Issued: September 12, 2023 Railroad Investigation Report: RIR-23-11

Collision between Amtrak Passenger Train and Union Pacific Railroad Roadway Maintenance Machine

Oakland, California
July 15, 2022

1 Factual Information

1.1 Collision Description

On July 15, 2022, about 11:01 a.m. local time, southbound Amtrak train 531, carrying 31 passengers and 4 crew, collided with an occupied Union Pacific Railroad (UP) speed swing roadway maintenance machine (RMM) at a highway-railroad grade crossing in Oakland, California.[1] The collision occurred as the RMM moved from main track 1 across main track 2, which was occupied by train 531.[2] (See figure 1.) The RMM operator was transported to a local hospital and treated for severe injuries; one passenger was transported to a local hospital for treatment for minor injuries; and two train crewmembers were treated at the scene for minor injuries. Visibility conditions were daylight and clear; the weather was 63°F with no precipitation. Amtrak estimated

[1] (a) Visit www.ntsb.gov to find additional information in the public docket for this NTSB accident investigation (case number RRD22FR011). Use the CAROL Query to search safety recommendations and investigations. (b) All times in this document are local time. (c) *Amtrak*, or the National Railroad Passenger Corporation, is a passenger railroad service that provides medium- and long-distance intercity passenger rail service in the contiguous United States and to nine cities in Canada. (d) A *speed swing* is a piece of equipment used to lift and move material; in this case, the roadway crew intended to use the speed swing to move automobiles abandoned in and near the railroad right-of-way.

[2] A house track (track used to store equipment) also intersects 50th Avenue at this crossing. The house track was not involved in the collision.

equipment damage to be about $92,000; UP estimated track and equipment damage to be about $216,000.

