SP 20534 Special Permit to transport LNG by rail in DOT-113C120W rail tank cars

Final Environmental Assessment

December 5, 2019

Docket No. PHMSA-2019-0100

1 Introduction

Methane refrigerated liquid commonly known as liquefied natural gas (LNG) is currently transported via truck and in United Nations (UN) approved International Organization for Standardization ("ISO") portable tanks by rail under a Federal Rail Administration (FRA) approval in accordance with the Hazardous Material Regulations (HMR; 49 C.F.R. Parts 171-180). Energy Transport Solutions LLC (hereinafter referred to as "ETS" or "Applicant") submitted a special permit application to the Pipeline and Hazardous Materials Safety Administration (PHMSA) for the transportation of LNG in DOT-113C120W tank cars. This final Environmental Assessment (EA) was prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), the President's Council on Economic Quality (CEQ) regulations implementing NEPA, and U.S Department of Transportation (DOT) policy. This final EA analyzes the potential environmental impacts that could result from PHMSA's issuance or denial of the special permit application. This EA considers the comments received in response to the draft environmental assessment, posted on June 6, 2019 and the Updated draft environmental assessment, posted on July 9, 2019. 49 CFR § 107.105(d) requires that PHMSA only grant special permits when the decision "achieves a level of safety at least equal to that required by regulation, or if a required safety level does not exist, is consistent with the public interest."

2 Background and Statement of Purpose and Need

ETS has applied for a special permit asking PHMSA to approve ETS's use of DOT-113C120W tank cars as an appropriate packaging for the transportation of LNG by rail tank car. ETS is a logistics company that provides transportation services to move LNG domestically and internationally. ETS applied for this special permit specifically to transport LNG between Wyalusing, PA and Gibbstown, NJ. ETS intends to use the special permit to facilitate shipments to customers who are principally exporters of LNG to foreign markets. ETS expects that the ultimate end-users of this LNG will be foreign generators of power for residential, commercial and industrial purposes. Nevertheless, it is possible that there will be some domestic end-users of the LNG—most likely industrial users who may buy LNG from ETS's customers for direct use.

To efficiently transport natural gas outside of a pipeline, the natural gas must first be liquefied, reducing its volume at ambient pressures by a ratio of more than 600 to 1 to maximize efficiency in transportation. In the liquefaction process, water and carbon dioxide, along with most hydrocarbons other than methane, are removed. The product is then cooled to -162 ºC (-260 °F) where methane, the predominant component of natural gas, transitions from a vapor to a liquid state. LNG is colorless and odorless and will vaporize (i.e., return to a gaseous state) if released to the atmosphere. As described in more detail below, LNG is similar to other hazardous materials currently authorized to be transported by rail in DOT-113C120W tank cars, such as Ethylene, refrigerated liquid. Like LNG, cryogenic ethylene is a flammable cryogenic material and has an established history of being transported by rail for over 50 years with very few incidents.

Pursuant to 49 C.F.R. § 172.101, LNG may currently be transported from any origin to any destination in an approved bulk packaging, like an ISO portable tank or a DOT specification cargo tank motor vehicle (MC-338). However, the DOT-113C120W tank cars that are the subject of the special permit application are not currently approved packaging for transporting LNG by rail. Until recently, the limited production and commercial use of LNG did not create an impediment in the transportation of natural gas utilizing existing DOT approved containers. However, recently U.S. production of natural gas has increased dramatically, resulting in growing market demand for low-cost and reduced emissions-intensive energy options for power generation and transportation fuels.

The U.S. Department of Energy (DOE) has acknowledged that natural gas production in the Appalachian region in particular has increased and "is expected to increase for decades to come."[1] However, DOE also found that "options for natural gas producers and processors in the Marcellus/Utica region to move [natural gas liquids (which differs from LNG)]," such as methane, "to other markets via pipeline remain limited, and a significant share of production moves by rail."[2] Natural gas that cannot move to market via pipeline must be moved in liquid state (LNG) in MC-338 cargo tanks by truck or in ISO portable tanks via highway or by rail. Transporting LNG in ISO portable tanks by rail requires an approval from FRA. Issuance of a special permit that allows ETS to utilize DOT-113C120W tank cars for LNG transportation could provide advantages over current transportation options for the reasons discussed below.

Other forms of petroleum-based gases are currently authorized to be shipped by rail in tank cars. For example, liquefied petroleum gases (LPGs) are authorized to be shipped via rail in DOT-105, DOT-112, or DOT-114 single-walled, pressurized tank cars. The DOT-113C120W tank cars that are the subject of ETS's special permit application are double-walled tank cars specifically designed for carriage of cryogenic materials, such as LNG. DOT-113C class tank cars are currently authorized under the HMR to move other cryogenic flammable liquids, including Ethylene and Hydrogen. ETS's special permit application requests authorization to move LNG by rail in DOT-113C120W tank cars filled to densities comparable to the maximum filling densities for cargo tanks, which transport LNG via highway, as required in 49 C.F.R. § 173.318(f)(3).
In a January 2017 petition for rulemaking, the Association of American Railroads (AAR) also requested that PHMSA authorize the use of DOT-113C tank cars for LNG transportation.

[1] U.S. Department of Energy, Natural Gas Liquids Primer *with a Focus on the Appalachian Region* (June 2018).
[2] *Id*.

PHMSA determined the petition "merits consideration in a future rulemaking."[3] Furthermore, Transport Canada has authorized DOT-113C120W equivalent tank cars (i.e. TC-113C120W) for transport of LNG since 2014.[4]

Statement of Purpose and Need

ETS seeks authorization to ship LNG via rail in DOT-113C120W tank cars in shipment configurations that could range from single to multiple tank cars (blocks) in general manifest trains, and, depending upon demand, up to dedicated train configurations consisting of up to 100 tank cars (unit train). ETS anticipates that at any given time, regardless of the train configuration, tank cars could be loading in preparation for transportation; in transportation to destination; at destination unloading; and/or in transportation as empty/residue shipments on a return trip to the LNG liquefaction facilities. Shipments of LNG in DOT-113C120W tank cars are subject to requirements that govern all current shipments of that approved packaging—specifically, all applicable provisions of 49 C.F.R Parts 172 and 173, including in particular 49 C.F.R. § 173.319, which regulates tank car shipments of cryogenic liquids, as well as Part 174 which adds additional requirements specific to rail.

PHMSA is responding to ETS's request for a special permit to use DOT-113C120W tank cars for the transportation of LNG by rail. Authorizing ETS to transport LNG in DOT-113C120W tank cars by rail either as an alternate packaging to MC-338 cargo tanks or UN ISO portable tanks, provides a more cost-effective mode of transport.

In ETS's request for a special permit, it stated that it was requesting to transport UN1972, Methane, refrigerated liquid, a Division 2.1 flammable gas material in unit train configurations. Unit train configurations typically consist of 70 or more cars transporting a single material. Based on the projected liquefaction capabilities of the proposed LNG facility that will originate the shipments for this special permit, the production capabilities of the manufacturers of cryogenic tank cars, and the actual market demands for LNG, it is projected that it will likely take ETS a number of years to reach the liquefaction capacity to transport LNG at the volumes indicated in the special permit application, as well as for the tank car manufacturers to produce the tank cars needed to support such volumes. The special permit will not limit the number of cars in a unit train or the number of daily shipments. Nonetheless, it is important to understand how the quantity of rail tank cars in transportation could change over time as capacity, demand, and production change.

3 Alternatives: Selected Action and No Action Alternative

Transport of LNG in MC-338 cargo tanks is currently authorized by the HMR. Transport of LNG in ISO portable tanks is already authorized by highway and is also authorized by rail with approval

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[3] U.S. DOT/PHMSA – Acceptance Letter, PHMSA-2017-0020-0005, May 10, 2018.

[4] Section 8.6.3.4 of "Containers for Transport of Dangerous Goods by Rail, a Transport Canada Standard." Accessed via https://www.tc.gc.ca/eng/tdg/containers-transport-dangerous-goods-rail-transport-canada-standard.html#_4.7_Schedule_2 on March 4, 2019.

from the FRA. In responding to the special permit application, PHMSA considered the following two alternatives:

(1) Selected Action Alternative: Approve ETS's special permit application to allow ETS to offer LNG for transportation in DOT-113C120W tank cars between Wyalusing, Pennsylvania and Gibbstown, New Jersey. A specific route is not dictated by the terms of the special permit but would be determined by ETS and the carrier in accordance with the plan that ETS must submit to PHMSA within 90 days after issuance, in accordance with the Operational Controls.

A number of different specifications govern the design and manufacture of DOT-113C120W tank cars.[5] The rail tank cars are built to a double vessel design with the commodity tank (inner vessel) constructed to withstand a minimum burst pressure of 300 pounds per square inch gauge (psig) and fabricated of ASTM A 240/A 240M, Type 304 or 304L stainless steel; the outer jacket (outer vessel) is typically constructed of carbon steel having a tensile strength greater than 70,000 psig. See 49 C.F.R. §§ 179.401-1, 179.400-5, and 179.400-8(d), respectively. The inner stainless-steel vessel is designed with a minimum plate thickness, after forming, of 3/16 inch, and the outer jacket thickness, after forming, may not be less than 7/16 inch[6]. Additionally, the minimum wall thickness, after forming, of the outer jacket heads may not be less than ½ inch and must be made from steel specified in §179.16(c) for tank head puncture resistance. The rail tank car is manufactured with an insulated annular space holding a vacuum between the two pressure vessels. This vacuum area and the insulation on the outer wall of the inner tank significantly reduce the rate of heat transfer from the atmosphere to the liquid inside the tank car, thus minimizing the heating of the cryogenic (i.e., refrigerated) liquid in the tank car while being transported. Other safety features of the tank car include protection systems for the piping between the inner tank and outer jacket, and multiple pressure relief devices.

Under the terms of the special permit, the regulations controlling the movement of LNG in the DOT-113C120W tank car would include all those that apply to the transportation of other cryogenic liquids, including ethylene.[7] Regulatory requirements governing these operational requirements appear in 49 C.F.R Part 174 and 49 C.F.R. § 173.319, which is administered by the FRA. The special permit also requires a number of additional operational controls as outlined later in this document, including that ETS provide training to emergency response agencies that could be affected between the authorized origin and destination. The training must conform to National Fire Protection Association (NFPA) 472, including known hazards in emergencies involving the release of LNG, and emergency response methods to address an incident involving a train transporting LNG. In addition, the AAR has issued Circular OT-55, which sets forth Recommended Railroad Operating Practices for Transportation of Hazardous Materials for trains meeting the AAR's key train definition. Rail hazmat carriers require compliance with the standard through AAR Interchange Rules.

