Note

The LNG Engine That Could: Creating Regulatory Certainty for LNG in Freight Locomotives

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A revolutionary transformation is coming down the tracks for how the U.S. rail industry fuels freight operations across this country.[2] While locomotives in the U.S. currently employ diesel gasoline as their chief fuel source, liquefied natural gas ("LNG"), which is cheaper and more abundant than diesel gasoline, has piqued interest throughout the rail industry.[3] This revolutionary transition could reduce operating costs through lower fuel costs and could potentially provide significant environmental benefits through reduced emissions of pollutants and greenhouse gases, "perhaps even besting the U.S. Environmental Protection Agency's Tier 4 air emission standard[s]."[4]

Still, several daunting obstacles must be overcome before this transition can occur.[5] For example, technical and operational challenges include the need for the development of major new sources of LNG supply,

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2. Jeff Stagl, *Liquefied Natural Gas Could Help Railroads Reap Locomotive Benefits If Regulatory, Technical Issues are Resolved*, PROGRESSIVE RAILROADING (Mar. 2014), http://www.progressiverailroading.com/mechanical/article/Liquefied-natural-gas-could-help-railroads-reap-locomotive-benefits-if-regulatory-technical-issues-are-resolved—39693.

3. *Id.*

4. *Id.*

5. *Id.*

the construction of LNG infrastructure, and the development of LNG-compatible locomotives.[6] However, before such obstacles can be overcome, governmental entities need to develop a regulatory framework that will provide the freight rail industry both guidance and flexibility, while simultaneously reducing regulatory uncertainty. Although the Federal Railroad Administration ("FRA"), which has primary oversight of the freight rail industry in this country, is currently "striving to craft regulations governing LNG locomotive operations," this specific activity remains unregulated in any formal sense.[7]

The objective of this comment is to identify regulatory uncertainty at the federal level and suggest methods to reduce that uncertainty in order to facilitate the adoption of LNG within the freight rail industry. The comment will: (1) provide an overview of the freight rail industry in the United States of America; (2) explore previous and current efforts to employ LNG in North American rail operations and summarize the economic and environmental benefits of the use of LNG in locomotives; and (3) review current and pending regulations, identify regulatory gaps, and suggest methods to close those gaps.

I. Overview of the U.S. Freight Rail Industry

The U.S. freight rail network is the largest in the world and is comprised of 561 railroad companies, 140,000 miles of railroad track, and 221,000 employees.[8] Out of the 561 railroads, only seven are Class 1 railroads, which by definition generate $433.2 million or more in operating revenues.[9] The seven Class 1 railroads are Burlington Northern Santa Fe ("BNSF"), Union Pacific, CSX Transportation, Norfolk Southern, Canadian National Grand Trunk ("CN"), Canadian Pacific Soo, and Kansas City Southern.[10] While small in number, the impact of Class 1 railroads is huge, "account[ing] for nearly 94% of total freight revenue."[11]

Hauling this much freight across the U.S. requires a tremendous amount of fuel; "in 2012, the seven Class 1s consumed more than 3.6 billion gallons of diesel fuel, amounting to 10 million gallons/day and representing 7% of all diesel fuel consumed in the United States."[12] This level of consumption translated into more than $11 billion spent on fuel in

6. *See* William C. Vantuono, *A Closer Look at LNG*, Ry. Age (Nov. 8, 2013), http://www.railwayage.com/index.php/mechanical/locomotives/a-closer-look-at-lng.html.

7. Stagl, *supra* note 2.

8. Nicholas Chase, *Potential of Liquefied Natural Gas Use as a Railroad Fuel*, U.S. Energy Info. Admin. (Apr. 4, 2014), http://www.eia.gov/forecasts/aeo/liq_nat_gas.cfm; Fed. R.R Admin., *Freight Rail Today*, http://www.fra.dot.gov/Page/P0362 (last visited Mar. 6, 2015).

9. Fed. R.R. Admin., *supra* note 8.

10. Chase, *supra* note 8, at Table IF3-1.

11. Chase, *supra* note 8.

12. *Id.*

2012 by Class 1 railroads.[13] In fact, BNSF "claims that it is the number two consumer of diesel fuel in the United States behind the U.S. Navy."[14] As a consequence, Class 1 railroads' fuel consumption represents as much as 23% of their total operating expense and "is now the second largest outlay for the Class 1s behind only wages and benefits."[15] This consumption is expected to increase drastically as the system "experience[s] a 22 percent increase in the total amount of tonnage it moves" between 2010 and 2035.[16] In order to meet increasing demands while controlling fuel costs, railroads are increasingly looking to LNG as a cost-effective alternative to diesel fuel.