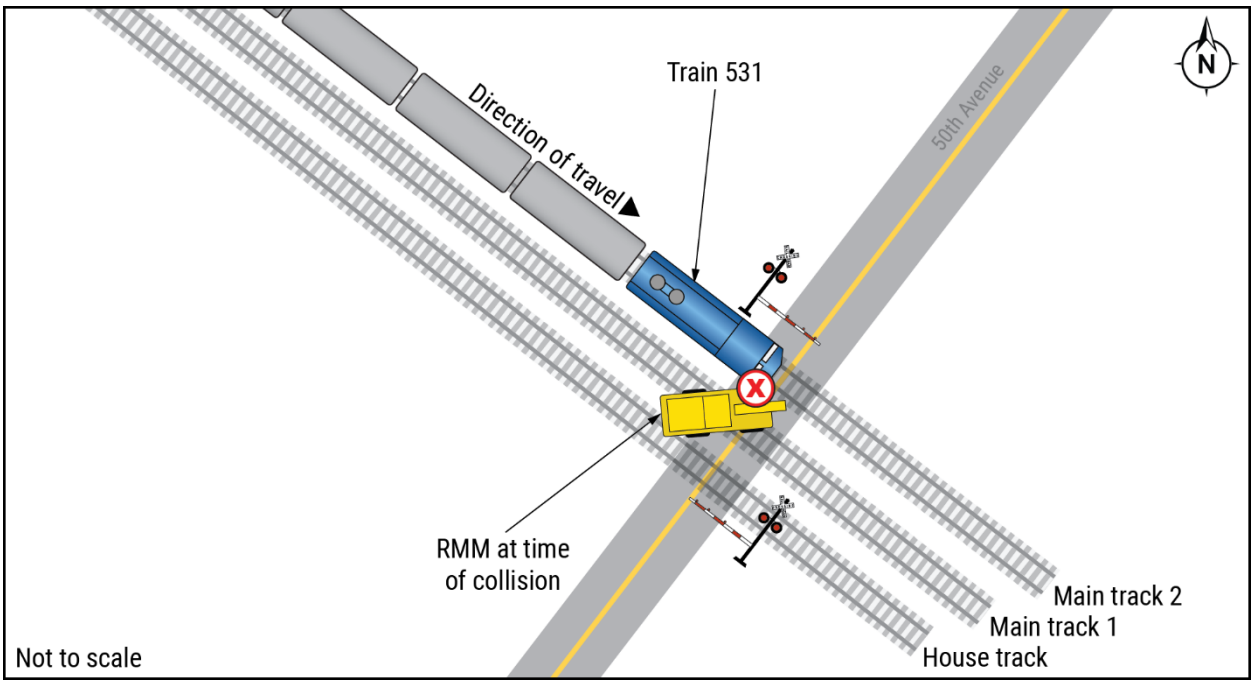

Figure 1. The collision site.

Amtrak train 531 was traveling from Sacramento, California, to San Jose, California. The train consisted of one head-end locomotive, four coach cars, and one cab car at the rear of the train.[3] Its crew of four Amtrak employees included one engineer in the locomotive.

The RMM was a Speed Swing Model No. 445E manufactured by Pettibone and owned and operated by UP as speed-swing No. SS007; it was a hi-rail vehicle capable of operating over highways and railroad tracks. On the day of the collision, the RMM was being used by a UP roadway work group assigned to the Alameda County Regional Auto Theft Task Force. A single operator was on board at the time of the collision. Two other UP personnel, a roadway worker-in-charge (RWIC) and a backhoe operator, were also part of the roadway work group.

The track near the collision was owned by UP.[4] The maximum operating speed for passenger trains in the area was 79 mph as set by timetable, and UP authorized train

[3] A *cab car* is a non-powered railcar from which a train can be operated.

[4] Amtrak trains regularly operate over track owned by other railroads.

movements through the area with a traffic control signal system.[5] Train movements were coordinated by a UP dispatcher at the UP dispatch center in Omaha, Nebraska. The track was signalized and equipped with a positive train control system that enforced signal indications.[6] The positive train control system was enabled and operating at the time of the collision.

The collision occurred at crossing number DOT 749716B (hereafter the crossing).[7] The crossing was at milepost 10.77 on the Niles Subdivision where main tracks 1 and 2 and a house track intersect 50th Avenue, a two-lane public highway. It was an active crossing, meaning that it was equipped with active warning devices to indicate a train approaching or occupying the crossing. The active warning devices at the crossing consisted of two sets of mast-mounted flashing lamps and two gates (one gate and set of lamps for each direction of highway approach). Each gate extended across a single lane of traffic when lowered.

Based on the engineer's interview with the National Transportation Safety Board (NTSB), train 531 was about three-quarters of a mile from the crossing on main track 2 when the engineer observed the RMM on main track 1. The engineer said that the RMM appeared to be stopped and that he commonly saw equipment stopped on adjacent tracks. According to event recorder data, the engineer began a horn sequence at 11:01:02 a.m. while about 1,440 feet from the crossing and traveling at 73 mph. (See section 1.7.1 for regulations on horn use at crossings.) Review of electronic crossing records showed the RMM operator had already lifted the RMM's rail gear wheels.[8] Image data from the locomotive's forward-facing image recorder showed the RMM stationary on main track 1; the RMM was facing away from the train with its wheels parallel to the track. At 11:01:11 a.m., the RMM visibly moved, and at 11:01:13 a.m., it began to turn toward main track 2. As shown by the locomotive's forward-facing image recorder and

[5] See Roseville Area Timetable No. 8, effective May 5, 2022.

[6] A *positive train control system* enforces speed limits and prevents a train from passing through a signal that requires it to stop.

[7] This designation is from the US Department of Transportation Crossing Inventory, a database of intersections between railroad tracks and public highways, roads, streets, and private roadways.

