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East Palestine, OH, Train Derailment and Hazardous Materials Shipment by Rail: Frequently Asked Questions

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On February 3, 2023, a freight train carrying hazardous materials operated by Norfolk Southern Railway Corporation derailed in the town of East Palestine, OH. The derailment involved a fire and damaged several railcars, but no deaths or injuries were initially reported. Emergency responders intentionally released a quantity of vinyl chloride, a flammable gas, from some of the damaged railcars to prevent them from exploding and then burned the gas to dispose of it. This action required the evacuation of many residents in and around East Palestine due to potential airborne exposure to toxic combustion byproducts. Once cleared to return to their homes, some residents complained of respiratory illnesses and the deaths of wild and domesticated animals.

The incident is being investigated by the National Transportation Safety Board. Cleanup efforts are being monitored by the Environmental Protection Agency. The derailment and the response to it have prompted calls for legislative and regulatory action related to the safe transportation of hazardous materials (hazmat) by rail. This Frequently Asked Questions (FAQ) report focuses on the federal safety standards, voluntary industry guidelines, railroad operating practices that may be considered in understanding how and why this derailment occurred, and how to prevent similar derailments in the future. It also provides a brief summary of past legislative responses to railroad safety issues.

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Background

On February 3, 2023, a freight train carrying hazardous materials operated by Norfolk Southern Railway Corporation derailed in the town of East Palestine, OH. The derailment involved a fire and damaged several railcars, but no deaths or injuries were initially reported. Emergency responders intentionally released a quantity of vinyl chloride, a flammable gas, from some of the damaged railcars to prevent them from exploding and then burned the gas to dispose of it. This action required the evacuation of many residents in and around East Palestine due to potential airborne exposure to toxic combustion byproducts. Once cleared to return to their homes, some residents complained of respiratory illnesses and the deaths of wild and domesticated animals.

The National Transportation Safety Board (NTSB) is investigating the incident. The Environmental Protection Agency (EPA) is monitoring cleanup efforts.¹ Norfolk Southern is one of the seven “Class I” railroads responsible for a majority of rail traffic in the United States. The derailment and the response to it have prompted calls for legislative and regulatory action related to the safe transportation of hazardous materials (hazmat) by rail. Train derailments are relatively uncommon given the size of the U.S. railroad system, occurring approximately once every 500 thousand train-miles. Reportable hazardous materials incidents account for roughly 2%-3% of derailments. In 2021, there were 1,087 derailments nationwide, of which 25 were reportable hazardous materials incidents. These figures are roughly in line with 10-year averages.²

What caused the East Palestine derailment?

Typically, NTSB identifies both probable cause(s) as well as contributing factors to assist policymakers in considering remedies to prevent future incidents. According to NTSB’s preliminary findings, a wheel bearing on one of the freight cars was overheating, which may have led to the failure of one of the car’s axles.³ Railroads use sensors alongside the tracks called wayside bearing failure detectors, or “hot box” detectors, to identify overheating bearings and address them before axle failure and resulting derailments occur. If a detector locates an overheating bearing, it transmits a message to the train driver, who can then slow the train to a safer speed or stop it to conduct a visual inspection. Before reaching East Palestine, the train that derailed passed several detectors measuring an increase in the bearing’s temperature above normal levels but not above thresholds set by Norfolk Southern that would have required stopping the train for inspection. A detector in East Palestine itself showed the bearing had risen above a “critical” temperature threshold, requiring the car to be removed from the train, but by then it was too late to stop the train before it derailed.⁴

Axle failure as likely occurred on the East Palestine train is a common cause of derailment. One analysis of Class I freight derailments on mainline track from 2006 to 2015 indicated that defects

¹ For more information about federal responses to oil and chemical spills, see CRS Report R43251, *Oil and Chemical Spills: Federal Emergency Response Framework*, by David M. Bearden and Jonathan L. Ramseur.

² Bureau of Transportation Statistics, *National Transportation Statistics*, Tables 2-06, 2-41, and 2-43, at <https://www.bts.gov/topics/national-transportation-statistics>. Requirements for hazardous materials incident reporting are codified at 49 C.F.R. §171.16.

