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Rail Transportation of Liquefied Natural Gas: Safety and Regulation

June 12, 2020

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R46414

CRS REPORT
Prepared for Members and
Committees of Congress

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SUMMARY

R46414

June 12, 2020

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Rail Transportation of Liquefied Natural Gas: Safety and Regulation

An emerging alternative to domestic natural gas pipelines is shipping natural gas by rail, creating what some refer to as "virtual pipelines." On April 10, 2019, the Trump Administration issued Executive Order 13868, directing the Secretary of Transportation to permit liquefied natural gas (LNG) shipment in rail tank cars throughout the U.S. rail network. In compliance with the order, the Pipeline and Hazardous Materials Safety Administration (PHMSA), in coordination with the Federal Railroad Administration (FRA), initiated a rulemaking on October 24, 2019. The executive order effectively set a deadline for a final rule of May 10, 2020. PHMSA forwarded the rule to the Office of Management and Budget for review on April 30, 2020. As of the date of this report, no such rule had been issued.

The federal agencies with principal oversight of LNG shipments by rail are PHMSA and FRA, both within the Department of Transportation. In addition, the National Transportation Safety Board (NTSB) investigates rail accidents and makes safety recommendations. The Transportation Security Administration (TSA) and PHMSA jointly oversee freight rail security. The U.S. Coast Guard regulates safety and security of ports, where LNG terminals receiving rail shipments may be located. Federal safety requirements apply to any train operating in the United States, regardless of origin or destination. In addition, the rail industry establishes its own consensus safety standards, which often exceed government requirements.

Vessels have shipped U.S. LNG overseas, and tanker trucks have shipped LNG domestically, for decades. However, domestic shipment of LNG by rail is new. In 2015, the federal government issued its first ever permit for LNG shipments by rail in multi-modal tank containers between Anchorage and Fairbanks. A second such approval was issued in 2017 for LNG shipments in Florida between Jacksonville and Miami. On December 5, 2019, the federal government issued its first special permit authorizing LNG transport in rail tank cars between Wyalusing, PA, and Gibbstown, NJ. Shipment configurations could range from a small number of tank cars in trains carrying mixed freight up to dedicated "unit" trains with as many as 100 tank cars of LNG. These approvals and the PHMSA rulemaking have drawn both support and criticism. The freight railroads and other industry groups support them, citing perceived economic opportunities and their safety record. Some in Congress also have supported LNG by rail for similar reasons. However, perceived public safety and security risks of LNG by rail have raised concerns among state officials, the National Transportation Safety Board, and other Members of Congress.

Natural gas is combustible, so an uncontrolled release of LNG poses a hazard of fire or explosion. LNG also poses hazards because it is so cold. Key safety issues include risk differences between trains carrying only LNG versus trains carrying LNG and other cargo, derailment risks, tank car crashworthiness, routing near populated areas, and emergency response capabilities, especially among local first responders. The security implications of LNG shipments by rail are also a consideration, as LNG shipments and facilities could be targeted by individuals with malicious intent, but also could provide backup natural gas supplies if pipelines were disrupted.

A 2019 House appropriations bill amendment (H.Amdt. 468 to H.R. 3055) would have prohibited appropriated funds from being used to carry out the LNG-by-rail provisions of the executive order or to authorize LNG transportation in rail tank cars by issuance of a special permit or approval; the amendment was not adopted. The House Committee on Appropriations report (H.Rept. 116-106) accompanying Division H of the Further Consolidated Appropriations Act, 2020 (P.L. 116-94) recommended FRA funding to research and mitigate risks associated with the rail transportation of LNG, including tank car research. The Protecting Communities from Liquefied Natural Gas Trains Act (H.R. 4306) would require federal agencies to conduct further evaluation of the safety, security, and environmental risks of transporting LNG by rail. The Pipeline and LNG Facility Cybersecurity Preparedness Act (H.R. 370, S. 300) seeks "to ensure the security, resiliency, and survivability" of LNG facilities and would require DOE to coordinate response and recovery to physical and cyber incidents impacting the energy sector. The INVEST in America Act (H.R. 2) would require FRA and PHMSA to further evaluate the safety, security, and environmental risks of transporting LNG by rail, including physical testing and a determination of whether new safety standards are needed. The bill would authorize between $6 million and $8 million in FRA funding to carry out the evaluation. It would rescind any special permit or approval for the LNG transportation by rail tank car issued prior to enactment and would prohibit any regulation, special permit, or approval prior to the conclusion of a specified study period.

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Introduction

Domestic transportation of natural gas occurs mainly by pipeline, but some parts of the United States may have insufficient pipeline capacity to meet expected demand. Although pipeline developers are expanding the nation's pipeline network, proposed pipelines in some regions, notably the Northeast and Mid-Atlantic, have encountered siting challenges. Facing these challenges, U.S. natural gas producers are pursuing other means to supply markets where pipeline capacity is constrained. The Trump Administration has been supporting these efforts. As the 2020 *Economic Report of the President* notes, "pipelines are not the only means of transporting natural gas domestically."[1]

One emerging alternative to transporting natural gas by pipeline is shipment by rail, creating what some refer to as "virtual pipelines." In 2015, the federal government issued the first permit allowing the transportation of liquefied natural gas (LNG) by rail—on one specific route—using multi-modal tank containers on flatbed railcars. In 2019, the Trump Administration issued Executive Order 13868, directing the Secretary of Transportation to finalize a rule which would permit the transportation of LNG in rail tank cars more widely.[2] In compliance with this order, the Pipeline and Hazardous Materials Safety Administration (PHMSA), in coordination with the Federal Railroad Administration (FRA), initiated a rulemaking on October 24, 2019. The executive order effectively set a deadline for the final rule of May 10, 2020. PHMSA forwarded the rule to the Office of Management and Budget for final review on April 30, 2020.[3] A final rule had not been issued as of the date of this report.

Large marine vessels have shipped LNG between U.S. and overseas ports for over 60 years and tanker trucks have transported LNG domestically since the 1970s. Bulk LNG shipments and the development of related facilities historically have been controversial due to safety and security concerns.[4] However, domestic shipment of LNG by rail is relatively new. The President's executive order is intended to provide "greater flexibility in the modes of transportation" of LNG to serve domestic and export markets. Gas producers and railroads view LNG shipments as "a growing opportunity" for new revenue and as a way to increase supply reliability.[5]

This report discusses the physical hazards of LNG as well as safety and security issues associated with LNG transportation by rail. The report examines relevant federal regulation and summarizes recent industry initiatives to transport LNG by rail for domestic and export markets. It reviews Presidential and federal agency efforts to facilitate the movement of LNG by rail and selected policy issues. The report concludes with a summary of legislative actions in the 116th Congress.

Characteristics of LNG

When natural gas is cooled to temperatures below minus 260° F it condenses into a liquid form, generally referred to as "liquefied natural gas," or LNG. As a liquid, natural gas occupies only 1/600th the volume of its gaseous state, so it is stored more efficiently in a limited space and is

[1] Executive Office of the President, *Economic Report of the President*, February 2020, p. 169.

[2] Executive Order 13868, "Promoting Energy Infrastructure and Economic Growth," 84 *Federal Register* 15495, April 14, 2019. The order was issued on April 10, 2019.

[3] Office of Management and Budget, online regulatory database, accessed May 11, 2020, https://www.reginfo.gov/public/do/eoDetails?rrid=130458.

[4] Jamie Smith Hopkins, "Cove Point Project Opponents Raise Safety Concerns," *Baltimore Sun*, January 26, 2014.

[5] See, for example, Natural Gas Supply Association and the Center for LNG, "NGSA and CLNG Joint Statement on Executive Order Promoting Energy Infrastructure," press release, April 10, 2019.

more readily transported. At warmer temperatures LNG becomes gaseous again and can be pumped into local natural gas distribution systems, or fed directly into power plants or industrial facilities.

Safety Hazards of LNG

Natural gas is composed primarily of methane, which is combustible, so an uncontrolled release of LNG poses a hazard of fire or explosion. LNG also poses hazards because it is so cold. The possibility of catastrophic releases at LNG production, transfer, and storage facilities, and from LNG marine tankers, has long been the subject of technical research and congressional interest.[6] LNG transportation by rail poses similar hazards, although at smaller scale.

Flammable Vapor Clouds

In the event of an uncontrolled LNG release directly from a tank container or tank car, some of the LNG will regasify in the warmer, ambient air and form a natural gas vapor cloud. If the incident causing the release creates a source of ignition (e.g., a spark), the vapor cloud could begin to burn immediately at the point of release. Burning LNG poses a significant thermal hazard as it is hotter and burns more rapidly than oil or gasoline fires.[7] Its thermal radiation may injure people and damage property a considerable distance from the fire itself.

