

National Transportation Safety Board
Office of Railroad, Pipeline and Hazardous Materials Investigations
Washington, D.C. 20594


Collision of SEPTA Light Rail Vehicle 155
Upper Darby, Pa
August 22, 2017
Mechanical Group Factual Report

Accident #: DCA 17 FR 012
Accident Type: Light Rail Rapid Transit Vehicle Collision
Location: Norristown High Speed Line in Upper Darby, PA
Date of Accident: August 22, 2017
Railroad Owner: SEPTA
Train Operator: SEPTA
Fatalities: 0
Injuries: 42

Mechanical Group Members

National Transportation Safety Board-Group Chairman
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SEPTA
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SYNOPSIS

For a summary of the accident, refer to the *Accident Summary* within this docket.



Figure 1 Photo of SEPTA car 155 in the Upper Darby repair facility while being examined.

EQUIPMENT INVOLVED

The SEPTA's Norristown N-5 car #155 is one of a fleet of 26 light rail rapid transit vehicles that was first delivered in 1993. The vehicle's dimensions are 65 feet 6 inches in length, 9 feet 10 inches in width, 14 feet in height, and has an unoccupied weight of 78,000 lbs.

The N-5 propulsion system is driven by a three-phase alternating current drive from a 630-volt DC third rail power supply controlled by GTO-Thyristors. These vehicle's can be either run individually or coupled together to form train sets. They are equipped with advanced microprocessor controlled diagnostics, radially

self-steering trucks, automatic speed control, redundant auxiliary power supplies, automatic couplers, and automatic climate control systems.

WRECKAGE DESCRIPTION

Car #155 remained in the upright position with all eight wheels on the rail. It sustained front end damage on the “A” end carbody. The coupler assembly sustained heavy damage. Pneumatic systems to the coupler and horn, and the “A” end wiring harness were also damaged as a result of the impact. The struck vehicle (car #148) had similar damage.

PRE-DEPARTURE INSPECTIONS

On August 21, 2017, the operator of car #155 conducted a pre-trip inspection with no exceptions. The following are items that were inspected:

- Air pressure
- Brakes
- Communication systems
- Mechanical systems including sanders and wheels
- Car body components
- Propulsion systems
- Electrical systems including breakers, cab signal, and lights
- Couplers
- Doors
- HVAC systems
- Vandalism

EQUIPMENT POST ACCIDENT INSPECTIONS

On August 23-24, 2017, investigators met with SEPTA personnel at the SEPTA's Norristown High Speed Line shop in Upper Darby to examine car #155. The following items were examined with no exceptions:

- Air brake valve functional testing
- Cab signal equipment self-test
- Friction brake pads and discs
- Friction brake operation
- Master controller

POST LAUNCH ACTIVITIES

In October of 2017, the NTSB formed a vehicle performance group with SEPTA, PennDOT, Bombardier Transportation, and NTSB members to evaluate the N5 car vehicle performance. A NTSB vehicle performance subject matter expert was assigned to collect and evaluate data. The group met on February 1, 2018, and March 27, 2019, at NTSB Headquarters and held multiple group conference calls to discuss findings and seek input.

The NTSB requested that SEPTA prepare car #155 for road testing to help evaluate the car's performance. After an assessment of damage, it was determined that road testing would not be safe due to damage to the running gear. The damage was too excessive to be repaired at SEPTA's repair facilities. After discussions with the group, it was determined that spin testing the wheels while car #155 was elevated on a lift would be conducted. Since car #155 had been inactive and in storage for a long time, this testing would be conducted in two stages. The first stage would be start up procedures, and the second stage would be the wheel spin testing.

On June 12-13, 2019, the group met at SEPTA's Norristown High Speed Line shop in Upper Darby to conduct start up procedures on car #155. Systems that were inspected and observed included batteries, air brakes, data recorders, master controller, electric contacts, sanders and wheel size calibration.

When car #155 was initially restarted, it displayed an inverter blower fault. Technicians repaired this fault by replacing the inverter blower module and fuse. Also, the data recorder was not recording and was repaired by replacing it. It was determined that these two conditions were caused by sitting dormant for months without use or maintenance. Both systems were operational and not defective days after the collision as observed by investigators.

The wheel sizes were not calibrated properly. The A computer was set at 27 inches and the B computer was set at 28 inches. Although the actual wheel size measured at 28 inches, neither computer's wheel settings were current. This is an indication that the wheel sizes were never calibrated in the TRACS system.

On July 23-24, 2019, the group once again met at SEPTA's Norristown High Speed Line shop in Upper Darby to physically and visually inspect the traction motor speed sensors and conduct the spin testing. The speed sensors showed normal signs of usage and all were affixed properly with no signs of damage or looseness. Inspection covers were removed from the traction motor gear cases to check for damage and measure the gap from the speed sensors to the traction motor gear. All measurements fell within required specifications and there was no evidence of speed sensor probe damage. During this activity, the mechanical group agreed that no further testing of the speed sensors was required.

Procedures for the spin testing were to test the A and B trucks separately and in the forward and reverse directions. In both directions the A and B trucks were spun up from an initial speed of 5 mph toward a target maximum speed of 35 mph (for safety reasons) at a speed increment of 5 mph. The A truck performed as expected in both the forward and reverse directions while the B truck anomalously performed in the reverse direction. The B truck performed as expected in the forward direction, but in reverse above 20 mph the speed would continue to increase without control until it was stopped by the technician. However, truck spin testing lacked representative wheel/rail adhesion and representative vertical, longitudinal, and lateral running loads, driving the need for dynamic road tests.

The thumbwheel switch located in the A end computer closet is used to send commands to the TRACS computer. Among the commands that can be sent is that which enables the computer to perform the wheel-size calibration routine when all requisite operating conditions are present. Testing proved that the thumbwheel

switch was defective, thus preventing the command to enable the wheel-size calibration routine from being received by the TRACS computer.

(For further detail and performance outcomes, see the Vehicle Performance Study in this docket.)

END OF REPORT

Group Member to the Investigation - Acknowledgment Signatures

The undersigned designated *Group Member to the Investigation* representatives attest that the information contained in this report is a factually accurate representation of the information collected during the on scene phase of this investigation, to the extent of their best knowledge and contribution in this investigation.

_____ Date _____
Joey Rhine, NTSB

_____ Date _____
Richard Ziegler, SEPTA

_____ Date _____
John Weisgerber, PennDOT

_____ Date _____
Michael Blauvelt, PennDOT

_____ Date _____
Jean Beauchemin, Bombardier Transportation