[8] The RMM was a hi-rail vehicle, meaning it had tires for traveling over highways and *rail gear wheels* for traveling over rails. On some hi-rail vehicles, including the one involved in this collision, the rail gear wheels can occupy a track circuit when lowered. The rail gear wheels must be lifted before a hi-rail vehicle can cross from one track to another. When the rail gear wheels are lifted from signalized track, they no longer occupy the track circuit, and signal or crossing prediction systems can detect that the vehicle is no longer on the rails. This change does not provide information about the physical location of the vehicle, including whether it is still positioned across a track.

the NTSB's review of the crossing's electronic records, the crossing's gates were down and its lamps were flashing, indicating an approaching train. (See figure 2.)

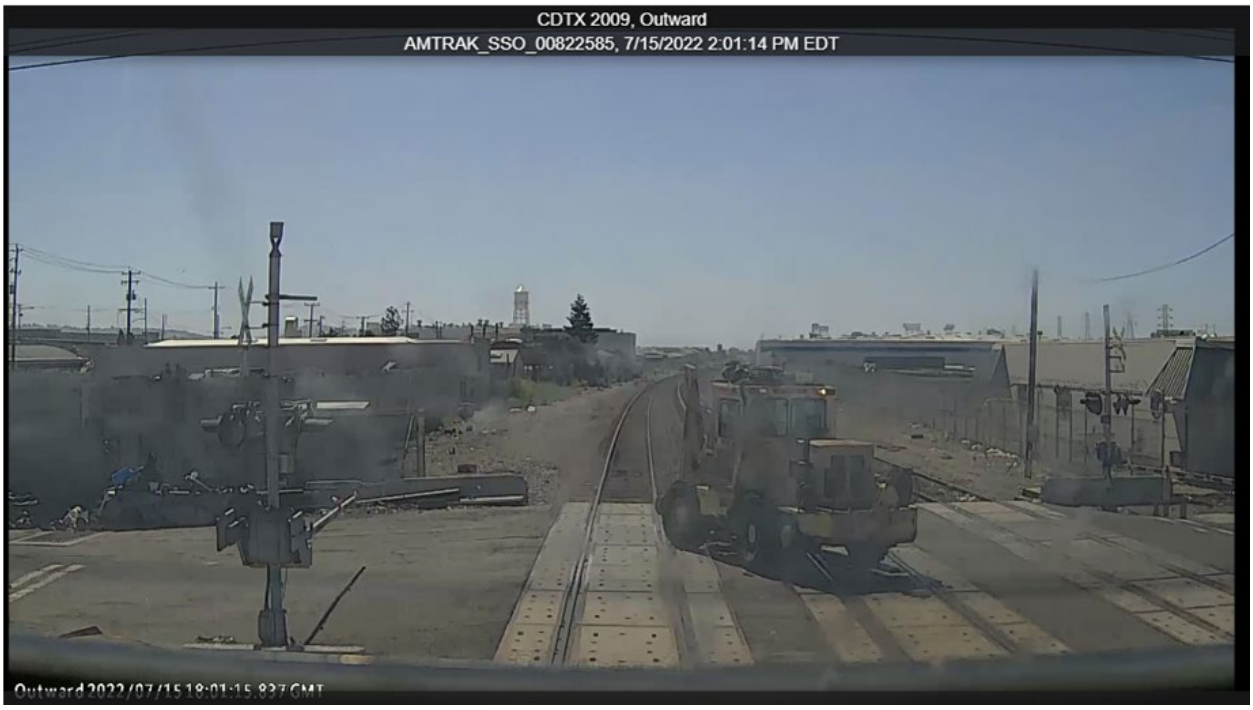

Figure 2. Locomotive image recorder frame showing the RMM shortly before the collision.

The engineer began the last part of the horn sequence and attempted an emergency application of the train's brakes as the RMM fouled main track 2.[9] The train struck the RMM at 11:01:16 a.m. at 68 mph and continued moving through the crossing. The engineer told the NTSB that the impact rocked the locomotive and prevented him from moving the brake handle to the emergency position immediately. Event recorder data showed that he began the emergency brake application after the collision at 11:01:19 a.m. The train stopped with its head end about 1,600 feet past the crossing. The engineer heard a roadway worker shouting that there was an emergency and contacted the UP dispatcher for assistance. Emergency responders arrived on the scene in about 5 minutes.