³ National Transportation Safety Board (NTSB), “Norfolk Southern Railway Train Derailment with Subsequent Hazardous Material Release and Fires,” Preliminary Report RRD23MR005, February 23, 2023, at <https://www.nts.gov/investigations/Documents/RRD23MR005%20East%20Palestine%20OH%20Prelim.pdf>.

⁴ *Ibid.*, p. 3.

in railcar wheels or axles were the second leading cause of derailments after track defects.⁵ Federal regulations do not currently require the use of defective bearing detectors nor do they specify temperature thresholds for inspection or removal of cars with overheating bearings. However, the Federal Railroad Administration (FRA) has published guidance concerning their placement and use.⁶

What federal requirements apply to rail shipments of hazardous materials?

The Pipeline and Hazardous Materials Safety Administration (PHMSA) issues regulations concerning the safe packaging and movement of hazardous materials, which FRA implements and enforces on rail lines. Both agencies reside within the U.S. Department of Transportation (DOT). Depending on the type and quantity of materials being moved, different safety requirements apply, such as restrictions on the type of railcars that may be used and their position within the train.⁷ Railroads are required to avoid prolonged idleness of hazmat railcars on their tracks.⁸ Train crews are required to keep up-to-date information on the products carried in each railcar so that first responders know what potential hazards they are dealing with, and each hazmat railcar must have placards on the outside of the railcar indicating the hazmat class.⁹

Among the derailed cars in the East Palestine incident were five tank cars of vinyl chloride (Class 2.1, flammable gas) and two tank cars of benzene residue (Class 3, flammable liquid).¹⁰ While the East Palestine derailed train did not meet the regulatory definition of a *high-hazard flammable train* (HHFT), it did satisfy the industry definition of a *Key Train*. Both of these designations, and the additional requirements applying to trains of each type, are discussed below.

Why was the derailed train not regulated as a High-Hazard Flammable Train?

HHFTs are defined as any train hauling either 20 cars of a Class 3 flammable liquid (such as crude oil) in a continuous block or 35 cars of a Class 3 flammable liquid throughout the train.¹¹ The emphasis on Class 3 flammable liquids in federal safety regulations was in response to a surge in crude oil shipments by rail, primarily from the Bakken Formation in North Dakota. The expanded crude oil shipments represented a new development in rail transportation in that hazardous materials were being carried in large quantities, including in “unit trains” carrying

⁵ Brandon Z. Wang, Christopher P.L. Barkan, and M. Rapik Saat, “Quantitative Analysis of Changes in Freight Train Derailment Causes and Rates,” *Journal of Transportation Engineering, Part A: Systems*, vol. 146, no. 11 (November 2020). The study indicates that mainline freight derailments for U.S. Class I railroads declined 49% from 2006 to 2015.

⁶ Federal Railroad Administration (FRA), *An Implementation Guide for Wayside Detector Systems*, May 2019, at https://railroads.dot.gov/sites/fra.dot.gov/files/fra_net/18667/Wayside%20Detector%20Implementation%20Guide.pdf.

⁷ 49 C.F.R. §173.314, 49 C.F.R. §174.85.

⁸ 49 C.F.R. §174.14.

⁹ 49 C.F.R. §174.26 and §174.59.

¹⁰ Environmental Protection Agency, “East Palestine, Ohio Train Derailment Emergency Response—Documents,” at <https://www.epa.gov/system/files/documents/2023-02/TRAIN%2032N%20-%20EAST%20PALESTINE%20-%20derail%20list%20Norfolk%20Southern%20document.pdf>.

¹¹ 49 C.F.R. §171.8.

many cars of a single product. If any of these trains derailed, it would therefore necessarily involve railcars containing hazardous materials. The East Palestine train was a “manifest” or “general merchandise” train hauling 149 freight cars, of which 20 were carrying hazardous materials of various kinds, which would not qualify it as an HHFT under federal regulations.

