

# ISSUE BRIEF **03.20.19**

## Is There a Correlation between Vapor Pressure and the Severity of Crude Oil Transportation Incidents?

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### TRANSPORT OF CRUDE BY RAIL INCREASING

Although crude oil has been transported by rail for years, there is a noticeable uptick in the Permian Basin and Bakken region as companies struggle to build pipeline infrastructure to meet production demands that are further delayed by legal challenges and public opposition. This resurgence could place pressure on the U.S. Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) to revitalize efforts to assess the safe transport of crude oil by rail and to specifically consider the roles of vapor pressure<sup>1</sup> and volatility<sup>2</sup> in an accident scenario. Past high-profile accidents have raised concerns for PHMSA about the safety of rail transport of crude oil, including physical and chemical properties; adequacy of transport regulations; rail integrity; packaging; and conditioning and stabilization practices.

In response to some of these concerns, PHMSA published a final rule that went into effect in July 2015, the Enhanced Tank Car Standards and Operational Controls for High-Hazard Flammable Trains (HHFT),<sup>3</sup> an expansive multibillion-dollar rulemaking intended to improve the safe transportation of large quantities of flammable materials, particularly crude oil and ethanol, by rail. The HHFT rule and other congruous agency

actions called for improved standards for both new and existing tank cars (retrofitting or new design specifications, such as thermal blankets and top-fittings); a sampling and testing program;<sup>4</sup> reduced operating speeds; information sharing to state emergency response commissions;<sup>5</sup> enhanced braking;<sup>6</sup> and comprehensive oil spill response plans.<sup>7</sup> Not long after, then-President Barack Obama signed the Fixing America's Surface Transportation Act (FAST Act) into law, which instructed DOT to institute additional regulatory amendments to tank car design standards and to revise the tank car phase-out schedule codified in the HHFT rule, prioritizing crude oil and ethanol. Neither the HHFT final rule nor the FAST Act directly addressed the role of volatility or vapor pressure thresholds of crude oil transported by rail.

There were several lines of reasoning behind this deliberate oversight. PHMSA did not propose new rules concerning vapor pressure, incentives to reduce volatility, or other specific requirements related to vapor pressure in the notice to proposed rulemaking of the HHFT. Accordingly, the agency could not introduce new changes or obligations in the final HHFT rule, as doing so would violate the Administrative Procedures Act by omitting public comment prior to a rule becoming final.<sup>8</sup> Also, in 2014 after many years of discussion, the rail and oil industry, with PHMSA's participation, developed the



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first ever recommended practice designed to improve crude oil rail safety through proper sampling, testing, classification, and loading practices. This resulted in an American National Standards Institute recognized industry standard and American Petroleum Institute Recommended Practice 3000, *Classifying and Loading of Crude Oil into Rail Tank Cars*.<sup>9</sup> In addition, the North Dakota Industrial Commission (NDIC), a body that regulates oil and gas drilling and production in North Dakota, issued a conditioning order requiring all oil producers in the state to significantly reduce the vapor pressure of all Bakken crude oil beginning April 1, 2015.<sup>10</sup> During this time, since a large proportion of the crude oil shipped on rail was originating from the Bakken region, PHMSA chose to rely on North Dakota and other oil-producing states to regulate the risk of vapor pressure through the NDIC order. Consequently, on January 18, 2017, two days before President Donald Trump was inaugurated, PHMSA published an Advance Notice of Proposed Rulemaking (ANPRM) soliciting input on the volatility of petroleum products and flammable liquids and the consideration of the establishment of a national vapor pressure threshold for these commodities on any mode of transport.

### WHY IS VAPOR PRESSURE AN ISSUE?

The concern with high vapor pressure is that it is indicative of a higher proportion of organic compounds of low molecular weight such as methane, ethane, or propane, known as "light ends," as well as elevated levels of dissolved gases. There are widely diverging opinions within DOT and industry regarding: (1) the role vapor pressure and volatility play in a normal transportation incident, (2) if elevated levels of dissolved gases increase the volatility of crude oil, and (3) if high vapor pressure accentuates the severity of consequences of an incident. However, studies have not conclusively quantified the potential hazard associated with higher vapor pressure in crude oil transportation scenarios.

