National Transportation Safety Board

Office of Railroad, Pipeline and Hazardous Materials Investigations

Washington, D.C. 20594

Sacramento Regional Transit District

Collision of Revenue Light Rail Train 9 with Maintenance Light Rail Vehicle 310

Sacramento, California

August 22, 2019

Mechanical Group Factual

Accident

NTSB Accident Number:	RRD19FR011
Date of Accident:	August 22, 2019
Time of Accident:	9:38 p.m. (WDT[1])
Type of Trains:	LRV
Railroad Owner:	SACRT
Train Operator:	SACRT
Fatalities:	0
Injuries:	27
Location of Accident:	Sacramento, CA

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[1] Pacific daylight time.

Accident Summary

On August 22, at 9:38 p.m., local time, northbound Sacramento Regional Transit District (SACRT) Blue Line train No. 9 collided head on with stopped southbound SACRT maintenance train No. 310 near Sacramento, CA on the N-Line outbound track section near milepost 6.72. There were no derailments or fires. There are an estimated 27 non-life-threatening injuries to passengers and crew members. Thirteen passengers were transported to area hospitals. Preliminary data from the event recorders show SACRT light rail revenue train No. 9 was travelling about 32 mph at the point of collision when it struck stopped maintenance LRV No. 310. At the time of the accident, the sky was clear, with 2 MPH wind, and the temperature was about 83° F.

On the day of the accident Train No. 9 was operating northbound on the outbound track and was about 15 minutes behind its designated schedule. A maintenance train technician requested and received radio permission from the controller at the Metro Control center to enter the mainline to complete post maintenance intervention propulsion testing.[2] After receiving permission, No. 310 proceeded northbound on the outbound track. The technician of maintenance LRV No. 310 made several throttle manipulations reaching speeds of 50 mph while operating from the B-End of the streetcar before bringing the train to a stop. The technician of maintenance train No. 310 then reversed ends and began operating southbound on the outbound track. Meanwhile, train No. 9 was moving northbound on the outbound track toward maintenance LRV 310.

Preliminary information from the event recorder from the leading car (LRV 103) of train No. 9 shows the following events:[3]

Table 1. Preliminary timeline of events from striking train No. 9.

Time	Event	Speed
21:38:04	Dynamic braking	55.4 mph
21:38:06	Emergency brake	48.4 mph
21:38:08	Deadman pressed	39.1 mph
21:38:09	Collision	32.5 mph

[2] Further information on the details of the radio permission received are discussed in the Operations Group factual report in NTSB docket RRD19FR011.
[3] Event recorder information in this report is preliminary as such. The final information will be contained in the Event Recorder Specialist's Report located in NTSB docket RRD19FR011.

21:39:04	Stopped	0 mph

Preliminary information from the event recorder from the leading car of train No. 9 shows the following events:

Table 2. Preliminary timeline of events of maintenance LRV No. 310.

Time	Event	Speed
21:38:00	Dynamic braking	28.6 mph
21:38:04	Emergency brake	17.8 mph
21:38:08	Zero speed (stopped)	0 mph
21:38:09	Collision	0 mph

Figure 1. Photograph of train No. 9 and maintenance LRV No. 301 at the point of rest after the collision.

Based on preliminary review of the event recorder data, maintenance LRV 310 was moving southbound on the outbound track at about 28.6 mph when braking began. No. 310 came to a stop

using emergency brakes and one second later was struck by train No. 9. Collision speed is estimated at 32.5 mph.

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

Event and Video Recorders

Investigators successfully downloaded emergency event and video recorder data from train No. 9 lead and maintenance LRV No. 310. The event recorder data was post processed by SACRT and viewed using a software provided by the original manufacturer. The time correction adjustment to the event recorder data was made in the following manner, 2-minutes and 17-seconds was added to train No. 9 lead car No. 103. The time correction adjustment to the event recorder data was made in the following manner, 23-seconds was subtracted to maintenance LRV No. 310. All data both unprocessed and post processed has been obtained and will be further analyzed by NTSB Research and Engineering.