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[5] *See, e.g.,* 49 C.F.R. Part 179, Subpart F and TC regulation TC14877E, Section 8.6 in addition to industry standards set by the Association of American Railroads.

[6] The Hazardous Materials Regulations establish minimum safety standards for package design.

[7] Paragraph 2 of the Special Permit states, "This special permit provides no relief from the Hazardous Materials Regulations (HMR) other than as specifically stated herein." Paragraph 7.c.2 of the Special Permit states, "Each tank car must be operated in accordance with § 173.319 except as specified in paragraph 7.a. above." Paragraph 7.a specifies the maximum permitted filling density and maximum operating pressure relevant to LNG.

As the AAR explained in a comment to the September 14, 2017 Federal Register notice of ETS's special permit application, AAR Circular OT-55 (currently designated as version Q) calls for operational controls for trains containing 20 or more loaded hazardous materials tank cars. The operational controls in OT-55Q for the transport of hazardous materials address a number of parameters and requirements, including the following:

- "Key Trains" are 20 carloads or intermodal portable tank loads of any combination of hazardous materials.

- "Key Trains," including LNG-carrying unit trains, are subject to a maximum speed restriction of 50 mph;

- "Key Routes," which are lengths of track on which either (i) 10,000 car loads or more of hazardous materials or (ii) 4,000 car loadings of flammable gas (such as LNG) will travel over a one-year period and are subject to additional inspection and equipment requirements;

- Separation distance requirements relating to the spacing of loading and operations, loaded tank cars, and other storage tanks at rail facilities; and

- Community awareness and preparations for emergency planning/incident response actions.

The special permit requires the following operational controls:

- Each tank car must be operated in accordance with § 173.319.

- Shipments are authorized between Wyalusing, PA and Gibbstown, NJ, with no intermediate stops.

- Within 90 days after issuance, the grantee shall prepare and submit a plan providing per shipment quantities, timelines, and other actions to be taken for moving from single car shipments to multi-car shipments, and subsequently to unit trains (20 or more tank cars).

- Trains transporting 20 or more tank cars authorized under this special permit must be equipped and operated with a two-way end of train device or distributed power.

- Prior to the initial shipment of a tank car under this special permit, the grantee must provide training to emergency response agencies that could be affected between the authorized origin and destination. The training shall conform to National Fire Protection Association NFPA-472, including, known hazards in emergencies involving the release of LNG, and emergency response methods to address an incident involving a train transporting LNG.

- While in transportation, the grantee must remotely monitor each tank car for pressure, location, and leaks.

Other Safety Control Measures:

Each tank car under the special permit must have:

- Pressure relief devices set to discharge at 75 psig;[8]
- A maximum permitted filling density (percent by weight) of 32.5%;
- A design service temperature of -162 ºC (-260 °F);[9]
- A maximum pressure when offered for transportation not to exceed 15 psig; and
- Remote sensing for detecting and reporting internal pressure, location, and leakage.

Additionally, the Special Permit includes the following Reporting Requirements:

- Shipments or operations conducted under this special permit are subject to the Hazardous Materials Incident Reporting requirements specified in 49 CFR §§ 171.15 - Immediate notice of certain hazardous materials incidents, and 171.16 - Detailed hazardous materials incident reports. In addition, the grantee(s) of this special permit must notify the Associate Administrator for Hazardous Materials Safety, in writing, of any incident involving a package or shipment conducted under terms of this special permit.
- Every three months, up to the first offering, the grantee must provide quarterly program updates describing:
    - The progress on manufacture and delivery of tank cars; and
    - The scheduled first shipment date.
    - This report should be submitted to specialpermits@dot.gov for review. The report should be provided to PHMSA by January 1st, April 1st, July 1st, and October 1st.
- Once shipments have begun, the grantee must provide a report every three months documenting the number of tank cars shipped under the terms of the special permit since the previous report was submitted including details on conformance to the plan required in paragraph 7.c.3 of the special permit. This report should be submitted to specialpermits@dot.gov for review. This report should be provided to PHMSA by January 15th, April 15th, July 15th, and October 15th.

Transport of LNG by rail will utilize existing rail infrastructure and implement existing requirements in the HMR for flammable cryogenic liquids. The railroads that ETS will use for

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[8] As required by 49 C.F.R § 179.15(b)(2)(i).

[9] As required by 49 C.F.R. § 179.401-1.

transportation have transported cryogenic flammable materials for decades, pursuant to 49 C.F.R. § 173.319, which is applicable to the transport of cryogenic liquids in tank cars. It is also important to note that the special permit does not waive any safety regulations. Instead, the special permit allows LNG to be transported in the already-approved DOT-113C120W tank car authorized for use with other cryogenic materials with similar characteristics as LNG. Any applicable requirements within the HMR, including 49 C.F.R. § 173.319 apply to the transportation that will take place under the special permit.

(2) No Action Alternative: Deny ETS's special permit application for transporting LNG in DOT-113C120W tank cars and continue limiting transport of LNG to the packagings currently authorized by the HMR without the need for a PHMSA special permit, including cargo tanks via highway and ISO tanks via rail and highway.

If the special permit is denied, ETS has stated that it will transport LNG by DOT specification MC-338 cargo tanks, which will increase the fleet of MC-338 dedicated to that purpose.

The baseline case for transportation of LNG to be considered is approximately 1200 additional MC-338 cargo tanks per day using local and state roadways as well as the National Highway System between the point of origin and destination. By issuing the special permit to approve the DOT-113C120W tank cars for transporting LNG by rail, ETS will have the option to transport LNG in DOT-113C120W tank cars. ETS does not require regulatory approvals from DOT to transport any quantity of LNG via highway in MC-338 cargo tanks.

The special permit will allow ETS to move LNG by rail in DOT-113C120W tank cars from supply sources to customers via existing rail corridors. The principal impacts from issuance of the special permit will be associated with fuel efficiency, engine emissions, and potential impacts from possible loss of containment in the event of a train derailment or other release events. These considerations are further analyzed in the sections below.

Use of ISO Portable Tanks- Eliminated from full discussion

According to the applicant, using ISO portable tanks to transport LNG for this project is economically undesirable due to the added infrastructure and operational costs associated with intermodal handling of containers. According to ETS, the use of ISO portable tanks would require additional facilities for handling the ISO portable tanks on truck chassis and during loading and unloading at intermodal yards. The applicant has informed PHMSA that it would not pursue this option due to cost. Approximately three to four times the number of ISO portable tanks would be required to ship the equivalent volume of LNG as compared to using DOT-113C120W tank cars as requested in the permit application. Although ETS has the option to seek approval from FRA to use ISO portable tanks for transportation of LNG on rail flat cars between Wyalusing, Pennsylvania and Gibbstown, New Jersey, ETS has indicated it does not intend to do so. Therefore, this alternative was eliminated from full discussion.

4 Environmental and Human Health Impacts of the Selected Action and No Action Alternative

Both the Selected Action and the no action alternative could result in impacts to the environment and pose risks to human health and safety. Both the MC-338 and the DOT-113C120W transport LNG in specialized insulated packagings that have the potential for LNG emissions through venting, although venting is not authorized during normal operation in either case. Impacts from potential loss of containment from both transportation methods are of the utmost concern. This analysis will focus on safety and risk associated with the transportation of LNG in DOT-113C120W tank cars. This analysis will also discuss the environmental impacts related to fuel efficiency and engine emissions.

Safety and Risk

LNG poses certain potential hazards as a cryogenic liquefied flammable gas. LNG has a shipping identification number of UN1972 for 'Methane, refrigerated liquid.' The liquefaction of natural gas is achieved by cooling it to its normal boiling point, -162° C (-260° F), at atmospheric pressure. At the normal boiling temperature, LNG does not need to be stored under pressure, but it must be insulated to avoid boiling due to heat leakage into the liquid. As the liquid boils at atmospheric pressure, it does so at its constant, boiling temperature of -162° C (-260° F). Heat leakage occurs even in highly insulated vessels and over long periods of storage could amount to substantial vaporization of the liquid. Also, accidents leading to failures in the insulation systems result in rapid heat leak into the liquid. Heat leak into a closed vessel results in an increase in the pressure within the vessel. When the internal tank pressure exceeds the set-to-discharge-pressure of the pressure relief valve, LNG vapors will be released into the atmosphere. No release of LNG vapor to the environment is allowed during the normal transportation of LNG in tank cars whether by roadway or railway.

Similar to other specification tank cars with outer jackets, the DOT-113C120W design provides an equivalent crashworthiness when compared to a single vessel-wall design rail tank car of similar materials with a total wall thickness as defined by the sum of the inner tank and outer jacket wall thicknesses of DOT-113C. The tank car insulation is required to be designed to ensure that the heat transfer from the ambient air to LNG in the tank does not result in a pressure rise of over 3 psig/day, on average. See 49 C.F.R., § 173.319(c). The start-to-discharge-pressure of the pressure relief valve is set at a sufficiently high value (generally 75 psig; 49 C.F.R. § 179.401-1) to ensure, at least, a 20-day transit time from the day of filling the tank car. See 49 C.F.R. § 173.319(a)(3).

