128 vehicles, 96 percent of which were passenger cars or light trucks.[11] The speed limit on this section of Lanetown Road is 35 mph. According to the Federal Railroad Administration's accident history for the Lanetown Road grade crossing, the only previous crash at the site occurred in February 1999, when an oncoming train struck an unoccupied car, resulting in no injuries.[12]

[10] The course was attended by the Albemarle County Emergency Management Agency, which manages disaster planning and conducts training exercises. Only a few of the invited first-responder agencies attended.

[11] Traffic count data showed that about 80 percent of the vehicles were classified as passenger cars, and about 16 percent were classified as two-axle, four-tire (2A-4T) vehicles. The Federal Highway Administration's 2A-4T classification includes pickup trucks, panel vans, and other vehicles such as campers, motor homes, ambulances, hearses, carryalls, and minibuses.

[12] According to Virginia Department of Transportation records, a crash occurred at this crossing in August 2016, when a vehicle struck the gate arm and signal bungalow. No train was involved.

Roadway Configuration and Grade Crossing Profile

Lanetown Road in the vicinity of the grade crossing consists of one southbound and one northbound lane, each 11 feet wide, without shoulders, and separated by two 4-inch-wide solid yellow lines. The road widens to 33 feet at the crossing, where it intersects the tracks at a 65-degree angle. Measured just north of the tracks, southbound Lanetown Road has a slight downhill slope of about 1.7 degrees. The slope becomes steeper south of the tracks—at a distance of 30 feet—to about 3.8 degrees.

Grade Crossing Signage and Warning System

The southbound approach to the Lanetown Road grade crossing has pavement markings and roadway signs to inform roadway users of the crossing. The markings and signs are found on Lanetown Road and on Railroad Avenue, the road the truck driver was on before he turned onto Lanetown Road (refer to figure 1). Along northwest-bound Railroad Avenue, the truck driver would have encountered three grade-crossing-related signs, including a low-ground-clearance grade crossing (LGCGC) warning sign.[13] Along southbound Lanetown Road, the driver would have encountered another LGCGC warning sign and three other signs related to the grade crossing (table).

Table. Roadway signs on Lanetown Road at southbound approach to grade crossing.

Name	Design	Dimensions	Distance to Crossing
Low-ground-clearance grade crossing warning		36 x 36 inches	449 feet
15-mph advisory speed limit plaque		18 x 18 inches	449 feet
Grade crossing advanced warning		36-inch diameter	280 feet
Grade crossing crossbuck		36 x 36 inches	13 feet

The southbound and northbound approaches to the Lanetown Road grade crossing each have a flashing-light signal, a bell, and an automatic gate assembly. The flashing-light signal consists of six sets of 12-inch-diameter red light-emitting diode (LED) lights mounted on a signal

[13] The LGCGC warning sign on Railroad Avenue is located about 142 feet from the intersection with Lanetown Road. The warning sign is combined with a supplemental arrow plaque. A parallel grade crossing and intersection warning sign is also located in this area.

mast to the right of Lanetown Road on both approaches. The distance of the signal masts from the tracks is 13 feet for the north mast and 14 feet for the south mast. The automatic gate assembly is attached to the signal mast and includes a drive mechanism and a gate arm marked with reflective red-and-white tape. Three 3-inch red LED lights are fitted on top of the arm. Blue signs attached to both signal masts display a toll-free number for reporting problems or emergencies. The arm on the north gate assembly is 19 feet long, and the arm on the south gate assembly is 17 feet long.

Refuse Truck

General

The refuse truck was manufactured in two stages. A Freightliner truck cab and chassis were built in the first stage, completed in April 2017. In the second stage, completed in August 2017, McNeilus Truck & Manufacturing added a rear-load refuse hopper to the chassis. The truck cab contained a driver seat and a two-passenger bench seat. As noted earlier, all three seats were equipped with seat belts—lap/shoulder belts on the driver and right passenger seats, lap belt on the middle seat.

Damage

The truck sustained severe damage to the body and major mechanical systems. The refuse hopper separated from the chassis at impact. The left rear of the hopper had contact damage from the locomotive, indicating that the truck was positioned at a slight angle on impact. The top of the truck's hood was displaced, and the bottom was partly disconnected from the front bumper. The windshield was shattered but still in place. The entire length of the truck's frame was twisted, and both frame rails were bent to the right at an angle of about 45 degrees. The rear of the cab was separated from the frame and displaced up and to the left.