Emergency responders are generally unable to extinguish LNG fires, except very small ones. As a 2019 study commissioned by PHMSA reported,

> LNG releases do not allow first responders to cap off a leak or interact with the container. LNG releases involving cryogenic gas would result in an immediate evacuation of the area and securing the adjacent facilities. Given the warming effect of water on cryogenic gases, putting water on a cryogenic release is not recommended.[8]

In most cases, therefore, an LNG fire will continue to burn until all the LNG feeding it is consumed. If the natural gas vapor does not ignite immediately upon release, the vapor cloud may drift from the site. If the cloud subsequently encounters an ignition source, those portions of the cloud with a combustible gas-air concentration may burn.[9] The nature of such a fire would depend upon local conditions. Whether an LNG vapor cloud can explode, potentially posing greater risks to people on the ground, is an open technical question.[10]

If LNG spills on land without igniting, it will flow away from the source, potentially pooling in ditches, culverts, sewers, or other lower-lying areas. LNG spilled on water will spread out in a pool on the surface of the water. The LNG will continue evaporating as it travels, creating a vapor

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[6] Walter Chukwunonso Ikealumba and Hongwei Wu, "Some Recent Advances in Liquefied Natural Gas (LNG) Production, Spill, Dispersion, and Safety," *Energy and Fuels*, Volume 28 (2014), pp. 3556−3586; Rob M. Pitbaldo and John L. Woodward, "Highlights of LNG Risk Technology*," Journal of Loss Prevention in the Process Industries*, vol. 24 (2011), pp. 827-836.

[7] Robert G. Zalosh, *Industrial Fire Protection Engineering*, John Wiley and Sons, Hoboken, N.J., 2003, Table A.1.

[8] Cambridge Systematics, Inc., *Risk Assessment of Surface Transport of Liquid Natural Gas*, Prepared for the Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety, March 20, 2019, p. 92.

[9] Methane, the main component of LNG, burns in gas-to-air ratios between 5% and 15%.

[10] PHMSA states that it "is not aware of any reliable reports of explosions of outdoor vapor clouds of natural gas and does not believe that there is a risk of vapor cloud explosions (VCEs) due to a release of methane in an open area." PHMSA, "LNG Safety," accessed March 18, 2020, at https://www.phmsa.dot.gov/pipeline/liquified-natural-gas/lng-safety.

cloud over these areas. Any resulting fire could spread farther outward as the LNG flow expands away from its source and continues evaporating.[11]

Boiling Liquid Expanding Vapor Explosions

One hazard of particular concern for transportation of combustible fuels in tank containers or rail tank cars is the possibility of a boiling liquid expanding vapor explosion (BLEVE). As a Canadian study explained in 2015,

> This type of accident occurs when a tank car is heated (typically by fire) until rupture, at which point the vapour suddenly expands and the liquid contents boil rapidly due to the pressure drop. BLEVEs can result in a blast wave, projection of tank fragments and/or a fireball.[12]

Because experience with LNG transport by rail is limited and few experimental studies have focused specifically on LNG releases from tankers, there are significant uncertainties about the risk of a BLEVE from an accident involving an LNG tank container or rail car.[13] Furthermore, the assessment of risk must take account of the safety measures (e.g., pressure relief valves) incorporated into tank and tank car designs, which may vary. Such incidents may not be ruled out entirely, however, as a BLEVE apparently occurred in Spain in 2002 following a highway crash involving an LNG tanker truck.[14]

Other LNG Safety Hazards

LNG vapor clouds are not toxic, but they could cause asphyxiation by displacing breathable air. Such clouds may begin near the ground (or water surface) at a spill site when they are still very cold, but rise as they warm because natural gas is lighter than air, diminishing the threat to people. Extremely cold LNG could injure people or damage equipment (e.g., by brittle fracture) through direct contact.

Environmental Risks

As noted above, LNG is composed principally of methane. In 2009, the Environmental Protection Agency (EPA) found that methane endangers public health and welfare within the meaning of the Clean Air Act because of its effects on climate as a greenhouse gas.[15] Operators do not

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[11] In a 1944 accident with East Ohio Gas involving a release from two very large LNG storage tanks, such LNG flows were a major contributing factor to the resulting fires: "As the gas vaporized, it flowed through gutters and along curbs until it reached catch basins and the underground sewage system, causing streets to explode and manhole covers to blow off. The gas eventually flowed into homes and businesses via the sewage system, causing further explosions, destruction, and injuries." See Western Reserve Historical Society, "History of the East Ohio Gas Explosion and Fire," at http://catalog.wrhs.org/collections/view?docId=ead/PG575.xml&doc.view=printead;chunk.id=0, accessed May 7, 2020.

[12] National Research Council Canada, *Rail Tank Cars Exposed to Fire*, Report A1-005795-01.1, March 31, 2015, p. 1.

[13] Nilambar Bariha, Vimal Chandra Srivastava, and Indra Mani Mishra, "Theoretical and Experimental Studies on Hazard Analysis of LPG/LNG Release: A Review," *Reviews in Chemical Engineering*, vol. 33, no. 4 (2017), pp. 387–432.

[14] Eulalia Planas, Elsa Pastor, Joaquim Casal, and J.M. Bonilla, "Analysis of the Boiling Liquid Expanding Vapor Explosion (BLEVE) of a Liquefied Natural Gas Road Tanker: The Zarzalico Accident," *Journal of Loss Prevention in the Process Industries*, vol. 34 (2015), pp. 127-138.

[15] Environmental Protection Agency, "Endangerment and Cause or Contribute Findings for Greenhouse Gases," 74 *Federal Register* 66496-66516, December 15, 2009. For more information, see CRS Report R44615, *EPA's Methane Regulations: Legal Overview*, by Linda Tsang.

intentionally vent LNG tanks in surface transportation during normal operation. In the event of an uncontrolled LNG release, methane that is not burned escapes into the atmosphere.[16] LNG dissipates completely and leaves no residue, so other environmental damage at the site of an LNG release would be confined to fire impacts in the immediate area and freezing impacts on adjacent facilities or equipment.

Security Risks

After the terror attacks of September 11, 2001, security risks to LNG infrastructure and marine tankers drew considerable attention.[17] Similar concerns may be relevant to movement of LNG by rail. In particular, some in Congress have expressed concern that individuals with malicious intent could seek to cause an uncontrolled release of LNG in a populated area to injure people.[18] The potential impact of an attack on a rail shipment of LNG could be considerably greater than that involving a truck shipment because the volume of LNG involved could be greater. A single LNG rail tank car can carry over 30,000 gallons of LNG compared to a typical LNG tanker truck which can carry roughly 13,000 gallons—and rail shipments may consist of multiple connected cars.[19] The hazards from an intentional release would be the same as those discussed above; however, the potential impact might be greater than that of an accident occurring at a random location.

While LNG shipments by rail may increase security risks to local communities and infrastructure, they may increase the resiliency of the energy sector more broadly. In particular, transporting LNG by rail may serve as a potential backup for pipeline natural gas supplies. In a December 2018 study, the Government Accountability Office (GAO) stated that since the terrorist attacks of September 11, 2001, "new threats to the nation's pipeline systems have evolved to include sabotage by environmental activists and cyber attack or intrusion by nations."[20] Pipeline disruptions could interrupt gas supplies to power plants, but LNG transport by rail potentially could provide emergency fuel supply to critical end users until pipeline supplies could be restored.[21] LNG shipments by rail also could be targeted, but an attack which could shut down a natural gas pipeline and simultaneously block rail shipments of LNG would be far more difficult to execute successfully. The effectiveness of LNG backup supplies could be limited, however, due to the time required for rail deliveries, the scale of rail equipment to handle the required LNG volumes, and the ability of end users to access such supplies.

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[16] A related issue of debate is the potential environmental impact of greenhouse gas emissions from natural gas production and transportation prior to rail shipment and from natural gas combustion by consumers. Analysis of this issue is outside the scope of this report.

[17] See, for example: Institute for the Analysis of Global Security (IAGS), *The Terrorist Threat to Liquefied Natural Gas: Fact or Fiction?*, February 2008; Government Accountability Office (GAO), *Maritime Security: Public Safety Consequences of a Terrorist Attack on a Tanker Carrying Liquefied Natural Gas Need Clarification*, GAO-07-316, February 2007; Jerry Havens, "Terrorism: Ready to Blow?," *Bulletin of the Atomic Scientists*, July/August 2003, p. 17.

