Draft Regulatory Impact Analysis

[Docket No. PHMSA-2012-0082] (HM-251)

Hazardous Materials: Enhanced Tank Car Standards and Operational Controls for High-Hazard Flammable Trains; Notice of Proposed Rulemaking

Prepared by
Department of Transportation
Pipeline and Hazardous Materials Safety Administration

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Executive Summary

The United States has experienced a dramatic growth in the quantity of flammable liquids being shipped by rail in recent years. According to the rail industry, in the U.S. in 2009, there were 10,800 carloads of crude oil shipped by rail. In 2013, there were 400,000 carloads. In the Bakken region, over one million barrels a day of crude oil was produced in March 2014,[1] most of which is transported by rail.

Transportation of flammable liquids poses safety and environmental risks. The risk of flammability is compounded in the context of rail transportation because petroleum crude oil and ethanol are commonly shipped in large unit trains.

In recent years, train accidents/incidents (train accidents) involving a flammable liquid release and resulting fire with severe consequences have occurred with increasing frequency (i.e. Arcadia, OH, Plevna, MT, Casselton, ND, Aliceville, AL, Lac-Mégantic, Quebec).

The Pipeline and Hazardous Materials Safety Administration (PHMSA) and the Federal Railroad Administration (FRA) are proposing a Notice of Proposed Rulemaking (NPRM), titled "*Hazardous Materials: Enhanced Tank Car Standards and Operational Controls for HHFTs*," in order to increase the safety of crude and ethanol shipments by rail. We are proposing revisions to the Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180) to establish requirements specific to high-hazard flammable trains (HHFTs), which would be defined as trains comprised of 20 rail car loads of a Class 3 flammable liquid. As described in greater detail throughout this document, the proposed rule is a system-wide, comprehensive approach consistent with the risks posed by high hazard flammable liquids transported by rail. Specifically, requirements address:

(1) rail routing restrictions;
(2) tank car integrity;
(3) speed restrictions
(4) braking systems;
(5) proper classification and characterization of mined liquid and gas; and
(6) notification to State Emergency Response Commissions (SERCs).

[1] Information regarding oil and gas production is available at the following URL: http://www.eia.gov/petroleum/drilling/#tabs-summary-2

Table ES1 summarizes major provisions of the proposal, and identifies those affected.

Table ES1. Proposed Requirements

Proposed Requirement	Affected Entity
Better classification and characterization of mined gases and liquids. • Written sampling and testing program for all mined gases and liquids, such as crude oil, to address: (1) frequency of sampling and testing; (2) sampling at various points along the supply chain; (3) sampling methods that ensure a representative sample of the entire mixture; (4) testing methods to enable complete analysis, classification, and characterization of material; (5) statistical justification for sample frequencies; and, (6) duplicate samples for quality assurance. • Require offerer to certify that program is in place, document the testing and sampling program, and make program information available to DOT personnel, upon request.	Offerors / Shippers of all mined gases and liquids
Rail routing risk assessment. • Requires carriers to perform a routing analysis that considers 27 safety and security factors. The carrier must select a route based on findings of the route analysis. These planning requirements prescribed § 172.820 and would be expanded to apply to HHFTs. Notification to SERCs. • Require trains containing one million gallons of Bakken crude oil to notify State Emergency Response Commissions (SERCs) or other appropriate state delegated entity about the operation of these trains through their States. Reduced operating speeds. • PHMSA is requesting comment on three speed restriction options for HHFTs: (1) a 40-mph maximum speed restriction in all areas; (2) a 40-mph speed restriction in areas with a 100K+ population; and (3) a 40-mph speed restriction in high threat urban areas[2]. • If tank cars in the HHFT meet specifications finalized in the enhanced tank car section of this rule, speed would be limited to 50-mph in all areas (rather than 40-mph). • PHMSA will also evaluate a 30-mph speed restriction for HHFTs that do not comply with enhanced braking requirements. Enhanced braking. • Require all HHFTs be equipped with alternative brake signal propagation systems. Depending on the outcome of the tank car standard proposal and implementation timing, all HHFTs would be operated with either electronic controlled pneumatic brakes (ECP), a two-way end of train device (EOT), or distributed power (DP).	Rail Carriers, Emergency Responders
Enhanced standards for both new and existing tank cars. • Require new tank cars constructed after October 1, 2015 (and are used to transport flammable liquids as part of a HHFT) to meet criteria for a selected option, including specific design requirements or performance criteria (e.g., thermal, top fittings, and bottom outlet protection; tank head and shell puncture resistance) is selected in the final rule. PHMSA is requesting comment on the following three	Tank Car Manufacturers, Tank Car Owners, Shippers and Rail Carriers

[2] As defined in 49 CFR 1580.3 – High Threat Urban Area (HTUA) means an area comprising one or more cities and surrounding areas including a 10-mile buffer zone, as listed in appendix A to Part 1580 of the 49 CFR.

options: o FRA and PHMSA Designed Car, or equivalent o AAR 2014 Tank Car o Jacketed CPC-1232[3], or equivalent • Require existing tank cars that are used to transport flammable liquids as part of a HHFT, to be retrofitted to meet the selected option for performance requirements. Those not retrofitted would be retired, repurposed, or operated under speed restrictions for up to five years, based on packing group assignment of the lading.	

Table ES2 presents the costs and benefits of the individual provisions of the proposed rule. PHMSA is proposing three different options for tank car standards, and three different options for speed restrictions. Table ES3 presents the costs and benefits of the various combinations of proposed tank car and speed restriction provisions.

Please note that because there is overlap in the risk reduction achieved between some of the proposed requirements listed in the Table ES2, below. The total benefits and costs of the provisions cannot be accurately calculated by summing the benefits and costs of each proposed provision. Table ES3, on the other hand, presents total benefits and costs of the combinations of speed restriction and tank car proposals. Explanation of the comprehensive benefits and costs of each combination of proposals is included at the end of the RIA.

Please also note that, given the uncertainty associated with the risks of crude oil and ethanol shipments in the table below Table ES2 contains a range of benefits estimates. The low end of the range of estimated benefits estimates risk from 2015 to 2034 based on the U.S. safety record for crude oil and ethanol from 2006 to 2014, adjusting for the projected increase in crude oil and ethanol shipment volume over the next 20 years. Absent this proposed rule, we predict about 15 mainline derailments for 2015, falling to a prediction of about 5 mainline derailments by 2034.

The high end of the range of estimated benefits includes the same estimate of 5 to 15 annual mainline derailments predicted based on the U.S. safety record, plus an estimate that the U.S. would experience the equivalent of 10 additional safety events of higher consequence—nine of which would have environmental damages and monetized injury and fatality costs exceeding $1.15 billion and one of which would have environmental damages and monetized injury and fatality costs exceeding $5.75 billion—over the next 20 years. This outcome could result from a smaller number of more severe events, or more numerous events that are less severe.

[3] Throughout this documents, the CPC 1232 refers to the “enhanced CPC 1232” tank car option described in the NPRM; these tank cars include an improved pressure relief valve and a removable bottom outlet valve handle.

Table ES2. 20 Year Costs and Benefits by Stand-Alone Proposed Regulatory Amendments 2015-2034[4] Provision			
Affected Section[5]	**Provision**	**Benefits (7%)**	**Costs (7%)**
49 CFR 172.820	**Rail Routing+**	Cost effective if routing were to reduce risk of an incident by 0.17%	$4.5 million
49 CFR 173.41	**Classification of Mined Gas and Liquid**	Cost effective if this requirement reduces risk by 0.61%	$16.2 million
49 CFR 174.310	**Notification to SERCs**	Qualitative	$0
	Speed Restriction: Option 1: 40 mph speed limit all areas*	$199 million – $636 million	$2,680 million
	Speed Restriction: Option 2: 40 mph 100k people*	$33.6 million – $108 million	$240 million
	Speed Restriction: Option 3: 40 mph in HTUAs*	$6.8 million- $21.8 million	$22.9 million
	Braking: Electronic Pneumatic Control with DP or EOT#[6]	$737 million – $1,759 million	$500 million
49 CFR Part 179	**Option 1: PHMSA and FRA designed car[7]**	$822 million - $3,256 million	$3,030
	Option 2: AAR 2014 Tank Car	$610 million – $2,426 million	$2,571
	Option 3: Jacketed CPC-1232 (new const.)	$393 million – $1,570 million	$2,040 million

Note: "+" indicates voluntary actions that will be taken by shippers and railroads

[4] All costs and benefits are in millions over 20 years, and are discounted to present value using a 7 percent rate.

[5] All affected sections of the Code of Federal Regulations (CFR) are in Title 49.

[6] All Costs (equipping tank cars, equipping locomotives and training) and benefits (safety and business benefits) of ECP braking are included here. Adding the costs and benefits of ECP braking and the PHMSA/FRA designed car will result in some double counting.

[7] Costs and benefits associated with equipping cars with ECP braking assigned to the PHMSA-FRA designed car only. PHMSA allocated 80% of the safety benefits of ECP braking to the PHMSA/FRA designed car because that was the portion of ECP costs from equipping tank cars. Adding the costs and benefits of ECP braking and the PHMSA-FRA designed car will result in some double counting.

"*" indicates voluntary partial compliance when transporting large volumes of crude oil in high-threat urban areas (HTUA)
"#" PHMSA does not propose to require additional top fittings protection for retrofits, because the costs are not supported by corresponding benefits. Newly constructed cars, however, are required to have additional top fittings protection. Except for additional top fittings protection, the requirements for newly constructed tank cars and retrofits are the same.

Table ES3: 20 Year Costs and Benefits of Combinations of Proposed Regulatory Amendments 2015-2034[8]

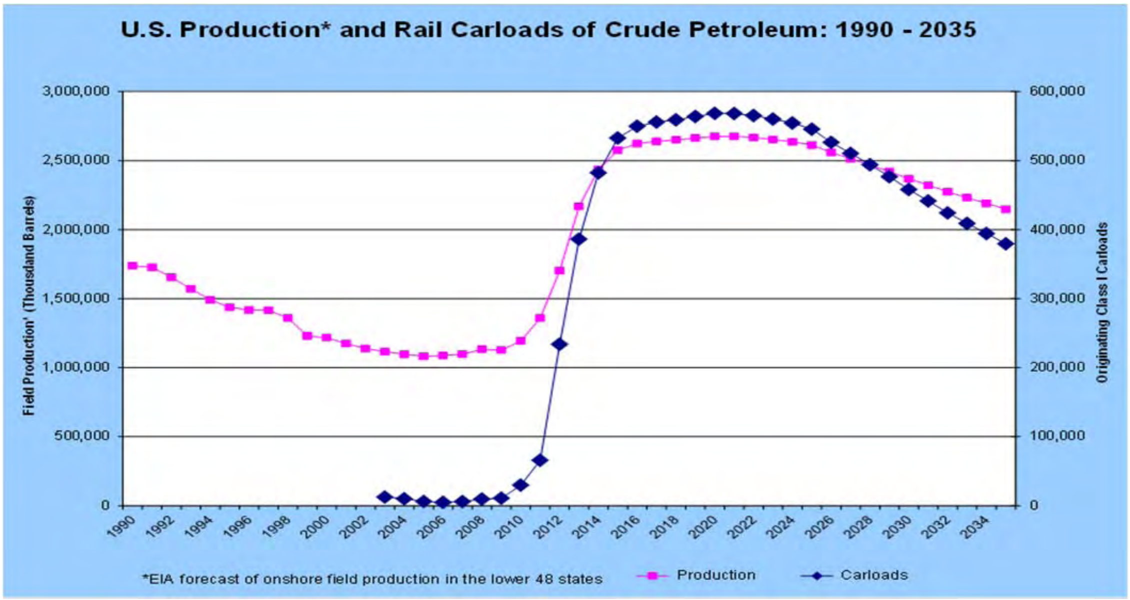
Benefits and Costs of Proposal Combinations		
Proposal	**Benefit Range**	**Cost**
PHMSA and FRA Design Standard + 40 MPH System Wide, 7% Discount Rate	**$1,436 - $4,386**	**$5,820**
PHMSA and FRA Design Standard + 40 MPH in 100K, 7% Discount Rate	**$1,292 - $3,836**	**$3,380**
PHMSA and FRA Design Standard + 40 MPH in HTUA, 7% Discount Rate	**$1,269 - $3,747**	**$3,163**
AAR 2014 Standard + 40 MPH System Wide, 7% Discount Rate	**$794 - $3,034**	**$5,272**
AAR 2014 Standard + 40 MPH in 100K, 7% Discount Rate	**$641 - $2,449**	**$2,831**
AAR 2014 Standard + 40 MPH in HTUA, 7% Discount Rate	**$616 - $2,354**	**$2,614**
CPC 1232 Standard + 40 MPH System Wide, 7% Discount Rate	**$584 - $2,232**	**$4,741**
CPC 1232 Standard + 40 MPH in 100K, 7% Discount Rate	**$426 - $1,626**	**$2,300**
CPC 1232 Standard + 40 MPH in HTUA, 7% Discount Rate	**$400 - $1,527**	**$2,083**

Crude Oil Transport by Rail

[8] All costs and benefits are in millions over 20 years, and are discounted to present value using a 7 percent rate.

Figure ES4 below shows the recent strong growth in crude oil production in the U.S., as well as growth in the number of rail carloads shipped. Figure ES4 also shows forecasted domestic crude oil production from the Energy Information Administration (EIA) and PHMSA's projected strong demand for the rail shipment of crude oil.

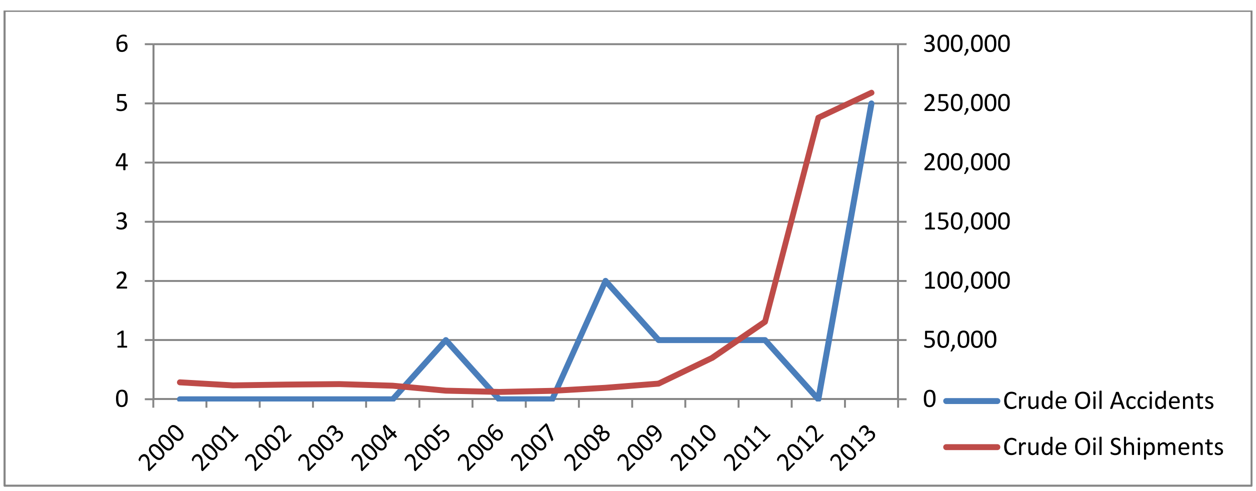
Figure ES4. Historic and Projected U.S. Production and Rail Carloads of Crude Petroleum 1990-2035



Source: 2014 EIA forecast

A rise in mainline derailments involving crude oil has also risen along with the increase in crude oil production and rail shipments of crude oil. Figure ES5 below shows this rise.

Figure ES5. Carloads of Crude Oil Shipped and Rail Accidents (Derailments) 2000-2013



Source: STB Waybill Sample and PHMSA Incident Report Database

Based on these train accidents, the projected continued growth of domestic crude oil production, and the growing number of train accidents involving crude oil, PHMSA concludes that the potential for a train accident involving crude oil has increased, which has raised the likelihood of a catastrophic train accident that would cause substantial damage to life, property, and the environment.

Additional factors give rise to increased risks, and thus the increased probability of a catastrophic event occurring. First, the risk of flammability is compounded, because of the practice of shipping very large quantities of oil in one train, as shown by the increased use of HHFTs. In 2008 there were less than 10,000 rail carloads of crude oil. By 2013 the number of rail carloads of increased to over 400,000.[9] Second, unlike other Class 3 manufactured goods, organic materials from oil and gas production represent a unique challenge in regards to classification. Differences in the chemical makeup of the raw material can vary across wells and over time. Unprocessed crude oil may present unique hazards such as corrosivity, sulfur content and dissolved gas content, thereby affecting the integrity of the tank car.

PHMSA's analysis of this combination of factors suggests an increase in the risk of rail related accidents and an increase in the likelihood of a catastrophic event.

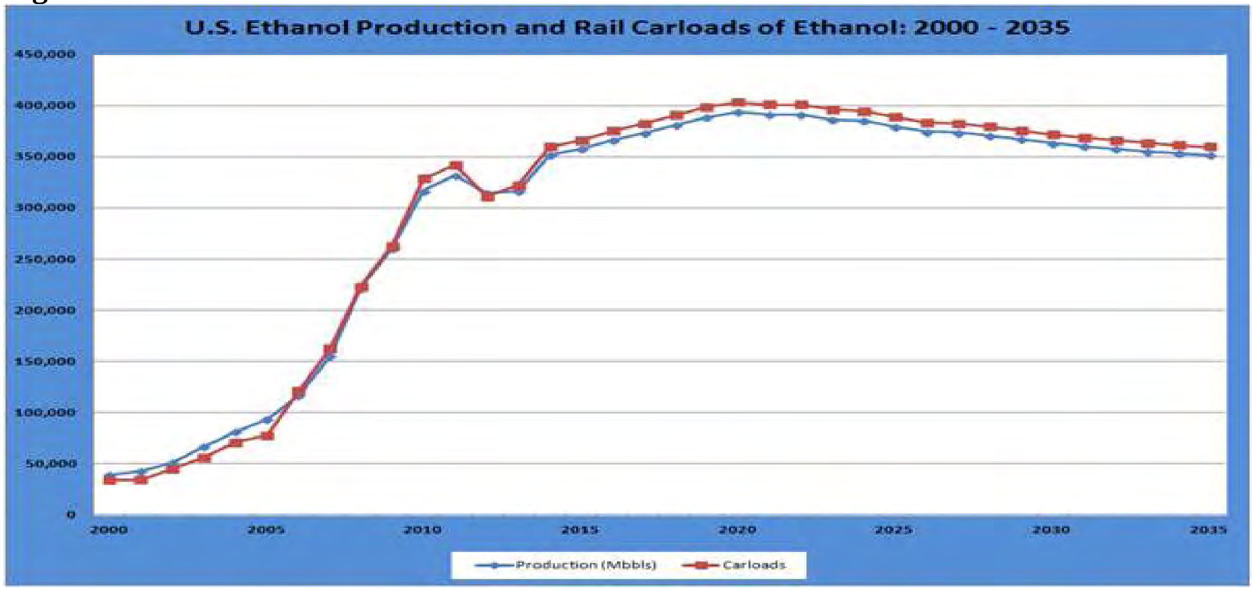
Ethanol

U.S. ethanol production has increased considerably during the last 10 years and has generated similar growth in the transportation of ethanol by rail, according to a recent white paper by the Association of American Railroads (AAR).[10] As shown in the figure ES6 EIA projects strong demand for ethanol in the future.

[9] http://www.stb.dot.gov/stb/industry/econ_waybill.html

[10] Association of American Railroads. 2013. Railroads and Ethanol. Available online at https://www.aar.org/keyissues/Documents/Background-Papers/Railroads%20and%20Ethanol.pdf

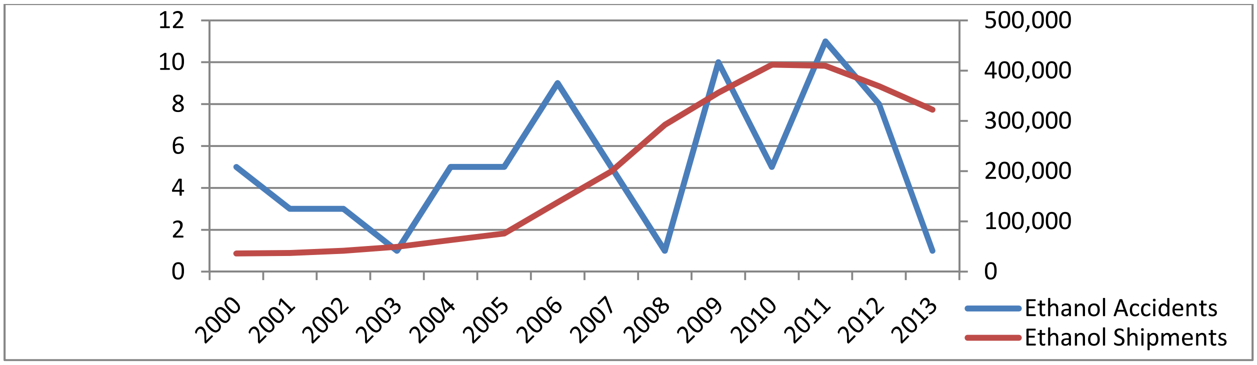
Figure ES6. Historic and Forecasted U.S. Ethanol Production and Rail Carloads 2000-2035



Source: 2014 EIA forecast

In 2008 there were around 292,000 rail carloads of ethanol. In 2011, that number increased over 40 percent to 409,000.[11] Not surprisingly, this growth in rail traffic has been accompanied by an increase in the number of rail accidents involving ethanol. Figure ES7 below plots the total number of rail accidents involving ethanol during the last 13 years compared to the total carloads of ethanol. The left axis shows the total number of rail derailments and the right axis shows total carloads shipped.

Figure ES7. Carloads of Ethanol Shipped and Rail Accidents (Derailments) 2000-2013



Source: STB Waybill Sample and PHMSA Incident Report Database

Summary of Regulatory Changes

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[11] http://www.stb.dot.gov/stb/industry/econ_waybill.html

As described in greater detail throughout this document, the proposed rule is a system-wide, comprehensive approach consistent with the risks posed by HHFTs by rail. Requirements address:

- Rail Routing;
- Tank Cars;
- Braking;
- Speed Restrictions;
- Classification of Mined Gases and Liquids; and
- Notification to SERCs.

This approach is designed to mitigate damages of rail accidents involving flammable liquids, though some provisions could also prevent accidents.

This Preliminary Regulatory Impact Analysis (RIA) discusses, consistent with the NPRM, six requirement areas. Although we analyze the effects of individual requirements separately, the preferred alternative proposed in this rulemaking is a system-wide approach covering all requirement areas consistent with the NPRM.

The analysis shows that expected damages based on the historical safety record could be $4.5 billion and damages from higher-consequence events could reach $14 billion over a 20-year period in the absence of the rule.

Introduction

PHMSA is proposing to amend the Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180) to establish specific requirements for HHFTs. The rulemaking concentrates on the following:

Requirement Area 1: Rail Routing
Requirement Area 2: Tank Car
Requirement Area 3: Speed Restrictions
Requirement Area 4: Braking
Requirement Area 5: Classification of Mined Gas and Liquid
Requirement Area 6: Notification to SERCs

The NPRM is consistent with the goals of PHMSA's HMR to:

(1) Ensure that hazardous materials are packaged and handled safely and securely during transportation,
(2) Provide effective communication to transportation workers and emergency responders of the hazardous materials being transferred, and
(3) Minimize the consequences of hazardous materials releases should they occur.

Executive Order 12866, "Regulatory Planning and Review," directs all Federal agencies to develop both preliminary and final regulatory analyses if their regulations are likely to be "significant regulatory actions" that may have an annual impact on the economy of $100 million or more. The more recent Executive Order 13563, "Improving Regulation and Regulatory Review," January 18, 2011, emphasizes careful consideration of costs and benefits and directs agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible and to proceed only if the benefits justify the costs.

This preliminary regulatory analysis was prepared in accordance with the guidance provided by the Office of Management and Budget's (OMB) Circular A-4[12] on the development of regulatory analysis as required under Section 6(a)(3)(c) of Executive Order 12866, the Regulatory Right-to-Know Act, and a variety of related authorities.

This will be an economically significant rule under 3(f)(1) of Executive Order 12866; PHMSA has also designated the rulemaking as a "significant" regulatory action because it is of significant public interest. The rulemaking would also be significant under the Department of Transportation's (DOT) regulatory policies and procedures (44 FR 11034; February 26, 1979).

Title II of the Unfunded Mandates Reform Act of 1995 ("the Act," 2 U.S.C. §1532) requires each agency to prepare a written statement for any proposed or final rule that includes a "Federal mandate that may result in the expenditure by State, local, and Native American Indian tribal governments, in the aggregate, or by the private sector, of $100,000,000 or more (adjusted annually for inflation) in any one year." The value equivalent of $100 million in 1995, adjusted for inflation to 2012 levels, is $151 million. This proposed rulemaking does not impose enforceable duties on State, local, or Native American Indian tribal governments. The Act was designed to ensure that Congress and Executive Branch agencies consider the impact of legislation and regulations on States, local governments, and tribal governments, and the private sector. With respect to States and localities, the Act was an important step in recognizing State and local governments as partners in our intergovernmental system, rather than mere entities to be regulated or extensions of the federal government.

This proposed rulemaking would impose enforceable duties on the private sector of an annualized value of about $250 to $600 million over a 20-year period. It likely would result in costs to the private sector that exceed $151 million in any one year and those costs and benefits associated with this rulemaking have been discussed under paragraph A, Executive Order 12866, Executive Order 13563, Executive Order 13610 and DOT Regulatory Policies and Procedures, of this section. In addition, the RIA provides a detailed analysis of the public sector costs associated with the proposed requirements. The RIA is available in the public docket for this rulemaking. PHMSA invites comments on these considerations, including any unfunded mandates related to this rulemaking.

Background

[12] See http://www.whitehouse.gov/omb/circulars_a004_a-4

PHMSA's mission is to protect people and the environment from the risks of hazardous materials transportation. To do this, PHMSA establishes national policy; sets and enforces standards, educates, and conducts research to prevent train accidents; and prepares the public and first responders to reduce consequences if accidents do occur.

PHMSA is proposing revisions to the HMR in response to the recent train accidents involving HHFTs transporting crude oil and ethanol. These proposed revisions would also respond to National Transportation Safety Board (NTSB) safety recommendations. NTSB issued six safety recommendations to PHMSA and FRA on January 23, 2014, focusing on accurate classification, a more robust tank car standard, routing, oversight, and adequate response capabilities.[13]

Portions of the NPRM were contemplated in PHMSA's September 6, 2013, Advanced Notice of Proposed Rulemaking (ANPRM; 78 FR 54849). In the ANPRM we requested public comments on issues raised in eight petitions and four NTSB recommendations regarding the rail transport of flammable liquids. In the ANPRM, PHMSA requested comments on amendments that would:

(1) Establish a new enhanced tank car specification for HHFTs;
(2) Add operational requirements to enhance the safe transportation of HHFTs;
(3) Afford DOT greater discretion to authorize the movement of non-conforming tank cars;
(4) Correct regulations that allow an unsafe condition associated with pressure relief valves (PRV) on rail cars transporting carbon dioxide, refrigerated liquid;
(5) Revise outdated regulations applicable to the repair and maintenance of DOT Specification 110, DOT Specification 106, and ICC 27 tank car tanks (ton tanks); and
(6) Except rupture discs from removal if the inspection itself would damage, change, or alter the intended operation of the device.

This NPRM was developed based on comments received to the ANPRM, accidents that occurred since the ANPRM was issued, and communications to the agency from NTSB, Congress, and other stakeholders, such as tank car manufacturers, shippers and carriers. The NPRM deals with the first and second items of the above list—the other items will be addressed in a subsequent rulemaking.

Market Profile of Flammable Liquids

Flammable liquids include a wide variety of chemical products. The items listed in the table below are generally considered Class 3 (Flammable liquids) and would be would be subject to the provisions of the proposed rule when shipped in a HHFT. Substances with a flashpoint over 100 °F would not be subject to the provisions of the NPRM. Diesel fuel is one such example. Some materials like crude oil display a wide range of flash points and as such may not be subject to the provisions in all cases. In other cases, a flammable liquid may be mixed with a non-hazardous material to the point that the flash point is over 100 °F and would not be subject to the provisions of the NPRM (e.g. dilute solutions of alcohol).

[13] NTSB Safety Recommendations: R14-1 through 3 and R14-4 through 6

As shown in the table below, approximately 68% of the flammable liquids transported by rail are comprised of crude oil, ethanol, and petrochemical or petroleum refinery products. These include UN 1987 Alcohols, n.o.s. [14], UN1170 Ethanol, UN1219 Isopropanol, UN1230 Methanol, UN1267 Petroleum crude oil, UN1238 Petroleum distillates, n.o.s. and UN3295 Hydrocarbons liquid n.o.s. Petrochemical or petroleum refinery products would include commonly shipped items like NA1993 Diesel fuel, NA1993 Combustible liquid n.o.s., UN1202 Diesel fuel, Gas oil, UN1203 Gasoline and UN1863 Fuel, aviation, turbine engine. The table below and Appendix A provide summary information for the industries that produce the most flammable liquid.

Further, as shown in the table below, ethanol and crude oil comprise approximately 65% of the flammable liquids transported by rail. Generally, ethanol is shipped as UN 1170 Ethanol, UN1987, Alcohols n.o.s., or UN3475 Ethanol and gasoline mixture or Ethanol and motor spirit mixture or Ethanol and petrol mixture, with more than 10% ethanol. Crude oil is shipped as UN1267 Petroleum crude oil, UN1268 Petroleum distillates, n.o.s. or Petroleum products, n.o.s., or UN3295 Hydrocarbons, liquid, n.o.s. PHMSA does not expect any Class 3 (flammable liquid) other than crude oil or ethanol to be shipped in a HHFT.

2012 Class 3 Tank Car Originations by Commodity[15]

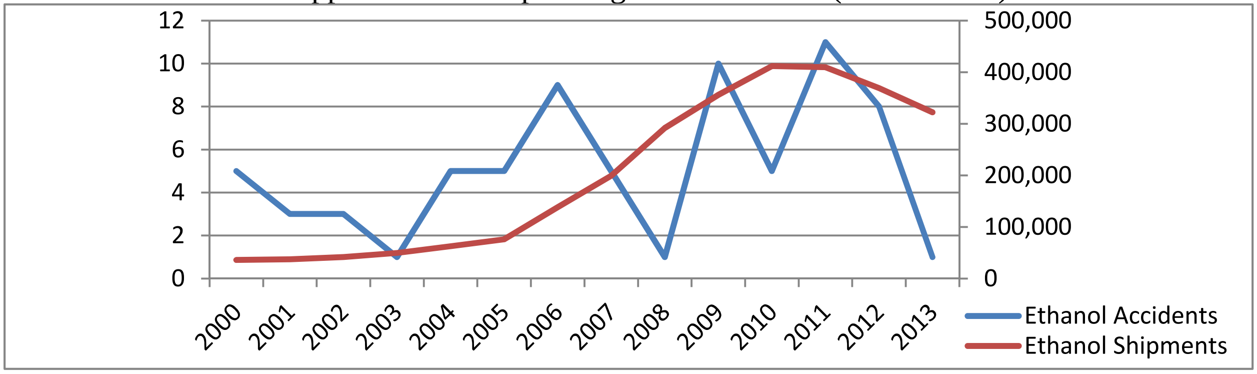
[14] Alcohols n.o.s. is a generic proper shipping name used to cover a variety of mixtures of alcohols such as ethanol mixed with methanol or isopropanol.

[15] Source: Annual Report of Hazardous Materials Transported by Rail by Association of American Railroads and Bureau of Explosives

UN/NA Identification Number	Commodity	Total Tank Car Originations	Percent of Class 3 Tank Car Originations
NA1993	Diesel Fuel, Fuel Oil, Combustible Liquids N.O.S.	26,662	3.0%
UN1202	Diesel Fuel, Gas Oil	49,877	5.7%
UN1090	Acetone	4,083	0.5%
UN1093	Acrylonitrile, Stabilized	2,684	0.3%
UN1114	Benzene	7,376	0.8%
UN1120	Butanols	1,685	0.2%
UN1145	Cyclohexane	2,755	0.3%
UN1170	Ethanol	12,914	1.5%
UN1203	Gasoline	52,137	5.9%
UN1208	Hexanes	1,505	0.2%
UN1218	Isoprene, Stabilized	1,258	0.1%
UN1219	Isopropanol	2,288	0.3%
UN1230	Methanol	19,283	2.2%
UN1238	Petroleum Distillates, N.O.S	3,917	0.4%
UN1247	Methyl Methacrylate Monomer, Stabilized	4,768	0.5%
UN1265	Pentanes	1,541	0.2%
UN1267	Petroleum Crude Oil	266,495	30.3%
UN1268	Petroleum Distillates, N.O.S	8,202	0.9%
UN1280	Propylene Oxide	4,394	0.5%
UN1294	Toluene	3,956	0.4%
UN1301	Vinyl Acetate, Stabilized	5,053	0.6%
UN1307	Xylenes	10,466	1.2%
UN1863	Fuel,Aviation,Turbine Engine	16,782	1.9%
UN1987	Alcohols, N.O.S	293,451	33.3%
UN1993	Flammable Liquids, N.O.S	36,114	4.1%
UN2055	Styrene Monomer, Stabilized	13,355	1.5%
UN2348	Butyl Acrylates, Stabilized	3,389	0.4%
UN2370	1-Hexene	1,718	0.2%
UN2924	Flammable Liquids, Corrosive, N.O.S	1,242	0.1%
UN3065	Alcoholic Beverages	1,267	0.1%
UN3256	Elevated Temperature Liquid, Flammable, N.O.S	1,849	0.2%
UN3295	Hydrocarbons, Liquid, N.O.S	10,745	1.2%
UN3475	Ethanol And Gasoline Mixture	7,730	0.9%
Total		880,941	

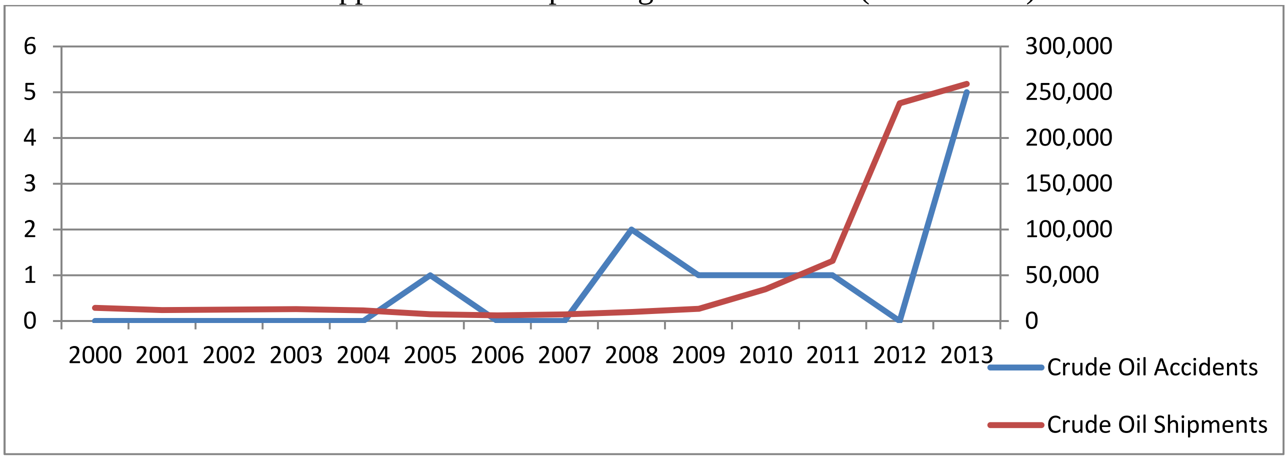
According to a June 2012 white paper by the AAR, U.S. ethanol production has increased considerably during the last 10 years and has generated similar growth in the transportation of ethanol by rail. Between 2001 and 2012, the number of rail carloads of ethanol increased by 650 percent. Similarly the number of rail carloads of crude oil has also exponentially increased. Unfortunately, this growth in rail traffic has been accompanied by an increase in the number of rail accidents involving ethanol and crude oil. The figures below plot the total number of train accidents involving ethanol and crude oil, respectively, based on carloads shipped over the last 13 years.

Carloads of Ethanol Shipped and Corresponding Rail Accidents (Derailments) 2000-2013



Source: PHMSA Incident report database, July 2014 and STB waybill sample

Carloads of Crude Oil Shipped and Corresponding Rail Accidents (Derailments) 2000-2013



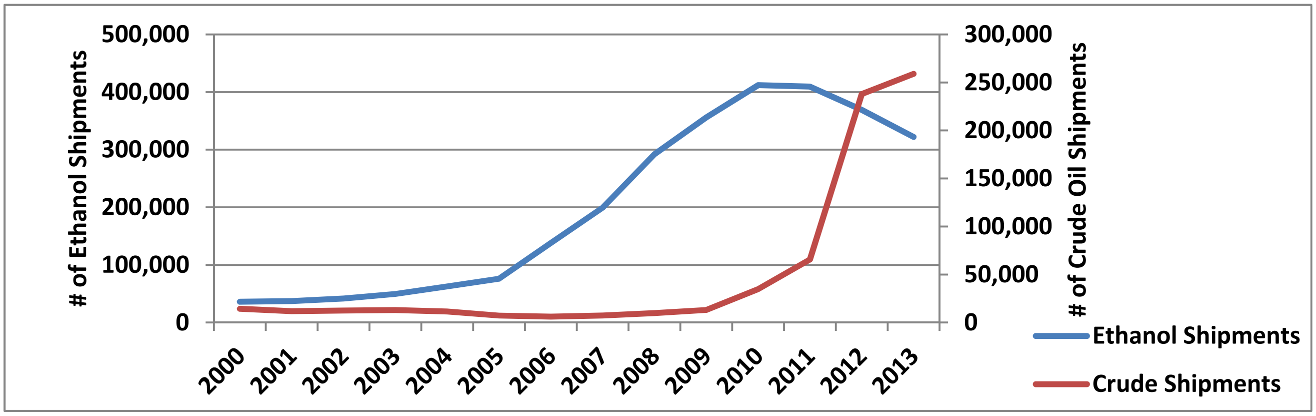
Source: PHMSA Incident report database, July 2014 and STB waybill sample

The U.S. is now the global leader in crude oil production growth. With the growth in crude oil production there has been an increase in the quantity transported by railroads. In the U.S. in 2009 there were 10,800 carloads of crude oil originations transported by Class I railroads, and in 2013, there were over 400,000 carloads of crude oil originations by Class I railroads.[16]

[16] https://www.aar.org/newsandevents/Freight-Rail-Traffic/Pages/2014-03-13-railtraffic.aspx

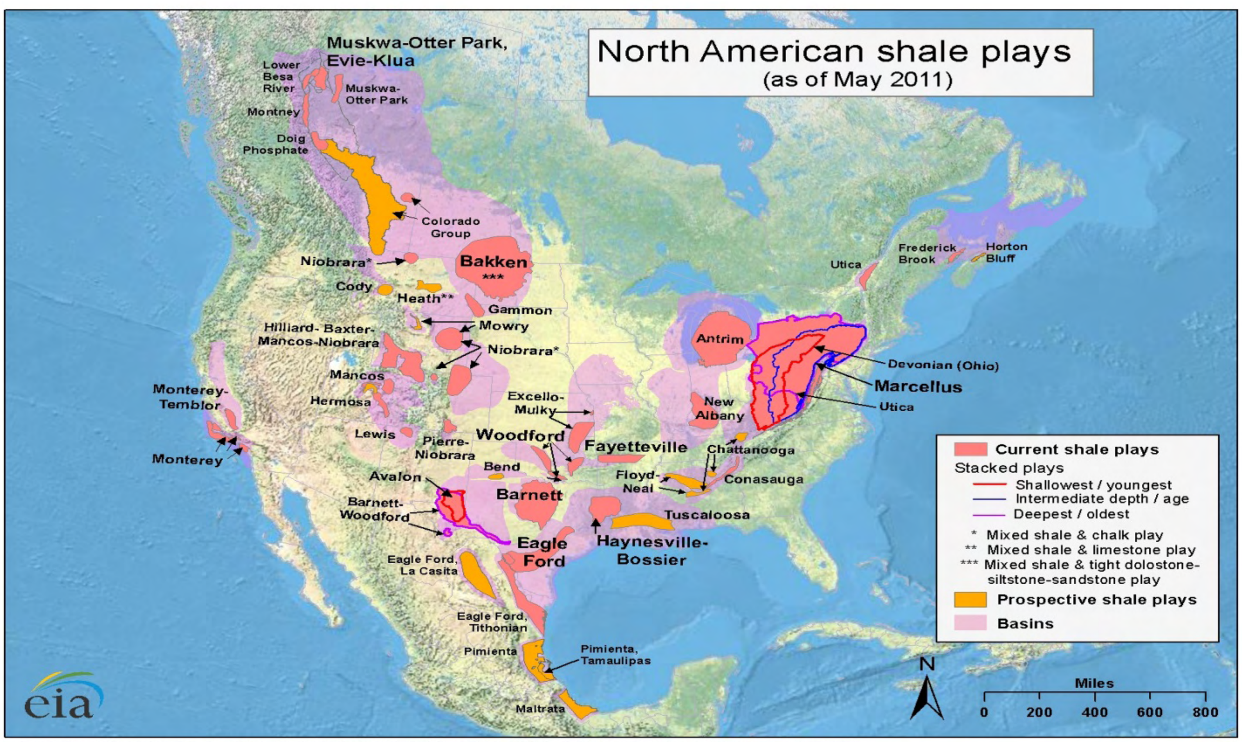
Ex3058-0015-VAN

Carloads of Crude Oil and Ethanol from 2000-2013



Source: STB waybill sample

The Bakken region of the Williston basin is now producing over one million barrels of oil per day, most of which is transported by rail.[17] The U.S. Energy Information Administration's *"Annual Survey of Domestic Oil and Gas Reserves"* reports that in addition to North Dakota's Bakken region, the shale plays in reserves in North America are extensive, as illustrated below.



Source: U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI.
Updated: May 9, 2011

North American Shale Plays

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[17] Information regarding oil and gas production is available at the following URL: http://www.eia.gov/petroleum/drilling/#tabs-summary-2

Determination of Need

The principal anticipated benefit associated with the proposed rulemaking is a reduction in the risk of HHFT accidents and mitigation of the consequences when such accidents do occur. The following discussion provides an overview of PHMSA's and FRA's concerns by first discussing rail accidents involving large volumes of flammable liquids, which forewarns of potential catastrophic train accidents in the future, and concludes with an appraisal of the regulatory options PHMSA is considering to limit future releases.

The market failure at issue is that the shippers and rail companies are not insured against the full liability of the consequences of incidents involving hazardous materials. As a result, these events impose externalities. Among Class I railroads, a self-insured retention of $25 million is common, though it can be as much as $50 million, especially when TIH material is involved. Smaller regional and short line carriers, i.e., Class II and Class III railroads, on the other hand, typically maintain retention levels well below $25 million as they usually have a more conservative view of risk and usually do not have the cash-flow to support substantial self-insurance levels. At this time, the maximum coverage available in the commercial rail insurance market appears to be $1 billion per carrier, per incident.[18] While this level of insurance is sufficient for the vast majority of accidents, it appears that no amount of coverage is adequate to cover a higher consequence event. One example of this issue is the incident that occurred at Lac Mégantic, Quebec, in July of 2013. The rail carrier responsible for the incident was covered for a maximum of $25 million in insurance liability and had to declare bankruptcy because that coverage and the companies remaining capital combined were insufficient to pay for more than a fraction of the harm that was caused. This is one example where rail carriers and shippers may not bear the entire cost of "making whole" those affected when an incident involving crude and ethanol shipment by rail occurs.

Another issue is that shippers, though responsible for packaging the material, and buying or leasing the tank cars in which these products are shipped, do not generally bear any liability for an incident once a rail carrier has accepted shipment, and rail carriers cannot refuse shipments. In addition, rates rail companies can charge to move these commodities are regulated by the Surface Transportation Board, carriers are constrained in their ability to unilaterally raise rates. Shippers, by virtue of not bearing liability, may lack an appropriate full incentive to ensure that the package is adequate to appropriately address the level of risk.

<u>Rail Accidents</u>

As is required of all accidents involving a release of hazardous materials in transportation in the United States,[19] derailments are reported to PHMSA and are recorded in the hazardous materials incident report database. As described in Appendix B, train accidents involving a release of flammable liquids and subsequent fire have occurred with increasing frequency, including:

- a train carrying crude oil derailed and ignited near Casselton, ND prompting authorities to issue a voluntary evacuation of the city and surrounding area. (December 2013);

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[18] http://www.dot.gov/office-policy/transportation-hazardous-materials-insurance-security-and-safety-costs

[19] See 49 C.F.R 171.15, 171.16.

- a train carrying crude oil to the Gulf Coast from North Dakota derailed in Aliceville, Alabama, spilling crude oil in a nearby wetland and igniting into flames (November 2013); and
- an unattended train carrying crude oil derailed in Lac-Mégantic, Quebec, Canada that caused the deaths of forty-seven individuals, extensive damage to the town center, and the evacuation of approximately 2,000 persons from the surrounding area (July 2013).

The Lac-Mégantic accident resulted in economic losses preliminarily estimated at more than $1 billion.[20] On August 2, 2013, FRA issued Emergency Order No. 28 which identified the following:

- Crude oil is problematic when released because of its flammability, and the risk is compounded because it is commonly shipped in large volume,
- Similar dangers exist with other hazardous materials such as ethanol, which was transported via rail more than any other hazardous material in 2012,
- Although the Lac-Mégantic accident occurred in Canada, the freight railroad operating environment in Canada is similar to that in the United States.

On January 23, 2014, in response to its investigation of the Lac-Mégantic accident, the NTSB released a report stating that at least 60 of the 63 derailed DOT Specification 111 tank cars released a total of about 1.6 million gallons of crude oil. According to the NTSB, "The Lac-Mégantic accident shows that railroad accidents involving crude oil have a potential for disastrous consequences and environmental contamination equal to that of the worst on-shore pipeline accidents."

Because this accident occurred in a relatively small town with low rail traffic volumes, the damages are much less than if the accident had occurred in a congested area with a high population density.[21] PHMSA and FRA are taking this regulatory step to mitigate accidents involving HHFTs, including accidents that could occur 'on the scale of' or 'greater than' a Lac-Mégantic accident from happening in the United States, as well as lower consequence events that do not involve outsized environmental and property damages or multiple fatalities.

Table 1 below and Appendix B highlight this risk by summarizing the impacts of recent accidents involving HHFTs of crude oil and ethanol. While not all accidents involving crude oil and ethanol release as much product or have as significant consequences as those shown in this table, these accidents indicate the potential harm from future releases.

[20] Please see Appendix C for a description of how these costs were estimated.
[21] According to the Canada 2011 Census, Lac-Mégantic had a population of 5,932. The town occupies a land area of 21.77 square kilometres (8.41 sq mi) and a population density of 272.5 inhabitants per square kilometre (706 /sq mi). Source; http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=2430030&Geo2=PR&Code2=24&Data=Count&SearchType=Begins&SearchPR=01&B1=All

Table 1: Major Crude Oil/Ethanol Train Accidents in the U.S. (2006-2014)								
Location	Date (MM/YY)	Number of Tank Cars Derailed	Number of Crude oil/ethanol cars penetrated	Speed at Derailment in Miles per Hour (mph)	Material and Type of Train	Product Loss (Gallons of Crude or Ethanol)	Fire	Type of Train Accident or Cause of Train Accident
LaSalle, CO	05/14	5	1	9	Crude Oil (unit)	5,000	No	To Be Determined (TBD)
Lynchburg, VA	04/14	17	2	23	Crude Oil (unit)	30,000	Yes	TBD
Vandergrift, PA	02/14	21	4	31	Crude Oil	10,000	No	TBD
New Augusta, MS	01/14	26	25	45	Crude Oil	90,000	No	TBD
Casselton, ND	12/13	20	18	42	Crude Oil (unit)	476,436	Yes	Collision
Aliceville, AL	11/13	26	25	39	Crude Oil (unit)	630,000	Yes	TBD
Plevna, MT	08/12	17	12	25	Ethanol	245,336	Yes	TBD
Columbus, OH	07/12	3	3	23	Ethanol	53,347	Yes	TBD--NTSB Investigation
Tiskilwa, IL	10/11	10	10	34	Ethanol	143,534	Yes	TBD--NTSB Investigation
Arcadia, OH	02/11	31	31	46	Ethanol (unit)	834,840	Yes	Rail Defect
Rockford/ Cherry Valley, IL	06/09	19	13	19	Ethanol (unit)	232,963	Yes	Washout
Painesville, OH	10/07	7	5	48	Ethanol	76,153	Yes	Rail Defect
New Brighton, PA	10/06	23	20	37	Ethanol (unit)	485,278	Yes	Rail Defect

Precursors and Forewarnings

To consider the likelihood of future catastrophic accidents in the absence of regulatory changes, PHMSA analyzed modal transportation data, historical accident data and the market forecasts for crude oil and ethanol.

In general, PHMSA and FRA found that several factors give rise to higher expected damages and probability of a catastrophic event. First, the volumes of crude oil and ethanol carried by rail are relatively large when compared to rail shipments of other flammable liquids. In particular, the volume of crude oil shipped by rail has been increasing rapidly during the past several years. Second, the crude oil originating in the Bakken oil fields is volatile which increases the risks while it is in transportation. Finally, crude oil and ethanol are shipped in HHFTs, compounding the risk when an accident does occur.

Due to these recent changes, PHMSA and FRA have concluded that the historical train accident record alone cannot determine the probability of a catastrophic event.

Appraisal of Proposed Regulatory Standards

In the absence of PHMSA regulatory action (no action alternative), current requirements would remain in place, and no new provisions would be added. In this case, the safety and environmental risks related to HHFTs would not be addressed. A lack of action by PHMSA would ignore the significant consequences experienced in serious train accidents such as in Lac-Mégantic, Quebec and Aliceville, AL. To appropriately mitigate the societal costs of future accidents, PHMSA has worked closely with FRA to take regulatory action that will prevent and mitigate future train accidents.

Benefits of Proposed Requirements

The benefits of the proposed requirements include averted damages from higher consequence events and lower consequence events. The methodology used to calculate benefits is documented in this section.

The RAND Corporation has defined risk as the product of threat, vulnerability, and consequence.[22] That is,
Risk = Threat × Vulnerability × Consequence,

where: *Threat* is the probability of an adverse event, *Vulnerability* is the probability that an adverse event will result in damage given that the adverse event has occurred, and *Consequence* is the expected damage for an adverse event that does cause damage.[23] Although this definition was previously developed for a terrorism risk management context, RAND's definition is broad enough to cover other risk circumstances. Using the following definitions, the equation can be used to quantify the risk of events being mitigated by the proposed regulations:

[22] Henry H. Willis, Andrew R. Morral, Terrence K. Kelly, Jamison Jo Medby, Estimating Terrorism Risk, RAND Center for Terrorism Risk Management Policy, 2005.
[23] *Ibid.*

- **Threat:** Probability of a major rail accident involving multiple tank cars carrying flammable liquid.
- **Vulnerability:** Given that an accident has occurred, the probability of a release of flammable liquid resulting in substantial damages. This factor also may be referred to as the conditional probability of release (CPR).
- **Consequence:** Based upon estimated damages.

Estimated benefits resulting from averted damages consists of two elements:

(1) An estimation of the probability of HHFT accidents involving flammable liquids in absence of the NPRM and an estimation of the expected damages from accidents extrapolated , from the existing U.S. safety record (we term these "lower-consequence events"); and

(2) An estimation of how many higher-consequence events might occur in absence of the NPRM and an estimation of expected damages from those higher-consequence events (the "additional higher-consequence events" range of estimates).

(1A) Probability of Major Rail Accident Based on U.S. Safety Record

PHMSA used the following methodology to estimate the probability of a major train accident involving multiple tank cars carrying flammable liquids.

To estimate the number of derailments associated with the movement of flammable liquids, we used FRA's Derailment Database and the Public Waybill Sample to develop an 18-year historical series on annual derailments per million rail carloads, across all commodities.[24,25] The Surface Transportation Board (STB) collects cargo waybill data under the requirements that all U.S. railroads that terminate more than 4,500 revenue carloads must submit a yearly sample of terminated waybills. This information provides an indication of the volume of freight rail traffic. We combined these figures with data obtained through rail accident and incident reports submitted to FRA on from Form FRA F 6180.54, "Rail Equipment Accident/Incident Report" to develop derailment rates. Rail carriers are required to report accidents that occur on the following types of track: main, yard, siding and industry. For this analysis we examined only derailments that occurred on mainline track because we believe that the proposed rule will do little to mitigate the derailments that occurred in rail yards.[26] Due to limitations in the reported data, it is impossible to isolate the derailment rate of only crude oil and ethanol trains. A second limitation of this analysis is that it is based on carload data which does not account for distance travelled per train. We use an 18-year time period to obtain the largest possible sample size and waybill data is not readily available by carload prior to 1995. These data are shown in the following table:

[24] http://safetydata.fra.dot.gov/officeofsafety/publicsite/Query/incrpt.aspx

[25] http://www.stb.dot.gov/stb/industry/econ_waybill.html

[26] For the purposes of the HMR, the term *movement* is defined in 49 CFR § 171.8.

Table B1. Carloads Shipped and Derailment Rates, All Commodities

Year	Carloads	Derailments	Derailments per million carloads
1995	29,045,247	1742	59.98
1996	29,723,309	1816	61.10
1997	30,136,925	1741	57.77
1998	31,311,638	1757	56.11
1999	31,966,252	1961	61.35
2000	32,890,352	2112	64.21
2001	32,832,391	2234	68.04
2002	33,385,605	1989	59.58
2003	34,912,071	2133	61.10
2004	35,495,079	2435	68.60
2005	36,897,468	2305	62.47
2006	38,499,461	2197	57.07
2007	37,371,510	1934	51.75
2008	34,817,858	1790	51.41
2009	30,253,710	1370	45.28
2010	33,328,373	1335	40.06
2011	33,845,323	1468	43.37
2012	34,377,852	1288	37.47

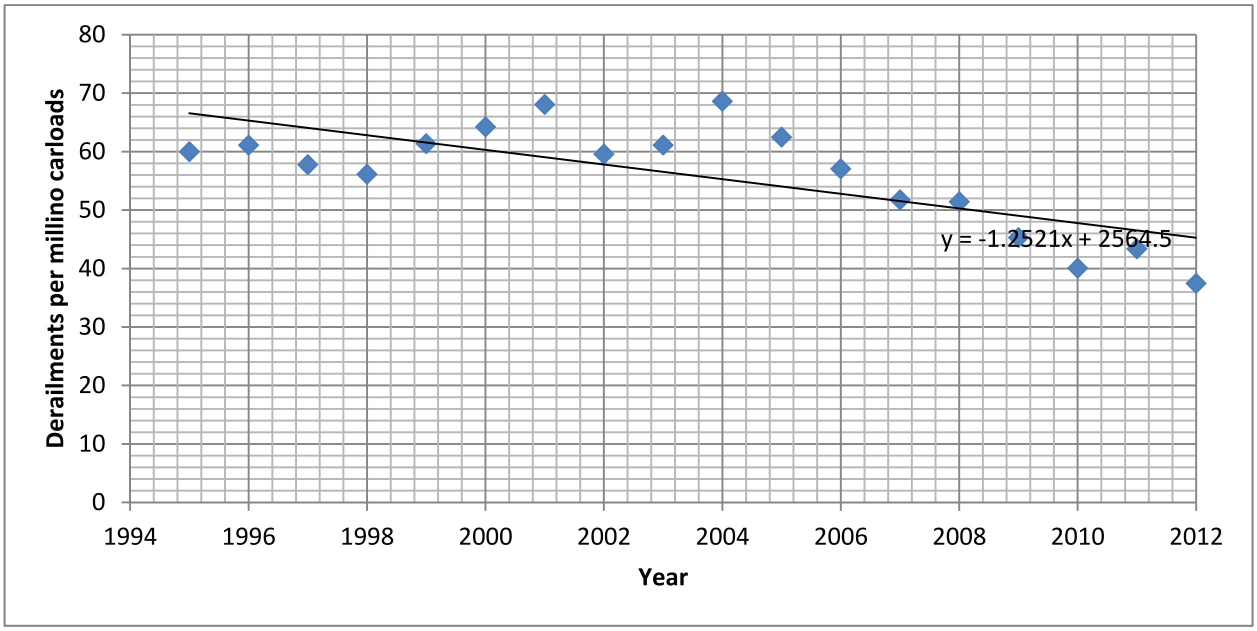
Source: STB Waybill sample http://www.stb.dot.gov/stb/industry/econ_waybill.html

PHMSA used the trend in this series to extrapolate the number of derailments per million carloads throughout the forecast horizon (2013 – 2034), using the equation shown in the chart below (derailments per million carloads = -1.2521*year + 2564.5). This trend was based on derailments for all commodities because neither PHMSA nor FRA databases capture all derailments of all trains carrying crude and ethanol. PHMSA requires an incident report to be filed if a hazardous material is released, so derailments that do not result in a release are generally not represented in the PHMSA database. FRA's derailment database lists whether a derailed train was carrying any quantity of hazardous material, whether or not material released, but does not provide the type of hazardous material present on the train. As a result, it is impossible to use FRA data to identify crude and ethanol derailments. We experimented with other functional forms but none fit the data better than the linear trend and all produced nearly identical predictions, so we used the linear trend for simplicity's sake.