Several issues warrant attention should PHMSA reopen this topic. First, the standardized sampling, testing, and

measurement methods and conditions utilized by PHMSA, the NDIC, Transport Canada, and various oil operators to test for vapor pressure throughout the 2013–2105 sampling period were not consistent. Furthermore, the vapor pressure methodology PHMSA employed is not currently incorporated into the U.S. regulations, nor are they integrated into Canada's Transportation of Dangerous Good (TDG) regulations or the United Nations (UN) Model Regulations. The lack of harmonization and recognition by these entities could cause enforcement issues as well as significant hazard classification and package selection discrepancies (e.g., non-pressurized tank car versus a pressurized tank car). Nearly every interested party disagrees with how crude oil should be sampled and tested (open cup versus closed cup, pressurized versus non-pressurized), what vapor pressure reading is most relevant for crude oil classification and transportation (Reid Vapor Pressure, or RVP, Reid equivalent, or true vapor pressure),<sup>11</sup> and the conditions of measurement (vapor-to-liquid ratio and temperature) that would yield reproducible and accurate vapor pressures. The general lack of uniformity in methods and quality assurance/quality control across the industry creates complications when comparing crude oil vapor pressure. Further, how a sample is collected and tested produces wildly disparate results, making all the difference when classifying the materials and selecting the appropriate packaging and transport system.

Second, although technically vapor pressure is a key property in determining whether a substance meets the definition of a liquid or gas, neither the UN Model Regulations, Transport Canada's TDG, nor the U.S. hazardous materials regulations define "vapor pressure" or how it should be determined and measured. It is also important to note that the current U.S. definition for a flammable gas differs from various international regulations, including Transport Canada's. In the U.S., the regulatory language for distinguishing between a flammable gas and flammable liquid is insufficient to manage materials that are a mixture of dissolved flammable gases within a flammable liquid. The crude oil samples

collected by PHMSA, the NDIC, and Transport Canada yielded vapor pressure readings that would push the classification from what would traditionally be a primary hazard class flammable liquid to a primary hazard class flammable gas.

With this designation, a crude oil that meets the definition of a flammable gas (with a secondary hazard classification as a flammable liquid) would theoretically require a more robust means of containment during transport, such as a pressurized tank car for rail or pressurized tank truck for highway transportation. However, there is technically no existing authorized tank or rail car to transport dissolved gases in flammable liquids since U.S. and international regulations lack a classification scheme for a mixture of this type. Another new tank car specification standard for transporting high vapor pressure crude oils with dissolved gases would not sit well with industry, which was recently mandated to phase out DOT-111 tank cars in favor of an enhanced non-pressurized tank car, DOT-117, the most technically rigorous specifications for carrying crude oil. This change stemmed from the HHFT rulemaking PHMSA finalized in the wake of the tragic Lac-Mégantic crude oil derailment in Canada.<sup>12</sup>

Additionally, crude oil shipped from Canada's shale plays contains dissolved hydrogen sulfide, a highly toxic and flammable gas. How this interacts with the classification scheme of high vapor pressure crude oil taxonomy and packaging is uncertain, as toxic gas transportation requires additional safety specifications. This highlights the limitations of the current testing methods for hydrogen sulfide in the vapor phase. Precise quantification of hydrogen sulfide in crude oil is a critical practice for product quality control, as well as worker and transportation safety purposes. In particular, quantification of hydrogen sulfide is critical due to its high toxicity in the gas phase. Exposures as low as 100 ppm can be fatal.<sup>13</sup> Using proper sampling techniques, temperature, and headspace conditions in ranges normally encountered during operations or transport would certainly provide a better assessment of the true hazard.

## VAPOR PRESSURE: MISALIGNED CONDITIONS FOR RULEMAKING

Since 2013, PHMSA has taken a number of actions to improve the safe transport of crude oil. Due to a shift in priorities with the change in political leadership, the Trump administration tabled the Obama-era ANPRM on the volatility of petroleum products. The ANPRM was PHMSA's reaction to several crude oil incidents and petitions for rulemaking, as well as the results of crude oil sampling and testing conducted by PHMSA, Transport Canada, the NDIC, and oil operators between 2013 to 2015. The data yielded a range of vapor pressure results, some exceeding the limit set by the NDIC. The presumption in the ANPRM was that limiting the product's vapor pressure could reduce the risk of death or damage from fire or explosion in an accident or derailment. The Trump administration, through several executive orders and directives, altered agency priorities and reformed the regulatory agenda to "eliminate regulatory burdens"<sup>14</sup> that "unnecessarily encumbered energy production, constrained economic growth, and prevented job creation."<sup>15</sup> It also mandated that the total incremental cost of all new regulations, including repealed regulations, be no greater than zero.<sup>16</sup> These actions considerably reprioritized the agency's agenda, and the rulemaking quickly plummeted to low priority on the regulatory schedule.

