April 14, 2022 Railroad Investigation Report NTSB/RIR-22/07

Collision Between Sacramento Regional Transit District Light Rail Vehicles

Sacramento, California
August 22, 2019

Abstract: This report discusses the August 22, 2019, collision between Sacramento Regional Transit (SacRT) District light rail vehicles in Sacramento, California. Thirteen people were transported to area hospitals with non-life-threatening injuries. Neither train derailed, and both trains experienced minimal structural damage. Safety issues identified in this report include performance deficiencies of the transportation supervisor as a controller; SacRT's failure to monitor the transportation supervisor's performance to ensure competency; irregular train operator reporting of train delays to Metro Control; SacRT's undefined testing practices on the mainline tracks; the impact of the California Public Utilities Commission's instruction to test vehicles after revenue hours; and the lack of transmission-based train control use on the SacRT light rail system. Four recommendations were made to the Sacramento Regional Transit District and one recommendation was made to the California Public Utilities Commission; one recommendation was reiterated to the Federal Transit Administration.

NOTE: This report was reissued on July 6, 2022 with corrections to the Board Member Concurrences that were not included in the previous posted report on page 30.

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Acronyms and Abbreviations

CPUC	California Public Utilities Commission
FTA	Federal Transit Administration
LRV	light rail vehicle
NTSB	National Transportation Safety Board
PIP	performance improvement plan
SacRT	Sacramento Regional Transit District
TBTC	transmission-based train control

Executive Summary

What Happened

On August 22, 2019, at 9:38 p.m. local time, northbound Sacramento Regional Transit District (SacRT) passenger train 9 collided head-on with a stopped southbound nonrevenue test train on the blue line near milepost 6.72 in Sacramento, California, at a speed of 32 mph. Train 9 had 1 operator and 27 passengers on board. The test train had one operator and two contractors on board. Thirteen people were transported to area hospitals with non-life-threatening injuries. Neither train derailed, and both trains experienced minimal structural damage. SacRT estimated damage to be $242,450.

What We Found

The collision happened because the transportation supervisor did not adhere to SacRT's controller procedures by allowing the test train to enter the mainline track without knowing the location of the passenger train or alerting the passenger train operator of the presence of the test train. We found that conspicuous warning devices placed on the main track before the test train began its testing would have alerted the operator of the passenger train of the ongoing testing. We noted that a fully implemented transmission-based train control system could have applied the brakes of the passenger train and stopped it before it collided with the test train.

Following the collision, the California Public Utilities Commission issued a letter instructing SacRT to immediately cease testing or troubleshooting of trains on its mainline track during revenue hours. We found the hazards of conducting high-speed testing during nonrevenue hours are different than those during revenue hours and identifying and addressing these hazards can help improve the safety of high-speed testing.

Although the transportation supervisor was on a performance improvement plan, it ended early due to a change in assignment provision. Had the improvement plan not ended, SacRT management would have been required to monitor the transportation supervisor's performance for 30 more days while he was on a new evening shift performing dual responsibilities.

The National Transportation Safety Board determines that the probable cause of the collision of two Sacramento Regional Transit District light rail trains was the Sacramento Regional Transit District's weak administrative controls that allowed the transportation supervisor to authorize a high-speed test train to enter the mainline without knowing the location of passenger train 9 on the same track. Contributing to the collision was senior management's failure to assess the transportation supervisor's competency in the combined role as both the controller and dispatcher on the evening shift.

What We Recommended

As a result of this investigation, we made recommendations to SacRT to do the following: ensure employee performance is monitored and evaluated while on a performance improvement plan for the intended duration of the plan or until the employee has demonstrated competency in the position they occupy; conduct a risk assessment of mainline high-speed testing and revise testing schedules and communication requirements to ensure that necessary controls are in place; improve the train delay reporting process; and install a transmission-based train control system. We also recommended that the California Public Utilities Commission revise its instruction to SacRT and require SacRT to conduct a formal risk assessment of high-speed testing.

Further, we reiterated a recommendation to the Federal Transit Administration to require rail transit agencies to implement transmission-based train control systems that prevent train collisions.

1. Factual Information

1.1 Collision Description

On August 22, 2019, at 9:38 p.m. local time, northbound Sacramento Regional Transit District (SacRT) light rail vehicle (LRV) train 9, a revenue passenger train, was traveling 32 mph when it collided head on with stopped southbound SacRT LRV train 310 (a nonrevenue "test train"), in Sacramento, California.[1] The incident occurred on the blue line on an outbound mainline track section near milepost 6.72. Train 9 had one operator and 27 passengers on board. The test train had one operator and two contractors on board. Thirteen people were transported to area hospitals with non-life-threatening injuries. Neither train derailed and both trains experienced structural damage. SacRT estimated damage to the LRVs to be $242,450.[2]

1.2 Events Before the Collision

1.2.1 Train 310 – Test Train

On August 22, 2019, the SacRT test train operator had recently completed maintenance on the test train and intended to verify that the propulsion system was operational. High-speed testing of the train was planned to occur on the outbound mainline track from the Metro Heavy Repair Facility, which was just south of Marconi/Arcade Station, northbound to Grand Avenue Bridge about 1 mile away, then reverse and continue testing southbound on the same track back to the maintenance facility.[3] (See Figure 1.) SacRT commonly performs high-speed testing on its mainline at this location, and typically the tests take about 10 minutes.

[1] All times in this report are in local time unless otherwise noted.

[2] Visit ntsb.gov to find additional information in the public docket for this NTSB investigation (case number RRD19FR011). Use the CAROL Query to search safety recommendations and investigations.

[3] In this report *high-speed* refers to speeds equal to or greater than 50 mph.

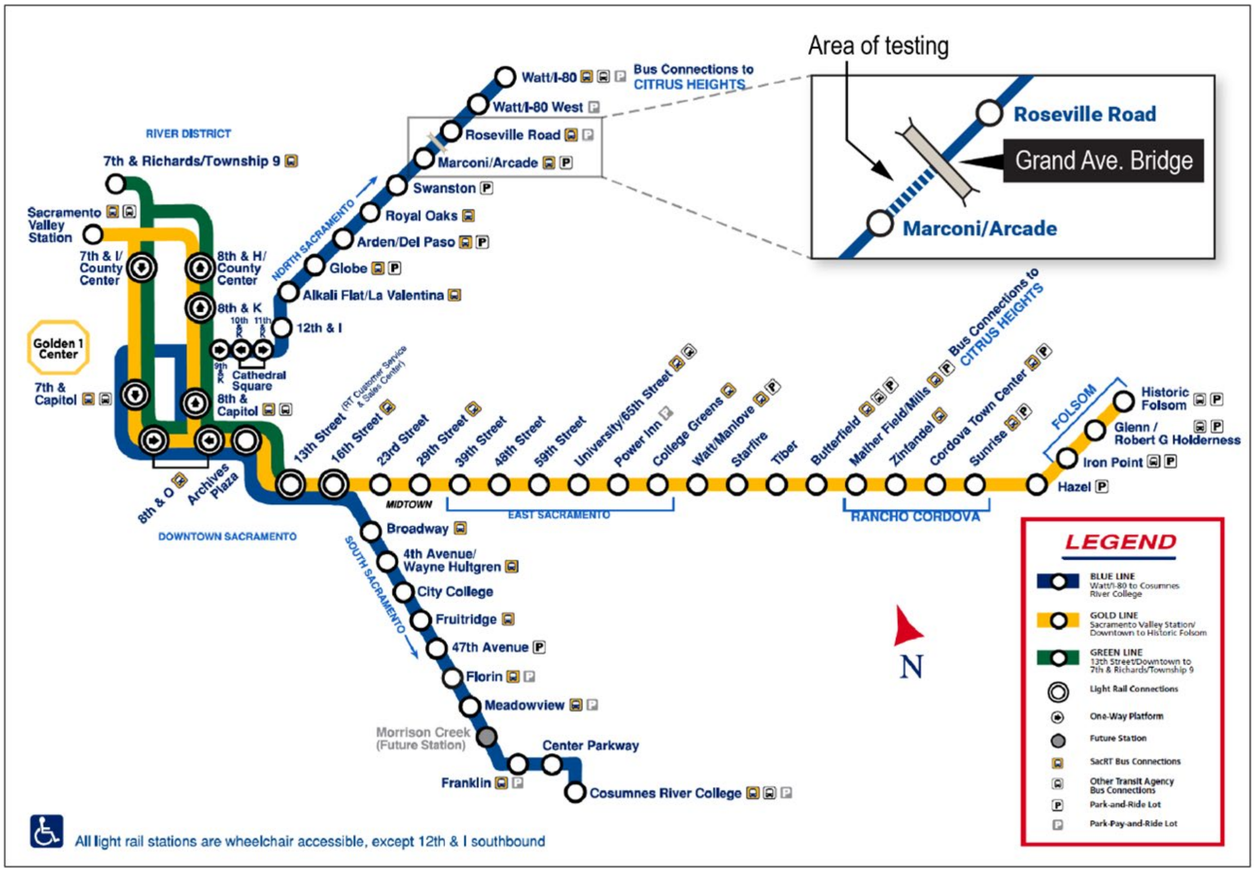

Figure 1. Sacramento Regional Transit District map highlighting area of testing. (Source: SacRT.)