PHMSA estimated this trend using data for all derailments (e.g., both yard movement and mainline derailments). Mainline derailments have declined at a sharper rate than all derailments over the past 20 years. However, the estimates that result from using the mainline derailment trend alone to project future derailment rates did not seem credible to subject matter experts, because that trend would forecast derailments of crude and ethanol trains to fall to essentially zero by 2026. Subject matter experts contend that, generally, mainline track and car maintenance tend to be related to the total volume of rail shipments, and the recession that started in 2007 may have influencing the mainline derailment trend. Higher volume often means more volume of traffic on rail lines between maintenance, as well as higher car utilization rates, which also results in more ton miles per car between maintenance. As a result, volume affects derailment rates. Rail freight volumes declined significantly in 2008 and had yet to rebound to pre-recession levels by 2012. Concern that the recession may be influencing the steepness of the trend led PHMSA to use a trend based on all derailments.

The trend we estimated results in a 141 percent increase in volume shipped per derailment (total predicted carloads shipped divided by predicted derailments) for crude and ethanol shipment from 2014 to 2034. Looking at mainline derailments for all commodities, the number of carloads shipped per derailment increased by 138 percent from 1995 through 2012. The estimated trend, adjusted for volume, seems fairly consistent with the historic decline in mainline derailments for all commodities, adjusted for volume. PHMSA seeks comment on whether an alternative approach would produce more accurate results.

Figure B2. Estimated Derailments per Million Carloads



Source STB Waybill Sample and FRA Office of Safety Analysis

(1B) Estimating Mainline Derailments

To predict the expected number of future HHFT mainline derailments in the absence of the NPRM, we assume that the trends in derailments for crude oil and ethanol will be consistent with other commodities. We projected derailment rates for all commodities, based on the trend equation computed above. PHMSA chose not to separate crude oil and ethanol into separate baselines because the materials present similar hazards and are transported in a similar way. Next, we used 2014 EIA data to project future carloads of crude and ethanol—these are in Column 2 of Table B3, below. We multiplied the projected derailment rates by the projected carloads to obtain the expected total annual derailments for crude and ethanol, these can be found in Column 3 of the table below. Finally, to project mainline derailment rates for crude and ethanol, we assume that the share of derailments that occur on mainline track is the same for crude and ethanol as it is for all commodities. The FRA derailment data from 1995-2012 indicates that approximately 38.5 percent of derailments of all commodities occur on mainline track.[27] We apply these proportions to the predicted number of crude oil and ethanol derailments to estimate the number of future mainline derailments. This derailment forecast is presented in the table below.

Table B3. Projected Carloads of Ethanol and Crude and Mainline Derailments

Year	Carloads	Main Line Derailments
2015	898,500	14.36
2016	924,707	14.34
2017	937,808	14.09
2018	949,434	13.80
2019	962,470	13.53
2020	971,605	13.19
2021	969,195	12.69
2022	965,957	12.18
2023	956,047	11.60
2024	948,974	11.05
2025	934,230	10.43
2026	909,673	9.72
2027	892,919	9.11
2028	873,274	8.49
2029	851,981	7.87
2030	829,771	7.26
2031	810,028	6.70
2032	790,030	6.15
2033	772,230	5.64
2034	755,613	5.16
2015-2034 Total		207

Source STB Waybill Sample and FRA Office of Safety Analysis

There is reason to believe that derailments of HHFTs will continue to involve more cars than derailments of other types of trains. There are many unique features to the operation of unit trains to differentiate their risk. The trains are longer, heavier in total, more challenging to control, and can produce considerably higher buff and draft forces which affect train stability. In addition, these trains can be more challenging to slow down or stop, can be more prone to derailments when put in emergency braking, and the loaded tank cars are stiffer and do not react well to track warp which when combined with high buff/draft forces can increase the risk of derailments.

[27] http://safetydata.fra.dot.gov

(1C) Product Lost per Derailment

PHMSA bases the costs associated with a derailment on the amount of product released when a derailment occurs. Because damages are higher for derailments on mainline track, these derailments are treated differently than those that occur in yards. In order to monetize mainline derailments it is necessary to determine the average amount of product lost in mainline derailments. This section deals with mainline track derailments.

PHMSA focused on derailments of crude oil and ethanol trains from 2006 through 2013. We focused on this date range because it encompasses the beginning of the shipment of flammable liquids in HHFTs. We chose to exclude 2014 because this represents only partial-year data and information for recent rail accidents may not be finalized. We include the preliminary figures inclusive of the six addition rail accidents in 2014 in Appendix B for informational purposes.

PHMSA examined two separate incident reporting databases to estimate the expected loss of product per derailment: (1) The PHMSA Hazardous Materials Incident Report database; and (2) the FRA Railroad Safety Information System. PHMSA collects information on incidents that result in the release of hazardous material in transportation including the type of hazardous material released, the mode of transport, the number of packages releasing hazardous. The FRA collects information on derailments regardless of the commodity, the type of track (mainline, siding, industry), the number of cars derailed, the number of cars that release product and whether hazmat was involved. We combined the information from these two datasets to estimate the number of derailments of crude oil/ethanol cars on mainline track.

PHMSA generally does not collect information on derailments unless the derailment results in the release of hazardous material, and FRA generally does not collect data on the specific hazmat commodity involved in a derailment. Due each dataset's limitations of the information collected it is possible that some mainline derailments of crude oil/ethanol that did not result in a release of product were not examined. We request comment on additional crude oil/ethanol derailments that should be considered in this analysis. Further, in the Paperwork Reduction Act section of the Preamble, we seek comment on how PHMSA might collect better incident reporting data through revisions to information collections.

For the time period between 2006 and 2013 we identified 40 mainline derailments that resulted in the release of 3,344,081 gallons of crude oil and ethanol for an average of approximately 83,602 gallons released per mainline track derailment. These 40 mainline derailments are listed in Appendix B. Before beginning computation, we removed derailments that occurred in rail yards and removed incidents that were not the result of a derailment because these accidents are not the focus of the NPRM and the proposed provisions would do little to mitigate these accidents.[28] In addition we corrected the data by comparing the PHMSA and FRA incident databases and detailed inspection reports when available.

[28] PHMSA reporting requirements only apply to mainline/siding track derailments. Nevertheless, some companies do report yard derailments. Further, this analysis focuses on the damages that result from a derailment, but some companies report releases that were not the result of a derailment.

Based on a review of the reported description of events and a comparison to the FRA incident database we identified the following crude oil/ethanol incidents that either occurred in a yard and are not subject to PHMSA reporting requirements or involved a release of ethanol or crude oil that was not a result of a derailment:

Missoula, MT: 6/18/2006
Kansas City, KS: 12/1/2006
Amarillo, TX: 12/25/2006
Los Angeles, CA 1/9/2007
Chicago, IL: 8/27/2007
La Mirada, CA: 4/9/2009
Martinez, CA: 4/13/2009
Rosemont, IL: 5/18/2009
Minneapolis, MN: 11/27/2009
Fresno, CA: 12/17/2009
Birmingham, AL: 2/18/2010
Harve, MT: 11/1/2010
Roanoke, VA: 12/2/2010
Jackson, NE: 3/17/2011
Antelope, CA: 6/11/21011
Texas City, TX: 09/13/2011
Hitchcock, TX: 09/13/2011
Stockton, CA: 6/27/2011
Pasco, WA: 11/07/2011
Monroe, LA: 12/1/2011
Las Vegas, NV: 08/11/2012
Knoxville, TN: 10/12/2012
Tampa, FL: 07/25/2013

The PHMSA hazardous material incident report database often contains inaccuracies. The database presents information on releases of hazardous material in transportation and relies on the person in possession of the hazardous material at the time of the incident to report on the incident. Often the amount of product released from a particular tank car is unclear or reported differently in the description of events than in the appropriate incident report fields. Additionally, the PHMSA incident reports often do not reflect the full extent of damages including property damage, cleanup and remediation costs because it may be months before full damage figures can be reported. By regulation the filer has a maximum of thirty days from the time of the incident to file a report. Even though the filer is responsible for updating or supplementing the initial report if additional information becomes available and has one year from the date of the incident to do so, PHMSA do not always obtain full information. When we compared the incident report information from the PHMSA hazardous material incident report Database with data obtained through more thorough investigations, we discovered that the quantity of product lost and number of cars releasing product were misreported in a number of cases. Below are notable examples:

- Parker's Prairie, MN 3/27/2013: The reported release in the report DOT 5800 report field suggested that one car released 10,000 gallons while the description of events reported that 4 cars derailed and released 15,000 gallons. In this case PHMSA compared this information to the FRA incident database for the same incident. The FRA information confirmed that for this incident 14 cars derailed and 3 cars released approximately 15,000 gallons.

- Aliceville, AL 11/07/2013: The initial estimate of crude oil lost in the Aliceville, AL, derailment was 28,000 gallons. Based on a follow-up from PHMSA personnel, the carrier has since revised this estimate to more than 450,000 gallons.
- Philadelphia, PA 1/20/2014: A 101-car train was travelling from Chicago to Philadelphia derailed on a bridge. Seven cars derailed and six of the derailed cars were carrying crude oil. There was no reported release of the crude oil. This derailment was reported to the FRA, but since it did not result in a release of hazardous material, so it was not reported to PHMSA.
- New Augusta, MS 1/31/2014: The product contained in the incident cars was reported to PHMSA as NA1993 Combustible Liquid, n.o.s. (fuel oil). Information obtained by the FRA during a follow-up investigation revealed that the cars that derailed contained crude oil. Because this was reported to PHMSA as NA1993 and not UN1267, it would not be found using the search for crude oil or ethanol. Based on this additional information, this incident was added to the list of incidents suitable for inclusion. In this analysis, PHMSA elected to use FRA inspection reports that state that for this incident 13 cars derailed and 4 cars released approximately 90,000 gallons.
- Vandergrift, PA 2/13/2014: The incident involved a train carrying crude oil and liquefied petroleum gas. The description of events in the PHMSA incident report states that four cars released a total of 8,300 gallons of product. The report fields for that same report suggested that six cars released 9,800 gallons of product. In this analysis PHMSA elected to use FRA inspection data that says 21 cars derailed, 4 cars released a total of 10,000 gallons

PHMSA seeks comments on the following questions regarding our estimates of the number of mainline derailments per year and the average product released per derailment. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, include supporting data, and explain the source, methodology, and key assumptions of the supporting data.

1. What factors, in addition to change over time, should PHMSA consider in assessing the probability of mainline derailments of ethanol or crude oil HHFTs based on the historic record of all derailments?
2. How does the probability of derailment differ between ethanol and crude oil HHFTs?
3. How can PHMSA improve the accuracy and completeness of the hazardous material incident report database, to better inform future rulemakings?
4. Should PHMSA require reporting on every car carrying hazardous material that derails, whether that car loses product or not? Such reporting would assist PHMSA in assessing the effectiveness of different kinds of cars in containing the hazardous materials that they carry.
5. How will the rate of derailments per million carloads, for crude and ethanol service, change over the next 20 years (as a result of regulatory and voluntary action)?
6. PHMSA seeks comment on how to account for distance travelled per HHFT. This would account for the change in risk associated with change in distance travelled.

(1D) Monetizing Events Based on Quantity Released

Each incident involving a significant spill of crude or ethanol will have numerous types of costs. In addition to the costs of any injuries or fatalities, which are addressed in the following section, spills will involve cleanup costs. The spills may also involve property damage, costs for emergency response, evacuation costs for residents or workers in the surrounding areas, environmental damage, transportation delays while the spill is being cleaned up, as well as other costs. As we discuss in the Higher Consequence Events section below, the costs of a spill will depend not only on the size of a spill, but also where it occurs, the type of material spilled, and the circumstances of the accident. There is likely to be more property damage if a spill occurs in a densely populated area or if it results in a fire. There is likely to be more environmental damage if the spill occurs in an environmentally sensitive area. Costs of cleanup may be higher for heavier crude that does not burn. Because of the uncertainties involved in projecting the costs of future spills, PHMSA requests comment on how we might improve the estimate presented here.

PHMSA estimates the costs of released product by applying a monetary value to each gallon spilled. This implicitly assumes that costs per gallon are linear with (i.e., vary in direct proportion to) the volume of product spilled, but PHMSA intends the value to reflect an average, recognizing the number may be declining with respect to the volume spilled due to economies of scale in cleanup costs. To estimate the cost per gallon of crude or ethanol released, PHMSA examined news and railroad reports from two crude oil incidents for which cost estimates are at least preliminarily available, evaluated cost estimates prepared by the NTSB, reviewed cost estimates reported by railroads to PHMSA in hazardous material incident reports for both ethanol and crude oil, and consulted preliminary modeling by Dagmar Schmidt Etkin on the cost of responding to oil spills. Of the two incidents for which PHMSA has the most reliable cost data (Lynchburg, Virginia and Lac-Mégantic, Quebec), PHMSA elected to use the Lynchburg incident for reasons explained below.

Below is a breakdown of the various costs associated with this rail accident:

Description: The train originated in the Bakken shale region in North Dakota and consisted of two locomotives and 105 cars. Seventeen cars were derailed and two of them spilled a total of approximately 30,000 gallons of crude oil in the James River. Approximately 350 residents were evacuated for approximately 3.5 hours.

Table B4. Breakdown of Damages as a Result of the April 30, 2014 Derailment in Lynchburg, VA

Description	Number/Quantity	Costs $Million
Fatalities	None	0
Injuries	None	0
Track Damage		$0.25
Equipment Damage		$3.29
Environmental Damage	30,000 gallons	$5.00
Property Damage		$0.05

Evacuation	350 residents	$0.40
Highway Closure		0
Total Costs		$8.99

Source: CSX as reported to FRA

In formulating this estimate, PHMSA relied only on cleanup and emergency response costs and not socioeconomic and environmental damages beyond cleanup costs. PHMSA believes that these additional costs are sometimes significant, but lacks data sufficient to estimate their magnitude directly.

The two crude oil incidents for which preliminary cost estimates have been made are the catastrophic incident at Lac Mégantic, Quebec, and the recent derailment at Lynchburg, VA. We do not consider Lac-Mégantic in this estimate as the damages are fully accounted for in the higher consequence damage estimates. An average based on Lac-Mégantic would not be representative of a typical accident. (see Appendix C, below). The Lynchburg incident resulted in a much lower quantity of 30,000 gallons spilled. The emergency response and cleanup costs for that incident were reported to the FRA by CSX as $8.99 million. Of this $8.99 million cost, an estimated $5 million was due to environmental damage. The CSX estimate of the costs of Lynchburg results in a cost per gallon of about $300.

PHMSA also examined NTSB reports of rail accidents, PHMSA's own hazardous materials incident report data, and modeling done by Etkin.

NTSB investigations of four ethanol and crude oil spills since 2006 are available. NTSB reports that the 2006 New Brighton incident released 485,278 gallons of ethanol and imposed estimated costs of $5.8 million, for a cost per gallon released of $12;[29] the 2009 Cherry Valley incident released 431,708 gallons of ethanol and imposed estimated costs of $7.9 million, for a cost per gallon released of $18;[30] the 2011 Tiskilwa incident released 259,000 gallons of ethanol and imposed estimated costs of $1.6 million, for a cost per gallon released of $6;[31] and the 2013 Casselton incident released 400,000 gallons of crude oil and imposed estimated costs of $6.1 million, for a cost per gallon released of $15.[32]

The NTSB data do not, in most cases, consider remediation and cleanup costs. In its Tiskilwa report, the NTSB's estimated damages represent only property damages. For Cherry Valley, damages seem to be limited to property damages, given where they are presented in the report (though NTSB does not specify). For New Brighton, the damages include $2.5 million that ostensibly accounts for lost product, emergency response, remediation, and incidentals—yet almost 500,000 gallons spilled. This estimate is not credible because the product alone was worth over $1 million. Although the source of the NTSB's damage estimate was, like the source of the Lynchburg damage estimate used in this NPRM, the railroad involved, PHMSA does not believe that Norfolk Southern railroad accurately estimated costs in the case of New Brighton.

[29] http://www.ntsb.gov/doclib/reports/2008/RAR0802.pdf
[30] http://www.ntsb.gov/doclib/reports/2012/RAR1201.pdf
[31] http://www.ntsb.gov/doclib/reports/2013/RAB1302.pdf
[32] http://www.ntsb.gov/doclib/reports/2014/Casselton_ND_Preliminary.pdf

PHMSA's hazardous materials incident report data are based on incident reports submitted by the involved railroad within 30 days of the incident. Among other information, the railroad is required to report a narrative description of the event, the commodity released, the volume of product lost, and the costs of the incident, including material loss, carrier damage, property damage, response cost, and remediation cleanup cost. Railroads are required to update their initial report if the initial estimates prove inaccurate. Of the 40 mainline derailments involving crude oil and ethanol releases since 2006, hazardous materials incident report data indicate that a total of 3,344,081 gallons were released and total damages were $47,252,409, for an average cost per gallon released of $14.13.

PHMSA believes the hazardous materials incident report data are also incorrect. Total damages from a narrative description of events often do not match the information provided in the corresponding report field. Additionally, damages and costs reported appear to be extremely low. A case in point is the Arcadia, Ohio (2/6/11) derailment (32 cars, the release of 786,245 gallons of ethanol and the evacuation of 25 people for 8 hours); the $187,410 damages reported for this incident is implausibly low. Damage information reported to PHMSA generally includes only the most basic costs such as the value of lost product and preliminary estimates of damages to rail cars or track. PHMSA believes that response costs and basic cleanup costs, when they are reported, do not represent the full costs of an accident or the response. Reports may exclude evacuation of the public, disposal of contaminated soil, air quality and site monitoring and other costs. While it is incumbent upon the person who reports a hazardous materials incident to supplement their initial report, this most often does not happen unless PHMSA follows up with the filer. For example, the initial estimate of crude oil lost in the Aliceville, AL, derailment was 28,000 gallons. Based on a follow-up from PHMSA personnel, the carrier has revised this estimate to more than 450,000 gallons. Beyond simple revisions in volume released, cleanup costs also tend to escalate after an initial report. PHMSA therefore expects costs reported to be biased downward.

Etkin presented preliminary results from a model she developed for estimating the cost of oil spills at the EPA Freshwater Spills symposium in April of 2004.[33] The model was developed from a record of historical oil spill case studies, primarily in inland waterways, and provides a methodology for estimating the cost of an oil spill based on the amount spilled, spill location, and material spilled, among other variables. PHMSA was unable to reproduce the model's results and elected not to rely on them.

Of the two crude oil incidents for which PHMSA has confidence in the reliability of their cost estimates, PHMSA relies on the $300 per gallon that resulted from the Lynchburg derailment because the costs associated with the Lac-Mégantic accident are accounted for in the higher consequence events section.

To estimate total property damage, remediation, and cleanup costs as well as socioeconomic costs and lasting environmental damages in the baseline, PHMSA multiplied the total estimated

[33] Etkin, 2004. Modelling Oil Spill Response and Damage Costs. EPA Freshwater Spills Symposium. Available online at http://www.environmental-research.com/erc_papers/ERC_paper_6.pdf

quantity to be released in future mainline derailments by $300. PHMSA estimates elsewhere in this analysis that the average expected release in the event of an accident will be 83,602 gallons. PHMSA notes that at a cost of $300 per gallon released, this implies that the average crude oil and ethanol mainline derailment results in $25 million in total costs (including property damages, cleanup, remediation, emergency response, socioeconomic and lasting environmental damages).[34]

PHMSA seeks comments on the following questions. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, include supporting data, and explain the source, methodology, and key assumptions of the supporting data.

1. Based on all derailments involving crude oil and ethanol releases in the U.S. since 2006, and commenters experience with other releases that may be relevant, PHMSA seeks comment on the cost per gallon spilled.
2. PHMSA recognizes that the cost per gallon spilled will vary based on the quantity released and various other factors. PHMSA seeks comment on the availability of data that may improve estimates of these costs based on the quantity spilled.
3. What is the likelihood that HHFT accident releases result in substantial socioeconomic costs and/or lasting environmental damages that would not be accounted for elsewhere in PHMSA's analysis of this rule as a "Higher-Consequence Event?"
4. How do the damages per gallon released differ between ethanol and crude oil spills?
5. Which of the data sources that PHMSA considered most accurately reflects the costs of crude and ethanol releases? Are they sufficiently different to warrant separate estimates? Are they sufficiently different to warrant consideration of different regulatory standards?
6. PHMSA collects information about releases of hazardous materials from pipelines. Should PHMSA consider these data when estimating the damages caused by releases from HHFTs or are pipeline releases sufficiently different that the comparison is not helpful?
7. How might PHMSA reliably use any of the data from sources cited above (including pipeline releases) to help estimate the average cost of releases?
8. What other data sources should PHMSA consider?
9. What methods can PHMSA use to directly estimate the socioeconomic and long-term environmental harms?
10. How can PHMSA improve the accuracy and completeness of the hazardous materials incident report data, to better inform future rulemakings?
11. Should PHMSA require reporting of data on the total damages that occur as a result of train accidents involving releases of hazardous material, including damages related to fatalities, injuries, property damage, environmental damage and clean-up costs, loss of business and other economic activity, and evacuation-related costs?

(1E) Monetization of Deaths and Injuries

[34] 83,602 gallons released x $300 per gallon lost = $25,080,600.

To fully monetize these events, we also considered injuries and fatalities. There was one fatality and three injuries that involved hospitalization resulting from crude and ethanol shipments by rail between 2006 and 2013. In addition, there were 10 injuries that did not involve hospitalization in crude and ethanol incidents from 2006-2013. PHMSA uses these incidents to estimate injury and fatality damages per carload shipped for crude and ethanol shipments. PHMSA then monetizes these damage estimates and adjusts them by the derailment trend presented above to account for baseline improvements in industry safety performance. We valued the fatalities at the current Value of a Statistical Life (VSL). The injuries were assumed to be severe injuries on the Abbreviated Injury Scale (AIS), and valued at 26.6 percent of the VSL as per DOT guidance. There were ten injuries that did not involve hospitalization associated with crude and ethanol shipments. These injuries were assumed to be minor on the AIS scale and valued at 0.3 percent of the VSL as per DOT guidance. The Table below presents the fatalities, injuries, and carloads shipped from 2006-2013 for crude and ethanol.

Table B5. Historic Deaths and Injuries in Crude and Ethanol Mainline Derailments with Carloads Shipped

Year	Mainline Derailments	Fatalities	Injuries Resulting in Hospitalization	Injuries not Resulting in Hospitalization	Crude and Ethanol Carloads Shipped
2006	5	0	0	0	144,238
2007	3	0	1	0	206,553
2008	3	0	0	2	301,636
2009	8	1	2	6	369,172
2010	3	0	0	0	446,639
2011	6	0	0	0	475,025
2012	6	0	0	2	607,014
2013	6	0	0	0	581,163
Grand Total	40	1	3	10	3,131,440

The total cost of fatalities and injuries was $17.2 million. Divided by the total crude and ethanol carloads shipped, this came to $5.50 per carload shipped in societal damages. These unit figures were multiplied by the forecasted carloads shipped (presented above) for each commodity to produce a stream of expected societal damages for crude oil shipments through 2034.

(1F) Baseline Fleet Projections

One further adjustment was made to account for the fact that the industry has recently committed to building only enhanced jacketed CPC 1232 cars for crude oil service going forward. These cars are expected to grow to 40 percent of the fleet by 2019 even without regulatory intervention, due to the high demand for more cars to ship crude oil. A jacketed, thermally protected CPC 1232 car, with improved pressure relief valves and bottom outlet valves, is significantly safer than either a jacketed or unjacketed DOT Specification 111 tank car. As discussed in the tank car effectiveness section, FRA modelling suggests that 40 percent fewer jacketed CPC 1232 cars would release product in a given derailment relative to a derailment consisting of unjacketed DOT Specification 111s. We therefore adjust our baseline by applying the full expected damages for the forty percent the fleet that consists of older tank cars, but only 60 percent of the damages to the remainder of the fleet that would be jacketed CPC 1232 cars. The table below presents how we expect the fleet to evolve going forward if regulations are not adopted.

Table B6. Expected Evolution of Tank Car Fleet in Absence of Regulation

Year	DOT 111s and Unjacketed CPC 1232s		Jacketed CPC 1232s	
	Number	%	Number	%
2015	79,572	0.73	30,150	0.27
2016	79,572	0.69	35,972	0.31
2017	79,572	0.66	41,794	0.34
2018	79,572	0.63	47,616	0.37
2019	79,572	0.60	53,438	0.40
2020	79,572	0.60	53,438	0.40
2021	79,572	0.60	53,438	0.40
2022	79,572	0.60	53,438	0.40
2023	79,572	0.60	53,438	0.40
2024	79,572	0.60	53,438	0.40
2025	79,572	0.60	53,438	0.40
2026	79,572	0.60	53,438	0.40
2027	79,572	0.60	53,438	0.40
2028	79,572	0.60	53,438	0.40
2029	79,572	0.60	53,438	0.40
2030	79,572	0.60	53,438	0.40
2031	79,572	0.60	53,438	0.40
2032	79,572	0.60	53,438	0.40
2033	79,572	0.60	53,438	0.40
2034	79,572	0.60	53,438	0.40

(1G) Summary of Damages from Lower Consequence Events

Table B7, below, summarizes the information presented above regarding the damages and assumptions attributable to lower consequence events.

Table B7: Summary of Assumptions and Estimates Used in Estimating Lower Consequence Damages			
Variable	**Formula/Input**	**Base Source**	**Year(s) in Data Set**
Number of **Ethanol Carloads** Per Year, 2015-2034	361,295 to 403,217 carloads (depending on year)	EIA Projections, DOT Estimates	2015-2034
Number of **Crude Oil Carloads** Per Year, 2015-2034	394,318 to 568,388 carloads (depending on year)	EIA Projections, DOT Estimates	2015-2034
Number of **Other Class 3 Flammable Liquid Carloads in HHFT**	None	DOT Estimates	2015-2034
Number of **Mainline Derailments** for Crude and Ethanol Service in 2015 (use linear trend for 2015-2034)	14.55 derailments	Linear Trend for All Commodities	DOT Estimate for 2015
Linear Trend for Number of Derailments Per Million Carloads, 2015-2034	-1.2521 (year) + 2564.5	FRA Database for All Commodities, STB Waybill Sample for All Commodities	1995-2012
Mainline Derailment Share, as Percentage of Total Derailments	39%	FRA Database for All Commodities	1995-2012
Property/Environmental Damage Cost Per Mainline Derailment	$25,080,600	Product of the Two Variables Below	DOT Estimate for 2015
Average Property/Environmental Cost, Per Gallon Released	$300	CSX Corporation Statement about Lynchburg Accident	2014
Average Gallons of Product Lost, Per Mainline Derailment	83,602 gallons	PHMSA Database for Crude Oil and Ethanol	2006-2014
Monetized **Non-Hospitalized Injury Risk** Per Mainline Derailment	$1,330	Product of the Two Variables Below	2006 --2013
Number of Non-Hospitalized Injuries Per Mainline Derailment	0.05	FRA Injury Database for Crude Oil and Ethanol	DOT Estimate for 2015
Monetized Cost of Non-Hospitalized Injury (AIS 1)	$27,926	DOT 2014 VSL Guidance, Scaled to 2015	2014
Monetized **Hospitalized Injury Risk** Per Mainline Derailment	$35,372	Product of the Two Variables Below	2006-2013
Number of Hospitalized Injuries Per Mainline Derailment	0.014	FRA Injury Database for Crude Oil and Ethanol	DOT Estimate for 2015
Monetized Cost of Hospitalized Injury (AIS 4)	$2,476,047	DOT 2014 VSL Guidance, Scaled to 2015	2014
Monetized **Fatality Risk** Per Mainline Derailment	$447,823	Product of the Two Variables Below	2006-2013
Number of Fatalities Per Mainline Derailment	0.048	FRA Injury Database for Crude Oil and Ethanol	DOT Estimate for 2015
Monetized Value of Statistical Life	$9.3 million	DOT VSL Guidance, Death, updated to 2015 using expected real wage growth	2015
CPC 1232 Jacketed Share without Regulation, 2015-2034	.19% to .40% (depending on year)	Railway Supply Institute at NTSB Forum, 4/22/14; DOT Estimate for Future Years	DOT Estimate for 2015 to 2034
Risk Reduction, CPC 1232 Jacketed Relative to Weighted Average DOT Specification 111 Tank Car	40%	Applied Research and Associates, Puncture Resistance Model; DOT Estimate for Other Features	2014

Crude Oil and Ethanol Service: Other Lower Consequence Damages Estimates and Assumptions		
Variable	**Formula/Input**	**Source**

Ex3058-0034-VAN

Crude Oil and Ethanol Service: Other Lower Consequence Damages Estimates and Assumptions		
Variable	**Formula/Input**	**Source**
Difference in Property/Environmental Damages Per Derailment Between Crude Oil and Ethanol	None	DOT Estimate
Difference in Monetized Injury Risk Per Derailment Between Crude Oil and Ethanol	None	DOT Estimate
Change in Share of Crude Oil and Ethanol Production that Travels on HHFT	None	DOT Estimate
Total **Property/Environmental Damages from Yard Derailments**	Not Estimated	DOT does not expect yard movement damages to materially decrease with this rule
Total **Monetized Injury Damages from Yard Derailments**	Not Estimated	DOT does not expect yard movement damages to materially decrease with this rule
Total **Property/Environmental Damages from Non-Accident Releases (NARs)**	Not Estimated	DOT does not expect NARs damages to materially decrease with this rule
Total **Monetized Injury Damages from Non-Accident Releases (NARs)**	Not Estimated	DOT does not expect NARs damages to materially decrease with this rule
Cars Derailed, Per Mainline Derailment	Not Estimated	Estimate implied in the average of 83,602 gallons of product lost per mainline derailment
Conditional Probability of Release, Per Derailed Car	Not Estimated	Estimate implied in the average of 83,602 gallons of product lost per mainline derailment
Average Gallons Lost, Per Releasing Car	Not Estimated	Estimate implied in the average of 83,602 gallons of product lost per mainline derailment

Table B8 below presents total estimated damages for crude and ethanol for lower consequence accidents over the next 20 years. The figures in these tables are developed by multiplying the number of mainline derailments from the derailment trend by the expected quantity lost from the table above for each year (83,602 gallons) and monetizing the damages using $300 in cost per gallon of product released. The exact calculation is:

Accidents in year Y x 83,602 (gallons spilled per accident) x $300 (cost per gallon spilled)

= Monetized damages in year Y

One further adjustment is made to account for the fact that within a few years jacketed CPC 1232s are expected to make up a significant portion of the fleet, resulting in reduced incident severity. We estimate that jacketed CPC 1232s are roughly 40 percent less likely to release product than lesser standard cars on average. If jacketed CPC 1232s make up 40 percent of the fleet, lower standard cars would make up the remaining 60 percent. Thus damages are adjusted by multiplying by .6 to account for likely damages attributed to legacy cars, and by .4 x .6, the portion of the fleet made up of jacketed CPC 1232s and the remaining damages once the greater effectiveness of these cars is accounted for (1-.4). To state this calculation more formally:

Total Damages (in the chart below) = (total damages prior to adjustment x .6 (the portion of legacy cars)) + (.4 (the portion of jacketed CPC cars) x (.6 expected remaining damages for incidents involving these cars) x total damages prior to adjustment.

Table B8, below, provides the projected damages resulting from mainline train accidents.

Table B8: Projected Damages from Mainline Train Accidents

Year	Crude Carloads	Ethanol Carloads	Damages, Property	Damages, Injury	Total Damages
2015	532,688	365,812	$320,619,882	$4,146,907	$324,766,789
2016	549,804	374,903	$314,764,950	$4,119,219	$318,884,170
2017	555,733	382,075	$304,629,404	$4,033,621	$308,663,025
2018	559,056	390,378	$294,352,245	$3,943,531	$298,295,776
2019	563,940	398,530	$284,783,129	$3,860,351	$288,643,480
2020	568,388	403,217	$277,626,660	$3,807,750	$281,434,410
2021	568,285	400,910	$267,103,299	$3,706,647	$270,809,946
2022	565,260	400,697	$256,409,127	$3,600,229	$260,009,356
2023	560,159	395,888	$244,077,179	$3,467,516	$247,544,695
2024	554,524	394,450	$232,641,943	$3,344,059	$235,986,002
2025	545,536	388,694	$219,547,498	$3,193,075	$222,740,573
2026	526,357	383,316	$204,545,541	$3,009,992	$207,555,533
2027	510,467	382,452	$191,717,665	$2,854,514	$194,572,178
2028	494,066	379,208	$178,638,350	$2,691,159	$181,329,509
2029	476,727	375,254	$165,637,087	$2,524,742	$168,161,828
2030	458,135	371,636	$152,899,306	$2,358,085	$155,257,392
2031	441,518	368,510	$141,041,696	$2,200,879	$143,242,575
2032	424,252	365,778	$129,542,924	$2,045,300	$131,588,225
2033	408,944	363,286	$118,788,134	$1,897,628	$120,685,763
2034	394,318	361,295	$108,564,546	$1,754,772	$110,319,319
					$4,470,490,543

(2A) Higher-Consequence Event Damages

In order to consider the full impacts of this rule, it is necessary to examine the potential for HHFT accidents greater in number or severity than those observed to date in the U.S. While there have been no higher consequence events in the U.S., we believe that such an event is possible. In the previous section we projected damages that might occur if the rate and size of future accidents were similar to the existing U.S. safety record. In this section, we consider whether, in addition to these projected accidents, there might be one or more higher-consequence events. Therefore, any benefits related to preventing the accidents examined in this section would be in addition to the benefits from preventing the lower-consequence accidents in the previous section.

A higher-consequence event occurred in the town of Lac Mégantic, Quebec, in July of 2013. This event is illustrative of, but not the limit of, a high-consequence event scenario for derailment of a HHFT. The event involved an unattended train that rolled downhill and resulted in a 63-car derailment at 65 mph. The derailment occurred in a small town with a low population density by U.S. standards, but resulted in the deaths of 47 people and the destruction of much of the downtown area. A year after the event, decontamination of the soil and water/sewer systems is still ongoing. Cleanup of the lake and river that flows from it has not been completed, and downstream communities are still using alternative sources for drinking water. Initial estimates of the cost of this event were roughly $1 billion, but the cleanup costs have doubled from initial estimates of $200 million to at least $400 million, and estimates of the total cost to clean up, remediate, and rebuild the town have risen as high as $2.7 billion.[35]

The frequency and magnitude of these events is highly uncertain. It is, therefore, difficult to predict with any precision how many of these higher consequence events may occur over the coming years, or how costly these events may be. In the worst case scenario for a fatal event, the results could be several times the damages seen at Lac Mégantic both in loss of life and other associated costs.

In estimating the damages of a higher-consequence event, we begin with $1.2 billion, which are the estimated damages of Lac Mégantic. We used this accident to illustrate the potential benefits of preventing or mitigating events of this magnitude. It is challenging to use this one data point to model potential damages of higher consequence events that differ in nature from the Lac Mégantic accident. However, as the volume of crude oil shipped by rail continues to grow, it is reasonable to assume that events of this magnitude may occur. To illustrate the uncertainty but provide some sense of the damages that could result from higher consequence events, PHMSA examines a range of potential outcomes, varying both the frequency and magnitude of these events. To illustrate the possible extent of this range, PHMSA assumed there would be between 0 and 10 such events over 20 years, in addition to the 5 to 15 annual mainline non-catastrophic derailments predicted based on extrapolation of the existing U.S. safety history in the previous section. PHMSA believes that the occurrence of 10 such higher consequence events occurring in the U.S. is unlikely – PHMSA considers that to be the upper bound for event frequency. The lower bound estimate is zero. Under the lower bound estimate, there are still expected to be rail incidents involving flammable liquids, but none that rise to the higher-consequence event level.

(2B) Estimated Magnitude of a Higher-Consequence Event

We examined three possible methods for estimating the damages that might result from a higher-consequence event. The first method would be to use the existing U.S. safety record and scale up the damages of one or several of the larger rail accidents in the record to account for possible risk factors which might exacerbate the consequence of the incident if a similar accident were to

[35] http://www.pressherald.com/2014/04/17/after-end-of-the-world-explosion-lac-megantic-aims-to-rebuild/

occur under different circumstances. Risk factors include condition of the track and supporting infrastructure; the presence or absence of signals; past incidents; population density along the route; environmentally-sensitive or significant areas; venues along the route (stations, events, places of congregation); emergency response capability along the route; measures and countermeasures already in place to address apparent safety and security risks; and proximity to iconic targets. For example, a 2009 19-car derailment in Cherry Valley, IL spilled about 230,000 gallons, caused a fire resulting in 1 fatality, 2 injuries, and $7.9 million in property damages, according to the NTSB. If this event had occurred in a more populated area, the consequences could have been significantly larger. This approach would involve placing such an event in another location, and adjusting total costs according to the likely increase in the value of property damaged and number of fatalities that may have resulted. For instance, property values and population densities are much higher in Chicago, IL. If the same event occurred in Chicago the value of the property damaged would have been much higher, and the damaged infrastructure may have imposed much larger delay costs to commuters and the overall rail network. In addition, more injuries and fatalities may have resulted, though it would be difficult to predict how many fatalities would result from such an event given that fatalities would depend on the exact concentration of people in a particular place at a particular time. As noted below, we seek comment on data sources and approaches we could use to improve the modeling approach for estimating damages associated with higher consequence events described below.

This exercise could be conducted for several other recent events involving crude and ethanol. For example, the derailment in Arcadia, OH, occurred very close to a fertilizer plant. Had the derailment hit the plant an anhydrous ammonia explosion on the order of that which occurred in West, TX,[36] may have occurred, resulting in much more severe damages. The train that derailed and punched a 35 foot hole in the wall of an industrial facility in Vandergrift, PA this past January was carrying heavy crude.[37] Had that train been loaded with more easily ignited ethanol or light, sweet crude, a violent release of ignited flammable liquid may have occurred, potentially killing some or all of the 65 employees working at the facility. Alternatively if the same derailment occurred in the neighboring borough of East Vandergrift the consequences might have been much worse. The derailment in Lynchburg, VA, had it occurred to the town rather than river side of the track, may have hit a busy lunchtime eatery, resulting in multiple fatalities despite the fact that only one car ruptured. A derailment on a bridge upstream from a reservoir that supplies drinking water to several communities or one large city could result in extensive costs to the municipality if the reservoir were contaminated and the communities that rely on it had to find an alternative supply for drinking water. Scaling up these events based on differences in location, tank car contents, or events, would require making assumptions about when and where such events might have occurred and what consequences would have resulted from those events in alternate locations. Clearly, from the above examples, slight adjustments in

[36] http://www.csb.gov/west-fertilizer-explosion-and-fire-/
[37] http://www.reuters.com/article/2014/02/13/us-energy-crude-derailment-idUSBREA1C13120140213

the assumed characteristics of an event could result in dramatic increases in event consequences. It is unclear to PHMSA what assumptions would be reasonable.

PHMSA acknowledges that event severity, especially property damage, is likely to be correlated with total quantity of product released, the geographic and environmental aspects of the location in which the event occurs, the proximity of high concentrations of people in said vicinity. Ideally, given enough information, the PHMSA would adjust high consequence event damages for all of these factors. We seek comment on how better to scale event damages for these various parameters.

For the remaining two methods, PHMSA instead looked to the estimated damages of the accident at Lac-Mégantic, Quebec to illustrate the potential benefits of preventing or mitigating higher-consequence events. PHMSA believes that no other higher consequence events have occurred that could better serve as the basis for estimating the damages from these events. We acknowledge that there is uncertainty about the potential magnitude, since there has only been one such event in North American rail history.

PHMSA considers $1.2 billion in damages to be a somewhat conservative measure of the damages that could be caused by a higher consequence event. For example, the event at Lac Mégantic Quebec produced damages close to half a billion dollars in terms of loss of life. Cleanup costs associated with the event, which had initially been estimated at $200 million, are now being estimated at twice that amount. It is still unclear when the lake and river that drain from the lake will be completely cleaned up, and the nearly the entire downtown has yet to begin reconstruction a year later. The value of lost business activity, temporary unemployment of those working at the businesses destroyed, etc. may be much more than the initial estimates on which the $1.2 billion figure are based suggest.

We considered several factors when deciding how to scale the damages from Lac Mégantic. For example, it is highly unlikely that there would be a derailment at 65 mph and the tank car standards proposed here are not intended to be sufficient to prevent a puncture at this speed and force —the highest speed of derailments in the U.S. safety record for ethanol and crude is 48 mph, and the rail industry has agreed to limit speeds for crude and ethanol unit trains to 50 mph. Similarly, it is highly unlikely that a 63-car derailment would occur—the largest derailment in the U.S. crude and ethanol record is a 31-car derailment. While speed and number of cars derailing will contribute to the severity of an accident and impact damages, we have not scaled down the damages from Lac Mégantic to account for a smaller expected number of cars derailed and lower speeds for two reasons. First, we believe extraordinary damages could have occurred even if the train in Lac-Mégantic had derailed at a slower speed. There have been large pool fires in many derailments that occurred at slower speeds. For example the accidents in Arcadia, OH, Aliceville, AL and Casselton, ND had pool fires.[38] Second, extraordinary damages may have

[38] See Appendix B for full details of these events.

occurred even if the train in Lac-Mégantic had only involved 20 or 30 cars. The damages were so high in Lac-Mégantic in part because the downtown area was so close to the track, where the train derailed. PHMSA seeks comment on what factors may contribute to event severity, including speed at time of derailment, the number of tank cars derailed, the number of tank cars that rupture, and whether it would be appropriate to scale high consequence events by these factors.

One factor which we believe has an important impact on the damages of an ethanol or crude accident is the population density where the accident occurs. The presence of a place of congregation was a particularly important factor in the damages from Lac-Mégantic. While imperfect, population density is a proxy for the presence of places of congregation. Other factors may affect the severity of an accident and we seek comment on appropriate factors to inform the analysis and sources of data for those factors. Population density is likely to affect the size of any property damages and the number of any injuries or fatalities. We modify the estimated potential damage figure by weighting the estimated damages from the Lac-Mégantic, Quebec rail accident (estimated cost of $1.17 billion) by the average track-mile weighted density along crude oil and ethanol routes in the U.S. Scaling potential risk by population density is a technique used frequently in the literature on the safety of hazardous material shipments. For example Verma uses population exposure as a component of a risk assessment framework for hazardous materials shipments by rail.[39,40] Glickman et al. uses population density as a risk factor to be used in making rail routing decisions for hazardous materials shipments.[41] Saat and Barkan use the number of people affected, which is a function of population density, to scale the consequence levels of hazardous materials rail accidents.[42] Kawprasert also uses population density as a factor that influences hazardous material risk.[43] It seems reasonable, given this body of research, to scale our damages to the average track mile weighted population density along U.S. crude and ethanol routes.

This population density, generated by a GIS analysis of Census blocks adjacent to crude and ethanol routes, is estimated at 141 people per half square km. PHMSA and FRA obtained this population density estimate as follows:

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[39] Verma, Manish. 2009. Railroad transportation of dangerous goods: a conditional exposure approach to minimize transport risk. Transportation research part C.

[40] Verma, Manish. 2009. A cost and expected consequence approach to planning and managing railroad transportation of hazardous materials. Transportation research part D

[41] Glickman, Theodore S., Erkut, Efhan, and Zschocke, Mark S. 2007. The cost and risk impacts of rerouting railroad shipments of hazardous materials. Accident Analysis and Prevention. 39. 1015-1025.

[42] Saat, M. Rapik, and Barkan, P.L. 2006. The effect of rerouting and tank car safety design on the risk of rail transport of hazardous materials. Proceedings of the 7th world congress on railway research. Montreal. June.

[43] Kawprasert, Athaphon. 2010. Quantitative analysis of options to reduce risk of hazardous materials transportation by railroad. Ph.D. Dissertation in civil engineering. University of Illinois at Urbana-Champaign.

- Selected appropriate records from the Confidential Surface Transportation Board 2012 Waybill Sample using Surface Transportation Commodity Codes "1311110" for crude oil and "28184" for ethanol.
- Assigned selected fuel waybill records to a routable rail network (scale 1:100,000) based on railroad ownership, trackage rights, and historical route densities. Identified all crude and ethanol rail corridors within the United States. The resulting rail fuel network includes all originating, terminating, and intermediate stations (nodes) and all rail links traversed by fuel cars. The process identified 20,420 rail links totaling 36,500 railroad miles. Rail link length ranged from .005 to 25 miles, with average link length at 1.8 miles. Over 10,500 rail links are less than 1 mile long.
- The 2010 Census Block data provides GIS population data down to the block level and includes over 11 million records. A 1 kilometer-wide buffer zone (1/2 kilometer on either side of the track) was imposed over the fuel rail network using GIS software. A half kilometer on either side was chosen to reflect the impact zone for the Lac-Mégantic incident.[44] Then the Census Blocks that overlap with that buffer zone are identified. Density was calculated for each Block by dividing population by the area, which yields the population per square km.
- The population per square km was weighted by the length of the rail link yielding "average weighted population density per rail route mile."[45] The average weighted population density per rail route mile was calculated over the entire 34,500 mile, 20,420 rail link fuel network. This calculation yielded an average value of 283 persons living within the 1 kilometer-wide buffer zone of the rail network (1/2 kilometer on either side of the track).
- For verifications, these results were compared to Census maps and 2006 Census Track Data.

The population density of Lac Mégantic, Quebec, is 136 people per half square km. The weighting factor is calculated by dividing the population density for Lac Mégantic into the average track weighted population density for communities along U.S. crude and ethanol routes, 141/136 (1.035). When multiplied by the total damages from the Lac-Mégantic accident, this generates an estimated average cost of $1.21 billion per event. To estimate the high end of the

[44] http://www.bloomberg.com/news/2013-07-06/train-carrying-crude-derails-in-quebec-town-sparking-explosions.html. This article reports that explosions and fires were concentrated in an area about one square kilometer, which indicates that a half-kilometer on either side of the track is a reasonable assumption. Another source provides a map that shows that the blast radius was about 125 meters (http://news.nationalpost.com/2013/07/07/graphic-timeline-of-key-events-in-quebec-train-disaster/). If PHMSA were to choose a smaller distance, the results would be different because there are some Census Blocks that would no longer overlap with the buffer zone. The weighted average population density would be larger if areas tend to be denser when very close to railroad corridors, and it would be smaller if areas tend to be less dense when very close to rail corridors.

[45] For Census Blocks that include an entire rail link, the population density of that Block was applied to the rail link. For rail links that include more than one Census Blocks, the population density along the rail link is taken as a weighted average of the population density of the Census Blocks—the weighting is for the proportion of the rail link's buffer zone area that each Census Block occupies.

range of benefits, we assume 9 events of this higher consequence scale will occur over the next 20 years in addition to the 5-15 lower consequence accidents.

In addition, to capture the possibility of an event exceeding the “typical” higher consequence event, we assume a 10th event occurs over the next 20 years in an area that is five times denser than average. This one event would produce roughly $6 billion in total undiscounted damages. Such an event is unlikely, but such damages could occur when a substantial number of people are harmed or a particularly vulnerable environmental area is affected. PHMSA invites comment on these assumptions, and on the extent to which population density may vary between crude oil routes and ethanol routes.

(2C) Potential and Expected Higher-Consequence Damages

The description above presents the methodology used by PHMSA to generate a range for the potential damages caused by higher consequence events. These events exceed the “typical” derailment event because they would result either in multiple fatalities or injuries, or would cause greater environmental damages than a typical derailment. The upper bound for the damages resulting from any one particular event was described as five times as great as the damages resulting from the event that occurred at Lac Mégantic, Quebec, adjusted for the track weighted population density along U.S. crude oil and ethanol routes.

Because of the uncertainty in the frequency and magnitude of these events we conducted a sensitivity analysis and present a range of potential damages based on a range of event frequency and magnitude.

We present figures for zero events and ten events and the associated undiscounted damages. As explained above, we assume that one of those ten events takes place in an area that is five times denser than average.

We expect an enhanced jacketed CPC 1232s (i.e., CPC 1232 cars with upgraded pressure relief valves and bottom outlet valve improvements) to be the baseline car going forward for newly constructed cars. These cars are estimated to mitigate impacts in comparison to the legacy DOT Specification 111 by roughly 40 percent. We reduce damages based on the proportion of jacketed CPC 1232 cars in the fleet. The methodology by which this is done is described in more detail in the baseline damages section, but we repeat it here: jacketed CPC 1232s are expected, if no regulation is imposed, to make up roughly 40 percent of the fleet by 2019. These cars also improve safety by roughly 40 percent when compared to legacy DOT Specification 111s. Thus, safety performance is expected to improve significantly for 40 percent of the fleet in absence of regulation. Expected damages are estimated at actual predicted damages for 60 percent of the fleet in absence of regulation. Baseline damages are calculated by the following calculation: (0.6 (percentage of fleet made up by legacy vehicles) x (lower consequence + higher consequence event damages)) + (0.4 x 0.6 x (lower consequence + higher consequence event damages). In the second term of this equation the .6 denotes the percentage of remaining damages after the improved safety performance of the jacketed CPC car are controlled for, and .4 is the percentage of jacketed CPC cars in the fleet without regulatory intervention. This calculation is done for the 20 year analysis period and summed to produce total benefits incorporating the upper end of higher consequence event damages. This adjustment puts the damages of 9 events in an average area at $1 billion per event, and the event that takes place in an area five times as dense would produce roughly $5 billion in total damages. Table B9 below presents upper higher consequence event damages over 20 years.

Table B9. Higher Consequence Event Damages

Year	High Consequence Event Damages - 9 events, undiscounted	High Consequence Event Damages - 1 event, 5 x greater undiscounted
2015	$456,367,240	$253,537,355
2016	$451,002,580	$250,556,990
2017	$446,317,408	$247,954,112
2018	$442,221,039	$245,678,357
2019	$438,638,756	$243,688,199
2020	$440,778,552	$244,876,968
2021	$442,943,571	$246,079,765
2022	$445,134,162	$247,296,754
2023	$447,350,582	$248,528,104
2024	$449,593,163	$249,773,984
2025	$451,862,217	$251,034,565
2026	$454,158,037	$252,310,021
2027	$456,480,954	$253,600,527
2028	$458,831,262	$254,906,262
2029	$461,209,329	$256,227,404
2030	$463,615,449	$257,564,135
2031	$466,049,951	$258,916,640
2032	$468,513,186	$260,285,105
2033	$471,005,483	$261,669,717
2034	$473,527,195	$263,070,668
Total	$9,085,600,117	$5,047,555,634

Clearly, events can vary in magnitude. The worst case scenario used in this analysis is a single event that resulted in impacts even greater than 5 times the average higher consequence event. However, the presentation of a range of figures must be limited by the practicality of presenting and analyzing a finite number of figures. We apply effectiveness rates for the various provisions of the proposed rule to these figures to obtain estimated benefits for each provision, and the proposed rule as a whole.

(2D) Monte Carlo Approach

PHMSA explored a third method to estimate the expected magnitudes associated with the projected higher-consequence events and seeks comment on its development.[46] This method also uses the damage estimates for the Lac-Mégantic accident in conjunction with an estimated population density of the areas within a half-square km of crude oil and ethanol routes in the U.S.[47] The table below provides the summary distribution based on over 20,000 values from FRA:

Table B10. Distribution of Population Densities along Crude Oil and Ethanol Rail Routes

[46] The methodology in this section were not used to calculate the benefits of the proposed rule.
[47] Federal Railroad Administration model and methodology developed for all crude oil and ethanol rail corridors and based on 2010 Census Block and Geographic Information System (GIS) population data.

Percentile	Population density per half-square km	Percentile	Population density per half-square km	Percentile	Population density per half-square km	Percentile	Population density per half-square km
100.0	5525.53	74.0	121.20	49.0	29.08	24.0	4.57
99.0	1507.25	73.0	114.51	48.0	27.44	23.0	4.09
98.0	1096.83	72.0	107.77	47.0	26.00	22.0	3.62
97.0	903.06	71.0	101.36	46.0	24.35	21.0	3.20
96.0	771.85	70.0	95.67	45.0	22.91	20.0	2.85
95.0	683.86	69.0	90.05	44.0	21.70	19.0	2.49
94.0	596.55	68.0	85.27	43.0	20.40	18.0	2.19
93.0	538.13	67.0	80.21	42.0	19.16	17.0	1.91
92.0	485.83	66.0	74.99	41.0	17.96	16.0	1.62
91.0	443.15	65.0	71.11	40.0	16.74	15.0	1.39
90.0	402.73	64.0	67.11	39.0	15.67	14.0	1.17
89.0	365.40	63.0	63.53	38.0	14.56	13.0	0.98
88.0	334.30	62.0	60.02	37.0	13.63	12.0	0.81
87.0	306.59	61.0	56.30	36.0	12.72	11.0	0.65
86.0	285.47	60.0	53.41	35.0	11.78	10.0	0.51
85.0	260.43	59.0	50.57	34.0	10.90	9.0	0.39
84.0	240.50	58.0	47.87	33.0	10.15	8.0	0.29
83.0	223.01	57.0	45.30	32.0	9.42	7.0	0.20
82.0	207.37	56.0	42.97	31.0	8.63	6.0	0.13
81.0	193.38	55.0	40.90	30.0	7.94	5.0	0.08
80.0	180.83	54.0	38.74	29.0	7.32	4.0	0.03
79.0	168.96	53.0	36.43	28.0	6.78	3.0	0.01
78.0	157.02	52.0	34.33	27.0	6.21	2.0	0.00
77.0	146.93	51.0	32.48	26.0	5.66	1.0	0.00
76.0	136.86	50.0	30.72	25.0	5.11	0.0	0.00
75.0	128.78						

The FRA calculations yield an average value of approximately 141 persons per half-square km. This estimate is roughly the same as the average population density of the Lac-Mégantic town. The blast resulting from the Lac-Mégantic derailment and accident covered a half square km. The average population density of the Lac-Mégantic town is approximately 136 people per half-square km[48] (272 people per square kilometer divided by 2). The number of fatalities as percentage of the average population density in the Lac-Mégantic accident is 34% (47 fatalities divided by the average population density per half-square kilometer of 136).

[48] The town of Lac-Mégantic has a population of 5,932 aaccording to the Canada 2011 Census. The town occupies a land area of 21.77 square kilometer and a population density of 272.5 inhabitants per square kilometer.

PHMSA has projected the number of high-consequence events that are likely to occur over the next 20 in the absence of this proposed rule. This would result in approximately 5 catastrophic events over the next 20 years.

For purposes of this estimation, the costs include fatalities,[49] property damage to the town, environmental and other cleanup costs, the costs associated with re-routed train traffic, evacuation and emergency response costs, and the value of the rail cars and oil that was lost.[50]

PHMSA developed a risk model to estimate a range of catastrophic damages by accounting for the uncertainties surrounding these estimates and to acknowledge that the cleanup and reconstruction efforts are still unfolding one year after the July 6, 2013, derailment and explosion in Lac-Mégantic, Quebec. The fatality and non-fatality damages are dependent on the draw of the population density random variable. Any realized values will be highly correlated. The model represents a Monte Carlo simulation[51] by substituting a range of values—a probability distribution—for these factors that have inherent estimation uncertainty as seen in the table below:

[49] The U.S. Department of Transportation (USDOT) has established a Value of Statistical Life (VSL) of $9.2 million for 2014 (http://www.dot.gov/policy). USDOT's guidance specifies that the VSL is expected to rise by 1.18 percent per year in response to expected increases in real incomes. That means that, over the 20-year analysis period, the VSL will rise to a value of $11.8 million in the 20th year, and will have an average value over the 20 years of the analysis of $10.55 million. PHMSA uses this value to monetize the casualty costs.