The hazardous properties (flammability and pressure build up) of LNG and liquefied ethylene (for comparison of a flammable cryogenic material already authorized in a DOT-113C120W tank car) are virtually identical when the parameters for filling the tank car are adjusted for the specific physical properties of the two materials. The safety profiles of transporting a single tank car of LNG in a DOT-113C120W and single tank car of cryogenic ethylene in a DOT-113 are very similar except that ethylene vapor burns in both lower and higher concentrations in air. Liquefied ethylene does not currently move in unit train configurations and normally ships in one to three cars travelling together due to prevailing customer requirements. Nonetheless, the applicant states that, depending on demand, it may offer into transportation up to 100 tank cars of LNG at a time once its project reaches full capacity. Consequently, the special permit requires that ETS submit quarterly reports to PHMSA regarding the pace of tank car manufacture, and after shipments begin, ETS must submit quarterly reports informing PHMSA of the number of shipments. These provisions will allow DOT to more closely monitor the LNG shipments by ETS. The special permit also imposes, for trains transporting 20 or more tank cars, a two-way end-of-train device or distributed power, which are additional requirements to improve braking and stopping distances.[10]

As with any hazardous material offered into rail transportation, each additional tank car containing a hazardous material (such as LNG) can increase the potential of a hazardous materials being involved should a derailment occur. LNG poses potential cryogenic temperature exposure hazards as well as fire and explosion hazards. Due to a large difference in temperature, the rapid transfer of heat from an object into the cryogenic liquid can cause burns if direct contact of liquid with skin occurs or if Personal Protective Equipment (PPE) is inadequate to prevent cold-temperature injury during an exposure. Additionally, large spills of the liquid onto metal structures that are not designed to withstand cryogenic temperatures can cause embrittlement and fracturing. Methane is odorless and LNG contains no odorant (unlike odorized residential natural gas supplies), making detection of a release difficult without a detector device. Vapor generated by the evaporation of LNG, comprised primarily of methane, is flammable when mixed with air in vapor concentrations between, approximately, 5% to 15% by volume; outside of this range, the vapor fuel will not burn. By comparison, the flammable ranges in air of ethylene is much broader, at 2.7–36%. Releases of LNG due to venting or to accidents, without immediate ignition, involving either a MC-338 cargo tank, an ISO portable tank, or a DOT-113C120W have the potential to create flammable clouds of natural gas. Large releases of LNG due to the breach of the inner tank of these transport vessels could result in a pool fire, vapor fire, and explosion hazards if methane vapors become confined. These flammability hazards pose the highest potential impacts when compared to localized cryogenic hazards.

The HMR currently authorizes transportation of "ethylene, refrigerated liquid," a cryogenic flammable gas in DOT-113C120W rail cars. The HMR also currently authorizes transportation of hydrogen, refrigerated liquid UN1966, in DOT-113 railcars. However, PHMSA does not believe cryogenic hydrogen UN1966 is currently transported in this manner in the United States. PHMSA has collected data on the safety history of DOT-113 from its own incident database and from AAR, which compiles data provided by FRA.

PHMSA has analyzed this data regarding DOT-113 damage history.[11] From 1980 to 2017 (a 37-year period), there were 14 instances of damage to DOT-113 tank cars during transportation. Of the 14 instances, there were two events involving three DOT-113 tank cars (one event involved one tank car and the other involved two tank cars) where lading was lost from a breach of both

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[10] Some commenters suggested requiring the use of electronically controlled pneumatic (ECP) brakes to provide further improved stopping ability and more reliable brake lines. However, the ECP brakes only function properly when all cars in the consist are equipped with ECP brakes. The applicant indicated that initially these cars will move on manifest trains that will not be equipped with ECP brakes.

[11] "RSI-AAR Railroad Tank Car Safety Research and Test Project," RA-19-03, May 3, 2019.

the outer jacket and inner tank. This is the most serious type of damage. Additionally, there were four instances in which a DOT-113 lost lading from damage or other failure to the valves or fittings.

The first derailment that resulted in the breaching of the inner tank of a DOT-113 occurred in May 2011 in Moran, Kansas. Three DOT-113C120 specification tank cars containing "Ethylene, refrigerated liquid" sustained significant damage. Two of the cars were breached in the derailment and initially caught fire. The breach and resulting fire consumed the contents of one of the tank cars. The other two cars were mechanically breached with explosives (i.e., intentionally breached) in a controlled vent and burn process to minimize risk to responders and to expedite the burning and consumption of the entire contents from the two tank cars so that the site could be cleared. The total quantity of refrigerated ethylene spilled was 124,000 gallons. The response cost was estimated at $210,255, and the total damage estimate was calculated at approximately $231,000 in 2017.[12] The other derailment that caused a tank failure occurred in October 2014 in Mer Rouge, Louisiana. The involved rail tank cars were filled with refrigerated liquid argon. One car was a DOT-113A90W specification tank car and the other was an AAR204W tank car (a car equivalent to the concept of a DOT-113 tank car). Both tank cars are authorized by special permit. The total quantity of refrigerated argon spilled was 47,233 gallons and the total damage estimate is calculated at approximately $228,000 (in 2017 dollars). No injuries or fatalities were reported because of the release of hazardous materials from either incident. Any breach of the inner tank of a rail car carrying cryogenic materials will most likely result in the loss of the entire contents of the tank, meaning that release amounts will typically equal the original lading amount. For safety reasons, a heavily damaged rail tank car filled with cryogenic material would be emptied prior to removal from the site of the incident. Response and mitigation techniques beyond evacuation for breaches in cryogenic tank cars do not exist or are impractical during a derailment scenario. The breach of a cryogenic tank car will typically result in the loss of the entire volume of material in the tank car. While neither ethylene nor refrigerated liquid argon are transported in the quantities that ETS plans to transport LNG, incidents are still rare. Despite the low probability, rail incidents can be high-consequence events, given the quantity of hazardous materials in transportation.

LNG Characteristics and Hazards

Methane is a non-toxic, flammable and odorless gas. In an accident, when LNG is spilled and its vapors encounter an ignition source, the vapor will ignite only if the vapor concentration in air is between 5% and 15% volume. Immediate ignition with liquid still on the ground could cause the spill to develop into a pool fire and present a radiant heat hazard. If there is no ignition source, the LNG will vaporize rapidly forming a cold gas cloud that is initially heavier than air, mixes with ambient air, spreads and is carried downwind. The dispersion of the cloud due to wind results in the cloud temperature rising as the methane vapor mixes with warmer air as well as coming into contact with other materials and surfaces. Because the temperature of the vapor cloud will be lower than air temperature, it will travel along the ground until the cloud temperature nears the ambient air temperature. The cloud is heavier than air and disperses hugging the ground with highest vapor concentrations at ground level. The density of the cloud will decrease due to

[12] Hazardous Materials Incident Report Form (DOT F 5800.1 (01-2004)), May 23, 2011; Moran, Kansas. RSI-AAR Railroad Tank Car Safety Research and Test Project RA-19-03 May 3, 2019.

continuous mixing with air and contact with other materials and surfaces; however, the cloud density is never lower than that of the ambient air. As stated above, the vapor is ignitable only in the 5% to 15% concentration range. In the initial stages, the dispersing cloud is cold (starting from -260 ºF), appearing visible as a white cloud due to the condensation of water vapor from the atmosphere. However, as the overall cloud temperature increases due to mixing with ambient air, and as the cloud temperature increases to above the "wet bulb" temperature corresponding to the relative humidity of the atmospheric air, the condensed water re-evaporates and the cloud becomes non-visible. The flammable region of the vapor cloud is enclosed within the visible vapor cloud if the ambient relative humidity is greater than or equal to 55%. For regions with relative humidity less than this value, the flammable cloud is outside the visible cloud. An ignition source can ignite the vapor cloud only when the methane vapor concentration is in the range of 5% to 15% vapor concentration in air. Once ignited, the vapors will burn back to the LNG source.

Methane in vapor state can be an asphyxiant when it displaces oxygen in a confined space. When spilled on the ground, into a confined area such as bound by a dike, the LNG will initially boil-off rapidly forming a vapor cloud, but the boil-off will slow down as the ground cools due to heat being extracted from the ground to provide for the evaporation of LNG. If spilled on water, the LNG will float on top of the water, spread in an unconfined manner, and vaporize very rapidly. This rapid vaporization will occur even at water temperatures near freezing since freezing water is significantly warmer than the spilled LNG.

In either scenario, the vapor cloud will be very cold and visible due to the condensation of water out of the air. Initially, if not ignited, the cloud will be dense and hug the ground. If there is no wind, the cloud will spread laterally from the spill. If there is a breeze, the visible cloud will initially hug the ground as it moves downwind from the spill. The subsequent dispersion behavior of the vapor cloud is as indicated earlier.

The distance over which an LNG vapor cloud remains flammable is dependent on several factors and difficult to predict. Weather conditions at the spill location (wind speed, atmospheric stability or turbulence), terrain, surface cover (i.e., vegetation, trees, and buildings) will influence how a vapor cloud disperses, and how rapidly it dilutes. If an LNG vapor cloud is ignited before the cloud has been dispersed or diluted to below its lower flammability limit, a flash fire may occur. An LNG vapor cloud will not entirely ignite at once. If ignited, the methane in LNG has a flame temperature of about 1,330°C (2,426°F). The resulting ignition leads to a relatively slow (subsonic) burning vapor fire which travels back to the release point producing either a pool fire or a jet fire. Such a slow burning vapor fire will not generate damaging overpressures (i.e., explosions), if propagating in the open with no significant obstructions. To produce an overpressure event, the LNG vapors need to be within the flammability range and ignited, and either be confined within a structure or the traveling flame in the open encounters densely packed structural obstructions (houses, trees, bushes, pipe racks, etc.) that can increase the flame turbulence significantly. Other hydrocarbons that are transported by rail and highway, such as propane and butane, are more susceptible to vapor cloud explosions when they become vaporized and are ignited in much less confined conditions.

LNG is stored and transported at -162 ºC (-260 °F). Due to this very low temperature, its contact with human skin or eyes will cause severe injury. It will also make ordinary metals subject to embrittlement and fracture when exposed to these temperatures. Transportation of cryogenic materials require specialized double walled tank cars (tank within a tank), with a stainless steel inner tank capable of holding the cryogenic liquid and wrapped with a highly insulating material, an outer carbon steel jacket, and the space between the tank and jacket evacuated to a vacuum to minimize heat transfer from the outside to the inner tank.

DOT-113 Tank Car Characteristics

The DOT-113 specification rail tank car is specifically designed for the transport of cryogenic liquids. This tank car design has been in use for over 50 years, and it has a favorable safety record. There are only two documented derailments of DOT-113 specification tank cars where breaches of inner tank holding the cryogenic material occurred. These two derailments have resulted in lading releases due to significant damage sustained during the derailments.

The DOT-113 specification tank car is a double walled, or tank-within-tank, rail car that uses specific grades and thicknesses (3/16-inch minimum) of stainless steel for the inner tank (product tank) that provide high-strength characteristics under cryogenic conditions. The outer jacket (outer vessel) is made of specific grades and thicknesses (7/16-inch minimum for sidewalls and ½-inch for tank heads) of carbon steel that provides protection to the inner tank and service equipment located in the annular space between tanks, as well as provide the car with a tank-head puncture resistance system, which is required by 49 C.F.R. § 179.16.