At 9:24 p.m., the test train operator made a telephone call to the transportation supervisor at Metro Control to ask if he could soon conduct high-speed testing on the mainline. The transportation supervisor responded that it was a good time to perform this testing.[4] The transportation supervisor later told the National Transportation Safety Board (NTSB) investigators that during the telephone call, he instructed the test train operator to wait until outbound passenger train 9 passed by the maintenance facility, and then contact him (the transportation supervisor) by radio to receive formal permission. The test train operator told the NTSB that they did not discuss train 9 during this telephone call.

To permit the test train operator to enter the mainline, the transportation supervisor had to ensure that other trains were not in the area where the test train would be operating. He was required to issue an advisory over the radio notifying all

[4] (a) This telephone call was made to the transportation supervisor’s landline. There was no recording of this conversation. (b) Transportation supervisor duties and responsibilities are explained in section 1.6.2 of this report.

trains operating on the mainline that a test train was entering the outbound mainline from the maintenance facility to Grand Avenue Bridge and reversing back to the maintenance facility.[5] The transportation supervisor was also required to have a radio conversation with the operator of the train closest to the maintenance facility (in this case, train 9) to verify its exact location. However, the transportation supervisor did not perform any of these procedures nor did he access the consist manager, a computer program that tracks the location of trains by global positioning system, to identify the location of all the trains on the system. He told the NTSB that at the time the test train operator called him, "ten things were going on at once," including a situation involving an unruly passenger on another revenue train.

The test train operator, who boarded the train along with two contractors, radioed the transportation supervisor and received authority to enter the mainline at 9:31 p.m., about 7 minutes after the initial phone call.[6] The transportation supervisor and test train operator did not discuss the location of train 9 during the radio communication. The test train operator then activated the track switch to line it from the maintenance facility to the outbound mainline. The test train entered the mainline just south of Marconi/Arcade Station at 9:32 p.m. on a green signal and proceeded northbound toward Grand Avenue Bridge.[7]

The test train operator operated the train at various speeds (up to 50 mph) and did not experience any deficiencies with the equipment. The test train arrived at Grand Avenue Bridge at 9:36 p.m. About 1 minute later, the operator changed direction of travel to return to the maintenance facility on the same track and continued to assess the train's performance operating at a slower speed while traveling southbound.[8] Shortly into his return trip, the test train operator noticed a headlight about 400 yards ahead of him that was partially obscured by trees and vegetation.[9]

[5] An *advisory* is information transmitted by Metro Control to train operators. Train operators were not required to acknowledge receipt of the message.

[6] Calls made radio-to-radio are recorded. However, the transportation supervisor did not note this communication into his log, which was required.

[7] A *green signal* allows a train to proceed at maximum authorized track speed throughout the block, which is a length of track of defined limits, where the movement of trains is governed by block signals.

[8] LRVs can be operated from either end of the vehicle.

[9] The test train operator told investigators that automobiles on a highway parallel to the tracks and trains traveling on an adjacent Union Pacific Railroad track can produce a similar visual effect.

He could not determine if the headlight he saw ahead of his train was on the same track until the opposing train, train 9, traveled around the curve and cleared the trees. (See figure 2.) At 9:38 p.m., while operating about 28 mph, the test train operator applied dynamic braking to slow his train.[10] Soon thereafter, he applied the emergency brakes, stopped the train, and evacuated the control cab into the passenger area before impact.

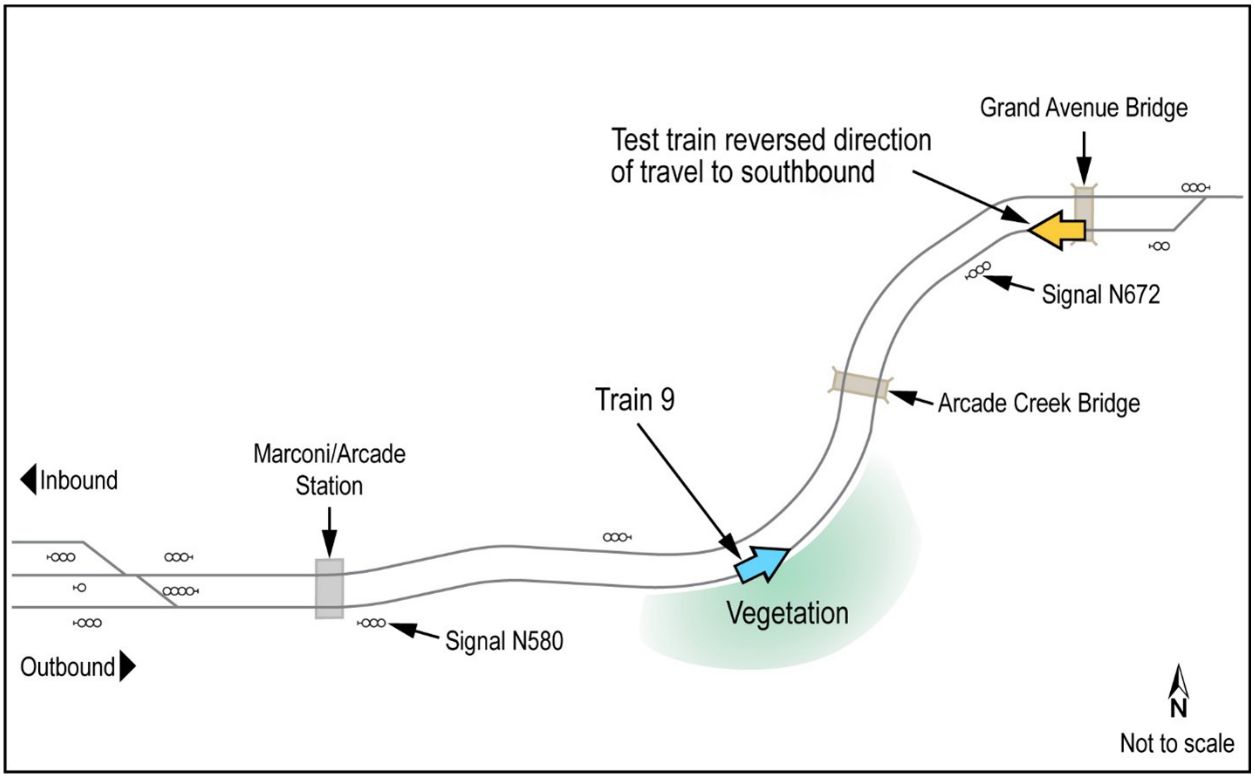

Figure 2. Train positions before the collision.

1.2.2 Train 9

The train 9 operator went on duty at 2:20 p.m. and then departed on the first of four scheduled roundtrips; the collision occurred on the third trip. During his first trip, the operator experienced a 15-minute delay due to a fire truck and an ambulance at 8th Street that were blocking the gold and green lines. This delay carried over to his subsequent trips. Early in his third trip, which was on the blue line, he radioed from Meadowview Station (about 45 minutes from Marconi/Arcade Station) to the transportation supervisor at Metro Control that he was delayed 15 minutes. The train 9 operator told investigators that he had radioed Metro Control

[10] *Dynamic braking* is a method of slowing the locomotive and train by using the LRV traction motors as generators. The current generated by the motors is dissipated through fan-cooled grids.

after reaching Arden/Del Paso Station (three stations south of Marconi/Arcade Station) to again report his delay.[11]

Train 9 continued traveling northbound on the outbound track (all northbound trains operate on the outbound track) and stopped at Marconi/Arcade Station. Train 9 departed Marconi/Arcade Station at 9:37 p.m. on a yellow station-leaving signal (signal N580).[12] The operator told investigators that it is not unusual to depart a station on a yellow signal or encounter a yellow signal along the track because trains typically are following other trains that cause the signals to automatically change from green to yellow. (The signal system is discussed further in section 1.5.)

The train soon crossed the Arcade Creek Bridge, and the operator saw the next signal (intermediate signal N672) about 250 to 300 yards away. As the operator approached that signal, he perceived the signal to have changed multiple times, with colors appearing for 2 or 3 seconds. Specifically, he saw the signal aspect change from yellow to red, and he applied the brakes to slow the train to stop at the red signal. He then observed that same signal change back to yellow then to red, and finally back to yellow.[13] (Postaccident testing indicated that a yellow aspect would have been displayed at N672 when train 9 departed the station and that a red aspect would have been displayed just before the collision.)

The train then entered a right-hand curve, and the operator saw a headlight from the opposing direction but was unable to immediately determine from what track. As his train proceeded, he noted that the opposing headlight was approaching on the same track about 65 yards away. At 9:38 p.m., while traveling 48 mph, the operator initiated emergency braking then activated the "deadman" feature and braced himself for impact.[14] Train 9's collision with the test train occurred seconds

[11] The recordings of the radio transmissions captured the train 9 operator only saying "Metro, train 9." Radio transmissions can be affected by operators improperly using the radio by, for example, not completely pressing the talk button or releasing it before the message is complete.