The RMM was destroyed by the collision. (See figure 3.) The RMM operator was severely injured, and emergency responders transported him to a local hospital for treatment. The locomotive of train 531 was heavily damaged; the front-right bulkhead was deformed and the engine was rendered inoperable. (See figure 4.) Two Amtrak

[9] *Fouling* refers to a person or object being in proximity to a track such that the person or object could be struck by a moving train.

employees were treated at the scene for minor injuries and one passenger was transported to a local hospital for treatment of minor injuries.

Figure 3. The RMM after the collision.

Figure 4. The locomotive after the collision.

1.2 Before the Collision

1.2.1 Amtrak Train 531

According to Amtrak records, train 531 underwent a pre-departure brake test on the morning of the collision, and the locomotive and passenger cars had a daily inspection on the evening of July 14, 2022. The test and inspections were performed in Oakland, California, by qualified Amtrak maintenance personnel in accordance with 49 *Code of Federal Regulations* (*CFR*) Parts 229 and 238.

The train's crew went on duty at 8:00 a.m. in Sacramento, California, and held a job briefing before departing on time. The engineer told the NTSB that the trip was uneventful before the collision.

1.2.2 RMM and Roadway Work Group

The RMM's last recorded safety inspection was on March 28, 2022. Investigators recovered a work equipment log from near the wreckage, but the log did not include records of a daily equipment inspection.

The NTSB interviewed the RWIC and backhoe operator to understand the events leading up to the collision. On the day of the collision, the roadway work group conducted a morning safety call and a 10:00 a.m. job briefing during which the RWIC outlined the planned work for the day. The roadway work group intended to use the RMM and backhoe to recover abandoned automobiles from near the tracks. The RWIC secured track authority from the UP dispatcher, who granted exclusive track occupancy for main track 1 to allow the RMM to reach the work site by rail.[10] The other two members of the roadway work group planned to travel by highway. The RWIC told the NTSB that he instructed the RMM operator to remain on main track 1 until the RWIC arrived, and that he planned to secure track authority for main track 2 to protect the automobile recovery work.

The backhoe operator told the NTSB that he arrived at the crossing first and parked the backhoe west of main track 1. He remained in the backhoe and saw the RMM arrive about 30–40 minutes later. The backhoe operator said that he was not looking at

[10] *Exclusive track occupancy* is a method of establishing working limits within which movement authority for trains and other equipment is held by an RWIC as described in 49 *CFR* 214.321. Under exclusive track occupancy, trains and other equipment are not permitted to enter the established working limits except as directed by the RWIC. See section 1.8.2.

the RMM during the collision but that he heard the impact. The RWIC arrived at the crossing after the collision.

1.3 Postcollision Inspections

1.3.1 Highway-Railroad Grade Crossing

On July 22, 2022, the Federal Railroad Administration (FRA) and NTSB inspected the crossing's warning system, including the rail crossing predictors that activate the lights and lower the gates when a train approaches. The inspection did not identify any problems that would have affected the system's operation.

1.3.2 Train 531

On July 17, 2022, the FRA observed tests of train 531's air brakes and the locomotive's horn, bell, and headlights. All systems that were not damaged by the collision severely enough to prevent testing functioned as designed.[11]

1.4 Sight Distance Observations

The NTSB's on-scene observations found that a signal cantilever extending across the tracks at milepost 9.6, or 1.11 miles from the collision site, was visible from the crossing. Southbound trains pass below this signal cantilever while approaching the crossing, and investigators used the signal cantilever's position to calculate the sight distance between the crossing and approaching trains to be a minimum of 1.11 miles.