Other key safety features of the DOT-113 specification tank car and operational requirements are included in Subpart F of Part 179 of the HMR, and include but are not limited to, the following:

- Several inches of aluminized Mylar super-insulation surrounding the inner tank.
- A high vacuum environment/annular space between the inner tank and outer jacket for enhanced product pressure and temperature control
- Specifically, designed loading and unloading equipment (piping, valves, gauges, etc.) for use in cryogenic service.
- Safety equipment (pressure relief valves, safety vents, and safety shut off valves) to prevent or limit overpressure issues or non-accident releases.
- In-transit tracking (time sensitive shipment) and car handling instructions.

DOT-113 Specification Tank Car Survivability

A DOT-113 specification tank car, because of its double walled construction and a thicker outer jacket (compared to normal tank car jacket thicknesses), generally offers equivalent crashworthiness and puncture resistance in derailment accidents when compared to the wall thickness of single wall rail tank cars of comparable materials and thicknesses. The DOT-113C120W tank car has an inner stainless-steel tank with a minimum plate thickness, after forming, of 3/16 inch, and the outer jacket shell thickness, after forming, may not be less than 7/16 inch. Additionally, the minimum wall thickness, after forming, of the outer jacket heads may not be less than ½ inch and must be made from steel specified in §179.16(c) for tank head puncture resistance. Although tank cars are designed to transport certain commodities and provide adequate levels of crashworthiness, the risk of damage causing a puncture to the outer jacket and/or inner tank increases with train speed and the unique conditions of each derailment. As with any tank car, the risk of puncture to a DOT-113 tank car increases with speed and the specific conditions in the derailment environment.

If in a rail accident only the outer jacket is breached, the history of how these cars behave indicates that the outer jacket breach will result in the loss of insulating vacuum between the inner tank and outer jacket walls. This will cause a higher rate of heat transfer to the inner tank from the ambient air and result in LNG vaporization causing a buildup of pressure. The resulting pressure build could eventually lead to the activation of the pressure relief systems on the rail car resulting in the controlled venting of LNG vapor. While this scenario is concerning, the controlled venting of LNG vapor is minor in comparison to the uncontrolled release of an entire LNG lading as liquid, assuming that the inner tank is punctured below the liquid-vapor interface level. Additionally, in the event the inner tank was damaged and releasing LNG, it is unlikely that the derailment would result in an explosion. This is because, if the liquid is released into the annular space between the inner tank and outer jacket (assuming the outer jacket is punctured but not torn apart entirely), the rapid evaporation of the liquid coming in contact with the warm outer jacket results in very large volume vapor production; this vapor whose concentration is nearly 100% will occupy the entire annular space and spill over to the outside. Because of its high concentration it will not burn inside the annular confined space, even if there was an ignition source nearby. Therefore, the possibility of an explosion is very low in this type of release. In a case where the liquid is released directly to the outside of the outer jacket and spills on the ground and evaporates, producing a vapor cloud, ignition of the vapor cloud would result in a flash fire and possibly a pool fire, if liquid still pooled on the ground. In this scenario also, there is no likelihood of an explosion.

We considered the risk of occurrence of a boiling liquid expanding vapor explosion (BLEVE) in the event of a derailment incident where the LNG tank car is exposed to an external pool fire.[13] A BLEVE scenario is considered highly unlikely if any one of the following conditions exist after the derailment:

> (1) The outer jacket of the LNG tank car is intact or has suffered a relatively small (less than 1 ft in diameter) puncture hole (leading to the loss of vacuum in the space between outer jacket and inner tank) and the pressure relief valves (RPVs) are not damaged and perform as designed.

[13] A BLEVE is not caused by a combustion explosion of a flammable material. As the name implies, it is the explosion caused by rapidly evolving vapor in relatively small space which leads to significant increase in pressure which may violently damage/destroy a damaged or weakened container. When a damaged or weakened container with a liquid in it is exposed to a fire or other heat sources and insufficient pressure relief, the liquid within it can be heated and cause an increase in the tank's internal pressure. If this increase in pressure causes the tank to fail (due to, say, wall metal failure), the rapid depressurization that results leads to an extremely rapid boiling of the liquid, and release of a significant mass of vapor, in microseconds to milliseconds, into the container. This can result in very high pressures inside the container leading it to burst, causing an "explosion" (an explosion is the release of energy in an extremely short duration of time).

(2) The outer jacket is damaged substantially but the insulation on the inner tank is substantially intact and undamaged (at least, in the vapor wetted wall area), and the PRVs work as designed.

(3) Both outer jacket and inner tank of the LNG tank car are punctured releasing LNG at a high rate out of the tank car and the PRVs work as designed. No test data or mathematical models exist to predict whether and when a LNG tank car exposed to an external fire would undergo a BLEVE.

The BLEVE event is also highly unlikely due to the mandated requirements for redundant pressure relief systems (valves and safety vents) that are built into each car. In addition, this special permit would require a 15 psig maximum loading pressure when LNG is offered for transportation in the DOT 113C120W tank car and an average 3 psig/day regulatory allowable pressure gain during transportation. The loading pressure was selected because of the 3 psig regulatory requirement, 20-day travel time, and the 75 psig pressure setting for relief valve operation. These loading conditions are similar to the requirements for refrigerated ethylene. The loading pressure, along with other safety requirements and operational controls minimize the potential of a BLEVE. Therefore, it is not possible to state with certainty whether a BLEVE is even possible in the case of an LNG tank car derailment and what conditions would need to exist for such an event to occur. However, recent full-scale test with a double-walled portable cryogenic tank filled with liquid nitrogen (and whose PRVs operated as designed) and exposed to a > 200-minute engulfing LPG pool fire was neither destroyed nor resulted in a BLEVE. A test was performed with liquid nitrogen in an ISO portable tank on a flatbed rail car and exposed to a propane pool fire underneath the rail car. While the flatbed car was seen to bend due to the heat from the fire, there was no significant damage to the ISO portable tank except for loss of vacuum insulation and melting of small parts of the physical insulation. BLEVE phenomenon did not occur. Although wind conditions prevented the complete fire engulfment of the tank and loss of data stream PHMSA finds the results helpful in assessing the likelihood of a BLEVE following a derailment.

LNG Release Scenarios

Based on the review of incident reporting and the 50-year history of transporting cryogenic liquids in DOT-113 specification tank cars, there are three (3) possible release scenarios that could occur during the transport of LNG by rail. Ranked in order of estimated probability, they are:

1. Non-accident release (NAR) from service equipment. Probability – moderate; Consequence – Low

2. Outer jacket damage resulting vapor release from pressure relief device (PRD). Probability – Low; Consequence – Low to High

3. Inner tank damage resulting in large release/spill. Probability –Low; Consequence – High

Although Scenario 3 has a low probability, a breached inner tank during a transportation accident could have a high consequence due to a higher probability of a fire due to the formation of a flammable gas vapor/air mixture in the vicinity of the spilled LNG. This probability is based on the likelihood of ignition sources (sparks, hot surfaces, etc.) being generated by other equipment, rail cars, or vehicles involved in a transportation accident that could ignite a flammable vapor cloud.

As with any incident involving a hazardous material in transportation, the actual hazard distance created by a material that is spilled or burning will be influenced by many factors. These factors include, but are not limited to the following:

- Spill Size
- Weather (wind, temperature, humidity, precipitation)
- Terrain Contours (hills, valleys)
- Surface Cover (vegetation, structures)
- Soil (dirt, clay, sand)

As stated previously, hazard distance of a vapor cloud dispersion of LNG is difficult to predict. Local weather conditions, terrain, surface cover (i.e., vegetation, trees, and buildings) will influence how a vapor cloud disperses, and how rapidly it diffuses.

Similarly, the actual distance that radiant heat effects from a pool fire of LNG would impact is dependent on the same factors that influence a vapor cloud, including and significantly depend on the size of the liquid pool formed (topography related) and the volume of LNG spilled. Additionally, the impact of radiant heat effects from a fire on occupied structures will be influenced by local building codes that govern building setback requirements from a railroad right-of-way. Depending on the jurisdiction, setbacks for occupied structures could be within fifty (50) feet of either side of a railroad track.

Regardless of the scenario, the recommended protective action distances identified in the PHMSA Emergency Response Guidebook (ERG) for LNG would be appropriate for the initial protection of the public during an incident involving LNG. However, these protective distances may encompass occupied structures along rail tracks, depending on the location of a failure and the proximity of occupied structures to a breached tank car.
Cascading Failure of Multiple DOT-113 Tank Cars

As stated previously, the unique design and materials used to construct DOT-113 specification tank cars used for the transportation of cryogenic liquids provides better construction and safety features when compared to other specification tank cars due to their unique design, and materials of construction, and their specific purpose to transport cryogenic liquids.
In the scenario where multiple DOT-113 specification tank cars are transported in a block or in a unit train configuration, there are two (2) stresses, fire/radiant heat exposure, or cryogenic temperature exposure, that could potentially lead to failure of otherwise undamaged tank cars and consequent release of the material. The DOT-113's double-wall design reduces the probability of

cascading failures of multiple other undamaged DOT-113 specification tank cars in a train consist, either as a block in manifest train or in a unit train configuration.

Fire/Radiant Heat Exposure

In a scenario involving fire/radiant heat exposure, an undamaged DOT-113 specification tank car exposed to a radiant heat source would eventually build pressure that would trigger the activation of the tank car's pressure relief device (PRD).

As stated previously, this scenario would result in the controlled venting of LNG vapor to the environment. Immediate ignition of these vapors could occur if an ignition source is present. The fire would be relatively small and will be contained to the proximity of the release point of the vapors from the tank car. Additionally, as stated previously, it is highly unlikely that an undamaged DOT-113 tank car involved in a derailment would result in explosion due to a BLEVE. This event is highly unlikely due to the design of the tank car, the loading pressure requirements for cryogenic materials, and the mandated requirements for redundant pressure relief systems (valves and safety vents) that are built into each tank car. The number of tank cars that could be impacted by this type of exposure would be dependent on multiple factors. Some of these include, but are not limited to: type of fire (i.e. pool fire versus pressure relief valve), duration of the fire, whether the flames are impinging upon the neighboring tank cars or whether the exposure is only by radiant heat, defensive actions of responders as outlined in the 2016 Emergency Response Guidebook (ERG)[14], etc.

Exposure to heat from an LNG pool fire or ignition of LNG vapors could result in fatalities, serious injuries, and property damage for those within the limited zone of hazard. These risks also exist in the transportation of LNG via highway, existing rail transportation, and pipeline. However, given the safety history of the DOT-113C120W tank cars, it is expected that the risk of a tank car failure and ignition is low.