Besides a reformation of administration priorities that promptly sidelined the ANPRM, the concern by DOT was the dearth of scientific evidence demonstrating that vapor pressure is correlated to safety outcomes in accidents. While numerous entities have collected data (including PHMSA, Sandia National Laboratories, the North Dakota Petroleum Council, Transport Canada, Canadian Crude Quality Technical Association, and various companies in the oil industry), none to date have illustrated that vapor pressure or volatility increases the consequences or probability of accidents involving trains transporting large quantities of flammable liquids.

**As of today, PHMSA still needs to determine what role, if any, vapor pressure plays in the severity of a transportation incident, and how it should be defined in the construct of the regulatory framework.**

**Equally critical to deciding whether vapor pressure plays a role in accident scenarios is determining which nationally recognized standardized sampling and analysis methods are best suited to provide accurate and reproducible data to characterize crude oil.**

This was also evidenced in the first phase of Sandia National Laboratories' multiyear crude oil characteristics research (commissioned in 2014 by DOT and the U.S. Department of Energy via a FAST Act congressional mandate) through a comprehensive data and literature review, which concluded that there is no established relationship between crude oil properties and the probability and severity of combustion events in rail car scenarios.<sup>17</sup> However, the study is multiphase and intended to link key crude oil properties to behavior in a derailment scenario. Therefore, completing each phase of research is necessary to make informed policy decisions. Since the scope of work represents a phased approach where knowledge gained from completing each task informs the execution of subsequent tasks, a proposed rulemaking that anticipated inaugurating a unilateral vapor pressure threshold was premature. Moreover, an incident scenario involving a derailment, tank car breach, pool fire, and subsequent tank car breaches presents multiple complex variables with poorly understood kinetics—the solution is not simply a matter of capping the vapor pressure. Without adequate modeling and experimental verification, it is not possible to estimate the degree to which dissolved flammable gases contribute to the severity of incidents. The third phase of this study was recently completed, which included combustion experiments and computational modeling to assess the effects of individual characteristics of select crude oil on its burn behavior. A draft report is currently in peer review and is scheduled to be published this spring.

From an international commerce perspective, harmonization of safety measures facilitates international trade by minimizing the costs and other burdens of complying with multiple or inconsistent requirements between countries. The UN Model Regulations are designed to reduce trade barriers, promote global access to markets, encourage economic development, and improve safety, compliance, and enforcement capabilities while streamlining training requirements for multimodal

interregional transport of hazardous materials. The UN recommendations are negotiated internationally and implemented into domestic regulations by regulatory bodies in each country, including Mexico's Secretariat for Communications and Transport, Transport Canada, DOT, etc. PHMSA is obligated through international agreements to ensure harmonization with UN standards regarding the classification and transport of hazardous materials. Unilateral deviations from these standards would affect the continuity of commerce between the U.S., Canada, and Mexico.

Federal law strongly favors the harmonization of domestic and international standards, but the law may deviate to promote safety or other overriding public interests.<sup>18</sup> Unilateral or arbitrary changes to the U.S. domestic regulations that are incongruous with the UN Model Regulations on the Transportation of Dangerous Goods requirements would severely constrain transborder shipments and create regulatory uncertainty for shippers and carriers. As the volume of hazardous materials transported in international commerce continues to grow, harmonization is increasingly important. The ANPRM, which contemplates a national U.S. vapor pressure threshold, is in direct contravention to these global priorities.

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## SAFEST MODES OF TRANSPORT

Nearly a million shipments of hazardous materials, such as crude oil, move throughout the U.S. each day on various modes of transport. Pipelines and barges have accommodated substantial portions of the growth in domestic energy products, and they have accomplished this without significant new safety issues and within the framework of their regulatory and safety assurance systems.<sup>19</sup> Tank barges have a long history of transporting crude oil, ethanol, and natural gas liquids (NGL) with improved safety performance as a result of extensive emergency preparedness planning and response training informed by lessons learned from catastrophic oil spills more than 30 years ago.