[12] SacRT Operational Rule 3.27—A *station leaving signal* is a special block signal providing indications of track occupancy of the next two blocks while simultaneously indicating grade crossing protection. Operators may proceed with caution on a "yellow" aspect but remain aware the next aspect could be "red." Operators must stop on a red signal.

[13] The NTSB conducted sight distance observations to determine what signal N672 was likely showing when the train 9 operator observed the test train's headlight. The headlight from the test train presented itself momentarily at the same height and adjacent to the aspect of wayside signal N672. During this recreation, investigators perceived it appeared as if the signal were presenting alternating colors beginning with a red aspect next to a white aspect; then a single yellowish aspect; and then a white aspect adjacent to a red aspect.

[14] The *deadman feature* is a device used on rail vehicles that must be held in the operating position while the vehicle is in motion and will bring the vehicle to a stop when released.

later, 50 yards south of the intermediate signal N672. Train 9 was traveling 32 mph when it collided with the stopped test train. (See figure 3.)

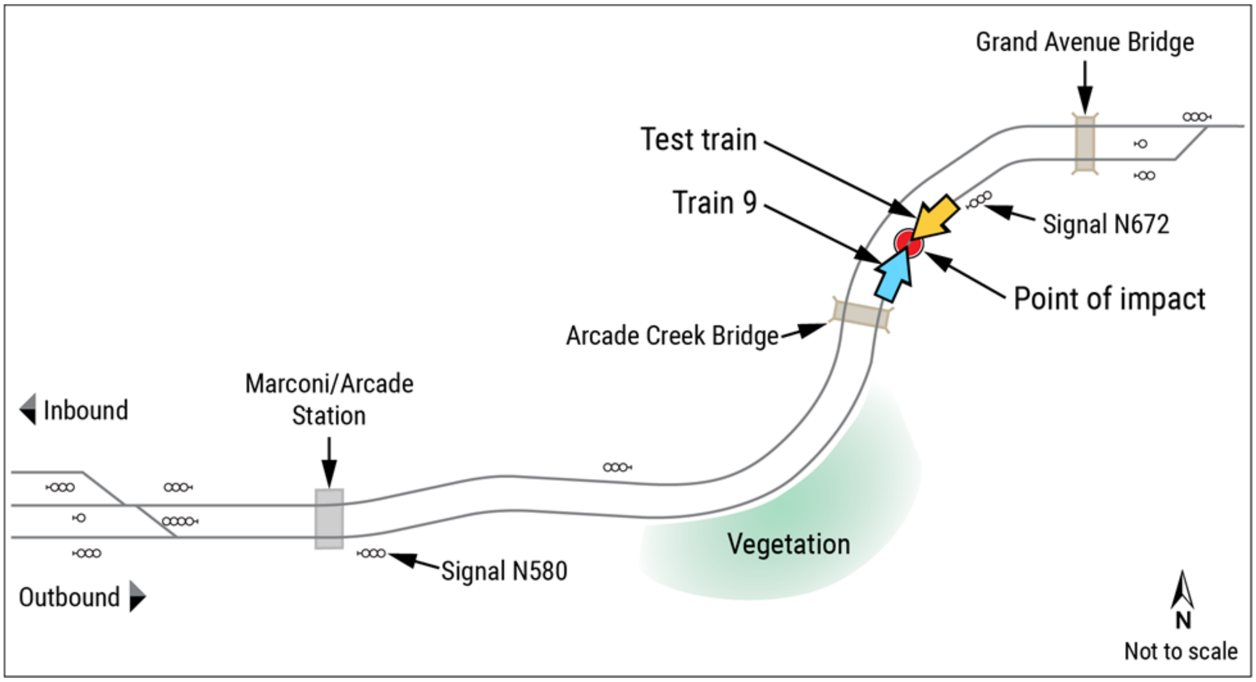

Figure 3. Movement of test train (LRV 310) and train 9 leading to the collision.

After the collision (See figure 4.), both operators radioed Metro Control to report the collision. The Sacramento police and fire departments, along with SacRT officials, responded to the collision. At the time of the collision, most passengers had been seated and many were thrown to the floor. Thirteen people were transported to area hospitals with non-life-threatening injuries.

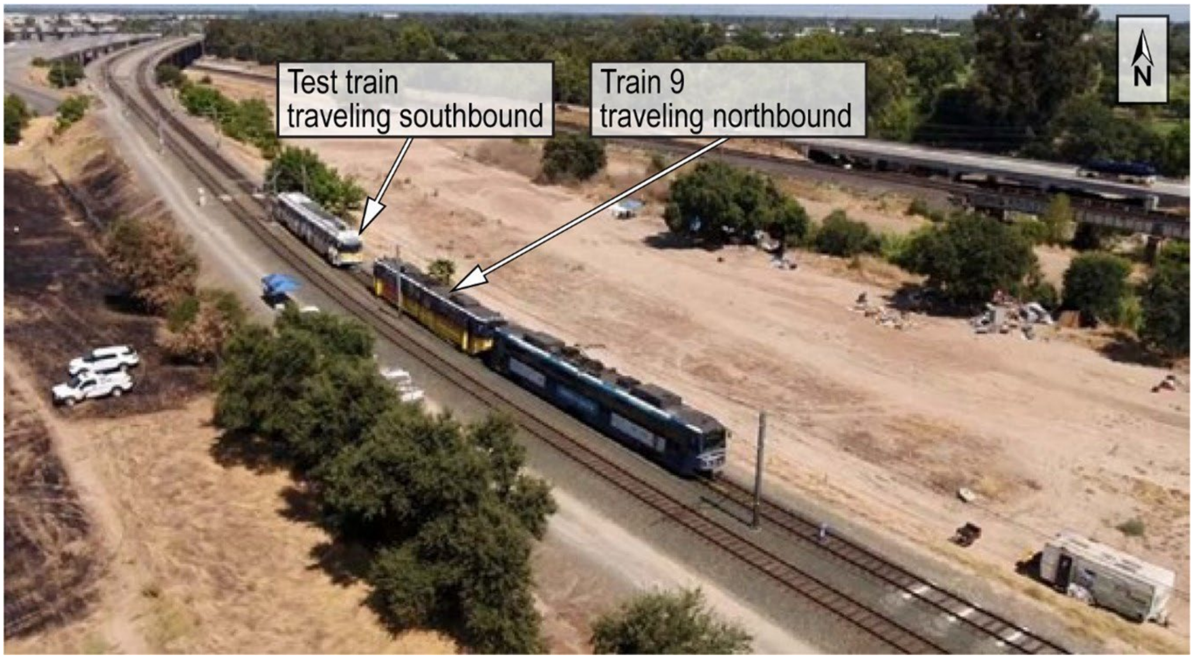

Figure 4. Aerial view of collision site. (Source: Associated Press.)

1.3 Equipment

Train 9 consisted of LRVs 103 and 227, and the test train was a single car train, LRV 310. Each LRV is a single-car, electrically powered vehicle designed to operate bidirectionally and equipped with an operating control cab at each end. The braking system is both friction and dynamic.[15]

1.4 Track Description

SacRT maintains a portion of the two main tracks on the blue line to Federal Railroad Administration track safety standards for Class 3 track, which allowed for a maximum operating speed of 60 mph.[16] The maximum authorized speed in the collision curve was 55 mph. The track in the area of the collision was last inspected on

[15] *Friction brakes* consist of one inboard friction ring with a pneumatic caliper mounted on each axle and two track brakes on each truck. A *track brake* is an electromagnetically activated mechanism that slows or stops the LRV by transmitting the braking force against the running rail. A *truck* is the frame assembly under the cars that contain the axles, wheels, and electric motors. As stated above, dynamic braking uses the LRV traction motors to provide resistance to slow the train.

[16] The Federal Transit Administration (FTA) has no official track safety standard regulations; therefore, SacRT chose to use the Federal Railroad Administration track safety standards outlined in Title 49 *Code of Federal Regulations* Part 213.

August 15, 2019, by a SacRT-qualified track inspector. The track inspector noted no defects in his report.

1.5 Signal System

Train movements on the segment of track where the collision occurred were governed by operating rules, general orders, and the signal indications of an automatic block signal system. An automatic block system is a series of consecutive blocks along the track in which signals are controlled by the trains themselves. Entry to each block is governed by block signals. The presence or absence of a train is determined by track circuits, which are activated by a train or by certain conditions affecting the use of the block. Signals are arranged for train movements in a specified direction on the inbound and outbound mainline tracks. (See figure 5.) For example, signal N580 has two track circuits in it, 580T and 620T, which end near signal N672. Track circuit 722T is the only track circuit for signal N672.

