.

DEPARTMENT OF TRANSPORTATION

Pipeline and Hazardous Materials Safety Administration

49 CFR PARTS 171, 173, 174 and 179

[Docket No. FRA-2006-25169]

Hazardous Materials:
Improving the Safety of Railroad Tank Car Transportation of Hazardous Materials

"PIH Tank Car Crashworthiness Performance Standards"

Notice of Proposed Rulemaking

Regulatory Impact Analysis

Pipeline and Hazardous Materials Safety Administration

19 March 2008

Table of Contents

Executive Summary

Hazardous materials are essential to the health of the economy of the United States and the well-being of its people. These materials are transported via different means, but rail transportation of hazardous materials is recognized to be a safe method for moving large quantities of hazardous materials over long distances. In particular, the vast majority of hazardous materials shipped by railroad tank cars each year arrive safely and without incident.

The Pipeline and Hazardous Materials Safety Administration (PHMSA) is responsible for the safe and secure movement of hazardous materials (hazmat) by all transportation modes, including the Nation's railroads. PHMSA, in consultation with the Federal Railroad Administration (FRA), is proposing revisions to the Federal hazmat regulations[1] that would improve the crashworthiness protection of railroad tank cars that are designed to transport poison inhalation hazard (PIH) materials. [2]

There are more than 20 hazardous materials that are considered to be PIH that are shipped by rail in tank car quantities. Chlorine and anhydrous ammonia represent over 78 percent of the total PIH shipments.

Over the past several years, several very serious accidents involving catastrophic releases of PIH materials have focused the attention of the public, press, National Transportation Safety Board (NTSB) and the Congress on the serious consequences of these events. Since 2002, the NTSB investigated three accidents involving tank cars transporting PIH materials. In response to all three accidents, the NTSB recommended that FRA study improving the safety and structural integrity of tank cars and develop necessary operational measures to minimize the vulnerability of tank cars involved in accidents. In particular, in response to a January 18, 2002, freight train derailment in Minot, North Dakota, which resulted in one death and 11 serious injuries due to the release of anhydrous ammonia when five tank cars carrying the product catastrophically ruptured, and a vapor plume covered the derailment site and surrounding area, the NTSB made four safety recommendations to FRA specific to the structural integrity of hazardous material tank cars. Subsequently, in 2005, section 20155 of the Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users, Pub. L. 109-59 (SAFETEA-LU) reiterated NTSB's recommendations in part by directing the Secretary of Transportation to "validate a predictive model to quantify the relevant dynamic forces acting on railroad tank cars under accident conditions." Section 20155 also directed the Secretary of Transportation to "initiate a rulemaking to develop and implement appropriate design standards for pressurized tank cars." During the same period, major railroads and shippers expressed growing concern over the actual and potential liability associated with rail transportation of these commodities and they also expressed their desire to reduce the risk of catastrophic releases.

This Notice of Proposed Rulemaking (NPRM) proposes enhanced tank car performance standards for head and shell impacts; operational speed restrictions for trains hauling PIH tank cars; interim operational restrictions for trains hauling tank cars not meeting the enhanced

---

[1] 49 CFR parts 171-180.

[2] PIH materials are gases or liquids that are known or presumed on the basis of tests to be so toxic to humans as to pose a hazard to health during transportation. See 49 CFR §§ 171.8, 173.15, and 173.312. See also 69 FR 50988 (Aug. 16, 2004).

performance standards proposed, but used to transport PIH materials and operating in non-signaled territory; and an allowance to increase the gross weight of tank cars that meet the enhanced tank-head and shell standards. The NPRM is designed to very substantially reduce the risk of catastrophic releases of PIH materials.

The proposed performance standards for tank-head and shell puncture resistance systems provide industry with flexibility to take advantage of innovative materials and technologies. The related proposed operational limitations would restrict the operating speed of all tank cars transporting PIH materials to a maximum speed of 50 mph.

The costs anticipated to accrue from adopting this proposed rule would include: (1) the labor and material costs for incorporating enhanced crashworthiness features into tank cars that transport PIH materials, (2) the design and re-engineering costs required to implement the proposed enhanced tank-head and shell puncture-resistance systems, (3) the costs for transferring existing PIH tank cars to other commodity services, and (4) the maintenance and inspection costs for the new more crashworthy tank cars. Additionally, there would be costs incurred as a result of the operational restrictions for tank cars that transport PIH materials, including: (1) the cost of restricting railroad tank cars used to transport PIH materials to 50 mph, and (2) the cost of temporarily restricting existing railroad tank cars used to transport PIH materials in non-signaled territory to 30 mph. Finally, there would be a cost for the increased traffic or volume of tank cars that transport PIH materials due to the increased weight, and thus lower commodity capacity, of those cars.

The primary potential benefits or savings expected to accrue from the implementation of this proposed rule would be the reduction in the number and severity of casualties arising from train accidents and derailments involving tank cars that transport PIH materials. In addition, benefits would accrue from a decrease in property damages, including damages to locomotives, railroad cars, and track; environmental damage; track closures; road closures; and evacuations. Moreover, there would also be a benefit in fuel savings (which may offset some of the operational costs) due to limiting train operating speeds.

This document presents a 30-year analysis of the costs and benefits associated with DOT's proposed rule, using both 7 percent and 3 percent discount rates. It also presents an analysis of a regulatory alternative considered, and sensitivity analyses associated with varying assumptions used for estimating PIH release-related benefits.

A *baseline* cost estimate is particularly important for the conduct of these analyses. The railroad industry has expressed its intention to proceed with a standard of its own absent issuance of a DOT rule requiring enhanced crashworthiness of PIH tank cars. In general, industry participants appear to recognize the need to improve the design of tank cars transporting PIH materials. In fact, the AAR has mandated (but temporarily suspended to permit issuance of this notice of proposed rulemaking) use of heavier cars with top fittings that meet specified requirements such as the new tank cars built by Trinity Industries, Inc. (Trinity) for the transportation of PIH materials in interchange. (These proposed interchange standards are referred to as the "AAR Interchange Standard"). Accordingly, the baseline for the analyses conducted reflects compliance with the AAR standard by replacing the existing fleet of PIH tank cars with AAR compliant Trinity-like tank cars. This baseline includes incremental costs associated with the design, construction, and operation of new Trinity-like tank cars to replace existing cars and the transfer of existing PIH tank cars to other commodity services. The 30-year cost estimates associated with this baseline are $476.6 million (PV, 7%) and $718.7 million (PV, 3%). Annualized costs are $38.4 million (PV, 7%) and $36.7 million (PV, 3%).

The analysis of the proposed rule takes into account the incremental impacts that would be incurred with meeting the proposed requirements (i.e., the design, construction, and operation costs for the new DOT-compliant cars in excess of the baseline impacts that would be incurred absent this rulemaking with the introduction of the AAR-mandated cars). In addition, the proposed rule analyzes full impacts related to the proposed operating speed restrictions). Thus, this analysis takes into account the fact that the AAR and shippers have active plans to make major changes in the tank car fleet that moves PIH commodities. The 30-year cost estimates associated with implementation of the proposed rule are $350.6 million (PV, 7%) and $431.6 million (PV, 3%). Annualized costs are $28.3 million (PV, 7%) and $22.0 million (PV, 3%).

The benefits of the proposed rule fall into two sub-groups. The first group consists of benefits that would accrue from avoidance of collision- and derailment-related PIH releases resulting from a combination of the enhanced tank car crashworthiness standards and operating speed restrictions. This group of benefits includes reductions in casualties; property damage, including damage to locomotives, rail cars and track; environmental damage; evacuation and shelter-in-place costs; track closures; road closures; and electric power disruptions. Casualty mitigation estimates are based on a value of statistical life of $5.8 million. This group of benefits also includes more difficult to monetize benefits such as the avoidance of hazmat accident related costs incurred by Federal, state, and local governments and impacts to local businesses. As with costs, the benefits associated with introducing DOT-compliant tank cars are reduced by the level of benefits that FRA estimates would accrue from replacing existing cars with AAR-mandated cars absent this rulemaking. This analysis includes a scenario which DOT believes is the most *realistic* projection of benefits that would be realized, including the possibility of an event with moderately more severe consequences than has occurred in the past 10 years. This approach recognizes the significant probability that, given the quantity of product released and the proximity of potentially affected populations to accident sites, in one or more events the consequences known to be possible will be realized, with loss of life on a scale not previously encountered.

The second group of benefits consists of business benefits that would accrue in response to the operating speed restrictions (which may partially offset the operating costs imposed by these restrictions) and the enhanced tank car design. This group includes fuel savings from economic efficiencies resulting from operating speed restrictions and repair savings from more salvageable tank cars. DOT believes that the useful life of compliant tank cars introduced during the 30-year analysis period will extend well beyond that period as further explained in section 12.14. Moreover, the residual value at year 30 of tank cars constructed to meet the enhanced standards proposed will be greater than the residual value of conventional tank cars and Trinity-like tank cars contemplated by AAR's new standard. Thus, the analysis includes a benefit reflecting the residual value for the new tank cars at year 30.

FRA then added up both of these groups of benefits over the next 30 years. Taking both of these groups of benefits, relative to the state of the world where the AAR would enforce it's interchange standard, the 30-year benefit estimates associated with implementation of the proposed rule are $666 million (PV, 7%) and $1.089 billion (PV, 3%). Annualized benefits are $53.7 million (PV, 7%) and $55.6 million (PV, 3%).

An evaluation of a "status quo" alternative is also included. In general, industry parties appear to recognize the need to improve the design of tank cars transporting PIH materials. In fact, as previously noted, the AAR Interchange Standard would require use of Trinity-like cars for the transportation of PIH materials in interchange. Accordingly, the "status quo" alternative would be to allow the AAR to enforce its interchange standard. The costs associated with such an alternative would still be represented by the baseline cost scenario; however, they would be equivalent to the costs the railroad industry is willing to incur voluntarily, and thus would not be considered true regulatory costs. In addition, this alternative would not include costs from any operating speed restrictions. The benefits from this alternative are estimated as approximately 15% of the benefits that would be expected to result from implementation of the crashworthiness requirements of the proposed rule. As with the costs, this alternative would not offer any of the business benefits associated with the DOT proposal due to the operating speed restrictions. The 30-year cost estimates associated with this alternative are $476.6 million (PV, 7%) and $718.7 million (PV, 3%).

Finally, three sensitivity analyses varying assumptions used to estimate the benefits of the proposed rule are included. The first addresses the uncertainty regarding the consequences from release of PIH materials resulting from train accidents. This analysis is based on the assumption that the consequences of projected incidents will be of the same average severity as those in the past ten years. It does not recognize how fortunate the circumstances surrounding recent past incidents have been. Given the rarity of the occurrence of rail accidents resulting in the release of PIH materials from tank cars, and the high variability in the circumstances and consequences of such events, this sensitivity analysis is useful. The 30-year benefit estimates associated with this scenario are $786,073,251 (PV, 7%) and $866,616,695 (PV, 3%). The second and third sensitivity analyses address the imprecision of assumptions regarding the value of a life, which affect the level of safety benefits (i.e., casualty mitigation) that would result from promulgation of the proposed rule. This analysis presents benefit levels associated with values of a statistical life of $3.2 million and $8.4 million. The 30-year benefit estimates associated with these scenario are $562,100,371(PV, 7%, VSL: $3.2M) and $857,952,000 PV, 7%, VSL: $8.4M).

This rulemaking would fulfill the mandate of SAFETEA-LU and respond to NTSB's recommendations pertaining to tank car structural integrity and operational measures, by specifying performance standards and operational restrictions sufficient to reduce the likely frequency of catastrophic releases to a level as low as reasonably possible, given the need to transport the products in question, and based on analysis of the forces that result from serious train accidents. PHMSA and FRA note that, while the proposed actions are based exclusively on railroad safety considerations, strengthening the protective systems on PIH tank cars may also reduce the likelihood of a catastrophic release caused by criminal acts, such as deliberately throwing a switch in the face of an oncoming train or taking other action that could result in a derailment or collision.

The proposed actions would not reduce to zero the probability of a catastrophic release. However, achieving that goal is likely inconsistent with the purpose of the transportation service provided and beyond design practice that presently can be conceived. The proposed actions would substantially reduce the risk presently attending transportation of the subject products, and these reductions can be achieved within a time certain. Providing reassurance to the communities through which these trains travel, that every feasible action has been taken to safeguard those potentially affected, itself provides societal benefits. Included among these benefits are peace of mind of residents and others within the potential zones of danger, and likely avoidance of more costly and less effective public responses (such as prohibiting transportation of the products outright or establishing burdensome conditions of transportation that are perceived to benefit individual communities while driving up total public exposure).

1.0 Introduction

PHMSA, in consultation with FRA, is proposing revisions to the Federal hazardous materials regulations that would improve the crashworthiness protection to railroad tank cars that transport PIH materials.

Hazardous materials shipments represented 5 percent of the total U.S. rail carloads, and 5.4 percent of the total tonnage in 2004. PIH[3] carloads for 2004 consisted of 105,000 carloads throughout the country.[4]

Hazardous materials are vital to maintaining the health of the economy of the United States and are essential to the well-being of its people. These materials are used in water purification, farming, manufacturing, and other industrial applications. The need for hazardous materials to support essential services means that transportation of hazardous materials is unavoidable. Generally, rail transportation in the United States is recognized as being a safe method of moving large quantities of hazardous materials over long distances. The vast majority of hazardous materials shipped by railroad tank car each year arrive safely and without incident.

2.0 Statement of the Problem and Need for Proposed Action

The Federal hazardous materials transportation law (Federal hazmat law, 49 U.S.C. §§ 5101 *et seq.*, as amended by section 1711 of the Homeland Security Act of 2002, Public Law 107-296 and Title VII of the 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)) authorizes the Secretary of the U.S. Department of Transportation (DOT) to "prescribe regulations for the safe transportation, including security, of hazardous material in intrastate, interstate, and foreign commerce." The Secretary has delegated this authority to PHMSA. The Secretary also has authority over all areas of railroad transportation safety (Federal Railroad Safety laws, 49 U.S.C. 20101 et seq) and has delegated this authority to FRA. See Title 49 Code of Federal Regulations (CFR) 1.49.

A primary safety and security concern in the rail transportation of hazardous materials is the prevention of a catastrophic release in proximity to such places as populated urban areas, events or venues with large numbers of people in attendance, iconic buildings, landmarks, or environmentally-sensitive areas. Such a catastrophic event could be the result of an accident—such as the January 6, 2005, derailment and release of chlorine in Graniteville, South Carolina; the accident and release of chlorine in Macdona, Texas, in June 2004; the derailment and release of anhydrous ammonia in Minot, North Dakota, in January 2002; or the derailment and release of chlorine in Alberton, Montana, in April of 1996. It should be noted that not only large urban areas are potentially at risk. In fact, in part as a result of the modestly higher train speeds that can be achieved through rural areas and smaller communities, compared to congested terminal areas in large cities, most of the fatal train accidents involving catastrophic release of these commodities have occurred in smaller towns and in the outskirts of larger population centers.

[3] NOTE: PIH is also referred to as Toxic by Inhalation (TIH). The terms are equivalent.
[4] Statement of Edward Hamberger, President & CEO, Association of American Railroads (AAR), before U.S. House of Representatives Subcommittee on Railroads, June 13, 2006, p. 3.

Railroads carry over 1.7 million shipments of hazardous materials annually. PIH materials are in the category of hazardous materials with the highest consequences (casualties and physical damage) when they are released because of loss of car integrity caused by a derailment or collision. Consequences of such a scenario could include: numerous casualties and injuries, particularly if it involves a highly hazardous chemical and occurs in a populated area; a high cost for decontamination; evacuation of nearby residences and business establishments; property and business damage; and a negative impact on other modes of transportation.

It is also important to note that transportation of such hazardous materials is particularly vulnerable to sabotage or misuse. In the wrong hands, hazardous materials can pose a significant threat.

Market Failure

Market failure exists when the allocation of goods and services by a market is not efficient. Currently, there are inefficiencies in the market relating to the rail transportation of PIH materials, such as chlorine and anhydrous ammonia, and these inefficiencies have led to a situation where the private markets are not adequately protecting the health and safety of the public.

Railroads transport a little over 100,000 carloads of PIH materials annually. According to the railroads, this traffic accounts for only 0.3 percent of all rail freight traffic. As the railroads have a common carrier obligation to carry all freight offered for transport, including PIH materials, they cannot refuse to transport shipments of PIH materials even if the perceived risk observed by the railroad is thought to be too high. PIH shipments frequently move through populated or environmentally-sensitive areas where the consequences of an accident could be the loss of life, serious injury, property damage, and significant environmental damage. The railroads have had three serious accidents involving PIH releases since 2002, resulting in 13 deaths and numerous injuries and significant property damage. The costs of the 2005 Graniteville, South Carolina accident alone totaled well over $100 million, and the railroad involved in that wreck is currently defending a suit in which a textile company that closed after the accident is seeking $420 million dollars in damages and an insurance company is seeking an additional $215 million for money it paid to the textile company. Despite their tort liability, many of the costs associated with PIH accidents (especially environmental damage, first responder costs, and disruptions to the economy) are external to the railroads and therefore may not be properly taken into account when the railroads are making private safety decisions.

There are a variety of steps railroads can take to reduce risks and increase revenues associated with the PIH traffic they carry. However, given the uncertainty of whether a particular railroad will have an accident involving the release of PIH materials and the severity of such an accident, let alone the possibility of a PIH release caused by criminal or terrorist activity, it is difficult for railroads to ensure that they are covering their costs associated with PIH traffic.

1) Railroads have attempted to cover their risk exposure by a combination of self-insurance and private insurance, but it is difficult for the railroads and their insurance underwriters to accurately predict what insurance level is adequate for a particular railroad.

2) Railroads can and have increased their shipping rates for PIH materials based on differential pricing and costs associated with the traffic (including insurance costs), and can continue to raise rates so long as the rates are reasonable. (Rate reasonableness is determined by the Surface Transportation Board in a formal proceeding that is initiated following a complaint from a shipper.) Given the uncertainties previously noted, it is difficult for the railroads to know whether the rates they are charging are adequate.

3) Railroads can also implement safety measures designed to avoid derailments and train collisions that might result in the release of PIH materials, although they are unlikely to be able to eliminate all such incidents.

4) Furthermore railroads can request PHMSA and FRA to impose new regulatory requirements (such as those proposed in this rulemaking) that would minimize the likelihood of a release of PIH materials in the event of a train collision or derailment, but have chosen not to seek such regulatory relief. Instead the railroads have decided to force anhydrous ammonia and chlorine shippers to purchase new and slightly upgrade tank cars by issuing an interchange rule through the Association of American Railroads (AAR). (Interchange rules establish standards that railroads must meet when they exchange rail cars with other railroads.) AAR Casualty Prevention Circular 1178 (Circular 1178) requires that newly built chlorine and anhydrous ammonia tank cars meet specified tank car standards that exceed current PHMSA standards, and precludes the use of nonconforming cars in interchange after December 31, 2018. The tank car standards are based on a tank car produced by Trinity Industries, Inc. Shippers, rather than railroads, will bear the cost of Circular 1178 since PIH tank cars are owned by shippers and fleet management companies that lease the cars to the shippers. Railroads are considering issuing similar restrictions for the rail movement of other PIH materials. The railroads have temporarily suspended Circular 1178 until March 31, 2008, to permit PHMSA and FRA to issue a notice of proposed rulemaking that would impose new and enhanced PIH tank car standards.

The Circular 1178 approach chosen by the railroads has two basic problems. First, the AAR proposed tank car standards will not likely prevent PIH tank car releases in even moderate speed train accidents. (As discussed latter, DOT has estimated that the Trinity car would only be about 15 percent as effective as cars built to the standards in this rulemaking in eliminating or mitigating the release of a PIH material during a train collision or derailment.) Second, chlorine and anhydrous ammonia shippers may be required to replace cars required by Circular 1178 before the end of their useful life as new PHMSA tank car standards become effective. Circular 1178 will, therefore, require huge expenditures by the PIH shippers for only modest actual benefits to the railroads or the public at large. Given the failure of the private markets to adequately reduce the risk of loss of lading in future derailments of tank cars transporting PIH materials, PHMSA and FRA have tentatively concluded that it is appropriate for PHMSA to issue regulations to reduce this risk. The PHMSA regulatory process can achieve a solution that is best suited to maximizing public safety with economically balanced requirements for PIH shippers and railroads that carry these commodities.

Federal Solution

When promulgating new or revised regulations, it is necessary to consider whether the regulation should be issued at the Federal level or at the state and/or local level. PIH materials are manufactured and used at numerous locations in the United States, and are routinely imported for use in the United States directly by rail from Canada and by ship to U.S. ports and then by rail to their final destination. This proposal would apply to all transportation of PIH materials by rail. Many railroads operate over extended areas that cross many local, and some state, boundaries. Local regulation of this issue would be extremely difficult and cumbersome. State regulation of this issue for the shippers of PIH materials would also be complicated and likely more burdensome. DOT believes that most large railroads and shippers would prefer a uniform Federal regulation to simplify the compliance and administrative costs. Shippers of PIH are relying on a Federal solution to ensure seamless transportation across multiple state and local jurisdictions.

3.0 Findings

This analysis includes qualitative discussions and quantitative measurements of costs and benefits of the proposed rule. The costs that would be imposed are primarily labor and material costs associated with incorporating the new crashworthiness features found in the proposed rule, and costs related to the designing and re-engineering required to implement the proposed safety enhancements. In addition, there would be costs associated with transferring current PIH tank cars to other commodity services, and costs associated with the proposed operating restrictions. Finally, there would be costs for the increased traffic or volume of tank cars on rail due to the increased weight, and thus reduced capacity, of the cars. A majority of the savings will accrue from implementation of the requirements that decrease the probability of death, and mitigation of potential injuries from accidents and derailments of trains that involve tank cars loaded with PIH materials. In addition, savings would accrue from a decrease in railroad and other property damages, environmental remediation, track closures, road closures, and evacuations.

For the 30-year period analyzed, the DOT PIH tank car proposal is estimated to have quantified costs totaling $1.566 billion with a PV (7%) of $827.2 million. For a 3 percent discount rate the PV is $1.150 billion. The benefits for this base case are estimated to total $1.6 billion. Over the 30-year period, the PV (7 %) of the estimated benefit is $744 million. For a 3 percent discount rate the PV is $1.242 billion.

The AAR Interchange Standard reflects the Trinity-like tank car. This is the baseline alternative in the analysis. It reflects the costs and benefits that the industry has and would spend to replace the PIH tank car fleet with aTrinity-like tank car. For this alternative, the total costs would be $1.05 billion, with a PV (7%) of $476.6 million. For a 3 percent discount rate the PV is $719 million. The total potential benefits for this case would be $276 million, with a PV of $79 million. For a 3 percent discount rate the PV is $153.7 million.

The true regulatory impact from this rulemaking would be the DOT proposal minus the AAR proposal. The the true regulatory cost for the DOT proposed alternative is $350.6 million (PV

7%) and with a PV(3%) $432 million. The true benefits for the DOT proposal would be $666 million (PV 7%) and a PV (3%) of $1.089 billion.

The results of this analysis are sensitive to the various inputs and assumptions used to estimate costs and benefits. For instance, the results could change if the total incremental costs for incorporating the new crashworthiness features were significantly different. Given that this proposed rule contains performance standards and not prescriptive design standards, it is possible that tank car manufacturers may be able to develop compliant designs that are less expensive. Another potential source of uncertainty affecting the level of compliance costs is future demand level for PIH materials. The degree and direction of any such fluctuation(s) over the 30-year period of this analysis is not predictable with any reasonable degree of confidence.

In addition, the value of a statistical life that is used for estimating safety benefits can also affect the overall cost benefit comparison and thus the outcome of this analysis. This analysis shows the differences from using different values for a Value of a Statistical Life (VSL). Specifically, the analysis uses a value of $5.8 million. It also shows what the benefit totals would be if the value was $2.6 million less, i.e., $3.2 million; and $2.6 million more, i.e., $8.4 million.

Other sources of uncertainty can be more readily analyzed. DOT conducted sensitivity analyses varying assumptions related to the value of a statistical life as well as accident severity projections used to estimate the benefits of the proposed rule. The first addresses the uncertainty regarding the consequences from release of PIH materials resulting from train accidents. This analysis is based on the assumption that the consequences of projected incidents will be of the same average severity as those in the past ten years. It does not recognize how fortunate the circumstances surrounding recent past incidents have been. Given the rarity of the occurrence of rail accidents resulting in the release of PIH materials from tank cars, and the high variability in the circumstances and consequences of such events, this sensitivity analysis is useful. The 30-year benefit estimates associated with this scenario are $586,624,122 (PV, 7%) and $926,731,141 (PV, 3%). The second and third sensitivity analyses address the imprecision of assumptions regarding the value of a life, which affect the level of safety benefits (i.e., casualty mitigation) that would result from promulgation of the proposed rule. Casualty mitigation benefits associated with this rulemaking were estimated using a value of statistical life of $5.8 million. Thirty-year benefit estimates associated with values of a statistical life of $3.2 million and $8.4 million would be $562,100,371 (PV, 7%, VSL: $3.2M), $587,952,000 (PV, 7%, VSL: $8.4M).

This analysis provides estimates of what the potential savings could be from accidents or derailments in which PIH tank cars do not lose their integrity as a result of implementing the proposed provisions. Such benefits include lives saved, injuries averted, evacuations avoided, environmental cleanup averted, track and road closures avoided, and property and business damages avoided. Other significant societal benefits are discussed, but their value is translated into monetary terms only to the extent it was possible to do so with the information available. This analysis also includes benefits associated with the fact that the proposed operating restrictions would produce absolute economic (non-accident related) benefits in terms of fuel savings. Finally, this analysis estimates that tank cars built to the proposed standards will have a significantly higher residual value at the end of the period analyzed (more crashworthy cars will likely not be scrapped at the same rate as current cars).

It is important to note, as several commenters at the public meetings relating to this rule have stated, that the tank car is only one component of the rail transportation system, and no single component of the system can provide the entire means to improving tank car safety.