The floor of the cab below the driver's seat was buckled and deformed upward, while the seat had rotated right and to the rear so that it protruded from the cab's rear window. The midsection of the passenger bench was displaced forward to within 3 inches of the console. The structural integrity of the roof was compromised in several places, with a maximum intrusion into the cab of 19 inches. Despite the intrusions, the cab had sufficient survivable space.

National Transportation Safety Board (NTSB) investigators examined all major mechanical systems of the truck. The steering, suspension, brake, and electrical systems sustained significant damage in the crash, but no evidence was found of preexisting damage or defects. According to maintenance records, the carrier conducted regular routine maintenance and had completed repairs to the truck under two warranty claims.[14]

[14] The warranty work included repairing the transmission and a leaking rear main seal.

Railroad Factors

Train, Railroad Operation, and Track Configuration

The Amtrak train consisted of two locomotives, six passenger cars, and two café cars.[15] As a result of the crash, the front end of the lead locomotive—specifically, the pilot and the knuckle—sustained damage that extended up to the windshield.[16] The left auxiliary light on the lead locomotive was broken, and the first axle of the locomotive had derailed. The other cars did not sustain exterior damage. The interiors of the locomotives and cars were not damaged.

The section of the railroad tracks where the crash occurred is configured as a single main track and uses a traffic control system to detect the presence of trains and communicate signals. The maximum authorized speed is 60 mph for passenger trains and 40 mph for freight trains. The grade crossing is on a wide curve, where vegetation grows along both sides of the track (figure 3).

Figure 3. Overhead view of railroad tracks in crash area, showing grade crossings and track geometry. (Source: Adapted from Google Earth)

Crew

The train engineer was a 43-year-old male who had held that position at Amtrak since 2013. As required by Amtrak policy, the engineer voluntarily submitted to postcrash toxicological tests.[17] The tests were conducted by the Virginia Department of Forensic Science Central Laboratory (DFSCL) and by Quest Diagnostics. The results were negative for alcohol, major drugs of abuse, and potentially impairing medications.[18] From the engineer's postcrash interview, his

[15] The train was operating in a push-pull configuration, in which the lead locomotive pulled the train and a remotely controlled rear locomotive pushed it.

[16] The locomotive *pilot* is a device mounted on the front of a locomotive to deflect objects; it is also known as a *cowcatcher*. The *knuckle* is part of a coupler, a device that connects one railcar to another.

[17] The circumstance of this crash did not meet the requirements of Title 49 *Code of Federal Regulations* (CFR) 219.201(b) for postcrash toxicological testing.

[18] The ACPD requested DFSCL testing. Amtrak requested Quest Diagnostics testing. For additional information on the substances tested by the two laboratories, see the Human Performance report in the NTSB public docket for this investigation (HWY18MH005).

phone records, and his work schedule, he obtained 7 to 9 hours of sleep on each of the four previous nights and was not using a cell phone at the time of the crash.

In his postcrash interview, the engineer said that he first sounded the train's horn for a private grade crossing about 1,000 feet east of the Lanetown Road crossing (refer to figure 3). He said he continued sounding the horn as the Lanetown Road grade crossing entered his view. At that point, he saw the refuse truck driving around the gates, which he reported were already lowered. He believed the truck had time to clear the crossing and at first was not concerned. Then he saw the truck stop and remain stopped. When he determined that the truck would not clear the tracks, the engineer engaged the train's emergency brake. The road foreman of engines also told investigators that he saw the truck drive around the lowered north gate and stop on the tracks.

Recordings

NTSB investigators examined data from the lead locomotive's event data recorder and the video recorded by the forward-facing camera. According to the event data recorder, the crash occurred at 11:16:42 a.m., and for about 2 minutes before the crash, the train was traveling at a speed of 58 to 62 mph.[19] The engineer activated the horn at 11:16:19 a.m., 23 seconds before impact, when the train was about 2,000 feet from the crossing. Except for a 1-second period, the horn remained activated until the collision. Three seconds before the impact, the engineer engaged the emergency brake, at a speed of 61 mph. At the time of impact, the train had decelerated to 35 mph.

