Federal Railroad Administration, Office of Railroad Safety

Accident Investigation Summary Report HQ-2023-1822

Norfolk Southern Railway Company (NS) Derailment
Springfield, Ohio
March 4, 2023

1. Executive Summary

On March 4, 2023, at 2:55 p.m., EST, Norfolk Southern Railway Company (NS) mixed freight train 179LC-04 derailed 28 cars, including 7 loads and 21 empties, at Milepost (MP) 178.7 on the Dayton District, near Springfield, Ohio. The train was 13,470 feet long and weighed 17,966 tons, configured with 5 locomotives (3 locomotives on the head end and 2 Distributed Power (DP)[1] locomotives placed mid-train between line Nos. 138 and 139), 120 loaded cars, and 90 empty cars.

The train was a designated Key Train [2]due to the amount of hazardous material cars this train was transporting, so a precautionary shelter in place order was issued for a 1,000-foot radius around the derailment site until 1 a.m.

The Federal Railroad Administration's (FRA) investigation and analysis found that the probable cause of this accident was excessive buffing or slack action[3] due to a combination of the use of dynamic braking with the makeup of the train.

Additionally, FRA determined the NS policy for, and promotion of, the use of dynamic braking as the preferred method of controlling train speed contributed to the accident.

2. Accident Description

Before departing Watkins Yard in Columbus, Ohio, on March 4, 2023, at 2 p.m., EST, NS train 179LC-04 received all required inspections by a qualified mechanical inspector (QMI), including

[1] Distributed Power (DP) locomotives are locomotives, distributed throughout the train, that are capable of being remotely operated in conjunction with the locomotives on the train's head end.
[2] A Key Train is a train that contains; one or more tank car load of a Toxic Inhalation or Poison Inhalation Hazard (PIH/TIH), 20 or more tank car loads of hazardous materials, or one or more carloads of spent nuclear fuel or high level radioactive waste.
[3] Slack action is the coupler forces that are parallel to the longitudinal axis of equipment. Compressive coupler forces are called buff forces, while tensile coupler forces are called draft forces.

the Class 1 brake test. There was a 2-man crew, consisting of an engineer and conductor, operating the train.

At 2:53 p.m., the train was traveling 40 mph at MP 179 when the engineer disengaged Trip Optimizer (TO)[4] and began to increase the Dynamic Brake (DB) to slow the train, in preparation for a 25-mph permanent speed restriction MP 182.2. The DP locomotives were left providing tractive effort, in throttle position 5, for about two minutes before transitioning to idle.

At approximately 2:55 p.m., the train had slowed to 38 mph when it experienced an undesired emergency brake application[5]. The conductor inspected the train and discovered the train had derailed 28 cars (consist line Nos. 69 through 96), which included 7 loads and 21 empties. While assessing the damage, the conductor noted cars blocking State Route 41 and notified the dispatcher to contact the Ohio State Highway Patrol. There were no injuries to the crew or the public, and no hazardous material was released.

3. INVESTIGATION AND ANALYSIS

Analysis – Train Build

NS Train 179LC-04 was comprised of 210 cars (120 cars with an average weight of 130 tons and 90 empty cars with an average weight of 40 tons). Eighty-two of the 210 cars were equipped with end-of-car cushioned drawbars. A car with an end-of-car cushioned drawbar can have anywhere from 5 to 8 times the free movement (slack) compared with a solid-drawbar-equipped car, and 82 cars equipped with cushioned drawbars can create approximately 112 feet of free travel over the length of the train. About 85 percent of the empty cars were distributed within the middle of the train between large blocks of loaded cars at the head end and the rear end of the train.

While the 82 cars equipped with end-of-car cushioned drawbars were distributed throughout the train, 21 of the 28 derailed cars were so equipped.

FRA determined the train make-up to be a contributing factor in the cause of the accident (buffing or slack action excessive, train makeup), with the 82 cars equipped with end-of-car cushioned drawbars increasing the risk of excessive in-train forces during dynamic braking.

Analysis – Simulation of Slack Action

FRA performed a simulation of the accident using a Train Energy and Dynamics Simulation (TEDS). Simulation analysis identified a wave of slack action moving through the train from the head end back, 30 to 50 seconds before the undesired emergency brake application. This slack action was the result of the dynamic brake application on the head end, and the transition of the train from a 0.7 percent descending grade to a 0.6 percent ascending grade. The mid-train DP

[4] TO is an energy management system, intended to reduce fuel consumption and improve train handling. The system operates the train, under the engineer's supervision, to achieve optimum efficiency.