[50] PHMSA used an estimate of non-fatality damages for the Lac-Mégantic accident of $658,275,160, which represents damages other than those associated with lives lost.

[51] Monte Carlo simulation performs an analysis by building models of possible results by substituting a likely range of values for any factor that has inherent uncertainty. The simulation then calculates results over and over, each time using a different set of random values from the probability functions, to generate a probability distribution of possible outcomes.

Table B11. Assumed Distribution of Input Values for Monte Carlo Analysis

Risk Variables	Probability distribution	Point estimate	Low	Mode	High
# of events	triangular*	5	2.5	5	7.5
Percent of Population Fatalities	triangular*	34%	25.5%	34.0%	37.4%
Baseline Non-Fatality Value ($)	triangular*	658,275,160	493,706,370	658,275,160	822,843,950
Random Selection of Population Density	custom**	141.000			

Notes:

*We chose a triangular distribution for most elements because of its ease of use and because it can show a lower limit, an upper limit and a mode for our inputs. Due to definite lower and upper limits we can avoid extreme values.
**The population density distribution is a custom distribution with points given by each of the percentiles from 0th percentile to 100th percentile in the table above titled "Distribution of Population Densities along Crude Oil and Ethanol Rail Routes."

The model executes 10,000 iterations on the forecasted inputs. Given the distribution of forecasted possible inputs presented in the table above, and assuming an event has an equal likelihood of occurrence every year, the following table shows a sampling of 40 possible sets of alternative outcomes (and the damages resulting from those outcomes) that might occur over the 20-year analysis period.

The scaling factor is calculated by dividing the population density by 136 (which is the population density per half-square-km for Lac-Mégantic). This assumes a linear response to changes in population density, a simple but conservative assumption for high-density areas. The non-fatality damage estimates are calculated by multiplying the non-fatality damages by the number of events and by the scaling factor relative to Lac-Mégantic.[52] The fatality damage estimates are calculated by multiplying the number of events by the percent of population fatalities, the population density, and the average VSL value over the 20-year period of analysis as determined above.[53]

[52] For instance, the value calculated for the first iteration $696.6 million = number of events * scaling factor * non-fatality damages = (6.36* 0.24 *$647.5 million)

[53] For instance, the value calculated for the first iteration is $981.3 million = number of events * percent of population fatalities * population density per half-square kilometer * average VSL over the 20-year period of analysis = (6.36 * 0.32 * 32.48 * $10.55 million).

Table B12. Sample Outputs of the Risk Model Showing 20-Year Values for Fatality and Non-Fatality Damages

# of Events	Percent of Population Fatalities	Population Density per half-square km	Scaling Factor	Non-Fatality Damages* (million)	Damages-Fatality (million)	Damages-Non-Fatality (million)
6.36	0.32	32.48	0.24	$647.5	$981.3	$696.6
5.68	0.35	36.43	0.27	$766.2	$1,163.8	$766.5
5.25	0.32	24.35	0.18	$705.9	$662.7	$429.2
3.84	0.29	157.02	1.15	$691.7	$3,060.8	$1,826.0
5.68	0.32	34.33	0.25	$671.2	$960.3	$651.2
5.14	0.35	29.08	0.21	$759.7	$833.7	$552.0
3.57	0.27	38.74	0.28	$725.8	$737.2	$387.5
5.33	0.31	19.16	0.14	$660.6	$495.5	$332.0
4.14	0.32	157.02	1.15	$745.9	$3,556.7	$2,215.9
3.64	0.31	2.49	0.02	$576.2	$38.4	$29.6
2.97	0.32	0.51	0.00	$640.4	$7.1	$5.1
3.90	0.35	10.90	0.08	$528.2	$164.7	$158.0
5.32	0.34	0.13	0.00	$721.0	$3.7	$2.5
4.73	0.28	5525.53	40.56	$572.7	$109,931.9	$78,343.1
5.83	0.35	107.77	0.79	$672.6	$3,101.3	$2,298.9
4.95	0.31	485.83	3.57	$618.1	$10,919.4	$7,891.8
4.48	0.34	40.90	0.30	$575.0	$773.7	$664.0
4.27	0.31	180.83	1.33	$568.7	$3,221.0	$2,557.9
4.86	0.35	2.19	0.02	$770.3	$60.2	$39.8
4.25	0.35	193.38	1.42	$609.9	$3,681.9	$3,005.5
5.44	0.33	22.91	0.17	$750.4	$686.7	$439.5
5.85	0.33	0.00	0.00	$662.0	$0.0	$0.0
5.61	0.32	38.74	0.28	$694.5	$1,107.5	$741.3
5.83	0.32	0.08	0.00	$628.3	$2.1	$1.6
3.97	0.34	80.21	0.59	$551.3	$1,288.9	$1,147.4
5.09	0.35	1507.25	11.06	$657.4	$37,035.8	$28,002.0
4.78	0.31	6.78	0.05	$587.0	$139.6	$106.0
5.35	0.32	22.91	0.17	$739.0	$664.3	$413.5
5.66	0.35	6.21	0.05	$645.8	$166.4	$128.7
6.94	0.36	402.73	2.96	$688.9	$14,130.8	$10,676.9
5.94	0.35	56.30	0.41	$671.1	$1,646.0	$1,250.9
5.01	0.36	538.13	3.95	$727.1	$14,395.0	$10,167.4
3.10	0.36	8.63	0.06	$579.9	$113.7	$100.9
3.87	0.34	136.86	1.00	$679.2	$2,640.6	$1,877.9
4.49	0.26	0.81	0.01	$654.3	$17.4	$10.0
4.75	0.34	10.90	0.08	$687.2	$261.4	$185.3
4.46	0.31	306.59	2.25	$676.0	$6,784.2	$4,503.5
4.93	0.35	260.43	1.91	$755.1	$7,114.4	$4,710.5
4.58	0.28	5.66	0.04	$516.7	$98.5	$77.8
5.49	0.36	4.57	0.03	$656.5	$120.8	$94.5

Note: *The value varies randomly according to the triangular distribution of non-fatality damages set forth in table titled "Assumed Distribution of Input Values for Monte Carlo Analysis."

The distribution of total estimated damages from high-consequence events over 20 years is shown as a percentile distribution from 0% to 100% in 5-percentile increments as follows:

Table B13. Distribution of Total Estimated Damages from High-Consequence Events over 20 years

Percentile	Damages-Fatality (million)	Damages-Non-Fatality (million)	Total Damages (million)
0%	$0	$0	$0
5%	$1	$2	$3
10%	$8	$11	$18
15%	$22	$32	$54
20%	$50	$71	$121
25%	$89	$126	$215
30%	$136	$191	$327
35%	$198	$280	$478
40%	$280	$400	$681
45%	$378	$537	$915
50%	$508	$717	$1,225
55%	$670	$942	$1,612
60%	$892	$1,263	$2,155
65%	$1,181	$1,682	$2,862
70%	$1,596	$2,268	$3,864
75%	$2,167	$3,074	$5,242
80%	$3,018	$4,288	$7,306
85%	$4,441	$6,346	$10,786
90%	$6,924	$9,826	$16,750
95%	$12,281	$17,653	$29,934
100%	$137,693	$202,848	$340,540

The mean of this distribution (i.e., the average estimated non-discounted total damages from high-consequence events over 20 years is $7.6 billion.[54] The median of the distribution (i.e., the 50th percentile) is $1.2 billion. The mean represents the average of all possible future outcomes (including some with extremely high damages); the median represents the outcome that has an equal probability that the actual outcome will be higher or lower than the median. The 80th percentile value ($7.3 billion) indicates that there is a 20-percent chance that the damages could be higher than $7.3 billion.

[54] For increased accuracy, this estimate is based on total high-consequence events damage estimate damage estimate over 20 years as a percentile distribution from 0% to 100% in one percentile increments rather than five percentile increments.

(2E) Higher Consequence Event Summary

PHMSA uses the approach described earlier, in which it assumes a specific range of catastrophic damages, to estimate the benefits of the provisions of this proposed rule. PHMSA seeks comment on whether the Monte Carlo approach described here might be a better way to produce a more accurate estimate of the likelihood of expected benefits. PHMSA also seeks comment on what assumptions should be made regarding the central estimates for variables included in the analysis, and their probability distributions.

Table B14 below summarizes the assumptions inherent in both the baseline and catastrophic damage estimates.

Table B14. Comparison of Assumptions: Lower and Higher Consequence Events

	Lower Consequence Events		**Higher Consequence Events (accidents with significant loss of life)**	
	U.S. Historical record *(1)*	**Projected 2015-2034**	**U.S. Historical Record**	**Projected 2015-2034** *(5)*
Number of Annual Mainline Crude/ Ethanol Derailments	5 *(2)*	10.5	0	0 to 0.5
Number of Mainline Crude / Ethanol Derailments Per Million Carloads	12.8 *(2)*	11	0	0 to 0.6
Population density per half sq. km along crude/ethanol rail lines	141 Per Half Square KM	No change assumed	N/A	141 (for 9 accidents) and 705 (10th accident)
Average Speed at Derailment (mph)	25.1 (2006-13)	No change assumed	N/A	65
Average Cars Derailed, per Mainline Derailment	5 (2006-14)	5	N/A	63
Average Non-Medical Cost, Per Gallon Released	$5.50(3)	$300 (3)	N/A	$632 (for 9 accidents) and $3,160 (for 10th accident) (6)
Average Gallons of Product Lost, Per Mainline Derailment	83,602 (2006-14)	83,602	N/A	1,580,000
Number of non-hospitalized injuries per mainline derailment	0.048(4)	.048	N/A	0
Number of Hospitalized Injuries Per	0.014 (4)	0.014	N/A	0

Mainline Derailment				
Number of Fatalities Per Mainline Derailment	.048(4)	0.048	N/A	49 (for 9 accidents) and 245 (for 10th accident) (7)
Adjustment to total damages made to account for industry adoption of CPC1232 jacketed cars	N/A	.6 x % new CPC in year	N/A	0.6 x % new CPC in Year(8)

(1) As a result of data limitations, estimates use varying source data and time periods to estimate the U.S. historical record. See notes (2), (3), and (4).

(2) Estimate is for 2006 to 2014 is for the number of mainline crude and ethanol derailments and is based on formula derived from the derailment rate per million carloads for *all commodities*, 1995 to 2012. PHMSA uses historical data to estimate a linear formula that accounts for a decrease in derailments as a result of regulatory and voluntary safety efforts. The formula is: derailment rate = 1.25(year) – 2564.47.

(3) Based on the Lynchburg, VA accident. PHMSA does not have data on most previous accidents that is sufficiently reliable to estimate Non-Medical costs using a greater number of accidents.

(4) Estimated based on the number of injuries and fatalities per million carloads for *crude oil and ethanol,* 2006 to 2013. PHMSA estimated the number of injuries and fatalities, carloads, and derailments (see note (2) for derailment rate) to calculate the rate of injuries and fatalities per derailment.

(5) The Lac-Mégantic accident in Canada is used as the basis for projecting damages that could occur from a catastrophic accident. That accident resulted in the deaths of 47 people and $658.275 million in non-medical damages. Projected damages for high-consequence events is scaled based on the difference in population density between the town of Lac-Mégantic (136), and average population density along crude/ethanol routes in the U.S (141). The scale-up factor for the nine high-consequence events is 141/136=1.03. The tenth event is estimated to occur at a population density about five times greater than the other nine high-consequence event.

(6) Estimated as Lac-Mégantic non-medical damages per gallon lost ($658.275 million / 1,580,000 gallons lost) multiplied by the scale-up factors described in note (6). See Appendix C for a description of Lac-Mégantic damages.

(7) Estimated as Lac-Mégantic fatalities per mainline derailment (47, up to 10 derailments) multiplied by the scale-up factors described in note (6). This assumes fatalities for 36% of the population within a half-square kilometer of a hypothetical accident. See Appendix C for a description of Lac-Mégantic damages.

(8) Damages were estimated based on accidents involving DOT-111 tank cars. Because PHMSA assumes—in the absence of regulations—all newly constructed cars will be Modified CPC 1232s, we adjust the damage pools to reflect higher performance standards of the Modified CPC 1232 relative to the DOT-111 car. Enhanced Jacketed CPC 1232's are anticipated to be 40 percent more effective than the DOT-111, and we reduce damages annually based on this difference in effectiveness and the proportion of jacketed CPC 1232 cars expected to be in the fleet.

PHMSA seeks comments on the following questions regarding our estimates of the number and costs of higher-consequence events. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, include supporting data, and explain the source, methodology, and key assumptions of the supporting data.

1. What factors should PHMSA consider when estimating the likely number and range of higher consequence accidents that may occur over the next 20 years?
2. Under the second approach outlined above (based on the Lac- Mégantic accident), what risk factors, in addition to population density, should PHMSA consider when scaling the estimated damages from the Lac-Mégantic accident? When using population density to scale the accident, are there other blast area or methodology PHMSA should consider? How should population density factor into estimating fatality rates within the blast area? In this analysis, is it reasonable to assume a 34% fatality rate?
3. In the second approach outlined above, PHMSA assumes that an accident involving 20-30 cars derailed would generate a similar level of damages to Lac-Mégantic accident, which involved over 60 cars derailed. Is this a reasonable assumption?

4. We request comment on the extent to which particular factors impact damages and the sources of data available on which PHMSA can evaluate how those factors affect damages and to what extent those factors vary along the routes.
5. Would the Monte Carlo approach using damages associated with the Lac-Mégantic accident be a better way to produce a more accurate range of expected benefits?
6. In a Monte Carlo analysis, what assumptions should PHMSA make regarding what variables should be included in the analysis, the central estimates for variables included in the analysis, the upper and lower bounds for each variable, and their probability distributions?
7. Another method would be to use the existing U.S. safety record and scale up the damages of one or several of the larger incidents in the record to account for possible risk factors which might exacerbate the consequence of the incident if a similar accident were to occur under different circumstances. PHMSA seeks comment on what risk factors may be appropriate to consider and how they could be expected to increase damages when present.
8. Another method would be to no longer divide the damage pool into higher-consequence and lower-consequence events, but instead use the existing U.S. safety record and increase the expected damages per derailment to incorporate the potential for higher-consequence events that are not in that record.
9. What other strategies for modeling low probability/higher-consequence events should PHMSA consider?
10. To what extent does population density vary between crude oil routes and ethanol routes?

Estimated Benefits

To estimate the benefits of this proposed rulemaking PHMSA has estimated the effectiveness rates of several of the provisions. The effectiveness rates of the requirements are interdependent and some requirements, such as routing, can mitigate both the likelihood and the consequences of an accident. The table below presents the total undiscounted damage pool from which benefits are derived.

Table B15. Summary of Total Estimated Damages

Year	High Consequence Event Damages - 9 events, undiscounted	High Consequence Event Damages - 1 event, 5 x greater undiscounted	Total Upper Bound High Consequence Event Damages	Lower Consequence Damages, Undiscounted	Total Damages, undiscounted
2015	456,367,240	253,537,355	709,904,595	324,766,789	1,034,671,384
2016	451,002,580	250,556,990	701,559,570	318,884,170	1,020,443,740
2017	446,317,408	247,954,112	694,271,520	308,663,025	1,002,934,545
2018	442,221,039	245,678,357	687,899,396	298,295,776	986,195,172
2019	438,638,756	243,688,199	682,326,956	288,643,480	970,970,436
2020	440,778,552	244,876,968	685,655,520	281,434,410	967,089,930
2021	442,943,571	246,079,765	689,023,335	270,809,946	959,833,281
2022	445,134,162	247,296,754	692,430,916	260,009,356	952,440,272
2023	447,350,582	248,528,104	695,878,686	247,544,695	943,423,381
2024	449,593,163	249,773,984	699,367,147	235,986,002	935,353,149
2025	451,862,217	251,034,565	702,896,782	222,740,573	925,637,355
2026	454,158,037	252,310,021	706,468,058	207,555,533	914,023,591
2027	456,480,954	253,600,527	710,081,482	194,572,178	904,653,660
2028	458,831,262	254,906,262	713,737,524	181,329,509	895,067,033
2029	461,209,329	256,227,404	717,436,733	168,161,828	885,598,562
2030	463,615,449	257,564,135	721,179,584	155,257,392	876,436,976
2031	466,049,951	258,916,640	724,966,592	143,242,575	868,209,167
2032	468,513,186	260,285,105	728,798,291	131,588,225	860,386,515
2033	471,005,483	261,669,717	732,675,201	120,685,763	853,360,963
2034	473,527,195	263,070,668	736,597,863	110,319,319	846,917,182
Total	9,085,600,117	5,047,555,634	14,133,155,750	4,470,490,543	18,603,646,293

Costs of the Proposed Requirements

This proposal has six separate requirement areas:
Requirement Area 1: Rail Routing
Requirement Area 2: Tank Cars
Requirement Area 3: Speed Restrictions
Requirement Area 4: Braking
Requirement Area 5: Classification of Mined Liquids and Gases
Requirement Area 6: Notification to SERCs.

In each requirement area the “Proposed Actions” are derived directly from the NPRM. The alternatives considered by PHMSA are discussed separately and include a review of the costs for each proposed requirement. PHMSA regards the cost estimate as conservative. In all likelihood, the combined forces of the market and technology may result in costs lower than those forecasted.

Requirement Area 1 – Rail Routing

Proposed Action: Expansion of Hazardous Materials Route Planning and Selection

PHMSA is proposing to require rail carriers develop and implement a plan that will result in the use of a safer and more secure route for certain trains transporting high hazard flammable liquid.

Determination of Need

There has long been considerable public and Congressional interest in the safe and secure rail routing of security-sensitive hazardous materials. In 2008, PHMSA, in coordination with the FRA and the Transportation Security Administration (TSA), issued a final rule requiring, among other things, that rail carriers compile annual data on certain shipments of explosive, toxic by inhalation (TIH or PIH), and Class 7 (radioactive) materials; use the data to analyze safety and security risks along rail routes where those materials are transported; assess alternative routing options; and make routing decisions based on those assessments (73 FR 20752). These requirements were codified at 49 CFR 172.820.

The 2008 rule also requires rail carriers transporting "security sensitive materials" to select the safest and most secure route to be used in transporting those materials, based on the carrier's analysis of the safety and security risks on primary and alternate transportation routes over which the carrier has authority to operate.

The NTSB report of January 23, 2014 states that at a minimum, the route assessments, alternative route analysis, and route selection requirements should be extended to key trains transporting large volumes of flammable liquid. NTSB Recommendation R-14-4 recommends that PHMSA should:

> Work with the Federal Railroad Administration to expand hazardous materials route planning and selection requirements for railroads under Title 49 Code of Federal Regulations 172.820 to include key trains transporting flammable liquid as defined by the Association of American Railroads Circular No. OT-55-N and, where technically feasible, require rerouting to avoid transportation of such hazardous materials through populated and other sensitive areas.

Although Class I rail carriers committed to voluntarily apply routing requirements to trains carrying 20 carloads or more of crude oil as a result of the Secretary's Call-to-Action:

- The voluntary actions do not extend beyond Class I railroads;
- The voluntary actions do not apply to all HHFTs;
- The proposed routing requirements would provide a check on higher risk routes or companies; and
- The proposed routing requirements would ensure that rail carriers continue their

voluntary actions in the future.

Alternatives Considered

Alternative 1: No Action Alternative– Status Quo

Route planning and route selection provisions currently required for explosive, PIH, or Class 7 (radioactive) materials are not required for HHFTs. If the proposed rule is not adopted, railroads would not be required to conduct route risk analysis nor are they required to reroute shipments over lower-risk routes. Specific identified criteria for the route and alternate route analyses may not be uniformly considered by all railroads, and written analyses of primary and alternate routes including safety and security risks would not be required. While the railroads are expected to continue voluntarily implementing these measures for crude oil, they have not made a similar commitment for ethanol trains (though PHMSA believes some of them may do so). The costs to society, the government, and the rail industry of an accident involving large shipments of flammable liquid are high. If no action is taken, the threat of catastrophic accidents in large populated areas or other sensitive environments will continue.

Alternative 2: Apply Routing to HHFTs

This alternative would apply safety and security routing assessments and rerouting to HHFTs. Railroads would be required to assess current routing of these trains as well as practical alternative routes. Railroads would have to choose the lowest risk practical route to move HHFTs. This alternative focuses the routing requirements on the flammable liquid shipments that pose the greatest risk to public safety.

Background

In November 26, 2008 PHMSA issued a final rule that required railroads to select a practicable route posing the least overall safety and security risk to transport security sensitive hazardous materials (Docket HM-232E: 73 FR 72182). The final rule implemented regulations requiring railroads to compile annual data of current shipment of explosives, PIH and Class 7 (radioactive) materials. The key provisions of that final rule are:

- Rail carriers transporting certain types of hazardous materials (materials that DHS has determined to be security-sensitive) must annually compile information and data on the commodities transported, including the transportation routes over which these commodities are transported.

- Rail carriers transporting security-sensitive materials must use the data they compile to annually analyze the safety and security risks for the route(s) used to transport a security-sensitive material. In performing this analysis the rail carrier must seek relevant information from State, local, and Native American Indian tribal officials, as appropriate, regarding security risks to high-consequence targets and the communities' emergency response capability, along, or in proximity to, the route(s) utilized. Rail carriers also are required to use the data to analyze the safety and security of all practicable alternative routes which the carrier is authorized to use. When determining practicable alternative routes, the rail carrier must consider the use of interchange agreements with other rail carriers and the potential economic effects of using the alternative route. The railroad must also consider any remediation measures implemented on a route. Using this process, the carrier must at least annually review and select the practicable route posing the least overall safety and security risk. The initial analysis and route selection must include a comprehensive review of a carrier's entire system. Subsequent analysis and route selection determinations must include a comprehensive, system-wide review of all operational changes, infrastructure modifications, traffic adjustments, countermeasures, changes in the nature of high-consequence targets located along, or in proximity to, the route and changes to community response capabilities, or other changes affecting the safety or security of the movements of the security-sensitive materials that were implemented during the calendar year. Rail carriers are required to maintain a copy (or electronic image thereof) of the data collected and the routing analysis for at least two years and make the records available upon request to authorized officials of the Departments of Transportation and Homeland Security.

- Rail carriers are required to specifically address the security risks associated with security-sensitive shipments delayed in transit or temporarily stored in transit as part of their security plans.
- Rail carriers transporting security-sensitive materials are required to notify consignees if there is a significant unplanned delay affecting the delivery of the materials.
- Rail carriers are required to conduct visual security inspections at ground level of rail cars containing hazardous materials to inspect for signs of tampering or the introduction of an improvised explosive device.

This rule addressed both safety and security concerns associated with the transportation of certain types of hazardous materials, particularly PIH materials. One part of the accompanying proposed rule would apply these route analysis, rerouting, and safety and security requirements to HHFTs. Because PHMSA believes it is rare that commodities other than crude oil and ethanol are shipped in HHFTs, PHMSA restricts the analysis to crude oil and ethanol, though it is possible that small quantities of other flammable liquids could be attached to such trains.

AAR Recommended Railroad Operating Practices for Transportation of Hazardous Materials

At the time that the rail routing rule was promulgated, the rail industry developed a detailed protocol on recommended railroad operating practices for the transportation of hazardous materials. The AAR issued Circular No. OT-55-I (OT-55-I), on August 26, 2005. OT-55-I detailed railroad operating practices for:

(1) designating trains as "key trains" that contain
    (i) five tank car loads or more of PIH materials,

(ii) 20 car loads or intermodal portable tank loads of a combination of PIH, flammable gas, Class 1.1 or 1.2 explosives, and environmentally sensitive chemicals, or

(iii) one or more car loads of spent nuclear fuel or high-level radioactive waste;

(2) designating operating speed and equipment restrictions for key trains;

(3) designating "key routes" for key trains, and setting standards for track inspection and wayside defect detectors;

(4) yard operating practices for handling placarded tank cars;

(5) storage, loading, unloading and handling of loaded tank cars;

(6) assisting communities with emergency response training and information;

(7) shipper notification procedures; and

(8) the handling of time-sensitive materials.

These recommended practices were originally implemented by all of the Class I railroad operating in the United States; short line railroads later joined as signatories.

OT-55-I defined a "key route" as:

> Any track with a combination of 10,000 car loads or intermodal portable tank loads of hazardous materials, or a combination of 4,000 car loadings of PIH (Hazard zone A, B, C, or D), anhydrous ammonia, flammable gas, Class 1.1 or 1.2 explosives, environmentally sensitive chemicals, Spent Nuclear Fuel (SNF), and High Level Radioactive Waste (HLRW) over a period of one year.

Any route defined by a railroad as a key route was required to meet the standards contained in OT-55-I. For example, wayside defective wheel bearing detectors should be placed at a maximum of 40 miles apart, or an equivalent level of protection may be installed based on improvements in technology. Main track on key routes should be inspected by rail defect detection and track geometry inspection cars or any equivalent level of inspection at least twice each year. Sidings on key routes should be inspected at least once a year; and main track and sidings should have periodic track inspections that will identify cracks or breaks in joint bars. Further, any track that is used for meeting and passing key trains should be FRA Class 2 track or higher. If a meet or pass must occur on less than Class 2 track due to an emergency, one of the trains should be stopped before the other train passes. The rail routing enhancements to the existing security rule partly reflected the recommended practices mentioned above, which were already in wide use across the rail industry.

On August 5, 2013 the AAR released a new Circular OT-55-N which expanded the definition of key trains to include any train with 20 or more carloads of any hazardous material.[55] That circular placed the following restrictions on such "key trains" which would include any train with 20 or more cars of flammable liquid:

1. Maximum speed -- "Key Train" - 50 MPH

[55] Available online at http://www.boe.aar.com/CPC-1258%20OT-55-N%208-5-13.pdf

2. Unless siding or auxiliary track meets FRA Class 2 standards, a Key Train will hold main track at meeting or passing points, when practicable.

3. Only cars equipped with roller bearings will be allowed in a Key Train.

4. If a defect in a "Key Train" bearing is reported by a wayside detector, but a visual inspection fails to confirm evidence of a defect, the train will not exceed 30 mph until it has passed over the next wayside detector or delivered to a terminal for a mechanical inspection. If the same car again sets off the next detector or is found to be defective, it must be set out from the train.

In addition to applying a 50-mph speed limit to HHFTs, which is already in effect due to universal compliance with Circular OT-55-N, this proposed rule would incorporate the route analysis and rerouting requirements, as well as the safety and security requirements described above as part of HM-232E to HHFTs. The cost of route analysis and rerouting for PIH trains was considered in 2008 in the regulatory evaluation accompanying the final rule.

Route Analysis Costs (Alternative 2)

On February 21, 2014 the AAR committed to apply the existing routing requirements described above to unit trains with 20 or more carloads of crude oil. Class I railroads have signed on to this agreement, and will voluntarily apply routing requirements to trains carrying 20 carloads or more of crude oil. Since the Class II and III railroads have not signed on to this commitment, the short lines would not voluntarily apply the route analysis requirements to HHFTs, and hence would bear costs associated with analyzing their networks, identifying alternative routes, and rerouting shipments along lower-risk routes where practicable. However, in practice, Class II and III railroads would bear little, if any, cost because much of the work to identify safest routes has already been done in compliance with the previous regulation. In addition most short line railroads operate along a small number of corridors – often only one – and would therefore not have practical alternative routes for HHFTs. These limited networks also mean that analyzing primary and alternative routes would be a minor task with de minimis cost for Class III railroads. As a result, we assume that the costs associated with this requirement would minimal for Class II and III railroads. PHMSA seeks comments on these assumptions.

This rule applies routing requirements to trains carrying 20 or more carloads of crude oil and ethanol. The AAR voluntary commitment only covers crude oil shipments, which leaves open the question of whether any additional burden would be imposed on the requirement to apply route analysis and rerouting to ethanol trains as well. PHMSA believes that the cost of covering HHFTs containing ethanol, given that railroads are already analyzing their networks to identify lower risk routes for PIH and crude oil shipments, would be minimal. The requirement imposed by these regulations is to analyze the entire network to identify lower risk routes. As described in the HM-232E RIA, the per-carrier costs associated with this analysis depend on the size of a carrier's network, which determined the number of primary and alternative routes that must be analyzed. The total costs are influenced by the number of carriers affected – i.e., the number of carriers that haul crude oil, PIH, and other high hazard materials covered by current rail routing requirements, and should the proposed rule be adopted, HHFTs containing ethanol.

PHMSA believes that all Class I and II carriers who haul ethanol also haul these other high-hazard materials. As a result the inclusion of HHFTs containing ethanol would not result in an increase in the number of routes that would have to be analyzed, nor the number of carriers who would have to analyze these routes to identify lower-risk alternatives. Since these networks are already being analyzed to identify lower risk routes for PIH and HHFTs containing crude oil, we believe that only a minimal amount of additional work, resources, or costs would be imposed by the additional requirement of covering high hazard ethanol trains under these requirements. PHMSA seeks comment from the industry on whether this assessment is accurate.

Routing Costs (Alternative 2)

PHMSA proposes to require rail carriers apply safety and security routing assessments and rerouting to HHFTs (Alternative 2). The routing requirements of this proposed rule require rail carriers to use the data it compiles to annually analyze the safety and security risks for the transportation route(s) used to transport HHFTs; analyze this data to establish the primary routes on which it ships HHFTs; analyze its rail network, consider and weigh 27 risk factors to identify any routes that might reduce the risk posed by HHFTs; reassess these risks and routing decisions on an annual basis. Costs associated with the provisions of this NPRM include costs for collecting and retaining data and performing the mandated route safety and security analysis if not already in place. When necessary, off-the-shelf software is available to perform routing assessments. There could be additional fuel, maintenance or shipment time if the analysis reveals a need to reroute high hazard flammable liquid trains that result in increased mileage.

The costs associated with gathering data and analyzing that data using these new requirements are minimal. Rail carriers and shippers may incur costs associated with rerouting shipments or mitigating safety and security vulnerabilities identified as a result of their route analyses. However, because this NPRM builds on the current route evaluation and routing practices already in place for most, if not all, rail carriers that transport the types of hazardous materials covered, we do not expect rail carriers to incur significant costs associated with rerouting. The rail carriers already conduct route analyses and re-routing that provides results in line with what this proposed rule is making a standard practice (in accordance with AAR Circular OT-55-N).

The analysis for the HM-232E final rule attributed minimal costs for rerouting shipments to lower risk routes. At the time of publication, PHMSA asked for comment on whether rerouting shipments covered under the new proposed regulations would impose an undue burden on the industry, and did not receive any adverse comments on the issue. As a result, PHMSA did not modify the assumption that rerouting would impose little if any cost on shippers or rail carriers. PHMSA and FRA make the same assumption for HHFTs in this RIA.

There is evidence that this assumption is reasonable. First, the industry has voluntarily agreed to apply these same routing requirements to HHFTs containing crude oil, which implies that rerouting does not impose a significant burden or at least that the burden does not significantly exceed the carriers' own expected safety benefits from rerouting. Second, no rerouting would be required if no practical alternative route is available. As noted above, the industry has not has not expressed concern on this issue in past rulemaking actions. Thirdly, the routing provisions require the rail carriers to consider various factors when selecting route including length of trip. As trip length increases, the exposure to the risk of derailment increases. A shorter route is a safer route, all other things held equal. Rail carriers are required to consider these factors when routing the types of hazardous materials covered under the previous rulemaking, and make the results of their routing plans available for review. In reviewing these plans, PHMSA and FRA observed little if any increase in total shipment mileage as a result of complying with this requirement.

Therefore, it seems unlikely that mileage or shipping time increases would impose significant costs if routing requirements are applied to HHFTs containing ethanol. Finally, a rail simulation study found that substantial risk reduction (reductions in either the likelihood or severity of an event) can be achieved through rerouting with very modest increases in shipment mileage. As a result, PHMSA does not attribute costs for rerouting of ethanol shipments in this analysis, but seeks comment from the industry on this assumption.[56]

In 2008, PHMSA estimated the cost of compliance with the routing final rule based on the size of the company. In this analysis, Class I and regional railroads (Class II) were considered "large railroads" and Class III railroads are considered "small railroads." There are 7 Class I railroads, 10 regional railroads, and more than 500 small railroads.[57] Based on consultations with FRA, we estimate that only 64 short haul rail carriers haul shipments of flammable liquid large enough to fall under the proposed regulations, so the total number of small carriers affected reflects this knowledge.

Table R1: Rail Carriers Subject to Routing Requirements

Number of Affected Rail Carriers by Size
17 large rail carriers
64 small rail carriers
81 total

On February 21, 2014 the AAR committed to apply the existing routing requirements described above to unit trains with 20 or more carloads of crude oil. Class I railroads have signed on to this agreement, and will voluntarily apply routing requirements to trains carrying 20 carloads or more of crude oil. As a result, no costs are attributed to Class I railroads for developing routing plans for crude oil shipments. PHMSA believes Class I railroads may already be applying route analysis to ethanol shipments despite the absence of a requirement or commitment to do so. Even if this is not the case, we believe there would be a de minimis cost to add ethanol to routing

[56] Glickman, Erkut, and Zschocke. 2007. The cost and risk impacts of rerouting railroad shipments of hazardous materials. Accident Analysis and Prevention. 39. 1015-1025.
[57] 'Railroad Facts', Association of American Railroads, 2004, p.3.

analysis for crude oil. As a result, we attribute no additional cost to Class I railroads to comply with these requirements, but seek comments on whether our assumptions are valid.

Since the Class II and III railroads have not signed on to this commitment, we assume Class II and III railroads would not voluntarily apply the route analysis requirements to HHFTs, and hence would bear costs associated with analyzing their networks, identifying alternative routes, and rerouting shipments along lower-risk routes where practicable. In practice, Class II and III railroads would bear modest costs because much of the work to identify safest routes has already been done in compliance with the previous regulation. In addition, most short line railroads operate along a small number of corridors – often only one – and would therefore not have practical alternative routes for HHFTs. These limited networks also mean that analyzing primary and alternative routes would be a minor task.

The labor rate used to estimate costs is $38.17. This labor rate is a combination of two employee groups listed in the Bureau of Labor Statistics May 2012 Industry-Specific Occupational Employment and Wage Estimates.[58] The two employee groups used were NAICS 482000-Rail Transportation occupational code 11-0000 "Management Occupations" and occupation code 43-6011 "Executive Secretaries and Executive Administrative Assistants." To calculate the hourly wage rates for every year of the analysis PHMSA takes into consideration an estimated 1.18 percent annual growth rate in median real wages.[59] After inflating the average hourly wage of $38.17 by 1.18%, we get an average hourly wage of $38.62 in 2014. PHMSA then inflates this wage by 60 percent to account for fringe benefits and overhead of $23.17 per hour, for a total weighted hourly wage of $61.80 in 2014. Following the same series of calculations (and holding the fringe benefit constant at $23.17), the total weighted hourly wage in 2015, the first year of the analysis, is estimated at $62.25. The resulting average hourly wage rate calculated for the subsequent years of the analysis (years 2-20) is $67.21.

PHMSA develops costs analogously to how they were estimated during the HM-232E rulemaking. The RIA for that rule presented three cost scenarios, but we present only one here. This scenario applies the most pessimistic assumptions from the HM-232E rulemaking about the amount of time/labor would be needed to analyze routing of HHFTs.

The routing requirements of this NPRM would require rail carriers to use the data it compiles to annually analyze the safety and security risks for the transportation route(s) used to transport HHFTs; analyze this data to establish the primary routes on which it ships HHFTs; analyze its rail network, and consider 27 risk factors to identify any routes that might reduce the risk posed by HHFTs; reassess these risks and routing decisions on an annual basis. We assume that the initial incorporation of HHFTs into route analysis would be more resource intensive than assessments in later years. This assumption is based on the belief that limited changes in rail networks make the task of assessing alternative routes and safety risks easier in later years than in the initial year.

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[58] Available online at http://www.bls.gov/oes/current/oessrci.htm

[59] Based on real wage growth forecasts from the Congressional Budget Office, DOT's guidance estimates that there will be an expected 1.18 percent annual growth rate in median real wages over the next 30 years (2013-2043). The wage rate in 2014 is calculated as follows: $38.17*1.0118 +$38.17*1.0118*0.6 = $61.80.

Annual Data Collection by Line Segment

As previously noted, the proposed rule would require a rail carrier transporting HHFTs to use the data it compiles to annually analyze the safety and security risks for the transportation route(s) used to by these trains. In performing this analysis the rail carrier must consult with state, local, and tribal officials, as appropriate, regarding security risks to high-consequence targets, countermeasures already in place, and the community emergency response capability along, or in proximity to, the route(s) utilized.

Hazmat shipment data is readily available to large railroads. Because small railroads do not frequently carry the hazardous materials addressed in this proposed rule, they may know exactly what commodities they carry and when. Small railroads that carry hazmat less frequently may not have electronic data and may have to physically search their records for this information. Both large and small railroads are assumed to require 40 hours to collect the data with which they analyze routes. This data would consist of collecting waybill data on the commodities covered by the requirement, examining origins and destinations for these shipments, identifying the routes over which these commodities travel, and identifying viable alternative routes. In addition, information on the safety characteristics of current routes and alternatives would have to be collected. This data includes population densities, derailment rates, track class, etc. These costs reoccur annually. The table below presents the estimated costs for this task.

Table R2: Annual Data Collection by Rail Group

Annual Data Collection by Rail Group			
Railroad size	Number of railroads in class affected	Maximum number of hours	Max. number of hours * hourly labor rate
Class I	0	0	$0
Class II	10	40	$24,901
Class III	64	40	$159,369
		Total	$184,270

Primary Safety and Security Route Analyses (Year 1)

The primary route analyses conducted in year 1 will cost more than the analyses done in subsequent years. The cost estimates presented here may overestimate costs for this requirement because, as mentioned above, much of the analytical work has already been done to comply with previous routing requirements

An important determinate of costs is the number of routes that must be analyzed. An example of a route is a major corridor. Larger railroads carry hazmat farther distances than small railroads. Therefore, the large railroads are estimated to have more routes per carrier than the small railroads. It is also anticipated that the larger railroads will have more complex route analyses to perform. Many small railroads do not need to perform sophisticated analyses in order to comply with the rule. In general, it was assumed that the small railroads, due to their limited size, would, on average, have no less than one and no more than two primary routes to analyze; so for 64 small railroads, there is a maximum of 128 primary routes to be analyzed. Because the distance covered by the small railroads' routes is likely contained within a limited geographic region, the hours estimated for analyses are fewer than those estimated for the larger railroads.

The number of routes and hours were used to estimate this cost element to ensure that full costs for developing route analyses and choosing alternative routes is captured. It is assumed that the railroads will consider each major corridor as a single route to minimize the number of routes analyzed. The rule does not mandate how the railroads identify each route, but it is reasonable to assume that railroads will use economic best practices. The initial analysis and route selection must include a comprehensive review of a carrier's entire system and include mitigation measures that the carrier intends to implement to increase the safety and security of the route(s).

Class II railroads are more likely to have several primary routes; Class III railroads operate over less track mileage. The Class II railroads analyze all alternate routes to determine, given the operation knowledge of the carrier, the route of a particular shipment on a particular day. Class II railroads are estimated to have a maximum of 50 routes combined. Class III railroads are estimated to have a maximum of 128 routes. These numbers are high and are not intended to suggest that this number of major corridors exist. The numbers are representative of all possible routes for the commodities included in this proposed rule. These numbers represent existing track infrastructure and are overstated to account for further unexpected route changes and potential acquisitions that may or may not occur.

Class II railroads are estimated to require 80 hours per route to conduct the initial analysis of primary routes. A Class III railroad is estimated to require 40 hours per route. The number of routes to be analyzed for each Class of railroad is multiplied by the number of hours the primary route analyses is anticipated to take, times the hourly labor rate calculated as shown above to develop costs for this task. These costs are presented in the table below.

Table R3: Year 1 Costs of Safety and Security Route Analyses

Primary Route Analyses by Rail Group – Year 1					
Railroad size	Number of railroads in class affected	Number of routes	Number of hours per route	Labor Rate	Number of routes * hours * hourly labor rate
Class I	0	0	0	$0.00	$0
Class II	10	50	80	$62.25	$249,014
Class III	64	128	40	$62.25	$318,737
				Total	$567,751

Annual Primary Safety and Security Route Analyses (Years 2-20)

After the first year's route analyses are completed, it is expected that analyses performed on the same routes in subsequent years will take less time. We anticipate the majority of the routes analyzed in year 1 will continue to be used in future years. Therefore, these routes would require only a review to ensure there have been no changes or planned mitigation measures that would impact the analyses in the future years. It is also assumed that there will be few changes in the high-consequence facilities located along or in proximity to these routes. It is further assumed that the railroads would experience some change in commodity flow that will impact their primary routes each year. However, a learning curve is anticipated. Therefore, the primary route analyses would be done every year, but will take fewer hours than the primary route analyses in year 1.

Rail companies would analyze the same number of routes in later years as described above in the initial year analysis section. Class II railroads are estimated to require 16 hours per route to update route analyses on an annual basis. A Class III railroad is estimated to require 8 hours per route. The number of routes that are to be analyzed for each Class of railroad is multiplied by the number of hours the primary route analyses are anticipated to take, times the hourly labor rate calculated as shown above. The cost estimates for this task are presented in the table below.

Table R4: Years 2-20 Costs of Safety and Security Route Analyses

Primary Route Analyses by Rail Group – Years 2-20				
Railroad size:	Number of railroads in class affected	Number of routes	Number of hours per route	Number of routes * hours * hourly labor rate
Class I	0	0	0	$0
Class II	10	50	16	1,021,565
Class III	64	128	8	1,307,603
			Total	**$2,329,169**

Alternate Route Economic, Safety, and Security Analyses (Year 1)

As previously noted, the proposed rule would require a rail carrier operating HHFTs to use the data it compiles to annually analyze the safety and security risks for all practicable alternative routes which the carrier is authorized to use. When determining practicable alternative routes, the rail carrier would consider the use of interchange agreements with other rail carriers. We expect that rail carriers would also consider the potential economic effects of using the alternative route, including, but not limited to, the economics of the commodity, route, and customer relationship. The rail carrier would also consider any remediation measures it intends to implement on a route. Using this process, the carrier would be required, at least annually to compare the safety and security risks on the primary and alternative routes and select the practicable route posing the least overall safety and security risk.

When selecting a primary route for the transport of hazmat, rail carriers normally analyze all routes they consider commercially and economically practicable. As stated previously, large rail carriers are more likely to have alternate routes than smaller rail carriers, which operate over fewer tracks. The larger rail carriers analyze all practicable alternate routes to determine, given the operational knowledge of the rail carrier, the route of a particular shipment on a particular day. The average number of practicable alternate routes analyzed by Class II railroads is 4 per railroad. Larger rail carriers, Class I and Class II, carry hazardous materials farther distances than smaller, Class III railroads. A practicable alternate route may not be available in many instances to a Class III railroad. This analysis conservatively assumes that half of the Class III railroads have practicable alternate routes resulting in 32 routes to analyze.

Class II railroads are estimated to require 120 hours to analyze each alternate route in the initial year for incorporation of HHFTs into routing plans. A Class III railroad is estimated to require 40 hours per alternate route. The number of routes that are to be analyzed for each class of railroad is multiplied by the number of hours the alternate route analyses is anticipated to take, times the hourly labor rate calculated as shown above to produce a total cost estimate. These figures are presented in the table below.

Table R5: Alternate Route Analyses – Year 1

Alternate Route Analyses by Rail Group – Year 1				
Railroad size	Number of railroads in class	Number of routes	Number of hours per route	Number of routes * hours * hourly labor rate
Class I	0	0	0	$0
Class II	10	40	120	$298,816
Class III	64	32	40	$79,684
			Total	$378,501

Alternate Route Economic, Safety, and Security Analyses (Years 2-20)

Subsequent alternative route analysis would include a comprehensive, system-wide review of all operational changes; infrastructure modifications; traffic adjustments; changes in the nature of high-consequence targets located along, or in proximity to, the routes; and any other changes affecting the safety or security of the movements of HHFTs that were implemented during the calendar year, as well as mitigation measures the carrier intends to implement.

Performing the alternate route analyses in years 2 through 20 is assumed to require 10 percent of the time the first year's route analyses required. This is based on estimates of limited changes in commodity flow or shipment volume and other changes that would impact practicable alternative routes to the primary route. The previously analyzed alternate routes will require some review to ensure there have been no changes that would impact the analyses in the future years; however, a learning curve is anticipated. These costs are presented in the table below.

Table R6: Alternate Route Analyses – Years 2-20

Alternate Route Analyses By Rail Group – Years 2-20				
Railroad size	Number of railroads in class affected	Number of routes	Number of hours per route	Number of routes * hours * hourly labor rate
Class I	0	0	0	$0
Class II	10	40	12	$612,939
Class III	64	32	4	$163,450
			Total	$776,390

Total Cost.

The table below presents total estimated costs for this proposal over 20 years. These costs reflect the resources required to collect data, analyze current shipping routes for flammable liquid shipments, and identify alternative routes, where feasible, that lower the overall risk of transporting this hazardous material. PHMSA considers these cost estimates to be conservative – it is possible that actual costs will be far below those presented here, and unlikely that they would be higher.

R7: Annual Costs of Routing

Costs of Regulation by Year	
Year	Costs
1	$1,130,522
2	$338,157
3	$340,672
4	$343,218
5	$345,793
6	$348,399
7	$351,036
8	$353,704
9	$356,403
10	$359,134
11	$361,897
12	$364,693
13	$367,522
14	$370,385
15	$373,281
16	$376,211
17	$379,176
18	$382,175
19	$385,211
20	$388,282
Totals:	$8,015,871
PV 3%	$6,103,093
PV 7%	$4,504,147

Table R8: Annual Cost of Routing by Railroad Class

Costs of Regulation by Year, by Railroad Class		
Year	Class II	Class III
1	572,731	557,790.36
2	105,360	232,796
3	106,144	234,528
4	106,937	236,281
5	107,740	238,054
6	108,552	239,848
7	109,373	241,663
8	110,204	243,499
9	111,045	245,358
10	111,896	247,238
11	112,757	249,140
12	113,628	251,065
13	114,510	253,012
14	115,402	254,983
15	116,304	256,977
16	117,217	258,994
17	118,141	261,035
18	119,075	263,100
19	120,021	265,190
20	120,978	267,304
Totals:	2,718,018	5,297,853
PV 7%	1,609,436	2,894,711

Benefits/Effectiveness

As noted above, Glickman et al analyzed the risk reduction benefits that might be achieved by rerouting hazardous material rail shipments to lower risk routes using a rail simulation model.[60] The authors found that substantial risk reductions could be obtained for modest or no increase in shipment mileage. In some cases, their modeling identified lower-risk routes that actually decreased mileage. Obtainable risk reductions obviously vary depending on the shipment's origin and destination, but the aggregate conclusion for all routes analyzed was that a 22 percent risk reduction could be obtained with an increase of roughly 5 percent in total shipment mileage.

[60] Glickman,Theodore S. Erkut, Efhan, and Zschocke, Mark S. 2007. The cost and risk impacts of rerouting railroad shipments of hazardous materials. Accident Analysis and Prevention. 39. 1015-1025.

It is important to note that risk can be minimized practically in two ways: one is to run shipments over the highest-quality track, i.e. track that poses the lowest risk for derailment, collision, or other train accident. The other way risk can be reduced is to reduce exposure to train accidents. Rerouting can address either or both of these risk factors, but in some cases one factor must be traded off against another.

For instance, rail track may be better maintained in high population density areas, therefore, accidents may be more likely in a rural area. However, should a hazardous material train accident occur in a high population urban area, the consequences may be much more severe than in a less populous area because more people are at risk of exposure, injury or death. In addition property value loss and the amount of infrastructure that may be destroyed is much higher in urban, high population areas.

This proposal requires railroads to balance these factors to identify the route that poses the lower risk. As such, they may, in certain cases, choose a route that eliminates exposure in areas with high population densities but poses a risk for more frequent events in areas with very low densities. In other cases the risk of derailment may be so low along a section of track that, even though it runs through a densely populated area, it poses the lowest total risk when severity and likelihood are considered. Glickman's estimate of safety improvements achievable by routing changes is based on an examination of how routing might vary as a rail carrier applies progressively heavier weights on various safety factors. In practice, it is impossible to know how much weight rail carriers will give to safety when making routing decisions. As noted above, based on past routing plans submitted by rail carriers to FRA for approval, application of the routing requirements resulted in modest changes to company routing decisions. It is therefore unclear to what extent these requirements would improve safety. However, PHMSA believes applying these routing requirements to HHFTs would have some effect. Even if very small, reductions in the risk of an adverse event due to the improved routing of HHFTs could produce benefits that outweigh the costs. For example, our current estimate of the total undiscounted lower-consequence damages of crude and ethanol derailments over the coming 20 years is expected to be $4.5 billion.

Using the lower-consequence damages baseline, PHMSA estimates that the Routing requirements would break-even if they reduced damages by 0.17%. PHMSA does not conduct a break-even analysis based on the combined damages from lower-consequence and higher-consequence events.

One of the limitations of this break-even analysis is that it compares the costs to a damage pool that includes damages that occurred on Class I railroads even though we impute no cost to those railroads. While it would be ideal to consider damages involving only class II and III railroads to make this comparison, such information has not been developed. If routing were to reduce risk of an incident by even one twentieth of one percent, the benefits would outweigh estimated costs (excluding the costs of added shipping miles). PHMSA believes this requirement would achieve at least that level of effectiveness.

Route planning and route selection provisions currently required for explosive, PIH, or radioactive materials are not required on HHFTs. Although voluntary actions were taken by the crude oil carriers from the Secretary's Call-to-Action, codification of these provisions is necessary. Codification is also a check on higher risk routes or companies. There is nothing in place/no incentive to require continued compliance with voluntary actions.

If the proposed rule is not adopted, railroads would not be required to conduct route risk analysis nor would they be required to reroute shipments over lower-risk routes. Specific identified criteria for the route and alternate route analyses may not be uniformly considered by all railroads, and written analyses of primary and alternate routes including safety and security risks would not be required. The costs to society, the government, and the rail industry of an accident involving a HHFT are high. If no action to better evaluate routing decisions, the threat of catastrophic accidents in large populated areas or other sensitive environments will continue.

Requirement Area 2 – Tank Car

Proposed Tank Car Specification Requirements

PHMSA is proposing three Options for newly manufactured DOT Specification tank cars that will address the risks associated with HHFTs. In addition, we are proposing to allow for tank cars to meet a performance standard equivalent to the selected prescribed tank car standard, which could be accomplished by designing a new car or retrofitting existing DOT Specification tank cars. The changes stipulate a new tank car prescribed and performance tank car—the DOT Specification 117 tank car—that will be phased in over time depending on the packing group of the flammable liquid. The provisions allow for tank cars to meet a performance standard equivalent to the DOT Specification 117, which could be accomplished by retrofitting existing DOT Specification 111/CPC-1232 tank cars. Cars that meet the DOT Specification 117 performance standard would be designated DOT Specification 117P.

Under the HMR, the offeror must select a packaging that is suitable for the properties of the material. The DOT Specification 111 tank car is one of several cars authorized by the HMR for the rail transportation of many hazardous materials. The DOT Specification 111 tank car, which can be jacketed or unjacketed, is used for the almost all of crude oil and ethanol service by rail.

Table TC1:Current Authorized Tank Cars[61]

Flammable Liquid, PG I	Flammable Liquid, PG II and III	Combustible Liquid
DOT 103	DOT 103	DOT 103
DOT 104	DOT 104	DOT 104
DOT 105	DOT 105	DOT 105

[61] Additional information on tank car specifications is available at the following URL: http://www.bnsfhazmat.com/refdocs/1326686674.pdf

DOT 109	DOT 109	DOT 109
DOT 111	**DOT 111**	**DOT 111**
DOT 112	DOT 112	DOT 112
DOT 114	DOT 114	DOT 114
DOT 115	DOT 115	DOT 115
DOT 120	DOT 120	DOT 120
	AAR 206W	AAR 206W
		AAR 203W
		AAR 211W

In 2011, the AAR issued Casualty Prevention Circular (CPC) 1232, which outlines industry requirements for certain DOT Specification 111 tanks ordered after October 1, 2011, intended for use in ethanol and crude oil service (construction approved by FRA on January 25, 2011 – see the Background below for information regarding a detailed description of PHMSA and FRA actions to allow construction under CPC-1232). Key tank car requirements contained in CPC-1232 include the following:

- PG I and II material tank cars to be constructed to AAR Standard 286; AAR Manual of Standards and Recommended Practices, Section C, Car Construction Fundamentals and Details, Standard S-286, Free/Unrestricted Interchange for 286,000 lb. Gross Rail Load (GRL) Cars (AAR Standard 286);
- Head and shell thickness must be 1/2 inch for TC-128B non jacketed cars and 7/16 inch for jacketed cars;
- Shells of non-jacketed tank cars constructed of A5l6-70 must be 9/16 inch thick;
- Shells of jacketed tank cars constructed of A5l6-70 must be 1/2 inch thick;
- New cars must be equipped with at least 1/2 inch half-head shields;
- Heads and the shells must be constructed of normalized steel;
- Top fittings must be protected by a protective structure as tall as the tallest fitting; and
- A reclosing pressure relief valve must be installed.

The CPC 1232 is a voluntary industry improvement on the DOT Specification 111. The technical background for its safety features, as well as the proposed safety features in the three tank car options, are described more fully in the preamble to the NPRM.

In the NPRM, PHMSA proposed the following schedule for continued use of existing DOT Specification 111 tank cars in HHFTs, including the recent voluntarily-upgraded CPC 1232 car:

Table TC2: Effective Dates for New Tank Cars

Packing Group	DOT Specification 111 Not Authorized After

I	October 1, 2017
II	October 1, 2018
III	October 1, 2020

Determination of Need

DOT conducted research on long-standing safety concerns regarding the survivability of the DOT Specification 111 tank cars designed to current HMR requirements and used for the transportation of crude oil and ethanol. The research found that special consideration is necessary for the transportation of crude oil and ethanol in DOT Specification 111 tank cars, especially when a train is configured as a HHFT. It is not possible to completely eliminate the probability that an accident involving multiple tank cars will occur. However, the increased number of trains consisting of a large number of tank cars carrying flammable liquid is poses an emergent safety risk, as described above.

We estimate that there are approximately 335,000 tank cars (pressure and non-pressure) in today's fleet, of which 272,000 are DOT Specification 111 tank cars. Of those 272,000, approximately 72,000 cars are used to transport ethanol or crude oil. Based on the weight of a tank car, train speed, and the volume of hazardous materials transported, major derailments often result in the release of hazardous materials. In published findings from the June 19, 2009, train accident in Cherry Valley, Illinois, the NTSB indicated that the DOT Specification 111 tank car can almost always be expected to breach in the event of a derailment resulting in car-to-car impacts or pileups.

Modeling and simulation of puncture speed velocity of DOT Specification 111 tank cars currently used to transport ethanol or crude oil indicate that when struck at a velocity of approximately 7.4 mph at the longitudinal center of the tank shell with a rigid 12" x 12" indenter with a weight of 297,000 pounds will result in a puncture.[62] Validation of this model has been accomplished using the results of puncture tests performed at the Transportation Technology Center in Pueblo, CO. Further, based on modeling and simulation, the head of an unjacketed DOT Specification 111 tank car, when struck with a 12" x 12" indenter weighing 286,000 pounds will puncture at 7.6 mph. Table TC31 provides the tank car shell and head puncture velocities of the DOT Specification 117 tank car Options proposed. Similar to the methodology for estimating the effectiveness of new cars, PHMSA uses the calculated puncture velocities to arrive at risk reduction estimates for retrofits. As discussed below and in the NPRM, these data show that the DOT Specification 111 is significantly more likely to puncture than the proposed alternatives.

All of the tank car Options discussed in this section are designed to address the survivability of the tank car and would mitigate the damages of rail accidents better than the current DOT Specification 111. Specifically, the tank car Options incorporate several enhancements to increase puncture resistance; provide thermal protection to survive a 100-minute pool fire; and protect top fitting and bottom outlets during a derailment. Under all Options, the proposed system of design enhancements would reduce the consequences of a derailment of tank cars

[62] "Detailed Puncture Analyses Tank Cars: Analysis of Different Impactor Threats and Impact Conditions" can be found at: http://www.fra.dot.gov/eLib/details/L04420

carrying flammable liquids. There would be fewer car punctures, fewer releases from the service equipment (top and bottom fittings), and delayed and reduced volumes of flammable liquid releases through the pressure relief devices.