II. The Trials and Calculations of LNG Locomotives

A. Model Trains

While "the concept of using LNG to fuel locomotives isn't new"—"Burlington Northern operated some natural gas-powered locomotives in the 1980s and 1990s"—lower natural gas prices prompted by the shale gas revolution in the United States have renewed meaningful research efforts by Class 1 railroads and their suppliers into the efficacy of LNG as a replacement fuel for diesel.[17] The focus of this interest is on "dual-fuel" engine technology, which allows locomotive engines to run on a mix of LNG and diesel.[18] Dual-fuel engines are necessary because the "technology does not currently exist to inject LNG directly into engine cylinders and properly combust it."[19] At an LNG-to-diesel ratio of 80/20 to 90/10, dual-fuel engines use diesel to ignite methane processed from LNG to power the locomotive, yet can still "revert to 100% diesel in the event of an LNG-related failure or the unavailability of an LNG stationary or mobile refueling station."[20]

In the U.S., CSX announced in November 2013 that "it partnered with [General Electric ("GE")] to [test] LNG-powered locomotives" using GE's NextFuel™ natural-gas retrofit kit.[21] Furthermore, BNSF began a one- to two-year pilot program in August 2013 to determine whether the company would begin retrofitting its existing locomotives for

13. *Id.*

14. Kevin Smith, *LNG: Fuel of the Future?*, Int'l. Ry. J. (Dec. 9, 2013), http://www.railjournal.com/index.php/locomotives/lng-fuel-of-the-future.html.

15. Chase, *supra* note 8, at Table IF3-1; Smith, *supra* note 14.

16. Fed. R.R Admin., *Freight Rail Overview*, http://www.fra.dot.gov/Page/P0528 (last visited Mar. 6, 2015).

17. Stagl, *supra* note 2 ("Five Class 1s are now preparing to test LNG-fueled locomotives . . .").

18. Vantuono, *supra* note 6.

19. *Id.* (quoting Mike Iden, General Director, Union Pacific).

20. Vantuono, *supra* note 6.

21. Stagl, *supra* note 2.

LNG use over the next few years.[22] Still, widespread trials have not been place in the U.S. due to uncertainty and the FRA's lack of regulatory approvals.[23] Consequently, despite cheap and abundant natural gas supplies in the U.S., "most natural gas rail activity is outside the United States, with projects in various stages in Russia, Brazil, Peru, Thailand, and India."[24]

The situation across the border in Canada is progressing faster, with the Canadian government having already allowed CN, its national railroad, "to test a LNG-fueled train on a 300-mile portion of its mainline . . . from September 2012 to September 2013."[25] To date, CN is "the only railroad that has tested LNG on a mainline," but even CN will not say it is "ready to go with LNG" until the U.S. provides regulatory approval to test LNG on America's railways.[26]

B. Hauling Economic and Environmental Benefits Coast-to-Coast

The renewed interest in switching to LNG-fueled locomotives is driven by economics that significantly favor natural gas over diesel fuel.[27] Retrofitting a diesel locomotive to run on LNG is expensive, adding as much as an additional $1 million to an already hefty $2 million price tag, and the capital outlay for the required LNG infrastructure is substantial.[28] However, "the potential $200,000 savings in fuel costs per locomotive per year" could allow railroads to recoup their initial investment in a reasonable payback period.[29] Admittedly, these savings are based on an assumption that natural gas prices will remain lower than diesel in the future,[30] creating some risk that such an assumption may not hold true. Nevertheless, as noted above, emerging dual-fuel technology allows railroads to revert to 100% diesel, thereby greatly reducing, if not eliminating, the risk of employing this technology based on future natural gas price assumptions.[31]

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22. *See* Smith, *supra* note 14.

23. Stagl, *supra* note 2.

24. *Rail*, HHP Insight, http://www.hhpinsight.com/resources/hhp-sectors/rail/ (last visited Mar. 6, 2015).

25. Stagl, *supra* note 2.

26. *Id.* (quoting Gerry Weber, Vice President, CN).

27. *See* Chase, *supra* note 8 ("The large differential between crude oil and natural gas commodity prices translates directly into a significant disparity between projected LNG and diesel fuel prices, even after accounting for natural gas liquefaction costs that exceed [diesel] refining costs.").