Cryogenic Temperature Exposure

In a scenario involving cryogenic temperature exposure, the risk to an undamaged DOT-113 specification tank car is the embrittlement of the tank car's outer jacket carbon steel due to exposure to the extremely cold temperatures; the inner stainless-steel tank will not be affected. As stated previously, if a DOT-113 specification tank car has its outer jacket compromised, it would lose its insulating vacuum and would eventually start to build pressure within the product tank. This pressure build would lead to the activation of the tank car's PRDs and result in the controlled venting of LNG vapors. Due to a large difference in temperature, the rapid transfer of heat from an object into the cryogenic liquid can cause burns and serious injury if direct contact with skin occurs or if PPE is inadequate to prevent cold-temperature injury due to an exposure.
Incident data with (non-LNG) hazardous materials may suggest that incidents involving rail tank cars can lead to a larger area of consequence as compared to hazard areas arising from incidents involving MC-338s cargo tank motor vehicles (or ISO portable tanks moved by rail). This is because of the larger volume of LNG in each tank car compared to that in a MC-338 cargo tank. However, the impact on people may be more (depending upon the location of the accident) in the

[14] Available at: http://phmsa.dot.gov/hazmat/outreach-training/erg.

case of a cargo tank because of the highway proximity to densely populated areas compared to the location of rail tracks. It is also noted that highway incidents in general are more common than rail incidents; so PHMSA assumes that this trend applies regardless of the cargo.[15] Therefore, PHMSA believes that from an overall risk to the public perspective, rail transportation is a safer option considering the quantity and distance transported.

No Action Alternative

It is important to note that the risks of transporting LNG via rail also apply to the shipment of LNG via highway. As discussed above, the transportation of LNG by cargo tank is already permitted by the HMR. Under the No Action Alternative, ETS has stated it would opt to transport most of the LNG it wishes to move to market over roadways in MC-338 cargo tank motor vehicles. The risks discussed above, inherent to the transportation of LNG, including, damage to human tissues and container integrity due to -162 ºC (-260 °F) cryogenic materials and the radiant heat from fires that could result from vapor ignition could increase with the selection of the No Action Alternative. The risks that would increase with the selection of the No Action Alternative are increased trips (because of lower volume transported per cargo tank), thereby increasing opportunity for an incident, higher accident rate for highway traffic as compared with rail traffic, and closer proximity to people, including other travelers, and inhabited structures along roadways as compared to rail rights of way. On the other hand, a larger quantity LNG loaded into each rail tank car, along with the risks that result from multiple tank cars moving together, could lead to higher consequences. A failure of either an MC-338 or a DOT-113 could cause injury, death, property destruction and environmental harm. The likelihood of failure of MC-338 is higher, but the scope of potential injury and death could be greater in a populated area for a DOT-113 failure because of higher volumes of LNG carried in each tank car (by about a factor of 3) compared to the volume transported in a MC-338 transport.

Fuel Efficiency

Fuel efficiency for transport of LNG can be calculated by two methods: (1) miles per gallon of fuel and (2) ton-miles per gallon of fuel. Miles per gallon gives the fuel efficiency of the transportation method, nonspecific to the cargo load. For example, a tractor-trailer with 46,000 pounds of payload, which corresponds to approximately 15,000 gallons of LNG,[16] may be expected to have 19.5 gallons diesel consumption per 100 miles.[17] While this method is commonly used with personal cars, it provides no information on how the efficiency is affected by the cargo load. A more standardized and accurate method for comparing the fuel efficiency across all trains and all freight trucks transporting cargo is in the method of ton-miles per gallon of fuel. This method takes the sum of annual ton-miles of freight transported divided by the annual fuel usage to result in ton-miles per gallon (stated as the miles a transportation method can

[15] It appears highway accidents are increasing with the growing economy and the rise in distracted driving, while rail incidents slightly declined in 2018. https://www.statista.com/statistics/204569/rail-accidents-in-the-us/ ; https://www.motus.com/car-accidents-increase-12-3-percent-finds-new-motus-distracted-driving-report/ (last accessed June 3, 2019).

[16] Chart ST-16300 LNG Transport Trailer, PN 14722928, 2013.

[17] Accessed via https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812146-commercialmdhd-truckfuelefficiencytechstudy-v2.pdf, pgs. 61-65, on February 20, 2019.

transport 1 ton of freight on a gallon of fuel). An example calculation would be of a heavy-duty diesel truck transporting 19 tons of freight a distance of 500 miles on 71 gallons of diesel fuel. This would result in

$$((19tons * 500miles)) \,/\, 71gallons = 134\text{ton-miles per gallon}$$

for a freight truck. Although the example is for a smaller cargo transportation, the 134 ton-miles per gallon is the value associated with overall freight trucks for their fuel efficiency.[18] For a locomotive, fuel efficiency is 471 ton-miles per gallon[11] resulting in trains having a fuel efficiency around 3.5 times more efficient at hauling freight than by trucks.

Denial of the special permit, which would be selection of the No Action Alternative, would result in ETS shipping larger quantities of LNG over the highway via cargo tank motor vehicle. A larger reliance on transportation via cargo tank motor vehicle would result in more fuel use and emissions, due to inferior fuel efficiency of highway transportation as compared to rail. Issuance of the special permit/selection of the Selected Action Alternative could result in ETS shipping smaller quantities of LNG over the highway in cargo tank motor vehicles and greater quantities of LNG via rail, which would result in less fuel use and less emissions. Moving one ton of freight by train would result in approximately 70% less fuel than moving the same freight by motor vehicle.

Engine Emissions

As shown with the fuel efficiency, trains can transport freight on approximately 30% of the fuel needed for a motor vehicle to transport an equivalent amount. Diesel engines produce a variety of regulated emissions, including: volatile organic compounds (VOC), carbon monoxide (CO), nitrogen oxides (NO_x), particulate matter less than 10 microns in diameter (PM_{10}), and sulfur oxides (SO_x). These emissions directly affect air quality which can cause negative health effects such as respiratory and cardiovascular complications.[19] A standardized comparison of the emissions of substances produced from rail and truck transportation methods was calculated by the United States Department of Transportation in their Freight Routing and Emissions Analysis Tool (FREAT).[13] A standardized unit, g/TEU-mi, converted the grams of pollutant produced per twenty-foot equivalent unit (TEU) per mile. A TEU is a commonly defined container unit for shipping cargo with volume of 20' length x 8'6" height x 8' width. The results of the standardized comparison of grams of pollutants produced per TEU per mile for transportation by truck, rail, and ship are shown below in Table 1.

Table 1. Summary of Emission Factors (g/TEU-mi).[20]

	Pollutant

[18] Accessed via https://www.csx.com/index.cfm/about-us/the-csx-advantage/fuel-efficiency/ on February 20, 2019.
[19] Accessed via Accessed via https://www.epa.gov/particle-pollution-and-your-patients-health/course-outlinekey-points on February 26, 2019.
[20] Accessed via https://cms.dot.gov/sites/dot.gov/files/docs/emissions_analysis_of_freight.pdf on February 25, 2019.

Mode	VOC	CO	NO_x	PM_{10}	SO_x
Truck	0.34	1.64	6.86	0.12	0.22
Rail	0.14	0.39	2.81	0.07	0.03
Ship	0.30	1.37	7.93	0.23	3.91

Transporting cargo by train results in significant decreases in emissions. Transport by rail substantially decreases the pollutant emissions by a minimum of 1.7 times the particulate matter (PM_{10}) which has direct effects on the quality of air. All other pollutants are within the 1.7 to 7.3x ranges resulting in a significant decrease in pollutants when transporting cargo by rail over truck.

Natural Gas Emissions through Venting

According to 49 C.F.R. § 173.318(e), the temperature of LNG in an MC-338 cargo tank should be sufficiently cold at the start of travel that the set pressure for the required pressure relief valve will not be met in less time than the marked rated holding time for LNG. Additionally, 49 C.F.R. § 173.319 provides requirements intended to prevent venting of rail tank cars carrying cryogenic liquids, with reporting requirements for tank cars that are not delivered within 20 days. Thus, no emissions due to warming of the LNG are anticipated during regular transport via rail or motor vehicle.

No emissions are expected during routine transport, as more than 99.99% of hazmat moved by rail reaches its destination and carrier operating restrictions exist which are intended to prevent venting during routine transport.[21,22] However, emissions of LNG can potentially occur if the tank car: (i) is involved in an accident; or (ii) is left unattended for an extended duration in transport, such as a lost tank car. All LNG transport containers are equipped with PRDs for venting of natural gas if such a situation occurs. If a venting event occurs during transport, there are safety mechanisms in place to limit the impacts. For a cryogenically transported DOT-113C120W tank car that has not arrived within 20 days of shipment, the FRA must be immediately notified.[23] This safety precaution exists in the design of the tank car. DOT-113C120W tank cars are designed to provide 40 days of transportation without venting. A train carrying cryogenic materials such as

[21] Fronczak, Robert E. Robert E. Fronczak to Record Center Pipeline and Hazardous Materials Safety Administration Department of Transportation, 2017. Letter. *Re: Special Permit Application Number 20534-N.* October 13, 2017.
[22] Fronczak, Robert E. Association of American Railroads to Pipeline and Hazardous Materials Safety Administration. Petition for Rulemaking to allow methane, refrigerated liquid to be transported in rail car. P-1697. January 17, 2017.
[23] 49 CFR § 173.319(a)(3).

LNG is unlikely to require 40 days to reach its destination under normal circumstances because of the notification requirement and the likely follow-up. Thus, the ability of the DOT-113C120W to hold LNG without venting for twice the time necessitated by the regulation for notification to FRA affords extra protections against any environmental impacts associated with venting while in transit.

LNG is most commonly transported in the United States on the highway through MC-338 cargo tanks with gross capacities up to 12,700 gallons,[24] subject to applicable restrictions on vehicle weight.[25] If the requested special permit is granted, then LNG may be transported via rail in DOT-113C120W rail tank cars with a gross capacity of 30,680 gallons,[26] around 2-3 times the capacity of the cargo tanks. In the event of an accident or insulation system failure or extended duration in transport, with no puncture of the tank, pressure in the container may rise slowly as the LNG warms due to heat leakage into the container. A spring-loaded and self-resetting PRD may temporarily open and vent some natural gas, which will reduce the pressure back to an acceptable level. The device will then reclose and prohibit the emission of additional natural gas unless experiencing pressure build-up again. The short duration of venting also provides some cooling to the LNG. This cycle will repeat until the container reaches its destination or is otherwise addressed. If a venting event should occur, tank cars would be expected to release more natural gas relative to a cargo tank (due to the higher volume of a tank car). However, a DOT-113C120W tank car has a lower boil-off rate because the surface area is less per unit volume and thus will vent with a lower frequency than an MC-338 cargo tank.