The video recorder hard drives were collected and shipped to NTSB video laboratories in Washington DC. The drives were collected from streetcar numbers, No. 103, No. 227 and No. 310.

Light Rail Vehicles (LRV)

The SACRT LRVs involved in this collision are No. 103 (striking), No. 227 and No. 310 (struck). All three LRV are manufactured by different manufacturers. See the characteristics of each car type shown in table 3 below. Each LRV is a single car, electrically powered vehicle. The LRVs are equipped with three trucks and four (4) traction motors. The braking system is both friction and dynamic. The friction brake consists of one (1) inboard friction ring with a pneumatic caliper mounted on each axle and two track brakes on each truck.[4]

[4] A track brake is an electromagnetically activated mechanism that slows or stops the LRV by transmitting the braking force against the running rail

Table 3. SACRT LRV Characteristics.

	Siemens	CAF	UTDC
Model	Single-articulated, Bi-directional	Single-articulated, Bi-directional	Single-articulated, Bi-directional
Number in fleet	36	40	21
Length	79' 6"	84'	88' 6"
Series	100	200	300
Width	8' 9"	8' 9"	8' 8"
Empty weight	38.9 tons	47 tons	49.35 tons
Braking system	Dynamic/friction/magnetic track	Dynamic Regenerative /friction/magnetic track	Dynamic/friction/magnetic track
Friction braking system	Single electro-mechanical controller	Independent for each truck, microprocessor controlled with active center truck braking	Pneumatic spring applied air release
Maximum speed	55 mph	55 mph	55 mph
Maximum deceleration	6 mph per second	6 mph per second	6 mph per second
Delivered	1987-1991	2002-2003	1998 VTA, delivered 2004 (RT) in service 2015 - 2016

Wrecked LRVs

SACRT estimated damages to be $3.9M. The damage is summarized in table 4 below.

Table 4. Estimated damages.

Disposition	Car Type	Number	Estimated damage
Total loss	LRV	103	$3,800,000.00[5]
Damaged	LRV	227	$87,730.00
Damaged	LRV	310	$50,000.00

Investigators completed examinations, collected measurements and visual assessments of the damage to the LRVs involved in the collision while the streetcars were still on-scene. When the LRV collided, train No. 9 struck the stopped maintenance LRV 310. The resulting collision shoved LRV 310 north about 65-feet. See accident diagram in figure 2.

[5] Estimated replacement cost of a light rail vehicle.