[18] See, for example, Representative Peter DeFazio, "Amendment No. 233 Offered by Mr. DeFazio," floor debate, *Congressional Record*, daily edition, vol. 165, June 24, 2019, p. 106.

[19] Volpe Center, U.S Department of Transportation, "Transportation Study: Impacts Associated with New and Emerging Natural Gas Liquefaction Facilities," white paper, January 2016, p. 23, https://rosap.ntl.bts.gov/view/dot/36455/dot_36455_DS1.pdf.

[20] Government Accountability Office, *Critical Infrastructure Protection: Actions Needed to Address Significant Weaknesses in TSA's Pipeline Security Program Management*, GAO-19-48, December 2018.

[21] For further discussion of pipeline security, see CRS Insight IN11060, *Pipeline Security: Homeland Security Issues in the 116th Congress*, by Paul W. Parfomak.

Federal Agency Roles

Several federal agencies are involved with the safety and security regulation of LNG shipments by rail. U.S. regulation applies to any train operating in the United States, regardless of its origin or destination. In addition, the rail industry establishes its own consensus standards, discussed later in this report.

Federal Railroad Administration

The Federal Railroad Administration (FRA), an agency within the Department of Transportation (DOT), has jurisdiction over U.S. railroad safety. FRA has about 370 federal inspectors throughout the country and also utilizes about 170 state railroad safety inspectors.[22] State inspectors predominantly enforce federal requirements because federal rail safety law preempts state law. FRA uses past incident data to determine where its inspection activity should be targeted. FRA regulations cover the safety of track, grade crossings, rail equipment, operating practices, and movement of hazardous materials (hazmat).

Pipeline and Hazardous Materials Safety Administration

PHMSA, also within DOT, issues regulatory requirements for the safe transport of hazmat, including LNG, by all modes of transportation.[23] FRA enforces PHMSA's hazmat regulations with respect to railroads.[24] FRA and PHMSA work together on rail hazmat safety but FRA's core focus is with train operations while PHMSA's core focus is on hazmat packaging requirements, such as the design of tanks used in LNG transportation. PHMSA also regulates the safety and security of certain LNG facilities which may be involved in rail transportation.[25]

National Transportation Safety Board

Rail incidents are investigated by the National Transportation Safety Board (NTSB), an independent federal agency. Although it has no regulatory authority, the NTSB makes recommendations to regulatory agencies toward preventing future incidents, based on its findings. The NTSB typically recommends specific regulatory changes based on the findings of its accident investigations, but may also prepare safety studies and special reports, and convene public forums, about safety issues on its own initiative.[26] Agencies such as FRA and PHMSA do not always agree with the NTSB's recommendations. If they choose to implement them, they normally must first go through a rulemaking process which involves consultation with industry advisory committees, public comment, and approval from the Office of Management and Budget.

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[22] FRA, "Office of Railroad Safety," October 31, 2019, https://railroads.dot.gov/about-fra/program-offices/office-railroad-safety.

[23] Through its Office of Pipeline Safety, PHMSA also sets and enforces safety standards for onshore natural gas pipelines and LNG facilities, including facilities for the production, storage, and transfer of LNG (49 C.F.R. §193). PHMSA works in partnership with state agencies to ensure that regulated LNG facility operators comply.

[24] DOT has the emergency authority to restrict or prohibit transportation that poses a hazard of death, personal injury, or significant harm to the environment. See 49 U.S.C. §20104.

[25] 49 C.F.R. §193.

[26] For rail examples, see NTSB, *Special Investigation Report on Railroad and Rail Transit Roadway Worker Protection*, NTSB Number SIR-14-03, September 24, 2014; and "NTSB Holds Forum on Safety of Rail Transportation of Crude Oil and Ethanol," press release, April 21, 2014.

Transportation Security Administration

Under the Aviation and Transportation Security Act (P.L. 107-71) and the Homeland Security Act of 2002 (P.L. 107-296), the Transportation Security Administration (TSA) within the Department of Homeland Security (DHS) is responsible for securing freight rail transportation. However, Section 1711 of the Homeland Security Act also gives DOT statutory authority to "prescribe regulations for the ... security, of hazardous material in intrastate, interstate, and foreign commerce," which would encompass LNG by rail. Presidential Policy Directive (PPD) 21 designates DOT and DHS as Co-Sector-Specific Agencies for Transportation Systems.[27]

Under PPD-21, issued in 2013, a sector-specific agency is responsible for "providing institutional knowledge and specialized expertise as well as leading, facilitating, or supporting the security and resilience programs and associated activities of its designated critical infrastructure sector in the all-hazards environment."[28] Within DHS these responsibilities are carried out by TSA, working jointly with PHMSA. TSA has developed a Transportation Sector-Specific Plan for freight rail security and is authorized to impose security directives, if needed, which have the force of regulations.[29] PHMSA has promulgated regulations for the security of hazmat shipments by rail, including a requirement for security plans, which are enforced by FRA.[30]

Other Federal Agencies

The Federal Energy Regulatory Commission, an independent agency, has siting authority under the Natural Gas Act over interstate natural gas pipelines as well as the place of entry and exit, siting, construction, and operation of LNG terminals used for interstate commerce, import, or export.[31] Some facilities producing, storing, or accepting LNG transported by rail could fall under the commission's jurisdiction. Department of Energy has authority under the Natural Gas Act to authorize the export of LNG to foreign buyers. Potential LNG exporters must file for an export authorization under the rules and procedures established by the department.[32] Therefore, shipments of LNG for export require its approval before leaving the United States. For applications to export LNG to countries with which the United States does not have a free trade agreement, the Department of Energy considers economic impacts, security of natural gas supply, and environmental impacts, among other factors.[33] The Coast Guard has jurisdiction over the safety and security of waterfront facilities supporting maritime commerce. Thus, if shipments of LNG by rail were to originate or terminate at a port facility, the Coast Guard would have jurisdiction over the rail operations occurring on port grounds.

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[27] Executive Office of the President, "Presidential Policy Directive—Critical Infrastructure Security and Resilience," PPD-21, February 12, 2013.

[28] PPD-21; Sector-specific agencies' responsibilities are further elaborated in Department of Homeland Security, *NIPP 2013: Partnering for Critical Infrastructure Security and Resilience*, 2013, Appendix B.

[29] Transportation Security Administration, *Transportation Systems Critical Infrastructure and Key Resources Sector-Specific, Plan-Freight Rail Modal Annex*, May 2007.

[30] 49 C.F.R. §§172.800 et seq.

[31] 15 U.S.C. §§717 et seq.

[32] 15 U.S.C. §717b(a); DOE regulations implementing those requirements were promulgated at 10 C.F.R. Part 590, "Administrative Procedures with Respect to the Import and Export of Natural Gas."

[33] Department of Energy, Office of Fossil Energy, "Policy Statement Regarding Long-Term Authorizations to Export Natural Gas to Non-Free Trade Agreement Countries," 83 *Federal Register* 28841-28843, June 21, 2018. For further background, see CRS Report R45006, *U.S. Liquefied Natural Gas (LNG) Exports: Prospects for the Caribbean*, by Michael Ratner et al.

Federal Approval of LNG by Rail

Federal hazardous materials regulations prohibit rail shipment of LNG except with either FRA approval or a PHMSA special permit.[34] FRA may allow LNG shipments in specialized, multi-modal tank containers of the type already approved for transporting LNG in general commerce (i.e., by truck or container ship). These intermodal tank containers have been approved by PHMSA and are built to specifications set by the International Organization for Standardization (ISO) and therefore are commonly referred to as ISO containers.[35] A special permit from PHMSA is required to transport LNG in rail tank cars because such cars are not currently authorized to carry LNG. Shippers with a special permit from PHMSA to ship LNG in rail tank cars would not require separate FRA approval because the agencies cooperate in reviewing such permit applications.

FRA granted its first LNG-by-rail approval in 2015 to the Alaska Railroad Corporation, which has subsequently transported LNG in ISO tank containers (**Figure 1**) from Anchorage to Fairbanks.[36] FRA issued a second such approval in 2017 to the Florida East Coast Railroad, which is using LNG as a locomotive fuel and is testing LNG transport in ISO tank containers from Jacksonville to Miami, possibly for export to locations in the Caribbean.[37]

Figure 1. Alaska LNG Shipment on Flatbed Rail Cars in ISO Containers

Source: Federal Railroad Administration, Office of Technical Oversight,

[34] Hazmat regulations are at 49 C.F.R. §172 et seq. PHMSA special permits are authorized under 49 U.S.C. §5117; special permits may be issued to any applicant performing a regulated function, including, a "person who—(i) transports hazardous material in commerce; (ii) causes hazardous material to be transported in commerce; (iii) designs, manufactures, fabricates, inspects, marks, maintains, reconditions, repairs, or tests a package, container, or packaging component that is represented, marked, certified, or sold as qualified for use in transporting hazardous material in commerce; (iv) prepares or accepts hazardous material for transportation in commerce; (v) is responsible for the safety of transporting hazardous material in commerce" (49 U.S. Code § 5103(b)(1)(A)). FRA approval is authorized under 49 C.F.R. §174.63 and applies to any "carrier," defined as "a person who transports passengers or property in commerce by rail car, aircraft, motor vehicle, or vessel" (49 C.F.R. §171.8).