1.5 Personnel Information

1.5.1 Amtrak Engineer

The locomotive engineer was hired by Amtrak on February 15, 2010, as a conductor, and was promoted to locomotive engineer on September 6, 2013. He operated over the Sacramento to San Jose route an average of 2–3 times each week. A review of the engineer's training records showed that he completed his last

[11] Damage to the locomotive forced testers to use a second locomotive to provide air pressure to test the brakes, which applied and released normally. Damage to the accident locomotive's auxiliary lights precluded testing.

re-certification on May 13, 2021, and his last engineer certification general knowledge exam on May 12, 2021.

1.5.2 RMM Operator

According to training records provided by UP, the RMM operator was first qualified to operate the speed swing in July 2007. The operator completed his last training in May 2021. UP representatives reported that the May 2021 training, a web-based training module titled "Engineering Services Roadway Maintenance Machine Training," did not include instructions regarding safety when occupying or operating over highway-railroad grade crossings.

1.6 Toxicology

Because there were no indications that the engineer violated regulations or operating procedures, he was not required to undergo drug or alcohol testing.[12]

The RMM operator underwent FRA postaccident toxicology testing.[13] Specimens tested positive for fentanyl at 1.3 nanograms per liter (blood) and 9.1 nanograms per liter (urine). His urine also tested positive for carboxy-tetrahydrocannabinol, the inactive metabolite of delta-9-tetrahydrocannabinol, at 18 nanograms per liter.[14] Delta-9-tetrahydrocannabinol was not detected in blood or urine specimens. According to hospital records, the RMM operator received fentanyl as pain management during treatment for injuries sustained during the collision.

[12] See 49 *CFR* 219.201(a)(5) and 49 *CFR* 219.201(b) for testing requirements.

[13] As part of FRA's post-accident toxicology testing, urine specimens are screened for amphetamines, barbiturates, benzodiazepines, cannabinoids, cocaine, MDMA/MDA, methadone, opiates/opioids, phencyclidine, tramadol, brompheniramine, chlorpheniramine, diphenhydramine, doxylamine, and pheniramine, and blood specimens are screened for ethyl alcohol. Confirmatory testing is performed on blood and urine for positive results.

[14] *Delta-9-tetrahydrocannabinol*, usually called THC, is the main psychoactive compound in marijuana. Its mood-altering effects include euphoria and relaxation. In addition, marijuana use causes changes in motor behavior, perception of time and space, and cognition. Significant performance impairments are usually observed for at least 1–2 hours after marijuana use, and residual effects have been reported after up to 24 hours. *Carboxy-tetrahydrocannabinol*, or THC-COOH, is produced as the body breaks down THC and is not psychoactive. THC-COOH is stored in fatty tissues and can be detected in the body for weeks.

1.7 Regulations and Operating Rules

1.7.1 Horn Use

Federal regulations at 49 *CFR* 222.21(a) require that a locomotive horn be sounded four times (long, long, short, long) as the locomotive approaches a public highway-railroad grade crossing. Usually, the first blast should be sounded between 15 and 20 seconds before the locomotive enters the crossing, as described in 49 *CFR* 222.21(b)(2). However, under 49 *CFR* 221.21(b)(3), if a train is approaching a crossing at more than 60 mph, the horn must be sounded no more than one-quarter mile (1,320 feet) from the crossing even if this reduces the warning time to less than 15 seconds. An engineer is not in violation of this requirement if they sound the horn early, provided that they act in good faith and do not sound the horn more than 25 seconds before entering the crossing. Regardless of the timing of the first blast, the last blast is to be maintained or repeated until the locomotive occupies the crossing.

1.7.2 Roadway Worker Protection

Federal regulations at 49 *CFR* 214 Subpart C contain requirements and methods for roadway worker protection, including exclusive track occupancy. Under 49 *CFR* 214.321, exclusive track occupancy is secured by placing track within working limits under the authority of one RWIC, who then controls movements through the working limits, coordinates with flagmen stationed at each entrance to the track within the working limits, or causes fixed signals at each entrance to the working limits to display an aspect requiring trains to stop. Movement of trains and other equipment, including RMMs, within working limits may occur only under the direction of the RWIC.