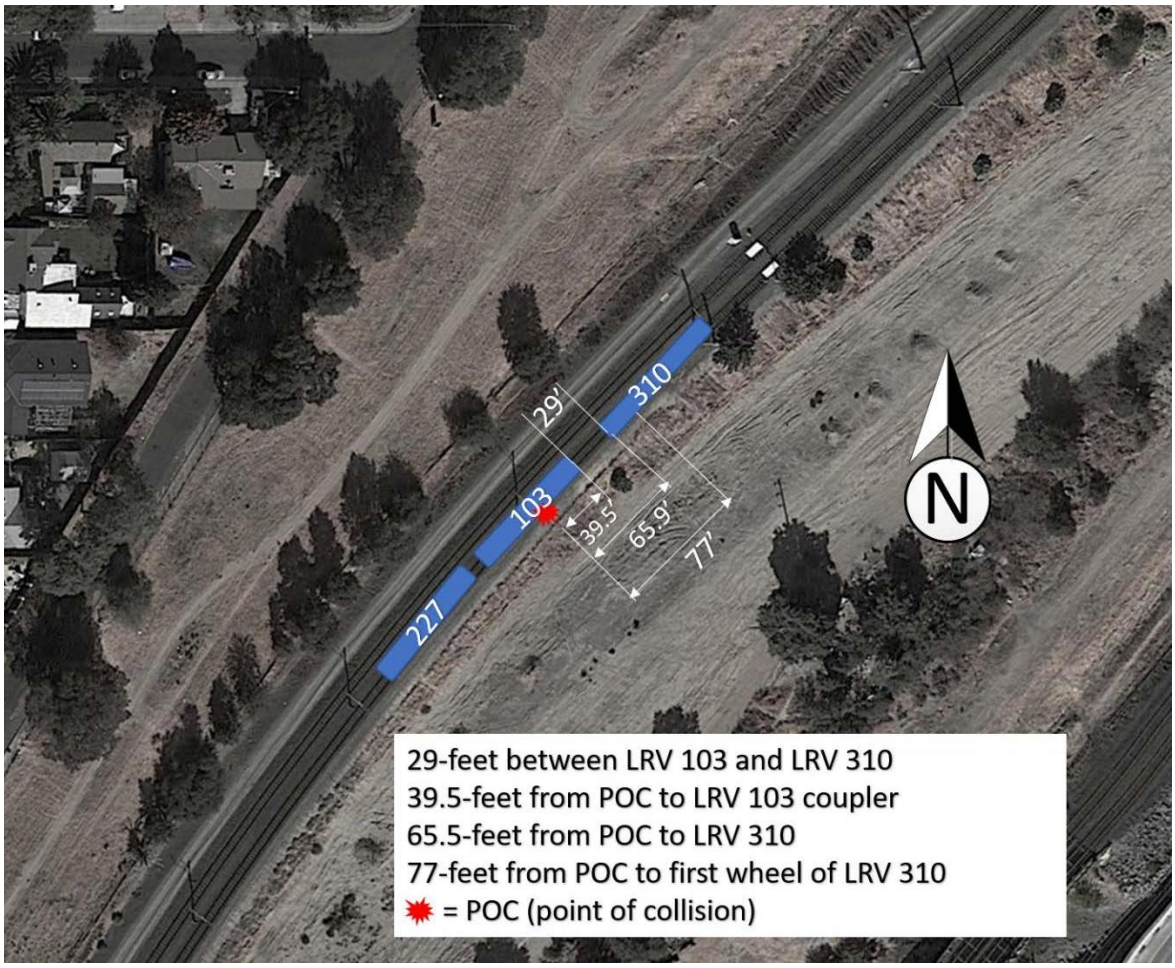

Figure 2. Accident diagram.

The following is a summary of the damage completed by SACRT.

- LRV 310, visible damage visible at the A end. The damage consists of a cracked windshield on both right and left side, coupler and minor damage to the anti-climber in addition to body damage on the front-end structural post on the driver's side.

Figure 3. Leading end of LRV 310.

- LRV 103, this LRV sustained major damage. Major damage was sustained to the anti-climber mechanical coupler, front lights and the following right-side components:
    - Underframe
    - Side sill (structural member)
    - Sidewall
    - Windshield

Figure 4. Leading end of LRV 103.

- LRV 227, the damage to this LRV was constrained to the mechanical coupler connected to LRV 227. There was no additional damage to this car.

Equipment Pre-Accident Inspection

SACRT train No.9 originated in Metro yard, in Sacramento, CA, on August 22, 2019. The train consisted of two LRVs, LRV 103 and 227. LRV 227 was in the shop on the morning of August 22, 2019 for a broken window replacement and LRV 103 was a spare stored in a pocket track downtown. According to SACRT the train was tow tested, meaning the train's braking and propulsion systems were verified as functional before being placed into revenue service. SACRT could not produce a record of test. According to SACRT, only yard consists have the pre-pullout inspection records. No such record keeping process was in place at the time of the collision. In interviews with NTSB investigators, the operator reported no problems with the brake system on the day of the accident.

SACRT LRV No. 310 was out of service due to a maintenance issue on August 22, 2019. The maintenance records indicate the issue was "jerking in propulsion" which is terminology meaning the system was not properly operational. Maintenance records indicate an intervention was completed to address the issue and SACRT representatives told investigators that the train would require mainline testing to verify the problem was corrected.