[35] 49 C.F.R. §178.274.

[36] Alaska Railroad Corp., "Stars Align for LNG-Haul Demo This Fall," *All Aboard*, newsletter, Second Quarter 2016, at https://insidetrack.akrr.com/web/NEWS/AllAboard/2016_2Qtr_AllAboard.pdf.

[37] PHMSA, *Risk Assessment of Surface Transport of Liquid Natural Gas*, March 20, 2019, p. 23.

In January 2017, the Association of American Railroads, a trade group, petitioned DOT to allow LNG to be transported in certain rail tank cars (the DOT-113 design) nationwide.[38] These rail tank cars can carry about three times more LNG than an ISO tank container. The association sought the change for LNG because, according to its petition, "it is a safe method of transporting this commodity, LNG shippers have indicated a desire to use rail to transport it, and because railroads potentially will need to transport LNG for their own use as a locomotive fuel."[39]

In August 2017, Energy Transport Solutions (ETS), a prospective LNG shipper, applied to DOT for a special permit to transport LNG in DOT-113 rail tank cars between three points of origin and three destinations "in LNG trains that consist of 20 or more tank cars in a continuous block on a single train or 35 or more tank cars across an entire train."[40] On December 5, 2019, PHMSA issued this special permit, authorizing ETS to transport LNG only between Wyalusing, PA, and Gibbstown, NJ, in DOT-113C120 tank cars with no intermediate stops and subject to certain operational controls.[41] The permit does not specify a particular route. The ETS special permit and tank car specification are further discussed later in this report.

Executive Order 13868

On April 10, 2019, the Trump Administration issued Executive Order 13868, *Promoting Energy Infrastructure and Economic Growth*, with the stated purpose of enabling "the timely construction of the infrastructure needed to move our energy resources through domestic and international commerce."[42] Among other provisions, the order states:

> The Secretary of Transportation shall propose for notice and comment a rule, no later than 100 days after the date of this order, that would treat LNG the same as other cryogenic liquids and permit LNG to be transported in approved rail tank cars. The Secretary shall finalize such rulemaking no later than 13 months after the date of this order.[43]

Based on the date of the order, issuance of the final rule was required by May 10, 2020. As of the date of this report, no such rule had been issued.

PHMSA LNG by Rail Rulemaking

In response to Executive Order and the AAR petition, on October 24, 2019, PHMSA published in the *Federal Register* a Notice of Proposed Rulemaking (NPRM) for public comment on potential changes to its hazmat regulations to authorize LNG transportation by rail throughout the U.S. rail

[38] Petition requirements are found at 49 C.F.R. §§106.95-106.105.

[39] Association of American Railroads, "Petition for Rulemaking to Allow Methane, Refrigerated Liquid to Be Transported in Rail Tank Cars," before the Pipeline and Hazardous Materials Safety Administration, P-1697, January 17, 2017, p. 1. The use of LNG as a fuel for rail locomotives also involves LNG movement by rail, but in relatively limited quantities for consumption by the locomotives themselves.

[40] Energy Transport Solutions, "Application for a Special Permit, to Transport Methane, Refrigerated Liquid, in DOT 113 Tank Cars," before the Department of Transportation, Research and Special Programs Administration, August 21, 2017, p. 3. The names of the points of origin and destinations were redacted from the application as confidential business information.

[41] PHMSA, Special Permit DOT-SP 20534, granted to Energy Transport Solutions, LLC, December 5, 2019, at https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/safe-transportation-energy-products/72906/dot-20534.pdf.

[42] Executive Order 13868, "Promoting Energy Infrastructure and Economic Growth," 84 *Federal Register* 72, April 14, 2019, p. 15495. The order was issued on April 10, 2019.

[43] 84 *Federal Register* 15497.

network in a specific type of DOT-113 rail tank car.[44] In its NPRM, the agency states that growth in domestic LNG production capacity "has led to significant challenges in the transportation system" and, therefore, that "there may be a demand for greater flexibility in the modes of transportation available to transport LNG." The NPRM further states that "some shippers have expressed that there is an interest in the transportation of LNG by rail (domestically and for international export), which would help address these challenges."[45] The comment period, after extension, closed on January 13, 2020.[46] The NPRM has drawn comment in support and opposition to it, including submissions from other federal agencies.

PHMSA's proposed rule would allow LNG to be carried in DOT-113C120W specification tank cars (**Figure 2**), which are designed to carry liquefied ethylene, "another flammable cryogenic liquid which shares similar chemical and operating characteristics with LNG."[47] In PHMSA's rulemaking, the agency, in conjunction with FRA, is examining potential limitations for routes and train length specifically for LNG shipments in rail tank cars. Speed restrictions and requirements that cars be equipped with specialized brakes (further discussed below) are also under consideration. The proposed rule does not discuss specific tank car features designed to reduce the chances of tank car punctures during derailment, such as those newly required of cars carrying crude oil.

Figure 2. Insulated Rail Tank Cars Proposed for LNG

Source: Chart Industries.

Selected Policy Issues

The federal government's issuance of the PHMSA rulemaking and its approvals of LNG shipments by rail have drawn both support and criticism. Consistent with the AAR's initial petition for PHMSA to allow LNG by rail, the association and other industry groups also support the broader rulemaking. However, the NTSB, as well as a coalition of state attorneys general,

[44] This is the rail car approved for use in the PA-NJ route mentioned above. PHMSA, "Hazardous Materials: Liquefied Natural Gas by Rail." Notice of Proposed Rulemaking (NPRM) at 84 *Federal Register* 56964-56977, October 24, 2019. (Hereinafter PHMSA NPRM.)

[45] Ibid, p. 56965.

[46] 84 *Federal Register* 70491, December 23, 2019.

[47] PHMSA NPRM, p. 56967.

environmental groups, and other groups, have expressed opposition. The following sections discuss selected issues raised during the rulemaking process.

Safety of Unit vs. Manifest Trains

An important safety aspect of the proposed rulemaking is how much LNG by rail would be carried in unit trains versus manifest trains. A manifest train carries a varied mix of products, usually in various different car types (e.g., box car, flatbed, tank car). A unit train comprises just one car type carrying a single commodity to a single destination, usually returning empty to its point of origin. Ethanol was the first hazardous material to be carried in unit versus manifest train formations in the United States, commencing in 2003.[48] Shipment of crude oil in unit trains grew significantly during the 2010s.[49]

PHMSA's final environmental assessment for the ETS special permit states that the applicant "seeks authorization to ship LNG via rail ... in shipment configurations that could range from single to multiple tank cars (blocks) in general manifest trains ... up to dedicated train configurations consisting of up to 100 tank cars (unit train)."[50] The assessment further evaluates a "baseline case" in which ETS would ship between two and four unit trains of LNG per day.[51] In its NPRM, the agency states

> While PHMSA expects LNG will initially move in smaller quantities (i.e., a few tank cars) as part of manifest trains, it is uncertain whether LNG will continue to be transported in those quantities or if LNG by rail will shift to be transported using a unit train model of service, and if so, how quickly that shift will occur.[52]

Therefore, while PHMSA's proposed rule does not predict future numbers of LNG unit train shipments, it would allow them. Whether LNG is carried in a manifest or unit train configuration has risk implications because of the placement of the cars relative to the location of crews and possible flaws in the tracks, discussed below.

Derailment Risks and Safety Measures

According to the Association of American Railroads, 99.999% of all hazmat railcars reach their destinations without an incident that releases product; in 2016, the number of train accidents with a hazmat product release was 0.69 for every 100,000 hazmat carloads.[53] Hazmat rail accidents not involving a release occur more frequently. Derailment is the primary type of rail accident, in

[48] Burlington Northern and Santa Fe Railway Company, "BNSF Moves 10,000th Carload of Ethanol Through BNSF Ethanol Express Unit Train Service," press release, September 28, 2004. Typically, ethanol is carried either in a unit train, or in a manifest train with numerous continuous cars carrying ethanol.