4.0 Background

The most recent statistics available indicate that there are approximately 1.7 million tank car shipments of hazardous materials in the United States and Canada annually. "Class 2 liquefied compressed gasses (LPG, anhydrous ammonia, chlorine, propane, and vinyl chloride) were among the top 10 shipments of hazardous materials commodities transported by tank car."[5]

During an NTSB hearing in July of 2002, an AAR official stated that the North American in-service tank car fleet totaled about 280,000 cars. At the same time, AAR provided data indicating that there were approximately 59,344 pressurized tank cars in service. According to AAR, of that number, 23,919 were built after January 1, 1989, and were manufactured from normalized steel.[6]

There are over 20 hazardous materials considered to be PIH that are shipped by rail in tank car quantities. However, chlorine and anhydrous ammonia represent over 78 percent of the total PIH shipments. In 2003, over 77,000 tank car loads of PIH materials were shipped by rail, and ammonia and chlorine represented 39.6 percent and 39.05 percent, respectively. Ethylene oxide represented 9.4 percent of the shipped loads in 2003.

The vast majority of hazardous materials shipped every year by rail tank car arrive safely and without incident. For example, in the year 2004, when there were approximately 1.7 million shipments of hazardous materials by rail, there were only 29 train accidents in which a hazardous material was released. As a result of these accidents, a total of 47 hazardous material cars released some amount of product. The likelihood of a release for 2004 was a small fraction of a percent (47/1,700,000, or 0.0028 percent). This suggests that there is a low probability of these types of accidents/incidents occurring. Nevertheless, the severity of the accidents that do occur can be very high.

4.1 Major PIH Accidents 1996 - 2005

As noted in section 2 above, in the last several years, there have been a number of rail tank car accidents in which tank cars transporting PIH materials were breached resulting in catastrophic releases of PIH materials. Athough none of these accidents was caused by the hazardous materials tank cars, the failure of the tank cars involved led to fatalities, injuries, evacuations, property and environmental damage.

---

[5] NTSB, "Derailment of Canadian Pacific Railway Freight Train 292-16 and Subsequent Release of Anhydrous Ammonia Near Minot, North Dakota January 18, 2002." Railroad Accident Report NTSB/RAR-04/01, Adopted March 9, 2004, p. 51.

[6] Ibid, p. 50.

Graniteville, SC, January 6, 2005
The Graniteville crash killed 9 people and injured more than 550 people. It was the deadliest train wreck involving hazardous material in nearly three decades. At 2:39 a.m., a train traveling at approximately 47 mph, crashed into a locomotive and two cars on a siding in Graniteville, South Carolina. The shell of a railroad tank car containing chlorine was punctured by the coupler of another car and instantaneously released approximately 9,220 gallons of chlorine, creating a toxic vapor plume that engulfed the surrounding area. The release occurred in commercial and residential areas of the city. Approximately 5,400 residents were evacuated from a 1-mile radius around the accident site. About 554 people complaining of respiratory difficulties were taken to local hospitals. Of those, 75 were admitted for treatment. Nine people died from exposure to chlorine gas.[7] Fifteen people were placed on ventilators in intensive care units. Twenty-five people were hospitalized for more than 3 days. Twenty-six people were hospitalized for 1 to 2 days. There were 68 repeat visits to the emergency department, 58 people with significant symptoms, and 98 with moderate symptoms. Forty-one people who visited the emergency department were released and 13 people were treated at a physician's office.[8]

Macdona, Texas, June 28, 2004
At approximately 5:03 am on June 28, 2004, a Union Pacific (UP) freight train collided with a BNSF train on the Del Rio subdivision near Macdona, Texas. It was dawn on a cloudy day with a light wind and 77 degrees Farenheit. The accident derailed 4 locomotives and 19 cars on the UP train and 17 cars on the BNSF train.

As a result of the derailment and pileup of railcars, a pressurized tank car containing chlorine was punctured in the lower quadrant of the tank car head. Chlorine escaping from the punctured car immediately vaporized into a cloud of chlorine gas that engulfed the accident area to a radius of at least 700 feet before drifting away from the site. Approximately 9,400 gallons of chlorine was released from the tank car. Three persons, including the conductor of the UP train and two local residents, died as a result of exposure to chlorine gas. The UP train engineer, 23 civilians, and 6 emergency responders were treated for respiratory distress or other injuries related to the incident.

An evacuation zone was established around the accident site with a radius of about 2 miles. Over 60 people were evacuated from their homes and a camping area near the accident site.

Minot, North Dakota, January 18, 2002
At approximately 1:37 am on January 18, 2002, a Canadian Pacific Railway freight train derailed 31 of its 112 cars about a half-mile west of the city limits of Minot, North Dakota. Eleven of the 31 derailed cars were pressurized tank cars transporting anhydrous ammonia. Five of those tank cars received sidewall impacts to their shells, causing the cars to catastrophically rupture. Approximately 146,700 gallons of anhydrous ammonia were released from those cars and a cloud of hydrolyzed ammonia formed almost immediately. This plume rose an estimated 300

[7] Data are from NTSB Report of Railroad Accident Collision of Norfolk Southern Freight Train 192 (which was traveling at 47 mph) with Standing Norfolk Southern Local Train P22 with Subsequent Hazardous Materials Release Graniteville, SC January 6, 2005, NTSB/RAR-05/04, Public Meeting Executive Summery, November 29, 2005.
[8] Data are from Earl Hunter, Commissioner, South Carolina Department of Health and Environmental Control.

feet and gradually expanded 5 miles downwind of the accident site and over a population of about 11,600 people.

One resident was fatally injured; 11 people sustained serious injuries; and 322 people, including 2 train crewmembers, sustained minor injuries. Railroad property damages exceeded $2 million, and more than $8 million has been spent for environmental remediation. In addition, other costs were incurred that are not quantified here such as liability payments and disruption to non-railroad businesses and community activities. Fatal and serious injuries were comparatively low, given the potential presented by the plume, as a result of a prompt decision by the incident commander to order shelter in place and by the fact that the incident occurred at approximately 1:37 am, a time when most residents were in their homes and activity on public streets was minimal. Over the next 5 days, another 74,000 gallons of anhydrous ammonia were released from the six other anhydrous ammonia tank cars.

The NTSB reported that approximately 20 homes in a half-mile radius immediately east of the derailment site were evacuated. The FRA investigation notes that approximately 100 people were evacuated. This evacuation went on for over 41 days (January 18, 2002 to February 27, 2002). Approximately 10,000 people were required to shelter in place.[9]

Alberton, Montana, April 11, 1996
At 4:10 a.m., 19 cars from a Montana Rail Link (MRL) freight train derailed. Six of the derailed cars contained hazardous materials. One of the derailed tank cars containing chlorine ruptured, releasing 130,000 pounds of chlorine into the atmosphere. About 1,000 people from the surrounding area were evacuated. The Alberton derailment killed 1 person and injured 350 others.

In addition to the chlorine that was released during this accident, other hazardous materials were also released. This included 17,000 gallons of potassium cresylate solution and 85 dry gallons of sodium chlorate.

4.2 Federal Regulatory History

The Secretary of Transportation has authority over all areas of railroad transportation safety (49 U.S.C. §§ 20101 *et seq.*), and has delegated this authority to FRA (49 CFR § 1.49). Pursuant to its statutory authority, the FRA promulgates and enforces a comprehensive regulatory program (49 CFR parts 200-244) covering all aspects of railroad operations. FRA inspects railroads and shippers of hazardous materials for compliance with both FRA and PHMSA regulations. FRA also conducts research and development to enhance railroad safety.

Since the 1970s, DOT has issued a number of regulations to improve the survivability of tank cars in accidents. In these rulemakings, DOT required the installation of a tank-head puncture resistance system (head protection), a coupler vertical restraint system (shelf couplers), insulation, and a thermal protection system for certain high-risk hazardous materials. The safety

[9] The reports do not note how long these people were required to be sheltered in place. DOT will assume approximately one day for this analysis. DOT is assuming a value of $50 per person per day for a value of sheltering in place.

record indicates that these systems, working in combination, have greatly reduced the potential harm to human health and the environment when railroad accidents and derailments involving tank cars occur.

On August 10, 2005, Congress passed Public Law 109-59 (SAFETEA-LU), which added section 20155 to the Federal hazmat law. See 49 U.S.C. § 20155. Reiterating in part NTSB's recommendations from the 2002, Minot, North Dakota accident, § 20155 required FRA to (1) validate a predictive model quantifying the relevant dynamic forces acting on railroad tank cars under accident conditions, and (2) initiate a rulemaking to develop and implement appropriate design standards for pressurized tank cars.

On May 24, 2006, PHMSA and FRA announced that they were initiating a comprehensive review of design and operational factors that affect the safety of railroad tank car transportation of hazardous materials.[10] In order to facilitate public involvement in this review, FRA established a public docket (docket no. FRA-2006-25169) to provide interested parties with a central location to both send and review relevant information concerning the safety of railroad tank car transportation of hazardous materials.[11] In addition, PHMSA and FRA held public meetings from May 31 to June 1, 2006, on December 14, 2006, and on March 30, 2007.[12] The primary purpose of the first meeting was to surface and prioritize issues relating to the safe and secure transportation of PIH hazardous materials by railroad tank car. The primary purpose of the second meeting was to solicit input and comments in response to specific questions posed by the DOT agencies. The primary purpose of the third public meeting was for FRA to share its preliminary research results regarding tank car survivability and to provide an update on the agency's progress towards developing an enhanced tank car standard. Transcripts of these public meetings are available in the docket of this proceeding.

4.3 Design and Construction of Tank Cars

The shell of a tank car is made from rolled plates of steel that are welded to form a cylinder. Pressed or spun steel tank heads are welded to the ends of the cylinder to form the completed tank. A stub sill and body bolster arrangement -the structural member for the couplers and draft gear and the attachment point for the wheel sets for the tank car—is attached to the underside of the tank at both ends of the tank. Other appurtenances such as brake system components are welded to pads that are, in turn, welded to the tank shell to improve stress distribution. A jacket consisting of 12 gauge steel, is often installed on the outside of the tank. Typically a layer of insulation, fire retardant material, or both are placed between the jacket and the tank car shell.

It is important to note that all pressure tank cars, including the class 105 and 112 tank cars built since January 1, 1989, have been required to have tank shell and heads constructed of normalized steel. The five tank cars that had catastrophic shell failures in the Minot accident in January, 2002 were built before 1989 and had tank shells fabricated from non-normalized steel.[13] "Normalized" steel is steel that has been subjected to a specific heat treatment procedure that

[10] See 71 FR 30019 (May 24, 2006).
[11] See 71 FR 37974 (July 3, 2006).
[12] See 71 FR 30019, 71 FR 67015 (Nov. 17, 2006), 72 FR 12259 (March 15, 2007).
[13] NTSB Report on the Minot, ND derailment; January 18, 2002.

improves the steel's ability to resist fracture. Current standards allow for the use of non-normalized steel tank cars until 2029.[14] The tank car punctured in the Graniteville accident, however, was manufactured after 1989 and built of out of newer, more ductile, normalized steel, leading NTSB to conclude that "even the strongest tank cars in service can be punctured in accidents involving trains operating at moderate speeds."[15] At the same time, a tank car manufactured in 1979 and built out of the same type of steel used in the failed Minot cars survived the Graniteville derailment with no loss of product.

4.4 PIH Hazardous Materials

Anhydrous Ammonia (NH_3) is transported as a liquefied compressed gas in pressurized rail tank cars. It is a compound formed by the combination of two gaseous elements, nitrogen and hydrogen. If it is released, it vaporizes and expands rapidly to return to a gaseous state. The boiling point of anhydrous ammonia is -28 degrees F. Anhydrous means "without water." Because NH_3 contains little or no water, it is attracted to any form of moisture.[16]

Ammonia was first produced from the nitrogen in the air in 1909 through the Haber Process, which was developed by Fritz Haber and Carl Bosch. This process was patented in 1910. The main uses of ammonia are in the production of fertilizers, explosives, and the synthesis of organonitrogen compounds. The most familiar use of ammonia to the general public is as an active ingredient in household glass cleaners. The first industrial use of ammonia was by the Germans during World War I. A blockade cut off the supply of nitrates from Chile. The Germans then used it to produce explosives to sustain their war effort.[17]

Under DOT regulations, (49 CFR Parts 171 - 180), anhydrous ammonia is classified and regulated for domestic shipments as a nonflammable gas, but is designated as an "inhalation hazard."

Ammonia is highly irritating to the eyes and respiratory tract. Exposure to ammonia can cause swelling and narrowing of the throat and bronchi, coughing, and an accumulation of fluid in the lungs can occur. Ammonia causes rapid onset of a burning sensation in the eyes, nose, and throat accompanied by lacrimation [discharge of tears], rhinorrhea [runny nose] and coughing. Upper airway swelling and pulmonary edema may lead to airway obstruction. Prolonged skin contact can cause pain and corrosive injury.

Anhydrous ammonia is an important source of nitrogen fertilizer for crops. If it is handled improperly, it can have catastrophic results on plants and farm workers.[18] It is used in farming because it is one of the most efficient and widely used sources of nitrogen for plant growth. It is relatively easy to apply and readily available, and thus, the use of it has increased. It also carries disadvantages to the farming environment because it must be stored and handled under high

[14] Statement of Edward Hamberger, President & CEO, AAR, before U.S. House of Representatives Subcommittee on Railroads, June 13, 2006, p. 6.
[15] NTSB Report on the Graniteville, SC derailment, January 6, 2005.
[16] National Ag Safety Database, "Anhydrous Ammonia Safety," http://www.cdc.gov/nasd/docs/d001001-d001100/d001021/d001021.html
[17] http://www.chm.bris.ac.uk/webprojects2001/prime/.
[18] National Safety Council, "Anhydrous Ammonia Safety," http://www.nsc.org/library/facts/agrianam.htm

pressure. Workers must be trained to handle it and to follow strict work procedures to ensure operator safety. It is the most dangerous chemical on the farm.[19] Anhydrous ammonia is also used for other uses beyond agriculture and fertilization. Anhydrous ammonia is also used in the production of explosives. In fact, it is so important that it is basic to the process of manufacturing approximately 95 percent of all commercial explosives. There is no substitute for it in the production of these products.[20]

Anhydrous ammonia is one of the gases used in the continuous cycle cooling units found in domestic refrigerators, recreational vehicles, and the year-round air conditioning of homes and large commercial buildings. Since the early 1900s, ammonia has been a primary transfer medium to refrigerate large, cold storage facilities. This accounts for less than 2 percent of the ammonia produced in the United States today.

Anhydrous ammonia is used in the manufacturing of nitric acid; certain alkalies such as soda ash; dyes; pharmaceuticals such as sulfa drugs, vitamins and cosmetics; synthetic textile fibers such as nylon, rayon and acrylics; and for the manufacturing of certain plastics such as phenolics and polyurethanes. Anhydrous ammonia is also used in the rubber industry for the stabilization of natural and synthetic latex to prevent premature coagulation. These industrial uses for anhydrous ammonia account for less than 18 percent of its total annual consumption.

Most anhydrous ammonia plants are dependent on natural gas for production. Therefore, the North America anhydrous ammonia production plants are typically built near a dedicated supply of natural gas. The price and demand for the product are also dependent on and responsive to the price of natural gas; thus, the production at some plants is currently down due to the price of natural gas. On the demand side of the economic equation, there is an increase in the demand and use of anhydrous ammonia due to the recent increase in the demand for ethanol. Ethanol is typically produced in the United States from corn, and the production of corn needs a lot of nitrogen, which typically comes from anhydrous ammonia.

Chlorine (Cl) was discovered by Carl Wilhelm Scheele in 1774. It was given its name by Humphry Davy in 1810. The physical form of the pure chemical element is a diatomic green gas. In its liquid form it is a powerful oxidizing, bleaching, and disinfecting agent. The boiling point for chlorine is -34.6 °C (238.55 K, -30.279997 °F). The element is a member of the halogen family which commonly form salts. In its gas form, chlorine readily combines with other elements.[21]

Chlorine is used as an elemental disinfectant for over 84 percent of large drinking water systems (those serving more than 10,000 people), according to the American Water Works Association. For pharmaceuticals, chlorine chemistry is essential to manufacturing 85 percent of their products. Chlorine chemistry is also used in 25 percent of all medical plastics, and 70 percent of all disposable medical applications. The single largest use of chlorine is for the production of

[19] National Ag Safety Database, “Using Agricultural Anhydrous Ammonia Safely,” http://www.cdc.gov/nasd/docs/d000801-d000900/d000875/d000875.html

[20] Institute of Makers of Explosives, Docket submission USDOT/FRA docket number 25169, p. 1. http://dmses.dot.gov/docimages/pdf97/404945_web.pdf

[21] Lenntech Water Treatment & Air Purification http://www.lenntech.com/Periodic-chart-elements/Cl-en.htm

polyvinyl chloride (PVC), which is used for building and construction materials such as siding, windows, pipes, decks and fences.[22]

Chlorine is a respiratory irritant. The gas irritates the mucous membranes and the liquid burns the skin. As little as 3.5 parts per million (ppm) can be detected as an odor, and 1,000 ppm is likely to be fatal after a few deep breaths. It is not found in a free state in nature, but is found commonly as NaCl (solid or seawater).

It is rarely necessary to make chlorine in the laboratory since it is readily available commercially in cylinders. Chlorine is found largely in seawater where it exists as sodium chloride. It is recovered as a reactive, corrosive, pale green chlorine gas from brine (a solution of sodium chloride in water) by electrolysis.[23]

Chlorine gas or liquid is not explosive or flammable, but it will support combustion. Chlorine is only slightly soluble in water. The gas has a characteristic, penetrating odor, a greenish yellow color and is about two and one-half times as heavy as air. Thus, if chlorine escapes from a container or system, it will tend to seek the lowest level in the building or area in which the leak occurs.[24]

The vaporization of liquefied chlorine at 32 degrees Fahrenheit at atmospheric pressure can generate a gaseous cloud with a volume 450 times greater than the volume of the liquid released.

In the United States, there are 35 chlorine production plants. The largest number of these plants is in the State of Louisiana. In the United States, there are 63 chlorine packing plants.

Ethylene Oxide(EtO) is a colorless, flammable gas or refrigerated liquid with a faintly sweet odor and dissolves easily in water. It is a manmade chemical and it is an important industrial chemical used as an intermediate in the production of ethylene glycol (a chemical used to make antifreeze and polyester) pasticisers, humectants, cosmetics, ointments, pharmaceutical preparations and brake fluids. Ethylene oxide gas kills bacteria, mold, and fungi and is widely used to sterilize medical supplies such as bandages, sutures, and surgical implements. Ethylene oxide is usually stored as a pressurized or refrigerated liquid. At room temperature and pressure, it rapidly evaporates, potentially causing frostbite in cases of skin exposure.

Ethylene oxide was first prepared in 1859 by the French chemist Charles-Adolphe Wurtz, who prepared it by treating 2-chloroethanol with a base. It achieved industrial importance during World War I as a precursor to both the coolant ethylene glycol and the chemical weapon mustard gas. In 1931, Theodore Lefort, another French chemist, discovered a means to prepare ethylene oxide directly from ethylene and oxygen, using silver as a catalyst.

Ethylene oxide is also an irritant to skin and the respiratory tract, and inhaling the vapors may cause the lungs to fill with fluid several hours after exposure.

---

[22] Reiner, Frank. Statement to the docket by the Chlorine Institute, Inc., December 14, 2006. http://dms.dot.gov.
[23] Chemistry WebElements Periodic Table http://www.webelements.com/webelements/elements/text/Cl/key.html
[24] The Chlorine Institute http://www.chlorineinstitute.org/aboutchlorine/content.cfm?itemnumber=856&snItemNumber=855

Other PIH materials transported by railroad tank car include: anhydrous hydrogen fluoride, sulfur dioxide, fuming sulfuric acid, methyl mercaptan, hydrogen chloride (refrigerated liquid), stabilized sulfur trioxide, stabilized acetone cyanohydrin, stabilized hydrogen cyanide, phosphorus trichloride, chlorosulforic acid, methyl bromide, dimethyl sulfate, allyl alcohol, bromine, and titanium tetrachloride. Among these PIH materials, in 2005 anhydrous hydrogen fluoride accounted for almost 4% of PIH shipments by railroad tank car, sulfur dioxide accounted for slightly over 2%, fuming sulfuric acid and methyl mercaptan accounted for a little over 1% each, and the remaining materials each accounted for only a tiny fraction of PIH shipments by railroad tank car (i.e., less than 1% each).

Although these PIH materials each constitute only a small percentage of the total PIH materials shipped by rail, each presents its own unique hazards. For example, hydrogen fluoride, which is used as a catalyst for petroleum processing and in the manufacture of aluminum and various refrigerants and propellants, constitutes under 4% of PIH shipments by railroad tank car, however, it is substantially more toxic than ethylene oxide (which constitutes approximately 10% of PIH rail tank car shipments).

4.5 NTSB Recommendations

The NTSB investigated three recent accidents involving tank cars transporting PIH materials which occurred between 2002 and 2005 in Minot, North Dakota; Macdona, Texas; and Graniteville, South Carolina. In its reports for the Minot and Graniteville accidents/incidents, the NTSB recommended that FRA study improving the safety and structural integrity of tank cars and develop necessary operational measures to minimize the vulnerability of tank cars involved in an accident.

On March 15, 2004, the NTSB released seven Safety Recommendations to FRA as a result of the Minot accident. Four of these recommendations (R-04-04, R-04-05, R-04-06, and R 04-07) concern tank car structural integrity and as discussed in the preamble to the NPRM served as the basis for the reformulation of FRA's tank car research program.

On December 12, 2005, the NTSB released Safety Recommendations R-05-14 through R-05-17 as a result of the Graniteville accident. Three of these recommendations (R-05-15, R-05-16, and R-05-17) related to operating speeds in non-signaled territory, as well as the transportation of PIH materials and other hazardous materials that may pose inhalation hazards in the event of unintentional release. In addition, the NTSB repeated its concern for crashworthiness integrity of railroad tank cars by restating what they said, in part, in response to the Minot accident:

> Improvements in the crashworthiness of pressure tank cars can be realized through the evaluation of alternative steels and tank car performance standards. The ultimate goal of this effort should be the construction of railroad tank cars that have sufficient impact resistance and that eliminate the risk of catastrophic brittle failures under all operating conditions and in all environments. Achieving such a goal does not necessarily require the construction of a tank car that is

> puncture-proof; it may only require construction of a car that will remain intact and slowly leak its contents if it is punctured.

On July 20, 2006, the NTSB released Safety Recommendations R-06-14 and R-06-15 as a result of the Macdona accident. Although neither recommendation specifically addressed the vulnerability of tank cars involved in an accident, the NTSB stated that the successful and timely implementation of its Safety Recommendations from the Minot accident and Graniteville accident may have prevented/mitigated the Macdona accident and any future catastrophic releases of hazardous materials from pressurized tank cars involved in accidents/incidents and derailments.

4.6 Industry Efforts and Initiatives

AAR

In early 2006, the Safety and Operations Management Committee (SOMC) of the AAR directed the AAR's Tank Car Committee (TCC) to consider improved packaging for the shipment of chlorine and anhydrous ammonia. Specifically, the SOMC directed the TCC to "present a plan for developing performance standards for chlorine and anhydrous ammonia tank cars that would reduce the probability of a release, given an accident, by a target of 65 percent from the current values and a plan to phase in the new improved cars within a target time frame of 5-7 years."[25]

The goal of a 65 percent reduction was based on research performed by the University of Illinois, which concluded that utilizing existing technology, the probability of a release of anhydrous ammonia and/or chlorine from a tank car involved in an accident could be reduced by 65 percent or more by substituting enhanced tank cars for the cars currently used to transport these materials. The enhanced tank cars contemplated in the University of Illinois research are the thicker, heavier, chlorine tank car design proposed by Trinity. The University of Illinois findings are premised on replacing the current 263,000 pound cars for anhydrous ammonia and chlorine with 286,000-pound cars equipped with additional head protection, thicker shells, and modified top fittings protection.

As a result of discussions with industry, on July 28, 2006, the TCC issued Casualty Prevention Circular 1175 (CPC-1175), which recommended that the proposal set forth by AAR member railroads and Trinity be implemented.[26] Significantly, this proposal contemplated that 50 percent of a car owner's fleet of anhydrous ammonia and chlorine cars would be replaced with the "enhanced cars" within approximately 6 years, with their entire fleets being replaced within approximately 11 years. In response to CPC-1175, several members of the hazardous materials shipping industry submitted comments to the AAR expressing concern with certain aspects of the proposal.

[25] TCC Docket T 87.2 (April 2006).

[26] The proposal suggested that anhydrous ammonia be transported in DOT 112J500W tank cars, equipped with full-height ½-inch thick or equivalent head shields and top fittings protection designed to withstand a rollover with a minimum linear velocity of 9 miles per hour. Similarly, the proposal suggested that chlorine be transported in tank cars built to the 105J600W specification, equipped with full-height ½-inch thick or equivalent head shields and top fittings protection designed to withstand a rollover with a minimum linear velocity of 9 mph.

In response to comments received, on October 18, 2006, the TCC issued Casualty Prevention Circular 1176 (CPC-1176), which adopted as a final TCC action the proposals set forth in CPC-1175 with minor modifications to the implementation period initially proposed. Specifically, the intermediate implementation goal of CPC-1175 (50 percent of the fleet by December 31, 2012) was eliminated and replaced by a requirement that the tank car owners' plans for implementation be submitted to AAR by December 31, 2007. Subsequently, on December 18, 2006, AAR issued Casualty Prevention Circular 1178 (CPC-1178) in response to appeals to CPC-1176. Although various aspects of CPC-1176 were appealed (e.g., the proposed implementation schedule, top fittings arrangement, and the scientific basis of the proposed design), CPC-1178 is substantially the same as CPC-1176, except the target implementation dates were delayed by 1 year (i.e., tank car owners' plans for implementation were required to be submitted by December 31, 2008, and tank cars were required to be 100 percent fleet compliant by December 31, 2018).

While the shipping community does not fully support the AAR's proposed interchange standard, there is a commitment by a coalition of chemical manufacturers to replace the entire American chlorine fleet by 2017 with tank cars that are more secure and safe.

The AAR has also developed a detailed protocol on recommended railroad operating practices for the transportation of hazardous materials. The AAR issued the most recent version of this document, known as Circular OT-55-I, on July 17, 2006. The Circular details railroad operating practices for, among other things, designating certain trains as "key trains," including trains containing five tank car loads or more of PIH materials. The Circular further designates operating speed and equipment restrictions for key trains; "key routes" for key trains; standards for track inspection and wayside detectors on these "key routes"; yard operating practices for handling placarded tank cars; storage, loading, unloading and handling of loaded tank cars; assisting communities with emergency response training and information; shipper notification procedures; and the handling of time-sensitive materials. These recommended practices were originally implemented by all of the Class I rail carriers operating in the United States; the most recent version of the Circular also includes shortline railroads as signatories.