Additional safety measures required of HHFTs that did not apply to the East Palestine derailed train include speed limits;¹² HHFTs are limited to 50 miles per hour (mph) generally, the same as an industry standard for all hazardous materials trains discussed below, and to 40 mph in certain areas, including large cities. HHFTs moving at over 30 mph must be equipped with secondary brake signaling devices at the rear of the train so that brake signaling travels to the cars from both the lead locomotive backward and from the rear of the train forward. The secondary brake signal can be a small electronic box fitted to the last car (“end-of-train” device) or an additional locomotive at the rear of the train (referred to as “distributive power”).

Railroads must inform state emergency response officials of the expected frequency of HHFTs traveling through their state, and they must develop oil spill response plans. They also must conduct a yearly HHFT safety and security routing analysis seeking to ensure that these trains are traveling the safest and most secure routes possible.¹³ This routing analysis is also required of trains carrying natural gas, explosives, radioactive materials, and poisonous by inhalation (PIH) material. While vinyl chloride—the chemical intentionally released in the East Palestine derailment—is not PIH and therefore not subject to the routing analysis, it does produce chemical compounds when heated that, if packaged separately, would be considered PIH (namely phosgene and hydrochloric acid gas).

What safety measures does the industry recommend for Key Trains?

The railroad industry has its own voluntary standard, Association of American Railroads (AAR) Circular OT-55, for recommended operating practices when transporting hazardous materials.¹⁴ These standards designate certain trains as Key Trains, including those hauling 20 or more car loads of any combination of hazardous materials. Key Trains are restricted to 50 mph, regardless of whether they are also HHFTs. If any car on a Key Train is found to have a defective bearing or sets off two consecutive bearing detectors, the standard requires it must be removed from the train. Similarly, OT-55 designates as “Key Routes” those rail lines that routinely handle certain quantities of hazardous materials in a given year. Key Routes are required to receive special inspections at least twice per year and be equipped with wayside defective bearing detectors at least every 40 miles (the average among all Class I railroads is roughly one every 25 miles).¹⁵ OT-55 also directs railroads to participate in the Transportation Community Awareness and Emergency Response (TRANSCAER) program, including by providing local emergency responders information about hazardous materials shipments in their communities. This information is provided only upon request, except when advance notification is required by federal regulations as noted above.

¹² 49 C.F.R. §174.310.

¹³ 49 C.F.R. §172.820

¹⁴ American Association of Railroads (AAR), *Recommended Railroad operating Practices for Transportation of Hazardous Materials*, Circular OT-55, May 1, 2019, at <https://public.railinc.com/sites/default/files/documents/OT-55.pdf>.

¹⁵ AAR, “National Wayside Detector System,” at <https://docplayer.net/17829351-Nationwide-wayside-detector-system.html>.

Because the East Palestine train was hauling 20 carloads of hazardous materials of various kinds, it would be classified as a Key Train under industry standard practices. It is not yet publicly known whether the tracks in East Palestine were part of an industry-designated Key Route.

What are Electronically Controlled Pneumatic Brakes?

Trains generally use compressed air to lift brakes away from train wheels while a train is in motion. When pressure in the main compressed air hose drops (whether commanded by the train driver or in a derailment), the brakes will engage. On a long train, this loss of air pressure can take several seconds to reach cars at the far end(s). This is one reason why, as noted above, HHFTs are required to be equipped with a device capable of engaging the brakes from the rear of the train as well as the front. A newer technology, electronically controlled pneumatic (ECP) braking, uses electrical signals instead of air pressure to engage brakes simultaneously, potentially reducing the distance needed to fully stop a moving train and reducing the “in-train” forces caused by some cars braking before others.¹⁶

In response to the surge in crude oil unit trains and some deadly and damaging derailments, DOT issued regulations in 2015 requiring all trains carrying 70 or more carloads of crude oil or any other Class 3 flammable liquid (designated “high-hazard flammable unit trains,” or HHFTs, a subset of HHFTs) to be equipped with ECP brakes. HHFTs generally shuttle loads between one point of origin and one destination without transferring cars to other trains, which could make ECP implementation more straightforward.¹⁷ However, later in 2015, a provision in Section 7311 of the Fixing America’s Surface Transportation Act (FAST Act; P.L. 114-94) required DOT to conduct additional testing and analysis of the costs and benefits of the ECP brake rule. When the rule’s costs were found to exceed its benefits, it was repealed in 2018 in fulfillment of the FAST Act’s requirements.¹⁸

The East Palestine train was carrying 20 cars loaded with various hazardous materials. It would not have qualified as an HHFT and therefore would not have been required to be equipped with ECP brakes. It is not yet clear whether ECP brakes would have reduced the severity of the derailment.