Alternatives Considered

PHMSA considered the status quo and three tank car options to address this emerging risk and they are:

No-Action Alternative

This alternative would continue to authorize the use of the non-jacketed and jacketed DOT Specification 111 tank cars, including CPC-1232 non-jacketed and jacketed cars, for the transportation of crude oil and ethanol. This alternative would impose no benefits or costs, because it would require no change in flammable liquid packaging.

Option 1: PHMSA and FRA Designed Tank Car

This analysis first considers the mandate that both newly manufactured tank cars and existing tank cars used for flammable liquids in a HHFT (e.g. crude oil and ethanol) meet the Option 1 prescribed car or performance standard with the proposed schedule for phasing in the DOT Specification 117, as provided in the table above.

Key features of the Option 1 car include the following:

- 286,000 lb. GRL tank car that is designed and constructed in accordance with AAR Standard S-286;
- Wall thickness after forming of the tank shell and heads must be a minimum of 9/16 inch constructed from TC-128 Grade B, normalized steel;
- Thermal protection system in accordance with § 179.18, including a reclosing pressure relief device;
- Minimum 11-gauge jacket constructed from A1011 steel or equivalent. The jacket must be weather-tight as required in § 179.200-4;
- Full-height, 1/2 inch thick head shield meeting the requirements of § 179.16(c)(1);
- Bottom outlet handle removed or designed to prevent unintended actuation during a train accident;
- ECP brakes; and
- Top fittings protection meeting the requirements of § 179.102-3 (not applicable to existing tank cars).

This option includes the highest safety enhancements of any of the proposed options, and thus is expected to yield the highest benefit to safety and the environment. It also has the highest cost of any of the three tank car options.

Option 2: AAR 2014 Tank Car

The second option considered is called the AAR 2014 car. This standard is based on the AAR's recommended new tank car standard, and approximately 5,000 of these new cars have been ordered by BNSF Rail Corporation.

The Option 2 car would be required for both newly manufactured tank cars and existing tank cars used for flammable liquids in a HHFT. Tank cars may meet either the prescribed car or performance standard with the proposed schedule for phasing in the DOT Specification 117, as provided in the table above.

These cars have most of the same safety features as the Option 1 tank car, including the same increase in shell thickness, but lack rollover protection and ECP brake equipment. Installation of ECP brake equipment would make the cost differential between the Option 2 car and the Option 1 car very small. The Option 2 lacks rollover protection, but the additional cost to install rollover protection is negligible in comparison to the cost of installing top fittings protection, which is standard on a CPC 1232 car. Put another way, PHMSA believes there is little to no marginal cost associated with installing rollover protection compared to top fitting protection, but seeks comment on whether this belief is accurate. In essence, examining these cars side by side in the following analysis provides a de facto comparison of the costs and benefits of equipping HHFTs with ECP braking.

This option has the second highest benefits and the second highest costs of the three tank car options.

Option 3: Enhanced Jacketed CPC 1232 Tank Car

The third option is an Enhanced Jacketed CPC 1232 car standard. It is the same as a jacketed CPC 1232 standard, described above, but with the same improvements made to the bottom outlet handle and pressure relieve valve as with the Option 1 and Option 2 cars. This standard is the car configuration PHMSA believes will be built for HHFT service in absence of regulation, based on commitments from two rail car manufacturers/leasers – Greenbrier, Inc. and the Railway Supply Institute.

The Option 3 car would be required for both newly manufactured tank cars and existing tank cars used for flammable liquids in a HHFT. Tank cars may meet either the prescribed car or performance standard with the proposed schedule for phasing in the DOT Specification 117, as provided in the table above. This alternative would not impose new costs for newly manufactured cars, because the industry has committed to building Enhanced Jacketed CPC 1232 standard cars for HHFT service, but would impose costs associated with retrofitting older DOT Specification 111 cars to meet the new performance standard.

This car has all of the same safety features of the Option 2 car, except it has 1/8-inch less shell thickness. This car also has most of the same safety features of the Option 1 car, but it has 1/8-inch less shell thickness, does not have ECP brakes, and does not have roll-over protection.

This car is a substantial safety improvement over the current DOT Specification 111 but does not achieve the same level of safety as the other two options. It is also the least costly.

Table TC3, below, compares the safety features associated with the three tank car options proposed in the NPRM.

Table TC3: Safety Features by Tank Car Option (for New Construction)

Tank Car	Bottom Outlet Handle	GRL (lbs)	Head Shield Type	Pressure Relief Valve	Shell Thickness	Jacket	Tank Material	Top Fittings Protection*	Thermal Protection System	Braking
Option 1: PHMSA and FRA Designed Tank Car	Bottom outlet handle removed or designed to prevent unintended actuation during a train accident	286k	Full-height, 1/2 inch thick head shield	Reclosing pressure relief device	9/16 inch Minimum	Minimum 11-gauge jacket constructed from A1011 steel or equivalent. The jacket must be weather-tight	TC-128 Grade B, normalized steel	TIH Top fittings protection system and nozzle capable of sustaining, without failure, a rollover accident at a speed of 9 mph	Thermal protection system in accordance with § 179.18	ECP brakes
Option 2: AAR 2014 Tank Car	Bottom outlet handle removed or designed to prevent unintended actuation during a train accident	286k	Full-height, 1/2 inch thick head shield	Reclosing pressure relief device	9/16 inch Minimum	Minimum 11-gauge jacket constructed from A1011 steel or equivalent. The jacket must be weather-tight	TC-128 Grade B, normalized steel	Equipped per AAR Specifications Tank Cars, appendix E paragraph 10.2.1	Thermal protection system in accordance with § 179.18	In trains with DP or EOT devices
Option 3: Enhanced CPC 1232 Tank Car	Bottom outlet handle removed or designed to prevent unintended actuation during a train accident	286k	Full Height 1/2 inch thick head shield	Reclosing pressure relief device	7/16 inch-Minimum	Minimum 11-gauge jacket constructed from A1011 steel or equivalent. The jacket must be weather-tight	TC-128 Grade B, normalized steel	Equipped per AAR Specifications Tank Cars, appendix E paragraph 10.2.1	Thermal protection system in accordance with § 179.18	In trains with DP or EOT devices
DOT Specification 111A100W1 Specification (Currently Authorized)	Bottom Outlets are Optional	263K	Optional; Bare Tanks half height; Jacket Tanks full height	Reclosing pressure relief valve	7/16 inch-Minimum	Jackets are optional	TC-128 Grade B, normalized steel/	Not required, but when Equipped per AAR Specifications Tank Cars, appendix E paragraph 10.2.1	Optional	Not required

*Please note that PHMSA does not propose to require additional top fittings protection for retrofits. While PHMSA expects additional top fittings protection would provide enhanced safety protection, the costs of retrofitting existing cars exceed the safety benefits by $500 million to $1 billion. Newly constructed cars, however, are required to have additional top fittings protection. Except for top fittings protection for retrofits, the requirements for newly constructed tank cars and retrofits are the same.

Baseline

The baseline for this assessment is the current HMR, with some modifications to account for other regulatory initiatives that will reduce the risk of a catastrophic event. Later in this section we use the lower consequence event damages presented as a pool from which to draw benefits. At present, we consider the cost of each proposed tank car standard.

For purposes of analyzing the tank car options, the baseline consists of a forecast of the size of the tank car fleet size, and its characteristics, in absence of the proposed tank car standard. Regarding the tank car fleet, PHMSA is assuming that all newly constructed tank cars for flammable liquid service in HHFTs will adhere to be the Enhanced CPC 1232 standard (Option 3) in the absence of a revised standard in the HMR. The CPC 1232 has been the industry standard for orders placed after October 2011, and PHMSA assumes that 100 percent of the newly constructed tank cars will be CPC 1232 jacketed plus improvements to pressure relief devices and bottom outlet values (i.e., the "Enhanced Jacketed CPC 1232"). This an assumption based on a commitment recently made by rail car manufacturers. It is also assumed that the DOT Specification 111 and the CPC-1232 cars have life spans of 40 years and 50 years, respectively.

These current fleet figures are based on an RSI presentation to NTSB in addition to figures supplied by RSI in a Executive Order 12866 meeting with the Department of Transportation and the Office of Management and Budget. In the NTSB presentation RSI indicated that as of early 2014 the combined crude and ethanol fleet stood at approximately 72,000 tank cars. RSI indicated an intention of building 37,800 new tank cars meeting either a jacketed or unjacketed CPC 1232 standard. The presentation also suggests that the unjacketed cars on order are backordered cars, but that going forward the industry plans to build only jacketed CPC 1232 cars for all new flammable liquid service orders. That presentation also states that industry capacity is approximately 33,800 cars per year. Given the build forecast in that presentation, it is apparent that some cars would have to be built in 2014 in order to meet the projected fleet growth by the end of 2015. PHMSA assumes that the first orders to be filled will be the unjacketed CPC 1232 orders, on the assumption that these are the longest outstanding orders. PHMSA assumes these cars will be built in 2014, along with an additional 5,000 jacketed CPC 1232 cars. By 2015, the earliest year in which this rule is likely to be finalized, PHMSA assumes the remaining 20,300 jacketed CPC cars on order would be built. These cars, it is assumed, would be built to whichever new standard is finalized with promulgation of this rule. PHMSA seeks comment on whether the assumptions about fleet composition in 2014-15 are valid, or whether the industry might hold off on any new construction until a final tank car standard for HHFTs is promulgated.

Table TC4 shows the current fleet composition:

Table TC4: Estimates for current fleet of rail tank cars[63]

Tank Car Category	Population
Total # of Tank Cars	334, 869
Total # of DOT Specification 111	272,119
Total # of DOT Specification111 in Flammable Liquid Service	80,500
Total # of CPC 1232 in Flammable Liquid Service	17,300
Total # of Tank Cars hauling Crude Oil	42,550
Total # of Tank Cars Hauling Ethanol	29,780
CPC 1232 (Jacketed) in Crude Oil Service	4,850
CPC 1232 (Jacketed) in Ethanol Service	0
CPC 1232 (Non-Jacketed) in Crude Oil Service	9,400
CPC 1232 (Non-Jacketed) in Ethanol Service	480
DOT Specification 111 (Jacketed) in Crude Oil Service	5,500
DOT Specification 111 (Jacketed) in Ethanol Service	100
DOT Specification 111 (Non-Jacketed) in Crude Oil Service	22,800
DOT Specification 111 (Non-Jacketed) in Ethanol Service	29,200

The crude and ethanol fleet is relatively new. Consultation with FRA industry experts, industry trade magazines, and crude and ethanol shippers indicates that virtually the entire crude and ethanol fleet has been built since 2000.[64] The newness of the fleet has implications for retrofit costs. Given that these cars have a service life of 40-50 years, we assume that it would be

[63] Source: RSI presentation at the NTSB rail safety forum April 22, 2014, update provided on June 18, 2014.
[64] http://ethanolrfa.org/page/-/rfa-association-site/Industry%20Resources/RFA.Ethanol.Rail.Transportation.and.Safety.pdf?nocdn=1

worthwhile to retrofit these cars to a new standard rather than retire them. Hence, PHMSA does not consider lost service value due to early retirement of cars. For the same reasons, PHMSA assumes no cars would be retired from reaching the end of their service lives, independent of retrofit costs.

As a result, our forecast of new construction going forward assumes that no new manufacture will be necessary in the next 20 years to replace cars that are retired because they have reached the end of their useful life. These cars have a useful lifespan of 40-50 years. If the older cars in the fleet are 15 years old, that implies 25 years of useful life remaining for the oldest cars in crude and ethanol service. This amount of remaining useful life extends beyond our 20 year analysis period.

Based on industry projections, PHMSA estimates that roughly 61,000 new cars will be needed to meet demand for increased shipment of crude oil by rail. RSI, in a presentation to the NTSB in April of 2014, indicated that they currently have orders for 55,400 tank cars, and intend to build 37,800 jacketed and non-jacketed CPC 1232 cars by the end of 2015. PHMSA assumes that continued growth in crude oil extraction/production will continue to drive new car manufacturing at a more modest pace once these outstanding orders are filled, resulting in a total increase of 61,000 new flammable liquid cars.[65] The ethanol fleet is assumed to grow at the same rate as the ethanol consumption over the entire forecast period. New construction estimates reflect the difference between the fleet sizes each year.

The table below titled, "Fleet Forecasts" presents tank car fleet size forecasts for crude oil and ethanol. Although ethanol shipments are forecast to grow moderately for the coming several years, consultation with the industry indicates that the ethanol fleet is large enough at present to accommodate the increase in volume. Since there is no demand or need for more ethanol cars going forward, PHMSA assumes no growth in the manufacture of ethanol cars. We estimate the current ethanol fleet at 30,000 cars. As such, all fleet growth is attributable to the crude oil fleet.

[65] See presentation at http://www.ntsb.gov/news/events/2014/railsafetyforum/presentations/Panel%201_B_William%20Finn.pdf

Table TC5: Fleet Forecast DOT Specification 111 and CPC 1232 from 2014-2034

	Fleet Forecast				
	Total Cars Baseline	**DOT 111**	**DOT 111 with Jacket**	**CPC 1232**	**CPC 1232 with Jacket**
2014	89,422	51,592	5,600	22,380	9,850
2015	109,722	51,592	5,600	22,380	30,150
2016	115,544	51,592	5,600	22,380	35,972
2017	121,366	51,592	5,600	22,380	41,794
2018	127,188	51,592	5,600	22,380	47,616
2019	133,010	51,592	5,600	22,380	53,438
2020	133,010	51,592	5,600	22,380	53,438
2021	133,010	51,592	5,600	22,380	53,438
2022	133,010	51,592	5,600	22,380	53,438
2023	133,010	51,592	5,600	22,380	53,438
2024	133,010	51,592	5,600	22,380	53,438
2025	133,010	51,592	5,600	22,380	53,438
2026	133,010	51,592	5,600	22,380	53,438
2027	133,010	51,592	5,600	22,380	53,438
2028	133,010	51,592	5,600	22,380	53,438
2029	133,010	51,592	5,600	22,380	53,438
2030	133,010	51,592	5,600	22,380	53,438
2031	133,010	51,592	5,600	22,380	53,438
2032	133,010	51,592	5,600	22,380	53,438
2033	133,010	51,592	5,600	22,380	53,438
2034	133,010	51,592	5,600	22,380	53,438

Cost Areas for Tank Car Options

This section presents the areas of costs associated with the proposed tank car options. The initiative would generate costs in the following areas:

- *Incremental cost of newly constructed tank cars*: the acquisition cost of the PHMSA and FRA design tank car option, compared to the baseline Enhanced Jacketed CPC 1232 tank car, is $5,000. The difference in costs between the two cars, multiplied by the forecast of newly constructed tank cars, reflects a societal cost;

- *Cost to retrofit existing tank cars*: the cost of labor and materials needed to bring most of the existing fleet up to the DOT Specification 117P standard. In addition, a portion of DOT Specification 111s are projected to be retrofitted with jackets and thermal insulation for repurposing to tar sands crude service.

- *Out-of-service costs*: in order to implement the retrofits necessary to bring an existing car up to the DOT Specification 117P standard, a car will need to be taken out of service and cleaned prior to the retrofit. The lost service value for the time needed to complete the retrofits, as well as the cleaning costs, are societal costs. Some retrofits may be conducted during decennial requalification; in these cases, the additional time beyond that normally required for a requalification is used to develop this cost.

- *Repurposing costs:* Some of these cars could be transitioned to other services. As discussed below, the existing jacketed DOT Specification 111 cars (that do not meet CPC 1232 standards) are assumed to be repurposed to haul Alberta tar sands crude, which is a combustible rather than flammable liquid. It is believed that demand for new cars to haul tar sands crude is sufficient to absorb these jacketed cars currently in crude and ethanol service. In addition, we assume that 15 percent of older non-jacketed DOT Specification 111s would be repurposed to other uses. We assume that all jacketed CPC 1232 cars are also transferred to tar sands service. Repurposing involves retrofitting these cars with jackets and thermal insulation.

- *Costs resulting from increased weight:* the heavier tank cars will lead to increased fuel expenditures and more track maintenance. The added weight of the car would also likely result in additional fees established by the rail carrier.

Key Assumption: Transfer to Alberta Tar Sands Service. PHMSA expects the demand for tank cars to carry heavy crude oil from the Canadian tar sands will start to grow in 2014 and then take off in 2016 and 2017.[66,67] Tar sands has a high flashpoint and is generally classified as a combustible liquid, which means tank cars carrying tar sands will not be covered by this rule. While the current fleet has significant useful life remaining, PHMSA assumes that 23,237 existing cars would be transferred to tar sands service.

First, 7,787 oldest cars in the fleet—unjacketed DOT Specification 111s that do not meet the CPC 1232 unjacketed specifications—would be repurposed to Alberta tar sands service rather than remaining in flammable liquid service. Retrofitting old DOT Specification 111s to meet the DOT Specification 117 standard is expensive—nearly the purchase cost of a DOT Specification 111. Meanwhile, only jackets and insulation are necessary for tar sands crude service (note: tar sands crude is very thick and must be heated to a sufficient temperature to increase its viscosity in order to unload the car). PHMSA assumes that the older cars would be repurposed to tar

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[66] Tar sands from western Canada produce a heavy crude oil. The tar sands or oil sands are technically called bituminous sands. Canada has approximately 70 percent of the tar sands in the world. Until recently the tar sands were not considered to be part of the world's oil reserves. However, higher oil prices and new technology have enabled profitable extraction and processing. The crude bitumen that is contained in the Canadian oil sands exists in the semi-solid or solid phase in natural deposits. It is a thick and sticky form of a hydrocarbon that is so heavy and viscous that it will not flow unless heated or diluted with lighter hydrocarbons. After the Bakken shale, BNSF has noted that the tar sands will be the next big wave which will move from Canada to the U.S. on CN or Canadian Pacific then heading to Gulf Coast refineries on BNSF. It is estimated that the heavy crude oil from the Canadian tar sands will start to grow in 2014 and then take off in 2016 and 2017. The heavy crude oil from the tar sands is carbon-heavy and hydrogen-light which is the opposite of light crude which is hydrogen-heavy and carbon-light. The high hydrogen content in light crude enables it to flow easily but also makes it very explosive. The bitumen-laden heavy crude from the tar sands is not as volatile as light crude but it may be particularly damaging to the environment.

[67] Crude oil forecast from the Canadian Association Petroleum producers http://www.capp.ca/getdoc.aspx?DocId=247759&DT=NTV

sands crude service because it reduces retrofit costs, is cheaper than buying a new tank car for tar sands service, and provides a better return for the remaining service life of the car than fully retrofitting the car to keep it in flammable liquid service.

Second, PHMSA expects all 5,600 existing jacketed DOT specification 111 cars (that do not meet CPC 1232 standards) would be transferred to tar sands service. Finally, we assume that 9,850 jacketed CPC 1232 built before 2015 are also transferred to tar sands service. Since transfer of jacketed cars to tar sands service allows these cars to be used, unmodified, for the rest of their natural service life, PHMSA assumes the industry would implement this transfer. We seek comment on whether these assumptions are valid.

Costs of the PHMSA and FRA Designed Tank Car (Option 1)

Unit Cost Estimates

This section presents unit costs used in the analysis to estimate the total costs for the above cost areas. We present a cost analysis of the Option 1 tank car, which serves as the basis for the analysis of Options 2 and 3.

1. Incremental costs of Newly Constructed Tank Cars

The cost to manufacture a car to the Option 1 standard is estimated based on the sale price of other similar cars, consultation with PHMSA and FRA engineers, and comments received on the ANPRM. The Option 1 tank car standard adds several enhancements to a standard DOT Specification 111 tank car, resulting in a somewhat higher retail cost. The difference in costs between the Option 1 tank car and the Option 3 tank car is $5,000. This figure represents the incremental costs to a buyer who is required to purchase the Option 1 tank car instead of the Option 3 tank car. Relative to the Option 3 tank car, the Option 1 tank car includes:

- New ECP brakes ($3,000)[68]
- An additional 1-8-inch shell thickness ($2,000)[69]
- Roll-over protection (roughly equivalent in cost to top fittings protection)

This $5,000 incremental cost is applied to all new cars. New fleet growth is expected to be: 14,800 in 2016; 20,720 in 2017; 29,008 in 2018; 675 in 2019; 154 in 2020; and 1,063 in 2021.

As discussed above, PHMSA assumes the 5,600 jacketed DOT Specification 111 and 9,850 jacketed CPC-1232 tank cars can be repurposed to the demand for heavy crude oil from the Canadian tar sands that will start to grow in 2014 and then take off in 2016 and 2017. Rather than purchasing new tank cars to haul tar sands crude, the industry can transition jacketed tank

[68] Federal Railroad Administration, ECP Brake System for Freight Service, Final Report, Booz Allen Hamilton, released August 2006.

[69] The extra cost of increased thickness is based on the amount of steel that is required to be added to a shell/jacket, and a cost per pound of steel of $0.40 per pound. Source: http://www.metalprices.com/p/SteelBenchmarkerFreeChart

cars to haul tar sands crude and buy new tank cars to replace the cars lost to flammable liquid service. For replacement of these transferred cars, the cost difference is $5,000 per tank car.

In addition, as described above, 7,787 of the oldest unjacketed DOT Specification 111s in crude oil and ethanol service are repurposed to tar sands crude by fitting them with jackets and thermal insulation. For replacement of these 7,787 transferred cars, the incremental cost for buying a new Option 1 tank car rather than an Option 3 tank car is $5,000. Please note that, as described below, the DOT Specification 111 transferred to tar sands service would have a retrofit cost of $27,000 ($23,000 for a jacket and $4,000 for thermal insulation).

2. Cost of Retrofitting Existing Tank Cars

The estimated costs to retrofit the various configurations of current in-service tank cars came from comments submitted to the docket by Watco and RSI. Both commenters provided detailed cost information on each of the enhancements necessary to bring older cars up to the new performance standard. These include the cost of top fitting protections, jackets, thermal protection or replacement of the pressure relief valve, a new bottom outlet valve handle, full-height head shields, and ECP brake installation (for Option 1).

Table TC6: Retrofit Costs for Public Comments

Retrofit Option	Cost
Bottom outlet valve handle	$1,200
Pressure relief valve	$1,500
New truck	$16,000
Thermal protection	$4,000
Full jacket	$23,000
Full height head shield	$17,500
Top fitting protection (if no top fitting protection)	$24,500
ECP brakes	$5,000

Two retrofit options—increased 1/8-inch thickness and roll-over protection—were not included in the public comments providing cost estimates. We expect that tank cars will meet the Option 1 standard by adding 1/8-inch thickness to the retrofitted jacket (increasing the jacket thickness from its usual 11-gauge thickness), and we assume this thicker jacket costs an additional $2,000 (from the estimated $23,000 cost for an 11-gauge jacket). In addition, we do not estimate the cost of roll-over protection, because we expect it to be small.

Key Assumption: No new trucks needed. In consultation with FRA and PHMSA tank car engineers, we have made modifications to the costs presented by Watco and RSI. Firstly, the crude and ethanol fleet is relatively new—PHMSA believes the vast majority of cars in crude and ethanol service have been built in the past 15 years. As a result, cars in this service should have a truck which would support the extra weight of the retrofits. PHMSA believes all cars manufactured in this time period were built to a 286,000 lbs. weight limit, which would include a truck that would support the extra weight of retrofits. The cost of a new truck is therefore not incorporated into the cost of retrofits for any configuration of tank car.

Key Assumption: Cost of full-height head shield included in $23,400 jacket cost. In addition, all retrofit cars will have to have jackets and thermal insulation applied to meet the puncture resistance and survivability standards established by this rule. We assume no car would have to have full height head shields mounted directly on the body—the cost of new head shields is built into the cost of a jacket. It is also PHMSA's understanding that adding full height head shields to a jacket during the manufacturing process would not increase costs other than the cost of material. PHMSA estimates the extra material required for full height head shields would be approximately 974 pounds of steel, which at $0.40 per pound would cost $386 per jacket. PHMSA rounds this figure to $400 and increases retrofit costs by that amount.

Key Note: No required top fittings for retrofitted tank cars. In addition, as noted in the preamble and above, retrofit requirements do not mandate top fittings protection, so those costs are omitted from the analysis. All the other tank car models described here have top fittings protections (or rollover protection) as a standard feature.

We expect two types of cars to be retrofitted: the unjacketed DOT Specification 111 and the unjacketed CPC-1232. The cost of upgrading an unjacketed DOT Specification 111 to the PHMSA and FRA designed car standard is presented in the table below. Please note we assume some level of returns to scale given the volume of retrofits, so we apply 10 percent cost reduction factor.

Table TC7: Retrofit Costs for the Unjacketed DOT Specification 111

Retrofit Option	Cost
Bottom outlet valve handle retrofit cost	$1,200
Pressure relief valve retrofit cost	$1,500
Thermal protection retrofit cost	$4,000
Full jacket retrofit cost (assumed to included full-height head shield cost)	$23,400
Increased 1/8-inch thickness (assumed to be added to jacket)	$2,000
ECP brakes retrofit cost	$5,000
Roll-over protection cost	Not Required
Unadjusted Total	**$37,100**
Economies of scale cost reduction	10%
Adjusted Total	**$33,390**

Non-jacketed CPC 1232 cars need less extensive retrofits, because they have 1/8-inch greater thickness than unjacketed DOT Specification 111s.We again assume some level of returns to scale given the volume of retrofits, assuming costs are reduced by 10 percent. The final retrofit costs are presented in the table below.

Table TC8:Retrofit Costs for the Unjacketed CPC 1232

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Retrofit Option	Cost
Bottom outlet valve handle retrofit cost	$1,200
Pressure relief valve retrofit cost	$1,500
Thermal protection retrofit cost	$4,000
Full jacket retrofit cost (assumed to included full-height head shield cost)	$23,300*
Increased 1/8-inch thickness (assumed to be added to jacket)	$1,500*
ECP brakes retrofit cost	$5,000
Roll-over protection cost	Not Estimated
Unadjusted Total	**$36,500**
Economies of scale cost reduction	10%
Adjusted Total	**$32,850**

* Because the CPC 1232 has better puncture resistance when compared to a legacy DOT Specification 111, we reduced the costs of features that improve puncture resistance for this car modestly.

3. Out of Service Costs (Lost Service Value)

PHMSA used a rental price of capital approach to estimate the service value of the tank cars; these values are needed to develop cost estimates for taking cars out of service to retrofit them. The approach takes into account depreciation and the opportunity costs of the asset, amortizing the acquisition costs over the average life span of the cars. PHMSA assumed a 7 percent interest rate, and 40 and 50 year life spans for the DOT Specification 111s and CPC-1232s respectively. The acquisition cost of the non-jacketed DOT Specification 111 was assumed to be $60,000, with the non-jacketed CPC-1232s being $85,000. These assumptions produce the annual service values listed in the table below.

PHMSA also estimates that retrofitting DOT Specification 111 cars would take an average of 12 weeks, and retrofitting CPC-1232 cars would take 8 weeks. As shown below, the annual values presented above are prorated accordingly and used to value the lost service time.

Table TC9:Value of Lost Service

Tank Car	Annual Service Value	Time Out-Of-Service from Retrofits	Total Lost Service Value from Retrofits
DOT Specification 111 (Non-Jacketed)	$4,474	12 weeks	**$1,033**

CPC-1232 (Non-Jacketed)	$6,137	8 weeks	**$944**

PHMSA and FRA solicit comments from industry on how these values compare to the annual costs of leasing these types of tank cars. PHMSA and FRA solicit comments on the time out-of-service estimates and whether they will increase as a result of an industry-wide retrofit.

4. Cost of Repurposing Existing Tank Cars

As mentioned during the discussion of the incremental cost of replacement cars, 7,787 unjacketed DOT Specification 111 are assumed to be transferred to Alberta tar sands service. These cars need retrofitted jackets and thermal insulation for tar sands crude service, because tar sands crude is very thick and must be heated to a sufficient temperature to increase its viscosity in order to unload the car. The total cost of retrofits and thermal insulation is $27,000. In this analysis, PHMSA applies a 10% reduction to account for economies of scale and increased labor productivity resulting in a total retrofit cost of $24,300.[70]

As noted above, PHMSA assumes all 5,600 jacketed DOT Specification 111 cars and 9,850 jacketed CPC 1232 cars also would be transferred into service hauling Alberta tar sands oil. We assume no costs from this transfer.

5. Costs Resulting from Increased Weight

We expect that the Option 1 car will be heavier than all of the existing cars as well as the Option 3 car that would be newly constructed in the absence of this rule. We estimate no costs from capacity loss, because we find that existing cars and the Option 3 car can withstand modification to the PHMSA and FRA designed car and still fall under the 286,000 GRL level. The additional safety features of the proposed new tank car standard could increase the weight of an unloaded tank car. For instance, all proposed Options for the DOT Specification 117 car include head shields, a jacket, thicker tank shell steel, and other safety features not required in DOT Specification 111 tank cars. Additional weight for the tank car could lead to a reduction in lading capacity per tank car, as rail cars must be under the applicable gross rail weight (GRL) when fully loaded. However, PHMSA and FRA believe there will not be less capacity in practice, for the following reasons:

1. PHMSA is proposing a performance standard and expects that the regulations will spur innovation in tank car design and construction. Industry is currently evaluating new, tougher steels as well as composite materials and crash energy management systems intended to improve energy absorption with little or no weight penalty. Innovation will be driven by a desire to decrease the tare weigh of the tank car. Assuming the market will be interested if the new materials will restore the pre-117 tare weight, the reduction will be at least 9%. This decrease in the tare weight will increase the load limit (carrying

[70] Jackets ($23,000) + Thermal Insulation ($4,000) – 10% for economies of scale and increased labor productivity ($2,700) = $24,300

capacity) of the car by 9%. Accordingly a shipper will need a smaller fleet and will pay for fewer shipments. These savings will negate the cost of innovative materials.

2. When considering risk associated with decreased tank car load limit it is the number of trains and derailment rate that is relevant. DOT believes the railroads will optimize unit train length which may result in longer trains. Optimization will be based on a number of factors including train length, available horse power, grade along route, required speed, loading rack capacity and loop size. Because there are so many variables it is difficult to predict the change in operations resulting from a potential decrease in load limit. As such, DOT is seeking comment on the issue.

3. The DOT Specification 117 is authorized operate at a GRL of 286,000 lbs. The regulations currently authorize the DOT Specification 111 to operate at a GRL of 263,000 lbs. However, DOT Specification 111 tank cars that meet the minimum standards provided in FRA's Federal Register Notice of January 25, 2011[71] are permitted to operate at a GRL of up to 286,000 lbs. The proposed tank car specifications meet those minimum requirements and PHMSA and FRA believe that the additional weight of the safety features will be accommodated by the increase in allowable GRL and will not decrease the load limit (or innage) as indicated in the table below. For example, a jacketed CPC 1232 can be loaded to 1% outage and not weigh 286,000 pounds (approximately 281,000 pound) and as such, there is no capacity gain to be had unless the allowable GRL is increased beyond 286,000.

4. Primarily bridge capacity along the routes limits the GRL of a particular railroad or segment of rail. The primary concern for this issue is the terminal railroads. DOT believes all of the Class I RRs are capable of 286K. The ASLRRA, website indicates that nearly half of its member railroads are capable of moving tank cars with a gross rail load of 286K. There is very little specific information provided and perhaps a RR has a trestle on a line not capable of handling a 286,000 car that would not necessarily affect the delivery of crude oil to a customer because the trestle exists beyond the delivery point. DOT is requesting information from industry that will provide a better understanding of the capacity of the terminal railroads.

The increased weight is estimated in the table below:

Table TC 10: Estimated Weight of Tank Cars

Tank Car Characteristics	Gross Rail load	Estimated Tare Weight	Ethanol Allowable Innage* (6.58 lbs./gallon)	Crude Oil Allowable Innage (6.78 lbs./gallon)	GRL Ethanol	GRL Crude

[71] This FR Notice required compliance with AAR standard S286. AAR Standard S-286 applied to four axel freight cars designed and designated to carry a gross rail load of greater than 268,000 pounds and up to 286,000 pounds. The standard includes requirements for car body design loads, fatigue design, brake systems. Bearings, axels, wheels, draft system, springs, trucks, and stenciling.

DOT Specification 111 specification non-jacketed	263K	67,800	29,666	28,790	263,000	263,000
	286K	67,800	29,700	29,700	233,226	269,166
DOT111/Enhanced CPC1232 non jacketed	263K	75,200	28,540	27,699	263,000	263,000
	286K	75,200	29,700	29,700	270,626	276,566
DOT111/Enhanced CPC1232 jacketed	263K	80,800	27,690	26,873	263,000	263,000
	286K	80,800	29,700	29,700	276,226	282,166
DOT117	263K	85,500	26,976	26,180	263,002	263,000
	286K	85,500	29,700	29,572	280,926	286,000

Innage is the volume of material in the tank car tank. 29,700 gallons is the minimum allowable outage (1%) on a 30,000 gallon capacity car.

PHMSA expects increased weight would have two primary effects: (1) increase in fuel expenses and (2) increase in repair and maintenance expenses, including track maintenance.

To estimate the increase in fuel expenses required for the additional weight of the retrofits, PHMSA developed an estimate of rail fuel expenditures per ton-mile. To develop the estimate, PHMSA relied on CSX data indicating that the railroads can move a ton of freight 450 miles using one gallon of fuel,[72] or that 1 ton-mile requires 1/450 gallons of fuel. To value this figure, PHMSA assumed an average retail price for diesel of $3.51 per gallon[73]—$3.90 reduced by 10 percent to allow for bulk purchase discounts. The resulting cost per ton-mile is estimated to be $0.0078.[74]

To estimate the increase in repair and maintenance expenses resulting from the additional weight of the retrofits, PHMSA developed an estimate of the railroads repair and maintenance expenditures per ton-mile. Operating expenditures by the railroads were obtained from STB's *Statistics of Class I Railroads*; PHMSA used the repair and maintenance line items for rails and tracks, ties, bridges and culverts, roadways, and tunnels and subways. These expenses were then divided by total freight ton-miles in the U.S., estimated using the rail public waybill data, and inflated to 2013 using BLS' producer price index for railroads. The cost per ton-mile is estimated to be $0.000826.

Table TC11: Increased Fuel and Maintenance Costs

Tank Car	Increased weight to achieve PHMSA and FRA designed	Miles Per Year, Per Car	Additional Fuel Costs per Ton-Mile	Additional Maintenance Cost per Ton-Mile	Annual Additional Fuel and Maintenance Costs

[72] See http://www.csx.com/index.cfm/about-csx/projects-and-partnerships/fuel-efficiency/

[73] Energy Information Administration. Gasoline and Diesel Fuel Update. Available online at http://www.eia.gov/petroleum/gasdiesel/

[74] Extra ton-miles total 77.6 billion over 20 years. The associated cost was calculated as follows: Each car is estimated to make nine 1,100 mile trips per year. The cost of extra fuel is calculated by multiplying the number of trips (9) by the miles per trip (1,100) by the average extra weight per car (7.65 tons) by the cost of fuel per ton mile ($0.0078) or extra maintenance ($0.00083) by the number of cars.

	car standard				
Retrofitted Unjacketed DOT Specification 111	11.93 tons	9,900	$0.0078	$0.00083	**$1,019**
Retrofitted Unjacketed CPC 1232	7.5 tons	9,900	$0.0078	$0.00083	**$641**
Enhanced Jacketed CPC 1232	3 tons	9,900	$0.0078	$0.00083	**$256**

Development of Total Cost

In this section, PHMSA combines the per unit cost estimates with quantity estimates to produce total costs estimates for the different cost factors.

There is a relationship between retrofitting costs, new construction costs, out-of-service costs and lost value of service; therefore, it is necessary to present these costs as a group, together with the methodology used to develop them.

Timing Assumptions

1. Tar Sands Service Transfer: Occurs in 2017 for Jacketed Cars and in 2018 for Unjacketed Cars: First, PHMSA assumed that the jacketed tank cars are transferred to transport Alberta tar sands crude oil, which can be transported as a combustible liquid under the HMR. This implies that these cars will have to be replaced with new construction by October 1, 2017. Since the transferred jacketed cars would still be hauling crude oil the replacement cars are factored into our fleet forecast figures. Unjacketed DOT Specification 111s would be transferred in 2018, for the reasons outlined in the following assumptions, and their replacement cars would be constructed in the same year.

2. Retrofitting: All Unjacketed Cars are in PG II and III Service, which has a 10/1/18 deadline Second, PHMSA assumed that non-jacketed cars are used for both Package Groups II and III, and that shippers would adhere to the October 1, 2018 deadline rather than trying to reserve cars specifically for Package Group III (which would allow them to extend their deadline to 2020).

3. Retrofitting: Occurs from 2016 to 2018 (one-third in each year). Third, due to the large number of retrofits, we assumed that companies would begin retrofitting tank cars in 2016 for the 2018 compliance date. In all PHMSA estimates that 66,185 cars would need to be retrofit and believes that insufficient shop space is available to retrofit that many cars in a single year. We therefore assume retrofitting would phase in over 3 years, with a third of the cars being retrofit in each year.

4. New Construction: Production of cars constructed to the new standard are assumed to be produced beginning in early 2015. As noted above, PHMSA assumes that beginning in 2015 cars would be constructed to the new standard, at a $5,000 cost differential compared to a jacketed CPC 1232 car. We forecast that 20,300 cars would be built in this year. In later years, new construction due to continued growth in demand for cars moderates to 5,800 cars constructed per year in years 2016 – 2019. These cars are in addition to newly constructed cars to replace those transferred to tar sands service

Methodology

To facilitate the calculations, the same methodology was used to develop estimates for the following four groups:

- Jacketed Ethanol Fleet
- Jacketed Crude Petroleum Fleet
- Non-Jacketed Ethanol Fleet
- Non-Jacketed Crude Petroleum Fleet

The methodology consists of the following five (5) steps. The computations for these five steps are listed below:

Step 1: Calculate the Cost of Building New Cars for Replacements: As noted above, roughly 15,450 jacketed cars are assumed to be transferred to Canadian tar sands crude service in 2017. This implies that these cars will have to be replaced with new construction by October 1, 2017. In addition, 7,787 unjacketed cars are assumed to be transferred to Canadian tar sands crude service. This implies that these cars will have to be replaced with new construction by October 1, 2018. The incremental cost to replace these cars with the Option 1 car, instead of Option 3, is $5,000.

Step 2: Calculate the Cost of New Construction for Non-Replacement Growth: The demand for new tank cars is based on two sources: replacement investment and new investment. Replacement investment occurs when companies purchase a new car to replace one they are transferring to a different service. New investment occurs when companies increase the size of their fleet to accommodate growth in the markets they serve. Replacement investment was addressed in Step 1 above. New investment was calculated in a similar fashion. Again, PHMSA assumed that all buyers would have purchased Option 3 car instead of the Option 1 car. For each year in the forecast horizon PHMSA multiplied the growth in the fleet by the incremental acquisition cost of $5,000.

Step 3: Calculate Retrofitting Costs: For the retrofitting costs PHMSA used the unit cost presented in table above titled, “Retrofitting Costs by Car Type” combined with cost estimates for taking the cars out-of-service to conduct the retrofits. PHMSA calculated that 14,601 unjacketed DOT Specification 111 cars would be retrofitted annually beginning in 2016 – October of 2018 at a cost of $34,433 per retrofit, including unit costs ($33,390) and out of service costs ($1,033). PHMSA calculated that 7,460 unjacketed CPC 1232 cars would be retrofitted per year over this same time frame at a cost of $33,844 per retrofit, including unit costs ($32,850) and out of service costs ($944).

For the unit costs, PHMSA took the adjusted totals presented in Tables TC8 and TC9. For the out-of-service costs, as explained above and shown in Table TC10, PHMSA divided the values in table titled "Annual Service Values per Car" by 52 to put them on a weekly basis, and then multiplied them by the estimated number of weeks needed to conduct the retrofits (12 weeks for unjacketed DOT Specification 111s, 8 weeks for unjacketed CPC-1232s). Thus, PHMSA calculated that unjacketed DOT Specification 111 cars would have an out-of-service cost of $1,033. PHMSA calculated that unjacketed CPC 1232 cars would have an out-of-service cost of $944.

In addition, as explained above, there is a $24,300 retrofit cost to jacket and insulate the 7,787 unjacketed DOT Specification 111s that are transferred to tar sands crude service. There are no costs for the jacketed DOT Specification 111s and jacketed CPC 1232s that are transferred to tar sands service.

Step 4: Compute Total Increased Operating Expenditures. Total increased operating expenditures resulting from the increased weight of the retrofits were estimated for fuel and for repair and maintenance. The cost estimates were developed by multiplying the number of retrofitted tank cars operating each year by the per-unit costs, the additional weight of the retrofits (in tons), the average number of carloads per tank car, and an estimate of the average miles per carload. The average number of carloads per tank car was estimated by dividing total crude oil and ethanol carloads (from the waybill) by the respective fleet size. Estimates for average miles per carload were developed using the waybill data. As shown in Table TC 12, this methodology generates an increase in annual operating expenditures of $1,019 for retrofitted unjacketed DOT Specification111 cars (starting in 2018), $641 for retrofitted unjacketed CPC 1232 cars (starting in 2018), and $256 for newly constructed cars (starting in 2016).

Step 5: *Compute Present Values*: The yearly costs over the forecast horizon were converted to present values using a 7 percent discount rates.

Total Cost Estimates

The following table summarizes the key inputs and sources into our total cost estimates:

Table TC12: Summary of Cost Estimates

Tank Car Option 1: FRA and PHMSA Designed Car		
Variable	**Formula/Input**	**Source**
Number of **DOT Specification 111 Unjacketed Retrofitted 2016-2018**	43,805 tank cars	DOT Estimate
Unit Cost Per Retrofit of DOT Specification 111 Unjacketed	$33,390	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Time Out-of-Service Cost of DOT Specification 111 Unjacketed	$1,033	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Additional Fuel and Maintenance Costs Per Year, Relative to FRA and PHMSA Designed Car(based on 11.93 tons of additional weight)	$1,019	DOT Adaptation of EIA and CSX Corporation Data

Tank Car Option 1: FRA and PHMSA Designed Car		
Variable	**Formula/Input**	**Source**
Number of **DOT Specification 111 Unjacketed Transferred** to Tar Sands Service in 2018	7,787 tank cars	DOT Estimate
Unit Cost Per Retrofit of DOT Specification 111 Unjacketed	$24,300	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Time Out-of-Service Cost of DOT Specification 111 Unjacketed	$1,033	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Additional Fuel and Maintenance Costs Per Year, Relative to FRA and PHMSA Designed Car	Not Estimated	N/A
Number of **DOT Specification 111 Jacketed Retrofitted** 2016-2018	None	DOT Estimate
Unit Cost Per Retrofit of DOT Specification 111 Jacketed	N/A	N/A
Time Out-of-Service Cost of DOT Specification 111 Jacketed	N/A	N/A
Additional Fuel and Maintenance Costs Per Year, Relative to FRA and PHMSA Designed Car	N/A	N/A
Number of **DOT Specification 111 Jacketed Transferred** to Tar Sands Service in 2016	5,600 tank cars	DOT Estimate
Unit Cost Per Retrofit of DOT Specification 111 Jacketed	$0	DOT Estimate
Time Out-of-Service Cost of DOT Specification Jacketed	$0	DOT Estimate
Additional Fuel and Maintenance Costs Per Year, Relative to FRA and PHMSA Designed Car	Not Estimated	N/A
Number of **CPC 1232 Unjacketed Retrofitted** 2016-2018	22,380 tank cars	DOT Estimate
Unit Cost Per Retrofit of CPC 1232 Unjacketed	$32,850	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Time Out-of-Service Cost of CPC 1232 Unjacketed	$944	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Additional Fuel and Maintenance Costs Per Year, Relative to FRA and PHMSA Designed Car (based on 7.5 tons of extra weight)	$641	DOT Adaptation of EIA and CSX Corporation Data
Number of **CPC 1232 Unjacketed Transferred** to Tar Sands Service in 2018	None	DOT Estimate
Unit Cost Per Retrofit of CPC 1232 Unjacketed	N/A	N/A
Time Out-of-Service Cost of CPC 1232 Unjacketed	N/A	N/A
Additional Fuel and Maintenance Costs Per Year, Relative to FRA and PHMSA Designed Car	N/A	N/A
Number of **CPC 1232 Jacketed Retrofitted** 2016-2018	None	DOT Estimate
Unit Cost Per Retrofit of CPC 1232 Jacketed	N/A	N/A

Tank Car Option 1: FRA and PHMSA Designed Car		
Variable	**Formula/Input**	**Source**
Time Out-of-Service Cost of CPC 1232 Jacketed	N/A	N/A
Additional Fuel and Maintenance Costs Per Year, Relative to FRA and PHMSA Designed Car	N/A	N/A
Number of **CPC 1232 Jacketed Transferred** to Tar Sands Service in 2017	9,850 tank cars	DOT Estimate
Unit Cost Per Retrofit of CPC 1232 Jacketed	$0	DOT Estimate
Time Out-of-Service Cost of CPC 1232 Jacketed	$0	DOT Estimate
Additional Fuel and Maintenance Costs Per Year, Relative to FRA and PHMSA Designed Car	Not Estimated	N/A
Number of **New PHMSA and FRA Designed Cars Constructed**, 2015-2019	66,825 tank cars	DOT Estimate
Incremental Cost of New PHMSA and FRA Designed Cars, Relative to Enhanced Jacketed CPC 1232	$5,000	DOT Estimate
Other Costs from Factory Re-Tooling or Capacity Issues	Not Estimated	N/A
Additional Fuel and Maintenance Costs Per Year, Relative to FRA and PHMSA Designed Car (based on 3 tons of extra weight)	$256	DOT Adaptation of EIA and CSX Corporation Data
Tank Car Capacity Loss from Enhanced Tank Car Standards	None	DOT Estimate
Number of Tank Car **Early Retirements** (as a result of the cost of retrofits), 2015-2034	None	DOT Estimate
Number of Tank Car **Retirements from End-of-Service Life**, 2015-2034	None	DOT Estimate
Number of Retrofitted Cars Needing **New Trucks** (for all tank car options)	None	DOT Estimate
Loading Facility Capacity Decrease	None	DOT Estimate
Percentage of **Track Capable of Handling 286,000 pounds of Gross Rail Load** (GRL)	100%	DOT Estimate
Percentage of **DOT Specification 111 Unjacketed** and **CPC 1232 Unjacketed** in PG II and PG III service	100%	DOT Estimate

Table TC13: Undiscounted Costs for the PHMSA/FRA Design Car

Undiscounted PHMSA and FRA Design Cost Stream					
Year	New Construction	111 Tar Sands Transfer	Retrofits (Includes Jacketed Tar Sands Transfer	Fuel and Maintenance	Total
2015	$101,500,000	$0	$0	$9,579,054	$111,079,054
2016	$29,110,000	$0	$754,730,980	$30,723,567	$814,564,548
2017	$29,110,000	$0	$831,980,980	$57,499,754	$918,590,735
2018	$29,110,000	$38,935,000	$951,995,407	$82,254,978	$1,102,295,385
2019	$29,110,000	$0	$0	$83,746,453	$112,856,453
2020	$0	$0	$0	$83,746,453	$83,746,453
2021	$0	$0	$0	$83,746,453	$83,746,453
2022	$0	$0	$0	$83,746,453	$83,746,453
2023	$0	$0	$0	$83,746,453	$83,746,453
2024	$0	$0	$0	$83,746,453	$83,746,453
2025	$0	$0	$0	$83,746,453	$83,746,453
2026	$0	$0	$0	$83,746,453	$83,746,453
2027	$0	$0	$0	$83,746,453	$83,746,453
2028	$0	$0	$0	$83,746,453	$83,746,453
2029	$0	$0	$0	$83,746,453	$83,746,453
2030	$0	$0	$0	$83,746,453	$83,746,453
2031	$0	$0	$0	$83,746,453	$83,746,453
2032	$0	$0	$0	$83,746,453	$83,746,453
2033	$0	$0	$0	$83,746,453	$83,746,453
2034	$0	$0	$0	$83,746,453	$83,746,453
Total	$217,940,000	$38,935,000	$2,538,707,368	$1,520,000,610	$4,315,582,977

Table TC14: Total Present Value Costs for PHMSA and FRA Designed Tank Car

PHMSA and FRA Design Cost Stream, Discounted at 7%					
Year	**New Construction**	**111 Tar Sands Transfer**	**Retrofits (Includes Jacketed Tar Sands Transfer**	**Fuel and Maintenance**	**Total**
1	$94,859,813	$0	$0	$8,952,387	$103,812,200
2	$25,425,801	$0	$659,211,268	$26,835,154	$711,472,223
3	$23,762,431	$0	$679,144,308	$46,936,927	$749,843,666
4	$22,207,880	$29,703,325	$726,272,738	$62,751,929	$840,935,871
5	$20,755,028	$0	$0	$59,710,064	$80,465,092
6	$0	$0	$0	$55,803,798	$55,803,798
7	$0	$0	$0	$52,153,082	$52,153,082
8	$0	$0	$0	$48,741,198	$48,741,198
9	$0	$0	$0	$45,552,522	$45,552,522
10	$0	$0	$0	$42,572,450	$42,572,450
11	$0	$0	$0	$39,787,337	$39,787,337
12	$0	$0	$0	$37,184,427	$37,184,427
13	$0	$0	$0	$34,751,801	$34,751,801
14	$0	$0	$0	$32,478,319	$32,478,319
15	$0	$0	$0	$30,353,569	$30,353,569
16	$0	$0	$0	$28,367,821	$28,367,821
17	$0	$0	$0	$26,511,982	$26,511,982
18	$0	$0	$0	$24,777,554	$24,777,554
19	$0	$0	$0	$23,156,592	$23,156,592
20	$0	$0	$0	$21,641,675	$21,641,675
Total	$187,010,953	$29,703,325	$2,064,628,313	$749,020,588	$3,030,363,180

Costs of Enhanced CPC1232 Standard (Option 3)

PHMSA also considers another standard that mandates all cars to meet or exceed the performance achieved by an Option 3 tank car (described above). This car is already in production and is the standard the tank car manufacturers have committed to build to for flammable liquid unit train service. The costs for mandating this standard are developed in this section. The cost analysis is similar to that for the Option 1, with the following changes:

1. Our baseline assumption is that this car would be the car that is produced in the in absence of regulation. As a result, we assume no incremental costs associated with building new cars to satisfy growing demand for tank cars to ship crude oil and ethanol in unit trains.
2. The industry would either produce new Option 3 car for tar sands, or use the jacketed DOT Specification 111s unmodified for tar sands service and build a new Option 3 car for flammable liquid service. Since transfer of jacketed 111s to tar sands service allows these cars to be used, unmodified, for the rest of their natural service life, PHMSA assumes the industry would implement this transfer. Therefore, we estimate no costs for replacing transferred jacketed cars.
3. The retrofit costs for both the DOT Specification 111 unjacketed and CPC 1232 unjacketed costs would be lower, because the Option 3 tank car does not require ECP brakes, roll-over protection, or increased shell thickness.
4. The additional fuel and maintenance costs would decrease for all retrofitted and newly constructed cars, because the Option 3 tank car is lighter than the Option 1 tank car.
5. Legacy Jacketed CPC 1232 cars would also be transferred to tar sands service. These cars would need to be retrofitted with a modified BOV handle and better PRV to remain in HHFT service. PHMSA assumes transfer to tar sands service would be possible at negligible cost but seeks comment on whether altering leasing agreements impose costs not anticipated by PHMSA. Since installing an alternative BOV handle and PRV on a new car is assumed not to impose costs when compared to installing the old PRV and BOV handle, we do not attribute any marginal cost to replacing these cars with Option 3 cars. There are 9,850 cars that were built with the older-design PRV and BOV handle.

We continued all other assumptions listed in the cost analysis for the Option 1 car. For example, we continue to assume unjacketed DOT Specification 111s mentioned would require more substantial retrofits to remain in flammable liquid service than would be the case if they are jacketed with thermal protection for tar sands service, so we continue to estimate these cars would be jacketed and used in tar sands service. The table below summarized the information that feeds into the cost analysis for this tank car option.

Table TC15: Retrofit Costs for the Unjacketed DOT Specification 111 (to Option 3 Tank Car)

Retrofit Option	Cost
Bottom outlet valve handle retrofit cost	$1,200
Pressure relief valve retrofit cost	$1,500
Thermal protection retrofit cost	$4,000
Full jacket retrofit cost with half height head shields	$23,000
Unadjusted Total	**$29,700**
Economies of scale cost reduction	10%
Adjusted Total	**$26,730**

Table TC16: Retrofit Costs for the Unjacketed CPC 1232 (to Option 3 Tank Car)

Retrofit Option	Cost
Bottom outlet valve handle retrofit cost	$1,200
Pressure relief valve retrofit cost	$1,500
Thermal protection retrofit cost	$4,000
Full jacket retrofit cost*	$22,400
Unadjusted Total	**$29,100**
Economies of scale cost reduction	10%
Adjusted Total	**$26,190**

* Because the CPC 1232 already has better puncture resistance and half-height head shields the jacket retrofit cost is assumed to be somewhat lower than for the DOT Specification 111

Table TC17:Increased Fuel and Maintenance Costs, Option 3 Tank Car

Tank Car	**Increased weight to achieve Enhanced Jacketed CPC 1232**	**Miles Per Year, Per Car**	**Additional Fuel Costs per Ton-Mile**	**Additional Maintenance Cost per Ton-Mile**	**Annual Additional Fuel and Maintenance Costs**
Retrofitted Unjacketed DOT Specification 111	8.93 tons	9,900	$0.01	$0.00	**$763**
Retrofitted Unjacketed CPC 1232	4.5 tons	9,900	$0.01	$0.00	**$384**

TC18: Summary of Cost Estimates for an Option 3 Tank Car

Tank Car Option 3: Enhanced Jacketed CPC 1232 Car		
Variable	**Formula/Input**	**Source**
Number of **DOT Specification 111 Unjacketed Retrofitted** 2016-2018	43,805 tank cars	DOT Estimate
Unit Cost Per Retrofit of DOT Specification 111 Unjacketed	$26,730	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Time Out-of-Service Cost of DOT Specification 111 Unjacketed	$1,033	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Additional Fuel and Maintenance Costs Per Year, Relative to Enhanced Jacketed CPC 1232 (based on 8.93 tons of extra weight)	$763	DOT Adaptation of EIA and CSX Corporation Data
Number of **DOT Specification 111 Unjacketed Transferred** to Tar Sands Service in 2018	7,787 tank cars	DOT Estimate
Unit Cost Per Retrofit of DOT Specification 111 Unjacketed	$24,300	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Time Out-of-Service Cost of DOT Specification 111 Unjacketed	$1,033	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Additional Fuel and Maintenance Costs Per Year, Relative to Enhanced Jacketed CPC 1232	Not Estimated	N/A
Number of **DOT SPECIFICATION 111 Jacketed Retrofitted** 2016-2018	None	DOT Estimate
Unit Cost Per Retrofit of DOT Specification 111 Jacketed	N/A	N/A
Time Out-of-Service Cost of DOT Specification 111 Jacketed	N/A	N/A
Additional Fuel and Maintenance Costs Per Year, Relative to Enhanced Jacketed CPC 1232	N/A	N/A

Tank Car Option 3: Enhanced Jacketed CPC 1232 Car		
Variable	**Formula/Input**	**Source**
Number of **DOT Specification 111 Jacketed Transferred** to Tar Sands Service in 2017	5,600 tank cars	DOT Estimate
Unit Cost Per Retrofit of DOT Specification 111 Jacketed	$0	DOT Estimate
Time Out-of-Service Cost of DOT Specification 111 Jacketed	$0	DOT Estimate
Additional Fuel and Maintenance Costs Per Year, Relative to Enhanced Jacketed CPC 1232	Not Estimated	N/A
Number of **CPC 1232 Unjacketed Retrofitted** 2016-2018	22,380 tank cars	DOT Estimate
Unit Cost Per Retrofit of CPC 1232 Unjacketed	$24,300	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Time Out-of-Service Cost of CPC 1232 Unjacketed	$944	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Additional Fuel and Maintenance Costs Per Year, Relative to Enhanced Jacketed CPC 1232 (based on 4.5 tons of extra weight)	$641	DOT Adaptation of EIA and CSX Corporation Data
Number of **CPC 1232 Unjacketed Transferred** to Tar Sands Service in 2018	None	DOT Estimate
Unit Cost Per Retrofit of CPC 1232 Unjacketed	N/A	N/A
Time Out-of-Service Cost of CPC 1232 Unjacketed	N/A	N/A
Additional Fuel and Maintenance Costs Per Year, Relative to Enhanced Jacketed CPC 1232	N/A	N/A
Number of **CPC 1232 Jacketed Retrofitted** 2016-2018	None	DOT Estimate
Unit Cost Per Retrofit of CPC 1232 Jacketed	N/A	N/A
Time Out-of-Service Cost of CPC 1232 Jacketed	N/A	N/A
Additional Fuel and Maintenance Costs Per Year, Relative to Enhanced Jacketed CPC 1232	N/A	N/A
Number of **CPC 1232 Jacketed Transferred** to Tar Sands Service in 2017	9,850 tank cars	DOT Estimate
Unit Cost Per Retrofit of CPC 1232 Jacketed	$0	DOT Estimate
Time Out-of-Service Cost of CPC 1232 Jacketed	$0	DOT Estimate
Additional Fuel and Maintenance Costs Per Year, Relative to Enhanced Jacketed CPC 1232	Not Estimated	N/A
Number of **New CPC 1232 Jacketed Constructed**, 2015-2019	66,825 tank cars	DOT Estimate
Incremental Cost of CPC 1232 Jacketed, Relative to Enhanced Jacketed CPC 1232	$0	N/A
Other Costs from Factory Re-Tooling or Capacity Issues	Not Estimated	N/A

Tank Car Option 3: Enhanced Jacketed CPC 1232 Car		
Variable	**Formula/Input**	**Source**
Additional Fuel and Maintenance Costs Per Year, Relative to Enhanced Jacketed CPC 1232	$0	N/A
Tank Car Capacity Loss from Enhanced Tank Car Standards	None	DOT Estimate
Number of Tank Car **Early Retirements** (as a result of the cost of retrofits), 2015-2034	None	DOT Estimate
Number of Tank Car **Retirements from End-of-Service Life**, 2015-2034	None	DOT Estimate
Number of Retrofitted Cars Needing **New Trucks** (for all tank car options)	None	DOT Estimate
Loading Facility Capacity Decrease	None	DOT Estimate
Percentage of **Track Capable of Handling 286,000 pounds of Gross Rail Load** (GRL)	100%	DOT Estimate
Percentage of **DOT Specification 111 Unjacketed** and **CPC 1232 Unjacketed** in PG II and PG III service	100%	DOT Estimate

Tables TC 19 and TC 20 summarize the 20 year cost streams for this tank car option. The first table presents undiscounted costs, the second costs discounted at a 7 percent discount rate.