1.8 Postcollision Actions

On March 14, 2023, UP informed the NTSB that it has revised its web-based training regarding highway-railroad grade crossing safety for RMM operators. Under the revised training, RMM operators may set their equipment off the track at highway-railroad grade crossings while warning devices are activated and exit the crossing by following one of two procedures:

- If possible, the operator must exit the crossing without fouling the adjacent track—that is, exit the crossing on the "field side."
- If they need to cross a live track, the operator is to turn off the AM/FM radio and any other audible distraction in the vehicle, and roll down the driver's-side window to allow them to hear the approach of a train or on-track

equipment.[15] The driver should ensure that there is enough sight distance to make a safe movement across the live track or tracks and should use a flagman when available.

UP's revised training also instructs operators to follow these procedures at crossings that are not equipped with active warning devices.

2 Analysis

In this collision, Amtrak train 531, traveling southbound on main track 2 of the Niles Subdivision, struck an occupied UP RMM at an active highway-railroad grade crossing. The RMM was crossing main track 2 from its original position on main track 1 at the time of the collision. Main track 1 near the collision site was protected by exclusive track occupancy within working limits established by a UP RWIC, but main track 2 was not. The RMM operator was severely injured; two Amtrak employees and one passenger on board train 531 were treated for minor injuries.

Based on interviews and data from the locomotive's event and image recorders, the NTSB determined that the train was traveling at 73 mph, below the maximum authorized speed of 79 mph, while approaching the crossing, and that the engineer responded appropriately to the presence of the RMM by sounding the locomotive's horn and attempting an emergency application of the train's brakes. About 3 seconds elapsed between the first visible movement of the RMM toward main track 2 and the collision; therefore, the engineer did not have time to avoid the collision, and his handling of the train was not a contributing factor.

The NTSB inspected the grade crossing warning system—including gates and flashing lamps activated by a rail crossing predictor—after the collision and found it operational. Image data from the locomotive's forward-facing image recorder showed the gates down and the lamps flashing before the collision. The NTSB also reviewed electronic records from the crossing itself. The records, images, and inspection results indicated that the crossing's active warning devices were functional and activated 28 seconds before the train reached the crossing.

The NTSB's sight distance observations showed that southbound trains were visible a minimum of more than 1 mile from the crossing. There was no evidence of visibility conditions that could have reduced the RMM operator's ability to see a train.

[15] *Live track* refers to unprotected track where train and equipment movements are not controlled by an RWIC.

No evidence suggests that the RMM operator was aware of the approaching train, toxicology testing did not indicate impairment, and the investigation did not determine why the RMM operator fouled main track 2. However, the most recent training received by the RMM operator did not specifically address safe operation of RMMs over track at highway-railroad grade crossings, and the RMM operator's decision to cross main track 2 despite the sounding of the locomotive's horn and a clear line of sight to the approaching train suggests that the RMM operator did not look or listen for trains before moving the RMM off protected track.

As a result of this collision, UP has revised its training for RMM operators to include instructions for how to exit highway-railroad grade crossings safely when warning devices are activated or not present. The revised training instructs operators to exit the crossing without fouling adjacent track when possible and, when fouling a track is unavoidable, to turn off audible distractions such as AM/FM radios, roll down a window to listen for trains or other equipment, and proceed only after confirming that there is enough sight distance to complete the movement safely.

3 Probable Cause

The National Transportation Safety Board determines that the probable cause of the collision between the Union Pacific Railroad roadway maintenance machine and Amtrak train 531 was the roadway maintenance machine operator moving for unknown reasons onto unprotected track and into the path of an approaching train.

The NTSB is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in the other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

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" (Title 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 (Title 49 *United States Code* section 1154(b)).

For more detailed background information on this report, visit the NTSB Case Analysis and Reporting Online (CAROL) website and search for NTSB accident ID RRD22FR011. 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