Could the derailment be related to Precision Scheduled Railroading?

Several of the largest railroads in North America employ a loosely defined set of industry practices designed to maximize efficient use of railroad assets, collectively known as “precision scheduled railroading” (PSR). Rather than adhering to regular schedules as the name suggests, these practices often involve planning train movements so as to reduce the amount of physical

¹⁶ Department of Transportation (DOT), “Pipeline and Hazardous Materials Safety Administration,” 80 *Federal Register* 26692, May 8, 2015.

¹⁷ DOT, “Pipeline and Hazardous Materials Safety Administration,” 80 *Federal Register* 26693, May 8, 2015.

¹⁸ Pipeline and Hazardous Materials Safety Administration, DOT, “Hazardous Materials: Removal of Electronically Controlled Pneumatic Brake System Requirements for High Hazard Flammable Unit Trains,” 83 *Federal Register* 48393, September 25, 2018, at <https://www.federalregister.gov/documents/2018/09/25/2018-20647/hazardous-materials-removal-of-electronically-controlled-pneumatic-brake-system-requirements-for>.

assets (such as yards and locomotives) needed to generate revenue, thereby improving an indicator of railroad performance called the operating ratio. Data have so far been inconclusive as to whether operational changes associated with PSR may have affected rail safety, according to a recent Government Accountability Office (GAO) study.¹⁹

PSR sometimes can be accompanied by workforce reductions, but labor unions have contended that it also has placed unrealistic workloads and duty schedules on remaining employees—a point raised during recent labor contract negotiations.²⁰ If NTSB finds the derailment was caused by a defective bearing on one railcar, an investigation of that railcar’s inspection records may reveal the extent to which—if at all—staffing issues may have allowed the defect to go undetected.

PSR is also associated with increased train lengths, and a longer train may take longer to come to a complete stop during an emergency. Depending on which car was the first to derail, the train’s length (and therefore weight) may have led more cars to derail or to collide with those that had already derailed. This, too, may be considered by NTSB in its investigation.

In a GAO report published in 2019, data provided by two Class I railroads indicated that their average train length had increased by about 25% since 2008, with average lengths of 1.2 and 1.4 miles in 2017. Officials from all seven Class I railroads reported to GAO that they were currently operating longer than average trains on specific routes, although some said such trains are a small percentage of the trains they operate. One railroad said it runs a 3-mile-long train twice weekly.²¹

What actions can Congress and the Department of Transportation take in response to the derailment?

DOT may issue emergency orders requiring immediate action by rail carriers, as it did in 2014 in response to crude oil derailments.²² NTSB is to publish a list of recommendations with its final report, which may include legislative and/or executive actions, but the agency has no regulatory authority of its own. In response to a 2012 crash that also involved the release of vinyl chloride, NTSB recommended that rail carriers provide advance notification to emergency responders of any shipments of hazardous materials, regardless of type or quantity. Because current advance notification is required only for HHFTs, this recommendation is still open.²³ Congress or DOT may also consider expanding the definition of HHFT to include a wider range of materials.

NTSB makes recommendations without conducting the type of benefit-cost analysis that PHMSA or FRA would undertake when issuing new regulations. Questions for further examination include whether industry-wide requirements for the transportation of hazardous materials by rail could have unintended environmental or economic consequences, such as diverting more hazardous materials traffic to trucks (truck crashes involving hazardous materials are generally much more common than derailments). Routing of hazardous materials to avoid densely

¹⁹ U.S. Government Accountability Office (GAO), *Freight Rail: Information on Precision-Scheduled Railroad*, GAO-23-105420, December 13, 2022, at <https://www.gao.gov/products/gao-23-105420>.