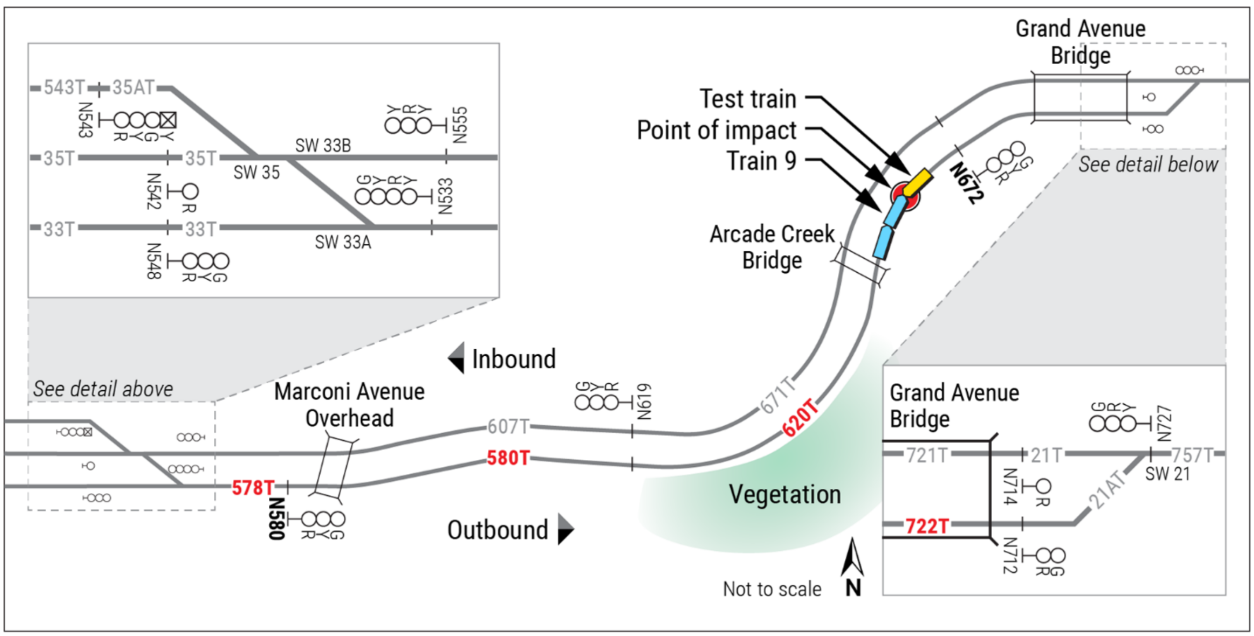

Figure 5. SacRT collision area depicting track circuits and signaling system.

The NTSB verified the track circuits for 578T, 580T, 620T and 722T.[17] After verifying the track circuits operated as the system was designed, investigators simulated train movements in both directions on the outbound track observing signal N672 to see how the signal aspects were displayed. During the simulation, signal personnel were stationed by signal N580 and signal N672. Investigators confirmed

[17] The verification process involves confirming the relays work properly with manual resetting. The track conditions were simulated manually by NTSB investigators.

signal aspects would change from red to yellow and yellow to red as expected, depending on the simulated train movements.[18]

A review of the signal download data showed that test train 310 occupied track circuit 722T (track circuit) before passing signal N672 and that 722T showed unoccupied shortly before train 9 struck the test train. The review did not reveal any abnormalities in the data and indicated proper operation of the signal system.

1.6 Operations

1.6.1 Sacramento Regional Transit District

SacRT began operations on April 1, 1973, with the acquisition of the Sacramento Transit Authority. SacRT operates over 43 miles of light rail serving 52 light rail stations within a 400-square-mile service area throughout Sacramento County, California. It also operates a bus system. Light rail trains begin operation at 4:00 a.m. with service every 15 minutes during the day and every 30 minutes in the evening. Train operations end either at 8:30 p.m. or 12:30 a.m., depending on the line. In fiscal year 2019 (July 1, 2018, through June 30, 2019), SacRT transported about 21 million passengers system-wide, averaging about 40,000 passengers on its light rail fleet per weekday. In 2020, it employed about 1,100 people and had an operating budget of almost $200 million.

1.6.2 Transportation Supervisor's Duties and Responsibilities

Transportation supervisors at SacRT are trained in two distinct duties: controller and dispatching operations. The controller duties primarily consist of communicating on the radio with train operators and issuing operating bulletins, including slow orders when necessary.[19] Controllers work with wayside operations personnel to issue orders to stop trains at a specific location while wayside personnel work along the track. Controllers are responsible for adding trains during peak hours and removing trains after the peak hours have ended. They are also responsible for controlling and monitoring any unique or unusual train movements that may occur, especially during service disruptions.

Dispatcher duties include scheduling and assigning operators to trains, distributing radios, accessing the extra board for staffing, and completing

[18] For example, if track circuit 722T was "down" or "occupied," then signal N672 would display red and N580 would display yellow.

[19] *Operating bulletins* are notifications (typically on paper) given to railroad employees informing them of a train movement or operational change.

paperwork.[20] Dispatchers make notations for track warrants where work will be performed and create operating bulletins for the next day. They assist in emergencies by contacting law enforcement and medical responders. Dispatchers also assist the controllers with train operations, if necessary.

1.6.3 Transportation Supervisor's Workload

On the day of the collision, the transportation supervisor went on duty about 2:00 p.m. as a "C Dispatch/Controller," which required him to perform the controller and dispatcher functions after 8:30 p.m. for both the blue and gold lines. Before 8:30 p.m., the transportation supervisor performed only dispatcher duties while two other transportation supervisors performed controller duties for the blue and gold lines. The two employees performing controller duties completed their shifts about 7:30 p.m. and 8:30 p.m., and from that point forward the transportation supervisor performed both dispatching and controller duties for both the blue and gold lines. During the day, there are 10 trains on each of the blue and gold lines, with a 15-minute gap between trains. After 8:00 p.m., passenger train service decreases, and both the blue and gold lines have five trains each operating in revenue service, with a 30-minute gap between them.

The transportation supervisor described his workload on the night of the collision as busy but normal. He twice communicated with another train operator who was dealing with an unruly passenger. Those communications occurred between the time the transportation supervisor spoke to the test train operator and the collision.

A senior transportation supervisor told the NTSB that the typical workload after 8:30 p.m. was not high and was manageable for one person. Dispatching duties decreased in the evening; most of those duties were typically completed by 8:30 p.m. He said that if the workload became excessive, the transportation supervisor could request assistance from a road supervisor who could assist with dispatching and controller duties. He further stated that other personnel were available as resources to manage high-workload situations.

1.6.4 Use of Consist Manager

SacRT's consist manager is a computer program accessible on the transportation supervisors' workstation that tracks the location of trains by using global positioning system technology. Figure 6 shows an example graphic displayed on the consist manager.

[20] An extra board employee does not have a regular job assignment; instead they serve as a substitute when a regularly assigned employee is not available.

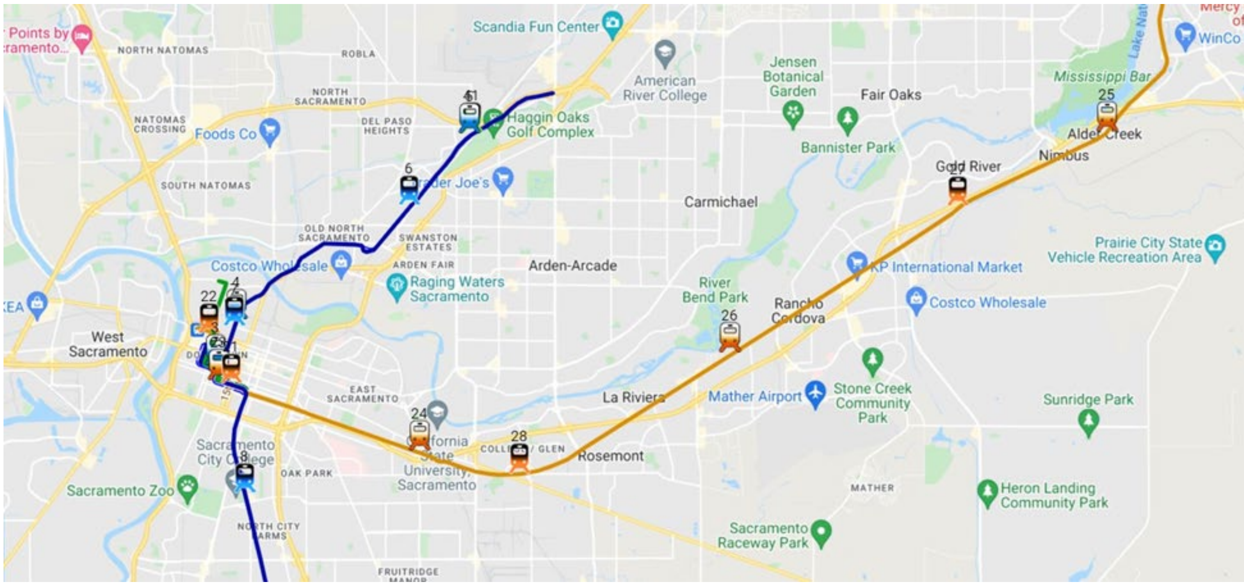

Figure 6. Example of the SacRT consist manager display.