Dow/UP

In October 2005, Dow and UP, Dow's largest rail service provider, formed a partnership to address rail safety and security improvements. Some of the specific goals of the agreement between UP and Dow include: (1) reducing idle times for hazmat shipments by 50 percent in high-threat urban areas, (2) redesigning Dow's customer supply chains to cut in half the amount of certain hazardous materials shipped by 2015, (3) eliminating all non-accidental leaks of certain hazardous materials in three years, and (4) monitoring shipments by satellite tracking tags and other sensors.[27] As Dow noted at the May 31-June 1, 2006, PHMSA/FRA public meeting, the companies' joint effort is focusing on six areas for improvement: (1) supply chain redesign, (2) next generation rail tank car design, (3) improved shipment visibility, (4) a strengthened commitment to TRANSCAER®, (5) improved rail operations safety, and (6) hazardous material shipment routing.

With regard to supply chain redesign, Dow is evaluating potential ways to reduce the number and distance of shipments involving high-hazard materials. Dow is evaluating the potential for

[27] John D. Boyd, UP, Down Sign Safety Pact, Traffic World (Mar. 19, 2007).

co-location of production and consumption facilities; the use of pipelines instead of rail in some instances; and the conversion of highly hazardous products to less hazardous derivatives before shipping.[28] At the same public meeting, Dow also noted that since 1999, the company has reduced the amount of chlorine it ships in the United States by 80 percent; noting the company's current commitment that by 2015, Dow will have further reduced by 50 percent the number of shipments and container miles traveled by its shipments of highly hazardous materials (i.e., PIH materials and flammable gases).

With regard to improving rail tank car design, Dow, UP, and the Union Tank Car Company, which had joined the Dow/UP Partnership specifically to participate on the Next Generation Rail Tank Car program (NGRTC), initiated the program for the stated purpose of collaborating on the design of a next generation railcar for the transportation of certain hazardous materials. FRA has entered into a memorandum of cooperation with the NGRTC program under which the agency and the other parties share engineering, testing and other resources to develop and demonstrate a next-generation tank. The project is a multi-generational project, with the first generation focusing on designing a breakthrough next generation tank car for the transport of PIH materials that will meet or exceed AAR TCC performance requirements and provide a five- to tenfold improvement in the safety and security performance of existing rail tank cars in PIH service. Subsequent generations of the project would build on the first generation to leverage the process, methodology, and criteria used in designing the next generation PIH tank car to design a tank car appropriate for other hazardous materials, such as flammable gases and environmentally-sensitive chemicals. Dow's stated goal is full implementation within Dow of a next generation PIH car by the end of 2014, and full implementation of further generations of tank cars for flammable gases and environmentally-sensitive chemicals by the end of 2029.

This regulatory proposal seeks to carry forward these private initiatives within a framework that is consistent with the mandate of SAFETEA-LU, ensuring that all parties contribute to the reduction of risk, while addressing additional areas of need, such as existing risks in non-signaled territory.

5.0 Summary of Regulatory Change

Approximately 1.7 million carloads of hazardous materials are transported by rail throughout the United States each year; equivalently thousands of carloads of hazardous materials are in transit every day. About 139 rail carriers offer for transportation or transport hazardous (PIH) materials to which these regulatory clarifications and enhancements apply. Of these, about 39 are large businesses, using definitions established for Class I and Class II (regional) rail carriers.[29]

Through this NPRM, DOT is proposing revisions to the hazardous materials regulations that would improve the crashworthiness protection of railroad tank cars designed to transport PIH materials. Specifically, the NPRM proposes enhanced tank car performance standards for head and shell impacts; operational speed restrictions for trains hauling PIH tank cars; interim

[28] See Transcript of May 31-June 1, 2006, public meeting in docket no. FRA 25169.
[29] Class I railroads, as designated by the Surface Transportation Board (STB), are those railroads with operating revenues of $272 million or more. Regional railroads, referred to as Class II, are those with at least 350 route miles and/or revenue of between $40 million and the Class I threshold.

operational restrictions for tank cars with more stringent restrictions for those not meeting the enhanced performance standards proposed and operating in non-signaled territory; and an allowance to increase the gross weight of tank cars that meet the enhanced tank-head and shell standards.

Specifically, the proposed performance standards for tank-head and shell puncture resistance systems provide industry with flexibility to take advantage of innovative materials and technologies. The related proposed operational limitations would restrict the operating speed of all tank cars transporting PIH materials to a maximum speed of 50 mph.[30]

As an interim measure, the proposed rule would also require tank cars that transport PIH materials, and do not meet the enhanced tank-head and shell puncture-resistance standards, to travel at speeds no higher than 30 mph in non-signaled "dark" territory.[31] The 30 mph speed restriction is based on FRA's finding that a disproportionate number of incidents resulting in loss of PIH material from head and shell punctures, cracks, and tears occurred at speeds greater than 30 mph in non-signaled territory. In lieu of complying with the 30 mph speed restriction, railroads would be allowed to implement alternative safety measures, such as switch position monitoring systems, track integrity circuits, enhanced operational safeguards, or positive train control, if those alternative measures provide an equivalent level of safety to a traffic control system and are authorized by FRA. As tank cars meeting the enhanced performance standard enter use, this 30 mph restriction would be phased out.

The rule would require tank cars that transport PIH materials to be designed and manufactured with tank-head and shell puncture-resistance systems capable of withstanding the proposed performance tests without loss of lading at a minimum 30 mph and 25 mph, respectively. The relevant research undertaken for this rule indicates that in general, the secondary car-to-car impact speed is approximately one-half of initial train speed. Therefore, requiring tank cars to withstand head and shell impacts of at least 25 mph and limiting the speed of those tank cars to 50 mph ensures that, in most instances, a tank car would not be breached if involved in a derailment or other similar type of accident. The higher impact speed proposed for the tank-head protection system is to take into account instances where the end of the tank car is involved in a primary collision as can occur in yards or in sidings. Compliance with the enhanced tank-head and shell puncture resistance systems can be shown by computer simulation modeling, by computer simulation in conjunction with sub-component testing, by full-scale impact testing, with appropriate FRA review of the modeling and testing plan, or a combination thereof.

The proposed rule would also authorize, without the need for special permit, an increase in the gross weight of tank cars from 263,000 pounds to 286,000 pounds to offset the potentially increased weight of an enhanced tank car. This measure should enable shippers to continue meeting customer demands without significantly increasing the total number of PIH shipments. Tank cars that exceed the 263,000 pound weight limitation must comply with the AAR standard

---

[30] This operating restriction is different from industry standards. AAR interchange rules only require that Key trains with 5 or more PIH tank cars in them be restricted 50 mph. Since it is an industry standard for AAR members this recommendation would not cover small and medium sized railroads.

[31] No industry standard or requirments restrict trains carrying PIH materials to 30 mph in non-signaled (dark) territory.

relating to the design, construction, and operation of rail cars with gross weights between 263,000 pounds and 286,000 pounds. This AAR industry standard would be incorporated by reference into the proposed rule through the Federal hazardous material regulations (49 CFR Parts 171- 185).

Table 1. Proposed Rule Implementation Schedule/Assumptions

<table>
<tr><th>Year (After effective date of rule)</th><th>Operational Limitations</th><th>Tank Car Crashworthiness Requirements</th><th>Assumed Level of Crashworthiness Implementation</th></tr>
<tr><td>Years 1 - 2</td><td rowspan="4">If a tank car that does not meet the tank-head and shell puncture-resistance systems is used to transport PIH materials, the maximum allowable operating speed of the train may not exceed 30 mph when transported over non-signaled territory.[32] No train transporting PIH materials may exceed 50 mph.</td><td>Increase in gross weight of tank cars is allowed to offset potentially increased weight of enhanced tank car.</td><td>Design / test new tank cars. Retool manufacturing facilities.</td></tr>
<tr><td>Years 3 - 5</td><td>Comply with years 1 - 2 crashworthiness requirements. New tank cars must be built with tank-head and shell puncture-resistance systems.</td><td rowspan="3">Each year, approximately 1 / 6 of the existing tank car fleet used to transport PIH materials is replaced with new tank cars that comply with the crashworthiness and materials requirements.

TCs w/ non-normalized steel for head or shell construction for the transportation of PIH materials are prohibited from being used 5 years after the rule's effective date.</td></tr>
<tr><td>By the end the 5th Year</td><td>> 50% of each owner's PIH tank car fleet must meet tank-head and shell puncture-resistance requirements. Submit implementation progress report. Tank cars manufactured using non-normalized steel for head or shell construction may not be used for the transportation of PIH materials.</td></tr>
<tr><td>Years 6 - 8</td><td>Comply with years 1 - 5 crashworthiness requirements.</td></tr>
</table>

6.0 Purpose and Methodology of this Economic Analysis

The purpose of this economic analysis is to analyze the costs and benefits of the proposed rule and discuss feasible alternatives to the Federal hazardous materials regulations (49 CFR Parts 171 - 185). For a 30-year period, this analysis assesses the proposed rule's known and foreseeable costs and benefits, which would likely impact society as a result of this proposed regulation. The exact 30-year period which this analysis covers is not specifically set forth because of uncontrollable factors in the rulemaking process. [33] The costs are assessed in terms of

[32] In lieu of complying with the 30 mph speed restriction, railroads may implement alternative safety measures, if those alternative measures provide an equivalent level of safety to a traffic control system and are authorized by FRA.

[33] The precise 30 year period is not noted in this RIA because the exact publication date of the final rule is not

"changes in" the current regulatory burden being added or removed by these proposed rule changes. In economics, this type of analysis is referred to as a marginal analysis.

This economic analysis adheres to methodologies historically followed and accepted at the DOT. It is in consistent with the guidelines in DOT's "Regulatory Policies and Procedures"[34]; Executive Order 12866, "Regulatory Planning and Review" and amendments[35]; and the Office of Management and Budget's (OMB) Circular A-4 on "Regulatory Analysis."[36]

The results of this analysis are a product of the assumptions, estimates, theories, methodologies and procedures utilized in it. This information is provided either in the text, footnotes, or in an appendix for transparency reasons. This transparency should assist interested parties by providing greater access to the information used to determine, assess, and estimate impacts. In general, this type of information should assist in improving the transparency of the regulatory process.

Data and calculations used in this analysis are provided so that the reader may replicate the analysis and quantify the assessments using information and data discussed and noted assumptions.

All of the spreadsheets for this analysis have been developed using an off-the-shelf software package. Some rounding of numbers has been performed for the sake of presentation clarity.

Quantitative methodologies such as this benefit-cost analysis are a useful way of organizing and comparing the favorable and unfavorable effects of proposed regulations such as this one. A benefit-cost analysis does not provide the policy answer, but rather defines and displays a useful framework for debate and review.[37] A benefit-cost analysis such as this analysis is intended to be a pragmatic instrument that is designed to ensure that the government and its relevant officials, and the public as a whole, view the consequences of the regulation. In addition, it assists the process by focusing on neglected problems and it also ensures that limited resources will be focused in areas where they will do the most good.[38]

known.

[34] See *44 FR 11034,* February 26, 1979.

[35] "Economic Analysis of Federal Regulations Under Executive Order 12866." http://www.whitehouse.gov/OMB/inforeg/riaguide.html, January 11, 1996.

[36] "Circular A-4: Regulatory Analysis." September 17, 2003. http://www.whitehouse.gov/omb/circulars/a004/a-4.pdf .

[37] AEI-Brookings Joint Center for Regulatory Studies, "Interests of Amici Curiae: American Trucking Associations, Inc. ET AL., v. Carol Browner, Administrator of the Environmental Protection Agency, ET AL., July 21, 2000, p. 8.

[38] Cass R. Sunstein, *Cost-Benefit Default Principles* Working Paper 00-7, AEI-Brookings Joint Center for Regulatory Studies. October 2000, p. 9.

7.0 Assumptions and Inputs Used in this Analysis

This economic analysis is based on certain assumptions, and unless otherwise noted the following assumptions apply to this analysis, its exhibits, and appendices.

Sunk costs are not factored into this analysis, unless necessary for comparison purposes. This analysis is based on changes in both the costs and benefits related to the rulemaking, over a 30-year period of time for the railroad industry, hazardous material shippers, tank car manufacturers, the DOT, and those who are impacted by the release of PIH materials from rail tank cars involved in derailments and collisions. Several key assumptions in the analysis are presented here:

- The PV of cost and benefit flows are calculated in this analysis. PV provides a way of converting future benefits and costs into equivalent dollars today. Consequently, it permits comparisons of benefit and cost streams that involve different time paths. The formula used to calculate these flows is: $1/(1+I)^t$ where "I" is the discount rate, and "t" is the year. Discount rate of 7% and 3% are used.[39]

- Cost estimates for the manufacturers' redesign and engineering for the proposed features, and the labor and supplies for the marginal changes necessary to build the proposed features are based on input from the DOT's Volpe Center, FRA, and PHMSA. These estimates are not a straight average of the cost estimates that might have been provided, but rather DOT's best approximation given the available information, its knowledge of the situation, and its experience with the redesign of other railroad equipment imposed by prior rulemakings. The cost estimates also include impacts for the DOT proposed operating restrictions.

- An important assumption in this analysis is that PIH tank cars with the same set of characteristics have the same accident performance.

- PHMSA and FRA will be assuming that the proposed PIH tank cars can be built to the 286,000-pound standard and that market standard trucks are on the cars.

- The average hourly rate for railroad workers for this proposed rule is $30.05. This rate includes benefits and overhead. FRA uses this rate of pay as being the <u>value</u> of the services rendered by an employee to a railroad employer.[40]

- The wage rate used for Tank Car Repairmen is $42.00 per hour. This rate is loaded.[41]

[39] The OMB Circular No. A-4, Regulatory Analysis. Discounting is used in economic analyses to make costs and benefits that occur in different time period comparable.
[40] The STB is supplied wage data from the railroads via a form that is reported to them. The FRA uses this data to reassess the accident/incident monetary threshold annually. The most current data is the second quarter of 2006. For the labor categories that it uses for its calculations is $21.458 for an hour of labor. This rate is rounded to $21.46. CALCULATION: [$21.46]*[1.0 + .4(benefit load factor)] = $30.044, which is rounded to $30.05.
[41] Loaded means includes benefits and overhead expenses.

- Economic research indicates that $5.8 million per statistical life saved is a reasonable estimate of people's willingness to pay for safety improvements.[42]

8.0 Research and Analysis of Tank Car Crashworthiness

When a tank car is damaged in an accident or derailment, it can lose lading in one of several different ways. These include: (1) through a rupture or breach in the tank shell, (2) through a rupture or breach in the tank head, and (3) through damaged bottom fittings or top fittings (if present). Review of accident data from 1965 forward shows that the predominant cause of loss of life from release of these products is from compromise of the tank head or shell.[43]

8.1 Scenarios

There are two train operation disruption scenarios that are being targeted for tank car crashworthiness performance improvement over the current-conventional tank cars. The proposed performance standards target these scenarios for a decrease in the likelihood that tank cars would lose their integrity or rupture during the events. The type of events are derailments and train-to-train collisions.

Derailment

The secondary car-to-car interactions that occur in derailments are head and shell impacts. These car interaction modes were determined through the conduct of numerical simulations in response to NTSB recommendations from the 2002 Minot, North Dakota derailment as well as through a review of historical accident consequences. The loss of some lading through fittings, although more common than the catastrophic breaches in the head or side of the tank car, usually results in much smaller quantities of lost material. FRA continues research into the development of improved fitting protection, but this aspect will not be part of this rulemaking.

As discussed in the preamble of the NPRM, a key result from Volpe's collision dynamic modeling of derailments is that the secondary car-to-car impact speeds are one-half the initial train speed. This is important because, if as proposed, all tank cars that transport PIH materials are restricted to a maximum speed of 50 mph and the protection afforded by a performance standard of at least 25 mph protects to train speeds of 50 mph, then together these requirements should prevent the significant loss of PIH material in future train incidents involving newly designed tank cars.

Train-to-Train Collision

---

[42] The DOT estimates the willingness to pay to avoid a fatality to be $5.8 million per life. This value was most recently increased in February 2008.

[43] This is an important difference with the approach of the University of Illinois utilized by the AAR to structure its own tank car initiative. Although PHMSA and FRA agree that reduction of losses through valves and fittings is an important safety objective, as discussed in the Preamble to the NPRM, historical accident data demonstrates that top fittings are not a significant factor in attempting to reduce the risk associated with large product losses. Accordingly, depending on the outcome of DOT's ongoing research and industry efforts, DOT will address this issue in a future rulemaking as appropriate.

The secondary car-to-car interactions of concern from train-to-train collisions include those discussed from derailments for tank cars situated some distance from the initial point of the train collision. The collision modes are impacts to the head and shell. Again, the loss of lading through fittings can occur, but is of secondary concern for this rulemaking process and will be addressed, as appropriate, in the future by the ongoing research program. An example of an accident that fits this scenario is the 2005 accident in Graniteville, South Carolina.

As discussed above, the key result from the collision dynamic modeling of train-to-train collisions where the tank cars are situated some distance from the initial point of impact is that the secondary car-to-car impact speeds are one-half the initial train speed. This is important because if, as proposed, all tank cars that transport PIH materials are restricted to a maximum speed of 50 mph, and the protection afforded by a performance standard of at least 25 mph protects against collisions resulting from train speeds up to 50 mph, then together these requirements protect against release resulting from most train-to-train collisions. However, FRA realizes that there are other situations that may occur involving head impacts that will result in some instances where the head is contacted at speeds somewhat higher than 25 mph; for instance, impacts that occur in yards or sidings. To help protect against such instances and because of greater space available for applying a head protection system, the performance standard requires that newly designed tank cars survive an impact at 30 mph. This should prevent the significant loss of lading in future incidents for trains that have the newly designed equipment.

Head Impact

Research has been conducted by FRA, with support from the Volpe Center and in conjunction with the NGRTCP, to develop a number of candidate designs for head protection systems. FRA is leveraging the knowledge gained through interactions with the NGRTCP to help develop costs and benefits associated with designing a tank-head protection system that is compliant with the proposed performance standards.

The key strategy chosen by FRA and the Volpe Center for the new design is to increase the energy absorption capacity of the tank-head protection system so as to maintain commodity tank integrity under the prescribed impact condition. By allowing for tank integrity to be maintained, FRA is helping designers from the perspective that they can now apply commonly used elastic-plastic large deformation modeling techniques while developing a new design. By excluding material failure on the commodity tank, FRA and the tank car designers have significantly increased confidence in the results from the required numerical simulations.

Technologies that can be applied to improve the tank-head puncture resistance performance include stiffened jackets with an underlying energy absorbing layer in the interstitial space where insulation typically is placed, as well as stiffening the commodity tank with external stiffeners. The goal of the system is to blunt the initial impact at the jacket layer and spread the load over as large an area as possible to engage as much energy absorbing material that lies between the outer jacket and the inner commodity tank. The goal is to have the load “footprint” bearing directly into the commodity tank be significantly larger than the initial impact "imprint." The larger this difference is, the better it is in terms of the commodity tank's ability to resist the load.

In order to develop a compliant design, FRA research suggests that commonly used materials and fabrication techniques already used in the tank car industry as well as other transportation modes can be used.

Shell Impact

Again, FRA is leveraging the knowledge gained through interactions with the NGRTCP to help develop costs and benefits associated with designing a side or shell protection system that is compliant with the proposed performance standard.

The key strategy as discussed above for tank-head protection systems is to increase the energy absorption capacity of the side or shell protection system so as to maintain commodity tank integrity under the prescribed impact condition. Designers can apply commonly used elastic-plastic large deformation modeling techniques while developing a new design. The exclusion of material failure on the commodity tank significantly increases the confidence in the results from the required numerical simulations.

Technologies that can be applied to improve the side or shell puncture resistance include stiffened jackets with an underlying energy absorbing layer in the interstitial space where insulation typically is placed, as well as stiffening the commodity tank with external stiffeners. The goal of the system is to blunt the initial impact at the jacket layer and spread the load over as large an area as possible to engage as much energy absorbing material as lies between the outer jacket and the inner commodity tank. The goal is to have the load "footprint" bearing directly into the commodity tank be significantly larger than the initial impact "imprint." The larger this difference the better in terms of the commodity tanks ability to resist the load.

In order to develop a compliant design, FRA research suggests that commonly used materials and fabrication techniques already used in the tank car industry as well as other transportation modes can be used.

8.2 Research, Analysis and Testing

Historically, DOT's research on tank cars was obtained through studying the structural response of the "tank car head from a coupler impact." Such impacts were examined using dynamic, elastic-plastic finite element analysis. Results from this method were validated using data from tank car head impact tests, which were conducted in the 1970s by the Railway Progress Institute and the AAR Tank Car Safety Research and Test Project. FRA felt comfortable using the information gained from the historical tank head research to move forward with the current rulemaking without further baseline car testing of head impacts similar to what is prescribed in the performance standard. Sufficient work/information is available.

However, the same is not true for impacts to the side of a tank car. There was no historical data available from testing or previous modeling results that could be used to assess the current pressurized tank car designs baseline strength. Therefore, FRA initiated research to study side impacts in conjunction with their research partners under the auspices of the NGRTCP.

Nevertheless, general results can provide some useful insights. For instance, the closing velocities between cars engaging in secondary contact appear to average about half the initial speed of the train. Another noteworthy result is that train speed appears to be the most important variable. With an increase in train speed, the number of derailed cars and the peak collision force also increase.

Ultimately, the predictions from DOT's analysis of tank shell accident survivability are intended to provide estimates of critical closing velocity, i.e., the lowest speed at which a car with lading would be penetrated. From that point, the work will be directed toward assessment of risk that penetration might cause an unstable fracture. The boundary between arrest and an unstable fracture is a function of penetration size and the car's internal pressure.

In conjunction with the NGRTCP, a series of side impact tests have been conducted to develop the level of performance of conventional tank cars under a prescribed impact condition that results in representative damage to the tank car compared with observations from historical accidents. Under this very stringent impact condition, the conventional car tested is able to withstand an impact at 10 mph.

FRA has extensive data available from previous tests for head impacts and is using this as the basis for establishing the baseline level performance under the proposed performance standard impact condition. Applying modeling methodologies developed in the side impact testing program, the predicted head performance under the proposed stringent impact condition for a conventional car is also 10 mph.

FRA investigated the influence of tank thickness on the performance of a tank car and predicts that increasing the thickness to an equivalent 600 psi car only increases the safe impact speed by 2 mph. Therefore for head and side impact conditions a 600 psi car is predicted to withstand impacts at 12 mph.

Full-Scale Testing

Three full-scale tests have been conducted to date: the first on April 11, 2007, the second on April 26, 2007, and the third on July 11, 2007. These tests were for a side impact between a rigid ram car with a stylized punch striking a standing pressurized 105 tank car broadside at the centerline of the tank, both horizontally and vertically. The ram car was ballasted to a weight of 286,000 pounds. The standing tank car was pressurized to 100 pounds per square inch gauge (psig) and was loaded with clay slurry with a density equal to liquid chlorine with an outage of 10.6 percent. The ram car was pulled back to a predetermined position on the slightly graded tangent track and released to achieve the desired impact speed. Just prior to impact with the standing tank car, the air brakes on the ram car were activated such that upon rebound a second impact would not occur. In the first two tests, the punch face size was approximately 23 inches by 17 inches; in the third test, the punch face size was approximately 6 inches by 6 inches.

The first test was a limited-instrument assurance test designed to develop information about how the colliding equipment interact and better understand the gross motions of the two cars. Because the test was designed to develop more detailed information about the interacting cars' behavior and puncturing the standing car would have unnecessarily complicated the analysis and test set-up, the test speed was defined such that no puncture would occur. Specifically, the first test was conducted at 9.6 mph and, as predicted, no puncture occurred. The limited instrumentation on both the ram car and the standing tank car were analyzed and the force-time histories measured and predicted were within the repeatability of the testing.

The second test conducted had a fully-instrumented standing tank car. The additional instrumentation helped to define load path into the tank car, the evolution of the plastic dent growth and recovery, and refined the measurements of the gross motions of the colliding cars' interaction. The test was conducted at 14.0 mph. As in the first test, this test speed was chosen so that puncture would not occur. The ram car was again released from a pre-defined location and allowed to roll freely under gravity and the grade to impact the standing tank car. The analysis of the test data suggests that again the force-time histories of the ram car and the struck tank car are within the repeatability of the testing. After the second test, a careful inspection of the ram car showed that a modest amount of damage was inflicted on the lead truck and its carbody attachment. This damage was attributed to the off-axis vertical motions resulting from the difference in the centerline of the impactor and the height of the ram car's center of gravity.

In order to safely run a test to puncture the baseline car, either a smaller punch would be needed along with maintaining test speed at 14 mph, or the ram car's center of gravity would have to be raised to be more in line with the centerline of the punch to minimize ram car vertical motions for impact speeds greater than 14 mph. The option selected was to reduce the punch size to 6 inches by 6 inches. There was equal confidence in simulating the influence of punch size and impact speed on tank rupture. DOT is seeking to significantly increase the impact speed for which tank cars carrying PIH materials can protect their lading. For a wide range of sizes, this goal is independent of punch size. In order to allow for safer test procedures and lower test speeds, it was decided to use the smaller punch size in the regulation.

Because of the results of the second test, in the third test, the punch face size was approximately 6 inches by 6 inches. The standing tank car that was used during the third test was fully instrumented. The test was conducted at 15.1 mph. This test speed was chosen so that puncture would occur. The third test was designed to confirm that material failure of the tank car and puncture would occur at 15 mph with a smaller impactor. The test also provides a comparative baseline reference for the enhanced tank car designs. As with the second test, the ram car was again released from a predefined location and allowed to roll freely under gravity and the grade to impact the standing tank car. The analysis of the test data suggests that again the force-time histories of the ram car and the struck tank car are within the standard deviation of the predicted test results.

9.0 Risk

Not all lading losses resulting from train collisions or derailments are alike. Nor are the consequences that result from such losses. Obviously DOT believes that the consequences from a PIH lading loss can be more severe than from a non-PIH lading loss. The quantity of lading that is released when a tank car loses its integrity during a collision/derailment can vary greatly. It is determined various factors including the car's capacity, the type of car, and the nature of the accident.

The proposed tank car crashworthiness standards are designed to significantly reduce or eliminate the hazards associated with release of PIH materials from tank cars involved in train accidents. They are not being promulgated in this rulemaking for the purpose of reducing or eliminating the hazards which cause these types of accidents/derailments.[44] Thus, the rulemaking's purpose is to decrease or eliminate the likelihood that loaded PIH tank cars become hazardous to the train crew and the general public immediately following an accident/derailment that results in a secondary collision involving loaded tank cars .