Crude oil transported via barge expanded rapidly after 2010 as hydraulic fracking activities increased the demand for crude oil transportation inland and on intracoastal waterways. Although traffic volumes of maritime transport exceed those of rail due to the large quantities of crude oil transported along the Gulf Coast, the safety record of energy liquids movement via waterways has been exemplary, with no reports of ethanol or NGL releases from tank barges over the last 10 years and rare reports of crude oil releases.<sup>20</sup>

Certainly, different modes of oil transport pose different risks, but aside from the maritime transportation system's commendable track record, pipelines are the safest means to transport energy, with pipelines safely delivering over 99.999% of all shipments.<sup>21</sup> However, despite the efficacy and safety record of pipelines, expansion projects such as Keystone XL and Trans Mountain continue to stall due to public opposition and legal hurdles. In geographic regions of the country that lack sufficient pipeline takeaway capacity and infrastructure, rail and surface highways are the only means to transport the commodity from the production site to where it can be refined and ultimately consumed.

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### IS THERE A WAY FORWARD?

Proper classification is a critical step in the transportation process for ensuring hazardous materials are shipped safely. Determining whether vapor pressure and volatility play a role in transportation safety is important for consistency in classification, packaging selection, compliance, and enforcement. Unlike manufactured goods or finished products, organic materials from oil and gas production represent a unique challenge in regard to classification. Unrefined petroleum-based products, including crude oil, have variable chemical properties and compositions. Differences in the raw material can vary across wellheads and fluctuate based on time, geographic location, and method of extraction. Consequently, there are multiple hazardous liquids that are commonly shipped from the wellsite, including crude oil,

condensate, and NGLs. In accordance with the U.S. hazardous materials regulations, the offeror must consider all hazards when classifying a hazardous material and account for whether the crude oil they intend to ship exhibits hazards beyond that of a flammable liquid, such as corrosivity, toxicity, etc. To reinforce this requirement, PHMSA proposed a new regulation in 2015 requiring a sampling and testing program for shippers of unrefined petroleum-based products, including crude oil, for all modes of transport. Shippers are required to consider and document the varying characteristics and properties of unrefined petroleum-based products. However, vapor pressure testing was not explicitly noted.

Should PHMSA move forward with the ANPRM and reinvigorate the vapor pressure debate, there are key actions that will improve domestic and international transport harmonization, reduce compliance uncertainty, and clarify enforcement strategies. As of today, the agency still needs to determine what role, if any, vapor pressure plays in the severity of a transportation incident, and how it should be defined in the construct of the regulatory framework. This has not yet been established by PHMSA, but it is important so that the regulated community and other stakeholders have transparent agency direction and consistent requirements. Notably, pipeline operators routinely set upper limits on RVP levels for crude oil accepted for transport to a distribution point as a matter of operational efficiency and standard operating procedures for compliance with the Clean Air Act governing the emission of volatile organic compounds in tanks. PHMSA has suggested that insight on how oil producers comply with the vapor pressure standards of pipeline operators, or how they ship crude oil with RVP levels that exceed pipeline operator limits by rail, could yield important information about the significance of setting RVP limits for rail or highway transport. In the pipeline industry, however, a variety of factors affect the degree to which an oil is conditioned and stabilized for post-production transport in the oil and gas supply chain, such as engineering, design standards,

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product specifications, market demands, economics, existing infrastructure, and government regulations. Apart from the NDIC vapor pressure standards, establishing vapor pressure thresholds is not merely an exercise based exclusively on safety. Maintaining product quality from the wellhead to the refinery is essential, so any modifications in vapor pressure during transportation could disrupt and reverberate throughout the supply chain. This is especially true if downstream operations are configured with a separate vapor pressure, as vapor pressure is a function of the engineering and design of the pipeline, the intended resulting product, and the specification of the downstream consumer. Examining vapor pressure practices between the pipeline and other transport industries may raise awareness about why and how pipelines set vapor pressure standards, but this information may not be relevant or transferrable to rail or highway.

Equally critical to deciding whether vapor pressure plays a role in accident scenarios is determining which nationally recognized standardized sampling and analysis methods are best suited to provide accurate and reproducible data to characterize crude oil, with emphasis on vapor pressure and light ends content. This will improve the ability to preserve original sample integrity; prevent contamination with inert atmospheric gases during sampling, handling, and analysis; and compare results across industry. As previously noted, there are currently numerous industry standards for sampling and determining vapor pressure of crude oil and other flammable liquids.