Tank Car and Commodity Comparison

Most commonly DOT-105 and 112 tank cars, but also DOT 109, 114, and 120 tank cars are allowed to transport flammable gases.[27] Rail tank cars are authorized to transport methane in liquefied form in other countries including Canada.[28] In the U.S., DOT-113C120W tank cars are authorized to transport refrigerated ethylene but not LNG for reasons stated in Section 2 of this Assessment. Other similar specification cryogenic tank cars are authorized for transporting hydrogen, nitrogen, oxygen, and argon. DOT-113C120W tanks are designed specifically for cryogenic cargo transportation and are equipped with additional safety features compared to pressurized tank cars. An important safety aspect of cryogenically transported liquids is the regulated maximum filling density for the container. In its petition for rulemaking, the AAR has proposed to add a column for methane (LNG) to the table in 49 C.F.R. §173.319. This change is summarized in Table 2 below.

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[24] Chart ST-16300 LNG Transport Trailer, PN 14722928, 2013.
[25] MC-338 cargo tanks with capacities of up to 16,300 gallons are manufactured in the U.S., however weight restrictions would require that a MC-338 of this size, fully loaded with LNG, would require overweight permits.
[26] Chart SR-603 LNG Tank Car, PN 14722936, 2013.
[27] 49 CFR § 173.319.
[28] Accessed via https://www.tc.gc.ca/media/documents/tdg-eng/tp14877_en.pdf on February 25, 2019.

Table 2. Pressure control valve setting or relied valve setting.[29]

	Maximum permitted filling density (percent by weight)				
Maximum Set-to-Discharge Pressure (psig)	**Ethylene**	**Ethylene**	**Ethylene**	**Hydrogen**	**Methane (LNG)**
17				6.60	
45	52.8				
70					
75		51.1	51.1		32.5
Maximum pressure when offered for transportation	10 psig	20 psig	20 psig		15 psig
Design service temperature	-260 °F	-260 °F	-155 °F	-423 °F	-260 °F
Specifications (see 180.507(b)(3) of this subchapter	113D60W 223C60W	113C120W	113S120W	113A175W 113A60W	113C120W 113C140W

Values for maximum permitted filling density for LNG were extracted from 49 C.F.R. § 173.318(f)(3) and adjusted for a 15% outage for consistency across standards for cryogenic flammable gases currently transported by both motor vehicle and rail in the U.S. The differences between the cryogenic tank cars specified above are due to gross volume and pressure. As shown by Table 2, the temperature of LNG is between the values for ethylene and hydrogen. LNG is also between the maximum set-to discharge pressures and the maximum permitted filling densities compared to ethylene and hydrogen. These parameters make the transport of LNG comparable to other cryogenic flammable liquids transported in DOT-113C120W tank cars. Transport of LNG by DOT-113C120W tank cars will be within current specifications of other cryogenic flammable liquids transported by DOT-113C120W tank cars posing no additional risks associated with the design specifications to accommodate temperature and pressure of LNG.

[29] Fronczak, Robert E. Association of American Railroads to Pipeline and Hazardous Materials Safety Administration. Petition for Rulemaking to allow methane, refrigerated liquid to be transported in rail car. P-1697. January 17, 2017.

Vegetation and Waterways

The behavior of LNG during a loss of containment (LOC) event is typical of any cryogenic liquid. A spill of LNG will vaporize when it contacts ambient air and when in contact with warm solids such as the ground, and leaves behind little to no residue. The cold vapors may condense humid air, causing fog formation and decreased visibility. After vaporization, the cold vapors are denser than ambient air and they will tend to stay close to the ground as they disperse, getting pushed by prevailing winds. The dense vapors can travel significant distances without complete dilution, as the mixing with ambient air is limited near the ground. Due to a large difference in temperature, the rapid transfer of heat from an object into the cryogenic liquid can cause burns if direct contact with skin occurs or if PPE is inadequate to prevent cold-temperature injury due to an exposure.

For small releases, such as a hole in the tank due to a damaged appurtenance or other accident, there will be insignificant difference in the extent of cryogenic damages for either tank cars or cargo tanks. The release will increase in proportion to the hole size in the container, not the volume of container. For catastrophic leaks, the pool size can grow proportionally to the tank volume. If the volume of the cargo tank is 1/3 of the volume of the tank car, for example, the area of the resulting pool spills will be proportional to the volumes. Maximum pool size is dependent upon the rate of release, the ground temperature, the ambient temperature, and the nature of the ground (brush, roadway, drainage ditches, etc.). Negative effects observed in the environment due to pooling of LNG may be expected to be similar to frost damage observed on plants after the first hard freeze of the year, in the area immediately adjacent to the pool.

Other liquefied gases behave similarly to LNG upon accidental discharge into the environment. For example, the U.S. Department of Homeland Security's Chemical Security Analysis Center has conducted experiments to study liquefied chlorine gas releases at the Dugway Proving Ground. Those tests observed that an accidental release of liquefied chlorine gas resulted in a pool of chlorine on the ground. After evaporation of the chlorine pool, there was "no appreciable contamination on or in common urban surfaces."[30] LOC of LNG is expected to have a similar negligible impact on soil or groundwater quality following evaporation. Due to their nature, cryogenic liquefied gas spills have much less impact to the environment compared to other flammable materials such as gasoline or crude oil with respect to leaching into the soil or waterways.

When considering a potential LOC event involving LNG, any LNG released would behave similarly regardless of whether the release event involved LNG from MC-338 cargo tanks or from a DOT-113C120W tank car. DOT-113C120W tank cars have a larger capacity than MC-338 cargo tanks and a unit train will transport multiple DOT-113C120W tank cars.

[30] Whitmire, M. & Schneider, J. *Evaluation of portable x-ray fluorescence for the determination of chlorine in the environment after chlorine releases at jack rabbit II*. US Department of Homeland Security, Chemical Safety Analysis Center. CSAC-16-004. February 2016.

Indirect Effects and Cumulative Impacts

The longevity of locomotives versus motor vehicles plays an impact in the environment due to the lifespan of the equipment associated with each transportation mode. A locomotive has a lifespan of approximately 30 years with freight cars having a lifespan of 50–65 years.[31] Motor vehicles have a lifespan of 2–7 years, and their trailers have around 8 years of life. The lifecycle of multiple vehicles transporting the same amount of LNG would have a larger environmental impact due to the longevity of the different transport methods. PHMSA assumes costs are representative of resources required. Truck rates per ton-mile are approximately four times those of rail[32] and costs paid directly by freight service providers are generally passed on to consumers.[33] The advantage of rail over truck in cost per ton-mile is based on fuel efficiency which is discussed in an earlier section, and lifecycle efficiency which is discussed here.

The frequency of highway cargo tanks transporting LNG will be 2-3 times that of a rail tank car for a given capacity of LNG; thus, the mileage for highway cargo tanks will be considerably higher than that of rail tank cars. The higher number of trips results in a higher baseline representative risk to the public for the highway transport of LNG when compared to rail transport of an equal quantity of LNG along a similar route. In addition to the increased trips resulting in increased risk, motor vehicle transport could increase the congestion on the highway. Conversely, a unit train may have impacts on highway congestion in areas in which the rail tracks cross the highway at grade, therefore halting traffic in certain areas for the duration of the train crossing. Given the baseline case of LNG movement presented here—700 motor vehicles or 2–4 unit trains per day—the impact on traffic for rail transport could be significantly lower on the local, state, and national road systems.

Greenhouse gas (GHG) emissions from diesel engines are directly related to fuel consumption, and as such a shift from highway to rail transportation of freight can decrease the GHG emissions per ton-mile by more than 85%.[34] While trains may not be able to get from door to door, a combined effort is underway by the EPA to increase the use of rail freight transportation to decrease GHG emissions. The EPA SmartWay Transport Partnership encourages intermodal ground freight transportation which combines motor vehicle and rail systems where freight trains will transport the cargo over long distance, high volume rail corridors where motor vehicles will then transport the cargo from the rail terminal to its final destination.

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[31] Accessed via http://railtec.illinois.edu/wp/wp-content/uploads/pdf-archive/9.1.pdf on February 25, 2019.
[32] Office of Transportation Analysis, Bureau of Transportation Statistics, National Transportation Statistics: Average Freight Revenue per Ton-Mile, Table 3-21, accessed via https://www.bts.gov/content/average-freight-revenue-ton-mile.
[33] U.S. Government Accounting Office, GAO-11-134 SURFACE FREIGHT TRANSPORTATION: A Comparison of the Costs of Road, Rail, and Waterways Freight Shipments That are not Passed on to Consumers at p. 13 (Jan. 2011).
[34] Frey, Christopher, and P. Kuo. "Assessment of potential reduction in greenhouse gas (GHG) emissions in freight transportation." *Proceedings, International Emission Inventory Conference, US Environmental Protection Agency, Raleigh, NC*. Vol. 15. 2007.

Transport Partnership encourages shippers to use locomotives for the bulk of their transportation due to the 65% decrease in GHG emission from the combined effort of locomotives and motor vehicles.[35] A comparison between GHG emissions is provided in Table 3. Motor vehicle transportation generates 6.9 times the amount of carbon dioxide compared to the rail transportation mode.

Table 3. GHG Emission Factors for Transportation Modalities (g/TEU-mi).[36]

Mode	**CO_2**
Truck	1001.00
Rail	144.97
Ship	292.83

It is conceivable that granting this special permit application may result in additional business opportunities to be realized because of the efficiencies of transporting LNG by rail and thereby further incentivize domestic production. Such business opportunities could include end-use applications (such as power plants), export facilities, and the associated loading/unloading facilities that would accommodate such developments. The significant increase in the domestic production and export/use of LNG already underway is independent of this special permit application, making it hard to pinpoint that authorizing ETS to utilize DOT-113C120W tank cars as an appropriate packaging to move LNG by rail would be the relevant cause of any continued increase in the production or utilization of natural gas.[37] Similarly, it is too speculative to reach any conclusions about whether approving this special permit would result in the development of new end-use projects, let alone the extent of any such projects' natural gas utilization or any increased production they might entail. As discussed above, ETS plans to transport LNG either by rail or highway. The rail lines on which LNG-carrying DOT-113C120W tank cars would travel have been built already.