The risk involved in an activity is not just determined by the probability that a hazard will occur, it also takes into account the severity of the negative consequence. Exposure to the hazards, and the severity of the adverse incident, if it occurs, are constituent components of the risk function for a given activity, event or situation. In other words, the risk is governed by the incident frequency and severity. Thus, risk could be represented by the following general functional equation:

$$\mathbf{R} = \boldsymbol{f}\,\mathbf{(E, S)}$$

whereas:

R represents the risk
E represents the level of exposure to the hazards
S represents the severity of the potential adverse event.

Finally, it is important to note, as several commenters at the public meetings have noted, that the tank car is only one component of the rail transportation system and no single component of the system can be used to address tank car safety in its entirety.

9.1 Exposure

The incident frequency or exposure/probability relevant for this rulemaking are the accident/incident and derailment rates, the amount of PIH commodities moved by rail and the distance moved, and how robust the tank car is. The primary crashworthiness requirements in this proposed rulemaking would not have an effect on the accident/incident or derailment rates. However, it would directly affect the robustness of the tank cars and could indirectly affect the amount of PIH material that is shipped by rail.

In July of 2002, the North American in-service tank car fleet totaled about 280,000 cars. Data from the AAR indicated that of these cars, the number of pressurized tank cars in service was 59,344. Only 15,300 of these pressurized tank cars are PIH tank cars. There are over 20

[44] The operating restrictions that are proposed in the rulemaking do potentially serve to decrease the likelihood that some accidents may happen. However, these restrictions most are intended to reduce the severity of any potential accident/incident that involves PIH tank cars.

hazardous materials that are considered PIH materials that are shipped by rail. However, chlorine and anhydrous ammonia represent over 78 percent of the shipments.

In 2004, there were over 54,000 tank car loads of anhydrous ammonia shipped by rail. For that same year, there were over 38,000 tank car loads of chlorine shipped by rail. In 2003, there were over 51,000 and 35,000 loads, respectively, and a total of 106,000 PIH shipments.[45]

Barkan & Saat use a risk equation where R = P1 * P2 * P3 * Q * C, where P1 = the probability of a derailment occurring, and P2 = the probability that a hazmat car is involved. P3 represents the probability that the hazmat car releases product, and Q = the probability of the distribution of the quantity lost. In their equation, C represents the consequences to people, property or the environment. This last variable is identical to the severity (S) variable noted above. This risk equation and its use of multiple variables to represent exposure is a specific form of the risk equation noted above. It represents a different way of looking at the same problem/issue.[46]

As stated above, of approximately 1.7 million shipments of hazardous materials by rail in 2004, a total of 47 hazardous material cars released some amount of product and the likelihood of a release was a tiny fraction of a percent (47/1,700,000, or 0.0028 percent). In addition, as noted above, in the 10-year period between 1996 and 2005, four major accidents/incidents or derailments resulting in PIH material release occurred. These incidents are discussed in more detail in Section 10 of this analysis.

The population densities for three of the four fatal release sites are as follows:

Aiken County, South Carolina – 144 persons/square mile
Minot, North Dakota (Ward County) – 29 persons/square mile
Alberton, Montana (Mineral County) – 3 persons/square mile

The fourth fatal accident occurred in Macdona, Texas. The NTSB report of its investigation of this accident describes Macdona as a “mixed rural & suburban area of Bexar County” and notes that the accident occurred “in an unincorporated rural area 1 miles east of the village of Macdona & about 17 miles southwest of downtown San Antonio.” DOT is aware that there are PIH rail movements along corridors with population densities several times higher than these. This coupled with the relatively favorable circumstances surrounding the four incidents leads DOT to believe that the mean of the casualties resulting from the releases analyzed is likely not the true mean of the distribution of the population of preventable releases, but rather lies in the lower end of the distribution.[47] DOT believes that absent issuance of the proposed standards a future incident could potentially result in a larger number of casualties than experienced in recent years.

It should be noted that railroads and shippers have been willing to take additional steps to decrease the exposure of these potential hazards. This has been accomplished in Canada by market swaps. This helps decrease the distance that the PIH materials have to travel. In the United States, railroads and shippers have been discussing similar shipping changes to ensure

[45] Data were provided by AAR. This data are for tank car traffic in the US and Canada.
[46] Saat & Barkan, “PIH Risk Analysis Presentation,” at DOT Public Meeting, 30 March 2007.
[47] See section 12.15 for further discussion of how various objective factors affect the consequences of PIH releases.

that the shortest route is used to get PIH materials from production to the end user. This is accomplished through meetings with the Federal Government, pursuant to FRA's authority under 49 U.S.C. Section 333.

9.2 Severity

The severity of the incidents that this rulemaking is attempting to mitigate is governed by several factors. The factors that affect the severity include: chemical volatility of the PIH materials, shipment size, toxicity of the PIH materials, the weather or meteorological conditions, time of day, and the population density where the incident occurs. This proposed rulemaking is not attempting to affect or impact the chemical volatility or toxicity of the PIH materials being shipped. The population density, time of day, and weather are also not in the purview of this rulemaking. The shipment size is, however, potentially affected indirectly by this rulemaking.

Factors such as the closing speed of a collision or derailment also affect the severity of the overall accident and the likelihood that a tank car would lose its integrity during an event. Any factor that increases the kinetic energy that will be transferred in a collision could potentially affect the severity of an accident and the likelihood of the loss of tank car integrity, i.e. the rupture of the tank car. In other words, the number of cars in a train, the total tonnage of a train, the mass of a potential striking object, the mass of an object being struck, and the speed of the train at impact (or during derailment) potentially affect its severity.[48] It is important to note that the increased robustness of PIH tank cars that this rulemaking is proposing would decrease the severity of the "overall" accident. But the direct purpose of the robustness is to decrease or eliminate the exposure due to the release of PIH materials that might occur during an accident/incident or derailment.

The most frequently reported symptoms among railroad employees (train crews) from the release of hazardous materials during accidents were respiratory irritation, nausea, vomiting, trauma, and headache. Injuries suffered by railroad employees seemed more severe than those of non-railroad employees. .

Chlorine is a respiratory irritant. The gas irritates the mucous membranes and the liquid burns the skin. As little as 3.5 ppm can be detected as an odor, and 1,000 ppm is likely to be fatal after a few deep breaths. The chlorine releases in the Graniteville, Macdona, and Alberton accidents/derailments totaled 13 fatalities and 931 injuries.

Ammonia is highly irritating to the eyes and respiratory tract. Swelling and narrowing of the throat and bronchi, coughing, and an accumulation of fluid in the lungs can occur. Ammonia causes rapid onset of a burning sensation in the eyes, nose, and throat accompanied by lacrimation [discharge of tears], rhinorrhea [runny nose] and coughing. Upper airway swelling and pulmonary edema may lead to airway obstruction. Prolonged skin contact can cause pain and corrosive injury. The release of more than 120,000 gallons of anhydrous ammonia in the Minot derailment in 2002 produced 1 fatality and 333 injuries.

[48] NOTE: The purpose of this rulemaking, in part, is to regulate the construction of tank cars that transport PIH materials so that they will absorb more of this kinetic energy during an accident/incident or derailment, and thus be less likely to rupture or lose its integrity.

9.3 Risk Characterization

The purpose of this rulemaking is not to eliminate or decrease the probability of any accidents/incidents or decrease derailments, although other FRA regulations and pending rulemakings have those goals. This rulemaking is intended to decrease the conditional probability that a PIH tank car that is involved in any future accidents/incidents or derailments will lose its integrity and release its lading. The discussion and assessments above note that the current probability of a PIH tank car losing its integrity when it is involved in such a situation is low. However, the severity of such an incident is usually very high. Thus, this proposed rule is focused on decreasing the exposure by decreasing the likelihood that a PIH tank car would lose its integrity when it is involved in an accident/incident or derailment by making these tank cars more robust.

As noted above, PHMSA and FRA have evaluated accident data using a representative time period, and focusing on the types of releases that cause fatal consequences and that may threaten larger population segments. FRA's research and analysis indicate that substantially greater improvements in effectiveness can be gained from also enhancing the car design. This is based on information gained from FRA's tank car research program, which includes computer modeling and the conduct of full scale crash testing, in concert with the Next Generation Tank Car Project. Recognizing the apparent logic of the SAFETEA-LU tank car mandates, and seizing upon advances in management of crash energy in other domains, the agencies propose performance standards for tank-head and shell protections, as well as operational speed restrictions that would achieve risk reductions (including the severity component) well in excess of the AAR targets.

10.0 Historical Accident Data and Information

Graniteville, SC, January 6, 2005

As noted above, the Graniteville crash killed 9 people and injured more than 550 people. It was the deadliest train wreck involving hazardous material in nearly three decades. At 2:39 a.m., a train crashed into a locomotive and two cars on a siding in Graniteville, South Carolina. A tanker containing chlorine was punctured in the shell by the coupler of another car and released chlorine. The release occurred in commercial and residential areas of the city. Approximately 5,400 residents were evacuated from a 1-mile radius around the accident site. About 554 people complaining of respiratory difficulties were taken to local hospitals. Of those, 75 were admitted for treatment. Nine people died from exposure to chlorine gas.[49] Fifteen people were placed on ventilators in intensive care units. Twenty-five people were hospitalized for more than 3 days. Twenty-six people were hospitalized for 1 to 2 days. There were 68 repeat visits to the emergency department, 58 people with significant symptoms, and 98 with moderate symptoms.

[49] Data are from NTSB Report of Railroad Accident Collision of Norfolk Southern Freight Train 192 (which was traveling at 47 mph) with Standing Norfolk Southern Local Train P22 with Subsequent Hazardous Materials Release Graniteville, SC January 6, 2005, NTSB/RAR-05/04, Public Meeting Executive Summery, November 29, 2005.

Forty-one people who visited the emergency department were released and 13 people were treated at a physician's office.[50]

To assist in determining the appropriate Abbreviated Injury Scale (AIS)[51] level to use, the injuries sustained in the accident defined previously will be used. One criterion for a reportable injury is that the injury requires medical treatment. Because one criterion of an AIS 2 injury is that it almost always requires treatment, it can be assumed that all injuries reported are at least AIS 2. Of the 554 people taken to the hospital, it was reported that 75 were admitted for treatment. It was further reported that 9 died, 15 people were placed on ventilators, 25 people were hospitalized for more than 3 days, and 26 people were hospitalized for 1 or 3 days. In the interest of being conservative, and without more specific information, an AIS 2 - moderate will be assessed for 479 persons and the remaining 75 persons admitted will be assessed as AIS 3 - severe.

Authorities evacuated homes and businesses within a mile of the crash, affecting about 5,400 people. Some were away from their homes for more than a week. On January 14, 2005, approximately 1,500 Graniteville residents were allowed to return to their homes. By January 17, 2005, an estimated 4,500 people had returned home, including the 1,500 individuals who had previously returned home on January 14. On January 19, 2005, residents remained displaced from an estimated 75 homes in the immediate area of the derailment.

The Graniteville incident caused some local businesses to have a dramatic drop in business immediately after the accident. Part of the reason for this drop was because parts U.S. Highway 1 were closed due to the deadly chlorine cloud. After four days the highway was opened but it had signs that noted that it was open only to local traffic.[52]

Macdona, Texas, June 28, 2004

At approximately 5:03 am on June 28, 2004, a UP freight train collided with a Burlington Northern Santa Fe (BNSF) train on the Del Rio subdivision near Macdona, Texas. It was dawn on a cloudy day with a light wind and 77 degrees F. The accident derailed 4 locomotives and 19 cars on the UP train and 17 cars on the BNSF train.

As a result of the derailment and pileup of railcars, a pressurized tank car loaded with liquefied chlorine was punctured. Chlorine escaping from the punctured car immediately vaporized into a cloud of chlorine gas that engulfed the accident area to a radius of at least 700 feet before drifting away from the site. Approximately 9,400 gallons of chlorine was released from the tank car. Three persons, including the conductor of the UP train and two local residents, died as a result of chlorine gas inhalation. The UP train engineer, 23 civilians, and 6 emergency responders were treated for respiratory distress or other injuries related to the incident.

---

[50] Data are from Earl Hunter, Commissioner, South Carolina Department of Health and Environmental Control.
[51] The AIS utilizes a system that assesses injuries with a numerical percentage of a statistical life. This provides a means of aggregating all casualties as statistical lives. The equivalent percentage of a life that an injury is assessed varies with the severity and location of the injury. More detail on the AIS can be found in Appendix B of this analysis.
[52] Cline, Damon, "Highway Business Report Fewer Customers," Augusta Chronicle, 10 January 2005.

An evacuation zone was established around the accident site with a radius of about 2 miles. Over 60 people were evacuated from their homes and a camping area near the accident site.

The railroad property damages reported to the FRA totaled over $6.3 million. There was also a report of $150,000 for environmental cleanup consequences. The NTSB reported that 2,820 homes and businesses had their electricity disrupted. The NTSB report does not note how long that disruption lasted. A UP mainline track was out of service for 2 days. This mainline provides service to New Orleans and Houston, and is the main connection into Mexico, via Laredo. Finally, the FRA accident report notes that the UP locomotives lost their diesel fuel as a result of the accident. In addition to the punctured chlorine tank car, other tank cars, loaded with ammonium nitrate solution, lost all or part of their contents.

For purposes of this analysis, the casualties were recorded as three fatalities, and one AIS 5 injury. In addition, there were 6 AIS 4 injuries, 22 AIS 3 injuries, and 12 AIS 2 injuries.

The NTSB determined that the probable cause of this collision was the UP railroad train crew fatigue that resulted in the failure of the engineer and conductor to appropriately respond to wayside signals governing the movement of their train. Contributing to the severity of the accident was the puncture of a chlorine tank car and the subsequent release of poisonous liquefied gas.

This incident also forced some temporary road closures. Further it hampered the operations at a nearby state jail and at the Seaworld amusement park, which is located 10 miles from the accident location.

Minot, North Dakota, January 18, 2002

At approximately 1:37 am on January 18, 2002, a Canadian Pacific Railway freight train 292-16 derailed 31 of its 112 cars about a half-mile west of the city limits of Minot, North Dakota. Five tank cars carrying anhydrous ammonia catastrophically ruptured, and a vapor plume covered the derailment site and surrounding area. One resident was fatally injured; 11 people sustained serious injuries; and 322 people, including 2 train crewmembers, sustained minor injuries. Railroad property damages exceeded $2 million, and more than $8 million has been spent for environmental remediation. In addition, other costs were incurred that are not quantified here such as liability payments and disruption to non-railroad businesses and community activities.

During the derailment, five anhydrous ammonia tank cars sustained catastrophic shell fractures that resulted in rupture and the complete and instantaneous loss of the cars' contents. About 146,700 gallons of anhydrous ammonia were released from the cars and a cloud of hydrolyzed ammonia formed almost immediately. This plume rose an estimated 300 feet and gradually expanded 5 miles downwind of the accident site and over a population of about 11,600 people. Fatal and serious injuries were comparatively low, given the potential presented by the plume, as a result of a prompt decision by the incident commander to order shelter in place and by the fact that the incident occurred at approximately 1:37 am, a time when most residents were in their homes and activity on public streets was minimal. Over the next 5 days, another 74,000 gallons of anhydrous ammonia were released from six other anhydrous ammonia tank cars.

The NTSB reported that approximately 20 homes in a half-mile radius immediately east of the derailment site were evacuated. The FRA investigation notes that approximately 100 people were evacuated. This evacuation went on for over 41 days (January 18, 2002 to February 27, 2002). Approximately 10,000 people were required to shelter in place.[53]

The derailment took a single main track (Class 3) out of service for 5 days. In addition, all streets and highways leading into the city, including U.S. Highways 2, 52, and 83 and Ward County 15 were closed. DOT does not know how long these roads were out of service, and it is difficult to put a value on their closure. Thus, DOT estimates $500,000 for the lost value of all of these roads being closed.

For purposes of this analysis, the casualties were recorded as 1 fatality, and 11 AIS 4 injuries. In addition, there were 322 AIS 2 injuries.

The NTSB concluded that the low fracture toughness of the non-normalized steels used for the tank shell of the five tank cars that catastrophically failed in this accident contributed to the cars' complete fracture and separation.

Alberton, Montana, April 11, 1996

At 4:10 a.m., 19 cars from a MRL freight train derailed. Six of the derailed cars contained hazardous materials. One of the derailed tank cars containing chlorine ruptured, releasing 130,000 pounds of chlorine into the atmosphere. About 1,000 people from the surrounding area were evacuated. The Alberton derailment killed 1 person and injured 350 others.

The appropriate AIS level was utilized to assess values of the casualties sustained in this accident. This accident included one fatality. Approximately 227 injuries were assessed at AIS 2. Approximately 114 injuries were assessed at AIS 3, and 9 injuries were assessed at AIS 4.

The authorities evacuated homes and business near the crash. This affected approximately 1,000 people. It is not readily known how long these evacuations lasted. This analysis assumes that it lasted 3.5 days.

U.S. Interstate Highway 90 (I-90) is parallel to and approximately 450 feet north of the MRL tracks at the derailment site. I-90 was closed after the derailment, requiring an 81-mile detour.[54] This road was out of service for approximately 17 days. The track at the derailment site was a Class 3 track with a speed limit of 38 mph. It is not known how long the track was out of service. This analysis assumes that it was out of service for at least 1 day and is valued at $1 million of lost value for that day.

---

[53] The reports do not note how long these people were required to be sheltered in place. DOT will assume approximately one day for this analysis. DOT is assuming a value of $50 per person per day for a value of sheltering in place.

[54] NTSB Brief Accident Report, RAB/98-07, August 18, 1998.

In addition to the chlorine that was released during this accident, other hazardous materials were also released. This included 17,000 gallons of potassium cresylate solution and 85 dry gallons of sodium chlorate.

PIH Incidents Over Time

The FRA analyzed data from chlorine incidents between 1965 and 2005, and for anhydrous ammonia incidents between 1981 and 2005, with regard to loss of product from tank-head and shell punctures, cracks, and tears. This analysis identified that a disproportionate number of these incidents occurred in non-signaled "dark" territory, as compared to the percentage of total train-miles in dark territory.[55] The review also noted that the vast majority of fatal injuries resulted from catastrophic losses of product due to head or shell damage as opposed to losses through valves and fittings.

11.0 Burdens on Society

A majority of the tank cars that would be replaced through implementation of the proposed rule transport chlorine and anhydrous ammonia. Most of the chlorine fleet is currently nearing replacement or retirement. Most of the anhydrous ammonia tank cars were involved in a replacement program several years ago, so it is a younger fleet. Almost every pre-1989 anhydrous ammonia tank car has been removed from service. For chlorine, the pre-1989 tank cars will be the first ones replaced.

This analysis assumes that existing chlorine cars can be put into ethanol or other non-TIH service. It also assumes that the current anhydrous fleet can be put into liquefied petroleum gas (LPG) service. FRA does not have sufficient detailed information to know whether the remainder of the PIH fleet has alternate uses and, if so, what modifications might be required. Comment is requested on this issue.

This analysis assumes that the railroads would gladly give up PIH shipments to another means of distribution—an assumption supported by public statements made on behalf of the major railroads. However, the risk and the liability make it an unlikely prospect that another transportation mode would be willing to assume such a service or that it would find the endeavor profitable. So, where it would be pertinent for this analysis to take into consideration the lost revenue from PIH shipments being shifted to another distribution means, there is no loss taken.[56]

This analysis presents the costs for the baseline, which is the AAR Interchange Standard (Trinity-like tank car). It also presents the costs for the DOT PIH proposed tank car. Both sets of costs represent incremental costs (e.g., the additional amount that it would cost to replace existing PIH tank cars with cars meeting the new AAR or DOT proposed standards). At the end of this section and in the analysis section the difference of these two alternatives will be shown. In reality the AAR Standard represents the "status quo" that would restul in absence of this rulemaking. Therefore the "true" regulatory burden from the DOT PIH proposed tank car is the difference between the two alternatives. However so as to show what the total cost (and

[55] See Appendix C.

[56] NOTE: Exhibit 2 of this analysis contains a table/spreadsheet with all of the costs by item and by year.

projected benefits) of the two alternatives, all of the burdens and benefits are displayed in this analysis. Utlimately this also permits evaluation of regulatory alternatives as well as conduct of sensitivity analyses.

11.1 Engineering and Design

This proposed rule would require tank car manufacturers to redesign PIH tank car models to meet the proposed tank-head and shell requirements. In order to meet the standards, manufacturers are expected to dedicate resources to the engineering and redesign of a new PIH tank car model. DOT expects that, generally, subsequent redesign of tank car models will be less costly in terms of the amount of time and expense necessary for the redesign of the first model from each manufacturer.

11.1.1 AAR Interhange Standard – Trinity-Like Car

DOT estimates retooling costs for the production of the Trinity-like tank car would total $400,000.

DOT estimates that approximately 8,000 hours of design and engineering planning for the Trinity-like tank car. This estimate covers the design time to prepare to make the different models fo the car. This cost is estimated to total $1,200,000.[57]

All costs for the designing of the Trinity-like car are in the first year of the analysis.

11.1.2 DOT proposed PIH Tank Car

In addition to the engineering and redesign, if pertinent, of tank car models, it is anticipated that there would also be a one-time cost related to retooling. There would also be one-time fixed costs for plant and equipment modifications which would be necessary to build the redesigned tank cars. These costs are partially factored into the engineering costs quantified below. To cover minimal retooling and manufacturing equipment costs, there is a cost assessed for $200,000 per builder. The analysis assesses this cost in the first year of the analysis.

DOT estimates that the redesign of tank car models will require 4,540 hours, which it believes is reasonable and appropriate for purposes of compliance with the proposed requirements. This analysis uses $150 per hour as the cost of the engineering design and development time. The engineer time is necessary to incorporate tank car features that would be required to meet the proposed energy absorption requirements. Thus, this is estimated to cost $681,600.[58] Note that this would be the estimated cost for the first design model created per company or builder. It is estimated that the second model by each company or builder would be half of that cost.

[57] CALCULATION: (8,000 hours) * ($150/hour) = $1,200,000.
[58] CALCULATION: (4,540 hours) * ($150.00/hour wage rate) = $681,600.

DOT is estimating that on average, there will be five manufacturers that will build the new PIH tank cars. DOT is also estimating that each builder will design two models. DOT estimates that the total design and engineering cost will be $6,107,500.[59] It is also estimated that this cost will be spread over the first 2 years of the analysis. The PV or discounted value of this cost over 30 years is approximately $5.6 million.

Finally, if it is necessary for new PIH tank cars to be designed for both 263,000- and 286,000-pound models, then there will be little or no additional costs. The basic difference between the two cars would be in length and would not really require any additional design time or costs.

11.2 Marginal Production Costs: Labor and Supplies

This analysis assesses the additional labor and material/supply costs for all new tank cars. The labor and material/supply costs are not for the redesigned crashworthy tank cars, but only for the crashworthy improvements.

11.2.1 AAR Interchange Standard – Trinity-Like Car

DOT's research and development program has estimated that the AAR standard or Trinity-like tank car will cost approximately $22,000 per car more than the typical PIH tank that exist today. DOT estimates 15,300 tank cars will be produced for operation in the United States, and this is estimated at a total cost of about $336,600,000. The discounted value of this cost over the 30-year analysis is $230 million.[60]

11.2.2 DOT proposed PIH Tank Car

DOT believes that the marginal costs for the materials and labor which are needed by the manufacturers to produce the crashworthy improvements would range between $30,000 and $50,000 per tank car, depending on the design of the car. This estimate is the estimated increase in cost of a PIH tank car when compared to the current fleet, and not the Trinity tank car.

As noted above in the assumptions section, this estimate is DOT's best approximation, given the information and input provided. Therefore, a reasonable central estimate to minimally meet the requirements of the proposed rule would be $40,000 per car.[61] DOT estimates 15,300 tank cars will be produced for operation in the United States, and this is estimated at a total cost of about $612,000,000 for the additional crashworthiness features. The discounted value of this cost over the 30-year analysis is $424.6 million.

---

[59] CALCULATION: ($681,600 cost for first model) * (5 builders) + ($681,600) * (.5 for second model) * (5 builders) + ($200,000) * (5 builders) = $6,107,500.

[60] Note the total costs include a small attrition replacement rate of about 15 cars per year for years 11 – 30 of this analysis.

[61] Most of this cost is for steel fabrication costs plus a small amount for foam costs.

This cost is expected to start in the third year of the analysis and will be accomplished in 6 years (years 3 - 8 of this analysis). Thus, the costs are $102,000,000 per year for those years. After that time, FRA estimates that the fleet will grow at 0.1 percent per year. Thus, for years 9 through 30, this is an additional cost of $612,000 per year. The total costs for the marginal crashworthy improvements would be $625,464,000. The PV for this cost stream is $428,586,000.

This analysis only considers the marginal cost or the additional cost for incorporating the more crashworthy features into the new fleet. It does not consider the full cost for replacing tank cars that have not reached the end of their life cycles, and are being replaced prior to their expected retirements. Tank cars built after July 1, 1974, can be operated for 50 years. Prior to that date, they could be operated for 40 years. In reality, most cars are only operated for about 35 years. DOT is assuming that current chlorine tank cars will be transferred to sulfur dioxide (SO_2) and potentially ethanol service, and the anhydrous ammonia cars to LPG service. DOT is taking a cost for the transferring the tank cars to another service (see section 11.3).

11.3 Transferring PIH Tank Cars to Other Service

DOT is assuming that the current PIH tank car fleet will be either excessed to scrap or transferred to another service. DOT is estimating that approximately 13,000 cars from the current PIH tank car fleet will be transferred to other services. DOT does not precisely know what it would cost to transfer a tank car from one service to another. The tank cars will need to be cleaned and have other modifications made to prepare them for transporting the new product. It is estimated that it will cost approximately $2,500 per car to transfer a PIH tank car to another service.[62]

11.3.1 AAR Interchange Standard – Trinity-Like Car

For the AAR Interhange Standard/Trinity-like car this cost will be spread over 9 years – years 3 through 11 of this analysis. For each of these years the cost would be $ 3.61 million. The total cost would be $32.5 million with a PV of $20.6 million.

11.3.2 DOT proposed PIH Tank Car

For the DOT proposed PIH tank car this cost will be spread over 6 years -- years 4 through 9 of this analysis. For each of these years, the cost would be $5.42 million. The total cost would be $32.5 million with a PV of $21.1 million.

