National Transportation Safety Board

Washington, DC 20594

Safety Recommendation Report

Train Emergency Brake Communication

Ongoing Investigation

On October 4, 2018, at 7:40 p.m. mountain daylight time, eastbound Union Pacific (UP) freight train MGRCY04 (striking train) collided with the rear of stationary UP freight train MPCNP03 (stationary train) after cresting a hill and traveling down a descending grade of up to 1.58 percent for about 13 miles.[1] The striking train consisted of 3 leading locomotives and 105 railcars. The engineer and conductor of the striking train were killed, and 3 locomotives and 57 railcars of the striking train derailed while 9 railcars of the stationary train derailed. Prior to the accident, the crew of the striking UP freight train reported problems with the train's air brake system and radioed the UP Harriman Dispatch Center to advise them they had accelerated to 50 mph and were unable to stop.[2]

Event recorder data from the striking train's lead locomotive showed changes in the air flow from the locomotive to the air brake pipe at specific locations earlier in the trip. When the train was stretched (when the locomotives pulled the train uphill), the air flow was steady at about 27 cubic feet per minute (CFM), but when the train was bunched (compressed when the locomotives slowed the train going downhill) the recorded air flow dropped to 0 CFM.

The air flow meter shows how much air the locomotive is providing to the air brake pipe to compensate for leakage and to maintain the pressure needed for the brakes to operate correctly. Initial information obtained during the National Transportation Safety Board (NTSB) investigation indicated that the air flow did not display on the engineer's console when it was below 20 CFM, and the recorded air flow dropped to 0 CFM. Air flow dropping to a low level can be an indication of an obstruction in the air brake pipe.

When the engineer of the striking train bunched the train using locomotive-only electric brakes (dynamic braking) to go down the hill, the recorded data indicated that the air flow dropped below 20 CFM. Dynamic braking alone was insufficient to slow the train on the long descending grade. The train started to accelerate down the hill and the engineer tried to compensate for the increase in speed by applying air brakes. Despite the air brake application, the train continued to accelerate. Before the train reached the railroad's 30-mph speed limit, the engineer made an emergency brake application. The air brake application would have reduced the pressure in the air

[1] For additional details on this accident, please review the preliminary report for this accident, RRD19FR001, at http://www.ntsb.gov.

[2] Train air brakes are controlled by an air brake pipe that spans the length of the train. Brakes are applied by reducing the air pressure in the air brake pipe. Emergency brakes are applied by rapid venting of the air brake pipe to atmosphere.

brake pipe at the lead locomotive, and the reduction in pressure in the air brake pipe should have propagated from the front of the train to the rear, causing the air brakes to be applied along the entire train. The emergency brake application would have rapidly vented the air brake pipe to atmosphere, again propagating from the front of the train to the rear. Air brakes applied along the entire train would have been enough to slow and then stop the train. NTSB investigators are examining the failure of the reduction in air brake pipe pressure to propagate to the rear of the train when the engineer applied the air brakes.

Normally when emergency brakes are applied, in addition to venting the air brake pipe at the lead locomotive, the head-of-train device (HTD) in the lead locomotive transmits a radio message to the end-of-train device (ETD) at the rear of the train to initiate an emergency brake application and vent the air brake pipe to atmosphere at the rear of the train at the same time the air brake pipe is vented at the front of the train. According to the event recorder, the ETD did not initiate an emergency application of the brakes by venting the air brake pipe to atmosphere from the rear of the train. Instead, the train continued to accelerate. NTSB investigators are researching the reason for the communication failure between the HTD and ETD.

Communicating Train Emergency Brake Signals

There are two methods of communicating an emergency brake signal from the front to the rear of a train: an air pressure reduction that propagates along the train's brake pipe and radio communication between the train's HTD and ETD, which will vent the air brake pipe from the rear of the train as well. The HTD communication with the ETD should be automatically synchronized with the application of emergency brakes using the brake handle, but the HTD can also be triggered to communicate an emergency braking signal to the ETD independently by toggling a switch on the HTD. These two communication channels provide redundancy, but there are occasions where both methods fail to operate as intended.

Problems Initiating Braking through Air Pressure Reductions

NTSB investigators relied on data from the locomotive's event recorder, evidence found while on scene, and accepted principles of train air brake systems to ascertain what happened in this accident. The air flow recorded by the event recorder showed there was steady air flow when the train was stretched. The event recorder showed that the air flow dropped when the train was bunched. This was likely caused by an obstruction in the air brake pipe, which spans the length of the train. The air hoses used to maintain brake pipe continuity between railcars are the components most likely affected when the train is changed from stretched to bunched. In addition, investigators identified wheels from the train that exhibited discoloration due to overheating associated with an emergency brake application only on railcars on the front end of the train. There was no evidence of braking behind these cars.

The location of discolored wheels and the event recorder data led investigators to the conclusion that the probable air hose obstruction occurred within the 19 railcars that were added to the front of the train at Laramie, which was about 38 miles from the accident site.

Evidence from another incident shows how this failure can occur. On November 23, 2018, another UP train crew working west of Cheyenne, Wyoming, experienced similar issues while descending in heavy grade territory. After applying the brakes (reducing the air brake pipe pressure) to slow the train, the crew realized that the pressure reduction was not propagated to the rear of the train. The crew made several attempts to initiate an emergency brake application by toggling the emergency brake function on the HTD. The first two attempts were unsuccessful. On the third attempt, the train went into emergency braking. Upon inspection, railroad employees discovered a kinked air hose, as seen in figure 1. When emergency braking was applied, the kinked hose prevented the venting of the air brake pipe to atmosphere to propagate from the front of the train to the rear of the train. The third emergency brake application on the HTD led to successful communication with the ETD, which vented the air brake pipe from the rear of the train.