The transportation supervisor who was on duty at the time of the collision told the NTSB that he routinely used the consist manager during the day and had the program pulled up on one of the computer screens in the control center.[21] However, he also told the NTSB that in the evening, he rarely used the consist manager because he was occupied with radio and phone communications and paperwork.

A senior transportation supervisor told investigators that the consist manager was always on full display during his shift at his workstation. He indicated that it displayed information close to real time, and that he used it to aid him in identifying the location of the trains on the system. He also depended on radio communication with the train operators to verify the exact location of a specific train.

1.6.5 Late Train Reporting Requirements

The blue line has 12 stations designated as "time points" or locations where operators must report if their train is behind schedule. SacRT Rule 2.14 states that train operators must report from each time point to Metro Control if their train is 3 or more minutes late. Train 9 had been running about 15 minutes late much of the day. The operator had reported the delay when he departed Meadowview Station (about 45 minutes before the collision). He told the NTSB that he had radioed Metro Control from some of the designated time points during his trip but did not radio in at all

[21] The transportation supervisor told investigators that, on the day of the collision, another employee informed him that there were problems with the consist manager most of the afternoon. The NTSB was not able to verify if any problems existed or when they might have been resolved.

locations if there was radio traffic. He also believed that Metro Control was aware of his delay because of his initial delay report. Audio recordings indicated that on his final trip he had radioed from only 2 of the 12 time points. He last radioed Metro Control at Arden/Del Paso Station, but after identifying himself as train 9, there was no further transmission. His next required time point was at Marconi/Arcade Station, but he did not radio Metro Control from that location.

1.7 Personnel Information

1.7.1 Transportation Supervisor

1.7.1.1 Experience

Before being hired by SacRT in January 2018, the transportation supervisor had worked 5 years as a train dispatcher with Canadian Pacific Railroad. On February 5, 2018, the transportation supervisor completed training for SacRT that allowed him to authorize train movements and issue bulletins by radio when an unusual condition occurred on or near the tracks.[22] He then completed his 6-month initial training at SacRT and worked independently for an additional 3 months, successfully completing his probation period in October 2018.[23] From November 2018 to January 2019, he was assigned relief duty and covered for other transportation supervisors who were on vacation. During this period, his dispatching duties increased and his duties as a controller decreased. From January 2019 to the day of the collision, his controller duties increased, and he continued to function as a dispatcher performing administrative tasks.

1.7.1.2 Work/Rest Cycle

The transportation supervisor regularly worked Thursday through Sunday. Before the day of the collision, he last worked on Sunday, August 18, from 2:30 p.m. to 12:30 a.m. He was off duty Monday through Wednesday (August 19–21). On his days off, he typically maintained a regular sleep schedule based on his late work schedule.

He told investigators that his sleep quality was good. On the day before the collision, he performed some home maintenance. He went to bed Thursday morning between 4:00 a.m. and 5:00 a.m. and awoke between 11:00 a.m. and noon. He

[22] Between February and April 2018, he completed all the training required by SacRT, including his Metro Control Certification.

[23] All new employees are on a probation period for 270 days from the date of the employment.

departed his house about 12:45 p.m. and had a 1-hour commute to work. He went on duty about 2:00 p.m. on August 22, 2019.

1.7.1.3 Medical Factors

The transportation supervisor reported he was in good overall health and had no serious medical conditions. He had not been diagnosed with any type of sleep disorder and reported receiving quality sleep and adequate rest before his shift.

1.7.1.4 Performance Evaluation

The transportation supervisor's first annual performance evaluation was conducted in January 2019 by a transportation superintendent.[24] The transportation supervisor was rated "Meets" expectations on each of the four job elements (technical expertise, administrative, other job skills, and other work habits) on a rating scale of "Below," "Meets" and "Exceeds" expectations. Documented in the comment section of his evaluation was "Radio control duties still needs to improve." Documented in the section indicating "Areas needing improvement/opportunities for development" was: "At times misses radio calls. Be more aware of the activity on the line. Slow decision making at times. At times no clear and concise directions." Also documented in the evaluation were errors by the transportation supervisor while performing dispatching duties, including errors such as incorrectly computing leave time for operators or inaccurately determining times for scheduled train trips when a train does not complete a trip. Under "Overall Performance," his evaluation included that "[he] has the ability of being a great asset to the department. Work on the tools mentioned above."

1.7.1.5 Performance Improvement Plan

Between January 2019 and April 2019, the transportation superintendent did not observe any significant improvement in the transportation supervisor's performance as a controller, and a performance improvement plan (PIP) was developed to address the performance deficiencies. On April 17, 2019, the transportation superintendent sent a letter to the transportation supervisor regarding his job performance, noting that his work performance

> met the acceptable standards expected of a Transportation Supervisor at that time, although comments [in the 2019 appraisal] were included that your Radio Control duties still needed to improve. It clarified that you were missing radio calls, needed to be more aware of the activity on the main line, and at times had exhibited slow decision making and provided no clear and concise directions. As of today, I have not

[24] The transportation superintendent was the SacRT director of light rail transportation.

> observed any significant improvement in your work performance and work product. Sacramento Regional Transit values you as an employee and desires to see you fulfill your potential.
>
> Therefore, you are being placed on a 90-day improvement period, where your work will be closely monitored and evaluated. The purpose and intent of this Performance Improvement Plan is to define areas of serious concern and/or deficiencies within your work performance, recap Sacramento Regional Transit's expectations, and provide you with the opportunity to demonstrate improvement and commitment.

The PIP listed 11 specific examples of poor radio control duties that occurred after the previous rating period, between January 7, 2019, and April 5, 2019. The PIP then listed improvement goals and expectations and directed the transportation supervisor to meet with the transportation superintendent every 2 weeks to discuss progress. The PIP also stated, "If your work assignment changes in June 2019, the improvement plan stops."[25]

During the week of April 15–19, the transportation supervisor was monitored by a senior transportation supervisor, who provided refresher training that focused on improving his radio skills associated with the controller position. The senior transportation supervisor also briefed his supervisor and the transportation superintendent about their progress. During postaccident interviews, he told the NTSB that initially there were areas that the transportation supervisor needed to improve upon. Delays in responding to calls were a significant problem. He was not responding appropriately to other routine operations, and some performance issues would often be repeated. However, the senior transportation supervisor saw improvement in the transportation supervisor's performance after 1 week. The transportation supervisor told the NTSB postaccident that he found the PIP program beneficial during the period he was working with the senior transportation supervisor.

Following his 1 week of close supervision, the transportation supervisor continued to work primarily as a controller and was being monitored by the senior transportation supervisor, who was working the same shift on an adjacent desk. The senior transportation supervisor believed that the transportation supervisor was performing his duties and meeting expectations. In mid-June 2019 (about 2 months after the start of the PIP and 2 months before the collision), the transportation supervisor changed shifts. This change in work assignment meant that his PIP ended,

[25] Typically, in June, SacRT employees may request changes to assignments, which include shift changes.

and he would no longer be monitored by a senior transportation supervisor during his new shift, which he worked until the day of the collision.

During postaccident interviews, the senior transportation supervisor told the NTSB that although he was not mentoring the transportation supervisor on his new shift, he did become aware from other SacRT employees of possible concerns about the transportation supervisor's performance as a dispatcher.

1.7.2 Train Operators

1.7.2.1 Experience

The test train operator was hired by SacRT in 2014 and worked as an LRV maintenance technician. His duties included troubleshooting operator-reported maintenance issues, conducting routine maintenance, and testing LRVs after repairs.[26] He was qualified to operate on the mainline track to perform testing but was not qualified to operate a train with passengers. His qualification included rule book training and completing mainline operation certification. His most recent mainline operation recertification was completed on May 2, 2019.

The operator of train 9 was hired by SacRT in 2014. He was hired as a bus operator and entered rail operations that same year. He was qualified to operate on the mainline track and with passengers. His most recent rule book training was on January 29, 2019.

1.7.2.2 Work/Rest Cycle

The test train operator was off duty the Tuesday before the collision. He recalled going to bed between 11:00 p.m. and midnight and waking up before noon on Wednesday. He was also off duty on Wednesday. That night he went to bed around midnight. On Thursday he departed for work about 2:20 p.m., went on duty at 3:00 p.m. and was scheduled to work until 11:00 p.m.

On Tuesday, the train 9 operator went on duty at 3:02 a.m. and worked until 11:15 a.m. He then returned home, ate, and watched television. He went to bed Tuesday evening between 5:30 p.m. and 6:00 p.m. On Wednesday, he went on duty at 3:02 a.m. and worked until 11:15 a.m. He then went home and ate. He went to bed Wednesday evening between 5:30 p.m. and 6:00 p.m. On Thursday, he woke up at 11:30 a.m., went on duty at 2:20 p.m. and worked until the time of the collision.

[26] The Light Rail Department Notice (April 23, 2020) details the requirements of train testing on the mainline during nonrevenue service hours.

1.7.2.3 Medical Factors

Both train operators were in good overall health and had no serious medical conditions. Neither had been diagnosed with any type of sleep disorder and both reported receiving quality sleep and adequate rest before their shifts. The test train operator had normal vision. The train 9 operator had corrective lenses that he was wearing at the time of the collision.