All SACRT LRV are required to have their brake system dynamically tested every 150,000 miles to verify that they are performing as designed (brake rate tests). Investigators examined the records for LRVs No. 103, 227 and 310 for this test.

- LRV No. 103, most recent test was completed on June 24, 2017
- LRV No. 227, most recent test was completed on October 11, 2018
- LRV No. 310, most recent test was completed on September 16, 2015.

All LRV passed the brake rate tests. Typically, the annual mileage for the LRV is about 54,000 miles. The UTDC fleet is operating at an average mileage of about 17,000 miles.

Equipment Post-Accident Inspections

NTSB investigators formed a mechanical group of qualified inspectors to evaluate the mechanical condition of the braking equipment on SACRT LRVs No. 103, 227 and 310.

On August 26, 2019, investigators completed visual inspections of SACRT LRVs No. 227 and 310 in the maintenance repair heavy facility shops at 2760 Academy Drive in Sacramento, CA. The inspections were completed on SACRT streetcar No. 103 on August 27, 2019, at the same location. Investigators observed all wheels on the equipment were full, had full flanges and normal wheel tread wear. All brake discs appeared normal (no cracks, chips, bluing) and all brake pads and discs were measured and within their tolerance.

The track brake assembly consists of spring mounted articulated magnetic track brakes which are suspended above the rail between the wheels of each truck. Force transfer members which connect the track brakes on each side of the truck to the truck side frame maintain the track brake magnets over the center line of the rail. The force transfer members are equipped with friction elements to transmit the braking force generated by the electromagnetic track brake. Investigators observed the spring suspension linkage, wiring transfer members and friction elements to be intact and within their tolerance.

Post-accident/incident brake functional tests (static testing) were completed by qualified SACRT inspectors and observed by investigators. The test consisted of actuation of the sanding systems on each operating end of the streetcar (A-end and B-end), friction brake release, and friction brakes applied using the brake control lever, and application of the track brake using the brake control lever. The speedometer tachometers were inspected for their correct adjustment on the center trucks of streetcar No. 103 and No. 310.

Streetcar No. 103 sustained damage to the front-end requiring investigators to isolate the following circuits to complete the tests, door safety loop and the coupler control on the A-end and the main (propulsion) circuit breaker. All tests were completed with only one exception taken; the sanding system failed to operate from the B-end (trailing end of the striking car).

All tests were completed on LRVs No. 227 and 310. No exceptions were observed.

Maintenance Operator

The maintenance operator has been employed with SACRT for about 5-years. He works the 3:00 pm to the 11:00 pm shift. His duties include, troubleshooting operator report maintenance issues, routine maintenance and testing LRV after repairs are made. The maintenance operator was

qualified to operate on the main track to perform this testing. His qualification included rule book training and mainline operation certification. He most recent recertification was completed on May 2, 2019. The qualification allows him to request permission from the Metro Control center to operate non-revenue trains on the main track. He is not qualified to operate a train with passengers.

Post Maintenance Mainline Testing

Investigators questioned SACRT personnel regarding their mainline testing program. SACRT personnel explained to investigators that because the agency does not have a test track, there are certain types of maintenance interventions requiring mainline testing to verify the issue was corrected. Typically, these are brake and propulsion maintenance interventions with require high speed testing (55 mph).

Regarding the standard operating procedures used to perform these test, SACRT personnel told investigators the procedures for entering and departing mainline are outlined in the Mainline Certification portion of the operational training.

Attachments

The attachments of this report are located in NTSB docket RRD19FR011.

1. SACRT LRV Daily Pre-Trip inspection procedure
2. Email regarding the pre-trip inspections for train No. 9
3. Pre-accident repair order for LRV 310
4. Pre-accident repair order for LRV 227
5. Most recent brake qualification test records for LRV 103
6. Most recent brake qualification test records for LRV 227
7. Most recent brake qualification test records for LRV 310
8. Maintenance operator's latest rules certification record