TC19: Undiscounted Costs for the Option 3 Tank Car

Undiscounted 20 Year Cost Stream for CPC 1232 Standard			
Year	Retrofit Costs (including tar sands transfer)	Fuel and Maintenan	Total
2015	$0	$0	$0
2016	$607,800,280	$14,001,296	$621,801,577
2017	$607,800,280	$28,002,592	$635,802,873
2018	$805,064,707	$45,614,599	$850,679,306
2019	$0	$45,614,599	$45,614,599
2020	$0	$45,614,599	$45,614,599
2021	$0	$45,614,599	$45,614,599
2022	$0	$45,614,599	$45,614,599
2023	$0	$45,614,599	$45,614,599
2024	$0	$45,614,599	$45,614,599
2025	$0	$45,614,599	$45,614,599
2026	$0	$45,614,599	$45,614,599
2027	$0	$45,614,599	$45,614,599
2028	$0	$45,614,599	$45,614,599
2029	$0	$45,614,599	$45,614,599
2030	$0	$45,614,599	$45,614,599
2031	$0	$45,614,599	$45,614,599
2032	$0	$45,614,599	$45,614,599
2033	$0	$45,614,599	$45,614,599
2034	$0	$45,614,599	$45,614,599
Total	$2,020,665,268	$817,452,074	$2,838,117,342

TC20: Costs for the Option 3 Tank Car Discounted at 7%

20 Year Cost Stream for CPC 1232 Standard, Discounted at 7%			
Year	**Retrofit Costs (including tar sands transfer)**	**Fuel and Maintenar**	**Total**
2015	$0	$0	$0
2016	$530,876,304	$12,229,274	$543,105,578
2017	$496,146,078	$22,858,457	$519,004,535
2018	$614,180,010	$34,799,159	$648,979,170
2019	$0	$32,522,579	$32,522,579
2020	$0	$30,394,933	$30,394,933
2021	$0	$28,406,480	$28,406,480
2022	$0	$26,548,112	$26,548,112
2023	$0	$24,811,320	$24,811,320
2024	$0	$23,188,149	$23,188,149
2025	$0	$21,671,167	$21,671,167
2026	$0	$20,253,428	$20,253,428
2027	$0	$18,928,437	$18,928,437
2028	$0	$17,690,128	$17,690,128
2029	$0	$16,532,830	$16,532,830
2030	$0	$15,451,243	$15,451,243
2031	$0	$14,440,414	$14,440,414
2032	$0	$13,495,714	$13,495,714
2033	$0	$12,612,817	$12,612,817
2034	$0	$11,787,679	$11,787,679
Total	$1,641,202,393	$398,622,320	$2,039,824,712

Costs of the AAR 2014 Standard (Option 2)

PHMSA also considers another standard that mandates all cars to meet or exceed the performance achieved by a Option 2 - AAR 2014 tank car (described above). The costs for mandating this standard are developed in this section.

The cost analysis is similar to that for the Option 1 car, with the following changes:

1. The incremental cost for newly constructed car—relative to the baseline Option 3 tank car—would be lower, because the Option 2 does not require ECP brakes or roll-over protection. Because PHMSA estimates the cost of ECP brakes on a new car at $3,000, and does not estimate the cost of roll-over protection, the incremental cost for a new Option 2 is $2,000 (instead of $5,000 for an Option 1 car).

2. The retrofit costs for both the DOT Specification 111 unjacketed and CPC 1232 unjacketed costs would be lower, because the Option 2 car does not require ECP brakes.

Table TC 21: Unit Cost of Retrofitting Unjacketed DOT Specification 111 (to Option 2 Tank Car)

Retrofit Option	Cost
Bottom outlet valve handle retrofit cost	$1,200
Pressure relief valve retrofit cost	$1,500
Thermal protection retrofit cost	$4,000
Full jacket retrofit cost (assumed to included full-height head shield cost)	$23,400
Increased 1/8-inch thickness (assumed to be added to jacket)	$2,000
ECP brakes retrofit cost	$0
Roll-over protection cost	Not Required
Unadjusted Total	**$32,100**
Economies of scale cost reduction	10%
Adjusted Total	**$28,890**

Table TC 22: Unit Cost of Retrofitting an Unjacketed CPC 1232 (to Option 2 Tank Car)

Retrofit Option	Cost
Bottom outlet valve handle retrofit cost	$1,200
Pressure relief valve retrofit cost	$1,500

Thermal protection retrofit cost	$4,000
Full jacket retrofit cost (assumed to included full-height head shield cost)	$23,300
Increased 1/8-inch thickness (assumed to be added to jacket)	$1,500
ECP brakes retrofit cost	$0
Roll-over protection cost	Not Estimated
Unadjusted Total	**$31,500**
Economies of scale cost reduction	10%
Adjusted Total	**$28,350**

We continued all other assumptions listed in the cost analysis for the PHMSA and FRA designed car. For example, we continue to assume unjacketed DOT Specification 111s mentioned would require more substantial retrofits to remain in flammable liquid service than would be the case if they are jacketed with thermal protection for tar sands service, so we continue to estimate these cars would be jacketed and used in tar sands service.

Table TC23:Increased Fuel and Maintenance Costs, Option 2 Tank Car

Tank Car	Increased weight to achieve AAR 2014 car	Miles Per Year, Per Car	Additional Fuel Costs per Ton-Mile	Additional Maintenance Cost per Ton-Mile	Annual Additional Fuel and Maintenance Costs
Retrofitted Unjacketed DOT Specification 111	11.5 tons	9,900	$0.01	$0.00	**$945**
Retrofitted Unjacketed CPC 1232	7.07 tons	9,900	$0.01	$0.00	**$546**
Modified Jacketed CPC 1232	2.57 tons	9,900	$0.01	$0.00	**$199**

Table TC24: Summary of Cost Estimates for Option 2 Tank Car

Tank Car Option 2: AAR 2014 Car		
Variable	**Formula/Input**	**Source**
Number of **DOT Specification 111 Unjacketed Retrofitted** 2016-2018	43,805 tank cars	DOT Estimate
Unit Cost Per Retrofit of DOT Specification 111 Unjacketed	$28,890	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Time Out-of-Service Cost of DOT Specification 111 Unjacketed	$1,033	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Additional Fuel and Maintenance Costs Per Year, Relative to AAR 2014 car (based on 11.5 tons of extra weight)	$945	DOT Adaptation of EIA and CSX Corporation Data
Number of **DOT Specification 111 Unjacketed Transferred** to Tar Sands Service in 2018	7,787 tank cars	DOT Estimate
Unit Cost Per Retrofit of DOT Specification 111 Unjacketed	$24,300	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Time Out-of-Service Cost of DOT Specification 111 Unjacketed	$1,033	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Additional Fuel and Maintenance Costs Per Year, Relative to AAR 2014 car	Not Estimated	N/A
Number of **DOT Specification 111 Jacketed Retrofitted** 2016-2018	None	DOT Estimate
Unit Cost Per Retrofit of DOT Specification 111 Jacketed	N/A	N/A
Time Out-of-Service Cost of DOT Specification 111 Jacketed	N/A	N/A
Additional Fuel and Maintenance Costs Per Year, Relative to AAR 2014 car	N/A	N/A
Number of **DOT Specification 111 Jacketed Transferred** to Tar Sands Service in 2017	5,600 tank cars	DOT Estimate
Unit Cost Per Retrofit of DOT Specification 111 Jacketed	$0	DOT Estimate
Time Out-of-Service Cost of DOT Specification 111 Jacketed	$0	DOT Estimate
Additional Fuel and Maintenance Costs Per Year, Relative to AAR 2014 car	Not Estimated	N/A
Number of **CPC 1232 Unjacketed Retrofitted** 2016-2018	22,380 tank cars	DOT Estimate
Unit Cost Per Retrofit of CPC 1232 Unjacketed	$28,350	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Time Out-of-Service Cost of CPC 1232 Unjacketed	$944	DOT Adaptation of Watco Companies, L.L.C. Public Comment on the 2013 APRM
Additional Fuel and Maintenance Costs Per Year, Relative to AAR 2014 car (based on 7.07 tons of extra weight)	$546	DOT Adaptation of EIA and CSX Corporation Data

Tank Car Option 2: AAR 2014 Car		
Variable	**Formula/Input**	**Source**
Number of **CPC 1232 Unjacketed Transferred** to Tar Sands Service in 2018	None	DOT Estimate
Unit Cost Per Retrofit of CPC 1232 Unjacketed	N/A	N/A
Time Out-of-Service Cost of CPC 1232 Unjacketed	N/A	N/A
Additional Fuel and Maintenance Costs Per Year, Relative to AAR 2014 car	N/A	N/A
Number of **CPC 1232 Jacketed Retrofitted** 2016-2018	None	DOT Estimate
Unit Cost Per Retrofit of CPC 1232 Jacketed	N/A	N/A
Time Out-of-Service Cost of CPC 1232 Jacketed	N/A	N/A
Additional Fuel and Maintenance Costs Per Year, Relative to AAR 2014 car	N/A	N/A
Number of **CPC 1232 Jacketed Transferred** to Tar Sands Service in 2017	9,850 tank cars	DOT Estimate
Unit Cost Per Retrofit of CPC 1232 Jacketed	$0	DOT Estimate
Time Out-of-Service Cost of CPC 1232 Jacketed	$0	DOT Estimate
Additional Fuel and Maintenance Costs Per Year, Relative to AAR 2014 car	Not Estimated	N/A
Number of **New AAR 2014 Constructed**, 2015-2019	66,825 tank cars	DOT Estimate
Incremental Cost of AAR 2014 Cars, Relative to AAR 2014 car	$2,000	DOT Estimate
Other Costs from Factory Re-Tooling or Capacity Issues	Not Estimated	N/A
Additional Fuel and Maintenance Costs Per Year, Relative to AAR 2014 car (based on 2.57 tons of extra weight)	$199	DOT Adaptation of EIA and CSX Corporation Data
Tank Car Capacity Loss from Enhanced Tank Car Standards	None	DOT Estimate
Number of Tank Car **Early Retirements** (as a result of the cost of retrofits), 2015-2034	None	DOT Estimate
Number of Tank Car **Retirements from End-of-Service Life**, 2015-2034	None	DOT Estimate
Number of Retrofitted Cars Needing **New Trucks** (for all tank car options)	None	DOT Estimate
Loading Facility Capacity Decrease	None	DOT Estimate
Percentage of **Track Capable of Handling 286,000 pounds of Gross Rail Load** (GRL)	100%	DOT Estimate

Tank Car Option 2: AAR 2014 Car		
Variable	**Formula/Input**	**Source**
Percentage of **DOT Specification 111 Unjacketed** and **CPC 1232 Unjacketed** in PG II and PG III service	100%	DOT Estimate

The 20 year undiscounted and discounted costs for this option are presented in the tables below.

Table TC 25: Total Undiscounted Cost for the Option 2 Tank Car

Undiscounted AAR 2014 Cost Stream					
Year	**New Construction**	**111 Tar Sands Transfer**	**Retrofits (Includes Jacketed Tar Sands Transfer)**	**Fuel and Maintenance**	**Total**
2015	$40,600,000	$0	$0	$8,206,057	$48,806,057
2016	$11,644,000	$0	$655,453,480	$28,326,709	$695,424,189
2017	$11,644,000	$0	$686,353,480	$53,511,725	$751,509,206
2018	$11,644,000	$15,574,000	$852,717,907	$77,243,088	$957,178,995
2019	$11,644,000	$0	$0	$78,520,785	$90,164,785
2020	$0	$0	$0	$78,520,785	$78,520,785
2021	$0	$0	$0	$78,520,785	$78,520,785
2022	$0	$0	$0	$78,520,785	$78,520,785
2023	$0	$0	$0	$78,520,785	$78,520,785
2024	$0	$0	$0	$78,520,785	$78,520,785
2025	$0	$0	$0	$78,520,785	$78,520,785
2026	$0	$0	$0	$78,520,785	$78,520,785
2027	$0	$0	$0	$78,520,785	$78,520,785
2028	$0	$0	$0	$78,520,785	$78,520,785
2029	$0	$0	$0	$78,520,785	$78,520,785
2030	$0	$0	$0	$78,520,785	$78,520,785
2031	$0	$0	$0	$78,520,785	$78,520,785
2032	$0	$0	$0	$78,520,785	$78,520,785
2033	$0	$0	$0	$78,520,785	$78,520,785
2034	$0	$0	$0	$78,520,785	$78,520,785
Total	$87,176,000	$15,574,000	$2,194,524,868	$1,423,620,144	$3,720,895,011

Table TC 26: Total Cost for the Option 2 Tank Car Discounted at 7%

AAR 2014Cost Stream, Discounted at 7%					
Year	New Construction	111 Tar Sands Transfer	Retrofits (Includes Jacketed Tar Sands Transfer	Fuel and Maintenance	Total
1	$37,943,925	$0	$0	$7,669,212	$45,613,137
2	$10,170,321	$0	$572,498,454	$24,741,644	$607,410,419
3	$9,504,972	$0	$560,268,889	$43,681,508	$613,455,369
4	$8,883,152	$11,881,330	$650,534,408	$58,928,382	$730,227,272
5	$8,302,011	$0	$0	$55,984,235	$64,286,246
6	$0	$0	$0	$52,321,715	$52,321,715
7	$0	$0	$0	$48,898,799	$48,898,799
8	$0	$0	$0	$45,699,812	$45,699,812
9	$0	$0	$0	$42,710,105	$42,710,105
10	$0	$0	$0	$39,915,986	$39,915,986
11	$0	$0	$0	$37,304,659	$37,304,659
12	$0	$0	$0	$34,864,168	$34,864,168
13	$0	$0	$0	$32,583,334	$32,583,334
14	$0	$0	$0	$30,451,714	$30,451,714
15	$0	$0	$0	$28,459,546	$28,459,546
16	$0	$0	$0	$26,597,707	$26,597,707
17	$0	$0	$0	$24,857,670	$24,857,670
18	$0	$0	$0	$23,231,467	$23,231,467
19	$0	$0	$0	$21,711,651	$21,711,651
20	$0	$0	$0	$20,291,263	$20,291,263
Total	$74,804,381	$11,881,330	$1,783,301,752	$700,904,576	$2,570,892,039

Request for Comments on Tank Car Cost Analysis

1. PHMSA assumes no unjacketed tank cars would be in PG I service in 2015 and 2016, in the absence of this rule. Does this assumption match the expected service of unjacketed tank cars?
2. To what extent would the timing estimates in the cost analysis differ from the expected implementation of the rule?
3. PHMSA expects about 23,000 cars will be transferred to Alberta tar sands service as a result of this rule. PHMSA also expects no cars will be retired as a result of this rule. As a result of this rule, how many crude oil and ethanol cars would be repurposed to tar sands service? How many would be repurposed to carry other commodities?
4. PHMSA estimates the cost to transfer jacketed tank cars to Alberta tar sands service is zero. We seek information to support or revise this estimate and the extent to which cars will either be retrofitted rather than repurposed.

5. PHMSA assumes no tank car early retirements from retrofitting costs or retirements from end of service life. Would any crude oil and ethanol tank cars be retired over the next 20 years?
6. PHMSA assumes all newly constructed cars would be Option 3 – Enhanced Jacketed CPC 1232 tank cars. Would all newly constructed tank cars, in the absence of this rule, meet the standard of an Option 3 tank car (i.e., would they have a jacket, thermal protection, TC-128 Grade B normalized steel, full height head shield, enhanced top fittings protection, and bottom outlet valve reconfigurations). Would any new crude oil or ethanol tank cars, manufactured in 2015 and beyond, not have all of these features? If so, please provide specific data on missing features and the numbers of cars in each category.
7. PHMSA estimates no decrease in tank car capacity from the increased weight of Options 1 and 2. However, some commenters on the ANPRM suggested otherwise. PHMSA solicits data and other relevant information in order to be able to fully evaluate such claims. What would be the benefits and costs of any decrease in capacity?
8. Are any of the cost estimates provided in this RIA inconsistent with expected market prices? Regarding out-of-service times and values, would tank car owners experience any bottleneck issues related to tank car shop capacity? Is the rental price of capital approach, as opposed to lease rates, the best way to capture the service value of existing tank cars?
9. To what extent would the rule generate additional costs not discussed or accounted for in this RIA?
10. This analysis assumes a 10 percent reduction on retrofit and new tank car costs due to "economies of scale." Economies of scale is the phenomenon of average (per unit) costs of production declining with higher rates of production. This usually occurs because fixed costs (i.e., costs that don't vary with production volumes, such as capital equipment in some cases) remain constant as production increases. Increasing labor productivity may also reduce costs as the facility acquires more experience with the retrofit process. To the extent that this may occur with respect to retrofits and tank car production, it may be offset if timeframes for compliance with this regulation are not be long enough to ramp up production in the most cost-effective manner, thus offsetting possible economies of scale. PHMSA seeks comment and data on the effect of this proposal on the average costs of retrofits and new tank car production.

Identification of Impacted Entities

Most rail cars are owned by shippers and companies that lease cars to shippers: not the railroads. Therefore, the entities affected by the proposed amendments impacting tank car design are primarily shippers that use rail to transport flammable liquid. Flammable liquid includes a wide variety of chemical products.

As shown in the table below, approximately 68% of the flammable liquids transported by rail are comprised of crude oil, ethanol, and petrochemical or petroleum refinery products. These include UN 1987 Alcohols, n.o.s. [75], UN1170 Ethanol, UN1219 Isopropanol, UN1230 Methanol, UN1267 Petroleum crude oil, UN1238 Petroleum distillates, n.o.s. and UN3295 Hydrocarbons liquid n.o.s. Petrochemical or petroleum refinery products would include commonly shipped items like NA1993 Diesel fuel, UN1202 Diesel fuel, Gas oil, UN1203 Gasoline and UN1863 Fuel, aviation, turbine engine. The table titled "Number of Firms by NAICS Industry and Enterprise Employment Size" and Appendix A provides summary information for the industries that produce most these major products. Significant differences exist in terms of the industry distributions across employment size classes; however, both crude petroleum extraction and ethanol manufacturing both show that over 90 percent of the firms in those industries have less than 500 employees. Of course, not all of these firms use rail to ship their products. Based on an analysis of PHMSA's Hazardous Materials Registration Database, PHMSA estimates that there are over 400 companies who use rail to ship flammable liquid, of which over 250 are self-reported to be small firms.

[75] Alcohols n.o.s. is a generic proper shipping name used to cover a variety of mixtures of alcohols such as ethanol mixed with methanol or isopropanol.

Table TC 27: 2012 Class 3 Tank Car Originations by Commodity[76]

UN/NA Identification Number	Commodity	Total Tank Car Originations	Percent of Class 3 Tank Car Originations
NA1993	Diesel Fuel, Fuel Oil, Combustible Liquids N.O.S.	26,662	3.0%
UN1202	Diesel Fuel, Gas Oil	49,877	5.7%
UN1090	Acetone	4,083	0.5%
UN1093	Acrylonitrile, Stabilized	2,684	0.3%
UN1114	Benzene	7,376	0.8%
UN1120	Butanols	1,685	0.2%
UN1145	Cyclohexane	2,755	0.3%
UN1170	Ethanol	12,914	1.5%
UN1203	Gasoline	52,137	5.9%
UN1208	Hexanes	1,505	0.2%
UN1218	Isoprene, Stabilized	1,258	0.1%
UN1219	Isopropanol	2,288	0.3%
UN1230	Methanol	19,283	2.2%
UN1238	Petroleum Distillates, N.O.S	3,917	0.4%
UN1247	Methyl Methacrylate Monomer, Stabilized	4,768	0.5%
UN1265	Pentanes	1,541	0.2%
UN1267	Petroleum Crude Oil	266,495	30.3%
UN1268	Petroleum Distillates, N.O.S	8,202	0.9%
UN1280	Propylene Oxide	4,394	0.5%
UN1294	Toluene	3,956	0.4%
UN1301	Vinyl Acetate, Stabilized	5,053	0.6%
UN1307	Xylenes	10,466	1.2%
UN1863	Fuel,Aviation,Turbine Engine	16,782	1.9%
UN1987	Alcohols, N.O.S	293,451	33.3%
UN1993	Flammable Liquids, N.O.S	36,114	4.1%
UN2055	Styrene Monomer, Stabilized	13,355	1.5%
UN2348	Butyl Acrylates, Stabilized	3,389	0.4%
UN2370	1-Hexene	1,718	0.2%
UN2924	Flammable Liquids, Corrosive, N.O.S	1,242	0.1%
UN3065	Alcoholic Beverages	1,267	0.1%
UN3256	Elevated Temperature Liquid, Flammable, N.O.S	1,849	0.2%
UN3295	Hydrocarbons, Liquid, N.O.S	10,745	1.2%
UN3475	Ethanol And Gasoline Mixture	7,730	0.9%
Total		880,941	

[76] Source: Annual Report of Hazardous Materials Transported by Rail by Association of American Railroads and Bureau of Explosives

Table TC 28: Number of Firms by NAICS Industry and Enterprise Employment Size

ENTERPRISE EMPLOYMENT SIZE	211111: Crude Petroleum and Natural Gas Extraction	211112: Natural Gas Liquid Extraction	324191: Petroleum lubricating oil and grease manufacturing	325110: Petrochemical manufacturing	324110: Petroleum refineries	325192: Cyclic crude and intermediate manufacturing	325193: Ethyl alcohol manufacturing
1: Total	6,523	136	248	43	198	25	168
2: 0-4	4,519	58	64	14	75	1	19
3: 5-9	946	11	36	2	23	1	8
4: 10-19	496	6	37	1	18	1	12
5: <20	5,961	75	137	17	116	3	39
6: 20-99	388	15	67	4	15	7	97
7: 100-499	87	9	22	5	23	3	17
8: <500	6,436	99	226	26	154	13	153
9: 500+	87	37	22	17	44	12	15
2: 0-4	69%	43%	26%	33%	38%	4%	11%
3: 5-9	15%	8%	15%	5%	12%	4%	5%
4: 10-19	8%	4%	15%	2%	9%	4%	7%
5: <20	91%	55%	55%	40%	59%	12%	23%
6: 20-99	6%	11%	27%	9%	8%	28%	58%
7: 100-499	1%	7%	9%	12%	12%	12%	10%
8: <500	99%	73%	91%	60%	78%	52%	91%
9: 500+	1%	27%	9%	40%	22%	48%	9%

Source: U.S. Census Bureau, Statistics of U.S. Businesses, 2011

Benefits for Tank Car Options

This section analyzes the benefits for the three tank car Options by considering the expected effectiveness of the enhancements in reducing the expected damages of crude oil and ethanol accidents. All of the Options are designed to address the survivability of the tank car and would mitigate the damages of rail accidents better than the current DOT Specification 111. Specifically, the tank car Options incorporate several enhancements to increase puncture resistance; provide thermal protection to survive a 100-minute pool fire; and protect top fitting and bottom outlets during a derailment. Under all Options, the proposed system of design enhancements would reduce the consequences of a derailment of tank cars carrying crude oil or ethanol. There would be fewer car punctures, fewer releases from the service equipment (top and bottom fittings), and delayed release of flammable liquid from the tank cars through the pressure relief devices.

We explain the benefits calculation for the Option 1 car first, as the benefits to the Option 2 and Option 3 cars were calculated in a similar way.

ECP Benefits of Option 1 Tank Car (ECP Applicable to Option 1 Only)

PHMSA begins the analysis by considering the effectiveness of Electronically Controlled Pneumatic (ECP) braking in improving braking; this requirement is applicable only to Option 1, the PHMSA and FRA Designed Car. ECP braking equipment—which must be on installed all cars in a train in order to work—enables faster brake signal propagation throughout the entire length of the train, thereby reducing kinetic energy and the likelihood of cars colliding with one another in the event of an incident that calls for emergency braking. (See Section 4 of the RIA, Braking for more detail).

Relative to two-way EOT devices and DP, ECP results in substantially greater reductions in kinetic energy reduction. The modelling suggests an additional 18 percent marginal improvement over two-way EOT and DP. We use this effectiveness to estimate the benefits that would result from deployment of ECP braking on unit trains of flammable liquid.

Please see Section 4 of the RIA, Braking, for more detail on the marginal effectiveness of various braking systems. PHMSA will place into the docket for this rulemaking a technical supplement that describes the model inputs and assumptions that were used to develop the effectiveness rates for each brake option.

The analysis of these benefits begins with the adjusted lower consequence damages, presented in the damages section. These figures are presented again here to make the description easier to follow.

Table TC 29: Lower Consequence Damages, Undiscounted 2015-2034

Year	Lower Consequence Event Damages Uniscounted
2015	$324,766,789
2016	$318,884,170
2017	$308,663,025
2018	$298,295,776
2019	$288,643,480
2020	$281,434,410
2021	$270,809,946
2022	$260,009,356
2023	$247,544,695
2024	$235,986,002
2025	$222,740,573
2026	$207,555,533
2027	$194,572,178
2028	$181,329,509
2029	$168,161,828
2030	$155,257,392
2031	$143,242,575
2032	$131,588,225
2033	$120,685,763
2034	$110,319,319
Total	$4,470,490,543

For the Option 1 tank car, these figures are multiplied by the percentage of cars equipped with ECP brakes in each year and by the effectiveness of ECP braking compared to alternative brake signal propagations systems such as two-way EOT or DP. As described in the braking section below, the effectiveness of ECP braking relative to these alternatives is 18 percent. Because roughly 80 percent of the costs of deploying ECP braking are the costs of equipping tank cars with ECP equipment, we multiply damages by .8 x .18 = .144 x the percentage of the fleet that is ECP equipped to generate estimated benefits. These calculations are presented in the table below for the 20 year analysis period

Table TC30: Benefits of ECP Braking for the Option 1 Tank Car

ECP Benefits		
Fleet ECP Equipped	x .18 x .8	Estimated Benefits
0.19	0.027	$8,086,352
0.42	0.060	$16,715,134
0.75	0.109	$27,341,181
0.87	0.125	$28,509,772
0.87	0.125	$25,782,475
0.87	0.125	$23,493,963
0.87	0.125	$21,128,074
0.87	0.125	$18,958,348
0.87	0.125	$16,868,690
0.87	0.125	$15,029,004
0.87	0.125	$13,257,435
0.87	0.125	$11,545,446
0.87	0.125	$10,115,174
0.87	0.125	$8,810,029
0.87	0.125	$7,635,764
0.87	0.125	$6,588,607
0.87	0.125	$5,681,064
0.87	0.125	$4,877,427
0.87	0.125	$4,180,671
0.87	0.125	$3,571,558
Total		$278,176,169

Using Marginal Effectiveness Rates

PHMSA assumes that all DOT unjacketed 111 and CPC 1232 unjacketed cars would be retrofit to meet one of the three DOT Specification 117 Options under consideration, so we adjust these figures by the accident mitigation ratio of a DOT Specification 111 and the new standard car. Thus, the benefits of retrofitting existing cars (DOT Specification 111 unjacketed and CPC 1232 unjacketed) is the effectiveness differential between existing cars and the DOT Specification 117.

For new construction – those cars that are built to satisfy growing demand going forward – the benefits are calculated using the effectiveness differential between an Option 3 tank car and the standard under consideration. Because an Option 3 tank car is the baseline newly constructed car, there will be no mitigation differential for new cars under Option 3.

Determining Effectiveness Rates

Table TC31 summarizes the effectiveness of the proposed elements of each option. The effectiveness was calculated using the following assumptions:

- PHMSA examined the 13 accidents provided in Table 1 to arrive at its effectiveness rates. This subset of 13 accidents used to calculate effectiveness rates may not be representative of all 40 mainline accidents, from 2006 to 2013, for trains carrying crude oil and ethanol. (see Appendix B for a complete listing of the 40 mainline train accidents during this timeframe). However, PHMSA uses this subset because the data has been verified and demonstrative of HHFT risk.
- DOT Specification 111 tank cars composed the vast majority of the type of tank cars involved in the derailments listed in Table 1. The type of damages these tank cars experienced were used to design the tank car options proposed in the NPRM.
- The volume of lading lost from each tank car in the derailments indicated in Table 1 compiled relative to the documented damage to each tank car that lost lading. These values were used as the baseline for tank car constructed to the current DOT Specification 111.
- Improvement in performance was based on the following assumptions.
    - The ratio of puncture force (DOT Specification 111/option) was used as a multiplier to determine the reduction in lading loss.
    - Thermal protection prevented thermal damage that results in loss of containment.
    - Top fittings protection halves the damage to service equipment.
    - BOV modification prevents lading loss through valve.
- The reduced volume of lost lading relative to each enhancement was compared to the baseline to calculate respective reduction or effectiveness.

The ratio of puncture force was developed using the analytical method developed by E.I. DuPont de Nemours and Company and validated by full scale testing performed at the Transportation Technology Center in Pueblo, CO, available for review in the public docket for this rulemaking, FRA calculated the shell puncture resistance of all three Options compared to the DOT Specification 111 tank car.[77]

[77] "Detailed Puncture Analyses Tank Cars: Analysis of Different Impactor Threats and Impact Conditions" can be found at: http://www.fra.dot.gov/eLib/details/L04420

Table TC 31: Effectiveness of newly constructed tank car options relative to the non-jacketed DOT111 specification tank car						
Tank Car	Total	Head puncture	Shell puncture	Thermal damage	Top fittings	BOV
Option 1	55	21	17	12	4	<1
Option 2	51.3	21	17	12	1.3	<1
Option 3	41.3	19	9	12	1.3	0

The rollover protection for the Option 1 tank car is based on the load conditions described in 179.102-3. The top fittings protection for the Options 2 and 3 cars must meet the load conditions in M-1002 Appendix E, 10.2. The former is a dynamic load and the latter is a static load. Modeling indicates the stresses imparted in the tank shell during the dynamic loads are three times those encountered during the static load. Therefore, DOT assumes the effectiveness of top fittings for the Option 1 tank car is three times that of the other tank car options.

PHMSA will place into the docket for this rulemaking a technical supplement that describes the model inputs and assumptions that were used to develop the effectiveness rates in TC30.

The proposed materials, minimum thickness of 9/16 inch, and jacket provide a 68 percent improvement in the puncture force for Options 1 and 2 relative to the current specification requirements for a DOT Specification 111 tank car. This translates to a 17 percent effectiveness rate. A tank car constructed to the proposed requirements of Option 3, would have a 35 percent improvement in puncture force relative to the current DOT Specification 111 tank car.[78] This translates into a 9 percent effectiveness rate.

The combination of the shell thickness and head shield of Options 1 and 2 provide a head puncture resistance velocity of 18.4 mph (21% effectiveness rate). Because the Option 3 tank car has a 7/16 inch shell, as opposed to the 9/16 inch shell in Options 1 and 2, it has a head puncture resistance velocity of 17.8 mph.

The results of this modeling are described in Table TC32.

Table TC32: Shell and Head Puncture Velocities by Tank Car Option		
Tank Car	**Shell Puncture Velocity (improvement relative to DOT111 non-jacketed)**	**Head Puncture Velocity (improvement relative to DOT111 non-jacketed)**

[78] Modeling and simulation of puncture velocity indicate a puncture velocity of approximately 7.4 mph for a legacy DOT Specification 111; 9.6 mph for Option 3; and 12.3 mph for the cars under Options 1 and 2. Puncture velocity is based on an impact with a rigid 12" x 12" indenter with a weight of 297,000 pounds.

Option 1	12.3 mph (66%)	18.4 mph (114%)
Option 2	12.3 mph (66%)	18.4 mph (114%)
Option 3	9.6 mph (30%)	17.8 mph (107)
CPC-1232 unjacketed	8.5 mph (15%)	Top – 10.3 (20%) Bottom – 17.6 (105%)
DOT-111 jacketed	9.3 mph (26%)	11.6 mph (35%)

The proposed changes for existing tank cars are based on comments discussed above, simulations, and modeling. Modeling and simulation of puncture speed velocity of DOT Specification 111 tank cars currently used to transport ethanol or crude oil indicate that a velocity of approximately 7.4 mph will puncture the shell of the tanks when struck with a rigid 12” x 12” indenter with a weight of 297,000 pounds. Validation of this model has been accomplished using the results of puncture tests performed at the Transportation Technology Center in Pueblo, CO.[79] Further, based on modeling and simulation, the head of an unjacketed DOT Specification 111 tank car, when struck with a 12” x 12” indenter weighing 286,000 pounds will puncture at 7.6 mph. Table TC31 provides the tank car shell and head puncture velocities of the DOT Specification 117 tank car Options proposed in the NPRM.

Table TC33: Effectiveness of existing tank car options relative to the non-jacketed DOT111 specification tank car

Tank Car	Total	Head puncture	Shell puncture	Thermal damage	Top fittings	BOV
Option 1	51	21	17	12	N/A	<1
Option 2	50	21	17	12	N/A	<1
Option 3	40	19	9	12	N/A	0

Similar to the methodology for estimating the effectiveness of new cars, PHMSA uses these puncture velocities to arrive at risk reduction estimates for retrofits.

In evaluating train accidents involving HHFTs listed in Table 1 above, we found that all but one of the derailments occurred in excess of 20 mph. Only two of the derailments occurred at a speed of between 20 mph and 30 mph, four occurred between 30 and 40 mph and six occurred at

[79] “Detailed Puncture Analyses Tank Cars: Analysis of Different Impactor Threats and Impact Conditions” can be found at: http://www.fra.dot.gov/eLib/details/L04420

speeds in excess of 40 mph. The documented derailment speeds exceed the puncture velocity of both the DOT Specification 111 tank car and the options proposed in this rule. However, during a derailment the speeds of impacts will vary considerably between cars, and many of those impacts will not result in a puncture. The portion of those impacts that could result in a puncture would decline with the higher puncture velocity of the DOT Specification 117 tank car options proposed in this NPRM. As a result of use of the proposed DOT Specification 117 tank cars, we would expect the volume of flammable liquid released into the environment, and the overall consequences of a train accident, to be reduced.

Table TC34: Comparison of Effectiveness Rates

Tank Car Option 1: PHMSA/FRA designed Car		
Variable	Formula/Input	Source
Risk Reduction, DOT SPECIFICATION 111 Unjacketed to PHMSA/FRA designed Car	51%	Applied Research and Associates, Puncture Resistance Model; DOT Estimate for Top Fittings, Bottom Outlet Valve, Pressure Release Valve, and Thermal Protection Enhancements
Risk Reduction, DOT SPECIFICATION 111 Jacketed to PHMSA/FRA designed Car	28%	Applied Research and Associates, Puncture Resistance Model; DOT Estimate for Top Fittings, Bottom Outlet Valve, Pressure Release Valve, and Thermal Protection Enhancements
Risk Reduction, CPC 1232 Unjacketed to PHMSA/FRA designed Car	21%	Applied Research and Associates, Puncture Resistance Model; DOT Estimate for Top Fittings, Bottom Outlet Valve, Pressure Release Valve, and Thermal Protection Enhancements
Risk Reduction, CPC 1232 Jacketed to PHMSA/FRA designed Car	10%	N/A

PHMSA does not propose to impose additional top fittings protection requirements on retrofits of existing DOT Specification 111 Unjacketed cars. Thus, the effectiveness rate of 51 percent—going from the 111 unjacketed to the Option 1 tank car—does not include additional top fittings protection. In addition, as a result of the uncertainty surrounding the marginal effectiveness of additional top fittings protection (estimated between 1 and 4 percentage points), PHMSA does not adjust other effectiveness estimates for retrofitted and newly constructed cars that would require additional top fittings protection. In other words, all effectiveness rates presented do not include any benefits from additional top fittings protection, because those benefits are relatively small and uncertain and would apply only to new construction.

Calculating Remaining Damages Pool (After ECP)

The ECP benefits calculated earlier in the tank car benefit section are subtracted from total lower consequence damages to generate the remaining damage pool from which the benefits of other improvements to the tank car can be drawn.

Calculating Tank Benefits

The other tank car benefits are calculated by multiplying the percentage of the fleet made up by each of the 4 variations of tank cars currently in flammable liquid service by the marginal effectiveness of the Option 1 tank car relative to each of these cars. The table below presents the expected fleet composition in each year.

Table TC35: Projected Fleet Composition 2014-2034

Year	Total Cars Baselir	DOT 111	DOT 111 with Jacke	CPC 1232	CPC 1232 with Jacket
2014	89,422	51,592	5,600	22,380	9,850
2015	109,722	51,592	5,600	22,380	30,150
2016	115,544	51,592	5,600	22,380	35,972
2017	121,366	51,592	5,600	22,380	41,794
2018	127,188	51,592	5,600	22,380	47,616
2019	133,010	51,592	5,600	22,380	53,438
2020	133,010	51,592	5,600	22,380	53,438
2021	133,010	51,592	5,600	22,380	53,438
2022	133,010	51,592	5,600	22,380	53,438
2023	133,010	51,592	5,600	22,380	53,438
2024	133,010	51,592	5,600	22,380	53,438
2025	133,010	51,592	5,600	22,380	53,438
2026	133,010	51,592	5,600	22,380	53,438
2027	133,010	51,592	5,600	22,380	53,438
2028	133,010	51,592	5,600	22,380	53,438
2029	133,010	51,592	5,600	22,380	53,438
2030	133,010	51,592	5,600	22,380	53,438
2031	133,010	51,592	5,600	22,380	53,438
2032	133,010	51,592	5,600	22,380	53,438
2033	133,010	51,592	5,600	22,380	53,438
2034	133,010	51,592	5,600	22,380	53,438

The next table presents the percentage of the fleet made up by each of the tank car types currently in service. These are calculated by dividing the relevant tank car type column by the total car figure column. These figures have been adjusted from those presented earlier in the document. The percentage of jacketed CPC 1232s is slightly lower than the actual number of CPC 1232s for 2015 and 2016. This is because those figures are used to calculate the benefits of the improved car over those that would obtain if a CPC 1232 were built instead of the improved cars. In order not to attribute benefits to the 9,850 CPC 1232s built before 2015, the ratio that applies is the percentage of cars built to the higher standard, which are reflected in the percentages below.

Table TC36: Projected Fleet Composition by % 2015-2034

Tank Car Fleet Makeup, by Percentage				
Year	**DOT 111 No Jacket**	**DOT 111 Jacket**	**CPC 1232 No Jacket**	**CPC 1232 Jacket**
2014	0.58	0.06	0.25	0.11
2015	0.47	0.05	0.20	0.19
2016	0.45	0.05	0.19	0.23
2017	0.43	0.05	0.18	0.34
2018	0.41	0.04	0.18	0.37
2019	0.39	0.04	0.17	0.40
2020	0.39	0.04	0.17	0.40
2021	0.39	0.04	0.17	0.40
2022	0.39	0.04	0.17	0.40
2023	0.39	0.04	0.17	0.40
2024	0.39	0.04	0.17	0.40
2025	0.39	0.04	0.17	0.40
2026	0.39	0.04	0.17	0.40
2027	0.39	0.04	0.17	0.40
2028	0.39	0.04	0.17	0.40
2029	0.39	0.04	0.17	0.40
2030	0.39	0.04	0.17	0.40
2031	0.39	0.04	0.17	0.40
2032	0.39	0.04	0.17	0.40
2033	0.39	0.04	0.17	0.40
2034	0.39	0.04	0.17	0.40

In order to calculate benefits, we multiply the effectiveness rate for each car relative to the Option 1 car presented above by the percentage of cars of that type to get weighted effectiveness rates, which are applied to the remaining damage pool after ECP benefits have been removed.

To provide a concrete example, unjacketed DOT Specification 111s make up 41 percent of the fleet in 2018. Retrofitting a 111 to the Option 1 tank car standard, or replacing it in flammable liquid service with an Option 1 car, would improve its safety performance by 51 percent. The benefits of converting DOT Specification 111s to the higher standard car in 2018 are calculated by multiplying .41 x .51 x remaining damages in 2018 once ECP benefits have been removed. The other tank car types are treated analogously to produce total benefits, which are presented below along with ECP benefits, and total benefits for this tank car standard, which are simply the ECP and Tank benefits added together.

For retrofits, one further adjustment must be described to arrive at final benefit figures. As noted in the cost section, we assume companies will begin retrofitting non-jacketed cars in 2016 and continue with this task through 2018. We assume 1/3rd of retrofits will be implemented in each year. Because of this phase in period, benefits for unjacketed cars must be adjusted as follows: for unjacketed DOT Specification 111s and CPC 1232s, 1/3rd of the cars would be retrofit in 2016. The percentages of cars from which benefits are derived in 2016 therefore must be divided by three to account for the fact that only a third of these cars are retrofit in that year before conducting the other calculations above. In 2017, 2/3rds of these cars would be retrofit, so the percentages of each car type are reduced to 2/3rds of their total. In 2018 the rest of the unjacketed cars are retrofit so the unadjusted percentage is applied in that and all later years.

For newly constructed cars, we make a similar adjustment. As noted above, we expect all new cars beginning in early 2015 to be built to the new standard promulgated by this rule. This leaves roughly 9,850 jacketed CPC 1232s that would not meet the new standard. These cars must be subtracted from the total number of jacketed CPC cars in 2015 to avoid applying benefits to unimproved cars. This calculation is reflected in the percentage of jacketed CPC 1232s in the table above for 2015 and 2016. In 2017 these cars are transferred to tar sands service and replaced by new tank cars that would meet the new standard, so the straight percentage can be applied in that and all later years. No benefits are claimed for jacketed 111 cars until 2017 when they are assumed to be transferred to tar sands service in 2018. The benefits from the non-ECP tank car enhancements are presented below, along with the ECP benefits and total benefits for the Option 1 tank car standard.

Table TC37: Benefits of the Option 1 Tank Car

Year	Tank Enhancement Baseline Benefits	ECP Brake Baseline Benefits	Lower Consequence Event Benefits
2015	$5,848,528	$8,652,397	$14,500,925
2016	$31,514,243	$19,137,157	$50,651,400
2017	$55,381,806	$33,494,122	$88,875,928
2018	$79,015,137	$37,370,495	$116,385,632
2019	$74,216,828	$36,161,255	$110,378,083
2020	$72,363,212	$35,258,103	$107,621,315
2021	$69,631,420	$33,927,070	$103,558,490
2022	$66,854,341	$32,573,972	$99,428,313
2023	$63,649,392	$31,012,399	$94,661,792
2024	$60,677,389	$29,564,326	$90,241,715
2025	$57,271,686	$27,904,939	$85,176,625
2026	$53,367,266	$26,002,557	$79,369,823
2027	$50,028,949	$24,376,003	$74,404,952
2028	$46,623,956	$22,716,961	$69,340,917
2029	$43,238,245	$21,067,314	$64,305,559
2030	$39,920,220	$19,450,646	$59,370,866
2031	$36,830,936	$17,945,430	$54,776,366
2032	$33,834,337	$16,485,373	$50,319,709
2033	$31,031,065	$15,119,512	$46,150,577
2034	$28,365,615	$13,820,804	$42,186,420
Total	$999,664,572	$502,040,835	$1,501,705,406

The benefits for the Option 1 tank car presented above do not include the benefits of higher consequence event risk. The costs presented do include the cost of retrofitting ECP brakes on the cars remaining in flammable liquid service as well as the cost of putting ECP brakes on all newly constructed Option 1 tank cars.

To account for higher consequence event risk, we calculate an overall effectiveness ratio for the DOT Specification117 using total non-catastrophic societal damages and non-catastrophic benefits. We divide total discounted non-catastrophic benefits in each year by total discounted expected lower consequence event societal damages for that year to get an effectiveness ratio for that year. The effectiveness ratio for each year is multiplied by catastrophic damages for that year to get higher consequence events benefits. We conduct this calculation for each of the 2 higher consequence event scenarios presented above those for baseline costs, assuming 0 higher consequence events, and 10 higher consequence events with one of those events being 5 times larger than the estimate for a typical high consequence event. The table below presents the full 20 year figures for the 2 event scenarios for the Option 1 tank car.

Table TC38: Option 1 Tank Car Benefits, Undiscounted 2015-2034

PHMSA and FRA Design Tank Car Benefits, Undiscounted						
Year	Tank Enhancement Baseline Benefits	ECP Brake Baseline Benefits	Lower Consequence Event Benefits	High Consequence with 1 Event 5 x Average	Effectiveness	High Consequence Event Benefits
2015	$5,848,528	$8,652,397	$14,500,925	$709,904,595	4%	$31,697,432
2016	$31,514,243	$19,137,157	$50,651,400	$701,559,570	16%	$111,435,368
2017	$55,381,806	$33,494,122	$88,875,928	$694,271,520	29%	$199,907,408
2018	$79,015,137	$37,370,495	$116,385,632	$687,899,396	39%	$268,396,713
2019	$74,216,828	$36,161,255	$110,378,083	$682,326,956	38%	$260,923,758
2020	$72,363,212	$35,258,103	$107,621,315	$685,655,520	38%	$262,196,611
2021	$69,631,420	$33,927,070	$103,558,490	$689,023,335	38%	$263,484,473
2022	$66,854,341	$32,573,972	$99,428,313	$692,430,916	38%	$264,787,541
2023	$63,649,392	$31,012,399	$94,661,792	$695,878,686	38%	$266,105,978
2024	$60,677,389	$29,564,326	$90,241,715	$699,367,147	38%	$267,439,976
2025	$57,271,686	$27,904,939	$85,176,625	$702,896,782	38%	$268,789,718
2026	$53,367,266	$26,002,557	$79,369,823	$706,468,058	38%	$270,155,384
2027	$50,028,949	$24,376,003	$74,404,952	$710,081,482	38%	$271,537,168
2028	$46,623,956	$22,716,961	$69,340,917	$713,737,524	38%	$272,935,249
2029	$43,238,245	$21,067,314	$64,305,559	$717,436,733	38%	$274,349,837
2030	$39,920,220	$19,450,646	$59,370,866	$721,179,584	38%	$275,781,113
2031	$36,830,936	$17,945,430	$54,776,366	$724,966,592	38%	$277,229,276
2032	$33,834,337	$16,485,373	$50,319,709	$728,798,291	38%	$278,694,528
2033	$31,031,065	$15,119,512	$46,150,577	$732,675,201	38%	$280,177,070
2034	$28,365,615	$13,820,804	$42,186,420	$736,597,863	38%	$281,677,107
Total	$999,664,572	$502,040,835	$1,501,705,406	$14,133,155,750		$4,947,701,708

Total benefits considering higher consequence events are calculated by adding the Lower Consequence Event Benefits column in the table above to the Higher Consequence Event Benefit column. Total discounted 20 year benefits and costs for this option are presented below

Table TC39: Option 1 Tank Car Benefits, 2015-2034, 7 Percent Discount

20 Year Costs and Benefits, PHMSA and FRA Design, 7 Percent Discount Rate		
	0 High Consequence Events	10 High Consequence Events*
Benefits	$822,050,966	$3,256,102,069
Costs	$3,030,363,180	$3,030,363,180
Net Benefits	-$2,208,312,214	$225,738,889

* 1 event of the 10 assumed to be 5x the average high consequence event in magnitude.

It is important to note that the tank car enhancements would produce slightly higher benefits if they were considered prior to ECP benefits. The order in which these two components of the Option 1 tank car are considered would not affect overall benefits for this tank car standard, but do affect the share of benefits attributed to the tank enhancements vs. the ECP braking effects. Whichever aspect of this standard is considered first appears to be marginally more effective because the effectiveness is being applied to a larger damage pool.

Benefits of the Enhanced Jacketed CPC 1232 (Option 3)

Benefits for the Option 3 tank car are calculated analogously to those for the Option 1 car. Because ECP braking is not required by this standard, no ECP braking benefits are estimated for this standard. The Option 3 tank car produces lower safety benefits for two reasons.

First, it is more likely to release contents if involved in an accident because it lacks rollover protection, lacks ECP brakes, and also has a thinner shell which is less puncture resistant.

Secondly, there are no benefits (or costs) associated with construction of an Option 3 tank car to satisfy new demand, because this is the car PHMSA assumes would be built for HHFT service in absence of regulation. The benefits therefore are only attributed to upgrading the safety of the cars that are retrofit and improving the safety of cars that get transferred to less hazardous tar sands service. Higher consequence event benefits are also estimated as described above for the Option 1 tank car. The effectiveness rates for upgrading other cars to this standard are presented in the table below.

Table TC 40: Relative Effectiveness of the Option 3 Tank Car

Tank Car Option 3: Enhanced Jacketed CPC 1232 Car		
Variable	**Formula/Input**	**Source**
Risk Reduction, **DOT Specification 111 Unjacketed** to Enhanced Jacketed CPC 1232 **Car**	40%	Applied Research and Associates, Puncture Resistance Model; DOT Estimate for Top Fittings, Bottom Outlet Valve, Pressure Release Valve, and Thermal Protection Enhancements
Risk Reduction, **DOT Specification 111 Jacketed** to Enhanced Jacketed CPC 1232 **Car**	11%	Applied Research and Associates, Puncture Resistance Model; DOT Estimate for Top Fittings, Bottom Outlet Valve, Pressure Release Valve, and Thermal Protection Enhancements
Risk Reduction, **CPC 1232 Unjacketed** to Enhanced Jacketed CPC 1232 **Car**	18%	Applied Research and Associates, Puncture Resistance Model; DOT Estimate for Top Fittings, Bottom Outlet Valve, Pressure Release Valve, and Thermal Protection Enhancements
Risk Reduction, **CPC 1232 Jacketed** to Enhanced Jacketed CPC 1232 **Car**	0	N/A

These effectiveness rates are used analogously to the way they were applied above for the Option 1 tank car standard. The fleet composition and all other parameters affecting benefits are assumed to be the same for this standard as for the Option 1 car so those tables are not repeated here.

The Table Below presents 20 year costs, benefits, and net benefits for this standard over 20 years, discounted at a 7 percent discount rate.

Table TC41: Costs and Benefits of the Option 3 Tank Car, 2015-2034, 7 Percent Discount

20 Year Costs and Benefits, CPC 1232 w Jacket, 7 Percent Discount Rate		
	Baseline - 0 High Consequence Events	10 High Consequence Events*
Benefits	$393,330,520	$1,569,543,743
Costs	$2,039,824,712	$2,039,824,712
Net Benefits	-$1,646,494,193	-$470,280,969

* 1 event of the 10 assumed to be 5x the average high consequence event in magnitude

Benefits of the AAR 2014 Tank Car (Option 2)

The Option 2 car benefits were calculated analogously to the Option 1 and 3 tank cars using the third group of effectiveness ratings. The only differences between the Option 2 car and the Option 1 car are rollover protection and ECP brakes. Accordingly, the effectiveness differences between this car and the Option 1 tank car are very slight until ECP effects are factored in. The differences in cost between the two cars, excluding ECP brakes, are also fairly minimal. The effectiveness rates of upgrading other tank car designs to this standard are presented in the table below.

Table TC 42: Relative Effectiveness of the Option 2 Tank Car

Tank Car Option 2: AAR 2014 Car		
Variable	**Formula/Input**	**Source**
Risk Reduction, **DOT Specification 111 Unjacketed** to **AAR 2014 Car**	50%	Applied Research and Associates, Puncture Resistance Model; DOT Estimate for Top Fittings, Bottom Outlet Valve, Pressure Release Valve, and Thermal Protection Enhancements
Risk Reduction, **DOT Specification 111 Jacketed** to **AAR 2014 Car**	21%	Applied Research and Associates, Puncture Resistance Model; DOT Estimate for Top Fittings, Bottom Outlet Valve, Pressure Release Valve, and Thermal Protection Enhancements
Risk Reduction, **CPC 1232 Unjacketed** to **AAR 2014 Car**	28%	Applied Research and Associates, Puncture Resistance Model; DOT Estimate for Top Fittings, Bottom Outlet Valve, Pressure Release Valve, and Thermal Protection Enhancements
Risk Reduction, **CPC 1232 Jacketed** to **AAR 2014 Car**	10%	Applied Research and Associates, Puncture Resistance Model; DOT Estimate for Top Fittings, Bottom Outlet Valve, Pressure Release Valve, and Thermal Protection Enhancements

Benefits for this car are calculated analogously to the methodology described for tank car Options 1 and 3. Estimated benefits for this tank car standard are presented below.

Table TC43: Costs and Benefits of the Option 2 Tank Car, 2015-2034, 7 Percent Discount

20 Year Costs and Benefits, AAR 2014, 7 Percent Discount Rate		
	Baseline - 0 High Consequence Events	**10 High Consequence Events***
Benefits	$609,983,048	$2,426,336,087
Costs	$2,570,892,039	$2,570,892,039
Net Benefits	-$1,960,908,991	-$144,555,952

* 1 event of the 10 assumed to be 5x the average high consequence event in magnitude

Request for Comment on Tank Car Benefits Analysis:

1. What other methodology could PHMSA use to evaluate effectiveness? To what extent could conditional probability of release (CPR) data, based on the historical safety record for all tank cars, be used to calculate effectiveness? If CPR data is used, to what extent are release rates for cars within a unit train interdependent?
2. Would the increased size and weight of the tank car Options have any other effects not discussed in RIA? To what extent would they affect braking effectiveness? To what extent would they affect track safety performance? To what extent would they affect loading practices?
3. What additional safety features not discussed here, if any, should PHMSA consider? If so, please provide detailed estimates on the costs and benefits of individual safety features.
4. Do any of the safety features included in any of the Options have costs that are likely to exceed benefits? If so, please provide detailed estimates on the costs and benefits of individual safety features.
5. PHMSA requests any available detailed data set on the safety features of the existing fleet.

Requirement Area 3 – Speed Restrictions

Proposed Action for Speed Restrictions

PHMSA is proposing to require a 50-mph speed restriction for HHFTs in all areas. This action aligns with the existing requirements imposed by AAR Circular No. OT-55-N. PHMSA believes that there will be no costs associated with a speed restriction of 50 mph, as this codifies current industry best practices.

PHMSA is also proposing to limit any HHFT to a speed of 40 mph in select areas unless the tank cars meet the new DOT Specification 117 standard. PHMSA is considering three Options for implementation of the 40-mph speed restriction and requesting comments on which Option would have greatest net social benefits and whether the 40-mph speed restriction is necessary. Further, any HHFT that does not meet the braking requirements in Requirement Area 4 -- Braking, discussed below, would be restricted to 30 mph. This section of the analysis will look at the costs associated with the slowdown of the rail network and the benefits from reducing the potential harm of HHFT accidents.