There is also room for improving the understanding of crude oil vapor pressure measurements for characterizing the volumes and compositions of gases that are likely to evolve from crude oil in transport spill scenarios. More research is needed to determine if and how these properties relate to fire and explosion hazards. In the event that a national vapor pressure threshold for the transportation of crude oil and other petroleum products is established, PHMSA would need to promulgate a rulemaking

and evaluate a variety of factors, including quantifying safety improvements, if any; balancing the benefits and costs (especially in a deregulatory administration with a below-zero regulatory budget); and evaluating the extent to which the enhanced DOT-117 tank cars mitigate the risk of transporting crude oil.

Transport Canada debriefed two UN Committees of Experts<sup>22</sup> in December 2015 about their sampling and testing findings on crude oils carried by highway and rail for UN consideration to formally undertake this issue, as it has relevance to all members where crude oil is extracted, transported, or handled. Should the UN decide to advance this topic, unresolved matters such as discrepancies in the definition of a flammable gas, vapor pressure significance, and the appropriate classification and packaging of crude oil with dissolved gases will have to be reconciled within the current domestic U.S. regulatory framework.

Rather than changing the physical and chemical properties of the transported materials, preventative efforts should be taken through a comprehensive, systematic investigation that examines immediate, underlying, and root causes such as track integrity and geometry, equipment deficiencies, and human factor contributions. Proper infrastructure maintenance and transportation practices are also key to reducing accidents. Furthermore, there are dozens of actions underway since the rollout of the HHFT rule and other FAST Act requirements. For instance, PHMSA recently issued a final rule to revise requirements for comprehensive oil spill response plans that will improve response readiness and mitigate the effects of rail incidents involving petroleum oil,<sup>23</sup> a requirement that expands upon oil spill response rules already established in both the Clean Water Act of 1972 and the Oil Pollution Act of 1990. This rulemaking, along with the HHFT final rule and other complementary congressionally mandated actions, is expected to improve the safe transport of energy products.

## CONCLUSION

PHMSA has long considered numerous regulatory and nonregulatory actions that would enhance the safety of transporting crude oil by rail. With crude-by-rail shipments increasing and projected to continue as pipeline projects face opposition and delays, pressure on the agency to take action lingers from multiple petitions for rulemaking, numerous National Transportation Safety Board recommendations associated with such petitions, and congressional interest, including several legislative mandates. Although PHMSA postponed immediate action on the proposed rulemaking to consider a vapor pressure cap (DOT's Fall 2018 Unified Agenda denotes "Next Action Undetermined"),<sup>24</sup> domestic and international interest will likely continue to force the agency into action.

Appropriate classification is necessary to ensure proper packaging, operational controls, and hazard communication, all of which are imperative to mitigate the negative effects of a train derailment or other hazardous materials incident. While more research is needed to determine the correlation of vapor pressure with the severity of consequences of crude oil transportation events, time should be allowed for the existing and unfolding crude oil safety plan to take root. In the meantime, as industry continues to research and integrate new methods and technologies to manage and upgrade the integrity of the nation's pipeline network, the efficacy and strong safety record of the pipeline transportation system should be underscored as a viable and safe means of transport for crude oil.

## ENDNOTES

1. Vapor pressure is pressure exerted by a vapor escaping from a liquid; it is quantified as the tendency of molecules to enter the gaseous phase. The vapor pressure of a mixture is commonly defined as the pressure where the first bubble of vapor is formed at a given temperature, but there are other definitions based on standardized experimental measurements or correlations.

2. Volatility is directly related to a substance's vapor pressure. At a given temperature, a substance with higher vapor pressure vaporizes more readily than a substance with a lower vapor pressure. A substance with a high vapor pressure at normal temperatures is often referred to as volatile.

3. HHFTs are continuous blocks of 20 or more tank cars loaded with a flammable liquid, or 35 or more tank cars loaded with a flammable liquid dispersed through a train.

4. Requirements implemented through 49 CFR, section 173.41. Effective July 7, 2015.

5. The information sharing requirement was adopted into PHMSA's "Oil Spill Response Plans and Information Sharing for High Hazard Flammable Trains" rulemaking, issued in February 2019. 84 F.R. 6910.

6. PHMSA rescinded its electronically controlled pneumatic (ECP) braking systems mandate after updated regulatory impact analysis showed that the expected costs of requiring ECP brakes would be significantly higher than the expected benefits.