The lead locomotive's forward-facing camera captured the train's approach to the grade crossing, the impact, and the train's postcrash movement. The video recording shows that:

- Twelve seconds before impact, as the train is about to cross the private grade crossing about 1,000 feet east of the Lanetown Road crossing, a white object comes into view beyond a line of trees around an oncoming curve.
- Five seconds before impact (1) the white object is clearly seen to be a refuse truck, (2) the warning lights at the Lanetown Road grade crossing are visible and flashing, and (3) the rear of the truck has just passed the north gate of the crossing.
- Three seconds before impact, the north gate arm is visible and horizontal; the truck is stopped on the grade crossing.
- The truck is stationary for the next 3 seconds, until the impact.
- The train stops 20 seconds after the impact.

The truck destroyed the signal bungalow—which stood about 28 feet west of Lanetown Road and 16 feet south of the nearest rail. Investigators were therefore unable to retrieve data related to the activation of the grade crossing warning system. The bungalow contained a model 3000 Safetran Grade Crossing Predictor, an electronic system designed to detect an approaching

[19] According to 49 CFR 229.117, when traveling above 30 mph, a locomotive's speed indicator is required to be accurate within 5 mph. The train's 61-mph speed is considered to be within the stipulated margin of error.

train and activate the grade crossing warning equipment at least 30 seconds before the arrival of a train traveling at or below 60 mph.[20]

Investigators examined the warning system's wreckage, including the warning lights and the gate arm assembly. The electrical contacts were intact, meaning that the lights could have been illuminated. The grade crossing warning system was therefore capable of functioning within the required parameters, a determination that supports both the witness reports of seeing the flashing warning lights and the data from the forward-facing camera. According to the timing designed into the warning system, the lights at the grade crossing would have begun flashing when the train was about 2,500 feet away.[21]

Postcrash Observations

Visibility

On February 2, 2018, NTSB investigators conducted distance observations at the crash site, using an exemplar train and an exemplar refuse truck, to determine at what point on the track the train's crew could have first seen the truck. One member of the crew on the exemplar train was the road foreman of engines, who had filled that role on the crash-involved train. When the exemplar train was about 896 feet east of the crossing, the road foreman of engines said that was where he first saw the crash-involved refuse truck drive around the north gate before stopping on the tracks. A high-definition image captured by an NTSB small unmanned aircraft system (UAS) shows that the north gate of the Lanetown Road grade crossing becomes visible about that far from the crossing (figure 4).[22]

Engineers routinely encounter vehicles that successfully drive around lowered gate arms, and based on that experience, they expect a vehicle to clear the tracks before a train reaches the crossing. Further, train derailment following the application of emergency braking is a likely possibility, particularly at higher speeds. Engineers consider such factors when determining the appropriateness of engaging the emergency brake. Given the speed of the train, the limited time the grade crossing would have been visible, the movement of the truck (which appeared at first to be clearing the tracks), and the brief period the truck was stopped on the tracks, the engineer's response time for engaging the train's emergency braking was reasonable.

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[20] According to 49 CFR 234.225, the minimum time for the activation of an active grade crossing warning system is 20 seconds before a train's arrival. However, most railroad companies have adopted a more stringent requirement of 30 seconds.

[21] At a constant speed of 60 mph, the train would have traveled 2,552 feet in 29 seconds. Typically, there is a delay of about 1 second before lights begin flashing after the initiation of the 30-second grade crossing warning. The gate arms typically begin to lower 3 seconds later.

[22] NTSB investigators flew a UAS, commonly known as a drone, at the approximate eye-height of the engineer on the crash train when the 4K video (resolution 3840 x 2160 pixels) was captured.