1.7.2.4 Cell Phone Usage

The inward-facing image recordings on the LRVs showed that neither train operator was using a cell phone before the collision, and both were engaged in the operation of their trains.

1.8 Toxicology

Following the collision, the transportation supervisor and the operators of the two LRVs were tested following Federal Transit Administration (FTA) guidelines for postaccident toxicological testing.[27] The results were negative for alcohol and the presence of tested substances.[28]

1.9 Transmission-Based Train Control

The SacRT system did not have transmission-based train control (TBTC) technology at the time of the collision. TBTC monitors train operations, enforces a safe braking distance as a train approaches a restrictive signal, and maintains train separation. If the train operator or engineer fails to operate the train so the train can comply with the restrictive signal, the TBTC will take some control away from the operator or engineer to slow or stop the train before a signal violation can occur. Some more robust TBTC systems are configured to prevent train collisions when trains are operating bi-directionally.

In April 2015, the NTSB released its report on the March 23, 2014, collision of Chicago Transit Authority (CTA) train No. 141 with the bumping post near the end of the center pocket track at O'Hare Station (NTSB 2015). The lead car rode over the bumping post and went up an escalator at the end of the track. The NTSB concluded

[27] Due to his injuries, the operator of the test train LRV310 was not alcohol tested within the 8-hour window as prescribed in 49 *Code of Federal Regulations* Part 40 and Part 655.

[28] See Title 49 *Code of Federal Regulations* Part 40 and Part 655. The following substances were tested for: amphetamines (amphetamine, methamphetamine, ecstasy), cocaine, marijuana, phencyclidine, opioids (codeine, morphine, 6-MAM, hydrocodone, hydromorphone, oxycodone, oxymorphone).

that a fully implemented TBTC system would have prevented the collision by applying the train's brakes before the train passed a red stop signal. The NTSB issued Safety Recommendation R-15-22 to the FTA to "require rail transit agencies to implement transmission-based train control systems that prevent train collisions." The FTA responded on August 10, 2015, stating that it planned to thoroughly evaluate existing research of this technology before determining whether to take the recommended action. NTSB classified this recommendation "Open—Acceptable Response" on March 29, 2016, based on FTA's plan to evaluate the technology. We have not received any updates from FTA.

The NTSB also issued Safety Recommendation R-15-24 to the CTA recommending that CTA install a TBTC system on all passenger train routes. On May 13, 2016, CTA replied that it had assessed the cost of fully implementing a TBTC system and found that implementation would pose significant financial and time challenges. CTA planned to immediately add provisions to its current fleet and infrastructure replacement programs to support migration to a TBTC system. NTSB classified this recommendation "Open—Acceptable Response" on November 15, 2016.

On April 30, 2021, CTA updated the NTSB on its actions to implement this recommendation. CTA estimated that the cost of implementing a TBTC for its system would be $2.45 billion. In comparison, CTA's entire capital budget was $3.5 billion and did not include any capital projects related to implementing TBTC. Further, TBTC was not included in CTA's current capital investment plan because the FTA had not indicated that it viewed TBTC as a universally warranted safety enhancement for transit systems. CTA further said TBTC did not conform to the priorities of the CTA's Transit Asset Management Plan. CTA's response discussed improvements made to its signal system to address the specific problem in the March 23, 2014, collision. As a result, CTA believed it had fully addressed the intent of Safety Recommendation R-15-24 and did not plan to take any further action. The NTSB is currently evaluating CTA's response.

1.10 Postaccident Actions

1.10.1 Sacramento Regional Transit

Following the collision, SacRT developed additional measures to protect test trains while they perform testing on the mainline at other times. For instance, SacRT now requires that after test train personnel receive authorization to enter the mainline, they must proceed directly to the test area and set up necessary wayside protections, such as derails and stop signs before proceeding with the testing.[29] SacRT has also revised the mainline train testing communication requirements between Metro Control, the test train employee-in-charge, and LRV maintenance supervisors during nonrevenue service hours.

Additionally, SacRT now requires transportation supervisors to issue a radio bulletin to train operators announcing that a test train will be entering the mainline. Train operators must acknowledge by radio that they received this bulletin. This exchange must be completed before the transportation supervisor grants permission for a test train to enter the mainline.

1.10.2 California Public Utilities Commission

The California Public Utilities Commission (CPUC) provides oversight over rail transit and other transit agencies in California and works in cooperation with the Federal Transit Administration.[30] CPUC enforces state and federal rail safety rules, regulations, and inspection efforts and carries out risk assessments to enhance public safety. As a result of this collision, on August 27, 2019, CPUC issued a letter instructing SacRT to “immediately cease testing or troubleshooting of trains on SacRT’s mainline track during revenue hours.” SacRT immediately halted testing of trains during revenue service and began performing all mainline high-speed train testing during the 2-hour nonrevenue service window from 1:30 a.m. to 3:30 a.m.

Several months after this went into effect, the NTSB asked SacRT for its opinion about the new testing schedule. SacRT identified significant issues with CPUC’s instruction. The instruction essentially ensures that high-speed testing is performed exclusively in the dark or in low light conditions. Certain months bring high precipitation and icy track conditions during nonrevenue hours that can create conditions prone to wheel slip and slide. The smaller testing window during the night led to fewer trains being repaired and tested, limiting availability for revenue service. Train testing during nonrevenue hours also began to compete with both LRV maintenance and track maintenance effort that occurred during this time. Scheduling changes for personnel, including safety-critical personnel, were also required to accommodate high-speed testing during nonrevenue hours because additional

[29] A *derail* is a device that sits on top of a rail and is designed to divert the wheels of a piece of equipment away from the main track or to the field side of the track it is on, thus keeping the equipment from entering another track, usually a main track.

[30] Public Utilities Code Section 99152.

personnel were required to be on duty during the testing period to accommodate an increased amount of high-speed testing on the mainline.[31]

[31] (a) Shift work hours typically begin between 10 p.m. and midnight and end between 6 a.m. and 8 a.m. (b) The work of safety-critical railroad employees (which include train operators, transportation supervisors and maintenance-of-way employees) has consequences for their own safety and the safety of other employees and passengers.

2. Analysis

2.1 Introduction

On August 22, 2019, at 9:38 p.m. local time, northbound SacRT District passenger train 9 collided head on with a stopped southbound nonrevenue test train in Sacramento, California, at a speed of 32 mph. Train 9 had 1 operator and 27 passengers on board. The test train had one operator and two contractors on board. Thirteen people were transported to area hospitals with non-life-threatening injuries. Neither train derailed and both trains sustained structural damage.

This analysis discusses the collision and the following safety issues:

- Performance deficiencies of the transportation supervisor as a controller. (See section 2.3.)
- SacRT's failure to monitor the transportation supervisor's performance to ensure competency. (See section 2.4.)
- Irregular train operator reporting of train delays to Metro Control. (See section 2.5.)
- SacRT's undefined testing practices on the mainline tracks. (See section 2.6.)
- Impact of CPUC's instruction to test vehicles during nonrevenue hours. (See section 2.6.)
- Lack of TBTC use on SacRT train lines. (See section 2.7.)

2.2 Exclusions

Following this collision, the NTSB examined the mechanical condition of both trains and found the brakes worked properly. The condition of the track was within the regulatory guidelines found in the Federal Railroad Administration's track safety standards for Class 3 track, and the signal system was working as intended and in compliance with the design specifications. Neither train operator nor the transportation supervisor reported serious medical conditions or had issues with their vision. Postaccident toxicological results from the employees were negative for alcohol and other tested-for drugs. There was no indication that the performance of the two train operators and the transportation supervisor were affected by fatigue.

The NTSB analyzed event recorder data, inward and outward facing image recordings, conducted interviews with the train operators, and completed a sight-distance observation to evaluate the performance of the train operators. The NTSB recognized that in the moments leading up to the collision, the train operators' line of sight and perception of the opposing train being on the same track were impeded by areas of dense vegetation, the curvature of the track, and darkness (sunset occurred about 7:51 p.m.). Additionally, during the NTSB sight distance observations of signal N672, NTSB observed signal indications to have changed colors as the train operator witnessed, indicating that the train 9 operator's view of the signal likely included the headlight, which changed the appearance of the aspect as well. Furthermore, neither train operator had any expectation that another train was on the same track headed toward them. Based on this information, the NTSB determined that the time it took each operator to detect the opposing train and identify its presence on the same track was reasonable. Moreover, each train operator made the appropriate decision and took action to quickly apply the brakes to attempt to avoid a collision, and one train was able to stop before impact.

The NTSB concludes that none of the following were factors in this collision: (1) the mechanical condition of the two trains, the condition of the track, or the signal system; (2) alcohol or other drug impairment, fatigue, vision, or cell phone use; or (3) the performance of the two train operators.