7. PHMSA, "Hazardous Materials: Oil Spill Response Plans and Information Sharing for High Hazard Flammable Trains (FAST Act)," 84 F.R. 6910, February 28, 2019, [https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/standards-rulemaking/hazmat/rulemakings/70471/hm-osrp-final-rule-fr-submission\\_1.pdf](https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/standards-rulemaking/hazmat/rulemakings/70471/hm-osrp-final-rule-fr-submission_1.pdf).

8. 80 Fed. Reg. at 26665.

9. Energy API, *ANSI/API Recommended Practice 3000* (API Global: Washington, D.C., 2014), [www.api.org/oil-and-natural-gas/wells-to-consumer/transporting-oil-natural-gas/rail-transportation/api-rp-3000](http://www.api.org/oil-and-natural-gas/wells-to-consumer/transporting-oil-natural-gas/rail-transportation/api-rp-3000).

10. North Dakota Industrial Commission (NDIC) Oil Conditioning Order No. 25417.

11. Vapor pressure, Reid Vapor Pressure, and true vapor pressure are often used interchangeably with reference to crude oils, leading to considerable confusion.

12. In 2013, 63 loaded tank cars carrying crude oil from the Bakken region of North Dakota derailed and ignited in Lac-Mégantic, Quebec, killing 47 people. The locomotives separated from the train and came to rest about 1/2 mile east of the derailment. At least 60 of the 63 derailed DOT-111 tank cars

released about 1.6 million gallons of crude oil.

13. See “Hydrogen sulfide,” The National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, <https://www.cdc.gov/niosh/npg/npgd0337.html>.

14. Executive Order 13777, “Enforcing the Regulatory Reform Agenda,” February 24, 2017, 82 F.R. 12285, <https://www.govinfo.gov/content/pkg/FR-2017-03-01/pdf/2017-04107.pdf>.

15. Executive Order 13783, “Promoting Energy Independence and Economic Growth,” March 28, 2017, <https://www.whitehouse.gov/presidential-actions/presidential-executive-order-promoting-energy-independence-economic-growth/>.

16. Executive Order 13771, “Reducing Regulation and Controlling Regulatory Costs,” January 20, 2017, <https://www.govinfo.gov/content/pkg/DCPD-201700084/pdf/DCPD-201700084.pdf>.

17. Tay Aulich and Chad Wocken, “DOE Crude Oil Characterization Research Study – Project Update,” (PowerPoint presentation, Crude Oil Quality Association Meeting, Minneapolis, MN, June 11, 2015), <https://www.osti.gov/servlets/purl/1256267>; David Lord and Anay Luketa. DOE Crude Oil Characterization Research Study – Project Update, June 1, 2015, <https://prod-ng.sandia.gov/techlib-noauth/access-control.cgi/2015/151823.pdf>.

18. 49 U.S.C. 5101 *et seq.*

19. The National Academies of Sciences, Engineering, and Medicine, *Safely Transporting Hazardous Liquids and Gases in a Changing U.S. Energy Landscape* (Washington, D.C.: The National Academies Press, 2017), <https://www.nap.edu/catalog/24923/safely-transporting-hazardous-liquids-and-gases-in-a-changing-us-energy-landscape>.

20. *Ibid*

21. The National Academies of Sciences, Engineering, and Medicine, under the auspices of the Transportation Research Board, conducted a study in late 2015 due to the heightened concerns about whether the domestic energy revolution was placing stress on the transportation system that would sacrifice safety. Modes of transport studied were maritime, highway, pipeline,

and rail. Although the committee found no new safety problems have emerged from the increased use of pipelines transporting larger amounts of domestic oil and gas, substantially more pipeline mileage and higher traffic volumes may result in more pipeline releases over time, simply because of the increase in exposure. The safety impact, however, is likely to depend on the extent to which new pipeline technologies, leak monitoring systems, and more vigilant and capable integrity management programs are effective in protecting the newer pipelines and the older ones that connect to them.

22. These were the UN Sub-Committee of Experts on the Transport of Dangerous Goods, and the UN Committee Sub-Committee of Experts on the Globally Harmonized System of Classification and Labelling of Chemicals.

23. PHMSA, “Hazardous Materials: Oil Spill Response Plans and Information Sharing for High Hazard Flammable Trains (FAST Act).”

24. See “Hazardous Materials: Vapor Pressure of Unrefined Petroleum Products and Class 3 Materials,” Office of Information and Regulatory Affairs, U.S. Office of Management and Budget, <https://www.reginfo.gov/public/do/eAgendaViewRule?pubId=201810&RIN=2137-AF24>.

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