28. Smith, *supra* note 14.

29. *Id.*

30. Chase, *supra* note 8.

31. Vantuono, *supra* note 6.

In addition to these favorable economics, the environmental benefits of switching to LNG are potentially huge. CN's tests, mentioned above, demonstrated an estimated 30 percent reduction in carbon dioxide emissions and an estimated 70 percent reduction in nitrogen oxide emissions.[32] Class 1 railroads view the transition to LNG as a method "to reduce our environmental footprint" while enabling them to meet the U.S. Environmental Protection Agency's Tier 4 air emission standards, both of which justify a transition from diesel to LNG.[33]

Despite the clear economic and environmental benefits Class 1 railroads can obtain from switching to LNG as the primary fuel for their locomotives, "none of the [Class 1s] are planning a large-scale adoption until there is regulatory certainty," underscoring the need for governmental entities, such as the FRA, to take appropriate regulatory measures in this arena to reduce uncertainty.[34]

III. Getting Regulation on the Right Track

A. Current State of LNG Locomotive Regulation

While the FRA has primary regulatory authority over the use of fuel cars, also known as tender cars, "current . . . [FRA] regulations do not allow for the use of natural gas tender cars and thus locomotives in commercial operations."[35] The FRA has directed Class 1 railroads seeking to test LNG in freight locomotives to obtain "a 'concurrence letter' from the FRA—essentially a special authorization granted outside of the current regulation—in order to use natural gas in a defined demonstration program."[36] Although the FRA has identified certain risk analyses that must be conducted in order to receive such authorization in two different letters to industry representatives, it should be noted that each letter identifies different items that must be classified and analyzed "at a minimum" in this same industrial process.[37] These discrepancies strongly suggest

32. Stagl, *supra* note 2.

33. *Id.* (quoting Louis Renjel, Vice President, CSX); *see also* Vantuono, *supra* note 6 (quoting Bob Fronczak, Assistant Vice President, Association of American Railroads) (reinforcing environmental benefits of switching from diesel to LNG).

34. Stagl, *supra* note 2.

35. Gladstein, Neandross & Assocs., LNG Opportunities for Marine and Rail in the Great Lakes, Gulf of Mexico, and Inland Waterways 29 (2014), *available at* http://anga.us/media/blog/2C4CAA90-5056-9F69-D4A529A12FD0D7D4/files/LNG%20Opportunities%20for%20Marine%20and%20Rail.pdf.

36. *Id.*

37. *Compare* letter from Michael J. Logue, Acting Assoc. Adm'r for R.R. Safety/Chief Safety Officer, Fed. R.R. Admin., to Patrick M. Brady, Assistant Dir. of Hazardous Materials, BNSF Ry., (May 13, 2013), *available at* http://www.fra.dot.gov/Elib/Details/L15899, [hereinafter Letter from Logue] *with* letter from Robert C. Lauby, Acting Assoc. Adm'r for R.R. Safety/Chief Safety Officer, Fed. R.R. Admin., to Robert Fronczak, Assoc. of Am. Rys., Thomas

that, at a minimum, the FRA needs to formalize the approval process for LNG applications. Formalization would allow any Class 1 interested in testing LNG to discern upfront what minimum risks need to be analyzed, rather than continuing on the seemingly *ad hoc* and arbitrary track implied by the glaring discrepancies in these two letters.

Notably, though, the FRA has clarified for those Class 1s interested in testing LNG that "although LNG is a regulated hazardous material under the Federal hazardous materials transportation law" ("HMR"), the use of LNG tenders to supply LNG to locomotives "is not within the scope of the HMR and is, therefore, not subject to those regulations."[38] Still, the FRA has informed Class 1s interested in testing LNG that "although the HMR are not directly applicable to the proposed equipment and its operations, the safety rationale underlying those regulations . . . must also be considered."[39]

More broadly, it should be recognized that existing regulations applicable to all aspects of locomotive operations currently encompass the use of LNG in locomotives. For example, 49 CFR 179.400-13 requires all locomotive fuel tenders, including LNG tenders, "be built to withstand 7 Gs of longitudinal impact force and 3 Gs of transverse and vertical impact force."[40] Furthermore, "there are specific statutory and regulatory requirements related to safety appliances on all vehicles, including locomotive tenders, which must be considered" in the specific context of LNG.[41] However, LNG use in locomotives differs from diesel fuel use in important ways, and the current regulatory framework will need to be amended to address LNG-specific concerns.