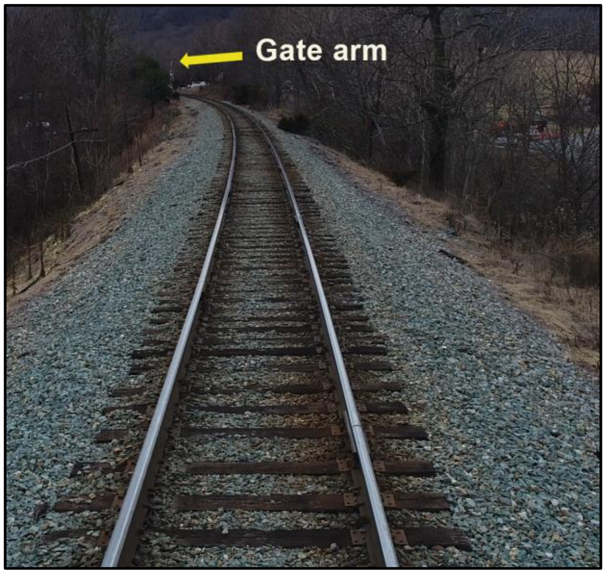

Figure 4. Location of exemplar locomotive at point where road foreman of engines recalled seeing refuse truck at north gate during postcrash distance observations. (Image captured by UAS)

Truck Movement

All the witnesses to the crash reported that the truck had stopped on the tracks and was motionless for several seconds before the impact with the train. To examine possible reasons for the truck's lack of movement, investigators used an exemplar truck and instructed its operator to drive around the lowered gates and try to cross the tracks. To recreate the conditions of the crash, the investigators placed the remnant of a post where the mailbox structure had been located.[23]

The driver of the exemplar truck maneuvered around the north gate, but he could not drive around the south gate and clear the tracks (figure 5). He stated that he could not safely exit the crossing. The position where the exemplar driver stopped appeared to be nearly the same as the crash truck's position at impact, based on the video from the forward-facing camera on the lead locomotive. The mailbox, which was south of the tracks and west of Lanetown Road, as shown in figure 5, would have prevented the crash driver from clearing the crossing without damaging the south gate arm, the mailbox post, or the side of the truck. The configuration of the grade crossing and the position of the mailbox structure indicate that maneuvering a refuse truck around the lowered gate arms could not have been the crash driver's routine practice at this grade crossing.

The left image in figure 5 indicates that there might have been sufficient space for the crash truck to reverse (although another vehicle approached the grade crossing before the crash), but it is unknown whether the truck driver—who refused interview requests by NTSB investigators—had the option of backing up before the impact. Although the approach to the grade crossing

[23] Two mailbox structures were located next to the west edge of Lanetown Road. The mailbox structure closer to the railroad tracks consisted of a large wooden post inserted into the ground. On top of the post was a mailbox encased in about 2 inches of concrete.

included LGCGC warning signs, the observations using the exemplar truck showed that the underside of the crash truck would not have become lodged on the crossing.

Figure 5. Overhead (top) and front (bottom) views of exemplar truck at position similar to that of crash truck at time of impact; also shown are locations of mailbox and remnant of mailbox post.

Motor Carrier Operations

Time Disposal, domiciled in Ruckersville, Virginia, has operated as an intrastate carrier since 1984. At the time of the crash, the carrier operated 26 refuse trucks and employed 21 drivers. Time Disposal's trucks are equipped with global positioning system (GPS) devices used to verify that stops are made at all collection points on each route. The carrier does not use GPS to track drivers' hours of service.

The owner of Time Disposal stated that the company does not have regular safety meetings or written policies and procedures for hiring and training. The owner said the carrier had a zero-tolerance policy on drug use but was unaware of the federal requirements for drug testing of commercial drivers. The carrier had a drug-testing program that used an over-the-counter urine test for drug screening. The crash driver had undergone a preemployment drug test in 2010 and six random drug tests. All test results were negative. NTSB investigators examined the drug-testing procedures of the over-the-counter screening kit and determined they did not meet the US Department of Transportation (DOT) requirements for drug testing of commercial operators found at 49 CFR Parts 40 and 382.[24] Since the crash, Time Disposal has established a DOT-compliant drug-testing program.

Truck Driver

Licensing, History, and Precrash Activities

The truck driver was a 30-year-old male who held a class B Virginia commercial driver's license (CDL), with no restrictions, and had been employed by Time Disposal as a driver since October 2010. According to Time Disposal's records, the driver had operated on the same weekly refuse collection route for several years before the crash.[25] NTSB investigators examined CDL information systems, Virginia Department of Motor Vehicle records, and carrier records for the driver's history of traffic violations. The records showed that between 2010 and 2016, the driver was cited for operating a commercial vehicle without a proper endorsement and had three crashes, one in a personal vehicle and the others nonreportable.[26]

In his most recent CDL medical examination in September 2017, the driver reported that he was not taking any medications and did not have any medical problems. He obtained a 2-year medical certificate.