11.4 Compliant Repairs

DOT anticipates that the more crashworthy PIH tank car design standards will result in more expensive repairs after damage to a tank car has occurred in an accident/incident or derailment. When an enhanced part or feature of a new crashworthy PIH tank car has to be repaired after a collision or derailment, the repair process and methods would have to meet the quality and

[62] DOT requests comment to this estimate. Please submit such comments to the docket.

standards of the original design and construction of the tank car. This is necessary to ensure the integrity of the enhanced tank-head and shell features.

It is difficult to anticipate how many repairs would be required and how much more the repairs would cost. DOT assumes that half of 1 percent (0.005), or approximately 77 tank cars, will need repairs that impact the new crashworthiness features of the cars annually.[63] DOT also assumes that the marginal difference for such repairs would be $200 for supplies, and 3 hours of labor ($126.00). Once all of the new PIH tank cars are phased-into the fleet, this would total $24,940 per year. The total cost over the 30-year analysis is approximately $611,600, with a discounted value of approximately $200,000.

For the AAR Interchange Standard the compliant repairs are expected to be less expensive than for the proposed DOT standard. It is estimated that the cost would be about one-third the cost of the DOT proposed PIH tank cars. Thus the 30 year total cost is $ $64,000 with a discounted value of approximately $20,000.

11.5 Maintenance and Inspection Costs

DOT anticipates that general maintenance for the new tank cars will be more burdensome than for the current fleet. Initially, the new PIH tank cars would be new and unproven items, and therefore more frequent checks and inspections would be necessary for data and assurance purposes. The tank car facility employees that are responsible for maintaining and inspecting these tank cars would also require additional training on the new cars.

Note that unless otherwise noted in this section that the maintenance and inspection costs do not differ between the AAR Interhange Standard (baseline) and the DOT proposed PIH tank car.

Training Costs

DOT anticipates that the people who inspect and maintain the new PIH tank cars would require additional training. This training would provide them with the necessary information on how the new PIH tank cars are different from the current fleet and how this would impact the inspection of the cars.

As this proposed regulation would require the new PIH tank cars to be built according to a performance standard, it is difficult to determine how much more training would be required. If it is assumed that the new PIH tank cars are an enhanced version of the 105J tank car, then it would be more feasible to make reasonably reliable cost estimates. DOT has not assessed much of a cost here because introduction of any new tank car would require some training. DOT estimates that there would be a one-time cost for supplies and materials related to this training for a new tank car in the industry. This cost is estimated to be $10,000.

[63] This number is DOT's best approximation. Any information that a commenter might provide to give greater clarity to this number should be submitted to the docket.

Maintenance Costs

DOT anticipates that the maintenance for the new PIH tanks cars would cost slightly more than for the existing PIH tank cars. This could be due to the use of new materials or the new designs that improve crashworthiness of the current design of tank cars that transport PIH materials. For instance, additional puncture resistance can be gained by moving the tank-head puncture resistance system away from the tank shell and filling the annular space with energy absorbing material. New designs or materials necessitate new and unproven qualification techniques. If it is assumed that the new PIH tank cars are basically an enhanced version of current 105J tank cars, then the maintenance costs are known.

Barkan and Saat estimated that the maintenance cost for a tank car over 10 years was $7,371.[64] The chemical shippers responded that this estimate is very high. Thus this analysis assumes that approximately $3,800 is the maintenance cost for a tank car over 10 years. It is also assumed that the maintenance cost for the new PIH tank cars would be approximately 15 percent more than for the current ones. That works out to be a one percent cost per year, or $55 per PIH tank car per year. For a typical year, after all of the cars have been replaced, this is an annual cost of $841,500. For the first year in which maintenance could be required, which is the fourth year of the analysis, the incremental cost is $140,000. In the second year in which maintenance could be required, which is the fifth year of the analysis, it would be $280,000. In the third year in which maintenance could be required, which is the sixth year of the analysis, it would cost $421,000. In the fourth and fifth years in which maintenance could be required, which are the seventh and eighth years of the analysis, it would cost $561,000, and $701,000, respectively. The total cost for this maintenance cost is $12.2 million over the 30-year analysis. The PV of this cost stream over the 30-year analysis is approximately $5.1 million.

The current tank car typically has little maintenance performed during its first 10 years. The first requalification occurs at the 10-year time frame so the only costs are valve requalification and any maintenance due to damage by the railroads during transportation. The primary maintenance cost that would be added to the new PIH tank cars would result from the use of unproven material or new designs. Costs could be lowered by additional testing of material prior to use on the PIH tank car.

In addition to the supplemental marginal costs for the maintenance of the new PIH tanks cars, there may also be some changes needed in the facilities in which the cars are maintained. New tools or supplies may be required for a testing process. DOT does not know how much this will cost. Therefore a best approximation of $1,000,000 for the entire industry has been added to this analysis. This cost has been split, with half of it taken in the second year and half in the third year of this analysis. DOT requests comments on this estimate.

Inspection Costs

DOT expects that the new PIH tank cars would require additional qualification (inspection) events during the first 10 years of their life cycles. For at least the first few years until there is

[64] Barkan and Saat, "Risk Analysis of Rail Transport of Chlorine & Ammonia on U.S. railroad Mainlines," Working Paper, 27 February 2006, p. 20.

enough data collected to enable adequate design or material performance evaluation, car owners would need to conduct additional inspections that ensure integrity of the materials and their applications. This could be supplemented with additional material testing and modeling prior to installation to reduce the cyclical inspection frequency. DOT assumes that 50 percent of the builders will conduct sufficient material testing and modeling to negate the need for data collection through inspection. Costs associated with material testing and modeling are already assumed in the design development costs. In addition, many of the tank car builders will opt to use already proven designs that will have been shown to meet the proposed enhanced standards. The use of proven designs is considered in taking the 50 percent reduction noted above.

DOT estimates that the annual inspection would take approximately 24 hours of additional labor time (beyond the time necessary for the current PIH tank cars) per tank car. DOT expects that the enhanced tank car will be based upon current DOT Class 105J tank cars and no additional revisions to the existing qualification requirements are proposed. Beyond the already required inspections, the tank car will have an overall qualification event for a new car construction. However, specific application of materials and design variances may occasion additional inspections to ensure appropriate life cycle planning.[65] It is assumed that portions of these new PIH tank cars, i.e., new energy absorbing materials or bracing, will be inspected every other year until there is sufficient data and confidence that they can go for a longer inspection period. DOT has assessed additional costs for these tank cars to be inspected every other year for the first 6 years they are in production. By that time, the cars should be moving towards their normal 10-year qualification program. All of the new tank cars built during the six years of production will go through at least one additional inspection when they are 2 years old, i.e., the cars built in the fifth and sixth year (eighth year of the analysis) will still undergo one additional inspection prior to their 10-year certification first scheduled (due to maximum regulatory time frames) requalification event.

While inspection ports are not mandated, DOT is considering whether regulatory action is needed to facilitate their use throughout the industry. DOT assumes that inspection ports will be installed in the new PIH tank car designs to facilitate more efficient inspections. Many builders currently use inspection ports to reduce costs and time during qualification events. These ports enable easier access to specific areas of the tank car (therefore enabling focused removal and reinstallation activities) and can be removed quickly without damaging the underlying materials and allowing a more thorough inspection. The use of inspection ports would enable inspections to be accomplished by tank car facility mobile crews at the shipper’s facilities rather than at a tank car facility. This would reduce the cost to the owner from transit time, lost cycles, and fleet sizing. It would also reduce the time required to inspect a tank car to one day (8 hours).

During the first biannual inspections, 2,550 PIH tank cars will be inspected. This is estimated to cost approximately $841,500. FRA anticipates hiring an engineer and utilizing reliability software that should eliminate this need for at least half of the pertinent tank cars. The annual cost will be approximately $420,750.

[65] This rule would not mandate the inspections or the inspection time-periods. Those are stipulated elsewhere in the hazardous materials regatulions and we are not proposing any changes at this time.

The total additional cost for the biannual inspections for the new PIH tank cars is approximately \$10.3 million. The discounted value of this cost over the 30-year analysis is approximately \$3.46 million.

It is important to note that tank cars currently have to be inspected every 10 years for certification. With the inspection ports, the time needed for the 10 year certification should actually decrease by approximately 12 hours. This reduction is primarily in the welding process for removal and replacement of the jacket of the tank car.

11.6 Fuel Costs: Impact of Additional Weight of PIH Cars

It is extremely difficult to predict the full and entire impact of the proposed requirements on fuel costs. On one side of the equation, the fuel costs should increase due to the extra weight per PIH tank car (approximately 23,000 lbs per car). On the other side of the equation, the temporary speed restrictions for dark territory and the 50 mph limit on signaled track would create fuel savings for the railroads. This is because trains are more efficient at lower speeds and the lower operating speeds will encourage the railroads to operate the trains in more of a pacing manner.

Thus, the question arises as to whether the additional fuel costs from the extra weight would be greater than the fuel savings from the proposed operating restrictions.

Based on the assumption that there will be approximately 15,300 new PIH tank cars, and that they will on average weigh 23,000 lbs more than the conventional ones, and the fact that the variable cost per ton-mile (based on STB data) is \$0.01993 per ton mile, a calculation of this impact can be performed. DOT is assessing a cost for extra PIH shipments separately, (see Section 11.8). DOT expects that only 15,000 of the new cars will actually weigh more, given that the weight of newly introduced AAR Interchange Standard compliant Trinity-like cars is comparable to the weight of the new PIH cars. DOT believes that this produces a very conservative estimate. Both the AAR Interchange Standard (Trinity-like tank car) and the DOT proposed PIH tank car are expected to weigh 23,000 lbs more than conventional tank cars.

It is also known that the average PIH tank car makes six trips per year, and that the average distance a train travels is 723 miles. Thus, the total cost for a year after the entire fleet has been replaced is \$14,913,719.[66]

11.6.1 AAR Interchange Standard – Trinity-Like Car

Since the AAR Trinity-like car will be implemented sooner and over a longer period of time, the extra cost for this burden will initiate in the second year of the analysis. It will reach its maximum of \$14.9 million in the 11th year of the analysis. This is estimated to total \$365.4 million for the thirty-year period. The discounted value of this is \$121.2 million.

11.6.2 DOT proposed PIH Tank Car

[66] CALCULATION: [(23,000 lbs/car) * (15,000 PIH Cars) * (6 trips/year) * (723 miles/trip)]/(2,000 lbs/ton) = 748,305,000; (748,305,000) * (0.01993) = \$14,913,719.

For the DOT proposed PIH tank car this cost will be phased in over 6 years and start in the third year of the analysis. This is estimated to total $372.9 million for the thirty-year period. The discounted value of this is $125.1 million.

It is true that locomotives use more fuel at higher speeds. The Davis Formula shows that this phenomenon is caused by wind resistance.[67] The rolling dynamics of the train make it more efficient up to 10 mph, but the aerodynamics and wind resistance cause the fuel efficiency to go down from there. For example, the resistance for a locomotive at 50 mph is almost three times the resistance for the same locomotive at 12 mph.

It is also true that having a lower operating speed will encourage railroads to utilize pacing, which would further contribute to the fuel savings. In general, when utilized judiciously, pacing will save fuel. Essentially, it allows a locomotive to use the minimal amount of fuel to get from one point to another.

The fuel savings for the operating restrictions from this proposed rule are discussed further and assessed in the Benefit Section of this analysis (Section 12).

11.7 Cost for Restricting Traffic Speed to 50 mph

This rulemaking proposes that PIH tank cars be limited to speeds of 50 mph on signaled territory or track. Dow noted in its comments at the July 2006 public meeting that the probability of a release of PIH materials depends on rail car design and operating conditions (e.g., speed restrictions, train configuration, tank car placement within train, and double shelf couplers on freight cars).[68]

It is difficult to fully know how this operational restriction will impact the railroad industry, its chemical shippers and their customers. The AAR has developed a detailed protocol on recommended railroad operating practices for the transportation of hazardous materials, which is known as Circular OT-55-I. Circular OT-55-I is described above in Section 4, above.

Additionally under FRA's Track Safety Standards,[69] there are minimum safety requirements the track must meet, and the condition of the track is directly tied to the maximum allowable operating speed for the track. Only the two highest categories of freight track, Class 4 and Class 5 have a maximum allowable operating speed above 50 mph. DOT believes that extending OT-55-I's 50 mph speed restriction to all tank cars transporting PIH material is a reasonable way to control the forces experienced by the tank car during most derailment or accident conditions and will not present an undue burden to industry.

---

[67] See: http://www.uwm.edu/~horowitz/PropulsionResistance.html.
$R_t = (1.3wn+29n) + bwnV + CAV^2 + 20wn*G$; where V = velocity = mph

[68] Ward, Henry C. Statement to the docket by the Dow Chemical Company, May 31, 2006, p. 5. , available at http://www.regulations.gov.

[69] 49 CFR Part 213.

It is not known how many trains operate with fewer than five PIH tank cars. It is known that since small railroads do not operate at speeds of 50 mph, it should not impact them. They primarily switch PIH tank cars to the large railroads to transport to the end destination. Almost all shortline railroads do not operate trains that travel at speeds above 30 mph. There are regional railroads and a few of the largest Class III railroads that might have some track with a 49 mph maximum authorized speed.

Potentially, the only trains that could be impacted by the 50 mph restriction are trains that currently operate in signaled territory with fewer than five PIH tank cars in the train makeup. DOT estimates that this could be about 10 percent of the estimated 78,000 tank car loads of PIH shipments per year.[70] In order to decrease the impact DOT assumes that the railroad industry will work to combine the shipments of PIH materials so that no train leaves with fewer than five tank car loads on it. Given the large volumes and varieties of commodities transported by large railroads, they are able to assemble "key trains" without unreasonably delaying delivery of PIH commodities. DOT therefore estimates that this will accommodate 100 percent of the impacted traffic. In order to accomplish this consolidation of shipments, it is estimated that a railroad would need 2 labor hours per tank car load for rearranging its shipment path and schedule. This is estimated to cost $468,780 per year. This cost would start in the first year of the analysis.

Many of the affected PIH shipments will most likely be delayed in their delivery. It is difficult to predict with certainty the average time or actual impact that would result. DOT is estimating that the lost value of the delay is $100 per car, per day. Therefore, assuming that each one of the 7,800 shipments was delayed one day, the lost value would be $780,000 per year.

It is also possible that the movement of "key trains" that would not be voluntarily formed in absence of the proposed speed restriction would impose a cost on those taking delivery of other commodities transported on the train. In addition, it is possible that restricting speed on one train may cause residual delays to other trains transporting commodities with sensitive delivery schedules. However, these impacts would be on a limited category of high density main lines where premium traffic is a factor (e.g., intermodal, finished auto) and siding capacity is an issue.

Assuming that 7,800 shipments are combined into at most 1,560 trains (5 shipments per "key train") and that on average for 25 percent of the "key trains" formed due to the proposed DOT requirement a car transporting a time sensitive commodity is delayed at an average cost of $4,000; this analysis assumes that the cost of such delays could total $1,560,000 per year.[71] The true cost of the delay would depend on the extent of the actual delay, which would vary by route. DOT appreciates that this is a potential cost driven by the economics of discrete, capacity-constrained line segments about which only the owning carriers would have sufficient detailed information to generate reliable estimates. Accordingly, comment is specifically solicited on this issue.

The total cost for both of these impacts over the 30-year analysis would be $89.9 million. The present value of this cost is $33.5 million.

---

[70] In 2003, the estimated number of PIH tank car loads was 77,000. Thus 78,000 tank car loads was utilized as a current estimate.

[71] Calculation: (1,560 trains) * (25 percent) * $4,000 = $1,560,000.

Although this analysis has assessed a value for the potential delay in some of these PIH tank car deliveries, it is just a value for that impact. Most of the customers that receive these shipments will not be negatively impacted by any delay. What is more important for them is that they have an accurate estimate of when the tank cars will arrive. Anhydrous ammonia shipments during the spring agriculture season would be an exception.

Finally, it is important to note that to accommodate this requirement and the other operating restriction requirement, there might be an increase in yard switching of PIH tank cars. This could increase the risk or hazard exposure of employees that perform this function.

11.8 Increased Traffic/Volume of PIH Tank Cars

Due to several requirements in this proposed regulation, it is anticipated that the actual PIH tank car traffic volume would increase. This is because the new enhanced PIH tank cars will weigh more and those not in chlorine service will have less space available to carry products. Some of the facilities and shortlines will not be able to accommodate the additional weight of the 286,000-pound tank cars, some because of the additional weight, and some because of the additional length of the new 286,000-pound cars. For some, it would be because they could not make it to the destination without going over a bridge that is not capable of handling the additional weight. However, FRA believes that railroads which handle PIH cars have, in general, already made the transition to track structure capable of handling 286,000-pound cars. Accordingly, the actual impact of the general increase in gross weight on rail of products in this commodity group in relation to the overall transition now being completed within the industry (which has been eased by tax incentives and, in some cases, government-guaranteed loan arrangements) should not be substantial. (Nevertheless, as further discussed below, FRA has conservatively assumed that some new 263,000-pound cars will be built for anhydrous ammonia service to address rail line and facility compatibility concerns.) FRA specifically requests comment on which rail lines and loading/unloading facilities may be impacted and for what periods, should only 286,000-pound cars be available as the implementation period for the proposed rule progresses.

DOT has estimated that both the AAR Interchange Standard “Trinity-like tank car” and the proposed DOT PIH tank car both have an increased weight of approximately 23,000 lbs. Thus the cost or impact of that is calculated in this section are identical.

DOT estimates that the traffic/volume of the PIH cars will increase by 2 percent. An assumption is made that a fleet of 15,300 PIH tank cars has enough down time that the actual number of cars will not increase, but rather just the volume of traffic.

The average length of a trip for a PIH tank car is 723 miles. The average number of tons of product transported for a PIH tank car is 79 tons. The average number of trips a PIH tank car took prior to this rulemaking was six per year. The variable freight cost per ton-mile received from STB via the waybill is $0.01993.[72]

[72] FRA receives waybill data from the STB. The Class I railroads report the data to the STB. FRA’s Office of Policy calculated this rate.

An increase of 2 percent in PIH car loads would be adding approximately 1,720 trips annually. The estimated cost of this increase in traffic is $11,747,700 per year. However, since it would be incurred due to the introduction of the new fleet of PIH tank cars, then the cost would also be phased-in after each year of increase.

11.8.1 AAR Interhange Standard – Trinity-Like Car

For the AAR Interchange Standard (Trinity-like tank car) the cost is phased-in starting in the second year of the aanalysis. It takes 9 years for it to be completely phased-in. The total cost for this additional volume is $282.6 million for this 30-year analysis. The discounted or present value of this cost is $92.1 million.

11.8.2 DOT proposed PIH Tank Car

For the DOT proposed PIH tank car this cost is phased-in starting in the third year of the analysis. It takes 6 years for it to be phased-in. The total cost for this additional volume is $288.8 million for this 30-year analysis. The discounted or present value of this cost is $95.2 million.

11.9 Agricultural Impacts Associated with NH_3

Several shippers and chemical manufacturers noted concern regarding reduced capacity, stating that infrastructure restrictions of many facilities and some shortline railroads would prohibit utilizing a car weighing 286,000 pounds. These commenters also noted that this reduced per car capacity could lead to an increased number of railroad tank car shipments, and in the case of anhydrous ammonia, a shift from the rail transportation to highway transportation.

DOT anticipates that there might be impacts, beyond those assessed in this analysis, on the agriculture industry from the proposed crashworthy improvements to PIH tank cars—specifically ones that carry anhydrous ammonia. Some facilities might not be able to handle a heavier or longer tank car. Thus, a smaller model of the crashworthy car is anticipated to be designed and built. It would probably be a 263,000-pound car but it would not carry as much product as the current PIH cars. This would cause there to be increased shipments. This burden is assessed above.

Additional impacts are difficult to determine. Many of the impacts noted in this analysis overlap with the impacts that the agriculture industry will incur. Commenters at the public meetings did provide input and remarks that can assist here. One noted that the survival of family farms in the Northwest is tied to cheap sources of nitrogen via $NH_{3,}$ which, for them, comes via rail.[73] Other commenters noted that NH_3 costs 40-50 percent less per pound of nitrogen than less concentrated

[73] USDOT Public Meeting Transcripts, Testimony of Fred Morscheck from the McGregor Company, May 31, 2006, p. 168.

forms of nitrogen.[74] For example another commenter noted that anhydrous ammonia costs $0.24 per pound of nitrogen, compared with $0.34 per pound for ammonium nitrate.[75]

Anhydrous ammonia is dependent on natural gas for its production. The North American anhydrous ammonia production plants are typically built near a dedicated supply of natural gas, and the price and demand for the product are also dependent and responsive to the price of natural gas. Thus, the production at some plants is currently down due to the price of natural gas. On the demand side of the economic equation there is an increase in the demand and use of anhydrous ammonia due to the recent increase in ethanol. Ethanol is typically produced in the United States from corn and the production of corn needs lots of nitrogen, which typically comes from anhydrous ammonia.

DOT encourages potentially affected entities to submit comments to the docket that would explain what additional impacts there are and how they were calculated.

11.10 Cost for Restricted Speed of 30 mph in Dark Territory

This proposed regulation imposes enhanced crashworthiness performance standards for PIH tank cars, including some operating restrictions. Limiting the operating speed of tank cars transporting PIH materials is one method to impose a control on the forces experienced by these tank cars. The combination of the two proposals, decreased speed and enhanced tank car performance standards, are intended to significantly decrease the risk of a PIH tank car losing its integrity in an accident/incident or derailment.

One of the operating restrictions that DOT has proposed in this rulemaking is a decreased maximum allowable operating speed for PIH tank cars that do not meet the head and shell puncture-resistance systems requirements when transported across non-signaled territory. Proposed Section 174.86(c) provides that PIH tank cars that do not meet the new performance requirements may not exceed 30 mph when that tank car travels in non-signaled territory. Railroads may exceed the 30 mph limit, however, provided that equivalent safety criteria are met. Examples of these safety criteria include a provision to effectively monitor switch positions and a means for detecting broken rails. The railroad would be required to complete a risk assessment that demonstrates an equivalent level of safety to a signalized system and submit it to FRA for approval. If FRA determines that an equivalent level of safety has been met through the alternative measures, it would notify the railroad that it has met the safety requirements.

FRA analyzed data from chlorine incidents between 1965 and 2005, and for anhydrous ammonia incidents between 1981 and 2005, with regard to those incidents resulting in loss of product from tank-head and shell punctures, cracks and tears.[76] This analysis identified a disproportionate number of these incidents had occurred in non-signaled (dark) territory, as compared to the percentage of total train-miles in dark territory. Additionally, this analysis showed that at the time of these accidents, the median train speed was 40 mph and the average speed was 38 mph. This analysis also demonstrates that approximately 80 percent of the losses occurred at speeds

[74] Ibid, p. 169.
[75] USDOT Public Meeting Transcripts, Testimony of Wolf Anderson (a shipper), May 31, 2006, p. 190.
[76] Reference Appendix C of this analysis.

greater than 30 mph. Notably, no catastrophic losses of chlorine occurred at speeds below 30 mph.

The railroad industry is making some efforts itself to decrease the number of collisions and/or derailments in dark territory. One railroad's efforts include implementing advanced train control technology, utilizing various freight car condition monitoring technologies, installing and maintaining switch point position indicators and broken rail protection in dark territory, as well as modifying the carrier's operating practices when transporting a significant amount of PIH materials over non-signalized territory. Specifically, noting that nearly 50 percent of its PIH movement is over non-signaled territory, the railroad explained changes in its operating practices aimed at ensuring the safe transport of PIH materials over this type of territory. The railroad noted the following changes in operating practices when transporting PIH materials over dark territory: (1) inspection of the route prior to operating trains carrying PIH materials, (2) restriction of speed for trains carrying PIH materials to 35 mph, (3) requiring trains hauling PIH to hold the main line during meets, and (4) requiring trains on sidings to stop before a PIH train passes.

Under FRA's Track Safety Standards,[77] there are minimum safety requirements which track must meet and the condition of the track is directly tied to the maximum allowable operating speed for the track. Only the two highest categories of track typically employed for freight service, Class 4 and 5, have a maximum allowable operating speed above 50 mph. Class 3 track has a maximum allowable speed of 40 mph. Class 2 track would not be pertinent (as far as impacts) since its maximum allowable speed is 25 mph. Additionally, for non-signaled track, speed is limited to a maximum of 49 mph in accordance with the limitation specified in 49 CFR Part 236. The burden of reduced operating speeds will impact primarily Class I railroads. Shortlines do not generally have track that would have a speed above 30 mph.

Some of the operations in dark territory are very short segments. They could just be a short movement from a manufacturer or facility to where it connects with a Class I railroad with signalized territory. Therefore, the portion of the operation in dark territory could be just under a mile on a shortline that interchanges with the appropriate large railroad. It is important to note that these shortlines almost definitely are operating at a speed under 30 mph.

In its public comments, AAR noted that 40 percent of track is in dark territory, and that it believes the system is close to capacity.[78] Utilizing data available from the analysis of Class I railroads, the FRA network, and railroads that transport PIH materials as well as STB variable and cost information, DOT estimated the impact to the railroads from the proposed 30 mph speed restriction in dark territory.

DOT estimates that dark territory totals approximately 89,000 miles of track. DOT's analysis focused on train movements in dark territory with traffic levels of 10 or more daily trains and where PIH carrying trains comprised 0.5 percent of all trains on those lines.

---

[77] 49 CFR Part 213.
[78] FRA Public Hearing December 14, 2006. AAR http://dms.dot.gov.

It is important to note that the impact of this requirement is a microanalysis and not a macroanalysis. The requirement will impact only the percentage of dark territory where PIH tank cars are shipped. In addition, if the current track speed is 30 mph or less, there will be no impact. If it is a lightly used line, then the speed decrease for PIH shipments will probably not negatively impact a significant number of other deliveries on that line or cause freight to be diverted to highway.[79] FRA's review of the data identified that only on the very lowest density lines does the PIH traffic make up any significant portion of the total traffic. These low density lines appear to consist primarily of track into the facilities where the PIH materials are manufactured or used. DOT does not have direct data, but it anticipates that these low density lines are primarily the lines which connect the facilities that manufacture and use PIH materials with the main line track. The PIH traffic is more likely to impact other freight, possibly resulting in delivery delays or possible diversion to the highway for rail lines where the density of train movements is moderate or high. Where this proposed requirement could cause a negative impact is if the particular dark territory line has intermodal trains or auto-rack shipments on it. These deliveries are much more time sensitive for delivery than unit trains carrying coal, or general products like lumber. However, for these medium and higher density lines, the PIH traffic makes up less than 4 percent of all traffic on the lines, which indicates that the potential impacts of the requirement would be low.