Additional possible indirect effects that may occur in connection with the two alternatives discussed in this draft EA are discussed in Table 4, assuming the transportation of the same quantity of LNG under each alternative.

Table 4. Overview of indirect impacts from transport of LNG by rail or truck.

Effect	**Alternative 1: LNG by Motor Vehicle**	**Alternative 2: LNG by Rail**

[35] Accessed via www.epa.gov/smartway on February 20, 2019.
[36] Accessed via https://cms.dot.gov/sites/dot.gov/files/docs/emissions_analysis_of_freight.pdf on February 25, 2019.
[37] Clements, Jude. "U.S. Liquefied Natural Gas Poised For 'Biggest Year Ever.'" Wall Street Journal, November 23, 2018.

Methane Production	Viable delivery options facilitates marketing and incentivizes production	Less costly/more efficient rail facilitates marketing and further incentivizes production
Manufacture	Fabrication by existing manufacturing plants of new MC-338s (3x more needed than DOT-113s); operational impacts of existing plants would be regulated by permits or existing laws	Fabrication by existing manufacturing plants of new DOT-113s; operational impacts of existing plants would be regulated by permits or existing laws
Quantity of tanks	2-3x more cargo tanks to transport LNG	Fewer tanks to transport LNG
Wear of highway	Increased wear on highway and roads (cost to taxpayers)	n/a
Wear of rails	n/a	Increased wear on rails (cost to railroads)
Congestion	Increased road congestion due to increased quantity of vehicle	Possible increased road congestion at railroad crossings with grade crossings
Noise/Vibration	Increased noise and vibration along route	Increased noise and vibration along rail right of way with increased rail traffic
Construction of road/rail	Construction of new access roads or reconstruction of existing roads to tolerate increased loads/traffic	Construction of new spur lines to facilities (impacts to be addressed by existing regulatory approval requirements)

Although indirect effects and cumulative impacts associated with the approval of this special permit may present themselves (e.g., construction of ancillary loading and unloading equipment), these activities are generally driven by numerous market forces and regulated by local/state/federal entities which may require environmental assessments and permitting. It is hard to identify any reasonably foreseeable future actions that might result in cumulative impacts from the issuance of the special permit because this special permit would allow ETS to add a new use to an existing set of infrastructure (rail lines). Minor modifications to existing or new infrastructure may be required to accommodate new rail loading or receiving facilities. The special permit would only approve an additional packaging for the transport of LNG, thereby providing an additional option of transport.

6 PHMSA's Response to Public Comments

On June 6, 2019, the PHMSA published a Notice of Draft Environmental Assessment for a Special Permit Request for Liquefied Natural Gas by Rail (PHMSA-2019-0100-0002) in the Federal Register. PHMSA solicited comment on the draft EA for a request for special permit from ETS. The notice specifically requested comment on potential safety, environmental, and any additional impacts that should be considered as part of the special permit evaluation process. PHMSA also included the draft special permit in the docket for this notice as further reference material.

The notice was published with an initial 30-day comment period, which was extended an additional 30 days per request from stakeholders. The comment period closed on August 7, 2019. PHMSA has considered the comments received in development of a U.S. Department of Transportation Special Permit (DOT-SP) that authorizes the transportation in commerce of methane, refrigerated liquid (commonly known as liquefied natural gas or LNG) in DOT specification 113C120W (DOT 113C120W) tank cars.

PHMSA received approximately 2,985 comments to the Draft Environmental Assessment for a Special Permit Request for Liquefied Natural Gas by Rail. Of the comments received, 18 show conditional support. The remaining comments opposed the issuance of the special permit. PHMSA received 10 form letters which include 2,545 individual comments. One form letter is signed by 24,433 individuals expressing the same position in opposition to the proposed special permit. PHMSA also received approximately 45 comments that were outside the scope of the special permit application, including comments expressing opposition to fracking, environmental damage, or other concerns not specifically relevant to this special permit. These comments did not express any direct concern for LNG being transported by rail tank car. PHMSA received comments and questions about the Proposed Action Alternative and the No Action Alternative. Commenters also questioned PHMSA's description of potential impacts associated with the selection of either alternative.

PHMSA has reviewed and organized the comments into six categories: (1) route selection, (2) suitability of the package (DOT-113C120W) for the transportation of LNG, (3) train length and weight, (4) general risks of transporting LNG, (5) emergency response training, (6) the alternatives analysis, and (7) environmental impacts.

- **Route Selection**

Approximately 66 commenters, including Sierra Club, Center for Biological Diversity, and Columbia Riverkeeper, disagreed with the lack of routing restrictions in the draft special permit. These commenters and others expressed concern that the LNG tank cars could pose risks to commuter trains, sensitive areas, including homes, schools, businesses, small towns, large cities, fire prone forests, protected waterways, wetlands, and a wide range of critical energy and transportation infrastructure resources. Given that the special permit applicant only needs to transport LNG between Wyalusing, Pennsylvania and Gibbstown, New Jersey, PHMSA has limited the scope of the special permit to only allow transportation of LNG in DOT-113C120W tank cars to and from these two locations. PHMSA is considering allowing the transportation of LNG more broadly in a separate rulemaking. However, there was no rationale to broaden the scope of the special permit when the applicant's proposal only involved the above-described locations. The origin and destination limitations are not the result of current safety concerns about the risks LNG tank cars could pose outside of the listed origin and destination.

- **Suitability of the package (DOT-113C120W) for the transportation of LNG**

Approximately 75 commenters expressed concerns about the suitability of the DOT-113C120W to transport LNG. However, as described extensively above, the DOT-113 tank cars are specifically designed to contain flammable cryogenic liquids and transport demands for LNG have historically been via vessel for import quantities and cargo tank or portable tank for bulk quantities by truck and rail, respectively. This limitation has not created a major impediment in the transportation of natural gas. While LNG has not previously been transported in DOT-113C120W tank cars, similar cryogenic flammable gases, including ethylene and hydrogen, have been authorized for decades. It appears that other cryogenic materials were first authorized for transportation in DOT-113C120W tank cars through the use of "exemptions," now referred to as special permits.[38] PHMSA is not aware of any instance in DOT's historical record wherein DOT stated that LNG in not a suitable material for transportation via DOT-113C120W.

DOT-113C120W tanks cars, including those authorized to transport LNG in this special permit, are subject to existing safety regulations for rail tank cars. For example, 49 C.F.R. § 173.319 requires testing of relief valves every five years, annual replacement of rupture discs, thermal integrity tests following an average daily pressure rise during any shipment exceeding 3 psig per day, and many other requirements specific to liquids in cryogenic tank cars. In addition, 49 C.F.R. Part 179, Subpart F "Specification for Cryogenic Liquid Tank Car Tanks and Seamless Steel Tanks (Classes DOT-113 and 107a)" applies to the tank cars authorized under this special permit. This subpart contains detailed design, construction, and operational requirements for DOT-113C120W tank cars. The HMR also requires pressure relief devices set to discharge at a minimum of 75 pounds per square in gauge (psig) and sets a design service pressure of -162° C (-260 °F) for the DOT-113C120W tank car.

In addition to the above-described existing safety measures within the HMR, PHMSA added additional operational controls to the DOT-113C120W tanks cars authorized under this special permit. These Safety Control Measures require that ETS utilize a maximum permitted filling density (percent by weight) of 32.5%, a maximum pressure when offered for transportation not to exceed 15 psig, and remote sensing for detecting and reporting internal pressure, location, and leakage. Although the draft special permit specifically incorporated OT-55 into the special permit, PHMSA has removed this incorporation in the final special permit because AAR frequently updates OT-55, and PHMSA would be required to update the special permit with each new version of OT-55 to keep the incorporation up to date. Regardless of permit conditions, the current version of OT-55 will continue to apply to ETS and the rail carrier due to contractual and membership obligations.

- **Train length and weight**

[38] 48 FR 27674-01 (June 16, 1983).

Some commenters proposed limiting the number of LNG tank cars in a train. Others expressed concern that these heavier tank cars could damage and degrade train tracks, leading to future derailments. Most commenters showed a general concern about the proposed length of 100 tank cars, as referenced in the special permit application. PHMSA received the following recommendations for limitation on the number of tank cars: 50, 35, and 6 tank cars. One commenter provided a suggestion of 5,200 feet, stating that the trains could be parked between most heavily traveled highway-rail grade crossings. Commenters stated that longer and heavier trains: increase braking time and distance; increase likelihood of air brake problems, especially in cold weather; increase overall likelihood and severity of derailments; increase slack action, which increases run-ins, run-outs, and break-in-twos; and are more difficult for the train crew to safely run, inspect, work, and test. Some commenters also advocated the benefits of electronically controlled pneumatic (ECP) brakes in providing an improved stopping ability and more reliable brake lines.

In response to comments about train handling for longer trains, FRA has informed PHMSA that the challenges of operating a longer train are essentially the same as those for operating a shorter one. Those challenges include (1) management of in-train forces, (2) proper train make up, (3) communications between the lead locomotive and the distributed power locomotives and/or end-of-train devices, and (4) proper training for train crews, including locomotive engineers and conductors. Current regulations require locomotive engineers to be trained and demonstrate proficiency is the most demanding type of service they may be permitted to perform, which includes operating longer trains. Additionally, any train, regardless of length, must meet all applicable Federal regulations, including the applicable air brake standards. In response to commenters' concerns, the special permit requires that ETS submit a plan that provides per shipment quantities, timelines, and safety actions to be taken for moving from single car shipments to multi-car shipments, and subsequently to unit trains (20 or more tank cars). PHMSA expects that this plan would consider populated areas and other factors in addressing route options along the rail corridor between Wyalusing, PA and Gibbstown, NJ. Furthermore, in addition to the speed restrictions that comport with the OT-55 industry standard, the special permit improves braking functions by requiring that all trains are equipped and operated with a two-way end-of-train device or distributed power braking system. However, at this time, PHMSA is not adopting a limitation in the special permit for train length. Also, while the special permit includes a provision to improve stopping time, PHMSA is not adopting requirements for trains operating under the special permit to be equipped with ECP brakes. For a train to operate in ECP brake mode,[39] the entire train consist essentially must be equipped with ECP brakes.[40] Railroads in the United States have very few ECP-quipped locomotives or railcars. As a result, the use of ECP brakes in the United States is confined to a handful of unit train operations. PHMSA expects that initially the grantee will transport LNG in manifest trains, meaning that it will be transported along with additional commodities in a single train. As a result, requiring the use of ECP brakes would render the special permit non-actionable until the grantee has enough DOT-113 tank cars in LNG service to operate using unit trains. Additionally, it is worth noting that the Department published a final rule in September 2018 that removed requirements pertaining to ECP brake systems on High-Hazard Flammable Trains (HHFUTs). The withdrawal was based on the

[39] 49 CFR 232.5.
[40] 49 CFR 232.609.