Another key regulatory entity that should be mentioned at least briefly is the Surface Transportation Board ("STB"), which has regulatory oversight over railroad rate and service disputes.[42] While this technology arguably can pay its own way given significant potential cost savings (as discussed above), any efforts by Class 1s to raise rates as a means to recoup some of their capital investment costs in LNG will need to gain the approval of the STB.[43] To date, however, the STB has remained silent as to the permissibility of such a cost recovery scheme.

Streicher, Am. Short Line and Reg'l. R.R. Assoc., & Lou Sanders, Am. Pub. Transp. Assoc., (Aug. 26, 2013), *available at* http://www.fra.dot.gov/Elib/Details/L15896.

38. *See* Letter from Logue, *supra* note 37.

39. *Id.*

40. Vantuono, *supra* note 6.

41. Letter from Logue, *supra* note 37.

42. FED. R.R ADMIN., *Data and Resources*, http://www.fra.dot.gov/Page/P0365 (last visited Oct. 18, 2014).

43. *See id.*

B. LNG Locomotive Regulation Coming 'Round the Bend

In the absence of formal regulation, the FRA is currently working with the American Association of Railroads ("AAR"), as well as other industry members, to develop LNG tender car design standards.[44] These standards are a necessary precursor to amending FRA regulations to allow LNG testing and implementation as a fuel source in freight locomotives, and the FRA projects this process will take four to five years to complete.[45] This group is specifically working to develop standards in the following areas:

> safety, crashworthiness, and environmental protection; tender design and construction; tender-to-locomotive interfaces and interconnections; tender-to-refueling infrastructure interfaces and connections; tender interoperability and interchangeability between railroads; and, maintainability.[46]

These efforts reflect the overarching belief that "fuel tender safety is . . . a prime consideration."[47]

Furthermore, the FRA's Office of Research and Development recently posted a Broad Agency Announcement seeking research papers that "identify regulatory changes needed for [the] wider implementation of natural gas fuels in the rail environment."[48] In addition to some of the topics already under consideration by the group above, the FRA has requested research into "fire suppression systems, . . . post-derailment inspection and handling, . . . required training for railroad employees and first responders to safely interact with natural gas fuels and equipment, . . . and emergency shut-off systems."[49] The closing date for submission of concept papers on these topics was May 30, 2014; the FRA has yet to announce the results of this solicitation.[50]

C. Staying on Track: Closing Regulatory Gaps Beyond Fuel Tender Safety

Despite these laudable efforts, significant regulatory gaps exist in other areas, and these gaps must be resolved before LNG can be effectively adopted as the primary fuel for freight locomotives in the U.S. One way to identify gaps in LNG locomotive regulation is to examine other transportation industries that have taken a more developed approach to

44. Gladstein, *supra* note 35, at 29.
45. *Id.*
46. Vantuono, *supra* note 6.
47. Smith, *supra* note 14.
48. Fed. R.R. Admin., Office of Research & Dev., FRA-RS-001, Natural Gas Locomotive Research 9 (2014), *available at* https://www.fra.dot.gov/eLib/Details/L04837.
49. *Id.*
50. *Id.*

LNG as a primary fuel source. One such industry is maritime shipping, which has used LNG "to fuel diesel propulsion systems . . . since 2006" and currently operates 48 existing LNG ships with dual-fuel technology similar to that proposed for LNG locomotives.[51] While LNG use in the marine shipping environment enjoys a good safety record, a recently released report by the Maritime Administration ("MARAD"), the regulatory equivalent of the FRA in the maritime shipping industry, identified significant regulatory gaps that suggest this safety record is a result of luck rather than effective regulation in certain areas.[52] The MARAD report identified the following regulatory gaps that are also applicable to LNG use in freight locomotives: metrology; inconsistency in local adoption of National Fire Protection Association ("NFPA") 59A, which provides minimum standards for fire protection, safety, and related requirements for the location production, storage, and handling of LNG; and, inconsistency in the quality of inspections and enforcements for LNG aboveground storage tanks ("ASTs").[53]

LNG metrology essentially measures the quality of LNG during a transfer from a fuel tank to determine the value of the LNG.[54] This measurement is necessary whenever LNG is used as a fuel source given the unique properties of LNG; "since lighter components of LNG boil off during the transit or storage and exit the tank, this changes the composition of the LNG and the quality of it for use of a fuel."[55] Regulation in this area is likewise necessary for LNG locomotives to allow parties to accurately value the LNG being transferred during fueling operations and to ensure the quality of the transferred LNG is sufficient for its use as a fuel.