DOT estimates that this proposed requirement would increase the variable cost per ton-mile. The variable cost per ton-mile used in this analysis is $0.01993. DOT estimates that for the miles of dark territory track impacted, this cost will increase by 25 percent. Based on FRA's limited review of potential PIH routes, DOT believes that most of the impact (25 percent) is credited to reductions from 35 mph to 30 mph. Thirty percent of the impact is credited to reductions from 40 mph to 35 mph, and 20 percent is credited to reductions from 49 mph to 40 mph. As stated above, 49 mph is the maximum speed in dark territory, but due to a variety of factors, regulatory and operational, much of the dark territory operations actually occur at speeds lower than 49 mph. This is the basis for assigning the majority of the impact to reduction at the lower speed levels. The proposal also provides a mechanism for the railroad to gain approval from the FRA to operate without the 30 mph speed restriction, when the proposed criteria are met. Though not specifically included in the cost estimate, this flexibility will help the railroads to minimize the impact of the proposal on those segments of track that do currently operate at the higher speeds.

To assess an impact or value for the impact from this proposed requirement, DOT has taken the dark territory lines with the most PIH materials traveling on them (most dense traffic) and aggregated the impacted million of gross ton-miles, approximately 13.4 million ton-miles. DOT estimates that this impact will total approximately $24.3 million in the first, second, and third years. After that, it would start to decrease as the new PIH tank cars come into service. The total cost over the 30-year analysis for this proposal is $133.8 million. The discounted value of it over the same period is $106.4 million. FRA has placed in the docket for this rulemaking a separate document containing a more detailed discussion of this analysis.

[79] Obviously the potential benefits to be gained from a lightly used line would be less too. However, note that the volume of traffic only decreases the exposure to the risk of the PIH materials. It does not decrease the severity of any unfortunate event that may occur there.

Finally, DOT requests comments on this impact. The AAR has indicated that there is a high degree of capacity constraint on these dark territory lines. In practice, that could drive this cost higher. However, other, significant reviews by the FRA have not indicated a generalized capacity constraint on non-signalized line. As a result, more detailed information about the level of capacity constraint on the impacted track would improve our analysis. However, DOT believes that the current cost estimate is also very close to the cost for the installation of a signal system on the impacted dark territory track, and this might provide an upper bound for the costs that the railroads would bear. DOT invites comments on this analysis as well as the impact that would result were DOT to adopt a requirement of 35 mph instead of 30 mph.

Note that this cost is an impact of the operating restriction that DOT is proposing in conjunction with its DOT PIH tank car. There is not a similar requirement for the AAR Interchange Standard. Thus this cost is only imposed on the proposed DOT PIH Tank Car.

11.11 Regulatory Compliance

This proposed rulemaking includes several compliance and paperwork burdens. Note that any government related burdens for the regulatory compliance will not require additional federal resources. The necessary services and time will be re-directed from other areas.

Use of Tank Cars - Section 173.31

In Paragraphs 5 and 6 of Section 173.31, DOT is proposing two new delimiters - "M" and "N." Since there is already a list of delimiters for tank cars, this proposal only adds to the current list. The burden should be minimal or none.

Reporting: Section 173.31 (b)(8)(iii)

Section 172.31(b)(8)(iii) proposes to require that the owners of PIH tank cars submit to the FRA a progress report that shows the total number of in-service tank cars that are subject to the pertinent paragraphs of this section after the initial 5-year implementation period has passed. These owners would need to provide the number of cars in compliance with the enhanced head and shell protection requirements of proposed §§ 179.16(b) and 179.24. In this report, the tank car owner would also certify that its fleet does not contain any tank car subject to paragraph (b)(8)(ii).[80]

DOT estimates that the burden for this reporting requirement would be 5 minutes per pertinent tank car. This requirement is estimated to cost $19,200 in the beginning of the sixth year of this analysis.[81] In addition, DOT has provided a postage, envelope and handling charges of $1 per tank car reported. This cost would total $7,650 which would also be in the beginning of the sixth year of the analysis.

[80] This proposed requirement restricts the use of PIH tank cars that were manufactured using non-normalized steel for head or shell construction. Under it, tank cars manufactured using non-normalized steel head or shell construction will no longer be authorized for the transportation of PIH materials five years after the effective date of the final rule.

[81] CALCULATION: [($30.05 wage rate)* (5 minutes/60 minutes)*(15,300 * .5) = $19,157.

The total cost for this requirement is $26,800. The discounted value of this over the 30-year analysis is $17,900.

Marking: Section 179.22

The proposed rule requires that the new PIH tank cars have either an “N” or “M” as the specific marking instead of an “A”, “J”, “S”, or “T.” These requirements can be found in proposed paragraphs (e) and (f). Since all tank cars currently are required to have markings on them, these markings are only for new tank cars. Thus, these additional choices would not impose any additional burden.

Demonstration of Compliance

Compliance with the proposed enhanced tank-head and shell puncture resistance standards can be shown by computer simulation, by simulation in conjunction with substructure testing, by full-scale impact testing, or a combination thereof. The lowest cost and lowest level of confidence is provided by simulation alone. Substructure testing increases the confidence in simulation modeling, potentially with relatively modest costs, depending on the details of the substructure test. The highest level of confidence is provided by full-scale impact testing, which also carries the greatest cost.

It is difficult to estimate the cost or impact of this compliance item. A manufacturer could demonstrate compliance by computer simulation. DOT estimates that this would require each manufacturer to incur 250 hours of engineering time to demonstrate compliance of the first design and half of that time for the second design. Assuming that five manufacturers would create two designs each, this would total $281,250 in the second year of the analysis.[82] The discounted value of this cost over the 30-year analysis is approximately $246,000.

It is potentially possible that one or a group of entities could provide the research for developing a computer tool for the modeling potential designs. FRA has been conducting some of this research through its Office of Research and Development and the Volpe Center. This could help reduce the cost of demonstrating the compliance of future designs.

Risk Assessments: Section 174.86(c)(2)

In Section 174.86(c)(2), DOT proposes to limit the speed of trains carrying loaded PIH tank cars to 30 mph, unless they comply with the enhanced tank-head and shell requirements. Alternatively, railroads could provide risk mitigation by implementing some of the items noted in the proposed rule and completing a risk assessment that includes data and analysis showing how certain operating conditions provide an equivalent level of safety as under Part 236. Section 174.869(c)(2)(i) proposes that this risk assessment must be submitted to FRA’s Associate Administrator for Safety for review and approval.

[82] CALCULATION: (5 builders) * (250 hours for compliance) * ($150/hour wage rate) = $187,500. ($187,500) + 1/2($187,500) = $281,250.

DOT does not expect a great number of these applications. A typical submission might consist of a promise to install a switch position monitoring system, track integrity circuits except in areas where new rail is prevalent, and a temporary speed reduction to 40 mph during the period a positive train control system is installed on the wayside, together with relatively simple calculations. DOT expects that the average submission would be between 20 and 30 pages.

DOT estimates that the average risk assessment will require 20 hours of engineering resources and 5 hours of other resources. DOT estimates that there will be a total of 10 of these submissions and they will be evenly spread across the second and third year of this analysis. This is estimated to cost a total of approximately $31,500.[83] The discounted value of this is $26,615.

11.12 Non-Normalized Steel

Most steel alloys have the ability to resist fracturing changes with the temperature of the steel. With a decrease in temperature, ductile steel becomes brittle and is more easily fractured. The change from ductile to brittle does not occur at a specific temperature. Instead, the steel changes from ductile to brittle steel over a temperature range and the ductile characteristic gradually becomes brittle. Ductile steel will deform before it fractures. In contrast, brittle steel shows no evidence of deformation and upon breaking will exhibit a fracture. Less impact energy is required to break brittle steel than to break the same steel when it is ductile. The chemistry, heat treatment, and rolling process determine the temperature at which the steel will change from ductile to brittle and the amount of energy required to cause fracture. A normalizing heat treatment is one method of lowering the ductile-to-brittle transition temperature. This heat treatment also increases the energy absorbed as the steel fractures.

In proposed Section 173.31(b)(8)(ii), tank cars manufactured using non-normalized steel for tank-head or shell construction are not authorized for transporting PIH materials 5 years after the effective date of the final rule.

It is estimated that there are approximately 700 anhydrous ammonia tanks cars, and almost 3,600 chlorine tank cars built prior to 1989 and manufactured using non-normalized steel.

DOT does not expect this proposed requirement to have an additional cost impact. First, this analysis already takes a burden for transferring the current chlorine and anhydrous ammonia cars to other service, which allows the use of such tank cars. Second, the pre-1989 tank cars that were manufactured without normalized steel on the head and/or shell will be the first ones that are replaced by the new PIH tank cars.

11.13 Diversion and Substitution

The transportation of PIH materials represents 0.3 percent of the freight traffic carried by Class I railroads. However, the three most recent incidents resulting in full release of PIH materials (Graniteville, Macdona, and Minot) have caused the cost of insurance to double for the railroads.

[83] CALCULATION: [10 Risk Assessments * (20 engineering hours * $150 labor rate + 5 other hours * $30.05 labor rate) = $31,503].

To the extent that this rulemaking raise shipping costs, customers and shippers may decide to try and substitute alternative chemicals. Although DOT believes that unlikely, switching to adequate substitutes may actually lower the costs of the rulemaking.

There is very little use of chlorine in the United States that could be replaced by another product. In most applications, the "substitution" of another product for chlorine is really not a feasible option. Where product substitution is feasible, manufacturers are already marketing other products. As noted above, the largest use of chlorine is in PVC home building supplies. For this use, there is no substitute. For water purification, bleach could be used, which is a much watered down version of chlorine, but it would require much larger quantities. One of the limitations of using chlorine bleach instead of chlorine is that the bleach has a short shelf life and becomes less effective with time. Chlorine, however, if stored properly has a very long shelf life. In Europe, ozone is used to purify water, but that would not work in the United States due to environmental requirements from the Environmental Protection Agency (EPA). In essence, the EPA requirement would still require that residual amounts of chlorine be used in the process.

One example of a product substitution for chlorine was at the Blue Plains Wastewater Treatment Facility in Washington, DC. Like most wastewater treatment facilities, it used chlorine to disinfect water. Because of its proximity to the Nation's capitol and terrorism concerns, the facility switched to sodium hypochlorite, which is a safer alternative.[84] However, utilizing sodium hypochlorite instead of chlorine at existing water treatment plants requires modifications to plant equipment and presents additional issues related to the physical quantity of the product required and storage of that product (in hot environments sodium hypochlorite must be stored in climate controlled areas). Accordingly, these requirements limit the practicality of converting existing chlorine water treatment facilities to sodium hypochlorite facilities.

Diversion to highways, as opposed to substitution, may actually have a net negative impact on safety. FRA and PHMSA believe, however, that the diversion of chlorine from railroads, although feasible, is unlikely. Chlorine could be diverted to being transported by highway tank cars, or by pipeline in some cases. In addition, one feasible means of averting all risk associated with the transportation of chlorine is to build a small plant everywhere it is needed, although this would be extremely costly and may not be acceptable to the local communities. The main material needed to produce chlorine is saltwater. An inexpensive supply of electricity is also needed.

Currently, there are approximately 85 highway chlorine tank trucks. Most of them operate in the western part of the United States. In general the trucks hold about 20 percent of the product that a rail tank car holds. Moving more chlorine to highway tank cars would transfer the risk to the highways from the rails and probably increase the risk in the process. Since a highway truck only carries 20 percent of the product that a rail car carries, there would be an increase in exposure. It is difficult to know exactly how much the immediate cost would be for diverting chlorine to the highways. One company paid $85,000 for a new highway tank car for the transportation of chlorine that was to be used in another country. It is difficult to translate that figure into what a new highway tank car that would operate in the United States would cost.

[84] Statement of Edward Hamberger, President & CEO, AAR, before U.S. House of Representatives Subcommittee on Railroads, June 13, 2006, p. 13.

Additionally, finding sufficient truck drivers to handle the additional chlorine traffic may be a problem.

About 4 percent of the bulk chlorine is shipped via waterways on barges. Two companies operate 17 barges on several waterways. While this is feasible for delivery to some locations, it is not feasible as a means of transport to replace all, or a large portion, of the chlorine that is shipped via rail today.

Anhydrous ammonia (NH_3) is used both in agriculture and industry. For agricultural purposes, urea, urea ammonium nitrate, or ammonium nitrate could be used as substitutes. Anhydrous ammonia has a free ammonia percentage of 86 percent. The substitutes have a free ammonia percentage of 46 percent, 28-32 percent, and 34 percent, respectively. These substitutes could be used for agricultural purposes. For industrial purposes, however, there are no alternative chemicals that could replace anhydrous ammonia. Ammonia nitrate (NH_4NO_3) is the only one of these chemicals that is regulated besides anhydrous ammonia. Ammonia nitrate however has also been used in the creation of bombs and in terrorist actions. Most importantly, all of these substitutes are produced from NH_3 and the chemical industry's ability to create these other materials is close to being maxed out. Finally, it is important to note that the lower amount of ammonia in the substitutes would indicate that more of the product would be needed, which would increase the shipments of those substitutes.

To replace 100 rail cars of anhydrous ammonia, 390 highway trucks would be needed.[85]

[85] USDOT Public Meeting Transcripts, Testimony of Joe Giesler from Terra Industries, May 31, 2006, p. 142.

TABLE 2: Costs (PV 30, 7%)

Requirement	**Baseline** (AAR Interchange Standard Mandate)	**DOT Proposal** (Full Cost)	**Regulatory Cost** (additional cost of DOT Proposal)
Construction, Maintenance & Operation of New Tank Cars			
Design & Engineering	$1,495,360	$5,551,780	$4,056,420
Marginal Production Costs: Labor & Supplies	$229,533,686	$428,585,922	$199,052,236
Compliant Repairs	$19,957	$66,797	$46,840
Training for Maintenance & Inspection	$3,115	$3,115	$0
Additional Fuel Charges	$121,226,693	$125,065,411	$3,838,718
Increased Shipments of PIH	$92,055,318	$95,129,559	$3,074,241
Maintenance	$4,225,615	$4,225,615	$0
Inspection of New Tank Cars	$7,209,972	$7,209,972	$0
Demonstration of Compliance	$245,644	$245,644	$0
Transfer Current PIH Cars to Other Service	$20,549,028	$21,075,167	$526,139
Reporting	$0	$17,861	$17,861
Subtotal - Construction, Maintenance &Operation	$476,564,388	$687,176,843	$210,612,455
Operating Restrictions			
50 mph Speed Restriction	$0	$33,539,718	$33,539,718
30 mph Speed Restriction	$0	$106,404,140	$106,404,140
Subtotal - Operating Restrictions	$0	$139,943,858	$139,943,858
TOTAL	**$476,564,388**	**$827,120,701**	**$350,556,313**

Note: Regulatory burden is calculated as the difference between the baseline (i.e., the incremental cost of complying with the AAR Interchange Standard) and the incremental cost of complying with the DOT proposal.

TABLE 3: Costs (PV 30, 3%)

Requirement	**Baseline** (AAR Interchange Standard Mandate)	**DOT Proposal** (Full Cost)	**Regulatory Cost** (additional cost of DOT Proposal)
Construction, Maintenance & Operation of New Tank Cars			
Design & Engineering	$1,553,398	$5,857,397	$4,303,999
Marginal Production Costs: Labor & Supplies	$286,445,149	$528,534,113	$242,088,964
Compliant Repairs	$37,415	$121,661	$84,246
Training for Maintenance & Inspection	$3,236	$3,236	$0
Additional Fuel Charges	$219,043,153	$224,673,897	$5,630,744
Increased Shipments of PIH	$168,187,704	$172,821,095	$4,633,391
Maintenance	$7,086,479	$7,086,479	$0
Inspection of New Tank Cars	$9,584,371	$9,584,371	$0
Demonstration of Compliance	$265,105	$265,105	$0
Transfer Current PIH Cars to Other Service	$26,502,502	$26,853,112	$350,610
Reporting	Not applicable	$22,450	$22,450
Subtotal - Construction, Maintenance &Operation	$718,708,511	$975,822,916	$257,114,404
Operating Restrictions			$0
50 mph Speed Restriction	Not applicable	$53,689,842	$53,689,842
30 mph Speed Restriction	Not applicable	$120,816,439	$120,816,439
Subtotal - Operating Restrictions		$174,506,281	$174,506,281
TOTAL	**$718,708,511**	$1,150,329,197	$431,620,685

12.0 Benefits

The benefits of the proposed rule fall into two sub-groups. The first group consists of benefits that would accrue from avoidance of collision- and derailment-related PIH releases resulting from a combination of the enhanced tank car crashworthiness standards and operating speed restrictions. This group of benefits includes reductions in casualties; property damage, including damage to locomotives, rail cars and track; environmental damage; evacuation and shelter-in-place costs; track closures; road closures; and electric power disruptions. Casualty mitigation estimates are based on a value of statistical life of $5.8 million. This group of benefits also includes more difficult to monetize benefits such as the avoidance of hazmat accident related costs incurred by Federal, state, and local governments and impacts to local businesses. As with costs, benefits associated with introducing DOT-compliant tank cars are reduced by the level of benefits that would accrue from replacing existing cars with AAR-mandated cars absent this rulemaking. This analysis includes a scenario which DOT believes is the most *realistic* projection of benefits that would be realized, including the possibility of an event with moderately more severe consequences than has occurred in the past 10 years. This approach recognizes the significant probability that, given the quantity of product released and the proximity of potentially affected populations to accident sites, in one or more events the consequences known to be possible will be realized, with loss of life on a scale not previously encountered.

The second group of benefits consists of business benefits that would accrue in response to the operating speed restrictions and the enhanced tank car design. This group includes fuel savings from economic efficiencies resulting from operating speed restrictions and repair savings from more salvageable tank cars. Moreover, the residual value at year 30 of tank cars constructed to meet the enhanced standards proposed will be greater than the residual value of conventional tank cars and Trinity-like tank cars contemplated by AAR's Interhange Standard. Thus, the analysis includes a benefit reflecting the higher residual value for the new tank cars at year 30.

Car-to-car impact speeds are expected to be approximately one-half of primary train collision or derailment speeds. The rule would require that newly built tanks maintain integrity during secondary car-to-car impacts of up to 30 mph and shell side impacts of up to 25 mph. This is a significant improvement over the performance of existing cars. Design engineers may build a more extensive margin of safety into the car designs.

Beneficiaries of reduced risk will be many different parts of society. Beneficiaries include railroads and their employees, shippers, and members of the general public that are in areas that PIH tank cars are transported. If one PIH release is avoided, that will result in reduction to the drain on local resources that an accident causes. Emergency response personnel and equipment will not bear the additional expense associated with a release from the accident. This benefit may be high in the case of a large release or quite modest if there is no or a smaller release.

The primary benefits expected to accrue from this proposed regulation are reductions in the number of casualties.

Benefits of avoiding some PIH material release from accidents also accrue to railroads. These benefits include the reduction in railroad property damages (locomotives, cars, and track). Additional benefits to railroads include the elimination of track out-of-service expenses. These out-of-service expenses include train delays and rerouting costs associated with the track being out-of-service. If the accident occurs on a single main track, it is more costly than if the area is double tracked. Where the area has more than one track, traffic can be more easily diverted around the affected track.

Accident data from the past is utilized to predict future potential benefit assessments from the proposed requirements to build enhanced PIH tank cars and to follow pertinent operating restrictions.

Table 3. Historical Accident Data

	Alberton	**Minot**	**Macdona**	**Graniteville**	**TOTAL**	**Total per Accident**
Fatalities	1	1	3	9	14	3.5
Injuries	350	333	41	554	1,278	426
Evacuation of People	1,000	100	65	5,400	6,565	1,641
Evacuation – evac days	3,500	4,100	3,315	52,350	63,265	15,816
Environmental Damage	INA	$8 M	$313K	$163 K	$8.475 M	$2.12 M
RR Damages	$3.9 M	$2.66M	$6.323M	$6.9 M	$19.8 M	$4.95 M
Track out of service	$1 M	$5 M	$4 M	$46 M	$56 M	$13.75 M
<u>Other</u>: Electric Disruption	INA	$1.7 M	$846 K	INA	$1.7 M	$425 K
Road Closures	$12.7 M	$600 K	$300 K	$1.2 M	$14.85 M	$3.713 M

INA: Information is not available.

Note that the DOT PIH tank car proposal is proposing making use of the operational restrictions outlined by the industry and restrict the speed of trains moving TIH materials to 50 mph. This means that if a derailment or collision were to occur the secondary car to car impact speeds will be roughly 25 mph. DOT is proposing a performance standard for shell and head impacts where under a prescribed impact condition the commodity tank must maintain integrity for impacts at 25 mph and 30 mph respectively. Imposing such standards should significantly reduce the potential for complete failure/rupture of a PIH carrying tank car.

Train collisions and derailments are very unique in nature. Many of the circumstances that determine severity of an incident can also be rather unique. Therefore, DOT is conservatively applying an effectiveness rate for car designs developed in compliance with the proposed performance standard of 85% for derailments or train collisions that occur at speeds at or below

50 mph.[86] DOT research has indicated that the estimated effectiveness for the AAR Interchange Standard/Trinity-like tank car is 15 % of the DOT tank car effectivess for derailments or train collisions at speed at or below 50 mph.[87]

12.1 Casualty Mitigation

The risk of exposure to PIH material releases varies with the number of individuals exposed. Without knowing where a release may occur, a reliable estimate of individuals who may be exposed to PIH materials cannot be made. Even when the location and census population is known, many factors affect the number of persons subjected to the toxic effects of the release, and the degree of that exposure, including presence of transient and special needs populations (on roadways, at playgrounds, nursing homes, hospitals, schools, etc.), product characteristics, rate of release, time of day, weather conditions, topography, and quality of the emergency response. Benefits of risk reductions depend on the number and severity of exposures.

The methodology utilized to estimate casualty mitigation in this analysis is based on the past accident data pool and the research that shows that a more crashworthy PIH tank car along with operating speed restrictions will be less likely to lose its integrity in an accident/incident or derailment. Thus, implementation of the proposed standards would result in a decrease in the likelihood and severity of casualties. DOT expresses this analysis as a probability that the severity of a casualty is mitigated. Thus, when accidents/incidents or derailments occur involving these more crashworthy PIH tank cars, DOT anticipates fewer fatalities and injuries. The rupture of a PIH tank car or the loss of its integrity in an accident or derailment either occurs or does not occur. It is more of a "yes/no" or "on/off" situation. The most likely and desired outcome, if the proposed requirements are implemented successfully, is that no fatalities or injuries will occur.

Relevant injuries from the past accidents were assessed for estimated injury severity levels utilizing the AIS.[88] The AIS utilizes a system that assesses injuries with a numerical percentage of a statistical life. This provides a means of aggregating all casualties as statistical lives. The equivalent percentage of a life that an injury is assessed varies with the severity and location of the injury.

12.1.1 DOT PIH Tank Car Proposal

Once the DOT PIH tank car is fully implemented the severity mitigation would reach 100 percent of its potential (85 percent effectiveness) or a total $23.6 million per year.[89] Since the new DOT PIH tanks cars will be phased-in over a period of time, DOT expects that this benefit will be 100-percent phased-in by the ninth year of this analysis. This benefit is calculated utilizing $5.8 million for the value of a statistical life saved (VSL).

---

[86] Based on research that the Volpe Center has performed, DOT has confidence that the proposed standard would have minimally 85 percent effectiveness once it is fully implemented.

[87] Note that would equal 15 percent of 85 percent.

[88] Appendix B provides greater detail on the use of the AIS, and it also provides an explanation on the "willingness to pay" method of assessing casualties as benefits.

[89] The potential benefits here are based on one tenth of the value of avoiding the 4 major PIH rail incidents that occurred between 1996 and 2005.

For sensitivity purposes the benefit would total $13 million per year if the VSL was $3.2 million, and $34.2 million if the VSL was $8.4 million. Note the benefits for this alternative start accruing in the third year of the analysis.

Given that the estimate of the success for this that might be accredited to this rulemaking is 85 percent, then the potential savings over 30 years is $590 million. The discounted value of such benefit would be $198 million.

12.1.2 AAR Interchange Standard – Trinity-Like Tank Car

Once the AAR/Trinity-like tank car is fully implemented the severity mitigation would reach 100 percent of its potential or a total $4.2 million per year. [90] Since the AAR standard calls for the new tanks cars to be introduced between now and 2018 the benefits will be phased-in over a period of time, the potential benefits are estimated to be 100-percent phased-in by the tenth year of this analysis. This benefit is calculated utilizing $5.8 million for the value of a statistical life saved (VSL). For sensitivity purposes the benefit would total $1.9 million per year if the VSL was $3.2 million, and $5.1 million if the VSL was $8.4 million. Note the benefits for this alternative start accruing in the third year of the analysis. Note the benefits for this alternative start accruing in the second year of the analysis.

Given that the estimate of the success for this that might be accredited to the AAR Interchange Standard/Trinity-like tank car is 15 % of the DOT tank car effectivess, then the potential savings over 30 years is $86.8 million. The discounted value of such benefit would be $28.8 million.

12.2 Environmental Remediation and Damage

The environmental remediation portion of the benefit assessment covers the determination of environmental remediation costs. Some of the environmental remediation costs are associated with damage to bodies of water affected by the incidents. The cost of chlorine or anhydrous ammonia cleanup are likely often not recorded or reported and, therefore, potentially not captured in this analysis. However, two of the accidents in the data set did have some reported environmental cleanup costs related to water. The Macdona accident reported $150,000 for environmental cleanup and the Minot accident reported $8,000,000.

12.2.1 DOT PIH Tank Car Proposal

It is estimated that the DOT proposed PIH tank car could produce benefits of $692,750 per year from this benefit. This is assuming the 85 percent effectiveness that the DOT research and development has predicted for the DOT proposed PIH tank car. This benefit is phased-in over years 3 through 8 of this analysis. For the thirty-year period of this analysis it totals $17.4 million. The discounted value of this benefit is $5.9 million.

[90] Ibid.

12.2.2 AAR Interchange Standard – Trinity-Like Tank Car

Given that the estimate of the success for this that might be accredited to the AAR Interchange Standard/Trinity-like tank car is 15 % of the DOT tank car effectivess, then the potential savings over 30 years totals $2.6 million. The discounted value of this benefit is $844,000. Annually this is a potential savings of $122,250.