Despite multiple requests, the truck driver refused to be interviewed by NTSB investigators. Based on the truck driver's work schedule and phone records, he had at least an 8-hour sleep opportunity on each of the three nights before the crash. His phone records show that he was not using his cell phone at the time of the crash.

Toxicology

At the request of the ACPD, a blood specimen was obtained from the driver at 4:09 p.m., almost 5 hours after the crash, and analyzed by the Virginia DFSCL. The tests identified 2.2 milligrams per liter of gabapentin, 6.6 nanograms per milliliter (ng/mL) of tetrahydrocannabinol (THC), and 59 ng/mL of THC carboxylic acid (THC-COOH), an inactive metabolite of THC.[27]

Gabapentin is an antiseizure medication that is also used to treat chronic pain. The quantity detected in the driver's blood was at the lower end of the therapeutic dosage.[28] The drug is a central nervous system (CNS) depressant and carries a warning about potential drowsiness and possible

[24] The over-the-counter kit is made by Alere, Inc. Compared with the DOT standard, the kit uses higher levels for the detection of drugs, does not monitor the temperature of a sample, and has no chain-of-custody requirements.

[25] As noted earlier, the truck occupants were en route to help another crew; thus, the grade crossing was not part of the truck driver's regular collection route.

[26] The carrier had records of two crashes that were not required to be reported to the DOT because they did not result in injuries or towing.

[27] For a complete list of the substances, see the Human Performance report in the NTSB public docket for this investigation (HWY18MH005).

[28] C. R. Baselt, *Disposition of Toxic Drugs and Chemicals in Man,* 10th edition (Seal Beach, California: Biomedical Publications, 2014).

effects on driving competence.[29] NTSB investigators could not find a prescription for gabapentin in the driver's name.

THC is the primary psychoactive chemical in marijuana, which is classified as a Schedule I controlled substance.[30] Marijuana typically results in significant decrements in perceptual and cognitive performance for 2 to 3 hours after use, with residual impairment lasting hours longer.[31] THC on its own can have some CNS-depressant effects, and in combination with gabapentin can have additive CNS impact, such as enhanced sedative and slower psychomotor effects.[32]

The THC level in a marijuana user's blood can reach more than 100 ng/mL while smoking but can drop to below 5 ng/mL about 3 hours afterward.[33] Blood THC levels after consumption are highly dependent on the potency of the drug, the method of ingestion (smoking, eating), and the person's frequency of use. Habitual marijuana users exhibited blood THC levels as high as 3.2 ng/mL after 2 days of abstinence in a 2008 study, or 2 ng/mL after 7 days of abstinence in a 2013 study.[34]

Impairment

Marijuana use is illegal in Virginia. The use of marijuana by the truck driver violated not only state law but also federal regulations at 49 CFR Parts 40 and 382.

The truck driver's blood sample was collected about 5 hours after the crash. Because the potency of the drug and the manner and the time of marijuana ingestion are unknown, it is not possible to determine the THC level in the driver's blood at the time of the crash. In addition, determining the level of impairment based on THC levels alone, especially at lower doses, is imprecise. However, it is likely that the truck driver's blood THC level at the time of the crash was higher than the 6.6 ng/mL detected nearly 5 hours after the crash.

At the time of the crash, the truck crew was en route to assist another crew in refuse collection. On examination of the driver's work schedule, investigators found no indication of time pressure. Statements from the train crew and from the police officer who was in the lead

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[29] See description of Neurontin (gabapentin) at *DailyMed* (website), National Institutes of Health/National Library of Medicine.

[30] Schedule I drugs, substances, or chemicals are defined as drugs with no accepted medical use and a high potential for abuse.

[31] National Highway Traffic Safety Administration, *Marijuana-Impaired Driving: A Report to Congress*, DOT HS 812 440 (Washington, DC: NHTSA, 2017).

[32] "Drug Interactions," *UpToDate* (website), Lexicomp® Online (Wolters Kluwer, 2018).