²⁰ See CRS Insight IN11966, *Legislation to Avert Railroad Strike Advances*, by Ben Goldman.

²¹ GAO, *Rail Safety: Freight Trains Are Getting Longer, and Additional Information Is Needed to Assess Their Impact*, GAO-19-443, May 30, 2019, at <https://www.gao.gov/products/gao-19-443>.

²² Office of the Secretary of Transportation, DOT, “Emergency Order Providing for Local Notification of High-Volume Rail Transport of Bakken Crude Oil,” 79 *Federal Register* 27363, May 13, 2014, at <https://www.federalregister.gov/documents/2014/05/13/2014-11068/emergency-order-providing-for-local-notification-of-high-volume-rail-transport-of-bakken-crude-oil>.

²³ NTSB, “Safety Recommendation R-14-014,” August 22, 2014, at <https://data.nts.gov/carol-main-public/sr-details/R-14-014>.

populated or otherwise sensitive areas could result in circuitous routes that increase exposure to incidents while making service slower and/or more expensive. Reducing train speeds for hazardous materials trains could worsen rail congestion that has been acute at times and has been the subject of recent federal regulatory proceedings. First responders may not necessarily consider derailment response training a priority given training time constraints and more likely hazards in their community.

Congress has placed new mandates on the rail industry to adopt safety measures or new technology in response to past accidents, sometimes over the objections of the rail carriers. In 2015, in response to crude oil spills, Section 7304 of the FAST Act required all tank cars carrying Class 3 flammable liquids to be built stronger and more crashworthy, using many of the additional crashworthiness features that are already present on tank car designs carrying compressed gases like vinyl chloride.²⁴ Older designs of tank cars have been phased out for use in carrying crude oil, and all others are required to be phased out by 2029.

In response to passenger train collisions, Section 104 of the Rail Safety Improvement Act of 2008 (RSIA; P.L. 110-432, Div. A) required the deployment of Positive Train Control (PTC) systems, which can automatically slow or stop a train to prevent collisions and some derailments. Notably, installation was required only on lines used by trains carrying passengers or PIH materials. This was originally to be carried out before the end of 2015, but full compliance was not achieved until the end of 2020 after a series of extensions. DOT provided over \$3 billion in grant and loan assistance to help achieve compliance, primarily to commuter rail authorities.²⁵

Congress created FRA in 1966 and reorganized NTSB in 1967 in response to a general decline in railroad safety that accompanied the industry's financial difficulties at the time. Prior to these actions, some aspects of rail safety had been regulated by another agency, the Interstate Commerce Commission, but were largely the responsibility of the industry. The law that granted FRA broad authority to regulate rail safety, the Federal Railroad Safety Act of 1970, was passed in part to prevent derailments of trains carrying hazardous materials (such as one in 1969 that resulted in the release and combustion of vinyl chloride in Glendora, MS).²⁶ As the industry's financial health recovered, the rate of train crashes and derailments steadily improved from the late 1970s to the late 1980s and has remained relatively stable since that time.

²⁴ Unlike most types of railcars that are owned or leased by the railroads, tank cars are typically owned or leased by the railroads' customers (e.g., chemical companies).

²⁵ FRA, "Steps Toward Full PTC System Implementation of Mandated Positive Train Control (PTC) Systems," at https://explore.dot.gov/t/FRA/views/PTCImplementationStatusReport/Overview?iframeSizedToWindow=true&%3Aembed=y&%3AshowAppBanner=false&%3Adisplay_count=no&%3AshowVizHome=no.

²⁶ Mark Aldrich, "Accidents," *Encyclopedia of North American Railroads*, 2007, p. 95; see also NTSB, *Railroad Accident Report: Illinois Central Railroad Company Train Second 76 Derailment at Glendora, Mississippi*, September 11, 1969, August 19, 1970, NTSB-RAR-70-2, at https://rosap.ntl.bts.gov/view/dot/45472/dot_45472_DS1.pdf.

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