A train collision or derailment which occurs at 40 mph rather than 50 mph would be less severe.[80] PHMSA anticipates the efforts made by reducing the speed of trains with less safe tank cars and braking systems will prevent fatalities and other injuries, and limit the amount of property damage done in an accident. PHMSA anticipates additional safety benefits will be realized as the tank car fleet meets the proposed integrity standards. The trains will no longer be subject to the speed restrictions discussed here, in Requirement Area 3, but will accrue the benefits discussed above, in Requirement Area 2, Tank Cars, and below, in Requirement Area 4, Braking. PHMSA believes that with the enhanced braking, and greater car integrity, the risk from a derailment of a train that is authorized to travel at 50 mph is less than the risk from a train not so equipped with a maximum authorized speed of 40 mph. PHMSA believes the enhanced braking is likely to reduce the speed at which the train enters an accident from the maximum authorized speed, and to do so more effectively than conventional braking would allow. Once the tank cars have enhanced integrity and braking systems they will be less likely to release product when involved in a derailment or collision. PHMSA expects reduced benefits attributable to speed restrictions as new tank cars make up a larger portion of the fleet and the reduction in risk is realized by the new tank cars. As a result PHMSA phases out the speed restriction as the new tank cars are introduced.

Determination of Need

Speed is a factor that may contribute to derailments. Speed can influence the probability of an accident, as slower speeds may allow for a brake application to stop the train before a collision. Speed also increases the kinetic energy of a train, resulting in a greater possibility of the tank cars being punctured in the event of a derailment. Under the current packaging requirement and until the new tank cars are fully in use PHMSA believes reduced speed is warranted.

Further, despite existing voluntary action, additional regulatory action on the 50 mph speed limit is necessary because OT-55 is a recommended practice and, as such, does not carry the weight of law. A subscribing railroad can, without concern of a penalty, move these trains at speeds exceeding the industry standard and as discussed previously, increase the energy and likelihood of catastrophic damage to tank cars involved in a train accident. Codifying this voluntary commitment will ensure that the benefits of these speed restrictions are realized indefinitely. Without codification of these requirements the speed restrictions could be subsequently lifted

[80] Kinetic energy varies directly with the square of speed (velocity). [Kinetic energy = ½ Mass x $(\text{Velocity})^2$] Forty mph is 80% of 50 mph. Assuming equal mass, the resulting change in energy is the square of the difference in velocity ($0.8^2 = 0.64$) or a reduction of 36% (100 - 0.64 = 0.36).

prematurely and increase risk.

Alternatives Considered

Alternative 1: 50 Miles Per Hour in All Areas

Currently there is no regulatory prohibition on speeds of HHFTs in excess of 50 mph (up to 79 mph). For purposes of this rulemaking and analysis PHMSA assumes that, in the absence of any regulatory action, all affected railroads will continue indefinitely to abide by the voluntary agreement currently in place to limit speeds to no more than 50 mph. Therefore, codification of the current 50 mph speed will result in the same level of damages occurring from derailments and the same probability of a higher consequence event, and there will be no marginal costs or benefits from this requirement. PHMSA believes the 50 mph is a current business practice adopted to reflect market pressures. Under these circumstances, this alternative would be, in effect, a "No Action" status quo alternative.

PHMSA asked several questions regarding AAR Circular No. OT-55-N in the September 6, 2013 ANPRM. Specifically, PHMSA asked if the Circular adequately addressed speed restrictions. The majority of the commenters indicated that the current self-imposed 50-mph speed restriction is acceptable. Further, during the recent industry Call-to-Action the rail and crude oil industries agreed to voluntarily consider potential improvements including speed restrictions in high-threat urban areas (HTUA), similar to the requirements that are established by the routing requirements in Part 172, Subpart I of the HMR.

Alternative 2: Additional Speed Reductions

The laws of physics indicate that if an accident occurred at 40 mph instead of 50 we should expect a reduction of kinetic energy by 36%. After consultations with engineers and subject matter experts, we can assume that this would translate to the severity of an accident being reduced by 36%. A slower speed may allow a locomotive engineer to identify a safety problem ahead and stop the train before an accident, which could lead to accident prevention. PHMSA only quantifies benefits in this proposed rule from mitigating the severity of accidents. With respect to prevention, PHMSA notes that reduced speeds will reduce the risk of accidents on net, though some risks could increase under limited circumstances.

PHMSA uses a ten mile speed differential in calculating an effectiveness rate for the 40 mph speed restriction options, which assumes that at the time of an accident trains would be going 10 mph slower if the speed restriction were at 40 mph rather than 50 mph. Braking is often applied before an accident occurs, and the speed differential at the time of an accident that results from trains operating at top speeds of 50 mph and 40 mph could be different than 10. Furthermore, in some cases other restrictions on speed that may apply, as well as congestion, would affect speed at the time of the accident. PHMSA lacks a basis to modify the assumption that speeds would be 10 mph different at the time of accidents and seeks comment on how we may better determine how speed restrictions would affect actual speed at the time of an accident.

FRA used simulation software[81] to estimate the effects of a 40 mph speed limit on delays of all crude and ethanol traffic traversing typical crude and ethanol corridors. The simulation software is based on long-standing industry standard approaches to analyzing train movements along a network. The initial data entered into the simulation is based on data from the Surface Transportation Board's 2012 Waybill Sample, the U.S. Energy Information Administration, and observations of FRA inspectors in the field. Separate simulations were done for crude oil (STC Code 13111) and ethanol (STC code 28184).

The waybill sample's total distance field was used to estimate the average length of haul of both crude oil and ethanol. FRA found that an average crude oil train travels over 1,000 miles on the rail network and an average ethanol train travels over 1,300 miles on the rail network, though as noted below, FRA estimated that each type of train is on transcontinental for 5/7 of each trip. FRA estimated the delay costs for each fuel train move were estimated by combining the results of two separate simulations to account for the different conditions when entering and exiting the major transcontinental corridors. FRA assumed that three hundred miles of each trip, at the origin and destination, takes place on double track territory with Centralized Traffic Control (CTC) signaling and 6 HHFTs operating reduced speeds. FRA assumed that the remainder of the trip takes place on the major transcontinental corridors, with CTC signaling and ten HHFTs operating at lower speeds. In both cases, FRA assumed that track grade and curvature have minor effects on train speed. FRA expertise provides the basis for these assumptions.

Passenger trains and intermodal are granted priority, so that fuel and general merchandise trains bear the majority of the delay. Taking into consideration the close proximity of waybill originations and assuming crude oil/ethanol trains would be routed to move as quickly as possible to major corridors, FRA grouped crude and ethanol traffic into sixteen and six separate smaller corridors, respectively, for the first 300 miles of the trip. FRA assumed crude oil trains travel across six major transcontinental corridors and ethanol trains are restricted to two.

FRA assumed moderate traffic densities for each of the subdivisions on the corridor but does not account for seasonal variation or extraordinary circumstances. As the number of fuel trains increased, net delay[82] increased exponentially.

This analysis provides an estimate of train delay at the corridor level. FRA does not have sufficient data to estimate the full impact of speed restrictions on the US railroad network. To the extent that HHFTs traverse the major U.S. railroad transcontinental corridors, the network impact could be significant. Other factors such as the demand and supply of crude oil and

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[81] The Federal Railroad Administration, Generalized Train Movement Simulator or (GTMS). This software in not publicly available and is based on the Train Performance System (TPS). TPS underlies all railroad simulation models including the Rail Traffic Controller (RTC) software used by the Class 1 railroads. The TPS model was documented by Transportation Systems Center, U.S. Department of Transportation. "USDOT/TSC Train Performance Simulator (TPS) User's Manual, Version 5." Manual, 1988.

[82] Net delay is the delay encountered in sidings, while stopped on the main line, due to schedule delay, or time spent waiting to be authorized to enter the territory.

ethanol would impact the outcome of this analysis. PHMSA and FRA specifically request comment on the assumptions used in modeling the impacts of speed restrictions, including output of other validated rail network models, and alternative input assumptions, or comments on the inputs themselves.

The following table shows the total daily train hours of slow down per corridor as estimated by FRA's simulation. The number of trains is the number of crude oil or ethanol trains in a single day over the corridor analyzed. For example, if there is one crude oil train on the corridor on one day, slowed to 40 mph, then all of the trains on the corridor will experience a total among them of 84 hours of delay in that one day.

Table S1. Time Impacts of a 40 mph Maximum Speed

Crude Oil Trains per day	Daily hours of delay for all trains	Ethanol Trains per day	Daily hours of delay for all trains
1	84	1	92
2	181	2	228
4	233	4	250
6	385	6	576
8	534	8	721
10	770	10	1522

The beginning years of the restriction would be the most burdensome as the industry works to build or retrofit tank cars to the required specifications.

The tables in the Slowdown sections below demonstrate the estimated number of hourly trains on each corridor on the first day that the speed restriction is in effect for each given year. The total delay hours for the slowdown to 40 mph in the first year are calculated by multiplying the number of corridors by the number of hours, times the percentage of usage, and (100% – the voluntary action reduction). For example, for the hours of delay from crude oil in start and end corridors, the calculation is 16 corridors x 385 hours of delay per corridor x 2/7 of train time spent in start and end corridors x (100% minus 1.78% for the existing voluntary action in HTUAs) = 1,729.

The "number of hours" of delay column is determined by referencing Table S1 above. The "percentage of usage" field weights the calculation based on the proportion of time that crude oil and ethanol trains spend on each type of track; the column in Table S2 shows that trains spend 2/7 of their time on start-end corridors and 5/7 of their time in the middle of the corridor. This ratio was calculated by considering usage characteristics to define two segments (start/end of a corridor and middle of a corridor), and then quantifying the proportion in terms of time that traffic within our sample spent on each type of corridor. PHMSA assumed that the crude and ethanol routes would have similar start-middle-end ratios. The distances were based on the average corridor mileage for ethanol and crude oil, described above.

The HTUA reduction removes from the cost of slowing crude DOT Specification 111 unit trains to 40 mph in HTUAs, because that is being done voluntarily (see further description below for how this was calculated). The total daily cost is determined by multiplying the total hours of delay by $500 per hour, which PHMSA estimates is the average cost of an hour of delay (see discussion below, in the Slowdown section).

To calculate the total annual cost of delay from a 40 mph speed limit in all areas for HHFTs, PHMSA multiplied the daily cost of delay by the number of days in a week and by the number of weeks in a year.

The phase in of DOT Specification 117 train sets is assumed to result in one-third of unit trains using only DOT Specification 117 tank cars to transport Class 3 flammable liquids by the beginning of year 2, two-thirds by year 3, and 100 percent by Year 4. This is expected to result in 4 trains per day affected on start-end corridors and 8 trains per day affected on middle corridors in Year 2, and in 2 trains per day affected on start-end corridors and 6 trains per day affected on middle corridors in Year 3.

Speed Analysis Limitations

This is a simplified analysis with several limitations. First, the analysis extrapolates from the geometric characteristics of a single 124-mile subdivision, which may not be representative. It is also possible that slower traffic along crude oil and ethanol corridors would lead to delays for the network overall. Further, the analysis does not take into account diversion of rail traffic from the rail line on which the speed restriction occurs to other rail lines. Such diversion would slow traffic on other lines, but speed traffic on the line with the speed restrictions (and speed the traffic diverted). Overall the effect of the diversion would be to reduce delays, because the railroad would presumably only divert traffic if it reduced delays.

This analysis also does not take into account the possibility of rail traffic, particularly intermodal traffic, being diverted onto truck or other modes of transit as a result of rail delays. This could have adverse safety, environmental, and state-of-good-repair costs. PHMSA does not believe that the speed limitations and potential resulting delays will have a large effect on unit costs of shipping by rail, and therefore any potential modal diversion would be minimal.

As discussed above, the impact of speed at accident is difficult to interpret as the speed immediately prior to the accident speed differential at different train speeds. PHMSA uses a ten mile speed differential in calculating an effectiveness rate for the 40 mph speed restriction options, which assumes that at the time of an accident trains would be going 10 mph slower if the speed restriction were at 40 mph rather than 50 mph.

Option 1: Restrict Speed to 40 mph in All Areas

Costs

The economic impact of slowing trains depends upon multiple factors including other types of trains, other train speeds, dispatching requirements, work zones, and topography. Looking at a numerous variables, for purposes of this particular analysis, DOT estimated the average cost of a train delay to be$500 per hour. This cost estimate was determined by reviewing costs associated with crew members, supply chain logistic time delays based on various freight commodities, and passenger operating costs for business and other travel. PHMSA seeks comments on this estimate/assumption.

Slowdown

DOT assumed that crude oil fuel trains travel across six major transcontinental corridors and ethanol trains travel across two. This assumption is based on observations and inferences drawn from the STB Waybill Sample.   In the first day of the implementation of this rule, PHMSA estimates that crude oil traffic would be slowed down by 4,970 hours, as 10 trains would delay traffic on six transcontinental corridors and six trains would delay traffic on 16 smaller corridors, the start or end corridors.   The total costs of crude oil train delay for the first day would be approximately $2.5 million.[83] PHMSA estimates that ethanol traffic would be slowed down by 3,162 hours as 10 trains would delay traffic on two transcontinental corridors and six trains would delay traffic on six smaller corridors.   The total ethanol train delay costs for the first day would be approximately $1.6 million.[84] The total cost for the first year would be $1.5 billion.[85]

Note that PHMSA took account of the voluntary compliance with a 40 mph speed limit for crude oil in HTUA. The voluntary compliance is limited to 2 percent of trackage, the proportion of trackage in HTUAs, and is limited to those shipments made in cars that do not comply with CPC-1232, which are not subject to the voluntary compliance. PHMSA's estimate of the proportion of CPC-1232 cars is based on the proportion in effect at the effective date of the rule, which PHMSA estimates will be 11% of the HHFT fleet in 2015. For the purposes of this analysis the number of CPC-1232 cars is held constant. PHMSA believes that the voluntary compliance amounts to 1.78 percent of crude oil shipments. This percentage is deducted from burdens (i.e., costs) estimated below and is also used to reduce the benefit estimates. PHMSA request comments on the ratio of the HHFT fleet that are currently CPC-1232 tank cars.

The phase in of ECP compliant train sets is assumed to result in equipping one third in year 2, two thirds in year 3, and 100 percent in Year 4. This is expected to result in 4 trains per day affected on start-end corridors and 8 trains per day affected on middle corridors in Year 2, and in 2 trains per day affected on start-end corridors and 6 trains per day affected on middle corridors in Year 3.

Table S2. Cost of 40 mph Speed Limit, Year 1

Cost of slowdown to 40 mph							
	Number of Corridors	Number of Trains	Number of Hours	Percentage of Usage	Small City Reduction	Total Hours	Total Daily Cost

[83] 4,970 (Hours delayed) * $500 (Train delay hourly cost) = $2,484,966
[84] 3,247 (Hours delayed) * $500 (Train delay hourly cost) = $1,580,857
[85] [$2,484,966 (Daily slowdown cost for Crude Oil) + $1,580,857 (Daily slowdown cost for Ethanol)]*7 (Days in a week) * 52 (Weeks in the year) = $1,479,959,624.

Crude Traffic at 40 mph							
Start-End	16	6	385	29%	1.78%	1,729	$864,336
Middle	6	10	770	71%	1.78%	3,241	$1,620,630
					Total	4,970	$2,484,966
Ethanol Traffic at 40 mph							
Start-End	6	6	576	29%	0%	987	$493,714
Middle	2	10	1,522	71%	0%	2,174	$1,087,143
					Total	3,162	$1,580,857

Table S3. Cost of 40 mph Speed Limit, Year 1	
Total Daily Cost	$4,065,823
Total Weekly Cost	$28,460,762
Total Annual Cost	$1,479,959,624

Table S4. Cost of slowdown to 40 mph Speed Limit, Year 2							
	Number of Corridors	Number of Trains	Number of Hours	Percentage of Usage	Small City Reduction	Total Hours	Total Daily Cost
Crude Traffic at 40 mph							
Start-End	16	4	233	29%	1.78%	1,046	$523,092
Middle	6	8	534	71%	1.78%	2,248	$1,123,917
					Total	3,294	$1,647,009
Ethanol Traffic at 40 mph, Year 2							
Start-End	6	4	250	29%	0%	429	$214,286
Middle	2	8	721	71%	0%	1,030	$515,000
					Total	1,459	$729,286

Table S5. Cost of 40 mph Speed Limit Year 2	
Total Daily Cost	$2,376,295
Total Weekly Cost	$16,634,064
Total Annual Cost	$864,971,307

Table S6. Cost of slowdown to 40 mph, Year 3							
	Number of Corridors	Number of Trains	Number of Hours	Percentage of Usage	Small City Reduction	Total Hours	Total Daily Cost
Crude Traffic at 40 mph							
Start-End	16	2	181	29%	1.78%	813	$406,350
Middle	6	6	385	71%	1.78%	1,621	$810,315
					Total	2,433	$1,216,665
Ethanol Traffic at 40 mph, Year 3							
Start-End	6	2	228	29%	0%	391	$195,429
Middle	2	6	576	71%	0%	823	$411,429
					Total	1,214	$606,857

Table S7. Cost of 40 mph Speed Limit, Year 3	
Total Daily Cost	$1,823,522
Total Weekly Cost	$12,764,656
Total Annual Cost	$663,762,122

As the industry builds or retrofits cars that meet the specifications of a tank car as proposed by this rule, PHMSA estimates that the delay in traffic will decrease. The tables below show that average cost of the slowdown by year. PHMSA anticipates that by the end of year 3, all cars would meet these standards; therefore, there would be no additional slowdown costs.

Table S8. Annual costs of Speed Reduction @40 mph in all areas – traffic slowed down over a 3-year period

Slow to 40 mph, All Tracks			
		Discounted Value	
		Discount Factor	
Year	Cost	7%	3%
2015	$1,479,959,624	$1,383,139,836	$1,436,854,004
2016	$864,971,307	$755,499,439	$815,318,416
2017	$663,762,122	$541,827,611	$607,436,370
2018	$0	$0	$0
Total	$3,008,693,054	$2,680,466,885	$2,859,608,790

Over a three year period, PHMSA estimates that the total costs associated with a 40 mph speed restriction would be $3.0 billion. Discounting the cost at 3 and 7 percent the cost would be $2.9 billion and $2.9 billion respectively. PHMSA seeks comments on all of these cost estimates.

Benefits

For each scenario, we did not account for benefits from slowing crude oil traffic in DOT Specification 111 tank cars in HTUAs, just as we did not account for costs from this slowdown, because industry is already voluntarily slowing these cars down in HTUAs. The effectiveness rates are presented in the table below.

Table S9. Speed Benefits Effectiveness Rates 40 mph in all areas

Year	Effectiveness Rate
2015	34.67%
2016	23.11%
2017	11.56%

The benefits of a 40 mph speed restriction in all areas for HHFTs that do not contain all tank cars meeting the new construction standard are presented below.

Table S10. Costs and Benefits of 40 mph Speed Limit, 7 Percent Discount

20 Year Benefits, Costs, and Net Benefits for System Wide 40 MPH Speed Limit, 7 Percent Discount Rate		
	0 High Consequence Events	Benefits with Lower Consequence Events + 10 High Consequence Events*
Benefits	$198,718,478	$635,852,405
Costs	$2,680,466,885	$2,680,466,885
Net Benefits	-$2,481,748,407	-$2,044,614,480

* 1 event of the 10 assumed to be 5x the average high consequence event in magnitude

If the industry builds or retrofit cars more rapidly, the costs and benefits associated with this component of the proposed rule would decrease proportionally and dramatically.

Option 2: Restrict speed to 40 mph in Cities with a Population Greater than 100,000

Under this alternative, PHMSA would require HHFTs to operate at speeds no greater than 40 mph only when transiting cities with a population greater than 100,000. PHMSA estimates that approximately 10% of the track miles for crude oil and ethanol traffic are traversed in cities, areas with a population greater than 100,000 people. We seek comments on this assumption. Therefore, only 10% of the track miles would be impacted, resulting in a 90% reduction of costs. The delay costs in cities may not be proportional to miles affected, because in and near cities congestion is more common. Where lines are congested and very few trains can reach track speed, the impact of a speed restriction is dramatically less per mile.

Calculations are performed as above, with a subtraction for the 1.78 percent of crude already covered by voluntary compliance in HTUAs and for the track miles not covered by this Option. To calculate the total hours of delay per day, the number of corridors are multiplied by the number of hours of delay times the percentage of usage times (100% minus the track miles covered reduction minus the voluntary action reduction). The tables below show the average cost of the slowdown by year, over a three year period.

Table S11. Cost of slowdown to 40 mph, Cities Only, Year 1

	Number of Corridors	Number of Trains	Number of Hours	Percentage of Usage	Small City Reduction	Total Hours	Total Daily Cost
Crude Traffic at 40 mph							
Start-End	16	6	385	29%	1.78%	145	$72,336
Middle	6	10	770	71%	1.78%	271	$135,630
					Total	416	$207,966
Ethanol Traffic at 40 mph							
Start-End	6	6	576	29%	0%	99	$49,371
Middle	2	10	1,522	71%	0%	217	$108,714
					Total	316	$158,086

Table S12. Cost of slowdown, Cities Only,Year 1	
Total Daily Cost	$366,052
Total Weekly Cost	$2,562,362

Total Annual Cost	$133,242,824

Table S13. Cost of slowdown to 40 mph, Cities Only, Year 2							
	Number of Corridors	Number of Trains	Number of Hours	Percentage of Usage	Small City Reduction	Total Hours	Total Daily Cost
Crude Traffic at 40 mph							
Start-End	16	4	233	29%	1.78%	88	$43,777
Middle	6	8	534	71%	1.78%	188	$94,060
					Total	276	$137,838
Ethanol Traffic at 40 mph							
Start-End	6	4	250	29%	0%	43	$21,429
Middle	2	8	721	71%	0%	103	$51,500
					Total	146	$72,929

Table S14. Cost of 40 mph Speed Limit, Cities Only, Year 2	
Total Daily Cost	$210,766
Total Weekly Cost	$1,475,364
Total Annual Cost	$76,718,907

Table S15. Cost of slowdown to 40 mph Speed Limit, Cities Only, Year 3							
	Number of Corridors	Number of Trains	Number of Hours	Percentage of Usage	Small City Reduction	Total Hours	Total Daily Cost
Crude Traffic at 40 mph							
Start-End	16	2	181	29%	1.78%	68	$34,007

Middle	6	6	385	71%	1.78%	136	$67,815
					Total	204	$101,822
Ethanol Traffic at 40 mph							
Start-End	6	2	228	29%	0%	39	$19,543
Middle	2	6	576	71%	0%	82	$41,143
					Total	121	$60,686

Table S16. Cost of 40 mph Speed Limit, Cities Only, Year 3	
Total Daily Cost	$162,508
Total Weekly Cost	$1,137,556
Total Annual Cost	$59,152,922

Table S17. Cost 40 mph Speed Limit, Cities Only			
		Discounted Value	
		Discount Factor	
Year	Cost	7%	3%
2015	$133,242,824	$124,526,004	$129,361,965
2016	$76,718,907	$67,009,265	$72,314,928
2017	$59,152,922	$48,286,405	$54,133,304
2018	$0	$0	$0
Total	$269,114,654	$239,821,673	$255,810,197

Over a three year period, PHMSA estimates that the total costs associated with this section of the proposed rule would be $269.1 million if a 40 mph speed restriction were imposed only in cities with 100,000 people or more. Discounting the costs at 3 and 7 percent, the 20 year cost would be $255.8 million and, $239.8 million, respectively.

PHMSA believes that any accident prevented in a city with a population of more than 100,000 would have a greater than average impact in the total benefit pool. The average population density in these cities is approximately ten times higher than the average area, but there are other mitigating factors, such as reduced speed, that could mitigate damages. To account for this, PHMSA doubles its estimate of the damages per track mile in cities with more than 100,000 people.

Only 10% of the track miles considered in the overall benefit pool are covered by this speed restriction option, and therefore no benefits are estimated for land outside of cities. Note that the city track miles also include all of the miles where crude oil HHFTs are currently voluntarily reducing their speed. Therefore, we estimate the benefits of speed restriction Option 2 by multiplying the benefits of a speed restriction in all areas in the absence of any voluntary action by 10% (to remove uncovered miles), doubling the damages (to account for the greater threat in these cities), and then subtracting the benefits attributable to the voluntary slowing of select crude oil trains. The effectiveness rates are presented in the table below.

Table S18. Speed Benefits Effectiveness Rates 40 mph, Cities Only

Year	Effectiveness Rate
2015	5.87%
2016	3.91%
2017	1.96%

The discounted costs and benefits associated with Option 2 are shown in the table below.

Table S19. Costs and Benefits of 40 mph Speed Limit in Cities with a Population of Greater than 100K; 7 Percent Discount

20 Year Benefits, Costs, and Net Benefits for 40 MPH Speed Limit in Cities with >100K Pop, 7 Percent Discount Rate		
	Baseline - 0 High Consequence Events	**Benefits with Lower Consequence Events + 10 High Consequence Events***
Benefits	$33,639,410	$107,638,199
Costs	$239,821,673	$239,821,673
Net Benefits	-$206,182,264	-$132,183,474

* 1 event of the 10 assumed to be 5x the average high consequence event in magnitude

Option 3: Restrict speed to 40 mph in High Threat Urban Areas

High Threat Urban Area (HTUA) means an area comprising one or more cities and surrounding areas including a 10-mile buffer zone as designated by the Department of Homeland Security see: 49 CFR part 1580—RAIL TRANSPORTATION SECURITY.

On February 21, 2014 the AAR signed a letter to DOT discussing the transportation of crude oil. One of the commitments that they made was:

> "*Railroad Subscribers commit to continue to adhere to a speed restriction of 50 mph for any Key Crude Oil Train. By no later than July 1, 2014, Railroad Subscribers will adhere to a speed restriction of 40 mph for any Key Crude Oil Train with at least one "DOT Specification 111" tank car loaded with crude oil or one non-DOT specification tank car loaded with crude oil while that train travels within the limits of any high-threat urban area as defined by 49 C.F.R. § 150.3. For purposes of these commitments, "DOT Specification 111" tank cars are those cars that meet DOT Specifications 111 standards but do not meet the requirements of AAR Circular CPC-1232 or any new standards adopted by DOT after the date of this letter.*"

In the call to action, there was voluntary compliance on the transportation of crude oil, however this did not include jacketed CPC-1232 tank cars, which incorporate around 11 percent of the fleet. Therefore, except for jacketed CPC-1232, PHMSA does not anticipate any new costs associated with the slowdown of traffic in a HTUA when transporting crude oil. Although the simulation only looks at a small segment of a subdivision, PHMSA estimates that around 2% of a crude oil corridor would have traversed through a HTUA. PHMSA seeks comments on this assumption.

Calculations are again performed as above, with the same reduction in costs to account for voluntary compliance for crude oil in HTUAs.

Table S20. Cost of 40 mph Speed Limit, HTUAs Only, Year 1

	Number of Corridors	Number of Trains	Number of Hours	Percentage of Usage	Small City Reduction	Total Hours	Total Daily Cost
Crude Traffic at 40 mph							
Start-End	16	6	385	29%	1.78%	4	$1,936
Middle	6	10	770	71%	1.78%	7	$3,630
					Total	11	$5,566
Ethanol Traffic at 40 mph							
Start-End	6	6	576	29%	0%	20	$9,874
Middle	2	10	1,522	71%	0%		$21,743

						43	
					Total	63	$31,617

Table S21. Cost of 40 mph Speed Limit, HTUAs Only, Year 1	
Total Daily Cost	$37,183
Total Weekly Cost	$260,282
Total Annual Cost	$13,534,664

Table S22. Cost of 40 mph Speed Limit, HTUAs Only, Year 2

	Number of Corridors	Number of Trains	Number of Hours	Percentage of Usage	Small City Reduction	Total Hours	Total Daily Cost
Crude Traffic at 40 mph							
Start-End	16	4	233	29%	1.78%	2	$1,172
Middle	6	8	534	71%	1.78%	5	$2,517
					Total	7	$3,689
Ethanol Traffic at 40 mph							
Start-End	6	4	250	29%	0%	9	$4,286
Middle	2	8	721	71%	0%	21	$10,300
					Total	29	$14,586

Table S23. Cost of 40 mph Speed Limit, HTUAs Only, Year 2	
Total Daily Cost	$18,275
Total Weekly Cost	$127,924
Total Annual Cost	$6,652,027

Table S24. Cost of 40 mph Speed Limit, HTUAs Only, Year 3

	Number of	Number of	Number of	Percentage of Usage	Small City	Total Hours	Total Daily

	Corridors	Trains	Hours		Reduction		Cost
Crude Traffic at 40 mph							
Start-End	16	2	181	29%	1.78%	2	$910
Middle	6	6	385	71%	1.78%	4	$1,815
					Total	5	$2,725
Ethanol Traffic at 40 mph							
Start-End	6	2	228	29%	0%	8	$3,909
Middle	2	6	576	71%	0%	16	$8,229
					Total	24	$12,137

Table S25. Cost of 40 mph Speed Limit, HTUAs Only, Year 3	
Total Daily Cost	$14,862
Total Weekly Cost	$104,036
Total Annual Cost	$5,409,882

Table S26. Cost of 40 mph Speed Limit, HTUAs Only			
		Discounted Value	
		Discount Factor	
Year	Cost	7%	3%
2015	$13,534,664	$12,649,219	$13,140,450
2016	$6,652,027	$5,810,138	$6,270,174
2017	$5,409,882	$4,416,076	$4,950,809
2018	$0	$0	$0
Total	$25,596,574	$22,875,432	$24,361,433

Over a three year period, PHMSA estimates that the total costs associated with this section of the proposed rule would be $25.6 million if a 40 mph speed restriction were imposed only HTUAs. Discounting the costs at 3 and 7 percent, the 20 year cost would be $24.4 million and, $22.9 million, respectively.

PHMSA believes that although only 2% of the track would have costs associated with them, any accident prevented would have a greater impact in the total benefit pool. Population densities in HTUAs are 10 to 100 times or more the average for smaller communities, and property values in these largest US cities are higher. As a result, more people in these areas will be affected by evacuation notices, damage to the transportation network, buildings and other infrastructure. We estimate the benefits of speed restriction Option 3 by multiplying the benefits of a speed restriction in all areas in the absence of any voluntary action by 2% (to remove uncovered miles), multiplying the damages avoided by 3.5 (to account for the likely greater harm that might result in these HTUAs), and then subtracting the benefits attributable to the voluntary slowing of select crude oil trains. The effectiveness rates are presented in the table below.

Table S27. Speed Benefits Effectiveness Rates 40 mph, HTUA

Year	Effectiveness Rate
2015	1.19%
2016	0.79%
2017	0.40%

PHMSA applies effectiveness rates here in the same manner as described in the sections above.

Table S28. Costs and Benefits of 40 mph Speed Limit in HTUA; 7 Percent Discount

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20 Year Benefits, Costs, and Net Benefits for 40 MPH Speed Limit in HTUA, 7 Percent Discount Rate		
	Baseline - 0 High Consequence Events	Benefits with Lower Consequence Events + 10 High Consequence Events*
Benefits	$6,814,061	$21,803,391
Costs	$22,875,432	$22,875,432
Net Benefits	-$16,061,371	-$1,072,042
* 1 event of the 10 assumed to be 5x the average high consequence event in magnitude		

PHMSA seeks additional comments on its approach to quantify the impacts of speed restrictions. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, include supporting data (especially data on train speed and track capacity), and explain the source, methodology, and key assumptions of the supporting data. Specifically, PHMSA seeks data and comments on the following issues:

1. What would the effects be of a 40-mph speed limit for HHFTs on other traffic on the network, including passenger and intermodal traffic, under each of the three described Options?
2. To what degree, if any, would a 40-mph speed limit in select areas (as defined by Options 2 and 3 below) cause rail traffic to be diverted to other lines, and what economic and safety effects would this shift have?
3. To what degree, if any, would a 40-mph speed limit cause rail traffic under each of the three Options, particularly intermodal traffic, to be diverted onto truck or other modes of transit as a result of rail delays, and what economic and safety effects would this shift have?
4. How might the extrapolation from the 124-mile subdivision to the entire rail network produce over- or underestimates of the effects of speed restrictions?
5. How does the likelihood and severity of an accident change in cities of more than

100,000 people and in HTUAs? In addition to population density and average speed, what factors should PHMSA consider in scaling the damages per track mile in urban areas, and what data are available to quantify these factors?
6. How would the safety benefits of the proposed speed limits change if combined with the proposed braking systems and tank car standards?
7. What would be the economic benefits of limiting the proposed 40 mph speed restrictions, under each Option, to DOT Specification 111 cars that do not meet the requirements of CPC-1232 or DOT Specification 117?
8. What would be the economic benefits of limiting the proposed 40 mph speed restrictions, under each Option, to tank cars that do not meet the requirements of DOT Specification 117 and are carrying crude oil?
9. What is the reduction in the probability of a derailment from reducing speed from 50 mph to 40 mph, and from 40 mph to 30 mph?
10. To what extent will changes in the proportion or number of unit trains affect the assumptions and estimates made in this section?

Requirement Area 4 – Braking

Proposed Action for Braking

- For all three tank car Options, by 10/1/15 HHFTs must be equipped and operated with two-way end of train (EOT) braking devices or distributed power (DP), or travel at 30 mph or lower.

- Applicable only to proposed tank car Option 1 (i.e., the PHMSA and FRA designed car), all HHFT tank cars built after October 1, 2015, and HHFT tank cars retrofitted to the PHMSA and FRA designed car standard, must be equipped with ECP brakes. Trains comprised entirely of PHMSA and FRA designed cars, except required buffer cars, must operate in ECP mode or travel at no greater than 30 mph.

Determination of Need

Braking systems reduce kinetic energy and therefore help prevent and mitigate the effects of train accidents. FRA has conducted research on the effectiveness of alternative brake signal propagation systems, which provide improved brake signal propagation time. PHMSA and FRA use that research to establish the need for alternative brake signal propagation systems requirements.

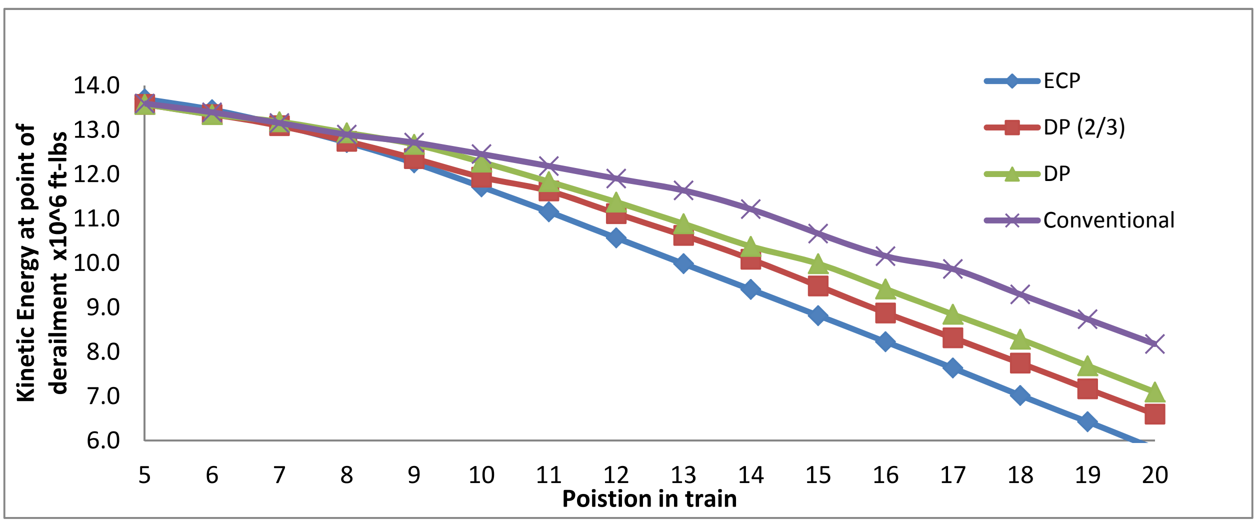
In particular, FRA conducted simulations to better understand the effect on energy dissipation and stopping distance of different brake signal propagation systems such as: conventional brakes, DP configurations, and ECP. The simulations were performed using the Train Energy & Dynamics Simulator (TEDS) program, developed by Sharma & Associates to study the dynamics and energy levels under a variety of operating conditions. Derailments involving trains equipped with two way EOT devices were not specifically simulated. In simulated derailment speeds of 50 and 60 mph, at approximately the 9th car there is a divergence in the kinetic energy of individual railcars at the point of derailment between ECP, DP (EOT), and conventional brake systems. At 50 and 60 mph, if a derailment occurs at the first car, changes in the brake signal propagation system will only be realized after the 10th car. At a derailment speed of 40 mph the divergence occurs at the 7th car. The following figures show the reduction in kinetic energy as a function of train speed and a tank car's position in a train for each of the brake signal propagation systems described above.

Figures 1, 2, 3 and 4 below are based on the following assumptions:

- Each train includes three locomotives at 415,000 lbs., 100 cars at 263,000 lbs., train length 6,164 ft.
- DP has two locomotives at front and one at rear of train.
- DP 2/3 has two locomotives at front of the train, and one placed two thirds from the front.

Dynamic brakes were assumed to be inactive for the purpose of the 18 percent effectiveness rate of DP, thus it is a fair statement to say DP at the end of the train without the benefit of dynamic brakes is equivalent to EOT. Therefore, for the purposes of our analysis, we assumed EOT is as effective as DP when it is located at the end of the train.[86]

Figure BR1. Kinetic Energy vs. Position in Train at a Derailment Speed of 40 Mph



[86] The specifics of this model will be placed in the docket for this rulemaking upon completion. This assumption would tend to underestimate the benefits of ECP brakes, because it enhances the safety level of the estimated baseline.

Figure BR2. Kinetic Energy vs. Position in Train at a Derailment Speed of 50 Mph

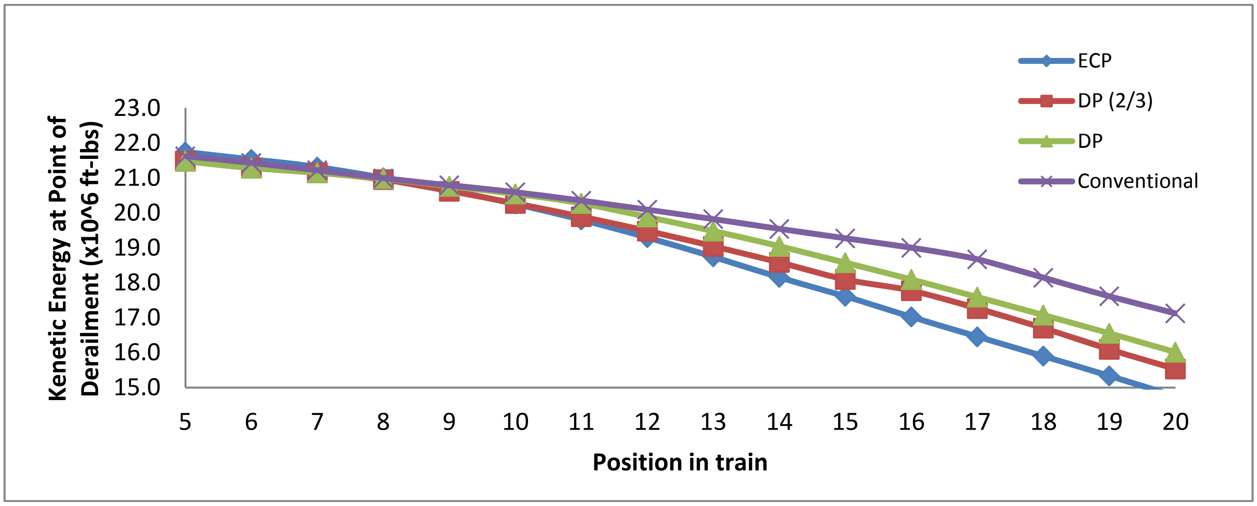
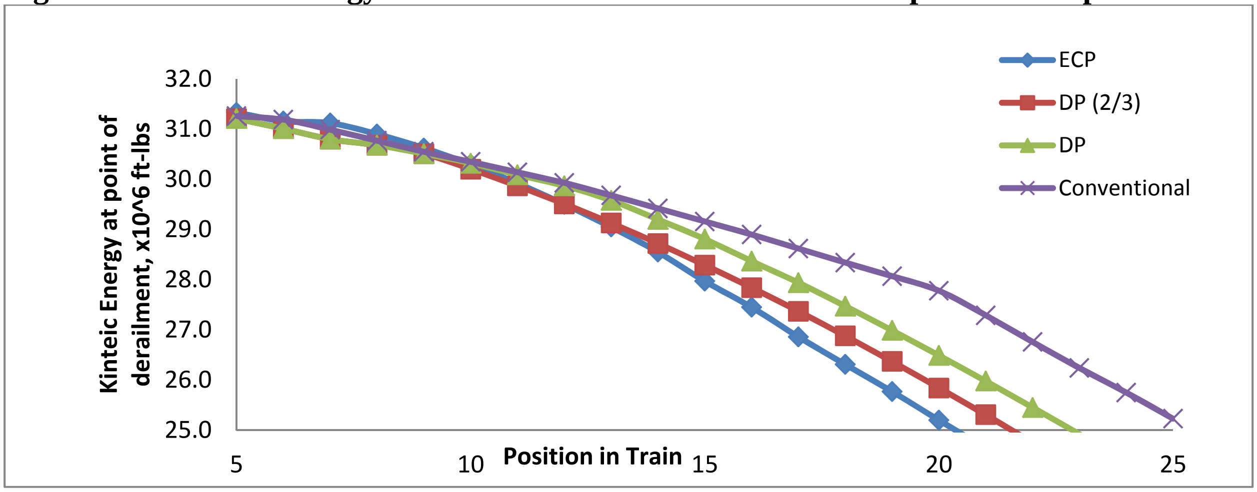
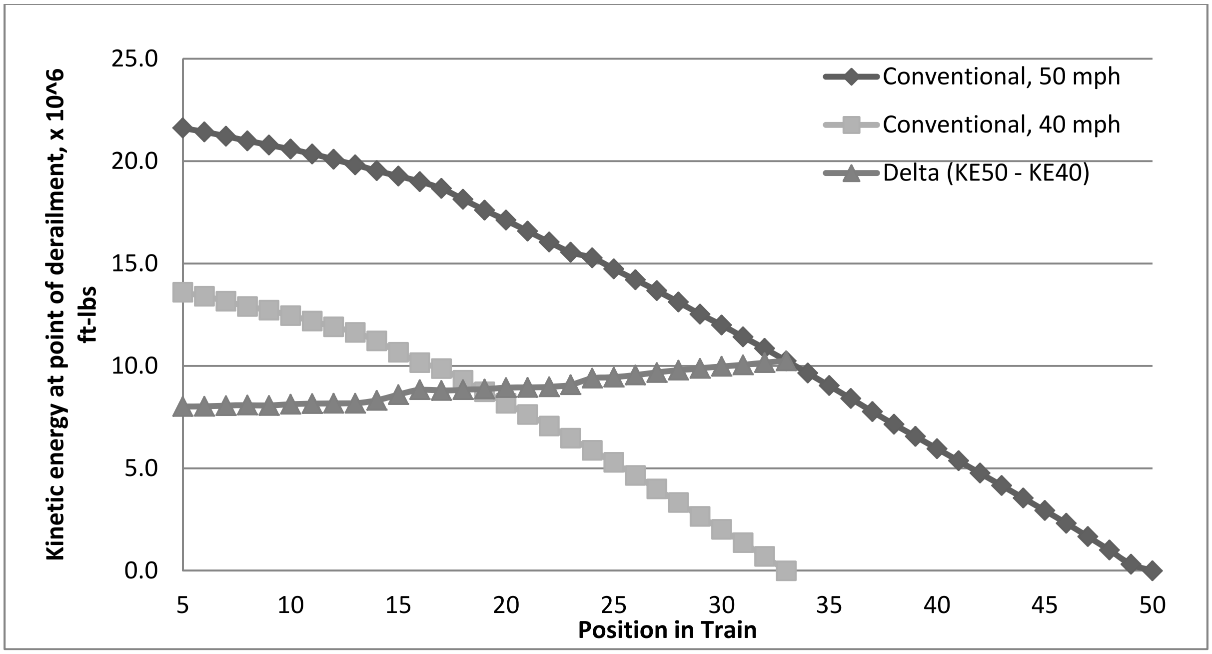


Figure BR3 Kinetic Energy vs. Position in Train at a Derailment Speed of 60 mph



The following graph provides the results of a comparison of the simulations of derailments at 40 and 50 mph. The data are the kinetic energy versus position in a train operating with conventional brakes. The trend line of the difference in energy per car is shown. The trend line is relatively flat, but the slope begins to increase slightly after 15th car.

Figure BR4 Kinetic Energy vs. Position in Train at Derailment Speeds of 40 and 50 Mph



The results of these simulations show that alternative brake signal propagation systems decrease brake signal propagation time relative to the conventional brake system. Thus, additional requirements for alternative brake signal propagation systems constitute a feasible set of alternatives for addressing HHFT risk.

- Using its methodology to evaluate the probability of tank car puncture, DOT calculated that a derailment involving a train made up of Option 1 tank cars (equipped with ECP brakes) will result in 36 percent fewer cars puncturing than the same train with conventional brakes. As such DOT estimates that ECP brakes would reduce the severity of a HHFT accident by an estimated 36 percent, compared to conventional brakes.
- Figures 1, 2 and 3 show that the ability for trains operating with two-way EOT device and DP brake systems to dissipate energy is between the abilities of those operating with ECP and conventional brake systems. Accordingly, DOT estimates that two-way EOT or DP would reduce the severity of a HHFT accident by 18 percent (half of the 36% estimated for ECP brakes), compared to conventional brakes.

Based on Sharma's modeling, the effectiveness of ECP was determined to be 36%, and DP was calculated (not simulated) to determine effectiveness of about 18 percent. However, as both DP and EOT effectiveness were calculated based on a number of factors and previous model runs, PHMSA and FRA will place a technical supplement into the rulemaking docket to provide greater detail on the inputs and assumptions underlying the model.

Alternatives Considered

Alternative 1: No Action Alternative – Status Quo

If the proposed braking requirements are not changed, the damages estimated in the absence of this rulemaking would not be reduced. This alternative would also impose no costs.

Alternative 2: End of Train Devices or Distributed Power, or 30 MPH in all areas

Alternative 2 would require each HHFT to be equipped and operated with either a two-way EOT device, as defined in 49 C.F.R. 232.5 of this title, or DP, as defined in 49 C.F.R. 229.5 of this title. If HHFTs are not equipped with two-way EOT devices or DP, they would have to travel at no greater than 30 mph.

Alternative 3 (*applicable to tank car Option 1 only*): Alternative 2, plus ECP on All Newly Constructed and Retrofitted DOT Specification 117 cars

Similar to Alternative 2, Alternative 3 would require HHFT to be equipped and operated with either a two-way EOT device, as defined in 49 C.F.R. 232.5 of this title, or DP, as defined in 49 C.F.R. 229.5 of this title. If HHFTs are not equipped with two-way EOT devices or DP, they would have to operate at no greater than 30 mph.

In addition, applicable to proposed tank car Option 1 only (i.e., the PHMSA and FRA Designed Car), Alternative 3 would require all HHFT tank cars built after October 1, 2015 to be equipped with ECP brakes in accordance with subpart G of 49 C.F.R. 232. Further, Alternative 3 would require all HHFT tank cars retrofitted to the proposed Option 1 tank car standard to be equipped with ECP brakes. After October 1, 2015, a HHFT comprised entirely of cars meeting the FRA and PHMSA Designed Car standard, except for required buffer cars, must be operated in ECP brake mode or travel at no greater than 30 mph.

Background

The two-way EOT device includes two pieces of equipment linked by radio that initiate an emergency brake application command from the front unit located in the controlling locomotive, which then activates the emergency air valve at the rear of the train within one second. The rear unit of the device sends an acknowledgment message to the front unit immediately upon receipt of an emergency brake application command. A two way EOT device is more effective than conventional brakes because the rear cars receive the brake command more quickly.

DP is a system that provides control of a number of locomotives dispersed throughout a train from a controlling locomotive located in the lead position. The system provides control of the rearward locomotives by command signals originating at the lead locomotive and transmitted to the remote (rearward) locomotives.

ECP systems simultaneously sends a braking command to all cars in the train, reducing the time before a car's pneumatic brakes are engaged compared to conventional brakes. The system also permits the train crew to monitor the effectiveness of the brakes on each individual car in the train and provides real-time information on the performance of the entire braking system of the train. ECP brake system technology also reduces the wear and tear on brake system components and can significantly reduce fuel consumption. All cars in a train must be equipped with ECP before a train can operate in ECP brake mode.

On March 9, 2011, AAR, on behalf of its members and the Tank Car Committee (TCC), jointly petitioned PHMSA and Transport Canada (TC) to establish new standards for DOT Class 111 tank cars used to transport hazardous materials in packing groups I and II. The petition (P-1577), which was an outgrowth of a TCC executive working group, proposed new construction standards and specifically recommended no modification for existing tank cars. The AAR agreed to forward the petition to PHMSA on behalf of the TCC as a result of a unanimous decision by the Committee.

On May 10, 2011 FRA met with the RSI Tank Car Committee to discuss improvements to tank cars used for the transportation of crude oil in unit trains. FRA requested this meeting to discuss improving tank car safety specific to crude oil tank cars given the recent increase in demand for these cars. At the meeting FRA presented information from a recent unit train accident in Arcadia, Ohio. The intent of the meeting was to spur discussion about innovative solutions that improve tank car safety for future changes in the hazardous materials transportation supply chain. The advent of increased shipments of crude oil in unit train quantities provided an avenue to discuss safety enhancements prior to a major tank car build. The FRA suggested a number of potential safety enhancement technologies such as spray-on thermal protection, manway redesign, and tank car design improvements (rounding edges of components) for consideration by the tank car builders/owners. The meeting resulted in the RSI members offering to develop an industry standard (non-regulatory) in collaboration with the AAR, the Renewable Fuels Association (RFA), Growth Energy, and the American Petroleum Institute (API). This effort was conducted through a TCC Task Force led by the FRA. This effort led to a task force known as the T87.6 Task Force.

The T87.6 Task Force developed several findings, including findings on alternative brake propagation systems. The alternative brake signal propagation systems considered included conventional air brakes, ECP, DP, and two-way EOT devices. As the name suggests the baseline system was conventional with ECP, DP, and EOT the proposed alternatives. The EOT device performs the same as DP with locomotives at the front and rear. Intermediate EOT technology is a system not currently in use nor developed.

The Train Energy & Dynamics Simulator (TEDS) was used to study the dynamics and energy levels of trains under a variety of operational conditions. Specifically, TEDS was used to determine the stopping distance and the rate of dissipation of kinetic energy (KE) of a generic, 100 tank car train on level tangent track equipped with the candidate brake signal propagation systems. The simulations were used to determine the relative performance of the different systems. The model was validated using brake signal propagation data from Wabtec and data from a BNSF test performed in 2008.

This modeling tool was then used to determine the remaining energy to be dissipated and the speed at selected locations in the train when that tank car reached a defined point specified as the Point of Derailment (POD). By comparing the results for each technology, assumptions were made for the difference in number of cars reaching the point of derailment, remaining kinetic energy of all of the cars in the train at a set time interval, and conditional probability of release (CPR) of the train.

A rough estimate of the conditional probability of release for a train equipped with ECP brakes was calculated as follows. The ratio of the KE of the cars equipped with ECP to that of conventional was determined to be 0.863. The square root of this number represents the ratio of the speed of the all of cars in the ECP train to the conventional train. This ratio is 0.929. Assuming the speed of the conventional train was 50 mph, the calculated speed of the ECP train is 46.5 mph. Using previous work relating train speed to train CPR18 (CPR at 18 mph), the calculated CPR50 (CPR at 50 mph) is 0.48 and the CPR46 (CPR at 46 mph) is 0.45. The ratio of the CPRs is 0.938 resulting is a 6.25% reduction in the CPR. The objective is to reduce the CPR and use of ECP brakes represents the upper limit in the reduction of CPR. In similar analyses industry has considered options resulting in a 20 percent reduction in the CPR to be worthy of further consideration and/or adoption.

Informed by a 2008 FRA rule on ECP,[87] the task force estimated unit costs for ECP to be $4,500 per car for new construction with an overlay (dual-use) system, $5,000 per car for retrofit with an overlay system and $44,000 per locomotive. The group found:

> Based on the simulation results and analysis of the data it was concluded the alternatives considered provided marginal benefits. Moreover the identified obstacles to implementation represent a considerable time and cost investment and the predicted benefits would not be realized for months or years in the future. As such, this working group will not make a recommendation related to alternative brake signal propagation systems.[88]

In the September 6, 2013 ANPRM, PHMSA specifically requested comments pertaining to alternative brake signal propagation systems (ECP, DP, and EOT devices) to reduce the number of cars and energy associated with derailments. In addition, FRA and RSAC have considered and evaluated the usefulness of alternative brake signal propagation systems. As described above, FRA has conducted simulations to better understand the effect on energy dissipation and stopping distance of different brake signal propagation systems.

Alternative 1: No Action Alternative – Status Quo

If the proposed braking requirements are not changed, the damages estimated in the absence of this rulemaking would not be reduced. This alternative would also impose no costs.

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[87] For the FRA final rule, https://www.federalregister.gov/articles/2008/10/16/E8-22549/electronically-controlled-pneumatic-brake-systems

[88] T87.6 Task Force Summary Report, PHMSA-2012-0082-0012, http://www.regulations.gov/#!documentDetail;D=PHMSA-2012-0082-0012

Please note that PHMSA expects all Class I and Class II railroads' HHFTs currently have EOT devices or DP. PHMSA also expects all Class III railroads' HHFTs to either have EOT devices or operate over track with a maximum authorized speed of 30 mph.

Alternative 2: End of Train Devices or Distributed Power, or 30 MPH in all areas

End of Train (EOT) Devices and Distributed Power (DP)

By October 1, 2015 PHMSA would require that every HHFT be equipped with a two way EOT device or DP, or would be required to travel at a speed no greater than 30 mph.

As noted above, PHMSA expects all Class I and Class II railroads' HHFTs currently have EOT devices or DP. Thus, PHMSA estimates no costs or benefits for Alternative 2 for Class I and II railroads.

Also noted above, PHMSA also expects that all of the Class III railroads that operate HHFTs on tracks with a maximum authorized speed in excess of 30 mph have a two-way EOT or DP. Those railroads are likely to be equipped with EOTs to use on trains that do not qualify for at least one of the exceptions to 49 CFR §232.40. Railroads operating over track with a maximum authorized speed of 30 mph would not be affected. Therefore, PHMSA estimates no costs or benefits associated with Alternative 2 for Class III railroads. PHMSA seeks comments on these assumptions.

PHMSA proposes to codify the existing alternative brake propagation system actions described above. For tank car Option 2 (i.e., the AAR 2014 car) and Option 3 (i.e., the modified CPC 1232 Jacketed car), PHMSA proposes Alternative 2 as the only braking requirement. For tank car Option 1 (i.e., the PHMSA and FRA Designed Car, PHMSA proposes Alternative 3, which includes the two-way EOT device or DP requirements of Alternative 2 and adds an ECP braking requirement.

PHMSA does not expect Alternative 2 to differ in effect from Alternative 1, the status quo.

Alternative 3 (applicable to tank car Option 1 only): Alternative 2, plus ECP Brakes

Alternative 3 would have the same two-way EOT device and DP requirements as Alternative 2, and—for the reasons discussed above—PHMSA no costs or benefits these requirements.

In addition, applicable to proposed tank car Option 1 only (i.e., the PHMSA and FRA Designed Car), Alternative 3 would also require a tank car manufactured for use in a HHFT after October 1, 2015, to be equipped with ECP brakes in accordance with subpart G of 49 C.F.R. 232. Further, Alternative 3 would require all tank cars retrofitted to the proposed PHMSA and FRA Designed Car standard to be equipped with ECP brakes. After October 1, 2015, a HHFT comprised entirely of cars meeting the FRA and PHMSA Designed Car standard, except for required buffer cars, must be operated in ECP brake mode or travel at no greater than 30 MPH.

If a train is operated with ECP brake systems, speed restrictions created by this proposed rule would not apply and a train could travel at speeds up to 50 mph.

Electronic Controlled Pneumatic (ECP) Brakes

For the purposes of this analysis, PHMSA is assuming that phase-in of equipment with ECP brakes would begin in 2015. PHMSA believes that within the first year enough tank cars would be available to begin making up a unit train meeting the Option 1 tank car specification and operating with ECP brakes. PHMSA estimates that there are 300 loaded unit trains on the general network at any given time. PHMSA requests comments on this assumption.