[49] For further discussion of crude oil shipment by rail, see CRS In Focus IF10727, *Rail Transportation of Crude Oil and the FAST Act: An Update*, by John Frittelli.

[50] PHMSA, *SP 20534 Special Permit to Transport LNG by Rail in DOT113C120W Rail Tank Cars, Final Environmental Assessment*, Docket No. PHMSA-2019-0100, December 5, 2019, p. 3.

[51] Ibid., p. 23.

[52] PHMSA NPRM, p. 56969.

[53] Association of American Railroads, "Railroads Safely Deliver Hazardous Materials," accessed May 12, 2020, https://www.aar.org/data/railroads-safely-deliver-hazardous-materials/.

general, accounting for over two-thirds (1,285) of all U.S. train accidents in 2019.[54] Over the last decade, derailment has been identified as the cause of several major hazmat rail accidents.[55]

A leading cause of derailments is a flaw in a steel rail. The locomotive and first few cars may successfully pass over this flaw, but their weight and the forces involved could exacerbate the flaw and cause a rail break. Succeeding cars passing over that point in the track would derail, at which time the emergency brakes would be applied. Before the last cars in the train pass over the rail break, the train could be significantly slowed or come to a stop. The first and last cars in the train, therefore, might avoid derailment or derail at a much slower speed.[56]

To reduce hazmat derailment risks, cars carrying hazmat in a manifest train can be placed either toward the rear or the front of the train. However, these configurations increase the likelihood that hazmat would be released if another train collides with the manifest train from the rear or if the manifest train itself collides with a train ahead. Such an incident could release hazmat closer to the train operators located at the front of a train. The NTSB has recommended that at least five "buffer" cars carrying non-hazardous material separate the head locomotive with train crew from the nearest hazmat car, but FRA has not adopted this recommendation.[57] An alternative is to surround a rail car carrying a flammable or otherwise hazardous product with cars carrying non-hazardous material. If that group of cars should derail, a fire or explosion due to release of material from the hazmat car would be less likely to trigger fires or explosions in the non-hazmat derailed cars nearby. Other relevant factors to consider in arranging the configuration of a train is the relative weight of individual cars, which affects train control, and whether the placement would require more switching in rail yards, which may pose other risks.

In a loaded unit train, any derailed cars will be carrying the hazardous material. Given some of the large fires and explosions that have occurred when crude oil and ethanol unit trains have derailed in the past,[58] DOT has mandated a number of specific measures for these trains to reduce the chances of derailment and mitigate the consequences of a derailment. Most of these measures are not being proposed as requirements in PHMSA's LNG-by-rail rulemaking, as further discussed below.

Cascading Failure

FRA has stated in past regulatory correspondence that "the transportation of large quantities of LNG in a single train presents unique safety risks."[59] Stakeholders have identified the potential for "cascading failure" as one of these risks. In this kind of event, an uncontrolled LNG release

[54] Federal Railroad Administration, "Total Accidents/Incidents, Jan–Dec," online database, April 29, 2020, https://safetydata.fra.dot.gov/officeofsafety/publicsite/summary.aspx.

[55] See, for example, National Transportation Safety Board, *Derailment of CN Freight Train U70691-18 with Subsequent Hazardous Materials Release and Fire, Cherry Valley, Illinois, June 19, 2009*, NTSB/RAR-12/01, February 14, 2012; and *Derailment and Hazardous Materials Release of Union Pacific Railroad Unit Ethanol Train, Graettinger, Iowa, March 10, 2018*, NTSB/RAR-18/02, October 30, 2018.

[56] This occurred, for example, in the 2018 Union Pacific ethanol train derailment. Ibid.

[57] National Transportation Safety Board, "2019–2020 NTSB Most Wanted List of Transportation Safety Improvements: Ensure the Safe Shipment of Hazardous Materials," fact sheet, 2019, at https://www.ntsb.gov/safety/mwl/Documents/2019-20/2019-20-MWL10-HazMat-R.pdf.

[58] National Transportation Safety Board, October 30, 2018; Transportation Safety Board of Canada, *Runaway and Main-Track Derailment, Montreal, Maine and Atlantic Railway Freight Train MMA-002 Mile 0.23, Sherbrooke Subdivision Lac-Mégantic, Quebec*, Report R13D0054, July 6, 2013.

[59] Karl Alexy, Federal Railroad Administration, Letter to James R. Hertwig, Florida East Coast Railway, March 3, 2016, p. 2. Available as "Exhibit D" at https://www.regulations.gov/document?D=PHMSA-2019-0100-2763, p. 1.

and fire from one failed tank would cause successive cars to fail due to heat exposure, thereby increasing the overall quantity of LNG released in the incident. Such failures have occurred in rail accidents involving shipments of crude oil and ethanol.[60]

PHMSA's NPRM discusses the possibility of cascading failure in an accident involving LNG tank cars. The NPRM concludes that, due to the design of the DOT-113 tank cars "the risk of tank car failure and ignition" due to heat exposure "is low."[61] The NPRM states that the "special design of the DOT-113 tank car reduces the probability of cascading failures of other undamaged DOT-113 specification tank cars being transported in a block or unit train configuration." It further states that exposure to heat or cryogenic temperature from a damaged LNG tank car "could potentially lead to the release of material or failure of otherwise undamaged tank cars," but "an undamaged DOT-113 specification tank car exposed to a radiant heat source could eventually ... trigger the activation of the tank car's [pressure release device]" which "would result in the controlled venting of LNG vapor" creating a significant risk of fire.[62] The NPRM also cites AAR Circular OT-55 provisions related to unit trains as sufficient for addressing the safety risks of LNG unit train shipments.[63] The proposed rule, therefore, does not propose additional restrictions on the number of tank cars carrying LNG in one train. Related to this issue, FRA conducted fire safety tests in 2017 demonstrating that the pressure relief devices on a multi-modal ISO container (filled with nitrogen), which are similar in design to those on a DOT-113 tank car, worked as expected. [64]

PHMSA's assertion that the design of DOT-113 tank cars makes it safe to carry LNG in configurations of multiple tank cars, including unit trains, is disputed. In particular, critics question PHMSA's conclusions regarding the risk of cascading failures in an accident involving unit trains.[65] FRA is conducting additional rail safety testing of multimodal ISO tank containers filled with LNG, but has not yet reported results.[66] With limited domestic experience of LNG-by-rail shipments in multiple car configurations, the risk implications of increasing the number of LNG cars in a shipment may continue to be the subject of disagreement.[67]

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[60] See, for example NTSB, "Railroad Accident Brief: Norfolk Southern Railway Company Train Derailment and Hazardous Materials Release," NTSB/RAB-14/08, September 18, 2014.

[61] PHMSA NPRM, p. 56974.

[62] Ibid.

[63] PHMSA NPRM, p. 56973.

[64] The FRA has reported the results of a fire safety tests conducted in 2017 on a multi-modal tank container filled with liquid nitrogen (a non-flammable cryogenic liquid) loaded on a rail flat car over a propane pool fire to evaluate the pressure relief valves. In the tests, the relief valve system successfully vented the evaporating nitrogen before the pressure became high enough for a BLEVE to occur (tank failure). See FRA, *Fire Performance of a UN-T75 Portable Tank Phase 1: Loaded with Liquid Nitrogen*, DOT/FRA/ORD-20/02, January 2020.

[65] See, for example, Earthjustice, "RE: Comments Objecting to the Proposed Rulemaking to Authorize the Transportation of Methane, Refrigerated Liquid by Rail, Docket No. PHMSA- 2018-0025 (HM-264), letter to PHMSA, January 13, 2020, p. 15; Representative Peter Defazio, "Amendment No. 233 Offered by Mr. DeFazio," floor debate, *Congressional Record*, daily edition, vol. 165, June 24, 2019.

[66] PHMSA, *Hazardous Materials: Liquefied Natural Gas by Rail, Notice of Proposed Rulemaking, Preliminary Regulatory Impact Analysis*, Docket No. PHMSA-2018-0025 (HM-264), RIN 2137-AF40, October 2019, p. 13.

[67] Japanese operators began shipping LNG by rail (in ISO containers) in 2000. Other countries, such as Germany, have since begun LNG rail shipments as well. However, differences in infrastructure and regulation may limit the applicability of foreign country experiences to the United States. See Ryosuke Hanafusa, "Transporting Natural Gas by Train: The Greener Way to Go," *Nikkei Asian Review*, March 16, 2018; VTG Aktiengesellschaft, "European Premiere: First LNG Tank Car Loading," press release, April 24, 2016.