Department's determination "that the expected benefits, including safety benefits, of implementing ECP brake system requirements do not exceed the associated costs of equipping tank cars with ECP brake systems, and therefore are not economically justified."[41] In response to the concerns regarding weight and possible damage to the rail line over time, PHMSA notes that the weight of the tank cars bears no additional stress to the railroads. The gross rail weight is limited to 286,000 pounds, which is the same weight limit applied to other DOT specification tank cars loaded with other hazardous material types (e.g., a DOT-117 tank car containing crude oil).

- **General risks of transportation of LNG**

Some commenters maintained that PHMSA did not fully recognize or convey the risks involved in the transportation of LNG. The commenters cited various release incidents in American history and two in Spain. First, commenters cited the dangers posed by LNG vapor clouds and described a 1944 incident in Cleveland, Ohio. The failure of an LNG storage tank caused LNG vapors to enter the city's sewage system, and the ignition of the vapors caused the death of 128 people. This incident resulted from embrittlement of the inner metal tank because it was unsuitable for cryogenic temperatures. As described above, DOT-113 tank cars are designed to withstand cryogenic temperatures and have been in service for many decades without failure due to cryogenic temperatures. Commenters also described an incident at the Plymouth LNG facility in Washington in 2014. This incident resulted from the failure to properly purge flammable vapors from piping during maintenance activities. The incident caused five injuries and an evacuation of surrounding neighborhoods. This incident did not involve the transportation of LNG via highway or rail and was caused by human error. Finally, commenters described two incidents in Spain involving the failure and BLEVE of LNG road tankers. The Spanish tanks involved were designed with a single metal inner tank, surrounded by foam insulation and a thin aluminum shell — essentially a single wall containment vessel.[42] By comparison, the DOT-113C120W tank car relative to the Spanish road tankers is more robust, and significantly less likely to suffer a BLEVE. While PHMSA fully recognizes that the transportation of LNG involves risk, PHMSA concludes that transportation of LNG by rail in DOT-113C120W tank cars involves less overall environmental impact and risk to human safety than carriage by MC-338 cargo tank motor vehicles on highways.

- **Emergency response preparedness related to a loss of LNG containment**

Other commenters discussed concerns about the preparedness of local first responders to respond to an LNG incident along rail tracks. Given these concerns, PHMSA met with the Federal Emergency Management Agency (FEMA) and the National Fire Academy (NFA) on October 14, 2019 with the purpose of seeking input about concerns and preparedness for LNG incident response in the mid-Atlantic region, specifically in Pennsylvania and New Jersey.[43] Members of

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[41] 83 FR 48393, 48395

[42] Planas E, E Pastor, J Casal, JM 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, January 2015.

[43] A summary report of the meeting appears on the docket for this action. "PHMSA/NFA Town Hall Meeting Report, Emergency Preparedness Issues Related to Proposed LNG Transportation by Rail."

the first responder community in attendance did not express opposition to the transportation of LNG by rail. However, meeting attendees recognized that increased methane production requires increased preparedness to respond to the transportation of LNG by various modes of transportation, including rail. Attendees noted that emergency response risks associated with the transportation of LNG are arguably less than those associated with Class 2.1 flammable liquefied gases (e.g. Liquefied petroleum gas (LPG)) and Class 2.3 toxic inhalation hazard (TIH) materials.

As a result of the information obtained at the meeting and in response to public comments, PHMSA included a provision in the special permit requiring that ETS provide training conforming to NFPA-472 to emergency response agencies that could be affected between the authorized origin and destination. NFPA-472 training includes known hazards in emergencies involving the release of LNG and emergency response methods to address an incident involving a train transporting LNG.

- **Alternatives Analysis**

Various commenters questioned PHMSA's description of the No Action Alternative. Some commenters stated that the No Action Alternative should describe the current levels of LNG transportation, not an equivalent amount of LNG moving via truck. It is important to reiterate that PHMSA does not require a special permit to transport LNG via highway in the DOT specification MC-338 motor vehicle cargo tanks. Under the HMR, highway transportation of LNG is authorized in MC-338 cargo tank motor vehicles. The HMR does not restrict the number of MC-338 cargo tank motor vehicles loaded with LNG in highway transportation. PHMSA has no basis to prevent such transportation. ETS's actions and statements make it clear it intends to transport LNG for export via available highway routes between Wyalusing, Pennsylvania and Gibbstown, New Jersey. PHMSA is not in a position and lacks authority to second guess financial decisions of the applicant. PHMSA believes that issuance of the special permit will provide safety and environmental benefits over the movement of three times the number trucks, in comparison with the number of railcars, transporting LNG via highway.

Other commenters stated that the use of UN ISO portable tanks and/or the construction of a new interstate pipeline should have been included as an alternative in the EA. According to the applicant, using ISO portable tanks to transport LNG for this project is economically undesirable due to the added infrastructure and operational costs associated with intermodal handling of the containers. According to ETS, the use of ISO portable tanks would require additional facilities for handling the ISO portable tanks on truck chassis and during loading and unloading at intermodal yards. The applicant has informed PHMSA that it would not pursue this option due to cost. Approximately three to four times the number of ISO portable tanks would be required to ship the equivalent volume of LNG in the DOT-113C120W tank cars requested by this permit. Although ETS has the option to seek approval from FRA to use ISO portable tanks for transportation of LNG between Wyalusing, Pennsylvania and Gibbstown, New Jersey, ETS has indicated it does not currently intend to do so because it would utilize DOT specification MC-338 cargo tank motor vehicles if PHMSA denied the special permit application. Therefore, this alternative was eliminated from full discussion.

Similarly, some commenters expressed that pipeline transportation of natural gas by pipeline is preferable to transportation by rail. However, PHMSA has no ability to require that the applicant transport natural gas via pipeline. According to the applicant, the more cost-effective option of pipeline transportation is not possible because pipeline capacity is not available between Wyalusing, Pennsylvania and Gibbstown, New Jersey. Furthermore, pipeline construction takes years to achieve due to potential opposition, planning, permitting and construction, which would delay or prevent the applicant from reaching potential customers. PHMSA has authority to consider the special permit application before it, but it lacks authority to require that a private applicant construct an interstate pipeline to facilitate natural gas transportation.

- **Environmental Impacts**

Many commenters expressed opposition to the special permit because they argued that it would facilitate and encourage the production of natural gas, which is a fossil fuel and a contributor to global climate change. Given that the United States is now the world's top producer of natural gas, and that the world's consumption of natural gas is increasing, it is difficult to point to any one factor causing the production of natural gas in one area over another. Nonetheless, increased use of natural gas is replacing more polluting, carbon-intensive fuels. The applicant has informed PHMSA that the natural gas may be utilized in Caribbean nations, wherein it would replace and reduce the burning of diesel, which is a more polluting fuel. Also, the movement of the natural gas in its cryogenic form by rail is very energy efficient and will significantly decrease the pollution and carbon emissions in comparison to highway transportation. Other commenters pointed out that natural gas/methane is a particularly harmful greenhouse gas when released before burning. However, the design of the DOT-113C120W, in particular the insulated annular space holding a vacuum, will prevent methane seepage during transportation, which is common in other forms of natural gas transportation. The capacity of the DOT-113C120W allows one-third the number of rail tank cars to be constructed in comparison to motor carrier tank cars that would otherwise travel over the highway. Rail cars remain in service for approximately 50 years, whereas the MC-338 motor vehicles remain in service for approximately 8 years or less. The rail car's long service life means that less materials and energy will be spent manufacturing replacements. Finally, the transportation of LNG by rail utilizes existing rail rights of way for transportation, and thus avoids construction of new pipelines, which can have impacts to water resources and habitats.

7 Agencies and Persons Consulted

FRA

PHMSA

Applicant-Energy Transport Solutions, LLC

Chris Guinta, Exponent

Delmar Morrison III, Ph.D., P.E., CPSP, Exponent

8 Conclusions

PHMSA is granting ETS' special permit application requesting PHMSA to authorize ETS's use of DOT-113C120W tank cars as a packaging for the transportation of LNG by rail, subject to the constraints discussed in this final EA. This EA was prepared to analyze the impacts to the environment of using DOT-113C120W tank cars as an appropriate packaging for transporting LNG by rail. PHMSA concludes that transportation of LNG by a DOT-113C120W tank car, as an alternative to the transport of LNG in MC-338 cargo tanks on the road, would provide a more cost-efficient mode of transport and reduce the environmental impacts of transporting LNG. Moreover, the existing regulatory requirements that govern the movement of cryogenic flammable materials similar to LNG are expected to provide adequate safety measures for LNG shipped in DOT-113C120W tank cars.

This analysis did not identify any significant environmental impacts resulting from the issuance of this special permit. The LNG-carrying DOT-113C120W tank cars would travel on existing main rail lines. The special permit authorizes the transport of an additional flammable, cryogenic material by rail using the same tank car and operating restrictions, albeit in likely greater quantities, and is not expected to introduce unacceptable risk to the public, particularly given the risks posed by the highway alternative. Furthermore, issuance of a special permit is expected to decrease the safety and environmental risks in comparison to the No Action Alternative associated with transporting the LNG that will be offered for transportation between Wyalusing, Pennsylvania and Gibbstown, New Jersey. Similarly, less wear-and-tear on public roadways would be expected. While it would be difficult to attribute any future LNG infrastructure construction (e.g., ancillary loading and unloading equipment) to PHMSA's issuance of this special permit, any such construction that may arise would be subject to relevant existing regulations at the local, state and federal levels to address potential impacts.

9 Finding of No Significant Impact (FONSI)

PHMSA incorporates the analysis and findings of the FEA into this FONSI. PHMSA finds that the issuance of the special permit or the Selected Action Alternative will not result in significant impacts to the human environment. No significant impacts were identified that require analysis in an environmental impact statement, as described in Section 5. While the Selected Alternative has some risk to public safety, similar to ongoing transportation of hazardous materials, the risk is considered very low and is minimized by implementing the safety control measures set forth in the special permit. Consistent with 49 C.F.R. § 107.105(d), PHMSA finds that the Selected Action achieves a level of safety at least equal to that required by regulation.