Tank Car Costs for ECP Brakes

Within the cost analysis for the Option 1 tank car, in the Tank Car section of the RIA, PHMSA estimated the cost and implementation timing for ECP brake on individual cars. In that section, PHMSA estimated:

- Cost of ECP brakes costs per newly constructed tank car: $3,000
- Cost of ECP brakes costs per retrofitted tank car: $5,000

The cost analysis for the Option 1 car explained the sources for these estimates.

As shown in the cost analysis for the Option 1 tank car, PHMSA assumes that ECP brakes are installed at the time in which a DOT Specification 111 unjacketed of CPC 1232 unjacketed is retrofitted to meet tank car Option 1, or when a new tank car is constructed to meet the Option 1 tank car.

For the 20-year period of analysis, the estimated total cost ECP brakes on tank cars is $422 million, discounted at a rate of 7 percent. This cost can be seen as the difference between the cost of tank car Option 1and tank car option 2, and it is described in the Tank Car section of the RIA.

Locomotive Costs for ECP Brakes

PHMSA estimates that 900 locomotives would be required to be retrofitted ECP brakes, as these trains would be designated unit trains. Class I railroads reported to PHMSA that the costs to retrofit a locomotive would be approximately $79,000. PHMSA assumes that the railroads would retrofit all impacted locomotives in the first year. PHMSA seeks comments on this assumption.

The total cost to retrofit the locomotives with ECP systems would be $71.1 million. As this cost is incurred in the first year it is not discounted.

PHMSA recognizes that other costs, such as the cost to repair ECP, may be incurred, but it does not estimate those costs.

Training Costs for ECP Brakes

There are two parts of training costs. The first cost is the training of the supervisors. These supervisors would then train the engineers and conductors, which is the second cost associated with training.

PHMSA estimates that 7 training classes of supervisors, class size between 25 and 30, would take place at the headquarters of each of the railroads. PHMSA estimates that the training would last 2 weeks, and that each of the trainers would take 2 weeks to prepare for the training sessions. PHMSA assumes the burdened hourly wage rate to be $61.16.[89] The total cost for the trainers would be $68,503.[90] PHMSA assumes that 200 supervisors would be flown into each railroads headquarters for this two week training. The total cost including flight, hotel, taxi, food, and wages would is $7,090 per employee.[91] Assuming that there are 200 supervisors the total cost would be $1.4 million.[92]

The second part of the training would be to train the locomotive engineers and conductors on how to use the ECP brakes.

PHMSA assumes that there would be 150 loaded train sets with crude oil and ethanol. Each haul is between 1,000 and 1,300 miles, requiring crew changes every 130 miles. The trains would need crews trained in ECP brakes for both the loaded and residue side of the trip. PHSMA also estimated that and extra crews would be needed. Therefore each train would require 60 employees (both engineers and conductors) for the full length of the trip. With 150 trains needing 60 employees PHMSA estimates that 9,000 locomotive engineers and conductors would need to be trained.

PHMSA estimates that there are 4,500 locomotive engineers who would need to be trained. These training classes would take place at the local sites in classrooms of 30 employees. These classes would be taught by the supervisors who were recently instructed on how to train the locomotive engineers who report to them. With 4,500 locomotive engineers, there would be approximately 150 classes taught. PHMSA estimates that these training classes would last two

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[89] PHMSA used the 2012 STB's Wage Statistics of Class I railroads to determine the number of Class I railroad employees who would be impacted by the proposed rule. Statement A-300 and the AAR Fact Book provided an employee count to assess the number of impacted railroad employee. PHMSA included all employees from Professional and Administrative and Transportation (Train and Engine). PHMSA incorporated a 75% overhead cost as well. This differs from the 60% overhead cost applied in the classification of mined liquids and gas and the routing sections. This is because BLS wage data includes some benefits while STB data does not. These wages were adjusted in accordance with the "Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses." http://www.dot.gov/regulations/economic-values-used-in-analysis.

[90] [$61.16 (Wage rate)*80 (Hours of training)*7 (Number of classes)]+[61.16 (Wage rate)*80(Hours to prepare for training)*7(Number of trainers)]=$68,503

[91] [12 (Days of the trip) * $100 (Daily hotel room cost)] + [315 (Average Cost of Flight)] + [12 (Days of the trip) * 46(Average per diem)] + [130 (Other transportation costs)] + [80 (Hours of training) * $61.16 (Wage rate)] = $7,090.06

[92] 200 (Number of supervisors) * 7,090.06 (Cost of training) = $1,418,013

weeks. The costs associated with the supervisors to train the locomotive engineers would be $733,960.[93] The proposal requires that all locomotive engineers be trained in order to ensure safe operations of the trains. The cost to train the all locomotive engineers would be $18.0 million.[94]

PHMSA estimates that there are 4,500 conductors who would also need to be trained. Similar to the previously described locomotive engineer training sessions, these would take place at the local sites in classes of 30 employees. These classes would be taught by the supervisors who were recently instructed on how to train the conductors who report to them. With 4,500 conductors, there would be approximately 150 classes taught. PHMSA estimates that these training classes would last two days. The costs associated with the supervisors to train the conductors would be $146,792.[95] The proposal requires that all conductors be trained in order to ensure safe operations of the trains. The cost to train the all conductors would be $3.6 million.[96]

For the 20-year period of the analysis, the estimated total cost associated with the training of engineers and conductors on how to operate ECP brakes would be $24.0 million. As this cost is incurred in the first year it is not discounted.

PHMSA assumes that any additional future training required for ECP would be tied into the current training programs and would therefore have minimal costs.

Summary of Costs

Table B1 below summarizes the individual costs and assumptions for Alternative 3. PHMSA seeks comments on all costs and assumptions presented in this section.

The benefits presented this section represent 100 percent of the costs of ECP braking requirements, including the $422 million attributed to the ECP requirement for tank cars. As mentioned, this $422 million is also accounted for in the cost analysis for the Option 1 tank car, in the Tank Car Section of the RIA. Thus, it must be emphasized that adding the ECP benefits from the Option 1 tank car benefits analysis section to the benefits presented here would result in a double-counting of benefits.

Table B1: ECP Braking Costs HHFTs with Option 1 Tank Car

Variable	Formula/Input	Source
Total Number of Existing Locomotives in HHFT Service Without ECP Brakes	900	DOT Estimate
Cost of ECP, Per Locomotive	$79,000	DOT Estimate
Cost of ECP, Per Retrofitted Car (included in retrofit cost of PHMSA and FRA Designed Car standard)	$5,000	DOT Estimate

93 150 (Number of classes) * 80 (Hours of training) * $61.16 (Wage rate) = $733,960
94 4,500 (Number of engineers) *80 (Hours of training) * $49.97 (Wage Rate) = $17,987,815
95 150 (Number of classes) * 16 (Hours of training) * $61.16 (Wage rate) = $146,792
96 4,500 (Number of conductors) *16 (Hours of Training) * $49.97 (Wage Rate) = $3,597,563

Table B1: ECP Braking Costs HHFTs with Option 1 Tank Car		
Variable	Formula/Input	Source
Cost of ECP, Per New Car (included in incremental cost of PHMSA and FRA Designed Car standard)	$3,000	DOT Estimate
Number of New Class I Locomotives Entering HHFT Service, 2015-2034	None	DOT Estimate
Cost of ECP Training for Supervisors in Year 1	$1,400,000	DOT Estimate
Cost of ECP Training for Engineers in Year 1	$18,400,000	DOT Estimate
Cost of ECP Training for Conductors in Year 1	$3,700,000	DOT Estimate
Costs of ECP All Training in Years 2-20	None	DOT Estimate
Costs of the 30 MPH Speed Limit for HHFT, with All ECP-Equipped Tank Cars, Not Operating in ECP Brake Mode	None	DOT Estimate
Cost of ECP Brake Repairs	Not estimated	DOT Estimate
Cost of Factory Expansion to Accommodate Demand Growth for ECP Brakes	Not estimated	DOT Estimate
Cost of ECP for buffer cars	None	DOT Estimate

For the 20-year period of the analysis, the estimated total cost associated with the implementation and training related to ECP brake system locomotives would be $95.1 million ($71.1 million for locomotives and $24.0 million for training).

Including the cost for tank cars, for the 20-year period, discounted at 7 percent, the estimated total cost associated with the ECP braking requirements for Alternative 3 be $510.8 million.

Safety Benefits of ECP Brakes

PHMSA finds ECP brakes would reduce the damages associated with HHFT accident. Benefits include both reductions in property damage caused as well as the number of fatalities and/or injuries.

As described in the analysis of the Option 1 tank car, within the Tank Car Section of the RIA, FRA research indicates that DP and two-way EOT devices reduce kinetic energy an average of 18 percent compared to conventional braking. PHMSA and FRA believe all trains hauling large volumes of flammable liquids are currently equipped with either two-way EOT or DP. As noted throughout this RIA, PHMSA and FRA believe all HHFTs are currently equipped with either two-way EOT or DP, or would be going 30 mph.

ECP results in substantially greater reductions in kinetic energy reduction than EOT or DP. FRA research suggests an additional 18 percent marginal improvement over EOT and DP. We use this effectiveness to estimate the benefits that would result from deployment of ECP braking on unit trains of flammable liquid. PHMSA will place into the docket for this rulemaking a technical supplement that describes the model inputs and assumptions that were used to develop the effectiveness rates for each brake option.

To derive benefits, the estimated damages in the absence of this rule are multiplied by the percentage of cars equipped with ECP brakes in each year and by the effectiveness of ECP braking compared to alternative brake signal propagations systems such as EOT or DP, which as noted is 18 percent.

Please note that the benefits of the Option 1 tank car also accounts for some of the benefits of ECP braking. Roughly 80 percent of the costs of deploying ECP braking are the costs of equipping tank cars with ECP equipment. In the benefits analysis for the Option 1 tank car, PHMSA multiplies damages by .8 x .18 = .144 x the percentage of the fleet that is ECP equipped to generate estimated benefits that it attributes to tank cars. It should be noted that equipping trains with ECP capability requires that equipment be installed on both the cars and locomotives in the train, and this analysis assumes that the percentage of the tank car fleet meeting the tank car Option 1 is equal to the percentage of HHFT operating in ECP brake mode.

The benefits presented this section represent 100 percent of the benefits of ECP braking requirements, including the 80 percent of benefits attributed to the ECP requirement for tank cars (as described in the Tank Car section of the RIA). It must be emphasized that adding the ECP benefits from tank car Option 1 benefits analysis section, from the Tank Car Section of the RIA, to the benefits presented here would result in a double-counting of benefits.

Table B2 below summarizes the estimates used in the benefits analysis for Alternative 3. PHMSA seeks comments these estimates.

Table B2: ECP Braking Benefits HHFTs with Option 1 Tank Car

Variable	Formula/Input	Source
Percentage of HHFT with Two-Way EOT Devices or DP Prior to ECP Installation, or Operating at 30 MPH	100%	DOT Estimate
Marginal Effectiveness (or Risk Reduction), DP Relative to Two-Way EOT Devices	None	DOT Estimate
Marginal Effectiveness (or Risk Reduction), ECP Brakes Relative to Two-Way EOT Devices or DP	18%	Sharma and Associates, Train Energy & Dynamics Simulator
Percentage of HHFT in ECP Brake Mode in 2016	19%	DOT Estimate, Based on Percentage of Fleet Meeting PHMSA and FRA Designed Car Standard
Percentage of HHFT in ECP Brake Mode in 2017	42%	DOT Estimate, Based on Percentage of Fleet Meeting PHMSA and FRA Designed Car Standard
Percentage of HHFT in ECP Brake Mode in 2018	71%	DOT Estimate, Based on Percentage of Fleet Meeting PHMSA and FRA Designed Car Standard
Percentage of HHFT in ECP Brake Mode, 2019-2034	87%	DOT Estimate, Based on Percentage of Fleet Meeting PHMSA and FRA Designed Car Standard

Business Benefits of ECP Braking

ECP braking systems also have additional potential operational and safety benefits. In 2008, FRA issued a final rule permitting the use of ECP brake systems. In an accompanying analysis, FRA found that ECP brakes offered major benefits in train handling, car maintenance, fuel savings, and network capacity under the operating conditions present in that timeframe. ECP brake use could also significantly enhance rail safety in ways beyond reducing the severity of derailments. The safety benefits of ECP brakes include: fewer and less-severe collisions with obstacles on the railroad, including vehicles stuck on grade crossings; fewer and less-severe train-to-train collisions; reduced chances of runaway trains; and fewer train-handling accidents, including derailments.

Compared with the potential performance of ECP brakes, conventional braking systems contribute to greater in-train forces, more complex train handling, longer stopping distances, and safety risks of prematurely depleting air brake reservoirs. Traditional train-handling procedures require anticipating draft (pulling) and buff (compressive) forces within the train, particularly on hilly terrain; and any misstep can result in derailment. Conventional braking systems are very complex and subject to failure, which is a maintenance challenge and a safety concern. Conventional brakes can also stop functioning on individual cars en route without the locomotive engineer being aware of it. These challenges and concerns are greatly reduced in the ECP brake mode of operation, during which all cars brake simultaneously by way of an electronic signal. ECP brake systems simultaneously apply and release freight car air brakes through a hardwired electronic pathway down the length of the train, and allow the engineer to “back off” or reduce the braking effort to match the track grade and curvature, without having to completely release the brakes.

These differences in the operation of the two braking systems give ECP brakes several business benefits. Operationally, ECP brakes have the potential to save fuel and reduce emissions, reduce wear and stress on wheels and brake shoes, and provide train engineers greater control on the braking characteristics of trains. From a safety perspective, ECP brakes greatly reduce the risk of runaway trains, and reduce the probability of an incident by providing 40 to 60 percent shorter stopping distances. ECP brake wiring also provides the train a platform for the gradual addition of other train-performance monitoring devices using sensor-based technology to maintain a continuous feedback loop on the train’s condition for the train crew.

The safety benefits of ECP brakes are included in the general benefits analyzed and accounted for above. The 2008 analysis accounted for four categories of benefits (three categories of safety benefits and one category of business benefits). The safety benefits included reductions in costs of highway-rail grade crossing accidents, reductions in costs of train and equipment accidents, and reductions in environmental and clean-up costs. Those benefits are already accounted for. The analysis above does not, however, account for business benefits.

Of the business benefits identified in the 2008 analysis, PHMSA is including in this analysis a subset of those benefits, adjusted as shown in tables below. The benefits are adjusted for differences in application and scale, differences in cost levels, and differences in fuel efficiency. PHMSA assumes that all train related benefits will accrue at 100 percent once brakes have been installed on all HHFTs by year 2018 and thereafter PHMSA assumes that one-third of the HHFT fleet will be equipped with ECP brakes in 2016, two-thirds in 2017, and all of the fleet in 2018 and subsequent years.

Assumptions used below include an assumption there will be 900 locomotives, three each in 300 sets, 100 trailing cars behind each set of locomotives, and that each train will travel an average of 220 miles per day. The 900 locomotives assumption is based on industry projections; the assumption there will be three locomotives in a train is based on industry practice observed by FRA staff and the number of loaded trains, 150, needed to haul the peak carloads in HHFTs. The assumption that an average train has 100 cars is based on observations of FRA and PHMSA field staff. FRA staff with experience in train operations, and data from waybills indicate that unit trains are likely to operate an average of 220 miles per day. FRA and PHMSA believe that with restrictions on trains not equipped with ECP brakes, railroads are likely to move as great a proportion of their HHFTs as possible in ECP equipped unit trains.

Train Velocity

In 2008, FRA calculated benefits from improved train velocity. PHMSA assumes that operators will derive no business benefit from improved train velocity because the proportion of trains expected to be equipped with ECP brakes is relatively small. Just a handful of equipped trains on any given line are unlikely to affect overall train velocity.

Set-Out Relief

Under the 2008 rule, trains equipped with ECP were given relief from set-out requirements. The benefit of set-out relief was described the analysis:

> Additional regulatory flexibility is provided by the rule. The removal of equipment with defective or inoperative brakes en route, known as set-outs, is eliminated. The defective equipment is permitted to remain in the train consist to destination, not to exceed 3,500 miles. ECP brake systems monitor in real time the health of the train's brake system, thus eliminating the safety concern that exists in conventionally-braked trains. Locomotive engineers operating trains equipped with ECP brakes have the ability to monitor the condition and the location of defective or inoperable brakes. ECP brake-equipped trains are not required to stop and set out a defective car. FRA requested and received comments and information on the cost per set-out. The AAR provided comments on the cost per set-out ($400) and the quantity of set-outs (10 percent). While FRA agrees that the original set-out percentage was high, the 10 percent long-haul train figure offered by AAR is too low. This figure does not address the extended mileage that the rule permits ECP brake trains to travel (3,500 miles versus 1,000 miles). FRA estimates, on average, 20 percent of trains must stop en route for one set-out due to the increased length of haul of ECP brake trains. FRA accepts the $400 figure provided by the AAR for the cost of a set-out. The number of ECP brake-equipped trains annually, as estimated above, is 178,071 + 14,000 unit trains = 192,071 trains per year. Approximately, half of these trains will likely avoid one set-out valued at $400 each.

For purposes of this analysis, there is no reason to increase the value of avoided set-outs from 10 percent to 20 percent, because only about half of set-outs are related to brake issues, so the value from the original analysis is halved. For example, a car may need to be set out because of a defective hand hold, and the likelihood of such a set-out is not affected by the presence of ECP brakes. In this analysis FRA assumes one brake caused set out avoided on 10 percent of 1,000 miles trips or one brake induced set-out avoided for every 10,000 miles of unit train travel. To update the numbers from 2008 to 2014, PHMSA used labor cost index values reported by AAR to the STB because the primary cost of a set-out is employee time. In Q2 2014 Class I railroads reported their labor cost index to be 388.1, and they had reported the labor cost index in Q2 2008 to have been 313.6. The ratio is 1.2376, which when multiplied by the 2008 estimate of $400, yields a 2014 estimate of $495.

PHMSA estimates that when all ECP locomotives have joined the fleet, each set of locomotives will operate 220 miles per day, 360 days per year, for a total of 79,200 miles per year. PHMSA estimates that 900 locomotives will be equipped, and that unit trains will require three locomotives each, thus there will be 300 sets, operating a total of 23,760,000 miles per year. If one set-out is avoided every 10,000 miles, these sets will avoid 2,376 set-outs a year, for an annual savings of $1,176,181 at full installation. PHMSA also increased the estimated real cost each year after 2014 to account for increased real wages, which are estimated to grow at 1.18 percent per year from the base year of 2015.[97] There is no reason to believe that the labor hours required for setting out a car will decrease because of improved productivity. As discussed above, PHMSA estimates one-third of full benefit in 2016, two-thirds of full benefit in 2017 and full benefit from 2018 onward.

			Discounted Value	
	Wage		Discount Factor	
Year	Inflator	Benefit	7%	3%
2015	101.18%	0	$0	$0
2016	102.37%	$401,367	$350,570	$378,327
2017	103.58%	$812,207	$663,003	$743,285
2018	104.80%	$1,232,687	$940,411	$1,095,226
2019	106.04%	$1,247,232	$889,259	$1,075,874
2020	107.29%	$1,261,950	$840,890	$1,056,863
2021	108.56%	$1,276,841	$795,152	$1,038,188
2022	109.84%	$1,291,907	$751,902	$1,019,844
2023	111.14%	$1,307,152	$711,004	$1,001,823
2024	112.45%	$1,322,576	$672,331	$984,121
2025	113.77%	$1,338,183	$635,761	$966,732

[97] These wages were adjusted in accordance with the "Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses." http://www.dot.gov/regulations/economic-values-used-in-analysis.

2026	115.12%	$1,353,973	$601,180	$949,650
2027	116.47%	$1,369,950	$568,481	$932,869
2028	117.85%	$1,386,116	$537,560	$916,386
2029	119.24%	$1,402,472	$508,320	$900,193
2030	120.65%	$1,419,021	$480,672	$884,287
2031	122.07%	$1,435,765	$454,527	$868,662
2032	123.51%	$1,452,707	$429,804	$853,313
2033	124.97%	$1,469,849	$406,426	$838,235
2034	126.44%	$1,487,194	$384,319	$823,423
Total			$11,621,571	$17,327,300

The total discounted value of this benefit is $11,621,571 at 7 percent and $17,327,300 at 3 percent.

Single Car Air Brake Test (SCABT) Relief

The item shown as "Single Brake Test" in the table below was described in the 2008 analysis:

> The [2008] rule also modifies periodic maintenance requirements, including certain SCABTs, in order to tailor the requirements more specifically for ECP brake systems. Due to the ECP brake system's ability to continuously monitor the condition of a car's air brakes, FRA believes that less frequent SCABTs are justified on ECP brake equipment. Railroads may retrofit ECP brake systems on existing cars equipped with conventional pneumatic brake systems. Accordingly, the performance of a SCABT is required prior to returning the car to revenue service after the application of the ECP brake system. This is already required when installing a new brake system, thus the cost of this test is not avoided with ECP brake systems. However, the self-monitoring capabilities of ECP brake systems may extend the time period to perform SCABTs. This would reduce the number of single car tests that must be performed on cars equipped with ECP brakes. Freight cars with conventional brakes receive a SCABT every time they are on the repair track if they haven't received one within the past 12 months. It has been estimated by the AAR that more than 99 percent of cars are on a repair track every 2 years. FRA estimates the benefits of SCABT avoidance once at the beginning of a five year period coinciding with the ECP brake installation rate, and once every 5 years thereafter. This estimate is conservative, and it is possible that these cars may avoid up to 2.5 SCABTs every 5-year period. Because this estimate is so conservative, this benefit is taken at the beginning of the 5-year period. The cost of the SCABT is either $89.22 for a manual test or $100.85 for an instrument test. FRA used the average value of these two tests, $95.04, to calculate this benefit.

The exception for ECP-equipped cars to avoid SCABTs when they are on a shop or repair track does not apply to dual mode ECP brake systems under 49 CFR §232.611(f). Dual mode systems can operate either in a conventionally equipped train with standard air brakes or in an ECP equipped train. PHMSA believes all affected tank cars will be equipped with dual mode systems, not standalone systems, because the railroads will need the flexibility to haul the cars in trains not equipped with ECP, whether moving them for repairs, or hauling commodities in a train not equipped with ECP brakes, perhaps because a short haul is involved, or the car has been shifted into service carrying a commodity not affected by the proposed rule. Thus, there is no benefit estimated for this provision.

Class I and Class IA Brake Test Relief

The 2008 analysis described the benefits of relief from "Class I and Class IA Brake Tests" requirements:

> The rule allows ECP brake-equipped trains to travel to their destination, not to exceed 3,500 miles. Extended haul and other trains are currently limited to 1,500 miles and 1,000 miles, respectively, between brake inspections. Thus, the rule will eliminate, conservatively, at least one Class I brake test or two Class IA brake tests on a long distance train equipped with ECP brakes, depending on current operations. The long-haul, unit, and unit-like trains are assumed to convert to ECP brake systems. Trains with conventional brakes that meet FRA's extended haul requirements are given 1,500 miles between intermediate terminal brake inspections. These requirements limit the number of times an extended haul train on extended haul can pick up or set out cars en route, and impose additional recordkeeping. Many long-haul unit trains are extended haul trains. FRA estimates that there are 40,000 extended haul trains that operate each year.
>
> The single largest cost savings in the brake inspection category is expected to be the elimination of the 1,000-mile intermediate terminal brake test (Class IA test) for trains operating in the ECP brake mode. Under current regulations, conventionally-braked trains are required to stop at a terminal for inspection every 1,000 miles, where the brakes on each car are inspected to determine whether they are fully functioning.
>
> With ECP brake systems, there is constant wire-based monitoring of the brake condition on all cars and hence a reduced need to stop and physically inspect the brakes every 1,000 miles after initial terminal departure. More than 10 years ago, the AAR calculated the cost of the intermediate brake test (Class IA) to be $450 per train, including both the direct cost of the inspection and delay costs of setting out or repairing defective equipment when identified. To reflect current costs as confirmed in the Booz Allen Hamilton98 report, FRA assumes that this cost is at least 10 percent greater 10 years later, or $500 per train. The Class I test is substantially more involved than the Class IA test and is estimated to cost $1,000 per train. Trains operating under the extended haul provisions, estimated at

[98] FRA commissioned a report by Booz Allen Hamilton (BAH) to describe a path to ECP brake implementation. A copy of this report has been placed in the public docket to this rulemaking at Docket Number FRA-2006-26175

40,000 trains each year, must receive a Class I test at the beginning of the extended haul segment and a Class I test at the end of the Class I segment if the train goes further than 1,500 miles. Thus, a train that travels more than 1,500 miles and uses the extended haul provision would receive two Class I tests ($2,000). With ECP brakes, the same train would only receive a Class I test at initial terminal, which would permit it to travel to 3,500 miles, or to its destination. A cycle train is a train that operates in a continuous loop(s), without a specific destination, that requires a Class IA test at a location not to exceed 1,000 miles. Every 3,000 miles, a cycle train must receive a Class I test. Many cycle trains are used in coal service, which will implement ECP brakes. With ECP brakes, the Class I test is still required, but two Class I A tests are eliminated. There are approximately 14,000 cycle trains that operate each year that are estimated to receive relief from two Class IA brake tests ($1,000).

Using the AAR Fact Book, the Freight Commodity Statistics, waybill data, and information provided by one Class I carrier, FRA estimates that approximately 178,071 trains travel more than 1,000 miles to destination and 88,045 (including the 40,000 extended haul trains) travel more than 1,500 miles to destination each year. Of these trains, approximately 25 percent operate over 2,000 miles and thus will receive relief from two Class IA brakes tests (2 X $500 = $1,000). Since extended haul trains are not required to have any Class IA brake tests they would not benefit from this relief.

As described above, PHMSA assumes that ECP equipped trains will travel 23,760,000 miles per year. PHMSA assumes that ECP equipped trains will function as cycle trains, running as a unit, at least from the point at which the trains are assembled, and often on a longer term basis from the point at which they are loaded, to the destination, typically a refinery, and back to the original assembly point or loading facility. PHMSA further assumes that each train will avoid 2 Class IA brake tests every three thousand miles, or 15,840 brake tests per year. The value per brake test, $500 is updated to 2014 values using the same multiplier for labor costs, 1.2376, yielding a savings per test of $618.78. Because this estimate is based on data from 1998 that is updated only to account for inflation (as measured by wage growth since this primarily a labor function, and there is no reason to assume that the hours of labor required to perform a brake test will be reduced by increased productivity), PHMSA seeks comment on this. Avoiding 15,840 tests per year will save $9,801,505. Savings will accrue at one-third of full value in 2016, two-thirds of full value in 2017 and full value starting in 2018.. This number largely represents wage costs, and is increased by a real factor of 1.18 percent per year past 2014. PHMSA estimates one-third of full benefit in 2016, two-thirds of full benefit in 2017 and full benefit from 2018 onward.

			Discounted Value	
			Discount Factor	
Year	Wage Inflator	Benefit	7%	3%
2015	101.18%	-	$0	$0
2016	102.37%	$3,344,728	$2,921,415	$3,152,727
2017	103.58%	$6,768,393	$5,525,024	$6,194,038

2018	104.80%	$10,272,389	$7,836,757	$9,126,885
2019	106.04%	$10,393,604	$7,410,496	$8,965,614
2020	107.29%	$10,516,248	$7,007,420	$8,807,192
2021	108.56%	$10,640,340	$6,626,269	$8,651,570
2022	109.84%	$10,765,896	$6,265,849	$8,498,698
2023	111.14%	$10,892,933	$5,925,034	$8,348,526
2024	112.45%	$11,021,470	$5,602,756	$8,201,009
2025	113.77%	$11,151,523	$5,298,008	$8,056,098
2026	115.12%	$11,283,111	$5,009,836	$7,913,747
2027	116.47%	$11,416,252	$4,737,339	$7,773,912
2028	117.85%	$11,550,964	$4,479,663	$7,636,548
2029	119.24%	$11,687,265	$4,236,003	$7,501,611
2030	120.65%	$11,825,175	$4,005,596	$7,369,058
2031	122.07%	$11,964,712	$3,787,721	$7,238,847
2032	123.51%	$12,105,896	$3,581,698	$7,110,938
2033	124.97%	$12,248,745	$3,386,880	$6,985,288
2034	126.44%	$12,393,280	$3,202,659	$6,861,859
Total			$96,846,424	$144,394,164

Wheel Savings

"Wheel Savings" were described in the 2008 analysis:

> Wheels are but one component of a freight car that could provide maintenance savings under ECP brake operation. Wheel damage is reduced due to more uniform braking and better train handling. One of the ways in which ECP brakes contribute to a reduction in premature wheel wear is by lowering the average brake friction temperature on the wheels through more consistent braking. Excessive buildup of heat in the wheels is a major contributor to wheel failure. The industry expenditure on wheel replacements warrants singling them out as a significant benefit of conversion to ECP brake systems. A recent study by the TTCI found that the rail freight industry spends 37 percent of its annual freight car repair cost of $1.5 billion on wheel replacements—representing $555 million. These data are for calendar year (CY) 2000, and the costs are undoubtedly higher now. Wheelsets need to be replaced because they are either worn out or damaged. Brake-related failures were found to reduce the life of wheelsets by more than 50 percent.
>
> Per wheelset replacement costs are now at least $1,250 and could range as high as $1,500. Using the lower end of this range ($1,250), the resulting 25 percent increase in per unit wheel replacement costs translates into a conservative estimate of $700 million in annual wheel repair expenditures, when applied to the CY 2000 data. Assuming that ECP brakes would eliminate half of all brake-related wheel defects, this would translate into $175 million annually for the

entire freight car fleet. Heavy-haul, high-mileage cars would account for a disproportionately high share of these savings. Using the same adjustment of 61 percent for ECP brake-related savings, the annual savings for the entire fleet of $175 million (.61) = $106,750,000. The 20-year wheel savings discounted at 7 percent equals $714,495,572.

PHMSA assumes that wheel replacement cost in freight cars is proportional to their mileage. PHMSA uses locomotive numbers as a surrogate for share of total miles. PHMSA estimates there will be 900 locomotives out of an industry wide fleet of 24,250 mainline locomotives, or 3.71 percent. If the industry wide cost of wheelset replacement was $555 million in year 2000, the cost for 3.71 percent of the fleet would be $20,412,371. Since brake-related failures account for only half of wheelset life reduction, the addressable pool is $10,206,186. Saving half of that would save $5,103,093 per year. This number needs to be adjusted for labor costs because the cost of a wheelset replacement is primarily employee labor. The labor index for Q2 2000 was 242.6, while the 2014 value was 388.1. The ratio, used here as a multiplier, is 1.598. Taking the value for the 900 locomotives, $5,103,093 per year, and multiplying it by 1.598, yields an annual expected value of $8,156,962 at full performance, expected in 2018. Although these values are largely labor costs, unlike other costs, PHMSA believes that shop labor costs subject to real wage growth are also subject to offsetting increases in productivity, so they are not multiplied by an annual real wage growth factor. PHMSA estimates one-third of full benefit in 2016, two-thirds of full benefit in 2017 and full benefit from 2018 onward.

		Discounted Value	
		Discount Factor	
Year	Benefit	7%	3%
2015	0	$0	$0
2016	$2,718,987	$2,374,869	$2,562,906
2017	$5,437,974	$4,439,007	$4,976,517
2018	$8,156,962	$6,222,907	$7,247,355
2019	$8,156,962	$5,815,801	$7,036,267
2020	$8,156,962	$5,435,328	$6,831,327
2021	$8,156,962	$5,079,746	$6,632,356
2022	$8,156,962	$4,747,426	$6,439,181
2023	$8,156,962	$4,436,847	$6,251,632
2024	$8,156,962	$4,146,586	$6,069,546
2025	$8,156,962	$3,875,314	$5,892,763
2026	$8,156,962	$3,621,789	$5,721,129
2027	$8,156,962	$3,384,849	$5,554,494
2028	$8,156,962	$3,163,410	$5,392,713
2029	$8,156,962	$2,956,458	$5,235,643
2030	$8,156,962	$2,763,045	$5,083,149
2031	$8,156,962	$2,582,285	$4,935,096

2032	$8,156,962	$2,413,351	$4,791,355
2033	$8,156,962	$2,255,468	$4,651,801
2034	$8,156,962	$2,107,914	$4,516,312
Total		$71,822,399	$105,821,542

Fuel Savings

In the 2008 analysis, fuel savings were calculated as a proportion of fuel used. This remains a reasonable assumption today, because even though locomotives use fewer gallons per ton-mile, braking still improves fuel efficiency by 5 percent[99]; therefore, improved braking still improves fuel efficiency by 5 percent of the new fuel consumption rate. A simple way to account for both factors at one time is to estimate the total expenditure on fuel, and then calculate the fuel savings assuming that ECP brakes will continue to save the same percentage of fuel. Class I railroads spent $3,202,554,000 on fuel in Q2 2014, or an annual rate of $12,810,216. PHMSA estimates that 900 locomotives will be affected of out of a potential fleet of 24,250, and PHMSA assumes that these locomotives use fuel in proportion to their share of the total locomotive fleet. Thus the fuel expenditure total is multiplied by 900/24,250. The estimated quarterly fuel use of the 900 locomotives, is $475,430,697. The savings from ECP Brakes would be 5 percent of $475,430,697, or $5,942,884 per quarter, or $23,771,535 per year. This savings might be greater if the added weight of the enhanced tank cars causes more fuel use, but PHMSA is not certain that fuel use will increase, because aerodynamic effects may offset increases in weight. Therefore, the measure of ECP induced fuel savings does not take into account the impacts of increased weight, which assumption, when used to estimate business benefits, is a conservative assumption. This savings is not adjusted for any changes in real wages, and accrues at full value beginning in year 2020. PHMSA estimates one-third of full benefit in 2016, two-thirds of full benefit in 2017 and full benefit from 2018 onward.

		Discounted Value	
		Discount Factor	
Year	Benefit	7%	3%
2015	0	$0	$0
2016	$7,923,845	$6,920,993	$7,468,984
2017	$15,847,690	$12,936,436	$14,502,881
2018	$23,771,535	$18,135,190	$21,120,701
2019	$23,771,535	$16,948,776	$20,505,535
2020	$23,771,535	$15,839,977	$19,908,286
2021	$23,771,535	$14,803,717	$19,328,433
2022	$23,771,535	$13,835,250	$18,765,469
2023	$23,771,535	$12,930,140	$18,218,902

[99] 'Benefit-Cost Analysis and Implementation Plan for Electronically Controlled Pneumatic Braking Technology in the Railroad Industry,' Booz Allen Hamilton, August 2006, p. III-2.

2024	$23,771,535	$12,084,243	$17,688,254
2025	$23,771,535	$11,293,685	$17,173,063
2026	$23,771,535	$10,554,846	$16,672,876
2027	$23,771,535	$9,864,342	$16,187,259
2028	$23,771,535	$9,219,011	$15,715,785
2029	$23,771,535	$8,615,898	$15,258,044
2030	$23,771,535	$8,052,241	$14,813,635
2031	$23,771,535	$7,525,459	$14,382,170
2032	$23,771,535	$7,033,139	$13,963,271
2033	$23,771,535	$6,573,027	$13,556,574
2034	$23,771,535	$6,143,016	$13,161,722
Total		$209,309,387	$308,391,844

Total ECP business benefits

PHMSA totaled all the discounted benefits in the table below:

	Discounted Value	
	Discount Factor	
Benefit	7%	3%
Set Out Relief	$11,621,571	$17,327,300
Class IA brake test	$96,846,424	$144,394,164
Wheel Savings	$71,822,399	$105,821,542
Fuel Savings	$209,309,387	$308,391,844
Total	$389,599,781	$575,934,850

The table below presents total estimated benefits and costs for ECP braking, including both safety benefits and business benefits as a stand-alone provision. The reader is reminded that the Option 1 tank car benefits also include a portion of the ECP benefits, so adding the figures in this section to the benefits of that section would amount to double counting a portion of the ECP benefits.

20 Year Benefits, Costs and Net Benefits for Stand Alone ECP Braking Requirements, 7 % Discount Rate		
	Baseline - 0 High Consequence Events	**10 High Consequence Events***
Benefits (Safety + ECP Business)	$737,319,993	$1,758,551,715
Costs	$500,189,377	$500,189,377
Net Benefits	$237,130,616	$1,258,362,339
* 1 event of the 10 assumed to be 5x the average high consequence event in magnitude		

PHMSA seeks comments on the benefits estimated in this section.

Requirement Area 5– Classification of Mined Liquids and Gases

Proposed Action for Classification of Mined Liquids and Gases

Any improper classification of crude oil and subsequent shipment in an unauthorized tank car diminishes industry efforts to improve the safety of transporting hazardous materials, and violates the requirements of the HMR. The proper classification of a hazardous material is a key requirement under the HMR, as it dictates exactly which other requirements apply, such as specific operational controls and proper packaging selection. Classification is simply ensuring that the proper hazard class and packing group (if applicable) have been assigned to a particular material. Characterization is a complete description of the properties of the material during the transportation cycle. Characterization includes the identification of the effects that a material has on both the reliability and safety of the packaging. Proper classification and characterization is especially important when dealing with a material such as mined liquids and gases, including crude oil, as these materials are variable. The characterization of crude oil may vary greatly depending on time, temperature, and the methods used to extract and process the material. In contrast, the classification and characterization of manufactured products is generally well understood and consistent.

Improper classification and characterization can also affect operational requirements under the HMR. Offerors and carriers must ensure that outage is considered when loading a tank car. Section 173.24b(a) of the HMR sets the minimum tank car outage for hazardous materials at one percent at a reference temperature that is based on the existence of tank car insulation. A crude oil offeror must know the specific gravity of the hazardous material at the reference temperature as well as the temperature and specific gravity of the material at that temperature when loaded. This information is then used to calculate the total quantity that can be safely loaded into the car to comply with the one percent outage requirement. If the outage is not properly calculated because the material's specific gravity is unknown (or is provided only as a range), the tank car could be loaded such that if the temperature increases during transportation, the tank will become shell-full, increasing the likelihood of a leak from the valve fittings or manway.

The proposed sampling and testing program is intended to ensure that:

(1) the proper regulatory requirements are applied to each shipment to minimize the risk of incident;
(2) first responders have accurate information in the event of a train accident; and
(3) the characteristics of the material are known and fully considered so that offerors and carriers are aware of and mitigate and potential threats to integrity of rail tank cars.

Determination of Need

Under § 173.22 of the HMR, it is the offeror's responsibility to properly "class and describe the hazardous material in accordance with parts 172 and 173 of the HMR." A hazardous material must be classified in accordance with the appropriate hazard class definitions included in Part 173 of the HMR. Once an offeror has determined the hazard class of the material, the offeror must select the most appropriate shipping name from the § 172.101 Hazardous Materials Table (HMT).

Relevant properties to properly classify mined liquids and gases include, but are not limited to the following: flash point; boiling point; corrosivity; specific gravity at loading; reference temperatures; and the presence and concentration of specific compounds such as sulfur. This information enables an offeror to properly classify a hazardous material, select the most appropriate shipping description, and the proper HMR-authorized packaging for transportation of that hazardous material. Proper classification and characterization is especially important when dealing with a material such as mined liquids and gases, including crude oil, as these materials' properties are variable. Such information and determination of the authorized packaging also ensures that the required tank car outage, or unfilled capacity, can be maintained in accordance with § 173.24(b).

Crude oil transported by rail is often derived from different sources and is then blended, complicating proper classification and characterization of the material. PHMSA and FRA audits of crude oil loading facilities indicate that the classification of crude oil being transported by rail is often based solely on a generic Safety Data Sheet (SDS). The data on these sheets only provides a material classification and a range of material properties. This SDS information is typically provided by the consignee (the person to whom the shipment is to be delivered) to the offeror. In these instances, it is possible that there has been no validation of the crude oil properties. Further, FRA's audits indicate that SDS information is often not assembled from any recently conducted tests or from testing for the many different sources (wells) of the crude oil.

In the rail environment, it is critical that the existence and concentration of specific elements or compounds be identified, along with the corrosivity of the materials to the tank cars and service equipment. Proper identification of these elements will enable a shipper to ensure the reliability of the tank car. Proper identification also enables a shipper to determine if there is a need for an interior coating or lining, alternative materials of construction for valves and fittings, and performance requirements for fluid sealing elements, such as gaskets and o-rings.

In addition, recommendation R-14-6, issued by the NTSB, recognized the importance of sufficient testing and documentation of the physical and chemical characteristics of hazardous materials to ensure the proper classification, packaging, and record-keeping of products offered in transportation. Correct classification decisions are essential for the selection of proper equipment (tank, service equipment, interior lining or coating) and use, or maintenance and qualification of the equipment. The statement on a shipping paper is the offeror's certification that a hazardous material, is properly classified, described, packaged, marked and labeled, and in proper condition for transportation according to the applicable regulations of DOT. Packaging decisions are based on the information provided by the offeror. Incorrect classification and characterization of hazardous material may lead to failures throughout the transportation system.

Alternatives for Classification of Mined Liquids and Gases

Alternative 1: No Action Alternative– Status Quo

The industry would continue the status quo and sample the material based on the existing classification and characterization methods. Rail derailment and accidents involving crude oil shipments that have been improperly classified may create potential risks for emergency responders.

Alternative 2: Require sampling and testing program

Under this alternative, PHMSA would require a documented sampling and testing plan for shippers of mined gases and liquids in commerce. This plan would enable PHMSA and shippers of this commodity to more easily ascertain the specific classification and characteristics of the commodity and help to minimize potential risks when responding to a derailment and accident. In Recommendation R-14-6 the NTSB recognized the importance of sufficient testing and documentation of the physical and chemical characteristics of hazardous materials. The testing and sampling plan is required to address the following areas:

- Frequency of sampling and testing to account for variability of the material, including the time, temperature, means of extraction (including any use of a chemical), and location of extraction;
- Sampling at various points along the supply chain to understand the variability of the material during transportation;
- Sampling methods that ensure a representative sample of the entire mixture, as packaged, is collected;
- Testing methods to enable complete analysis, classification, and characterization of the material under the HMR;
- Statistical justification for sample frequencies;
- Duplicate samples for quality assurance purposes; and
- Criteria for modifying the sampling and testing program.

Proposed § 173.41(c) would require that the sampling and testing program be documented in writing and retained for as long as it remains in effect. The proposed requirement specifies that the sampling and testing program must be reviewed annually, at a minimum, and revised and/or updated as necessary to reflect changing circumstances.

Proposed § 173.41(d) would mandate that each person required to develop and implement a sampling and testing program must maintain a copy of the sampling and testing program documentation (or an electronic file thereof) that is accessible at, or through, its principal place of business and must make the documentation available upon request, at a reasonable time and location, to an authorized official of DOT.

Costs

First Year - Development and Implementation

The costs are attributed to the time cost of developing then implementing the sampling plan. Costs associated with additional equipment for sampling or testing or changes in shipping behavior or equipment (such as increased use of lined tank cars) are not estimated. Since sampling and testing of this material are already required to properly classify these materials, PHMSA assumes that shippers already have sampling methods and testing protocols in place and are compiling and organizing the testing results in some form. Therefore, PHMSA attributes low costs to the development of a testing and sampling plan. The proposed rule would require that a report compiling sampling and testing procedures and tracking testing results be produced and updated as necessary. The time necessary to document a sampling and testing program report is estimated at 40 hours per shipper. PHMSA estimated 10 hours per shipper to annually update a sampling and testing program. If an average of 250,000 crude oil carloads are tested annually, this amounts to 4 minutes of burden time per carload tested. PHMSA further outlines this calculated burden, and is seeking comments on these estimates, and the assumptions below, in both this section and in the “Paperwork Reduction Act” section of the Preamble.

PHMSA assumes a Chemical Engineer is the labor category most appropriate to describe sampling methodologies, testing protocols, and present test results. The median mean hourly wage for a Chemical Engineer is $46.02.[100] To calculate the hourly wage rates for every year of the analysis PHMSA takes into consideration the 1.18 percent annual growth rate in median real wages.[101] Inflating the 2013 wage by 1.18 percent gives us a 2014 wage of $46.56. We then inflate this wage by 60 percent to account for fringe benefits and overhead of $27.94 per hour, for a total weighted hourly wage of $74.50 in 2014. Following the same series of calculations (and holding fringe benefits constant at $27.94), the total weighted hourly wage in 2015, the first year of the analysis, is estimated at $75.05. We request comment on the most appropriate labor category to use in this analysis. PHMSA estimates there are 1,538 entities that offer mined gases and liquids for transportation to which sampling and testing requirement could apply. We request comment on the most appropriate labor category to use in this analysis. PHMSA

[100] BLS May 2013 National Occupational Employment and Wage Estimates, available online at http://www.bls.gov/oes/current/oes_nat.htm#17-0000.

[101] Based on real wage growth forecasts from the Congressional Budget Office, DOT's guidance estimates that there will be an expected 1.18 percent annual growth rate in median real wages over the next 30 years (2013-2043). The wage rate in 2014 is calculated as follows: $46.02*1.0118 +$46.02*1.0118*0.6 = $74.50.

estimates there are 1,538 entities that offer mined gases and liquids for transportation to which sampling and testing requirement could apply.[102]

PHMSA assumes that there are 1,538 offerors of mined liquids and gases and 40 hours for development and implementation of the sampling and testing program. Thus, for offerors subject to the sampling and testing program, PHMSA estimate the costs to develop and implement a sampling and testing program will be $4,617,000 (1,538 offerors x 40 hours/entity x $75.05/hour).

Subsequent Year – Update

This NPRM requires companies that offer mined liquids and gases for transportation to update their sampling and testing program as necessary to account for changing circumstances. PHMSA assumes that companies will review and update their sampling and testing programs once a year. PHMSA estimates the costs to update a sampling and testing would be on average $1,246,158 per year.[103]

Table CL1: Costs to Develop, Implement and Update Sampling and Testing Program

Sampling and Testing Plan	
Initial Year cost	$4,617,000
Later year cost (average over years 2-20)	$1,246,158
20 Year total, undiscounted	$28,294,000
7 Percent discount rate	$16,169,983
3 percent discount rate	$21,694,965

PHMSA is seeking additional comments on the number of offerors impacted by this proposed requirement and the assumption regarding the labor category and estimated time used to quantify the costs with documenting a sampling and testing program report.

Benefits

The proposed sampling and testing program is intended to minimize the risk of incident by ensuring the proper regulatory requirements are applied to each shipment and mitigate the potential threats to the integrity of the rail tank cars when the offerors and carriers know and fully consider the characteristics of the material. Proper classification and characterization is

[102] Source: PHMSA Hazmat Intelligence Portal (HIP) based on NACIS Codes for 211111 – Crude Petroleum and Natural Gas Extraction; 211112 – Natural Gas Liquid Extraction; and 424710 – Petroleum Bulk Stations and Terminals. The data are for active PHMSA registrations.

[103] $1.25 million = 1,538 entities x 10 hours/company x $81.02/hour (average hourly rate calculated for the subsequent years of the analysis (years 2-20) is based on the expected 1.18 percent annual growth rate in median real wages as mentioned above).

especially important when dealing with a material such as unrefined mined liquids and gases, including crude oil, as these materials' properties are variable. Such information and determination of the authorized packaging also ensures that the required tank car outage, or unfilled capacity, can be maintained in accordance with § 173.24b(a).

In calculating the benefits for the proposed change, we focused on crude oil, as we assume the vast majority of mined liquids and gases transported by highway and rail is crude oil. Further, any mined gases moving by highway or rail are required to be transported in more robust packaging than for liquids, such as crude oil. Further, crude oil accounted for most non-accident releases (NARs) by commodity in 2012, nearly doubling the next highest commodity (alcohols not otherwise specified, which accounts for a comparable annual volume transported by rail). FRA's data indicates that 98 percent of the NARs involved loaded tank cars. Also, less than 2 percent of the NARs occurred at the bottom outlet valve. Product releases through the top valves and fittings of tank cars when the hazardous material expands during transportation suggest that loading facilities may not know the specific gravity of the hazardous materials loaded into railroad tank cars, resulting in a lack of sufficient outage. We anticipate some reduction in NARs as a result of improved testing and characterization but did not include this reduction.

FRA's review of the one-time movement approval (OTMA) data indicates an increasing number of derailment and accidents involving damage to tank cars in crude oil service in the form of severe corrosion of the internal surface of the tank, man way covers, and valves and fittings. A possible cause is contamination of the crude oil by materials used in the fracturing process that are corrosive to the tank car and service equipment.

Therefore, when crude oil is loaded into tank cars, it is critical that that the existence and concentration of specific elements or compounds be identified, along with the corrosivity of the materials to the tank cars and service equipment. Proper identification of these elements will enable a shipper to ensure the reliability of the tank car. Proper identification also enables a shipper to determine if there is a need for an interior coating or lining, alternative materials of construction for valves and fittings, and performance requirements for fluid sealing elements, such as gaskets and o-rings. Thus, by having proper characterization of these materials PHMSA expects the maintenance time for the tank cars to be reduced.

DOT assumes that the sampling and testing program would affect all projected lower consequence damages associated with crude oil incidents. DOT has not limited this estimate to accidents that would have been prevented through appropriate classification and packaging of materials. PHMSA expects the proposed requirements would reduce the expected lower-consequence damages. PHMSA conducted a break-even analysis to determine the effectiveness rates for which the proposed sampling and testing requirement would be beneficial to society. Lower-consequence event estimated damages for with the sampling and testing requirement over the next 20 years for a total of $2.58 billion as seen in the table below:

Table CL2: Total Estimated Damages Over 20-Years

Year	Crude Carloads	Ethanol Carloads	Total carloads	Ratio of crude oil carloads to total carloads	Total Lower Consequence Damages	Total Lower Consequence Damages - Sampling and Testing
1	532,688	365,812	898,500	0.59	$324,766,789	$192,542,355
2	549,804	374,903	924,707	0.59	$318,884,170	$189,599,313
3	555,733	382,075	937,808	0.59	$308,663,025	$182,909,810
4	559,056	390,378	949,434	0.59	$298,295,776	$175,645,754
5	563,940	398,530	962,470	0.59	$288,643,480	$169,124,830
6	568,388	403,217	971,605	0.58	$281,434,410	$164,638,939
7	568,285	400,910	969,195	0.59	$270,809,946	$158,788,769
8	565,260	400,697	965,957	0.59	$260,009,356	$152,152,607
9	560,159	395,888	956,047	0.59	$247,544,695	$145,039,306
10	554,524	394,450	948,974	0.58	$235,986,002	$137,896,158
11	545,536	388,694	934,230	0.58	$222,740,573	$130,067,493
12	526,357	383,316	909,673	0.58	$207,555,533	$120,096,306
13	510,467	382,452	892,919	0.57	$194,572,178	$111,233,678
14	494,066	379,208	873,274	0.57	$181,329,509	$102,589,452
15	476,727	375,254	851,981	0.56	$168,161,828	$94,095,206
16	458,135	371,636	829,771	0.55	$155,257,392	$85,721,026
17	441,518	368,510	810,028	0.55	$143,242,575	$78,076,494
18	424,252	365,778	790,030	0.54	$131,588,225	$70,663,830
19	408,944	363,286	772,230	0.53	$120,685,763	$63,910,615
20	394,318	361,295	755,613	0.52	$110,319,319	$57,570,307
Total					$4,470,490,543	$2,582,362,250

Table CL3: Prevented Damages at the Break Even Point

Year	Total Lower Consequence Benefits - Sampling and Testing - 3% discounted	Total Lower Consequence Benefits - Sampling and Testing - 7% discounted
2015	$1,416,962	$1,426,973
2016	$1,375,691	$1,333,619
2017	$1,335,623	$1,246,373
2018	$1,296,721	$1,164,835
2019	$1,258,953	$1,088,631
2020	$1,222,284	$1,017,412
2021	$1,186,684	$950,852
2022	$1,152,120	$888,647
2023	$1,118,563	$830,511
2024	$1,085,984	$776,179
2025	$1,054,353	$725,401
2026	$1,023,644	$677,944
2027	$993,829	$633,593
2028	$964,882	$592,143
2029	$936,779	$553,405
2030	$909,494	$517,201
2031	$883,004	$483,365
2032	$857,285	$451,743
2033	$832,316	$422,190
2034	$808,074	$394,570
Total	$21,713,244	$16,175,586

To break even, the sampling and testing plan must achieve an effectiveness rate of 0.758% and 0.793% to be beneficial at 3% respectively 7% discount rates. While it would be ideal to consider damages that specifically resulted from improper classification, such information has not been developed. PHMSA believes that this provision will reduce the risk of release of these materials to the environment. As a result, we expect the sampling and testing plan to result in net benefits.

PHMSA also request comments on the following questions. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, include supporting data, and explain the source, methodology, and key assumptions of the supporting data.

1.) To what extent are offerors of mined liquids and gases already in possession of a sampling and testing program?

2.) To what extent is there a lack of compliance with HMR characterization and testing requirements, and to what extent does compliance vary between mined liquids and gases?
3.) What are potential costs and benefits of the sampling and testing program not accounted for in this analysis?
4.) What data exists on the extent to which improper classification contributed to a rail derailment or accident?
5.) How could PHMSA provide flexibility and relax the sampling and testing requirements for offerors who voluntarily use the safest packaging and equipment replacement standards?
6.) What characteristics (e.g. vapor pressure specific gravity, dissolved gas content, concentration of specific compounds such as sulfur) should an offeror test for that would impact the integrity of the tank car?

Requirement Area 6 – Notification to SERCs

Notification to State Emergency Response Commissions of Petroleum Crude Oil Train Transportation

On May 7, 2014, the United States Department of Transportation (DOT; Department) issued an Emergency Restriction/Prohibition Order (EO) pursuant to 49 U.S.C. 5121(d).[104] This EO was issued to all rail carriers that transport in a single train in commerce within the United States, 1,000,000 gallons or more of UN 1267, Petroleum crude oil, Class 3, sourced from the Bakken shale formation in the Williston Basin (Bakken crude oil). By this EO, DOT required that each rail carrier provide the State Emergency Response Commission (SERC) for each state in which it operates trains transporting 1,000,000 gallons or more of Bakken crude oil, notification regarding the expected movement of such trains through the counties in the state. The notification should identify each county or a particular state or commonwealth's equivalent jurisdiction (e.g., Louisiana parishes, Alaska boroughs, Virginia independent cities), in the state through which the trains will operate.

PHMSA proposes to codify the requirements of the May 7, 2014 EO into the HMR. Specifically PHMSA would require notifications from rail carriers that transport in a single train in commerce within the United States, 1,000,000 gallons or more of UN 1267, Petroleum crude oil, Class 3, in packing groups I and II sourced from the Bakken shale formation in the Williston Basin (Bakken crude oil).

PHMSA would require rail carriers to notify the SERCs in writing for each state in which the rail carrier operates trains transporting 1,000,000 gallons or more of crude oil. The contact information for each SERC is located on the U.S. Environmental Protection Agency's (EPA) website related to the Emergency Planning and Community Right-to-Know Act of 1986

[104] A copy of this Emergency order may be obtained from PHMSA's Operation Safe Delivery website: http://www.phmsa.dot.gov/hazmat/osd/calltoaction.

(ECPRA). The notification must provide information regarding the estimated volumes and frequencies of train traffic implicated.

Specifically, the notification must:

- Provide a reasonable estimate of the number of trains implicated by this Order that are expected to travel, per week, through each county within the state;
- Identify and describe the petroleum crude oil expected to be transported in accordance with 49 CFR part 172, subpart C;
- Provide all applicable emergency response information required by 49 CFR part 172, subpart G; and,
- Identify the routes over which the material will be transported.

This notification also must identify at least one point of contact at the railroad (including name, title, phone number and address) responsible for serving as the point of contact for SERCs and relevant emergency responders related to the rail carrier's transportation of crude oil. To ensure that the information provided to a SERC remains reliable, rail carriers shall update notifications prior to making any material changes in the estimated volumes or frequencies of trains traveling through a county. Rail carriers must assist the SERCs as necessary to aid in the dissemination of the information to the appropriate emergency responders in affected counties. Copies of rail carrier notifications to SERCs must be made available to the DOT's Federal Railroad Administration (FRA) upon request. This would not preclude rail carriers from taking any additional steps to communicate with state and local emergency responders regarding the transportation of hazardous materials or any other commodities within a state or local jurisdiction.

PHMSA estimates there are essentially no new costs associated with this proposal, because rail carriers are already subject to the EO. The collection of information associated with the Secretary's Emergency Order Docket No. DOT-OST-2014-0067 was developed by the FRA and approved in OMB No. 2130-0604. FRA and PHMSA have overlapping jurisdictions when it comes to rail hazardous materials shipments. This information collection actually augments information that is collected by PHMSA under OMB No. 2137-0034. However, due to the additional retention of documentation requirement, PHMSA is seeking comment on the clarity of the notification requirements, the paperwork burden, frequency of the notifications, access to the data, and any other issues associated with these requirements.