Reducing the chances of derailment requires more frequent track and rolling stock inspections. Reducing the consequences of a derailment—including cascading failure—involves the crashworthiness of tank car design standards, braking systems, train speed, routing analysis, and the preparedness of emergency responders. While the proposed rulemaking mentions AAR Circular OT-55, the industry safety standard for trains carrying 20 or more cars of hazardous material (referred to by the rail industry as "key trains"), it does not incorporate these standards into the rulemaking.[68] Circular OT-55, among other things, limits the speed of key trains to 50 miles per hour and specifies the frequency of inspections of tracks and rail cars supporting their movement.

Tank Car Safety Design and Safety Record

In a derailment, the forces applied as rail cars ram into one another (or into a significant fixed structure along the track) are so great that it is impracticable to build a tank car that is puncture proof in these scenarios. The strategy, instead, has been to reduce the number of cars being punctured with practical design elements.

Safety design elements for rail tank cars include increasing the metal thickness of the outer tank shell (adding a jacket layer) or adding metal protective shields to parts of the tank car most exposed to ramming by another car. The DOT-113C120W tank car mandated in PHMSA's proposed rule is essentially designed like a thermos bottle to keep the LNG at the required cryogenic temperature. The tank car has a vacuum-insulated inner container (tank) enclosed within an outer shell. The inner tank is ¼-inch stainless steel and the outer tank is 7/16-inch carbon steel.

In addition to increasing the shell thickness of the DOT-113 tank car, several other design features relevant to puncture resistance may be considered for further improvement. Car couplers, which are the devices used to connect rail cars together, can often act as ramming devices for a neighboring car, with more frequent punctures at the head or rear of the tank. The "double-shelf" coupler, required for tank cars carrying hazmat, is designed to reduce the chances of cars becoming decoupled in a derailment. Valve openings and/or housings, where product is loaded or unloaded from the tank car, may also be reinforced so that they do not shear off during a derailment. Tank car thermal insulation is also a critical design element, affecting heat absorption from a neighboring derailed car that is on fire. Pressure relief valves, particularly their capacity, also have been redesigned so that pressure which may build up in an un-punctured derailed car (e.g., due to external heat) can be released, preventing or delaying an explosion. Relatedly, regulations can specify how much product can be loaded into a tank car, which also affects internal tank pressure. Pressure relief valves and insulation can provide more time for emergency responders to move intact cars away from any that are on fire. PHMSA has required enhancements to these design elements for tank cars carrying crude oil and ethanol in unit train formations.[69]

PHMSA's proposed rule would allow the existing DOT-113 tank car design to be used for LNG. The existing fleet of DOT-113 tank cars consists of 405 cars and most of them are used to carry a non-flammable material (refrigerated carbon dioxide). Fewer than 3% of shipments using DOT-113 tank cars carry a flammable material (refrigerated ethylene).[70] The NTSB therefore contends

[68] AAR Circular OT-55, at https://public.railinc.com/sites/default/files/documents/OT-55.pdf.

[69] The enhancements distinguish the older DOT-111 tank car design from the newer DOT-117 design (49 C.F.R. §179.202-12) for carrying crude oil and ethanol.

[70] Association of American Railroads, "Petition for Rulemaking to Allow Methane, Refrigerated Liquid to Be

that the derailment experience with DOT-113 tank cars carrying flammable gases is too limited to draw conclusions about the robustness of the design for LNG. Consequently, the NTSB recommends that DOT perform a comprehensive review of the crashworthiness and puncture resistance of the DOT-113 tank car at different speeds.[71] In November 2019, DOT performed a test simulating a railcar coupler ramming a DOT-113 tank car positioned perpendicularly against a fixed structure. Moving at about 17 mph, the ramming device punctured both walls of the DOT-113 tank car.[72] FRA was planning a crash test of two additional DOT-113 tank cars at its Pueblo, CO, facility, a test project that was to conclude in May 2020.[73] No information about the test results had been released as of the date of this report.

The Railroad Tank Car Committee

The Railroad Tank Car Committee (TCC) is a long-standing industry group which evaluates and sets industry standards for tank car designs.[74] Its members represent railroads, tank car leasing companies, and shippers (rail customers, such as chemical or petroleum companies that own the cargo). Under the Hazardous Materials Transportation Act (P.L. 93-933) and DOT regulations, the TCC has authority to review the "designs, materials and construction, conversion or alteration of tank car tanks" and to review "proposed changes in or additions to specifications for tanks."[75] The TCC may make recommendations for DOT to consider, although it has no authority, itself, to regulate tank car specifications. Thus, the DOT relies on the TCC in an advisory capacity with respect to regulating tank cars. The TCC is evaluating the DOT-113 tank car design and is expected to provide its recommendation on any safety design improvements to DOT in the summer of 2020.[76]

Most often, in the tank car segment, shippers rather than the railroads either own or lease the tank cars from tank car leasing companies. Since rail shippers provide the tank cars while railroads provide the track and train operations, there can be disagreement between railroads and tank car shippers about how much emphasis should be placed on tank car safety versus track inspections and train operating parameters.[77] Railroads, which have the majority vote in the TCC, want to

Transported in Rail Tank Cars," before the Pipeline and Hazardous Materials Safety Administration, P-1697, January 17, 2017, p. 3. National Transportation Safety Board, letter submission to the U.S. Department of Transportation, Docket No. PHMSA–2018–0025 (HM–264), December 5, 2019, p.3.

[71] National Transportation Safety Board, letter submission to the U.S. Department of Transportation, Docket No. PHMSA–2018–0025 (HM–264), December 5, 2019, p.3.

[72] Federal Railroad Administration, "Full-Scale Shell Impact Test of a DOT-113 Tank Car," February 2020, at https://railroads.dot.gov/sites/fra.dot.gov/files/2020-02/Full-Scale%20Impact%20Test%20DOT-113%20Tank%20Car.pdf.

[73] PHMSA, Preliminary Regulatory Impact Analysis, p. 13, at https://www.regulations.gov/document?D=PHMSA-2018-0025-0001.

[74] Rail cars often traverse the track of more than one railroad. Therefore, industry has needed to set design standards for many rail car components to ensure interoperability; for instance, general elements like axle width and coupler height, and very detailed car specifications. These design standards enable railroads to maintain and repair cars interchanged among them.

[75] 49. C.F.R. §§179.3-179.4. In addition to defining this "delegated authority," §179 refers to the TCC's specifications for tank cars in discussing more detailed aspects of tank car design in over 60 subparts of the code.

[76] Comments of the Association of American Railroads (AAR) and the American Short Line and Regional Railroad Association (ASLRRA) submitted to DOT, Docket No. PHMSA–2018–0025 (HM–264), "Notice of Proposed Rulemaking (NPRM) to Authorize the Transportation of Liquefied Natural Gas by Rail Tank Car," December 19, 2019, https://www.regulations.gov/document?D=PHMSA-2018-0025-0112.

[77] Thompson Hine LLP, Counsel for Petitioners American Chemistry Council, et al., Petition to Amend Relating to Tank Car Standards, August 12, 2016, PHMSA petition no. P-1678, Docket no. PHMSA-2016-0093, August 12, 2016,

increase the thickness of the outer shell of the DOT-113 tank car from 7/16 inch to 9/16 inch, the same design change made for crude oil and ethanol tank cars (DOT-117 tank cars). Railroads also seek more protective housing for the valves and fittings on the DOT-113 tank car.[78] Tracks are generally built for a maximum gross rail car weight of 286,000 lbs. each, so shippers have concern that increasing the empty weight of a rail car may significantly reduce the amount of product that can be loaded.

Train Speed and Braking Systems

The extent of derailment and the probability of cars being punctured and releasing product also relate to rail car speed at derailment and the braking time. For trains carrying ethanol, crude oil, or any Class 3 flammable liquid, PHMSA regulations impose a speed limit of 50 miles per hour for trains carrying 20 or more tank cars in a continuous block or 35 or more such cars anywhere in the train (49 C.F.R. 174.310(a)(2)). Trains with this many tank cars of flammable liquid are referred to in the regulations as Highly Hazardous Flammable Trains (HHFT). The speed limit is reduced to 40 miles per hour if any of the tank cars are of an older, less safe design and the train is traveling through certain urban areas (High Threat Urban Areas listed in Appendix A to 49 C.F.R. Part 1580). Because LNG is categorized in Class 2.1, as a flammable gas, and not in Class 3, as a flammable liquid, LNG trains would not fall under the HHFT operating rules. The NTSB recommended that these speed limits be applicable to trains carrying LNG as the NPRM does not propose mandating a speed limit. Railroads have expressed concern that adding trains carrying LNG at reduced speed could further reduce the capacity of their entire networks.