[5] Undesired emergency brake application is an unintentional and irretrievable application of the maximum braking force available from a train's brake system. An undesired emergency brake application is not intentionally initiated by the crew and occurs when there is a separation in a train's airline and air pressure is released from the system.

locomotives were being operated in idle, asynchronously from the lead locomotive, and not providing any dynamic braking to control the slack action in the train.

The simulation indicated the slack action generated buff forces of about 230 KIPS[6], and likely derailed one of the empty cars between consist line Nos. 70 and 72. The cars in this position were all empty coil cars which weighed only 48,000 lbs., making the 230,000 lbs. of buff force more than enough to cause the empty car to be lifted from the rail and depart from the normal running path. At that time, these cars would have been within about 2,600 ft. of the highway-rail grade crossing for State Route 41. When the derailed car entered the highway-rail grade crossing, it struck a signal mast and was deflected away from the track, causing the rest of the 28 cars to derail.

FRA concluded the buff forces caused by the dynamic braking, on the head end only, was the probable cause of the accident.

Analysis – Train Handling

FRA investigators analyzed the event recorder data for all locomotives in train 179LC-04's consist. The train had three locomotives on the head end (2 were online providing tractive effort and 1 was isolated) and two DP locomotives placed 138 cars behind the lead locomotives.

Position	Locomotive	Status
1	NS 4458	Online
2	NS 4392	Online
3	NS 3626	Isolated
139	NS 4201	Online – DP
140	NS 4460	Online - DP

Approaching MP 179, the train was being operated by TO, under the engineer's supervision, with the lead locomotives in dynamic brake position 3. The mid-train locomotives were being operated asynchronously, providing tractive effort, before being set to idle. At about 2:53 p.m., the engineer turned TO off and began to increase the dynamic brakes from position 3 to position 8 over about one minute. The mid-train DP locomotives remained in idle, providing no braking or tractive effort.

The engineer was using the dynamic brakes, on the lead locomotives only, to slow his train in advance of a 25-mph permanent speed restriction. Analysis of the event recorder data demonstrated the engineer was operating in a safe manner, with sufficient planning, using the dynamic brakes as the primary means of reducing the train's speed as required by NS rules.

FRA determined the engineer's operation of the locomotives complied with NS Rules[7], however the use of dynamic braking, along with transitioning from the 0.7 percent descending grade to the 0.6 percent ascending grade, created the slack that caused the empty car to derail.

[6] KIPS is the measure of coupler impact force in thousands. E.g., 300 KIPS is 300,000-pounds of force on the coupler.
[7] NS-1 Rules for Equipment Operation and Handling, effective January 1, 2019.

Analysis – Mechanical
FRA found no evidence of deficiencies, irregularities, or non-compliance in all aspects of the mechanical condition of the equipment, and to the track over which the train was traveling at the time of derailment.

Analysis – Crew Member Training, Experience and Qualifications
FRA's investigation included evaluation of each crew member's qualification, certification, and testing records, as well as the crew's actions. FRA took found no evidence of deficiencies, irregularities, or non-compliance in the crew's training, qualification, and testing records or to the crew's hours of service records. FRA also conducted a fatigue analysis of each crew member's relevant work/rest schedule and found no excessive fatigue risk. In addition, the results of each crew member's FRA Post-Accident Toxicological Testing were negative, indicating that neither drugs nor alcohol contributed to the cause or severity of the accident.

4. CONCLUSION

The Federal Railroad Administration's (FRA) investigation and analysis found that the probable cause of this accident was excessive buffing or slack action due to a combination of the use of dynamic braking with the makeup of the train. Further, FRA determined the NS policy for, and promotion of, the use of dynamic braking as the preferred method of controlling train speed contributed to the accident.

In response, on April 10, 2023, FRA issued Safety Advisory 2023-02, *Train Makeup and Operational Concerns*, emphasizing significant safety concerns related to train configuration and calling for railroads to exercise diligence in managing varying train configurations, load placements, distributed power, and other operational factors. Subsequently, on May 2, 2023, FRA issued Safety Advisory 2023-03, *Accident Mitigation and Train Length*, to increase awareness of the complexities of operating longer trains and ensure railroads take necessary steps to mitigate associated risks.

These actions underscore the FRA's proactive approach to addressing safety risks and fostering safe practices across the rail industry.