Separately, the EPA assesses civil monetary penalties against railroads for violations of environmental regulations. Assessments against railroads may also require the railroad to take remedial action or preventive measures, such as cleaning up the affected site, purchasing new equipment, and forming environmental response plans. The civil penalties represent a transfer payment, a monetary payment from the railroad to the Federal Government, and not a real resource cost. Such monetary payments are used for general public welfare. The remedial and preventive measures do represent real expenditures. In addition, the administrative costs associated with the transfer payment, such as the time and materials needed for assessing, collecting, and accounting for the civil penalty, are real resource costs. The proposed rule potentially will reduce the number of EPA assessments against railroads. The resulting reduction in civil monetary penalties, while an actual private benefit to the railroad, are a transfer payment and not included in the regulatory analysis. The reduced administrative costs are likely to be relatively minor. The primary social benefit of less environmental damage is accounted for above, using data from actual accidents.

12.3 Track Delay, Rerouting, and Associated Out-of-Service Expenses

The Graniteville accident occurred on January 6, 2005 at approximately 2:40 a.m. and train service resumed on January 29, 2005, at approximately 4:00 p.m. The single main track was out of service for more than 23 days. The costs associated with a single main track outage are extremely high for the owner of the track. All traffic must be rerouted over other track. If the company does not have trackage rights over alternate track, the distances could be large. Larger distances have higher associated costs. If trackage rights do exist the company has to pay the equivalent of a toll to use track it does not own. Alternate track may also not be available at any price. Track utilization in the United States is extremely high; it is estimated at over 90 percent. When traffic is rerouted, it slows down other traffic and has far reaching effects on the system. It is frequently estimated that blocking a single main line for 1 hour costs approximately $1 million. Obviously, this amount depends on numerous factors. Some single main line track outages cost less than $1 million per hour and some cost more than that amount. In Graniteville, the track was out of service for more than 23 days, or 565 hours. At approximately $1 million per hour, 565 hours equates to $565 million. Because all associated costs and rerouting decisions and effects are not known, a conservative estimate of $2 million per day will be used to estimate the value of out-of-service time for the track. Therefore, the total estimate value for track out-of-service time is $46 million.

For the Minot derailment in 2002, track was out of service for 5 days. The information on this track out of service is not as clear as with Graniteville, so using the same type of logic and a $1 million a day value (versus $2 million a day), the total lost value was estimated to be $5 million. For the Macdona accident in 2004, the mainline track and siding involved were out of service for at least 2 days. This mainline track was the UP's main artery into and out of the Gulf Coast, i.e., Houston and New Orleans. This mainline also provided service into the United States largest point of rail interchange with Mexico (Laredo). It was also a route on which Amtrak operated. Thus, the value used here is the same as Graniteville, $2 million per day for lost use. The total loss for 2 days out of service was estimated to be $4 million. It is also known that the Class 3 track involved in the Alberton derailment was out of service. It is not known how long this track was out of service, and therefore this analysis assumes that the track was out of service for at least one day at the value of $1 million.

12.3.1 DOT Proposed PIH Tank Car

For the DOT proposed PIH tank car this benefit could total $5.6 million per year from decreasing track outages, however, given that the estimate of the success that might be accredited to this rulemaking is 85 percent this translates to a benefit of $4.76 million per year. This benefit is phased-in over years 3 through 8 of this analysis. For the thirty-year period of ths analsyis it totals $119 million. The discounted value of this benefit is $39.9 million.

12.3.2 AAR Interchange Standard – Trinity-Like Tank Car

Given that the estimate of the success for this that might be accredited to the AAR Interchange Standard/Trinity-like tank car is 15 % of the DOT tank car effectivess, then the potential savings totals $17.5 million for the thirty year period. The discounted value of this benefit is $5.8 million. This produces a yearly benefit potential of $714,000 per year, which is phased-in over years 2 through 10 of this analysis.

12.4 Disruption of Electrical Power

At least one of the accidents noted above resulted in the disruption of electrical power to residences and business located near the accident site. It is difficult to know the full value of having electricity supplied to a home or business. DOT assumes that the value was at least $100 per residence or business. When the data concerning the length (in days) of the disruption was not available DOT assumed that the outage lasted for 3 days.[91] Thus the lost value from this disruption was estimated to be $1,692,000.

12.4.1 DOT Proposed PIH Tank Car

For the DOT proposed PIH tank car this benefit could total $3.6 million per year from reducing the disruption of electrical power. The discounted value of this benefit is $1.2 million. This benefit is phased-in over years 3 through 8 of this analysis. For the thirty-year period of ths analsyis it totals $3.6 million. This produces an annual benefit of $143,820.

12.4.2 AAR Interchange Standard – Trinity-Like Tank Car

[91] This is an estimate on which DOT would encourage and request additional data. Please submit comments related to this issue to the docket for this rulemaking.

Given that the estimate of the success for this that might be accredited to the AAR Interchange Standard/Trinity-like tank car is 15 % of the DOT tank car effectivess, then the potential savings totals $529,000. The discounted value of this benefit is $175,000. This produces a yearly benefit potential of $22,000 per year. This benefit is phased-in over years 2 through 10 of this analysis.

12.5 Evacuations

In the four fatal accidents included in the data analysis there were evacuations. Information for some accidents was more robust than for others.

As a result of the 2005 Graniteville accident, approximately 5,400 people were evacuated for varying periods of time. The evacuation periods varied between 9 and 13 days. FRA used a value for the lost time away from a home or business for an individual of $200 per person, per day.[92] For Graniteville this is a lost value of $10,470,000.

The 2004 Macdona accident (collision) resulted in approximately 65 people being evacuated for 51 days. Using the same value for evacuation described above results in a lost value of $663,000. As a result of the 2002 Minot derailment, approximately 100 people were evacuated for 41 days. The estimate for the lost value is $820,000. In response to the 1996 Alberton derailment, approximately 1,000 people were evacuated for 14 days. The estimated value for the lost value is $2,800,000.

The potential savings over 30 years from avoiding evacuations is more than $44 million.

12.5.1 DOT Proposed PIH Tank Car

For the DOT proposed PIH tank car this benefit could total $3.6 million per year from mitigation of the need to evacuate communities. This benefit is phased-in over years 3 through 8 of this analysis. For the thirty-year period of ths analsyis it totals $31.4 million. This produces an annual benefit of.$1.254 million.

12.5.2 AAR Interchange Standard – Trinity-Like Tank Car

Given that the estimate of the success for this that might be accredited to the AAR Interchange Standard/Trinity-like tank car is 15 % of the DOT tank car effectivess, then the potential savings totals $4.6 million The discounted value of this benefit is $1.53 million. This produces a yearly benefit potential of $188,000 per year. This benefit is phased-in over years 2 through 10 of this analysis.

<u>Shelter in Place</u>
One of the four fatal incidents discussed above resulted in local residents having to "shelter-in-place." It is difficult to assess a value for this situation (which in the case of Minot, included loss

[92] Jordon, Jacob. " Judge Approves Preliminary Settlement in Graniteville Train Wreck," Associated Press, May 27, 2005.

of power during very cold temperatures). DOT assumed $100 per day, per person for lost value. The value of this loss totals $100,000 per year.

12.5.3 DOT Proposed PIH Tank Car

For the DOT proposed PIH tank car this benefit could total $85,000 per year from mitigation of the need to evacuate communities. This benefit is phased-in over years 3 through 8 of this analysis. For the thirty-year period of ths analsyis it totals $2.125 million. This produces an annual benefit of $713,000.

12.5.4 AAR Interchange Standard – Trinity-Like Tank Car

Given that the estimate of the success for this that might be accredited to the AAR Interchange Standard/Trinity-like tank car is 15 % of the DOT tank car effectivess, then the potential savings totals $312,000. The discounted value of this benefit is $104,000. This produces a yearly benefit potential of $12,750 per year. This benefit is phased-in over years 2 through 10 of this analysis.

12.6 Property Damage

In all four of the fatal incidents noted, there was property damage, some of which was rather significant. It is important to note that the property damage used in this analysis, for the most part, includes only the damage figures that railroad are required to report to the FRA according to 49 CFR Part 225. Thus, there probably is damage that is not taken into account because it was not reported. For example, in the Graniteville accident, the damage that was reported does not include any environmental damage off of the railroad property, such as the damage incurred by the local community (homes and businesses). The damage included primarily is for damage to railroad rolling stock and equipment, as well as to track and signal systems. Damage to the railroad-related lading would also be included.

For the 2005 Graniteville derailment, railroad damages were reported as $6,900,000. For the 2004 Macdona accident, the two railroads involved reported damages of $6,323,068. For the 2002 Minot derailment, the railroad damages were reported as $2,666,000; and for the 1996 Alberton derailment, the railroad reported damages of $3,900,000.[93]

DOT believes that these damages are only a fraction of the total damages that the railroads assumed from the incidents. This is discussed in greater detail in Section 12.12 of this analysis.

12.6.1 DOT Proposed PIH Tank Car

This benefit is phased-in over years 3 through 8 of this analysis. For the thirty-year period of ths analysis it totals $48 million. The discounted value of this benefit is $16.1 million. This produces an annual benefit of $1.9 million.

[93] The dollar value of these damages has been adjusted to 2007 values. For Graniteville that is $7.360 million; for Macdona it is $6.974 million; for Minot it is $3.088 million, and for Alberton it is $5.179 million.

12.6.2 AAR Interchange Standard – Trinity-Like Tank Car

Given that the estimate of the success for this that might be accredited to the AAR Interchange Standard/Trinity-like tank car is 15 % of the DOT tank car effectivess, then the potential savings totals $7.1 million. The discounted value of this benefit is $2.3 million. This produces a yearly benefit potential of $288,163 per year. This benefit is phased-in over years 2 through 10 of this analysis.

12.7 Other Transportation Disruption

Road Closures

All of the fatal accidents in the data set included the closure of major roads for a period of time. For example, the Minot derailment caused all streets and highways leading into the city, including US Highways 2, 52, and 83 and Ward County 15 to be closed for a period of time. The Alberton derailment closed Interstate 90 for 17 days and caused an 81-mile detour. This Interstate highway was closed for 17 days. The loss value for it was estimated to be at least $750,000 per day.

12.7.1 DOT Proposed PIH Tank Car

This benefit is phased-in over years 3 through 8 of this analysis. For the thirty-year period of ths analysis it totals $31.6 million. The discounted value of this benefit is $10.6 million. This produces an annual benefit of $1.3 million.

12.7.2 AAR Interchange Standard – Trinity-Like Tank Car

Given that the estimate of the success for this that might be accredited to the AAR Interchange Standard/Trinity-like tank car is 15 % of the DOT tank car effectivess, then the potential savings totals $4.6 million. The discounted value of this benefit is $1.5 million. This produces a yearly benefit potential of $189,340 per year. This benefit is phased-in over years 2 through 10 of this analysis.

12.8 Benefits from Non-Fatal Accidents During the 10-year Period from 1996-2005

Appendix C of this analysis ("List of Accident-Caused Releases of TIH Materials from Tank Cars 1965-2005 Report") lists the 18 accidents that resulted in releases from 1996-2005. However, two of those accidents occurred in Canada and are therefore not included in this analysis of benefits. Four of those accidents involved fatalities and are discussed in the previous section. Of the remaining 12 accidents, two did not have reports available in the FRA accident/incident database. The reports not in the FRA database are for the 1997 Elkhart, Indiana, release and the 2003 Camden, New Jersey, release. Therefore, the data used for the 1997 Elkhart release impacts is from the NTSB Report. In the 2003 Camden, New Jersey, release the cause of the lading loss in this accident is listed as "pressure plate missing," and therefore does not qualify for this analysis. Three other reports have causes for lading loss that do not qualify them for this analysis (gauging device loose, gauging device broken, and safety valve broken). The damage estimates for equipment and track are given for the year the accident occurred and in 2005 dollars. The BLS inflation calculator was used to adjust these estimates for 2005 dollars.[94]

The eight remaining PIH tank car releases that occurred from 1996-2005, other than the Minot, Macdona, Graniteville, and Alberton accidents, did not have any fatalities. The total damage estimates from these accidents is $9,600,595.22. These damage estimates do not include the costs of disruption to the transportation process that are incurred for these accidents. At a minimum, any hazardous release extends the dwell time of all cars that are located in a yard where the accident occurs, or trains that are not allowed to enter an area due to a hazardous material release. Extending the dwell time extends the shipping time and can impose costs on shippers. Railroads need additional personnel to reduce shipping backlogs that these accidents cause. The disruption to the transportation process may affect as few as 20 to over 2,500 cars per accident. The table below summarizes the eight accidents at issue.

[94] The BLS inflation calculator is located at www.bls.gov.

Table 4. Injury, Evacuation, Track, and Equipment Damage from Lading Loss Accidents from Tank Cars Carrying PIH Materials During 1996-2005, Not Involving Fatalities

Date	State	Lading	Cause of Lading Loss	Inj.	Evac.	Equipment + Track Damage Estimate on FRA Form F 6180.54	Track + Equipment Damage in 2005 dollars	Injury Costs @ AIS 2 ($89,900)	Evac. Costs @ $200 per day	Total
1/5/96	IL	anhydrous ammonia	shell rupture	1	0	$1,428,508	$1,778,124	$89,900		$1,868,024
2/28/96	MN	anhydrous ammonia	shell rupture	3	33	$691,350	$860,552	$269,700	$6,600	$1,136,852
1/13/97	IN	anhydrous ammonia	head crack > 18”	0	0	$20,000	$24,336			$24,336
7/24/99	ID	anhydrous ammonia	head puncture 8” to 18”	0	200	$525,000	$615,441		$40,000	$655,441
12/21/00	PA	oleum[95]	head puncture < 8”	0	0	$1,056,633	$1,198,376			$1,198,376
12/10/01	GA	anhydrous ammonia	shell rupture	0	0	$32,357	$35,682			$35,682
9/15/02	TN	oleum	shell rupture	20	3500	$957,730	$1,039,715	$1,798,000	$1,750,000	$4,587,715
5/8/03	KS	chlorine	head puncture < 8”	0	95	$2,050,350	$2,176,268		$9,500[96]	$2,185,768
								Total		**$11,692,194**

This Table and the potential benefits reflect the 2008 update for the DOT Value of a Statistical Life (VSL). The annual potential (at 100 percent effectiveness) for this benefit is $1.17 million. This is based on the the data being from a 10 year period and taking the average of those totals.

12.8.1 DOT Proposed PIH Tank Car

For the DOT proposed PIH tank car this benefit could total $994,000 per year from decreasing track outages, given that the estimate of the success that might be accredited to this rulemaking is 85 percent. This benefit is phased-in over years 3 through 8 of this analysis. For the thirty-year period of ths analysis it totals $24.9 million. The discounted value of this benefit is $8.3 million.

[95] Oleum refers to a solution of sulfur trioxide in sulfuric acid or sometimes more specifically to pyrosulfuric acid, disulfuric acid. An advantage of oleum is that it can be shipped in bulk liquid railcars, because it is solid at room temperature and thus enhances the safety of the shipment. It can be converted into a liquid at the destination by steam heating.

[96] Because the accident evacuation lasted less than 12 hours, a cost of $100 per evacuee was used. Other accidents are assigned $200 per day per evacuee.

12.8.2 AAR Interchange Standard – Trinity-Like Tank Car

Given that the estimate of the success for this that might be accredited to the AAR Interchange Standard/Trinity-like tank car is 15 % of the DOT tank car effectivess, then the potential savings totals $3.65 million. The discounted value of this benefit is $1.2 million. This produces a yearly benefit potential of $149,075 per year. This benefit is phased-in over years 2 through 10 of this analysis.

12.9 Incidental Safety Benefits

The proposed rule may also create some incidental safety benefits when other hazardous materials are carried in trains with reduced operating speed as a result of the rule's operational restrictions. For a variety of reasons, railroads typically transport hazardous materials in "key trains." If a key train consist includes cars carrying PIH materials, and must slow to a speed of 30 mph or less in dark territory, then the risk of loss of lading of other hazardous materials due to breaches in the tank cars that transport them is likely to decrease. Some of the most expensive railroad accidents in history have involved releases of hazardous liquids which must be removed from the ground in order to avoid polluting groundwater used for drinking water.

For example, on September 28, 1982, several cars of an Illinois Central Gulf freight train derailed at Livingston, Louisiana. As a result of the derailment, one tank car spilled approximately 14,000 gallons of perchloroethylene (an HOC). Two weeks after the incident, the Louisiana Department of Natural Resources (DNR) detected perchloroethylene in concentrations of up to 25 parts per million (ppm) in the soil at the derailment site. It was also discovered that the chemical migrated well beyond the derailment location.

At the time, the town of Livingston obtained its drinking water from wells by tapping a deep aquifer and, to prevent human health risks from the chemical, the DNR established a 0.3 ppm concentration of perchloroethylene as the criteria for the maximum safe level of groundwater contamination. Since the accident, the railroad has incurred over $20 million dollars in liabilities for environmental clean-up.

In addition, in a 1990 report,[97] the AAR estimates that the release of HOCs in railroad accidents has resulted in environmental clean-up costs exceeding $50 million over the previous 10 year period of the report. They also estimated that, even though these materials accounted for less than one percent of the total car volume of hazardous materials movements, their releases amount to 60 percent of all railroad environmental clean-up costs during the time period studied

[97] Barkan, Glickman, & Harvey, *Benefit-Cost Analysis of Using Type 105 Tank Cars Instead of Type 111 Tank Cars to Ship Environmentally-Sensitive Chemicals*, R-794, (1991), AAR Document Distribution Center, Chicago, IL.

Although PHMSA and FRA have since taken many steps to reduce the likelihood and severity of liquid spills since the time of this accident and follow-up report, DOT believes the reduced speed required by the proposed rule may reduce this risk even further.

12.10 Fuel Savings from Operating Restrictions

This proposed rule has two operating requirements that restrict the speed of trains carrying PIH materials. DOT anticipates that these requirements will produce cost savings in the area of fuel consumption.

It is true that locomotives use more fuel at higher speeds. The Davis Formula shows that the wind resistance would be the cause of this phenomenon.[98] The rolling dynamics of the train make it more efficient up to 10 mph but the aerodynamics and wind resistance cause the fuel efficiency to go down from there. For example, the resistance for a locomotive traveling at 50 mph is almost three times the resistance for the same locomotive traveling at 12 mph.

It is also true that having a lower operating speed will encourage railroads to utilize pacing, which would further contribute to the fuel savings. In general, pacing, when utilized judiciously, will save fuel. Essentially, it allows a locomotive to use the minimal amount of fuel to get from one point to another.

It is difficult to estimate fuel savings. It is also difficult to assess how much of the savings would be due to this proposed rule. DOT estimates that the savings from the operating restrictions are easily twice the amount of the annual fuel costs that this rule imposes due to increased weight, which can be found in Section 11.6. (In addition, there should be additional fuel savings due to the pacing. However, this rule does not calculate any benefit for that operation. It is up to the individual railroads to actually implement such savings.) However, this rule will not take credit for all of the savings. DOT estimates that only 85 percent of this would be credited to this rulemaking. The first year of this savings is estimated to total $24.3 million. This benefit should decrease as more of the new strengthened tank cars are added to the PIH tank car fleet. Although the 50 mph limit will not disappear as new PIH tanks cars are added to the fleet, the impact and the need to restrict trains to 30 mph in dark territory will decrease as new cars are added. Thus, it will decrease every year. By the ninth year of the analysis it is estimated to total $4.87 million. The total savings is estimated to total $243.4 million. The discounted value of this benefit is $138.8 million.

12.11 Fewer Destroyed PIH Tank Cars

The main purpose of this proposed rulemaking is to have PIH tank cars designed and built that are capable of sustaining derailments or collisions. Therefore, more PIH tank cars will survive crashes, accidents, derailments, etc. without the loss of the tank car's integrity. Thus, more of these cars will not be scrapped or destroyed.

If a heavier car of the existing design (i.e., a Trinity-like tank car) is involved in an accident that results in structural deformation, but no puncture damage, the car is more likely to be scrapped

[98] See http://www.uwm.edu/~horowitz/PropulsionResistance.html

and replaced than it is to be repaired due to the cost of structural deformation damage repair and residual liability. On the other hand, the DOT-compliant PIH tank car would have an energy absorbing layer that would significantly reduce the probability of non-puncture structural deformation resulting from certain accidents, making repairs more feasible. Basically this means that DOT proposed PIH tank car's "tank" is less likely to be impacted. This is because the intermediate layers of protection will absorb the impact therby preventing contact with the tank shell. This is especially true at lower speeds where the current (and Trinity-like) tank car shells will sustain damage from the impacting item, e.g., coupler, end of car, rail or other equipment. Given that railroads currently scrap tank cars that have relatively minor damage, this translates to improved tank car salvagability. Note that this benefit would exist for the DOT proposed PIH tank car but not the AAR Interchange Standard (Trinity-like tank car).

This analysis is taking a benefit for this improvement. DOT estimates that once the entire fleet is replaced, approximately five PIH tank cars will be saved per year that would not have been saved based on the previous build standards. This benefit will be phased-in starting in the fourth year of the analysis. DOT uses an average value of $100,000 per PIH tank car saved. In the ninth year, this benefit totals $500,000 per year. The total savings for this benefit is $12.2 million. The discounted or PV of this savings is $4 million.

12.12 Operating Restrictions Safety Benefit

Safety benefits are also expected to accrue from the 30-mph speed restriction that would be imposed in years one through eight. Although the purpose of imposing this restriction is to provide an increased level of safety for movements with higher risk levels (i.e., those along dark territory) until the more crashworthy PIH tank cars (proposed in this rulemaking) are introduced, the speed restriction will not reduce the risk of release from train collision occurring at speeds between 20 and 30 mph. Thus, the safety benefits resulting from the speed restriction would not be as high as the benefits that would accrue for using the more crashworthy PIH tank cars. Conventional tank cars protect well for train collision levels up to 20 mph. Historically, conventional equipment has performed better at speeds between 20 and 30 mph than at higher speeds. Between 1980 and 2005), only six percent of train accidents that resulted in relevant full releases (involving head or shell rupture) occurred at train speeds between 20 and 30 mph – with no resulting fatalities. Therefore, the effectiveness of a 30 mph speed restriction at large can reasonably be expected to be at least 90%.[99] However, since speeds would be restricted only for movements in dark territory this estimate is adjusted. Sixty percent of the chlorine and anhydrous ammonia releases in the US analyzed since 1965 and 1980, respectively, occurred in dark territory. Therefore, it would not be unreasonable to assume that restricting the speed of existing tank cars transporting PIH materials in dark territory would provide slightly more than half (0.90 x .60, or roughly 55%) of the total potential safety benefits. These benefits would be phased-out as new tank cars are introduced.

[99] FRA research into the collision dynamics of train collisions and derailments has provided information that the secondary car to car impact speeds are roughly one-half the initial train speed. Collisions where the tank cars are situated away from the primary collision degenerate into a derailment situation.

There is also a residual benefit from the 50-mph operating restriction that continues to accrue in years 9 through 30. DOT conservatively estimates that this would annually be approximately 2 percent of the primary safety benefits total or $464,000 per year.

The total potential value of these benefits over a 30-year period is $74.1 million. The discounted value of this total is approximately $54.4 million.

12.13 DOT Estimate of Difficult to Quantify "Miscellaneous" Societal Benefits[100]

There are numerous damages and expenses that are incurred directly and indirectly from a spill or release of a PIH material. The magnitude of the impact of these will vary depending on factors such as the location of the incident and the number of cars that release material. Unfortunately, such impacts are difficult to express in quantitative or monetary terms, thus they are often described only qualitatively.

These benefits include non-railroad property damages (which have not been accounted for above in this analysis); impacts on local businesses; Federal, state and local response efforts; and unaccounted for impacts on the environment.

Impacts to Businesses and Commerce

After spending over $140 million on cleaning, repairs, and damage mitigation as a result of the derailment, in July 2006, Avondale Mills, a textile manufacturer, closed its 10 mills in South Carolina and Georgia. At the time of its closure, the company employed approximately 4,000 people and found itself unable to recover financially from the derailment. For example, Avondale Mills was unable to identify cleaning and restoration protocols that would successfully or economically halt the chlorine's corrosive effects, repair the damage caused by the chlorine exposure, and return the affected facilities and equipment to their pre-derailment condition. As a result, Avondale Mills was faced with an expensive replacement of damaged assets in addition to the lost business, higher manufacturing costs, and lower profits related to the reduction in productive capacities resulting from the derailment. Ultimately, the company concluded that it was not prudent to continue to invest in the repair or remediation of the damage caused by the derailment and that profitable ongoing operation of the company's business, or any portion of the Company's business, was not feasible based on the damage caused by the derailment.

In May 2006, Avondale Mills reached a $215 million settlement with its primary property and casualty insurer for claims relating to the derailment. Avondale Mills has a pending lawsuit against Norfolk Southern Railway (NS) seeking $420 million in damages.

This incident impacted all Avondale Mills employees, not just those who were at the facility at the time of the incident. The employees who survived the incident were eventually left jobless. Many who had highly specialized skills acquired through many years of work at the manufacturing facility had to be retrained so they could acquire skills that would make them marketable. Their former productivity levels were replaced with lower productivity levels in new jobs. The months that former Avondale Mills employees were away from productive jobs,

[100] Note: This benefit is only included in the benefit totals for Case 2, and Case 3 of this analysis. A discussion of this can be found in Section 14 of the RIA.

while they received unemployment compensation and were retrained, translated into lost productivity that will not be recovered. For many, the product of their hard work during this time resulted in productivity levels that may never rival the levels they had reached at Avondale Mills.

The NS had commercial insurance to cover incidents such as this, beyond the retention amount. Up to the retention amount railroads are basically self-insuring the costs/damages and burdens. NS notes that its commercial insurance policies were expected to cover "substantially all expenses related to this derailment" beyond the retention amount. These costs included NS' response cost and legal fees.[101] In 2005, NS recorded expenses of $ 41 million related to this incident. This burden includes property damage and other economic losses, personal injury and individual property damage claims as well as third-party response costs.[102]

It should be noted that railroads can be liable or have claims filed from many different entities and individuals related to incidents like this. For example, the Minot incident in 2002 resulted in over 20,000 claims filed against the railroad. Three years after that incident the number of claims for that anhydrous ammonia release was about 25,000.[103]

Federal, State, and Local Government Response Efforts

For a railroad incident with a PIH material release there are many government entities that respond and provide valuable services during the period following such a disaster. For example, operating under a unified command structure, 111 agencies participated in the Graniteville, South Carolina response. The responsibility for enforcing the evacuation fell to the South Carolina Highway Patrol, the South Carolina Transport Police, the Aiken County Sheriff's Office, and other law enforcement from around the State. The U.S. Coast Guard assigned a Gulf Coast strike team to the emergency.