Figure 1. Kinked end-of-railcar air hose on railcar brake rigging of train involved in the November 23, 2018, incident west of Cheyenne, Wyoming. (Photograph provided by UP.)

On December 20, 2018, a UP mechanical employee discovered a similar kink in an air hose on a railcar on an outbound train that had recently received end-of-railcar hose repairs from a railcar repair shop. The end-of-railcar hose was configured incorrectly which kinked the hose, as seen in figure 2.

Figure 2. Kinked intermediate end-of-railcar air hose that was discovered during an inspection after an end-of-railcar air hose configuration was incorrectly applied. (Photograph provided by UP.)

Although the NTSB is still investigating the Granite Canyon accident, data from the event recorder indicates that air flow was obstructed in the air brake hose when the train bunched as it traveled downhill. Some of the railcars that were picked up by the accident train in Laramie would have had similar end-of-railcar air hose arrangements as the subject cars in the November 23, 2018, incident and the December 20, 2018, inspection. UP had procedures in place prior to the accident regarding the inspection of air hoses and air hose assemblies. After the accident and after the subsequent fouled air hoses were found, UP issued guidance to focus attention on inspecting cars with these air hose arrangements. The NTSB concludes that incorrectly configured air brake hoses could result in the inability to slow or stop a train. Therefore, the NTSB recommends that the Class I railroads review and issue guidance as necessary for the inspection of end-of-railcar air hose configurations to ensure the air hose configuration matches the intended design.

Problems Initiating Braking with Radio Communication

Emergency braking is enhanced with communication between the HTD and ETD because braking by venting the air brake pipe can be concurrently activated from both the front and the rear of the train, resulting in the rapid reduction of pressurized air from two opposite directions. If there is an obstruction in the air brake pipe, the brakes on all railcars would engage, up to and including the point of obstruction from both ends of the train. The emergency braking action initiated from a locomotive without the aid of an ETD would only be effective up to the point that air flow is obstructed. Under such circumstances, the amount of effective braking would be dependent upon where the restriction occurred in the air brake pipe; the closer the obstruction was to the front of the train, the less braking effort would be available. Inadequate or nonexistent airflow at the blockage point would preclude the activation of emergency brakes on all railcars behind the blockage. ETDs are proven critical hardware components that provide a quicker application of emergency brakes and provide a redundant path to induce braking in the event of an air brake pipe obstruction.

Radio telemetry between ETDs and HTDs can be interrupted by natural obstructions, changes in track grade, and track curvature during normal operations. Notifications to the train crew of such communication interruptions do not initiate until there has been a loss of communication for a minimum of 16 minutes and 30 seconds. Therefore, train crews may not be aware of communication interruptions between the HTD and ETD in a timely manner.

When an emergency brake application is initiated, the HTD transmits an emergency command signal to the ETD for 2 minutes or until the HTD receives an acknowledgement signal from the ETD. After 2 minutes with no reply from the ETD, the HTD emergency command transmission ends and the HTD will not start transmitting another emergency command signal unless the train crew initiates another emergency brake application. The NTSB is continuing to investigate these communication issues and they will be addressed further in the final report on this accident.

Class I railroads have air brake and train handling rules, and system special instructions (SSI) that stipulate operating procedures when ascending and descending graded territory. SSI typically contain information that tells the engineer and conductor where and when to check the braking performance of the train. In addition, the SSI includes special instructions on operating the device and what to do if there is an HTD/ETD communication failure. In this accident, these procedures did not prevent the brake failure on a grade, leading to the accident.

The NTSB concludes that the interruption of radio telemetry between an HTD and ETD could result in a lack of redundancy for emergency braking. Therefore, the NTSB recommends that the Class I railroads review and revise their air brake and train handling instructions and two-way ETD instructions to include: monitoring locomotive air flow meters for unexpected fluctuations, checking the status of communication between HTDs and ETDs before cresting a grade, and actions to take if the air pressure at the rear of the train does not respond to an air brake application. Furthermore, the NTSB recommends that the American Short Line and Regional Railroad Association alert its member carriers to (1) inspect the end-of-railcar air hose configurations and ensure the hose configurations match the intended design and (2) review and revise their air brake and train handling instructions for grade operations and two-way ETD instructions to include: monitoring locomotive air flow meters, checking the status of communication between HTDs and ETDs before cresting a grade, and actions to take if the air pressure at the rear of the train does not respond to an air brake application.

Recomendations

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

To the Class I Railroads:

> Review and issue guidance as necessary for the inspection of end-of-railcar air hose configurations to ensure the air hose configuration matches the intended design. (R-19-41)
>
> Review and revise your air brake and train handling instructions for grade operations and two-way end-of-train device instructions to include: monitoring locomotive air flow meters, checking the status of communication between the head-of-train and end-of train devices before cresting a grade, and the actions to take if the air pressure at the rear of the train does not respond to an air brake application. (R-19-42)

To the American Short Line and Regional Railroad Association:

> Alert your member carriers to (1) inspect the end-of-railcar air hose configurations to ensure the hose configurations match the intended design and (2) review and revise their air brake and train handling instructions for grade operations and two-way end-of-train device instructions to include: monitoring locomotive air flow meters, checking the status of communication between the head-of-train and end-of-train devices before cresting a grade, and the actions to take if the air pressure from the rear of the train does not respond to an air brake application. (R-19-43)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT, III
Chairman

BRUCE LANDSBERG
Vice Chairman

JENNIFER HOMENDY
Member

Date: September 16, 2019