Applying emergency brakes can cause derailment of cars even without a fault in the rails or a defect in the cars. The braking signal travels from the locomotive to the following rail cars sequentially and will take a few seconds to reach the last car. The rear-most cars, therefore, push on cars in front that already have their brakes applied. To reduce the time required for the braking signal to reach all cars, a second signal device or another locomotive at the end of the train can almost simultaneously begin signaling braking forward.[79] Rear-end train brake signaling is currently required by federal regulation for HHFT trains but the NPRM does not propose it for LNG trains.

In addition to rear-end train brake signaling, debate continues on a 2015 PHMSA proposal (in coordination with FRA) that cars carrying flammable liquids be required to have Electronically Controlled Pneumatic (ECP) brakes, which can simultaneously signal all the cars to begin braking.[80] In 2015, Congress directed GAO to conduct an independent evaluation of ECP braking systems.[81] GAO raised questions about DOT's methodology and the transparency of its data.[82] After DOT conducted a revised cost benefit analysis in 2017, it found the benefits did not

https://www.regulations.gov/searchResults?rpp=25&po=0&s=PHMSA-2016-0093&fp=true&ns=true.

[78] AAR and ASLRRA, December 19, 2019.

[79] 49 C.F.R. §§229.5 and 232.5.

[80] 80 *Federal Register* 26644, May 8, 2015.

[81] FAST Act (P.L. 114-94) §7311.

[82] GAO, *DOT's Rulemaking on Electronically Controlled Pneumatic Brakes Could Benefit from Additional Data and Transparency*, GAO-17-122, October 12, 2016.

outweigh the costs and withdrew the rulemaking.[83] The NTSB recommends that DOT require LNG trains either to use rear-end train brake signaling or require ECP brakes on the tank cars.[84]

Track Quality and Routing Analysis

One means of mitigating the consequences of an LNG tank car derailment is to have trains carrying these cars avoid densely populated areas or other risk-sensitive areas. Railroads determine the routes over which they carry LNG. Some rail shippers may prioritize reliability of delivery over speed of delivery. For these shippers, taking a more circuitous route for delivering LNG, thereby avoiding populated areas, may still meet the needs of the customer. However, a more circuitous route that avoids town or city centers would mean a longer journey both in terms of time and distance, thereby increasing the overall likelihood of a safety incident. A more circuitous routing also could mean use of less busy track that typically is of poorer quality and less well maintained, which may have higher derailment rates.[85]

As mentioned above, a leading cause of train derailments is defective rail. Much of the time these defects are invisible fractures within the interior of a piece of rail. A secondary cause is rolling stock defects such as a broken axle or wheel. Railroads have deployed detection technologies, such as ultrasonic probes or acoustic and temperature sensors, intended to spot track and railcar defects long before they can cause a derailment. Railroads also evaluate equipment failure history and operational and environmental factors to pinpoint track segments and railcars that are at higher risk and warrant more frequent inspection.[86]

In 2016 correspondence with the Florida East Coast Railway, the FRA discussed the "complexity" and safety issues involved with shipping LNG on routes that "traverse congested, highly populated areas, with frequent highway-rail grade crossings" and share track with passenger trains.[87] As discussed earlier, the FRA ultimately approved LNG shipments on these routes. Similarly, the challenge of trying to avoid urban areas in routing LNG shipments has arisen for shipments by Energy Transport Solutions (ETS) under its special permit. While ETS has not publicly disclosed its actual routing of LNG shipments, press reports suggest that these shipments would likely be carried through Philadelphia and over the Delaware Bridge to New Jersey due to the limited rail options for crossing the Delaware River in this region. This route would traverse densely populated areas of the city and share the rail bridge and tracks also used by NJ Transit for one of its commuter lines.[88] Prior to reaching Philadelphia, ETS shipments could pass through other populous communities in Pennsylvania, depending upon the route chosen. Since Amtrak or commuter railroads may own or use some of these route segments, freight trains could be restricted temporally (e.g., nighttime only) or require some other accommodations for passenger trains.

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[83] 82 *Federal Register* 58582, December 13, 2017.

[84] National Transportation Safety Board (NTSB), letter submission to the U.S. Department of Transportation, Docket No. PHMSA–2018–0025 (HM–264), December 5, 2019.

[85] Xiang Liu, M. Rapik Saat, and Christopher P.L. Barkan, "Freight Train Derailment Rates for Railroad Safety and Risk Analysis," *Accident Analysis and Prevention*, vol. 98, 2017, pp 1-9.

[86] Track inspection regulations are codified at 49 C.F.R. §§213.231-213.241.

[87] Karl Alexy, Federal Railroad Administration, Letter to James R. Hertwig, Florida East Coast Railway, March 3, 2016, p. 2. Available as "Exhibit D" at https://www.regulations.gov/document?D=PHMSA-2019-0100-2763.

[88] Andrew Maykuth, "Federal Officials will let LNG be Shipped by Rail to Greenwich Township Port," *The Philadeplphia Enquirer*, December 10, 2019.

After the September 11, 2001, terrorist attacks, Congress required railroads to perform a routing analysis for identifying the safest and most secure routes for trains carrying explosives, radioactive material, and toxic-by-inhalation products.[89] The regulation lists 27 factors related to the immediate environment of the route that the railroads must consider. Later, this also became a requirement for HHFTs. The HHFT planning requirements include route selection based upon "a safety and security risk assessment of the alternative routes" taking account of "the risk of a catastrophic release from a shipment traveling along each route."[90] The NTSB has recommended that PHSMA impose additional planning requirements for shipping LNG by rail, similar to those required for HHFTs under the existing regulations.[91]

Emergency Response Capabilities

Another issue of concern in debates about LNG shipment by rail is whether local first responders would have sufficient training and resources to manage an accident involving an LNG release.[92] At a 2019 "town hall" meeting on LNG by rail emergency preparedness conducted by PHMSA and the Federal Emergency Management Agency's National Fire Academy, a "key question" discussed was "what additional training is needed for local responders ... to be ready to address potential LNG release challenges."[93] Although participants commented that "experienced" emergency responders "deal with products with far greater potential hazardous results/impact" than LNG on a daily basis, they also concluded that "first responders in communities through which LNG is transported will require supplemental information and training that complements current hazmat training."[94] Accordingly, the special permit PHMSA issued to ETS requires the company to train emergency responders along the proposed shipping route in conformance with National Fire Protection Association standards "including known hazards in emergencies involving the release of LNG, and emergency response methods to address an incident involving a train transporting LNG."[95]

Some Members of Congress have expressed specific concerns about the ability of emergency responders to deal with an LNG by rail accident, especially in smaller, rural communities.[96] Likewise, in comments on PHMSA's NPRM, the International Association of Fire Fighters states, "it is highly likely that only a few fire departments will have an adequate number of sufficiently trained personnel to effectuate safe and efficient evacuations while simultaneously mitigating or

[89] 49 C.F.R. §172.820.

[90] 49 C.F.R. §172.820(d).

[91] National Transportation Safety Board, letter submission to the U.S. Department of Transportation, Docket No. PHMSA–2018–0025 (HM–264), December 5, 2019, p. 5.

[92] See, for example, Jesse Roman, "LNG By Rail," *NFPA Journal*, March 1, 2020.

[93] PHMSA and U.S. Fire Administration, *PHMSA/NFA Town Hall Meeting Report: Emergency Preparedness Issues Related to Proposed LNG Transportation by Rail*, November 18, 2019, p.8.

[94] Ibid. pp. 8, 10. Such products include flammable liquefied gases (e.g., propane) and toxic inhalation hazards (e.g. ammonia).

[95] PHMSA, December 5, 2019, p. 3. See National Fire Protection Association (NFPA), *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, NFPA-472, 2018. NFPA is a non-profit, membership organization which promotes fire safety consensus standards, research, training, and education.

[96] Senators Ron Wyden and Jeffrey A. Merkley, Letter to Mr. Howard Elliot, PHMSA Administrator, January 14, 2020, p.1, at https://www.wyden.senate.gov/imo/media/doc/011420%20Wyden%20Merkley%20LNG%20Letter.pdf. "Rural communities ... often lack adequate emergency response resources to address the types or large scale of accidents that are possible when transporting bulk quantities of LNG by rail."

suppressing the hazards of the gas release or fire."[97] Given these concerns, training and resources for emergency responders along LNG by rail routes may continue to be an issue.