NFPA 59A provides LNG plant siting requirements,[56] something Class 1 railroads will need to consider in locating LNG fueling depots and storage tanks to support LNG locomotives. Different states take different approaches to compliance with NFPA 59A; for example, some require compliance with the code while others make such compliance optional.[57] Because the U.S. freight rail network expands across the

51. FREDERICK ADAMCHAK & AMOKEYE ADEDE, POTEN & PARTNERS, LNG AS MARINE FUEL 2, *available at* http://www.gastechnology.org/Training/Documents/LNG17-proceedings/7-1-Frederick_Adamchak.pdf.

52. Stagl, *supra* note 2 (quoting Louis Renjel, Vice President, CSX); *see* DANIELLE HOLDEN, DET NORSKE VERITAS, LIQUEFIED NATURAL GAS (LNG) BUNKERING STUDY (3d. rev. 2014), *available at* http://www.marad.dot.gov/documents/DNVLNGBunkeringStudy3Sep14.pdf.

53. *See* HOLDEN, *supra* note 52, at 87-90.

54. *Id.* at 87.

55. *Id.*

56. *Id.* at 89.

57. *Id.* at 89-90.

country, federal regulation mandating compliance with the 2013 version of NFPA 59A would provide Class 1s with a national "baseline for how to address typical LNG storage tank scenarios,"[58] thereby reducing regulatory uncertainty in this specific regard.

Another LNG fueling and storage consideration that will need to be addressed through federal regulation is the quality of inspections and enforcements relating to LNG ASTs.[59] Similar to NFPA 59A compliance, different states and local enforcement agencies take different approaches to regulating the inspection and enforcement of ASTs, resulting in "a lack of consistency between the states in the level of inspection and proactive enforcement."[60] Consequently, the FRA should identify national regulatory standards that would provide Class 1s a baseline to address LNG AST inspection and enforcement, which in turn would effectively raise the quality of these activities to a nationally acceptable and highly consistent level while simultaneously reducing regulatory uncertainty around this activity.

In addition to these regulatory gaps, the MARAD report recommended the adoption or development of several LNG standards and guidelines.[61] While the FRA is currently addressing many of these recommendations (as discussed above), the MARAD report made one suggestion that is particularly applicable to LNG locomotives, but remains seemingly unaddressed by the FRA: requirements for simultaneous LNG fueling and freight loading/unloading.[62] these two activities can occur simultaneously in LNG locomotives, the FRA should consider adopting uniform regulations, or, at a minimum, standards, that will provide Class 1s sufficient guidance on how to conduct these activities simultaneously and safely.

Ultimately, more testing needs to occur to ensure any regulations facilitate the operational requirements of LNG locomotives rather than stifle innovation and the development of best practices. Furthermore, the FRA must recognize that "the U.S. freight rail network connects with Canada and Mexico through several key gateways along the borders,"[63] and should therefore both consider international standards and work with its Canadian and Mexican counterparts to ensure that any regulations it adopts will not create inconsistencies for the freight rail industry.

58. *Id.* at 90.
59. *Id.*
60. *Id.*
61. *Id.* at 106.
62. *Id.*
63. FED. R.R. ADMIN., *supra* note 8.

IV. Pulling into the Station of Regulatory Certainty

Although the FRA's work on tender car design standards and its clarification as to HMR regulations are positive first steps toward reducing regulatory uncertainty, numerous regulatory gaps remain and need to be closed before LNG can be adopted as the primary fuel source for freight locomotives. The author recommends the FRA formalize its test plan approval process to provide Class 1s more certainty as to the steps they must take to obtain FRA approval; otherwise, the current inconsistency will continue to impermissibly delay the testing needed to inform effective regulation. Moreover, given the relative lack of data on the application of LNG to the rail industry, the FRA should look to other transportation sectors, such as the maritime shipping industry, to take advantage of lessons learned that are similarly applicable to the rail industry. In short, the FRA's regulation of LNG should occur in a phased approach that allows for technological and operational innovation, responds to lessons learned from testing these innovations both in the rail and other environments, and serves to protect the public.