Conclusions

Comprehensive Benefits and Costs

<u>Tank Car Standard and ECP Brakes</u>

To this point in the analysis, costs and benefits of the various provisions of this proposal have been estimated on a stand-alone basis. The lone exceptions are the costs and benefits attributed to the Option 1 tank car standard and ECP brakes. If there were no overlap in either benefits or costs, total benefits and costs could be obtained by adding the costs of the various provisions together and adding benefits together to calculate totals for each. There is, however, some overlap, for both costs and benefits, between the effects of the tank car standard and the effects of ECP brakes. As noted above, the estimated costs of the Option 1 tank car includes the cost of outfitting tank cars with ECP braking equipment. Those costs are also described in the braking section. In addition, a portion of the benefits of ECP braking are presented in both sections, which creates some overlap on the benefits. Finally, the benefit estimate for each individual provision is obtained by multiplying the effectiveness of the provision by the total societal damages expected from unit train derailments. Because of this, adding the benefits for each provision to the benefits of other provisions results in some double counting of benefits.

A stylized example may help illustrate this issue. Consider a proposed rule that involves two provisions that are each expected to reduce expected damages by 30 percent. If the total expected damages are $100 in the absence of the rule, each provision enacted on its own would be expected to generate $30 in benefits. However, those provisions together would not generate $60 in benefits. Instead, one provision should be applied first, generating $30 in benefits and leaving $70 in expected damages. The second provision would generate benefits equal to 30 percent of the $70 that remains of expected damages, or $21. Total benefits for this example would then be $51 ($30 + $21).

In this section, we make a series of calculations to eliminate these overlaps and develop costs and benefits of combinations of various proposals. On the cost side, the issue only applies to ECP braking and the Option 1 tank car. We begin by taking the cost of the tank car, adding the cost of equipping locomotives with ECP equipment, and adding training costs for ECP braking. This represents the total cost of ECP braking and the new tank car standard. Then, we can add the costs of the other provisions to obtain total costs. The Option 1 tank car standard is estimated to cost approximately $3.6 billion when discounted at 7 percent. This figure includes the cost of equipping tank cars with ECP brakes. To this figure, PHMSA adds training ($18.7 million) and locomotive retrofit costs ($50.7 million) for ECP brakes. This set of calculations yields the total cost of the braking and tank car requirement for the Option 1 tank car standard. The other tank car standards do not require ECP brakes, so the cost estimates for them do not include ECP costs.

On the benefits side, we begin with the tank car standard, although it does not matter in which order these calculations are carried out—the total benefits for each combination of proposals would be the same if we started with speed restrictions or ECP brakes instead. We begin with low-consequence damages, discounted at 7 percent, which are presented in the table below.

Table CB1. Low-Consequence Baseline Damages, 2015-2034 (discounted at 7 percent)

Year	Discounted Lower Consequence Event Damages
2015	$303,520,363.66
2016	$278,525,783.68
2017	$251,960,971.77
2018	$227,568,419.05
2019	$205,798,812.16
2020	$187,531,630.41
2021	$168,646,824.07
2022	$151,327,812.54
2023	$134,647,912.32
2024	$119,963,317.12
2025	$105,822,441.61
2026	$92,157,138.84
2027	$80,740,536.57
2028	$70,322,709.78
2029	$60,949,585.36
2030	$52,591,050.19
2031	$45,346,931.01
2032	$38,932,207.48
2033	$33,370,619.03
2034	$28,508,608.33
Total	$2,638,233,674.99

The series of calculations used to generate benefits for the comprehensive packages, starting with the tank car standard, then adding ECP braking, where applicable, and finally adding marginal speed benefits are as follows:

Equation 1: (total low-consequence baseline damages) – (benefits of tank car standard) = (remaining damages 1)

Equation 2: (remaining damages 1) x (proportion of cars ECP-equipped) x (ECP effectiveness) = (marginal ECP benefits)

Equation 3: (remaining damages 1) – (marginal ECP benefits) = (remaining damages 2)

Equation 4: (remaining damages 2) x (speed restriction effectiveness) = (marginal speed restriction benefits)

First, we subtract the benefits of the tank car option in question. For the Option 1 tank car, we subtract only the benefits of the tank car itself, not the ECP braking benefits, which are handled later in the calculations for options that include that car. This leaves us with a remaining damages pool, which provides the opportunity to achieve benefits from the next provision of the set of proposals. The calculations for estimating the benefits of the Option 1 tank car are presented in the tank car benefits section, but the dollar figures discounted at 7 percent are presented below.

Table CB2. Benefits of Option 1Tank Car, 2015-2034 (discounted at 7 percent)

Year	PHMSA and FRA Design Tank Car Benefits
2015	$5,615,522
2016	$29,283,125
2017	$50,710,867
2018	$68,913,789
2019	$60,494,299
2020	$55,124,684
2021	$49,573,519
2022	$44,482,618
2023	$39,579,582
2024	$35,263,064
2025	$31,106,372
2026	$27,089,474
2027	$23,733,578
2028	$20,671,271
2029	$17,916,053
2030	$15,459,072
2031	$13,329,673
2032	$11,444,073
2033	$9,809,251
2034	$8,380,069
Total	$617,979,954

These benefit figures are subtracted from the discounted low-consequence baseline damages to arrive at the remaining damages pool, which provides opportunities to achieve benefits from other provisions. This remaining damages pool is presented in the table below.

Table CB3. Damages Remaining After Subtracting Benefits of Option 1 Tank Car, 2015-2034 (discounted at 7 percent)

Year	Remaining Damages After PHMSA and FRA Design Tank Car
2015	$ 297,904,841
2016	$ 249,242,658
2017	$ 201,250,105
2018	$ 158,654,630
2019	$ 145,304,514
2020	$ 132,406,947
2021	$ 119,073,305
2022	$ 106,845,195
2023	$ 95,068,330
2024	$ 84,700,253
2025	$ 74,716,070
2026	$ 65,067,665
2027	$ 57,006,959
2028	$ 49,651,439
2029	$ 43,033,532
2030	$ 37,131,978
2031	$ 32,017,258
2032	$ 27,488,135
2033	$ 23,561,368
2034	$ 20,128,539
Total	$ 2,020,253,721

PHMSA next applies ECP braking effectiveness. The effectiveness rate of ECP brakes is 18 percent for trains running either distributed power or end-of-train devices. PHMSA believes all trains in operation are using one of these two braking performance improvements. The 18-percent effectiveness rate is multiplied by the percentage of cars that are ECP-equipped in a given year.

ECP braking is phased in as new ECP-equipped cars are built and can be run as train sets. The PHMSA assumes that these cars would be grouped together and run as unit trains to obtain the safety benefits attributed to them. ECP deployment is expected to reach a maximum of 87 percent of train sets hauling crude and ethanol, because the remaining train sets are not expected to be unit trains and thus cannot be run in ECP brake mode. This is expected to be achieved in

2018 when the retrofit of older cars would be complete. The PHMSA assumes 19 percent of trains would be ECP-equipped in 2015, so the benefits are obtained by multiplying 0.19 by the effectiveness rate, 0.18, which equals 0.034. This figure is multiplied by remaining damages in 2015 to estimate ECP benefits in that year. By 2016, 42 percent of the fleet would be ECP-equipped, and by 2017 71 percent would be ECP-equipped. As noted above, by 2018 ECP is assumed to be fully deployed on 100 percent of unit trains, but since we assume that only 87 percent of the product would be shipped in unit trains, the 87-percent factor is applied in years 2018 and beyond. The table below presents the deployment percentages, which are multiplied by the effectiveness rate (0.18) and by the remaining damages to estimate ECP safety benefits. The calculation of ECP business benefit is geared to the equipping of the locomotives, and hence trainsets. If the first year 300 locomotives are equipped, and used in unit trainsets, the minimum number of tank cars needed to equip 100 trainsets with 100 cars per train is 10,000 cars, less than the number of tank cars projected for the first year. The lowest cost compliance path would put the ECP equipped tank cars into unit train service first, in order to realize the business benefits of ECP as early as possible. Likewise in the second year, another 300 locomotives and 10,000 cars would go into unit train service, and in the third year, the last 300 locomotives would go into unit train service, as would another 10,000 tank cars.

Table CB4. Damages Remaining After Subtracting Option 1 Tank Car and ECP Brake Benefits, 2015-2034 (discounted at 7 percent)

Year	ECP Deployment	ECP Benefits	Remaining Damages after Tank Car and ECP
2015	0.19	$9,920,930	$287,983,911
2016	0.42	$18,697,212	$230,545,447
2017	0.75	$27,297,955	$173,952,150
2018	0.87	$24,845,315	$133,809,315
2019	0.87	$22,754,687	$122,549,827
2020	0.87	$20,734,928	$111,672,019
2021	0.87	$18,646,880	$100,426,425
2022	0.87	$16,731,958	$90,113,237
2023	0.87	$14,887,700	$80,180,630
2024	0.87	$13,264,060	$71,436,193
2025	0.87	$11,700,537	$63,015,533
2026	0.87	$10,189,596	$54,878,069
2027	0.87	$8,927,290	$48,079,669
2028	0.87	$7,775,415	$41,876,024
2029	0.87	$6,739,051	$36,294,481
2030	0.87	$5,814,868	$31,317,110
2031	0.87	$5,013,903	$27,003,356
2032	0.87	$4,304,642	$23,183,493
2033	0.87	$3,689,710	$19,871,658
2034	0.87	$3,152,129	$16,976,410
		$255,088,765	$1,765,164,956

Speed Restrictions

We apply speed restriction effectiveness to this remaining damage pool. Since accurate effectiveness measures cannot be obtained for the other provisions (routing, classification, and SERC notification), PHMSA does not calculate specific benefits for those provisions.

The 40-mph speed restriction is expected to reduce the consequences of incidents by 36 percent. The speed restriction benefits do not apply to HHFTs that have the new tank car standard, and for the purposes of the speed restriction the effectiveness rate is assumed to decline by 1/3 each year, until there are no longer any benefits after Year 3. The speed restriction effectiveness rate is also adjusted to account for voluntary industry action to slow crude oil trains that do not meet the CPC-1232 standard in High Threat Urban Areas. This produces effectiveness rates of 34.67 percent in 2015, 23.11 percent in 2016, and 11.56 percent in 2017.

The limited speed restriction (40 mph in areas of 100,000 people or more, and 40 mph in HTUAs) benefits are calculated by taking a percentage of benefits from the system-wide speed restriction, as described in the Speed Restriction section of this analysis. For the speed limit in cities with 100,000 or more of population, system-wide speed restriction benefits are multiplied by 5.87 percent in 2015, 3.91 percent in 2016, and 1.96 percent in 2017 to obtain benefits. For a speed limit in HTUAs, the system-wide benefits are multiplied by 1.19 percent in 2015, 0.791 percent in 2016, and 0.4 percent in 2017.

Once this series of calculations is complete, the marginal benefits for ECP brakes and speed restrictions are added to the benefits of the tank car standard to obtain total safety benefits for the set of proposals. The annual marginal benefits from each safety feature are shown below, along with the total benefits.

Table CB5. Benefits of Option 1 Tank Car Standard, ECP Brakes, and System-Wide Speed Restrictions, 2015-2034 (discounted at 7 percent)

Year	117 Benefits	ECP Benefits	Universal Speed Benefit	Total
2015	$5,615,522	$ 9,920,930	$ 99,844,732	$115,381,184
2016	$29,283,125	$18,697,212	$53,280,223	$101,260,560
2017	$50,710,867	$27,297,955	$20,103,213	$98,112,035
2018	$68,913,789	$24,845,315	$0	$93,759,104
2019	$60,494,299	$22,754,687	$0	$83,248,985
2020	$55,124,684	$20,734,928	$0	$75,859,612
2021	$49,573,519	$18,646,880	$0	$68,220,399
2022	$44,482,618	$16,731,958	$0	$61,214,575
2023	$39,579,582	$14,887,700	$0	$54,467,283
2024	$35,263,064	$13,264,060	$0	$48,527,124
2025	$31,106,372	$11,700,537	$0	$42,806,908
2026	$27,089,474	$10,189,596	$0	$37,279,070
2027	$23,733,578	$8,927,290	$0	$32,660,868
2028	$20,671,271	$7,775,415	$0	$28,446,686
2029	$17,916,053	$6,739,051	$0	$24,655,104
2030	$15,459,072	$5,814,868	$0	$21,273,940
2031	$13,329,673	$5,013,903	$0	$18,343,575
2032	$11,444,073	$4,304,642	$0	$15,748,715
2033	$9,809,251	$3,689,710	$0	$13,498,961
2034	$8,380,069	$3,152,129	$0	$11,532,198
Total	$617,979,954	$255,088,765	$173,228,169	$1,046,296,887

The remaining tank car options are considered analogously with the exception that the ECP braking calculations are omitted. Any car could be equipped with ECP brakes, but both costs and benefits for a tank car standard would rise if ECP brakes are mandated for that standard. Because the Option 1 and 2 tank cars are very close to each other in terms of overall safety impact with the exception of ECP brakes, the comparison between these two standards in effect indicates the expected effects of ECP braking.

The Option 1 tank car scenarios all include the costs and benefits of ECP braking. Since ECP is identified solely with tank car Option 1, specifying that a combination of proposals includes the Option 1 tank car is sufficient to identify it as including ECP brakes as well. The speed limit restrictions are identified as "40 MPH" for the 40-mph system-wide speed limit; "40 mph in 100K" for the proposed speed limit imposed in cities with 100,000 or more in total population; and "40 mph in HTUA" for a 40-mph speed limit in high threat urban areas.

To account for the risk of high-consequence events, we calculate an effectiveness ratio for each combination of proposals by dividing total discounted benefits for low-consequence events by total discounted societal damages for low-consequence events. We then apply this ratio to the total damages that would result from 10 higher consequence events, with one of those events having an impact 5 times greater than the average high-consequence event. Thus, if total lower-consequence plus high-consequence events are $10 billion, and the ratio of low consequence events to low consequence total damages is 50-percent, total benefits would be approximately $5 billion.

These effectiveness ratios for each proposal are presented below.

Table CB6. Low Consequence Effectiveness Ratios for Proposal Combinations

Comprehensive Proposal	Ratio of Discounted Benefits to Discounted Baseline Damages
117 + Universal 40 MPH	0.40
117 + 40 MPH in Cities with >100K Population	0.34
117 + 40 MPH in HTUA	0.33
CPC 1232 + Universal 40 MPH	0.22
CPC 1232 + 40 MPH in Cities with >100K Population	0.16
CPC 1232 + 40 MPH in HTUA	0.15
AAR 2014 + Universal 40 MPH	0.30
AAR 2014 + 40 MPH in Cities with >100K Population	0.24
AAR 2014 + 40 MPH in HTUA	0.23

For those options with ECP brakes, we add ECP business benefits to the final estimated safety benefits to get total benefits for the PHMSA and FRA Design Tank Car Options. ECP produces business benefits of $420,574,497 million over 20 years when discounted at 7 percent.

The first table presented shows total costs, benefits, and net benefits for the PHMSA and FRA Design standard with a system-wide 40-mph speed limit, including both safety and business benefits.

PHMSA and FRA Design Standard + 40 MPH System Wide, 7% Discount Rate	
Costs	$5,820,338,444
Lower Consequence Event + ECP Business Benefits	$1,435,896,668
Benefits with 10 High Consequence Events + ECP Business Benefits	$4,386,021,162
Net Benefits (low consequence only)	-$4,384,441,776
Net Benefits (with high consequence Events	-$1,434,317,282

The next table presents costs, benefits, and net benefits for the Option 1 tank car standard and a 40-mph speed limit in cities with 100,000 or more population.

PHMSA and FRA Design Standard + 40 MPH in 100K, 7% Discount Rate	
Costs	$3,379,693,232
Lower Consequence Event + ECP Business Benefits	$1,291,993,170
Benefits with 10 High Consequence Events + ECP Business Benefits	$3,836,369,313
Net Benefits (low consequence only)	-$2,087,700,062
Net Benefits (with high consequence Events	$456,676,081

The next table presents these figures for the Option 1 tank car standard and the 40-mph speed limit restricted only to high threat urban areas.

PHMSA and FRA Design Standard + 40 MPH in HTUA, 7% Discount Rate	
Costs	$3,162,746,991
Lower Consequence Event + ECP Business Benefits	$1,268,608,851
Benefits with 10 High Consequence Events + ECP Business Benefits	$3,747,050,887
Net Benefits (low consequence only)	-$1,894,138,140
Net Benefits (with high consequence Events	$584,303,897

The next series of proposed rule packages combine the Option 2 tank car with the speed restriction alternatives. As noted above, neither the costs nor the benefits of ECP braking is incorporated into these figures. First, we present the Option 2 tank car combined with the 40-mph system-wide speed limit.

AAR 2014 Standard + 40 MPH System Wide, 7% Discount Rate	
Costs	$5,272,033,055
Lower Consequence Event Benefits	$794,278,015
Benefits with 10 High Consequence Events	$3,033,813,518
Net Benefits (low consequence only)	-$4,477,755,040
Net Benefits (with high consequence Events	-$2,238,219,537

Next, the Option 2 tank car is combined with a 40-mph restriction in cities with 100,000 or more population.

AAR 2014 Standard + 40 MPH in 100K, 7% Discount Rate	
Costs	$2,831,387,843

Lower Consequence Event Benefits	$641,181,037
Benefits with 10 High Consequence Events	$2,449,046,382
Net Benefits (low consequence only)	-$2,190,206,806
Net Benefits (with high consequence Events	-$382,341,461

Finally, the Option 2 tank car is combined with a 40-mph speed limit in high threat urban areas.

AAR 2014 Standard + 40 MPH in HTUA, 7% Discount Rate	
Costs	$2,614,441,602
Lower Consequence Event Benefits	$616,302,778
Benefits with 10 High Consequence Events	$2,354,021,722
Net Benefits (low consequence only)	-$1,998,138,824
Net Benefits (with high consequence Events	-$260,419,880

The final set of tables present the costs and benefits for the standards that combine speed restrictions with the Option 3 tank car standard. The first table presents the costs and benefits of a package that combines Option 3 tank car with a 40-mph system-wide speed restriction.

CPC 1232 Standard + 40 MPH System Wide, 7% Discount Rate	
Costs	$4,740,965,728
Lower Consequence Event Benefits	$584,452,390
Benefits with 10 High Consequence Events	$2,232,366,412
Net Benefits (baseline only)	-$4,156,513,338
Net Benefits (with high consequence Events	-$2,508,599,317

The next table presents the Option 3 tank car combined with a 40-mph speed restriction in cities with 100,000 or more population.

CPC 1232 Standard + 40 MPH in 100K, 7% Discount Rate	
Costs	$2,300,320,516
Lower Consequence Event Benefits	$425,684,128
Benefits with 10 High Consequence Events	$1,625,937,314
Net Benefits (baseline only)	-$1,874,636,389
Net Benefits (with high consequence Events	-$674,383,203

The final Option 3 tank car scenario combines that standard with a 40-mph speed restriction limited to high threat urban areas.

CPC 1232 Standard + 40 MPH in HTUA, 7% Discount Rate	
Costs	$2,083,374,275
Lower Consequence Event Benefits	$399,884,285
Benefits with 10 High Consequence Events	$1,527,392,585
Net Benefits (baseline only)	-$1,683,489,990
Net Benefits (with high consequence Events	-$555,981,690

A few conclusions can be drawn from this presentation. Firstly, the Option 1 tank car with limited speed restrictions are the only scenarios with net benefits, and these scenarios only have net benefits with the inclusion of higher consequence event damages. Secondly, although it imposes higher costs, the Option 1 tank car tends to also produce the lowest net costs under most scenarios. The Option 3 tank car might be superior if cost imposition is the chief concern—it has lower costs than the Option 1 or Option 2 tank cars. It is also the tank car option that is currently in mass production. Benefits fail to exceed costs for all options if no high-consequence events are assumed to occur.

Conclusions

Hazardous materials such as crude oil and ethanol are essential to the economy of the U.S. and the well-being of its people. These materials are an important part of the U.S. economy and have many manufacturing, and other industrial applications. The need for these hazardous materials to support essential services means transportation of hazardous materials is unavoidable and rail transportation of hazardous materials in the United States is generally recognized to be a safe method of moving large quantities of hazardous materials over long distances.

PHMSA, in coordination with FRA, is proposing new operational requirements for HHFTs comprised of twenty rail car loads of a Class 3 flammable liquid to ensure that the rail requirements are closely aligned with the risks posed by the transportation of these trains.

PHMSA is proposing improvements in tank car standards for HHFTs and revision of the general requirements for offerors to ensure proper classification and characterization of mined gases and liquids. These new requirements are designed to lessen the frequency and consequences of derailments involving ethanol, crude oil, when moved as a HHFT. The growing reliance on trains to transport large volumes of flammable liquids poses a significant risk to life, property, and the environment. These significant risks have been highlighted by the recent derailments of trains carrying crude oil in Casselton, North Dakota, Aliceville, Alabama, and Lac-Mégantic, Quebec, Canada.

Shipments of flammable liquids in large volumes pose a risk of catastrophic consequences during transportation. In addition, both the number of shipments and accidents involving large flammable liquids has increased. In the NPRM the proposed requirements focus on the transportation of crude oil and ethanol.

Consistent with the NPRM, the following table provides the six (6) requirement areas considered in this analysis and their costs:

Table ES2. 20 Year Costs and Benefits by Stand-Alone Proposed Regulatory Amendments 2015-2034[105]
Provision

Affected Section[106]	**Provision**	**Benefits (7%)**	**Costs (7%)**
49 CFR 172.820	**Rail Routing+**	Cost effective if routing were to reduce risk of an incident by 0.17%	$4.5 million
49 CFR 173.41	**Classification of Mined Gas and Liquid**	Cost effective if this requirement reduces risk by 0.61%	$16.2 million
49 CFR 174.310	**Notification to SERCs**	Qualitative	$0

[105] All costs and benefits are in millions over 20 years, and are discounted to present value using a 7 percent rate.
[106] All affected sections of the Code of Federal Regulations (CFR) are in Title 49.

	Speed Restriction: Option 1: 40 mph speed limit all areas*	$199 million – $636 million	$2,680 million
	Speed Restriction: Option 2: 40 mph 100k people*	$33.6 million – $108 million	$240 million
	Speed Restriction: Option 3: 40 mph in HTUAs*	$6.8 million- $21.8 million	$22.9 million
	Braking: Electronic Pneumatic Control with DP or EOT#[107]	$737 million – $1,759 million	$500 million
49 CFR Part 179	**Option 1: PHMSA and FRA designed car**[108]	$822 million - $3,256 million	$3,030
	Option 2: AAR 2014 Tank Car	$610 million – $2,426 million	$2,571
	Option 3: Jacketed CPC-1232 (new const.)	$393 million – $1,570 million	$2,040 million

Note: "+" indicates voluntary actions that will be taken by shippers and railroads
"*" indicates voluntary compliance of crude oil in HTUA
"#"PHMSA does not propose to require additional top fittings protection for retrofits, because the costs are not supported by corresponding benefits. Newly constructed cars, however, are required to have additional top fittings protection. Except for additional top fittings protection, the requirements for newly constructed tank cars and retrofits are the same.

Preliminary assessments of the Lac-Mégantic accident suggest that damages exceed $1.2 billion. Because this accident occurred in a relatively small town with low rail traffic volumes, the damages are much less than they would have been if the accident had occurred in a congested area with high population density. Using 12 years of FRA accident data (2001-2013) we estimated the relationship between carloads and derailments, and used this relationship to forecast the annual number of derailments going forward for the next 20 years. We assume that any catastrophic event will stem from a derailment resulting in the damage of 5 or more tank cars.

To estimate benefits associated with the proposed regulations PHMSA assumed there would be between 0 and 10 higher consequence events over 20 years, in addition to the 5 to 15 annual mainline lower consequence evetns predicted based on extrapolation of the existing U.S. safety

[107] All Costs (equipping tank cars, equipping locomotives and training) and benefits (safety and business benefits) of ECP braking are included here. Adding the costs and benefits of ECP braking and the PHMSA/FRA designed car will result in some double counting.
[108] Costs and benefits associated with equipping cars with ECP braking assigned to the PHMSA-FRA designed car only. PHMSA allocated 80% of the safety benefits of ECP braking to the PHMSA/FRA designed car because that was the portion of ECP costs from equipping tank cars. Adding the costs and benefits of ECP braking and the PHMSA-FRA designed car will result in some double counting.

history. . PHMSA used damage estimates for the Lac-Mégantic accident in conjunction with an analysis of the population densities of U.S. populated places to estimate the expected magnitudes associated with the projected higher consequence events.

The benefits of the proposed requirements include averted damages resulting both from catastrophic and non-catastrophic events. The effectiveness of the requirements are interdependent on each other, and some of the requirements such as routing can mitigate both the likelihood that an accident will happen as well as the outcome if an accident does happen. For these reasons, more complex analysis may need to be done to establish a separate effectiveness rate for each requirement.

This analysis shows that expected damages based on the historical safety record could reach $4.5 billion and that damages from high-consequence events could reach $14 billion over a 20 year period in the absence of the rule.

Appendix A: 2011 U.S. Business Statistics for Selected Industries that Ship Class 3 Hazardous Materials

NAICS CODE	NAICS DESCRIPTION	ENTERPRISE EMPLOYMENT SIZE	NUMBER OF FIRMS	NUMBER OF ESTABLISHMENTS	EMPLOYMENT
211111	Crude petroleum and natural gas extraction	1: Total	6,523	7,757	108,954
211111	Crude petroleum and natural gas extraction	2: 0-4	4,519	4,531	7,361
211111	Crude petroleum and natural gas extraction	3: 5-9	946	963	6,099
211111	Crude petroleum and natural gas extraction	4: 10-19	496	514	6,685
211111	Crude petroleum and natural gas extraction	5: <20	5,961	6,008	20,145
211111	Crude petroleum and natural gas extraction	6: 20-99	388	458	13,989
211111	Crude petroleum and natural gas extraction	7: 100-499	87	216	11,507
211111	Crude petroleum and natural gas extraction	8: <500	6,436	6,682	45,641
211111	Crude petroleum and natural gas extraction	9: 500+	87	1,075	63,313
211112	Natural gas liquid extraction	1: Total	136	338	10,005
211112	Natural gas liquid extraction	2: 0-4	58	58	0
211112	Natural gas liquid extraction	3: 5-9	11	11	67
211112	Natural gas liquid extraction	4: 10-19	6	6	0
211112	Natural gas liquid extraction	5: <20	75	75	250
211112	Natural gas liquid extraction	6: 20-99	15	16	536
211112	Natural gas liquid extraction	7: 100-499	9	21	947
211112	Natural gas liquid extraction	8: <500	99	112	1,733
211112	Natural gas liquid extraction	9: 500+	37	226	8,272
324191	Petroleum lubricating oil and grease manufacturing	1: Total	248	289	9,285
324191	Petroleum lubricating oil and grease manufacturing	2: 0-4	64	64	125
324191	Petroleum lubricating oil and grease manufacturing	3: 5-9	36	36	241
324191	Petroleum lubricating oil and grease manufacturing	4: 10-19	37	37	493
324191	Petroleum lubricating oil and grease manufacturing	5: <20	137	137	859
324191	Petroleum lubricating oil and grease manufacturing	6: 20-99	67	73	2,695
324191	Petroleum lubricating oil and grease manufacturing	7: 100-499	22	34	2,528
324191	Petroleum lubricating oil and grease manufacturing	8: <500	226	244	6,082
324191	Petroleum lubricating oil and grease manufacturing	9: 500+	22	45	3,203
325110	Petrochemical manufacturing	1: Total	43	60	10,398
325110	Petrochemical manufacturing	2: 0-4	14	14	0
325110	Petrochemical manufacturing	3: 5-9	2	2	0
325110	Petrochemical manufacturing	4: 10-19	1	1	0
325110	Petrochemical manufacturing	5: <20	17	17	49
325110	Petrochemical manufacturing	6: 20-99	4	4	260
325110	Petrochemical manufacturing	7: 100-499	5	5	433
325110	Petrochemical manufacturing	8: <500	26	26	742
325110	Petrochemical manufacturing	9: 500+	17	34	9,656
324110	Petroleum refineries	1: Total	198	296	63,150
324110	Petroleum refineries	2: 0-4	75	75	0
324110	Petroleum refineries	3: 5-9	23	23	148
324110	Petroleum refineries	4: 10-19	18	18	249
324110	Petroleum refineries	5: <20	116	116	490
324110	Petroleum refineries	6: 20-99	15	18	662
324110	Petroleum refineries	7: 100-499	23	25	2,766
324110	Petroleum refineries	8: <500	154	159	3,918
324110	Petroleum refineries	9: 500+	44	137	59,232
325192	Cyclic crude and intermediate manufacturing	1: Total	25	28	3,166
325192	Cyclic crude and intermediate manufacturing	2: 0-4	1	1	0
325192	Cyclic crude and intermediate manufacturing	3: 5-9	1	1	0
325192	Cyclic crude and intermediate manufacturing	4: 10-19	1	1	0
325192	Cyclic crude and intermediate manufacturing	5: <20	3	3	0
325192	Cyclic crude and intermediate manufacturing	6: 20-99	7	7	243
325192	Cyclic crude and intermediate manufacturing	7: 100-499	3	3	338
325192	Cyclic crude and intermediate manufacturing	8: <500	13	13	605
325192	Cyclic crude and intermediate manufacturing	9: 500+	12	15	0
325193	Ethyl alcohol manufacturing	1: Total	168	219	10,299
325193	Ethyl alcohol manufacturing	2: 0-4	19	19	30
325193	Ethyl alcohol manufacturing	3: 5-9	8	8	0
325193	Ethyl alcohol manufacturing	4: 10-19	12	13	175
325193	Ethyl alcohol manufacturing	5: <20	39	40	257
325193	Ethyl alcohol manufacturing	6: 20-99	97	99	4,038
325193	Ethyl alcohol manufacturing	7: 100-499	17	37	2,299
325193	Ethyl alcohol manufacturing	8: <500	153	176	6,594
325193	Ethyl alcohol manufacturing	9: 500+	15	43	3,705

Source: U.S. Census Bureau, Statistics of U.S. Businesses, 2011

Appendix B: Crude Oil/ Ethanol Derailment Accidents Research

Fatalities, Injuries, Evacuation of People, Evacuation – Evacuation Days, Environmental Damage, Railroad Damages, Track Out of Service, Electric Disruption, Road Closures, etc.

Mainline Derailments of Crude Oil and Ethanol from 2006-2013

Incident Date	Product Name	UN Number	Speed at Derailment (mph)	Cars Releasing	# Main Line Incidents	Qty. Released per derailment	Unit of Measure	Location City	Location State or Province
4/22/2006	Ethanol	UN1268	5	1	1	9,000	LGA	CHILLICOTHE	OHIO
5/30/2006	Ethanol	UN1987	50	0	1	0	LGA	TRIBES HILL	NEW YORK
10/20/2006	Ethanol	UN1987	37	20	1	485,278	LGA	NEW BRIGHTON	PENNSYLVANIA
11/11/2006	Ethanol	UN1987	10	1	1	1,000	LGA	PORTAGE	INDIANA
11/22/2006	Ethanol	UN1987	24	7	1	24877	LGA	CAMBRIDGE	MINNESOTA
2006 Total				**29**	**5**	**520155**	**LGA**		
6/30/2007	Ethanol	UN1987	20	1	1	29357	LGA	PLUMAS	CALIFORNIA
10/10/2007	Ethanol	UN1987	48	5	1	55200	LGA	PAINESVILLE	OHIO
12/28/2007	Ethanol	UN1987	23	2	1	16000	LGA	NEW FLORENCE	PENNSYLVANIA
2007 Total				**8**	**3**	**100557**	**LGA**		
8/16/2008	Ethanol	UN1987	17	1	1	12,447	LGA	COUNCIL	NORTH CAROLINA
8/22/2008	Crude Oil	UN1267	19	5	1	80746	LGA	LUTHER	OKLAHOMA
12/7/2008	Crude Oil	UN1267	55	6	1	140	LGA	PAGE	NORTH DAKOTA
2008 Total				**12**	**3**	**93333**	**LGA**		
1/12/2009	Ethanol	UN1987	44	1	1	1	LGA	DEFIANCE	OHIO

3/8/2009	Ethanol	UN1987	10	2	1	85	LGA	JESUP	IOWA
5/28/2009	Ethanol	UN1987	18	1	1	100	LGA	GREEN MOUNTAIN	NORTH CAROLINA
6/19/2009	Ethanol	UN1987	19	13	1	232693	LGA	CHERRY VALLEY	ILLINOIS
7/23/2009	Ethanol	UN1987	11	1	1	174	LGA	MAX	NORTH DAKOTA
9/15/2009	Ethanol	UN1987	2	2	1	8204	LGA	KNOXVILLE	TENNESSEE
10/28/2009	Crude Oil	UN1267	30	1	1	1	LGA	LODI	OHIO
12/13/2009	Ethanol	UN1170	15	1	1	1	LGA	CARBONDALE	ILLINOIS
2009 Total				**22**	**8**	**241259**	**LGA**		
2/20/2010	Ethanol	UN1987	20	1	1	24175	LGA	KEENE	CALIFORNIA
3/11/2010	Ethanol	NA1987	10	1	1	5	LGA	WINDHAM	CONNECTIC UT
4/19/2010	Ethanol	UN1987	41	8	1	57613	LGA	BRYAN	OHIO
2010 Total				**10**	**3**	**81793**	**LGA**		
1/8/2011	Ethanol	UN1987	5	0	1	0	LGA	ROANOKE	VIRGINIA
2/6/2011	Ethanol	UN1987	46	31	1	834840	LGA	ARCADIA	OHIO
5/4/2011	Ethanol	NA1987	24	1	1	28000	LGA	BURLINGTON	OREGON
7/6/2011	Ethanol	UN1987	28	1	1	1	LGA	MORRISTOWN	INDIANA
7/19/2011	Ethanol	UN1987	10	1	1	366	LGA	AURORA	SOUTH DAKOTA

10/7/2011	Ethanol	UN1987	34	10	1	143534	LGA	TISKILWA	ILLINOIS
2011 Total				**44**	**6**	**1006741**	**LGA**		
1/6/2012	Ethanol	UN1987	44	5	1	2.25	LGA	WESTVILLE	INDIANA
6/1/2012	Ethanol	UN1170	25	2	1	40099	LGA	OAKLAND CITY	INDIANA
7/11/2012	Ethanol	UN1987	23	3	1	53347	LGA	COLUMBUS	OHIO
8/5/2012	Ethanol	UN1987	23	12	1	245336	LGA	PLEVNA	MONTANA
11/30/2012	Ethanol	UN1987	8	1	1	1	LGA	PAULSBORO	NEW JERSEY
12/30/2012	Ethanol	UN1987	15	1	1	16000	LGA	MOUNT VERNON OUTLAND AIRPORT	ILLINOIS
2012 Total				**24**	**6**	**354785**	**LGA**		
3/27/2013	Crude Oil	UN1267	40	3	1	15000	LGA	PARKERS PRAIRIE	MINNESOTA
5/23/2013	Crude Oil	UN1267	23	0	1	0	LGA	BEAR CREEK	ALABAMA
7/17/2013	Ethanol	UN1170	28	1	1	1	LGA	BUFFALO	NEW YORK
10/21/2013	Crude Oil	UN1267	20	1	1	1	LGA	SMITHBORO	ILLINOIS
11/7/2013	Crude Oil	UN1267	39	25	1	455520	LGA	ALICEVILLE	ALABAMA
12/30/2013	Crude Oil	UN1267	42	18	1	474936	LGA	CASSELTON	NORTH DAKOTA
2013 Total				**48**	**6**	**945458**	**LGA**		
1/20/2014	Crude Oil	UN1267	7	0	1	0	LGA	PHILADELPHIA	PENNSYLVA NIA
1/31/2014	Crude Oil	UN1267	45	4	1	90000	LGA	NEW AUGUSTA	MISSIPPI

2/11/2014	Ethanol	UN1987	10	1	1	25	LGA	JACKSONVILLE	FLORIDA
2/13/2014	Crude Oil	UN1267	31	4	1	10000	LGA	VANDERGRIFT	PENNSYLVANIA
4/30/2014	Crude Oil	UN1267	23	2	1	30000	LGA	LYNCHBURG	VIRGINIA
5/9/2014	Crude Oil	UN1267	9	1	1	7932	LGA	EVANS	COLORADO

Lynchburg, VA, April 30, 2014– Crude oil

A CSX Transportation, Inc. (CSX) unit train consisting of 105 tank cars loaded with petroleum crude oil derailed in Lynchburg, Virginia. Seventeen of the train's cars derailed, and one of the tank cars was breached. A petroleum crude oil fire ensued, and emergency responders evacuated approximately 350 individuals from the immediate area. Three of the derailed tank cars containing petroleum crude oil came to rest in the adjacent James River, spilling up to 30,000 gallons of petroleum crude oil into the river. The National Transportation Safety Board (NTSB) and DOT are both investigating this accident.

Sources:

- http://www.timesdispatch.com/news/state-regional/ntsb-clears-crew-in-lynchburg-derailment/article_5017e96e-8916-58f0-8a8e-1428a3b1845b.html
- Form DOT F 5800.1 (Hazardous materials incident report)

Vandergrift, PA, February 13, 2014 – Crude oil

A Norfolk Southern (NS) train with 119 cars derailed 21 cars. There were no injuries or fatalities. Approximately 10,000 gallons of crude oil were spilled. One of the derailed cars went through the wall and into MSI Corporation (Steel Processor). Employees at the MSI Corporation were evacuated after the derailment. The derailment site is located approximately 150 yards from the Conemaugh River.

Sources:

- http://www.post-gazette.com/local/westmoreland/2014/02/13/Train-carrying-crude-oil-derails-in-Vandergrift/stories/201402130275
- Form FRA F6180.39 (Accident Report)

New Augusta, MS, January 31, 2014 – Crude Oil

A Canadian National Railway (CN) train with 85 cars derailed 20 cars. Twenty people (a dozen families) within a ½-mile radius were forced to evacuate their homes. Nearby highway (U.S. Route 98, a four-lane, major east-west highway in southern Mississippi) was shut down as a precaution because of ethanol's flammable nature, although no fire occurred. This event triggered an "all-out response" from fire, police, the Mississippi Department of Transportation, and the Environmental Protection Agency (EPA). At least 50 responders were at the scene. At least four of the derailed cars ruptured and were leaking (other source says eight cars). Earthen dams were built to contain the leakage and prevent it from contaminating local streams (ground seepage is inevitable). Crude oil and Methanol—liquid fertilizer—is believed to have been in the tank cars that were leaking. CN dispatched equipment to drain the tank cars and right them.

Sources:

- http://usnews.nbcnews.com/_news/2014/01/31/22524183-50-evacuated-after-chemical-train-derailment-in-mississippi
- http://www.sunherald.com/2014/01/31/5301747/train-derailment-chemical-spill.html
- http://www.cnbc.com/id/101381562
- http://www.youtube.com/watch?v=teuiF9lLI0A

Plaster Rock, New Brunswick, Canada, January 7, 2014 – Crude oil and propane products

A CN mixed freight train with 122 cars derailed 19 cars and a remote locomotive. Nine of the cars—five carrying crude oil and four propane—burst into flames and the fire burned for several days. About 150 workers were on the scene. Hazmat responders were dispatched and 50 wells were tested for pollution. Although there were no injuries as a result, 150 people in 50 homes within a 1.2-mile radius were evacuated for 3 nights. When they returned, they were warned not to use the tap water as a result of the accident. Contaminated soil was hauled away for cleanup and testing. Those who lived within a 100-meter radius were not allowed to return to their homes for several weeks. The probable cause of the accident a cracked wheel; however, this is still under investigation.

Sources:

- http://www.cbc.ca/news/canada/new-brunswick/plaster-rock-derailment-fires-out-evacuees-going-home-1.2492805
- http://www.cbc.ca/news/canada/new-brunswick/cn-derailment-near-plaster-rock-involved-mechanical-failure-1.2488358
- http://globalnews.ca/news/1074001/cn-working-to-tackle-fire-burning-on-derailed-train-near-plaster-rock/
- http://www.cbc.ca/news/canada/new-brunswick/cn-rail-derailment-site-longley-road-reopens-to-public-1.2531276
- http://www.tsb.gc.ca/eng/enquetes-investigations/rail/2014/r14m0002/r14m0002.asp

Gainford, Alberta, Canada, October 19, 2013– Crude oil product, Liquefied Petroleum Gas

CN Train with 134 cars, experienced an undesired emergency brake application in the area of the Gainford siding. Inspection revealed that cars 13 through 25 had derailed and were on their side. The first four derailed cars were carrying petroleum crude oil and the following 9 cars were carrying liquefied petroleum gas. Sparks and flames were visible to the crew. No injuries were reported.

- http://www.tsb.gc.ca/eng/enquetes-investigations/rail/2013/r13e0142/r13e0142.asp

- http://www.reuters.com/article/2013/10/19/us-cnrailway-derailment-idUSBRE99I04820131019

Casselton, ND, December 30, 2013 – Crude oil product

A BNSF Railway (BNSF) grain train derailed on a track parallel to an eastbound crude oil train with 106 tank cars, striking some of the tanks and triggering explosions. Eighteen cars derailed and ignited a fire. Once the fire started, the engineer unhooked the remaining 25 oil cars and pulled them safely away from the fire. If not for this act, it is deemed that the explosions would have been much worse. Approximately 474,936 gallons of oil spilled. Although there were no injuries, officials asked 2,400 residents of Casselton to voluntarily evacuate, and approximately 1,500 did for one day. Cleanup is expected to last until the summer of 2014. Over 9,000 cubic yards of dirt and other material has been removed from the crash site and sent mostly to out-of-State landfills. The State requires that the runoff be contained in the spring, and further testing is required to be sure that the oil has been recovered and is not leaching downward. Estimated damages were $5,305,216 (railroad equipment, track and signals).

Sources:

- http://www.foxnews.com/us/2013/12/31/no-injuries-reported-in-fiery-north-dakota-train-derailment/
- http://www.kxnet.com/story/24711675/cleanup-at-nd-oil-train-crash-to-last-until-summer
- http://www.nbcnews.com/id/54339936/ns/local_news-fargo_nd/t/engineer-training-honored-quick-thinking-after-casselton-derailment/
- http://www.inforum.com/event/article/id/426338/

Aliceville, AL, November 7, 2013 – Crude oil product

An Alabama Gulf Coast Railway train derailed 26 cars and one locomotive near Aliceville, AL, on November 7, 2013, at approximately 11:35 pm (CST). The train consisted of two BNSF locomotives and 90 freight cars (88 of which contained crude oil), and 2 box cars of sand. The train was traveling at 38 mph (40 mph is the maximum authorized speed) when the crew reported feeling a “thud” as they passed a trestle and saw explosions as the cars derailed. There were no injuries reported and no evacuation required. An estimated 455,000 gallons of crude oil spilled into the surrounding wetlands and ignited a fire that was still burning through the next day. Estimated damages were $3,904,000 (railroad equipment, track and signals).

Sources:

- http://articles.latimes.com/2013/nov/09/nation/la-na-nn-train-crash-alabama-oil-20131109
- http://www.americanownews.com/story/23913896/train-derailment-causes-fire-and-crude-oil-spill-near-aliceville
- Form FRA F6180.39 (Accident Report)

Lac-Mégantic, Quebec, Canada, July 6, 2013 – Crude oil product

On July 6, 2013, a catastrophic railroad accident occurred when an unattended freight train containing crude oil rolled down a descending grade and subsequently derailed. The derailment resulted in multiple releases and subsequent fires, which caused the confirmed deaths of 47 individuals. In addition, according to many news reports, this derailment caused extensive damage to the town, the destruction of over 30 buildings and approximately half of the downtown area, a release of hazardous materials that would require cleanup costs and the evacuation of approximately 2,000 people.

The costs of the Lac-Mégantic train accident are still being estimated as cleanup and reconstruction efforts continue and lawsuits and insurance cases still need to be resolved. These costs include casualties (deaths and injuries), property damage to the town, environmental and other cleanup costs, the costs associated with rerouted train traffic, evacuation and emergency response costs, and the value of the railcars and oil that were lost. PHMSA estimates that the overall cost of this accident may exceed $1.4 billion.

Source:

- PHMSA

Plevna, MT, August 5, 2012 – Denatured alcohol product

A BNSF train derailed 18 of 106 cars, 17 of which were carrying denatured alcohol. Twelve of the 17 cars released the material and began to burn, causing two grass fires. Additionally, the highway near the site was closed. The probable cause of this accident is an irregular track alignment (a sunkink) due to a temperature of 92 degrees. Damages were reported as $1.085 million (equipment) and $315,000 (track). Approximately 310,000 gallons of denatured alcohol was consumed by the fire. No evacuations were required. The rail company responded to the scene along with Fallon County and several emergency crews from across the region.

Sources:

- http://www.ktvq.com/news/train-derailment-causes-multiple-explosions-near-plevna
- Form FRA F6180.39 (Accident Report)

Columbus, OH, July 11, 2012 – Ethanol product

A Norfolk Southern Railway (NS) train with 98 cars derailed 17 cars loaded with grain, syrup, and ethanol. Three tank cars of ethanol were breached and caught fire, prompting an evacuation of 100 people within a 1-mile radius of the accident site. The evacuation was lifted approximately 32 hours later. No crewmembers were injured, but two citizens had minor burn injuries because they approached the site and attempted to run away as the fire erupted. Estimated damages were $591,000 (equipment), $77,500 (track), and $551,400 (lading). The adjacent track was closed for approximately 36 hours, and the track that failed, causing the accident, was closed for approximately 48 hours. The following groups responded to the scene: City of Columbus Fire and Police Departments, Franklin County Sheriff's Department, Ohio Environmental Protection Agency–Air and Water, Public Utilities Commission of Ohio, National Transportation Safety Board (NTSB), and FRA.

Source:

- Form FRA F6180.39 (Accident Report)

Tiskilwa, IL, October 7, 2011 – Ethanol product

An Iowa Interstate Railroad train derailed 26 loaded freight cars approximately one-half mile east of Tiskilwa, IL. The train consisted of 2 locomotives and 128 cars. The derailed cars consisted of 15 covered hoppers loaded with corn mash, a covered hopper loaded with sand, and 10 tank cars loaded with ethanol. Of the estimated 143,534 gallons of ethanol spilled, approximately 61 percent of it was from cars with shell and/or head punctures and tears caused by contact. An additional 23 percent was lost by breaches caused by thermal expansion. The release of ethanol and resulting fire initiated an evacuation of about 500 residents within a ½-mile radius of the accident scene. There were no injuries or fatalities as a result of the accident and assistance was provided by a hazardous materials response team from the LaSalle Fire Department. Five additional fire departments were contacted to respond to the train accident. Estimated damages were $1,847,619 (railroad equipment, track and signals).

Sources:

- Form FRA F6180.39 (Accident Report)
- NTSB Accident Brief: http://www.ntsb.gov/doclib/reports/2013/RAB1302.pdf

Arcadia, OH, February 6, 2011 – Ethanol product

An NS train consisting of 2 locomotives and 62 cars (61 loaded and 1 empty) derailed 34 cars in Arcadia, OH. The derailed train caused a pileup of 33 loaded tank cars containing ethanol. It is estimated that 900,000 gallons of the product was lost. There were no injuries to the two-man train crew or to the public as a result of the derailment; however, evacuations were ordered for 60 residents (approximately 30 households) within a 1½-mile radius. Estimated damages were $1,895,500 (railroad equipment, track and signals). One hundred firefighters from surrounding departments responded to the scene. The fire from the explosion burned for almost 24 hours. It is estimated that approximately 50 trains go through the area on a regular basis.

Sources:

- Form FRA F6180.39 (Accident Report)
- http://www.yourlawyer.com/topics/overview/arcadia-ohio-norfolk-southern-train-derailment-lawsuit-lawyer
- http://www.gordon-elias.com/blog/2324/norfolk-southern-train-derails-catches-fire-and-explodes-in-arcadia-oh/

Rockford (Cherry Valley) IL, June 19, 2009 – Denatured ethanol product

About 8:36 p.m., central daylight time, on Friday, June 19, 2009, eastbound Canadian National Railway Company freight train U70691-18, traveling at 36 mph, derailed at a highway/rail grade crossing in Cherry Valley, Illinois. The train consisted of 2 locomotives and 114 cars, 19 of which derailed. All of the derailed cars were tank cars carrying denatured fuel ethanol, a flammable liquid. Thirteen of the derailed tank cars were breached or lost product and caught fire. At the time of the derailment, several motor vehicles were stopped on either side of the grade crossing waiting for the train to pass. As a result of the fire that erupted after the derailment, a passenger in one of the stopped cars was fatally injured, two passengers in the same car received serious injuries, and five occupants of other cars waiting at the highway/rail crossing were injured. Two responding firefighters also sustained minor injuries. The release of ethanol and the resulting fire prompted a mandatory evacuation of about 600 residences within a 1/2-mile radius of the accident site. Monetary damages were estimated to total $7.9 million. The evacuation was lifted the following day. Estimated damages were $1,292,460 (equipment) and $402,000 (track and signal). Of the estimated 323,963 gallons of ethanol lost, 90 percent was lost from cars with shell and/or head punctures and tears. The EPA estimated that 60,000 gallons of ethanol spilled into an unknown stream, which flowed near the Rock and Kishwaukee Rivers. The railroad hired a company to perform river assessments on both rivers in response to a report that hundreds of dead fish were allegedly found in the Rock River. The loss of lading from the 11 cars occurred primarily through punctures and tears in or near the tank heads and/or shells caused by contact with other tank cars and track structures. Sizable breaches in several cars were caused by the failure of the cars' B-end stub sills to separate from their stub sill cradle pads as intended by AAR Specification for Tank Cars M-1002 design criteria. The quantity of ethanol released would have been reduced significantly had tank head puncture resistance safety systems (head shields) been applied to the cars.

Source:

- Form FRA F6180.39 (Accident Report)
- http://www.ntsb.gov/doclib/reports/2012/RAR1201.pdf

Painesville, OH, October 10, 2007 – Ethanol, liquefied petroleum gas, phthalic anhydride products

A CSX Transportation freight train derailed 31 cars while being operated on a main track. The train consisted of 2 locomotives and 112 cars (106 loaded and 6 empty). The derailed cars included seven tank cars carrying ethanol, one tank car carrying liquefied petroleum gas, and one tank car carrying phthalic anhydride. Also among the 31 cars that derailed were covered hoppers carrying corn, wheat, feed, plastic, and lumber. The resulting fire caused 26 of the derailed cars to be destroyed. About 1,400 area residents were evacuated from an area of approximately 3 square miles. There were no reported injuries. Estimated damages and environmental cleanup costs were $8.48 million.

Source:

- https://www.ntsb.gov/investigations/fulltext/RAB0902.html

New Brighton, PA, October 20, 2006 – Denatured ethanol product

An NS train containing 83 tank cars loaded with denatured ethanol derailed on a bridge near New Brighton, PA, about 26 miles northwest of Pittsburgh, PA. Twenty-three of the tank cars derailed near the east end of the bridge, with several of the cars falling into the Beaver River. The probable cause of the derailment was a broken rail. Of the 23 derailed tank cars, about 20 released ethanol, which subsequently ignited and burned for about 48 hours. Some of the unburned ethanol liquid was released into the river and the surrounding soil. Approximately 485,278 gallons of product were estimated to have been released. Numerous city and county emergency responders, fire, and police personnel rushed to the derailment site where the Beaver County emergency response director established an train accident command center. In response to the intense heat and smoke from the fire, the emergency response director ordered the evacuation of a 7-square-block area of New Brighton, which affected approximately 100 people, including businesses and residents. The evacuation was lifted approximately 36 hours later when the situation was determined to be under control. No injuries or fatalities were reported. Damages were sustained in the amount $1,388,755 (Equipment) and $325,000 (track and structures). The train derailed on a track that has passenger traffic. Approximately 50 trains use the affected track daily.

Sources:

- Form FRA F6180.39 (Accident Report)
- http://www.ntsb.gov/doclib/reports/2008/RAR0802.pdf
- http://www.post-gazette.com/frontpage/2006/10/22/Massive-rail-cleanup-in-New-Brighton/stories/200610220178
- http://www.foxnews.com/story/2006/10/21/investigators-on-scene-pa-freight-train-fire

Appendix C: Lac-Mégantic Accident Non-Fatalities Potential Damage Estimates

A On July 6, 2013, a catastrophic railroad accident occurred in Lac-Mégantic, Quebec, Canada when an unattended freight train containing crude oil rolled down a descending grade and subsequently derailed. The derailment resulted in multiple releases and subsequent fires, which caused the confirmed deaths of forty-seven individuals. In addition, according to many news reports this derailment caused extensive damage to the town, the destruction of over 30 buildings and approximately half of the downtown area, a release of hazardous materials that would require clean-up costs, and the evacuation of approximately 2,000 people. Although the event took place in Canada, PHMSA believes it presents a unique data point that can be used to characterize the magnitude of a potential future catastrophic event that could occur in the U.S.

The costs of the Lac-Mégantic train accident are still being estimated as cleanup and reconstruction efforts continue and lawsuits and insurance cases still need to be resolved. Therefore, it probably won't be possible to obtain a final tally for several more years. PHMSA compiled different costs reported in the media, and have developed estimates of other costs on our own in order to produce and a very rough preliminary estimate of what we think the final cost of such an occurrence might be. These costs consist of property damage to the town, environmental and other cleanup costs, the costs associated with re-routed train traffic, evacuation and emergency response costs, and the value of the rail cars and oil that was lost. These costs exceed $450 million and include about $200 million in property damage and $200 million in environmental cleanup, as seen in the table below:

Inputs into Non-fatalities Damages Estimates

Cost Item	Units	Number of Units	Cost per Unit	Total Cost	Notes and Sources
Evacuation	Person Days	8400	217	$1,822,800	1200 people at 3 days, 800 people at 6 days, exlcudes long-term living costs for people whose homes were damaged
Emergency Response	Person Hours	7200	50	$360,000	150 firefighters (http://newsinfo.inquirer.net/439937/at-least-80-missing-in-canada-train-blaze-firefighter), assume 48 hours per person, assume $50 per hour including benefits and overhead
Property Damage and Survivor assistance to town				$200,000,000	Bangor Daily News, Oct 14, 2013
Environmental Cleanup				$400,000,000	http://www.thestar.com/news/canada/2014/06/16/quebec_claims_400_million_for_lacmgantic_train_disaster.html
Loss of Tank Cars	Number	74	115,000	$8,510,000	Assume all tank cars unusable
Loss of Product	Barrels	44,982	92	$4,138,344	$85 per barrel for Bakken Crude + $7 for transportation (from waybill), 714 barrels per tank car, 63 cars destroyed
Delay/Reroute Crude from Bakken	Barrels	9,510,480	4.2	$39,944,016	74 cars per day: assuming large daily shipments to Irving refinery based on Dec 26 2012 Bloomberg News article "Irving Refinery Said to Get 90,000 Barrels a Day by Rail": http://www.bloomberg.com/news/2012-12-26/irving-refinery-said-to-get-90-000-barrels-a-day-by-rail.html; 714 barrels per car (AAR), 6 months since accident happened, 30 days per month, 4.2 dollar rail differential on crude shipped from Alberta vs Bakken (waybill). Within 6 days of the accident, Irving was already rerouting Bakken crude through Southern Maine and (Pan Am Railway) and on CN tracks (CBS News - New Brunswick, July 12). The total cost increase should not exceed $4.2 per carload as Irving would just switch to using Alberta oil instead of Bakken oil at that point.
Dealy/Reroute Lumber from New Brunswick	Carloads	1,500	1000	$1,500,000	Waybill, cost increase based on figure reported by Lumber shipper who cited $500-$1500 per carload increase (WLBZ2 News, Augusta Maine, July 31)
Dealy/Reroute Other products Canada to Maine	Carloads	2,000	1000	$2,000,000	Waybill, cost increase based on figure reported by Lumber shipper who cited $500-$1500 per carload increase (WLBZ2 News, Augusta Maine, July 31)
Total Costs to Date				$658,275,160	

Note: Estimates based on analysis of Waybill data, where products are sourced and where they go, and train routes to estimate diverted traffic volumes through Lac Mégantic. The figures reflect the marginal increase in transportation costs. Network effects are assumed to be marginal given the low volume of trains on the particular track that runs through Lac Mégantic.