Security of LNG Shipments

The security of hazardous cargo shipments by rail has been a long-standing issue of concern in Congress and among homeland security analysts. A 2009 report from GAO states:

> experts consider the U.S. rail system to be an attractive terrorist target because of its public accessibility, long stretches of open and unattended track, and the difficulty of securing a wide array of rail assets that are difficult to patrol. Further, an attack on the U.S. freight rail system could lead to catastrophic loss of life because the system often traverses densely populated urban areas carrying highly hazardous materials.[98]

As discussed earlier, PHMSA requires hazmat shippers to prepare and adhere to planning requirements for transportation security. These requirements apply to multimodal tank and tank car shipments of LNG, which are considered "a large bulk quantity of Division 2.1 material" as defined under the federal hazmat classification system.[99] Under these requirements, among other things, transportation security plans for LNG shippers must include:

- an assessment of transportation security risks for shipments of the hazardous materials, including risks associated with LNG-handling facilities;
- measures to confirm information provided by job applicants hired for positions that involve access to and handling of the LNG;
- measures to prevent unauthorized access to the LNG, rail cars, or trains;
- measures to address the risks of LNG shipments en route from origin to destination, including shipments stored incidental to movement; and
- identification of responsible senior management, staff security duties; security staff notification; and a plan for training hazmat employees.[100]

TSA has promulgated additional security regulations for shipments of certain other hazmat materials considered to be of particularly high risk, such as documenting the chain of custody and control. These regulations do not apply to shipments of LNG.[101]

Safety and Security of LNG Facilities

Local communities have expressed concerns about the safety and security of facilities being developed to supply or transfer rail shipments of LNG, such as the ETS facility in Gibbstown, NJ.[102] PHMSA regulates the safety and security of certain facilities that may be used to supply,

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[97] International Association of Fire Fighters, December 23, 2019, letter to U.S. Department of Transportation, "RE: Comments Pursuant to the Notice of Proposed Rule Making re: Changes to Hazardous Materials Regulations to Allow Bulk Liquefied Natural Gas by Rail Tank Car," Docket No. PHMSA-2018-0025 (HM-264), December 23, 2019, p. 3.

[98] Government Accountability Office, *Freight Rail Security*, GAO-09-243, April 2009, p. 2.

[99] 49 C.F.R §172.800(b)(3).

[100] 49 C.F.R §172.802.

[101] 49 C.F.R. §1580.107. Per 49 C.F.R. §1580.100, the regulations apply to a rail car containing more than 5,000 pounds of certain explosives, a tank car containing certain poisonous materials, or a rail car carrying certain quantities of radioactive material.

[102] See, for example, Karl Baker, "Energy Company Says It's Bringing LNG Port to the Delaware River," *The News Journal*, March 2, 2019.

store, load, or unload LNG in rail transportation.[103] However, PHMSA has interpreted its jurisdiction to apply only to an LNG facility if it "either receives from or delivers to" a pipeline regulated by the agency, which may not cover all facilities serving LNG shipments by rail.[104] The agency's LNG facility safety regulations cover facility design, construction, equipment, operations, maintenance, personnel, and fire protection.[105] Its security regulations include requirements for security procedures, protective enclosures, communications, lighting, and monitoring.[106] TSA also has jurisdiction over the security of LNG facilities, although it exercises its authority through voluntary security guidelines, which cover risk assessment, criticality assessment, and facility security measures.[107] The Coast Guard has jurisdiction over the security of LNG facilities on a waterfront that interact with vessels. It has promulgated a Facility Security Rule which includes requirements for security procedures, access restrictions, cargo handling, monitoring, security assessments, and security plans, among other provisions.[108]

Depending upon the nature and location of an LNG facility, PHMSA, the Coast Guard, and TSA may share jurisdiction over its security. How these agencies work together to secure LNG facilities used in rail transportation, and whether LNG shipments by rail or LNG facilities associated with such shipments require additional security measures may be considerations for Congress. Because TSA, PHMSA, and the Coast Guard also share jurisdiction over aspects of freight rail security more broadly, and FRA is involved with enforcement, any regulatory changes would likely need to account for the distinctive roles and regulations of the relevant agencies.

Legislative Actions in the 116th Congress

Although some Members of Congress have supported LNG shipment by rail, generally, and Executive Order 13868, specifically, citing various perceived benefits, others have raised concerns about the safety and security of such shipments.[109] There have been several legislative actions relevant to LNG shipment by rail in the 116th Congress.

A 2019 House appropriations bill amendment (H.Amdt. 468 to H.R. 3055) would have prohibited appropriated funds from being used to carry out the LNG by rail provisions of Executive Order 13868 or to authorize LNG transportation in rail tank cars by issuance of a special permit or approval. That amendment was not adopted.

The House Committee on Appropriations report (H.Rept. 116-106) accompanying Division H of the Further Consolidated Appropriations Act, 2020 (P.L. 116-94) recommended funding of $2,500,000 for FRA to research and mitigate risks associated with the rail transportation of hazardous materials, specifically including LNG and tank car research. The report also directed FRA, in collaboration with PHMSA, to support cooperative research on "methods to safely use

[103] 49. C.F.R. §193.2007 et seq. PHMSA regulations define "LNG facility" as "a pipeline facility that is used for liquefying natural gas ... or transferring, storing, or vaporizing liquefied natural gas" and further define "pipeline facility" to include "any equipment, facility, or building used in the transportation of gas" (§193.2007).

[104] PHMSA, "Jurisdiction of LNG Plants," January 31, 2018, at https://www.phmsa.dot.gov/pipeline/liquified-natural-gas/jurisdiction-lng-plants.

[105] 49 C.F.R §§193.2101 et seq.

[106] 49 C.F.R. §§193.2901-193.2917.

[107] Transportation Security Administration, *Pipeline Security Guidelines*, March 2018.

[108] 33 C.F.R. §105.

[109] See, for example, Floor Debate on H.Amdt. 232 During Consideration of the Bill, H.R. 3055, *Congressional Record*, daily edition, vol. 165, part 106 (June 24, 2019), pp. H5053-H5055.

LNG as a fuel for locomotives and to transport LNG in bulk in tank cars" to "inform the development of new regulations."

The Protecting Communities from Liquefied Natural Gas Trains Act (H.R. 4306) would require federal agencies to conduct further evaluation of the safety, security, and environmental risks of transporting LNG by rail. On September 13, 2019, the bill was referred to the House Committee on Transportation and Infrastructure, Subcommittee on Railroads, Pipelines, and Hazardous Materials.

The Pipeline and LNG Facility Cybersecurity Preparedness Act (S. 300, H.R. 370) would require the Secretary of Energy to enhance coordination among federal agencies, state agencies, and the energy sector "to ensure the security, resiliency, and survivability" of pipelines and "liquefied natural gas facilities." The bill does not define "liquefied natural gas facilities." Depending upon its interpretation, it could cover certain facilities (but not others) used in rail transportation of LNG. The bill also would require DOE to coordinate response and recovery to physical and cyber incidents "impacting the energy sector," which would likely apply to attacks on LNG shipments by rail. The recovery provision could involve the use of LNG shipments by rail as backup supplies in the event of a pipeline disruption. On January 31, 2019, S. 300 was referred to the Senate Committee on Commerce, Science, and Transportation. On November 20, 2019, H.R. 370 was reported by the House Committee on Energy and Commerce (H.Rept. 116-303, Part I) and referred sequentially to the House Committee on Transportation and Infrastructure, Subcommittee on Railroads, Pipelines, and Hazardous Materials.

The INVEST in America Act (H.R. 2) would authorize between $6 million and $8 million in FRA funding to carry out further evaluation of LNG-by-rail safety. It would require FRA and PHMSA to physically test DOT-113 rail tank cars to evaluate their performance in an accident or derailment, analyze multiple LNG release scenarios, and examine tank car exposure to different climate conditions across rail networks. Among other LNG safety provisions, the bill would require the agencies to evaluate the public safety and environmental impact of an LNG release, including the effect of route restrictions, speed restrictions, enhanced braking, and other operational controls; train configuration; potential accident impact areas; air quality impacts; advanced notice of shipment routes; first responder requirements; thermal radiation risks; and the risks of LNG shipments in ISO containers. The bill would require the agencies to determine whether new safety standards are needed for LNG transportation by rail. It would require a report on the above within two years of enactment, independently verified by the GAO. The bill also would rescind any special permit or approval for the LNG transportation by rail tank car issued prior to enactment and would prohibit any regulation, special permit, or approval prior to the conclusion of a specified study period. The bill text was released by the chairman of the House Committee on Transportation and Infrastructure on June 3, 2020, for committee markup on June 17, 2020.

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