[33] R. L. Hartman and others, "Effect of Blood Collection Time on Measured Δ9-Tetrahydrocannabinol Concentrations: Implications for Driving Interpretation and Drug Policy," *Clinical Chemistry* 62, no. 2 (2016): 367--377.

[34] (a) G. Skopp and L. Potsch, "Cannabinoid Concentrations in Spot Serum Samples 24–48 Hours After Discontinuation of Cannabis Smoking," *Journal of Analytical Toxicology* 32, no. 2 (2008): 160–164. (b) M. Bergamaschi and others, "Impact of Prolonged Cannabinoid Excretion in Chronic Daily Cannabis Smokers' Blood on Per Se Drugged Driving Laws," *Clinical Chemistry* 59, no. 3 (2013): 519–526.

locomotive at the time of the crash, along with the position of the truck at the time of the crash, indicate that the driver intentionally drove around the gates and attempted to cross the tracks after the grade-crossing warning system activated.

Testing with an exemplar truck showed that the crash driver would likely have had to damage the gate arm, the mailbox structure, or the side of the truck to clear the tracks. The video from the locomotive camera, along with the witness statements, indicate that the truck remained motionless for at least several seconds before impact. Although the available evidence indicates that the driver intentionally entered an active grade crossing, the extent to which his poor and unsafe actions were due to impairment requires examination.

Although both impaired and nonimpaired drivers can make the poor, unsafe decision to circumvent active warnings at grade crossings, the truck driver's actions (and the lack of them) parallel some of the effects of THC and gabapentin impairment. THC can increase the time it takes a person to respond to sudden events, a decrement that is exhibited with higher THC doses.[35] The effects of THC impairment are also exhibited in slower and poorer decision-making.[36] The truck driver's lack of response after stopping the truck and being positioned between two obstacles for several seconds is an example of slow decision-making. THC can diminish perception and executive control, necessary components of safe driving.[37] These decrements can be exacerbated when combined with gabapentin, a CNS depressant.

Thus, the NTSB concludes that based on the truck driver's postcrash toxicology and his unsafe actions at the grade crossing, particularly his indecision when he encountered obstacles while trying to cross the tracks, it is likely that he was impaired due to the combined effects of THC and gabapentin.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the crash in Crozet, Virginia, was the truck driver's decision to enter an active grade crossing and his inaction when he encountered obstacles while attempting to cross the railroad tracks, most likely due to his impairment from the combined effects of the drugs marijuana and gabapentin. Contributing to the severity of the injuries was the lack of seat belt use by the truck occupants.

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[35] R. L. Hartman and M. A. Huestis, "Cannabis Effects on Driving Skills," *Clinical Chemistry* 59, no. 3 (2013): 478–492.

[36] J. G. Ramaekers, J. H. Van Wel, and R. J. Verkes, "Cannabis and Tolerance: Acute Drug Impairment As Function of Cannabis History," *Scientific Reports* 6 (2016): 26843.

[37] A. Ménétrey and others, "Assessment of Driving Capability Through the Use of Clinical and Psychomotor Tests in Relation to Blood Cannabinoids Levels Following Oral Administration of 20 mg Dronabinol or of a Cannabis Decoction Made with 20 or 60 mg Delta9-THC," *Journal of Analytical Toxicology* 29, no. 5 (2005): 327--338. See also, as cited above, Hartman and Huestis, "Cannabis Effects on Driving Skills"; Hartman and others, "Effect of Blood Collection Time"; and National Highway Traffic Safety Administration, *Marijuana-Impaired Driving*.

Previously Issued Recommendation Reiterated in This Report

As a result of its investigation, the National Transportation Safety Board reiterates the following safety recommendation.

To the Commonwealth of Virginia:

> Enact legislation that provides for primary enforcement of a mandatory seat belt use law for all vehicle seating positions equipped with a passenger restraint system. (H-15-42)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT, III
Chairman

EARL F. WEENER
Member

BRUCE LANDSBERG
Vice Chairman

JENNIFER HOMENDY
Member

Adopted: March 11, 2019

For additional details about this crash, visit the NTSB public docket and search for NTSB accident ID HWY18MH005.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties . . . and are not conducted for the purpose of determining the rights or liabilities of any person." 49 *Code of Federal Regulations*, section 831.4. Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report. 49 *United States Code*, section 1154(b).