2.3 Performance of the Transportation Supervisor

Although, at the time of the collision, the transportation supervisor was dealing with multiple issues, including an unruly passenger on another train, such a workload is not unusual, and the transportation supervisor is expected to effectively manage his workload. This collision revealed that the transportation supervisor did not adhere to effective controller procedures that were a component of his job, even though he had received supplemental training on the procedures as part of his PIP. His lack of adherence to SacRT's controller procedures led to the collision. Specifically, he did not make a radio announcement (advisory) to notify all other train operators about the test train entering the mainline; he did not use the consist manager computer program to track the location of trains on the light rail system; and he did not radio the operator of the passenger train (train 9) closest to the test train to verify its location. Therefore, the NTSB concludes that the transportation supervisor did not adhere to SacRT's controller procedures and allowed the test train to enter the mainline track without knowing the location of other trains. The NTSB further concludes that the transportation supervisor did not notify the train 9 operator of the presence of the test train; thus, the train 9 operator was unaware that he would be traversing an area where the test train was operating on the same track.

2.4 Failure to Monitor Performance to Ensure Competency

The transportation supervisor had been employed by SacRT for about 1 year as a controller and dispatcher when he received his first annual performance evaluation in January 2019. He received a "Meets" expectations rating, although shortcomings were identified. Over the next 3 months, SacRT management did not observe improvement in the transportation supervisor's performance related to his controller skills and placed him on a 90-day PIP, which included strategies to improve his performance, practice with a senior transportation supervisor, and reviews every 2 weeks. In June, about 2 months into the PIP, the transportation supervisor began working a new shift. The change to the new shift ended his PIP in accordance with the change in assignment provision, and his performance was no longer closely monitored under the plan.

Although SacRT managers successfully identified an underperforming employee and subsequently developed a PIP to identify areas needing improvement, define expectations, and give him the opportunity to improve, they did not ensure that the transportation supervisor's performance was regularly monitored and evaluated for the duration of the 90-day plan. Moreover, during the day shift, the transportation supervisor performed either controller or dispatcher duties, not both. However, when he moved to the evening shift, after 8:30 p.m., these duties were combined. SacRT missed an opportunity to monitor how the transportation supervisor, who was continuing to develop and refine his skills, performed with these combined task demands. By choosing to terminate his PIP and to not continue monitoring the transportation supervisor, SacRT had no reliable means of determining if the transportation supervisor performed his duties at an acceptable level. Therefore, the NTSB concludes that had the transportation supervisor's PIP not ended due to the change in assignment provision, SacRT management would have been required to monitor the transportation supervisor's performance on the new evening shift, when controller and dispatch duties were combined, for 30 more days. Therefore, the NTSB recommends that SacRT ensure that an employee's performance is monitored and evaluated while on a PIP for the intended duration of the plan or until the employee has demonstrated competency in the position they occupy.

2.5 Reporting Delays to Metro Control

The train 9 operator did not radio a delay report to the transportation supervisor from Marconi/Arcade Station, which was near the area where the test train was operating. Although the transportation supervisor was already aware of the train's 15-minute delay, an updated delay report would have alerted the transportation supervisor that train 9 was near the block where the test train was operating, which may have provided him the opportunity to identify the potential conflict and take corrective action.

The operator of train 9 had radioed Metro Control at only 2 of the 12 time points where he was required to report his delay. He told the NTSB that radio interference from other trains deterred him from communicating with the transportation supervisor at some of the time points. The NTSB was able to verify periods of high radio traffic from other trains during his trip. Therefore, the NTSB concludes that radio traffic from other trains on the system likely dissuaded the train 9 operator from reporting his train's delay to Metro Control from all the required time points. Although the consist manager can be used to identify the locations of trains in the SacRT system, communication between operators and the controller is critical because it provides the controller with information about the reasons for the delay and the length of delay, which allows the controller to better manage movement throughout the system. Further, if there is a mechanical issue or a passenger who needs immediate medical attention, the inability to communicate because of interference could prolong response to assist with the situation. Readily available communication between operators and controllers can improve the overall safety of the system. Therefore, the NTSB recommends that SacRT identify factors that may deter train operators from following the rule to report delays to Metro Control from all time points and develop training or testing and/or modify the reporting process to ensure compliance.

2.6 Vehicle Testing on the Mainline Tracks

2.6.1 Warning Devices

At the time of the collision, SacRT had no rules or procedures regarding the use of conspicuous warning devices, such as flags, lights, or cones, when they were testing vehicles on the mainline. These types of devices provide an additional layer of protection to help ensure the safety of workers and equipment on a section of track and alert operators not to enter that section of track while work is being performed. This type of track protection method is routinely used in other transit operations. For instance, the Southeastern Pennsylvania Transit Authority rule book discusses protection during vehicle testing on the mainline track: shop personnel place cones at both ends of the mainline section and turn on protection lights. No operator is permitted into the closed track area until both safety cones are removed, and the lights have been turned off. Such conspicuous devices and procedures can alert train operators not to enter areas on the mainline where work is being performed. Thus, the NTSB concludes that conspicuous warning devices placed on the main track before the test train began its testing would have alerted the train 9 operator not to enter the area where the testing was taking place. Such warning devices are an example of one control that could help mitigate risk.

2.6.2 Risk Assessment for High-Speed Testing

Although the subject is not covered by a federal regulation or industry standards, the NTSB is aware that transit agencies can perform the majority of maintenance and testing activities during nonrevenue hours. This practice limits the risk exposure of passengers and employees. In transit operations such as the CTA, scheduled work is planned, and operational mitigations such as outages or single tracking are advertised to passengers in advance.

On August 27, 2019, CPUC issued an instruction by letter to SacRT stating that SacRT should immediately stop the testing or troubleshooting of trains on mainline track during revenue hours. However, SacRT identified significant issues with CPUC's instruction, including poor visibility due to dark or low-light conditions, challenging weather conditions and train testing competing with maintenance activities. Further, additional personnel, including safety-critical personnel, were required to be on duty during the testing period to accommodate an increased amount of high-speed testing on the mainline, leading to the disruption of work schedules. For many of these employees, their schedules were temporarily modified for them to be on duty and performing safety critical operations when they normally would be asleep. Safety-critical personnel who normally work daytime hours who must also participate in train testing after midnight may experience reduced alertness leading to an increase in errors, incidents, and collisions.[32]

Moreover, because CPUC's instruction essentially ensures that high-speed testing is performed exclusively in the dark or in low levels of light, human performance may be impaired by decreased conspicuity of hazards and personnel on or along the tracks and by physical and cognitive limitations of human perception and performance in low light levels. This performance reduction could negatively affect one's ability to interact with the environment and consequently reduce safety.

The NTSB recognizes that CPUC issued this instruction to SacRT to prevent similar collisions from occurring while the investigation was underway and that there are risks of testing trains during both revenue and nonrevenue hours. Additionally, CPUC's letter states that the instruction would be revisited as investigation findings become established. The NTSB, however, is concerned that this instruction was made without conducting a formal assessment of the risks that could result from its implementation. A risk assessment is needed before a decision is made mandating testing during nonrevenue hours. Therefore, the NTSB concludes that the hazards of conducting high-speed testing during nonrevenue hours are different than those during revenue hours and identifying and addressing these hazards can help improve the safety of high-speed testing. Consequently, the NTSB recommends that SacRT conduct a formal risk assessment of high-speed testing on the mainline track

[32] NTSB's past collision investigations in all modes of transportation have shown that a high frequency of collisions occur because of human fatigue (NTSB 1996, 2006, 2015, 2016). This is often due to the disruption of normal circadian rhythms or excessive hours of wakefulness.

then revise testing schedules and communication requirements to ensure that necessary controls are in place to mitigate the identified risks.

The NTSB also recommends that CPUC revise its instruction to SacRT to require that SacRT conduct a formal risk assessment of high-speed testing on mainline track and implement controls to mitigate identified risks.

2.7 Transmission-Based Train Control

As previously discussed in section 2.3, the transportation supervisor did not follow the controller procedures intended to prevent this type of accident. Moreover, the train operators had no way to know that the transportation supervisor was not adhering to the controller procedures as train 9 entered the area where the test train was operating. Controller procedures are administrative controls that are dependent on human interaction, and not following them properly can result in an accident such as this one.[33] Therefore, the NTSB concludes that, because of SacRT's reliance on administrative controls, SacRT operations are vulnerable to incidents and accidents that are due to controller errors.

Engineering controls such as TBTC are not as subject to human error because they do not require human interaction to perform their safety function.[34] Engineering controls can be more effective and reliable than administrative controls because they are designed to operate without human intervention. In this regard, the NTSB is a strong advocate of advanced train control systems that mitigate the risk of failures in train operations and has repeatedly concluded that technological solutions such as TBTC have great potential to reduce the number of serious train collisions (NTSB 2010, 2015). Technological solutions such as TBTC monitor train operations and enforce a safe braking distance as a train approaches a restrictive signal. If the train operator or engineer fails to operate the train so the train can comply with the restrictive signal, the advanced train control system will assume some control, stopping the train. TBTC can also provide protections during bi-directional movement, as occurred before this collision.

