

# **Derailment of Washington Metropolitan Area Transit Authority Train**

Arlington, Virginia  
October 12, 2021

This accident reconstruction shows the sequence of events of the accident, which occurred at 4:49 p.m. eastern daylight time on October 12, 2021, when Washington Metropolitan Area Transit Authority (WMATA) train 407 derailed at a switch about 166 feet south of Rosslyn Station, where the Blue Line separated from the Orange and Silver Lines in Arlington Virginia.

The animation begins with a map of the WMATA rail system that provides a timeline of train 407's derailment and rerailling when northbound at Arlington Cemetery Station and again when westbound at Largo Town Center Station prior to the derailment after leaving Rosslyn Station. The direction of the train is indicated with dotted blue arrow, and the time of each event is displayed.

Video from a surveillance camera at Arlington Cemetery Station shows the fifth railcar experiencing a vertical body disturbance as the rear truck of the car derails and then reraills. An arrow highlights the movement seen at the top of the railcar. Video from a surveillance camera at Largo Town Center Station shows dust consistent with derailed wheels disturbing the concrete under the rails, which is highlighted by an arrow; the same truck derailed, but because the train was traveling in the opposite direction, it was the lead truck on the fourth railcar. Videos do not include any audio.

A graphic shows a wheelset, which consists of two wheels mounted on each end of an axle. The graphic shows that by design, the distance between wheels on a wheelset should not exceed  $53 \frac{3}{8}$  inches. The graphic shows that after the derailment, the distance between wheels on the derailed wheelset was about 2 inches more than allowed, as a result of wheels moving outward on the axles, which is labeled wheel migration.

An animation shows the derailment and rerailling of the rear wheels of a truck at Arlington Cemetery Station. A truck carries two wheelsets, one at the front and one at the rear. The animation shows labels for track 1 on the right and track 2 on the left side of the screen and depicts the widened wheelset on the rear axle of the truck, colored yellow, on track 1 approaching the switch points of a crossover. A crossover contains four switches that allow trains to cross between tracks. The animation shows the widened wheelset derailing to the left in the switch point area where trains on track 1 can be diverted to track 2. The switch point area is highlighted with a circle and a label. When the derailed wheelset reached the frog area where trains from track 2 can pass onto track 1, the rails leading from track 2 into track 1 pushed the wheelset back into position on the rail. The frog area is highlighted with a circle and a label. The derailment and rerailling at Largo Town Center was similar to what happened at Arlington Cemetery Station.

A second animation shows the Rosslyn Station derailment. Train 407 was traveling in the opposite direction from the incident at Arlington Cemetery, and the animation shows the widened wheelset on at the front of the truck, colored yellow, derailing at a switch area.

A series of graphics depict the assembly of wheelsets by pressing the wheels onto the axles. The axle diameter is larger than the wheel bore diameter, and after the wheels are pressed onto the axle, the joint is held in place by friction.

A summary of actions taken as a result of the investigation is accompanied by a photograph of a 7000-series railcar.

## **Narration**

1. On October 12, 2021, NTSB investigators responded to the derailment of southbound WMATA train 407 on the Blue Line near Rosslyn Station.
2. The train derailed at 4:49 pm at a switch about 166 feet south of Rosslyn station, where the Blue Line separates from the Orange and Silver Lines.
3. Passengers evacuated on foot south to Arlington Cemetery Station.
4. Investigators found evidence that train 407 had derailed but then gotten back onto the tracks (or rerailed) on its prior trip at rail crossovers at two additional locations: northbound at Arlington Cemetery Station at 3:24 p.m. and westbound at Largo Town Center Station at 4:13 p.m.
5. Surveillance cameras at Arlington Cemetery Station and Largo Town Center Station captured these previous derailments on video.
6. The video from Arlington Cemetery Station shows the fifth railcar experiencing a vertical body disturbance as its rear truck derails and then rerails. The movement can be seen at the top of the car.
7. At Largo Town Center Station, the same truck on the same railcar derailed and rerailed. Because the train was traveling in the opposite direction, it was the lead truck of the fourth railcar. Note the dust visible underneath the train, consistent with the derailed wheels disturbing the concrete under the rails.
8. By design, the width of WMATA's railcar wheelsets should not exceed 53-3/8<sup>th</sup> inches.
9. However, investigators found that the distance between the wheels on the derailed wheelset was about 2 inches more than allowed in the design specification.
10. Laboratory examination found that the extra width was a result of wheel migration: the gradual outward movement of the wheels on the axle.
11. As the widened wheelset on the rear axle of the truck approached the switch points of the Arlington Cemetery crossover, the wheelset derailed to the left in the switch point area where trains on track 1 can be diverted to track 2.
12. The switch was set for the train to pass straight through on track 1.
13. The wheelset remained derailed until it reached the frog area of the next switch, where trains from track 2 can pass onto track 1.
14. The rails leading from track 2 into track 1 pushed the wheelset back into position on the rails.
15. The derailment and re-railment at Largo Town Center happened the same way.
16. In the Rosslyn Station derailment, the train was still traveling in the opposite direction from the incident at Arlington Cemetery, and the front axle of the lead truck on the 4<sup>th</sup> car derailed.

17. The widened wheelset derailed at the switch where the Blue Line separates from the Orange and Silver Lines, which is not part of a crossover. Because there was no crossover leading back to the Blue Line to guide the derailed wheelset back onto the track, the train remained derailed.
18. The derailments occurred in the switch areas because fastening and bracing makes the track structure stiffer in these locations.
19. The increased stiffness of the track structures forced the widened wheelset upward and off the rails.
20. In response to the derailment and subsequent NTSB investigation, WMATA removed all 7000-series railcars from service and inspected all 2,992 of their wheelsets.
21. During these inspections, WMATA identified about 50 wheelsets that exceeded the maximum allowable width.
22. In the 4 years before the derailment, WMATA had identified about 30 other wide wheelsets, for a total of about 80 wheelsets that exceeded the maximum allowable width.
23. None of the other wide wheelsets showed wheel migration as severe as the roughly 2 inches observed on the accident wheelset.
24. Wheelsets are assembled by press-fitting wheels onto axles.
25. In press fitting, the axle diameter is greater than the wheel bore. The difference is called “interference.” The resulting joint, or “interference fit,” is held together by friction.
26. Analysis of the widened wheelsets found that wheelsets assembled with greater interference were more resistant to wheel migration.
27. WMATA increased the specified interference for 7000-series wheelsets and began replacing wheelsets in July 2023, with the replacement of wheelsets for the entire fleet scheduled to take 3 years.
28. WMATA has gradually been returning 7000-series railcars to service. They physically inspect wheelset widths every 30 days for railcars still using their original wheelsets and every 60 days for railcars with new wheelsets.