At the time of the collision, SacRT did not have TBTC technology on its system. Although the NTSB determined that the train operators took the appropriate action to quickly apply the brakes, a TBTC system designed to protect the movement of

[33] *Administrative controls* are work procedures, such as written safety policies, rules, supervision, schedules and training, that can reduce the duration, frequency and severity of exposure to hazardous situations.

[34] *Engineering controls* eliminate or reduce exposure to a physical hazard through the use or substitution of engineered safety features, such as improved ventilation, noise reduction techniques, chemical substitution and equipment and facility modifications.

trains in both directions would have been able to stop both trains and prevent the resulting damage to the equipment. Therefore, the NTSB concludes that a fully implemented TBTC system configured to prevent train collisions, including those when trains are operating bi-directionally, could have applied train 9's brakes as it approached the red signal, stopping train 9 before it collided with the test train. Consequently, the NTSB recommends that the SacRT install a TBTC system, which includes bi-directional collision avoidance, on all passenger train routes.

In April 2015, the NTSB issued Safety Recommendation R-15-22 to the FTA to require rail transit agencies to implement TBTC systems that prevent train collisions. On August 10, 2015, the FTA replied that it planned to thoroughly evaluate existing research of this technology before determining whether to take the recommended action. On March 29, 2016, Safety Recommendation R-15-22 was classified "Open—Acceptable Response" pending the FTA completing the recommended action. Although in the 6 years since this response, the FTA has not provided the NTSB with the results of its evaluation, or of any other action taken, the NTSB is aware of a February 6, 2019, FTA request for information to state safety oversight agencies to inventory hazards, incidents, and safety risk related to train control systems. On March 2, 2019, the FTA released a summary report, "Train Control Systems (TCS) Information Request," with the responses to the request for information. The report indicated that the FTA was collecting information to address Safety Recommendation R-15-22.

On August 21, 2020, the NTSB wrote to the FTA and asked for an update on Safety Recommendation R-15-22 because there had been no update from FTA in over 5 years, and Safety Recommendation R-15-22 was on the NTSB's 2019–20 Most Wanted List of Transportation Safety Improvements in the issue area "Fully Implement Positive Train Control." The letter also noted that the NTSB generally expects actions to complete safety recommendations within 5 years. The CTA's recent response to Safety Recommendation R-15-24 said that it was not including a TBTC system in its capital budget because the FTA has not indicated that such systems are needed. This, combined with the circumstances of the SacRT collision where a TBTC system could have prevented the collision, shows the continuing need for the FTA to require rail transit agencies to implement TBTC systems. Therefore, the NTSB reiterates Safety Recommendation R-15-22. Further, because the FTA has not provided any information on its actions in response to this recommendation in over 5 years, Safety Recommendation R-15-22 is classified "Open—Unacceptable Response."

3. Conclusions

3.1 Findings

1. None of the following were factors in this collision: (1) the mechanical condition of the two trains, the condition of the track, or the signal system; (2) alcohol or other drug impairment, fatigue, vision, or cell phone use; or (3) the performance of the two train operators.

2. The transportation supervisor did not adhere to Sacramento Regional Transit District's controller procedures and allowed the test train to enter the mainline track without knowing the location of other trains.

3. The transportation supervisor did not notify the train 9 operator of the presence of the test train; thus, the train 9 operator was unaware that he would be traversing an area where the test train was operating on the same track.

4. Had the transportation supervisor's performance improvement plan not ended due to the change in assignment provision, Sacramento Regional Transit District management would have been required to monitor the transportation supervisor's performance on the new evening shift, when controller and dispatch duties were combined, for 30 more days.

5. Radio traffic from other trains on the system likely dissuaded the train 9 operator from reporting his train's delay to Metro Control from all the required time points.

6. Conspicuous warning devices placed on the main track before the test train began its testing would have alerted the train 9 operator not to enter the area where the testing was taking place.

7. The hazards of conducting high-speed testing during nonrevenue hours are different than those during revenue hours and identifying and addressing these hazards can help improve the safety of high-speed testing.

8. Because of Sacramento Regional Transit District's reliance on administrative controls, Sacramento Regional Transit District operations are vulnerable to incidents and accidents that are due to controller errors.

9. A fully implemented transmission-based train control system configured to prevent train collisions, including those when trains are operating bi-directionally, could have applied train 9's brakes as it approached the red signal, stopping the train 9 before it collided with the test train.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the collision of two Sacramento Regional Transit District light rail trains was the Sacramento Regional Transit District's weak administrative controls that allowed the transportation supervisor to authorize a high-speed test train to enter the mainline without knowing the location of passenger train 9 on the same track. Contributing to the collision was senior management's failure to assess the transportation supervisor's competency in the combined role as both a controller and dispatcher on the evening shift.

4. Recommendations

4.1 New Recommendations

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

To California Public Utilities Commission:

> Revise your instruction to Sacramento Regional Transit District to require that Sacramento Regional Transit conduct a formal risk assessment of high-speed testing on mainline track and implement controls to mitigate identified risks. (R-22-3)

To Sacramento Regional Transit District:

> Ensure that an employee's performance is monitored and evaluated while on a performance improvement plan for the intended duration of the plan or until the employee has demonstrated competency in the position they occupy. (R-22-4)
>
> Identify factors that may deter train operators from following the rule to report delays to Metro Control from all time points and develop training or testing and/or modify the reporting process to ensure compliance. (R-22-5)
>
> Conduct a formal risk assessment of high-speed testing on the mainline track then revise testing schedules and communication requirements to ensure that necessary controls are in place to mitigate the identified risks. (R-22-6)
>
> Install a transmission-based train control system, which includes bi-directional collision avoidance, on all passenger train routes. (R-22-7)

4.2 Recommendations Reiterated and Classified

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

To the Federal Transit Administration:

> Require rail transit agencies to implement transmission-based train control systems that prevent train collisions. (R-15-22)

This recommendation is classified "Open—Unacceptable Response" in section 2.7.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

JENNIFER HOMENDY
Chair

MICHAEL GRAHAM
Member

BRUCE LANDSBERG
Vice Chairman

THOMAS CHAPMAN
Member

Report Date: April 14, 2022

Appendixes

Appendix A: Investigation

The National Transportation Safety Board (NTSB) was notified on August 22, 2019, that a northbound Sacramento Regional Transit District Light Rail Vehicle train 9, a revenue passenger train, collided head on with a stopped southbound nonrevenue test train in Sacramento, California. The NTSB launched an investigator-in-charge and a system safety investigator to investigate the collision on August 22, 2019.

Parties to the investigation included the Federal Transit Administration; State of California Public Utilities Commission; Sacramento Regional Transit District, Amalgamated Transit Union; International Brotherhood of Electrical Workers; and the American Federation of State, County and Municipal Employees.

Appendix B: Consolidated Recommendation Information

Title 49 *United States Code* (U.S.C.) 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 Sacramento Regional Transit District

R-22-4

Ensure that an employee's performance is monitored and evaluated while on a performance improvement plan for the intended duration of the plan or until the employee has demonstrated competency in the position they occupy.

Information that addresses the requirements of 49 U.S.C. 1117(b), as applicable, can be found in section 2.4 Failure to Monitor Performance to Ensure Competency, (b)(2) is not applicable; and information supporting (b)(3) is not applicable.

R-22-5

Identify factors that may deter train operators from following the rule to report delays to Metro Control from all time points, and develop training, testing, and/or modify the reporting process to ensure compliance.

Information that addresses the requirements of 49 U.S.C. 1117(b), as applicable, can be found in section 2.5 Reporting Delays to Metro Control, (b)(2) is not applicable; and information supporting (b)(3)can be found in 1.10 Postaccident Actions.

R-22-6

Conduct a formal risk assessment of high-speed testing on the mainline track then revise testing schedules and communication requirements to ensure that necessary controls are in place to mitigate the identified risks.

Information that addresses the requirements of 49 U.S.C. 1117(b), as applicable, can be found in section 2.6.2 Risk Assessment for High-Speed Testing, (b)(2) is not applicable; and information supporting (b)(3) can be found in section 1.10 Postaccident Actions.

R-22-7

Install a transmission-based train control system, which includes bi-directional collision avoidance, on all passenger train routes.

Information that addresses the requirements of 49 U.S.C. 1117(b), as applicable, can be found in section 2.7 Transmission-Based Train Control, (b)(2) is not applicable; and information supporting (b)(3) is not applicable.

To the California Public Utilities Commission

R-22-3

Revise your instruction to Sacramento Regional Transit District to require that Sacramento Regional Transit District conduct a formal risk assessment of high-speed testing on mainline track and implement controls to mitigate identified risks.

Information that addresses the requirements of 49 U.S.C. 1117(b), as applicable, can be found in section, 2.6.2 Risk Assessment for High-Speed Testing, (b)(2) is not applicable; and information supporting (b)(3) can be found in section 1.10 Postaccident Actions.

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The National Transportation Safety Board (NTSB) is an independent federal agency dedicated to promoting aviation, railroad, highway, marine, and pipeline safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974, to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

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 investigations website and search for NTSB accident ID RRD19FR011. 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–

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