According to the South Carolina State Emergency Operations Center, in response to the Graniteville incident, between 200 and 300 law enforcement officers from various agencies assisted the Aiken County Sheriff's Office in patrolling the overall incident and enforced the curfew. In addition, officers from Aiken County, Greenwood, City of Columbia, Lexington County, Orangeburg, Beaufort, South Carolina Highway Patrol, and State Law Enforcement Division conducted security operations throughout the night.

The Graniteville-Vaucluse-Warrenville Fire Department operates five engines, one ladder, one service truck, and two first responder/rescue vehicles from three stations. The headquarters station of this department was located about 100 yards from the Graniteville train derailment site. Despite the equipment losses and injuries due to the chlorine exposure the fire department maintained control of the response and continued to provide public protection during the incident.

[101] Norfolk Southern Railway Annual Report; 2006, p. K28.
[102] Norfolk Southern Railway Quarterly Financial Review; Fourth Quarter 2006, pp. 4 – 5.
[103] Wagner, Steven P., "Family OKs Derailment Settlement" The Forum – 10/13/2005, http://wwwin-forum.com/specials/ minot/part5.cfm?id+105572

The U.S. Environmental Protection Agency (EPA) conducted air quality monitoring and assessed the level of fish kill in Langley Pond, the largest pond in the world, which is downstream from the derailment site. State environmental and natural resource agencies also evaluated nearby bodies of water. Ten days after the incident they completed an evaluation of the fish kill along Horse Creek and Langley Pond.

Schools within a 1-mile radius were closed. Although, this cost was included in the evacuation costs quantified in the analysis, the related cost of air sampling conducted, wiping down surfaces, and discarding many opened and unopened food supplies before allowing schools to reopen was not.

The South Carolina Emergency Management Division coordinated the deployment of the U.S. Department of Homeland Security Pre-Positioned Equipment Pod (PEP) that provided "truckloads" of protective equipment to incident first responders. The Graniteville emergency marked the first time that the PEP "pod" system has been used. PEP is comprised of highly specialized equipment, as well as off-the-shelf items, stored in 11 pods dispersed nationwide and transportable by land or air within one to 12 hours. Through formal request, the Federal government transfers custody of these assets to local officials.

In most major disaster situations, the local communities set up shelters for the residents that are dispersed from their homes and for responders. In addition, communities help feed displaced residents and emergency responders.

<u>Unaccounted for Impacts on the Environment</u>
According to the EPA, the chlorine released in the Graniteville incident required twelve days to be completely purged from the rail tank car and the area immediately around it. During that time the EPA was monitoring the transfer of chlorine vapor from the damaged rail tank car and worked with local school officials to conduct air monitoring and sampling at two schools.

A separate concern in the aftermath of the Graniteville incident was the degree to which homes in the evacuation area were contaminated or damaged by the chlorine. The EPA and NS contracted with the Center for Toxicology and Environmental Health to do home inspections. At least 550 homes were inspected.

Chlorine gas is more than twice as heavy as air. Therefore, it can settle in low lying areas in the absence of wind. Humans detect the presence of chlorine at as low concentrations of 1 to 3 ppm. At 30 ppm, coughing and pain result; at 430 ppm death results in as little as 30 minutes. Higher concentrations can cause rapid fatality. Chlorine gas reacts with water in the air to form vapors of hydrochloric acid and liberate nascent oxygen, both of which cause massive tissue damage.

In an aquatic environment, chlorine gas reacts with water to form hypochlorous acid and hydrochloric acid. The breakdown of hydrochloric acid causes a decrease in the pH of the water, making it more acidic. These changes in water chemistry can cause wide spread damage to aquatic environments, including fish kills. In the Graniteville incident, fish kills occurred in two bodies of water (a creek and a large pond) in the vicinity of the release site.

If chlorine gas is released into soil, chlorine will react with moisture forming hypochlorous acid and hydrochloric acid. These compounds can react with other substances found in soil. Contamination of the soil would require removal to avoid contamination of ground water.

Impact of PIH Accidents on Shipping Rates
Although insurance premiums themselves would be considered "transfer" payments, and therefore are not included in this analysis, they represent actual consequences to railroads and shippers of PIH materials. This analysis attempts to capture as much of the increased risk-of-loss to society that the increased premiums represent.

It is also important to note that these types of incidents have caused the costs that railroads pay for insurance to escalate. AAR President Edward Hamberger noted "The Federal Government today, through railroads' common carrier obligation, requires railroads to transport these shipments [PIH], whether they want to carry them or not. Every time a railroad moves one of these shipments, though, it faces potentially ruinous liability. The insurance industry is unwilling to insure the railroads against the multi-billion-dollar risks associated with highly-hazardous shipments."[104] The railroads have also noted that the transport of PIH materials represents 0.3 percent of their business, but the exposure to the liability of the PIH materials has more than doubled their insurance costs.

This increase in risk, and/or the rail insurance rates is reflected in rail shipping rates for PIH materials. Minimally, the rates for the transport of PIH materials have doubled. It is noted that some of the rates of carriers have increased by four times.[105] It is also apparent that the rates do not appear to be stabilizing, and railroads claim that with their rate increases, they are still not fully-compensated for the substantial risks they undertake in the transportation of PIH materials. It is actually anticipated that these rates are on an upward increase for the foreseeable future. To the extent that this rulemaking has greater benefits than costs, in other words, if the mitigation measures required in this rulemaking are less costly than the expected damages due to derailments, this proposed rulemaking may cause the rates to stop increasing and possibly start going down or at least stay flat. This is because this proposed rulemaking will significantly reduce the risks of a PIH tank car losing its integrity in an accident/incident or derailment.

Miscellaneous Items Related to the Graniteville Incident
There are also additional miscellaneous impacts or burdens that were associated with the Graniteville accident. For instance, the Federal Aviation Administration instituted a Temporary Flight Restriction at 11:10 AM on January 6, with a 5-mile radius from the surface to 3,000 feet. (This was reduced to a 3-mile radius on January 9, and was decreased to 2,000 feet on January 13).

South Carolina Electric & Gas (SCE&G) needed to conduct an analysis of components in its heavily damaged power stations that served the Graniteville area and at Avondale Mills. Because of size of the disaster at Graniteville, the cleanup of the substation at the textile mill was

[104] Statement of Edward Hamberger, President & CEO, AAR, before U.S. House of Representatives Subcommittee on Railroads, June 13, 2006.
[105] It is noted that one shipper had its rates increased over 4.8 times in a 2-year period. This is a 240 percent increase per year.

delayed 17 days. Avondale Mills had contracted Georgia Tech Research Institute (GTRI) to do materials testing and assessment of all parts of the mill's property.

Lisa Detter-Hoskin, Senior Research Scientist at GTRI, noted that for locations such as Avondale Mills' textile mill and the SCE&G substation that "[b]asically you had items sitting in an acid bottle for days."[106] Essentially the chlorine gas had plenty of moisture to react with, both on the surfaces and in the air, and it reacted with almost anything to transform it into reactive chorine derivatives.

It is difficult to total or aggregate these miscellaneous societal burdens because they are so hard to quantify. As noted above, Avondale Mills spent over $140 million on cleaning, repairs, and damage mitigation as a result of the derailment and was still unable to financially recover from the incident. In addition, although Avondale Mills also reached a $215 million settlement with its primary insurer for claims related to the derailment, the company asserted that the amount was substantially less than the full value of the losses incurred as a result of the derailment and the company has a pending lawsuit against NS seeking $420 million in damages. These could or could not be costs passed on to NS and its insurer. DOT estimates that any of these figures, combined with the unaccounted for damages and expenses described in this section (e.g., impacts to businesses and commerce; Federal, State, and local government response efforts; unaccounted for impacts on the environment) would total over $350 million. If half of the amount is discounted to ensure that there is no double counting of other damages quantified in this analysis, then this would produce a potential benefit pool of $175 million. After dividing this number by ten the annual potential benefit would be $17.5 million.[107]

12.13.1 DOT PIH Tank Car

DOT has assessed an 85 percent effectiveness rate on this benefit, similar to the primary safety benefits. The total potential value of this benefit over a 30-year period is $371.9 million. The PV of this total is approximately $124.7 million.

12.13.2 AAR Interchange Standard – Trinity-Like tank car

Given that the estimate of the success for this that might be accredited to the AAR Interchange Standard/Trinity-like tank car is 15 % of the DOT tank car effectivess, then the potential savings totals $2,230,000. The total potential value of this benefit over a 30-year period is $53.7 million. The PV of this total is approximately $17.5 million.

[106] Sanders, Jane M., "Chlorine's Casualties and Counsel: Nation's worst chlorine gas leak wreaked havoc, but research reveals lessons learned," Horizons Research, Fall 2006.

[107] The number is divided by ten because the base accident data set covers a ten year period. Thus it would assume such a loss or impact would only be occurring once over a ten year period.

12.14 Residual Value of Tank Cars at the End of this Analysis

The DOT proposed PIH tank cars have a higher residual value than existing cars, since the inner commodity tank, which is not subject to the in-train forces, can be placed in a new carbody. Existing cars are not handled in the same process because bolster frames are welded to the tank and removal is not a viable option. With the proposed DOT tank car, once the outer tank reaches the mandated freight car life (40 years) the tank retains its usability and replacing the carbody is a more economic approach. Since this analysis is only run for 30 years, we are assuming this residual value can be recovered in the last year of this analysis.

For the DOT proposed PIH tank car this value, which is entered as a benefit, is calculated by multiplying the number of PIH tank cars by the marginal cost of the improvements by 18 percent. This methodology only takes credit for the residual value of the improvements of the tank cars. This is entered in the 30th year of the analysis. The value is \$110.2 million, and the discounted value of this is \$14.5 million.

For the AAR Interchange standard, i.e., Trinity-like tank car the benefit is calculated the same way. However the marginal cost of the improvements were less so the total residual value calculated for the 30th year is less. The value is \$60.6 million, and the discounted value of this is \$8 million.

12.15 Moderate Case Scenario Benefit: Graniteville Revisited[108]

The accidents in Minot, Macdona, and Graniteville resulted in a relatively small number of fatalities compared to the potential that existed in each event. This is primarily because of a number of factors that worked in the favor of the public. These included time of day, ability of emergency responders to recover from exposure and formulate a plan, weather conditions, release quantity, and location of populations to the releasing material. A change in any one of these conditions would most certainly have resulted in an increased number of fatalities and injuries.

Modern risk assessment tools allow an analysis that combines an engineering analysis with historical data in a comprehensive and integrated way. A December 2000 report issued under a Department of Energy contract[109] suggests that the potential risk to large populations of people continues to exist despite the relatively sparse historical data available and low probability of an accidental release of PIH material from a railroad tank car. This analysis, accomplished prior to the three aforementioned accidents, predicted 16 fatalities from railroad transportation every 10 years. In addition, the report highlighted the potential for a serious incident involving a high number of fatalities. This potential has not presently been reduced.

The potential for a rail transportation event is demonstrated by the 2007 calendar year data collected by FRA. In 2007 train accident rates declined by almost 14% yet accidents where hazardous materials were released rose by 42%. One difficulty in understanding the numbers

---

[108] Note: This benefit is only included in the benefit total for Case 3 of this analysis.

[109] Argonne National Laboratories, "A National Risk Assessment for Selected Hazardous Materials in Transportation." Report ANL/DIS-01-1, December, 2000.

relates to the fact that the results are developed from an extremely small dataset. For example, train accidents involving hazardous materials rose from 28 in 2006 to 43 in 2007, even though both the total number of train accidents and the train accident rate declined over the period.

The area affected from a release is directly related to the amount of energy imparted into the product upon release. Generally this energy is imparted through heat from the surrounding air and ground. Chlorine gas expands 450 times its liquefied amount at atmospheric conditions. Therefore the amounts released in Alberton, Macdona, and Graniteville had the potential of impacting areas 547,000; 565,000; and 554,000 cubic feet respectively. The amount of ammonia released in Minot would have covered an area 16,700,000 cubic feet[110]. These areas would be at near 100% concentrations. Given that the expanding vapors would disperse with atmospheric gas (air) the area impacted within the toxic limits would be significantly larger.

Chlorine gas is heavier than air, and therefore, a chlorine gas cloud will remain low to the ground[111]. How this cloud of chlorine gas dissipates or moves is determined by variables such as terrain, temperature, humidity, wind speed and its direction, and volume of the release. Most importantly, a chlorine gas cloud can travel several miles within in a few hours and still maintain concentrations at or above toxic concentrations.

Given the demographics and topography surrounding the previous accident sites, had these accidents occurred at a different time of day, or had any of the atmospheric variables been different (e.g., wind speed or direction, temperature, barometric pressure, or humidity), it is likely that many more people would have been exposed to the chlorine plume. For instance, if the Graniteville accident had occurred while the Avondale Mills plant was fully staffed, or during an afternoon shift change, it is likely that hundreds of individuals would have been exposed. Similarly, a middle school is located approximately 1,000 feet north of the accident site (well within the area of the plume that did occur). Had the accident happened while school was in session, it is likely that approximately 500 students, along with scores of school staff, would have been exposed to the toxic plume.

Significant gathering places (i.e. hospitals, schools, and places of worship) are often in proximity to railroads. This proximity increases the likelihood that a significant number of people would be affected if a similar accident occurs during a time when the public is congregated in these areas.

Similarly, if any atmospheric variable changes (e.g., wind speed or direction, temperature, barometric pressure, or humidity) it is likely that the chlorine plume will expand more rapidly and affect a greater area. For instance, in Graniteville, at the time of the accident, a light wind was blowing in a south-southwest direction. The accident site was located in a north-south valley where light winds caused air swirling and pocketing of gas. If the wind had been blowing at the same intensity, but in a south-southeast direction, the chlorine plume could have hovered over the southeasterly side of the accident site, rather than the northwesterly side. Southeast of the accident site is primarily a residential area and given the size of the plume that did result, the plume could have endangered approximately 185 homes. Given the average household size of

[110] Ammonia expands 850 times its liquid volume when converting to gas.
[111] Ammonia is lighter than air so the cloud would be higher than a chlorine release.

2.68 in Aiken County,[112] almost 500 people to the southeast of the accident site could have been exposed to vapors above the ERPG-3 level causing significantly more casualties and fatalities.[113] Had it been warmer, the additional atmospheric temperature would have provided additional energy for the chlorine to expand and it is likely that the chlorine plume would have expanded faster, thereby engulfing the area at a higher rate than experienced.

The risk from a release is spread across the country, albeit at different rates depending on variables such as temporal, infrastructure, and atmospheric conditions (to name a few), and has the potential to impact any city or town in the United States. Census data shows that cities containing 46 of the continental U.S. State capitals have railroads operating within their boundaries and all but 2 of the urbanized areas with populations greater than 50,000 are intersected by rail lines.[114]

Another factor that impacts potential severity of an accident is the ability of emergency responders to identify and respond to a release. In Macdona and Graniteville responding fire department personnel were overcome after driving into the chlorine plume. These exposures adversely impacted the ability of the department personnel to address the problem. Had these personnel been overcome to the point of incapacitation, the resulting fatalities would have greatly exceeded the actual outcome.

Within the United States emergency response to accidents is provided through a network of more than 1.2 million fire department personnel. However, the preponderance of these organizations are staffed by voluntary and unpaid workers; 93% of the 26,354 fire departments in the United States are represented by volunteer firefighters with 19,224 departments fully volunteer; 3,845 mostly volunteer; and 1,407 mostly career. The ability to train these personnel has continued to be a difficult task and the risk to the public is commensurate with their response. The vast differences in capabilities to respond to an incident can either mitigate or exacerbate a release of PIH material from an accident.

Location of emergency response equipment also plays a key role in determining potential risk. For example, the Graniteville-Vaucluse-Warrenville Fire Department operates five engines, one ladder, one service truck, and two first responder/rescue vehicles from three stations. The headquarters station of this department was located about 100 yards from the Graniteville train derailment site. The injuries sustained by firefighters during the initial response to the incident were the result of these personnel reporting in the early morning hours to the headquarters station where a primary response would have been launched from. In addition, the switch for activating the community notification system was located in the headquarters station. With the toxic cloud overcoming the station, this system was unavailable and caused significant delays in evacuation.

---

[112] U.S. Census Bureau, American FactFinder (available at http://factfinder.census.gov).

[113] "ERGP-3 level" refers to the American Industrial Hygiene Association's (AIHA) Emergency Response Planning Guideline level 3 which means "[t]he maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects." See AIHA, Emergency Response Planning Committee, Procedures and Responsibilities, at 1 (Nov. 1, 2006) (downloaded from http://www.aiha.org).

[114] Olson, Leslie E. et al, "Alternative Technologies to Railroad Tank Car Placarding." Texas Transportation Institute, March, 2005, Report HSTS02-04-C-MLS006.

With the proximity of the station to the incident, it is foreseeable that, if the incident had occurred during a time when the emergency response personnel were at the station, the ensuing vapor cloud might have resulted in the inability of these responders to effectively escape the concentrations at or above the level of "immediately dangerous to life and health" (IDLH); potential fatalities to the responders; and the potential for an ineffective emergency response, and therefore, additional fatalities.

Hence is not hard to imagine an incident such as those previously experienced with a level of casualties moderately higher than what occurred. DOT hypothetically predicted such a scenario with the casualty consequences for that accident if there had been a change in one of the variables.

12.15.1 DOT Proposed PIH Tank Car

For the DOT proposed PIH tank car this benefit could total $11.1 million per year from decreasing track outages, given that the estimate of the success that might be accredited to this rulemaking is 85 percent. This benefit is phased-in over years 3 through 8 of this analysis. For the thirty-year period of ths analysis it totals $162 million. The discounted value of this benefit is $68.9 million.

12.15.2 AAR Interchange Standard – Trinity-Like Tank Car

Given that the estimate of the success for this that might be accredited to the AAR Interchange Standard/Trinity-like tank car is 15 % of the DOT tank car effectivess, then the potential savings totals $34.1 million. The discounted value of this benefit is $11.2 million. This produces a yearly benefit potential of $1.42 million per year. This benefit is phased-in over years 2 through 10 of this analysis.

TABLE 6: Benefits (PV 30, 7%; VSL: $5.8M)

Requirement	Baseline Interchange (AAR Standard)	Proposal (DOT PIH TC)	Regulatory Benefit (Additional Benefits from DOT Proposal)[115]
Accident Mitigation Savings			
Casualties	$28,777,179	$197,889,019	$169,111,840
Environmental Damage	$844,371	$5,853,438	$5,009,067
Track closures	$5,801,788	$39,899,539	$34,097,751
Disruption of Electric Power	$175,297	$1,205,518	$1,030,221
Evacuation	$1,528,462	$10,511,191	$8,982,729
Shelter-in-Place	$103,603	$2,124,997	$2,021,394
Property Damage	$2,341,547	$16,102,130	$13,760,583
Road Closures	$1,538,514	$10,580,247	$9,041,733
Minor Accident Benefits	$1,211,347	$8,331,652	$7120,305
Operating Restrictions Safety Benefit	$0	$81,359,670	$81,359,670
Moderate Case Graniteville Scenario	$11,168,463	$90,054,305	$78,885,842
Miscellaneous Societal Benefits	$17,484,158	$124,684,745	$107,200,587
Subtotal - Accident Mitigation Savings	$70,974,729	$588,596,451	$517,621,722
Business Benefits			
Operating Restrictions Fuel Savings	$0	$138,798,305	$138,798,305
More Salvageable Tank Cars	$0	$3,990,323	$3,990,323
Residual Value of Tank Cars	$7,959,271	$14,471,402	$6,512,131
Subtotal - Business Benefits	$7,959,271	$157,260,030	$149,300,759
TOTAL	**$78,934,000**	**$744,443,964**	**$665,509,964**

115 Note this is the difference: DOT proposal benefits minus the Baseline/AAR Standard.

TABLE 7: Benefits (PV 30, 3%; VSL: $5.8M)

Requirement	**Baseline Interchange** (AAR Standard)	**Proposal** (DOT PIH TC)	**Regulatory Benefit** (Additional Benefits from DOT Proposal)[116]
Accident Mitigation Savings			
Casualties	$52,003,795	$355,560,337	$303,556,542
Environmental Damage	$1,525,882	$10,493,586	$8,967,704
Track closures	$10484,536	$71,688,706	$61,204,170
Disruption of Electric Power	$316,783	$2,166,001	$1,849,218
Evacuation	$2.762,117	$18,885,882	$16,123,765
Shelter-in-Place	$187,224	$1,280,142	$1,092,918
Property Damage	$4,231,456	$28,931,277	$24,699,821
Road Closures	$2,780,282	$19,009,990	$16,229,708
Minor Accident Benefits	$2,189,051	$14,969,842	$12,780,791
Operating Restrictions Safety Benefit	$0	$95,437,329	$95,437,329
Moderate Case Graniteville Scenario	$20,279,521	$163,491,281	$143,211,760
Miscellaneous Societal Benefits	$31,944,058	$224,025,576	$192,081,518
Subtotal - Accident Mitigation Savings	$128,704,705	$1,005,939,949	$877,235,244
Business Benefits			
Operating Restrictions Fuel Savings	$0	$183,812,103	$183,812,103
More Salvageable Tank Cars	$0	$7,278,933	$7,278,933
Residual Value of Tank Cars	$24,961,454	$45,384,461	$20,423,007
Subtotal - Business Benefits	$24,961,454	$236,475,497	$211,514,043
TOTAL	**$153,666,158**	**$1,242,415,446**	**$1,088,749,287**

13.0 Results

For the DOT PIH tank car proposal 30-year period analyzed, the estimated quantified costs total $1.566 billion with a PV, (7%) of approximately $827 million. The benefits for this car would potentially total $1.605 billion with a PV,(7%) of $744 million.

[116] Note this is the difference: DOT proposal benefits minus the Baseline/AAR Standard.

For the AAR Interchange Standard (Trinity-like tank car) alternative the 30-year period analyzed, the estimated quantified costs total $1.049 billion with a PV (7%) of approximately $477 million. The benefits for the base case would potentially total $276 million with a PV (7 %) of $79 million.

14.0 Analysis

The results of this analysis indicate that for the 30-year period analyzed a combination of accident related and business benefits resulting from implementation of DOT's proposed rule would exceed and therefore justify the costs associated with such implementation. This is true based on calculations performed using discount rates of 7% and a 3%.

DOT also analyzed the costs and benefits associated with a "status quo" regulatory alternative in which the AAR Interchange Standard mandating Trinity-like tank cars would be enforced. This analysis indicates that implementation of this alternative would also result in higher benefits than costs. However, given that implementation of this alternative standard would not result in avoidance of any of the ruptures that resulted in fatal PIH releases experienced in the past ten years, DOT believes that this alternative would not sufficiently address the market failure leading to this rulemaking. Note that the AAR standard does not contain any operating restrictions.

15.0 Uncertainty, Variability & Sensitivity Assessment

The findings, results, and conclusions of this analysis could change if the assumptions or inputs were to change. Therefore, the findings of this analysis are sensitive to its assumptions. The cost estimates are largely driven by the number of new PIH tank cars produced and the estimated marginal cost increase for including the proposed features. The potential benefit calculations are largely driven by the estimated savings from casualty severity mitigation. Thus, the savings could vary based on the estimated value of a life saved. Economic analyses such as this one are also sensitive to variables such as the interest rate that is used for the discount rate. The sensitivity to these key variables was demonstrated by Hahn (2004).[1]

In accordance with guidance from DOT, this analysis is based on a value of a statistical life (VSL) of $5.8 million.[117] OMB Circular A-4 states that the majority of studies of VSL range from roughly $1 million to $10 million. Use of a higher or lower VSL could significantly affect potential safety benefits and could ultimately the relative standing of costs to benefits for this rulemaking. In recognition of this potential impact and the imprecision of assumptions regarding the value of a life, DOT also analyzed the sensitivity of its findings by evaluating key safety benefits using VSLs of $3.2 million, and $8.4 million.

DOT also performed a sensitivity analysis to address the uncertainty regarding the consequences from release of PIH materials resulting from train accidents. This sensitivity analysis is based on the assumption that the consequences of projected incidents will be of the same average severity as those in the past ten years. It does not recognize how fortunate the circumstances surrounding

[117] DOT last revised this value on February 5, 2008.

recent past incidents have been. However, given the rarity of the occurrence of rail accidents resulting in the release of PIH materials from tank cars, and the high variability in the circumstances and consequences of such events, DOT believes this sensitivity analysis is useful.

The table below presents the benefit levels associated with the three sensitivity analyses performed.

Table 6 - Sensitivity Analysis (PV 30, 7 Percent)

	Benefits
VSL, $3.2 M	$562,100,371
VSL, $8.4 M	$857,952,815
Conservative accident consequences	$586,624,122

DOT believes that the range of benefit levels presented in this table show that, despite the uncertainty surrounding the assumptions related to release consequences, substantial benefits would be realized through implementation of the proposed rule.

15.1 Other DOT Initiatives

In the area of human factors, FRA has issued a proposed rule which seeks to ensure better management of railroad programs of operational tests and inspections and to establish greater accountability for compliance with operating rules involved in approximately half of the human factors train accidents. FRA has completed consultations within the RSAC regarding resolution of public comments on the proposed rule, and a final rule should be issued this year.

Recognizing that the best answer to human factor risks is sometimes technology that can “backstop” the person in cases where errors have high consequences, FRA continues to work actively to promote Positive Train Control (PTC) systems and similar technology. FRA expects that implementation of PTC systems and similar technology will, over time, reduce the risk of collisions.

In the field of track safety, FRA is taking concrete steps in both research and enforcement. FRA research has provided a new tool to detect cracks in joint bars. This optical recognition technology can capture and analyze images for very small cracks while mounted on a hi-rail truck or other on-track vehicle. The system is already in initial use by two major railroads. Recently FRA also promulgated a final rule on Continuous Welded Rail (CWR) “joint bars” that requires track owners to develop and implement procedures for detailed inspections of rail joints in CWR. It identified specific items, such as things that track inspectors should look for like rail end batter that track owners must address in their plans.

However, railroad operations continue to present significant safety risks and are likely to do so for the foreseeable future. Increased rail traffic is putting significant pressure on the existing infrastructure, and the increasing density of operations continues to drive up the “chances” for minor events to become disasters. Accordingly, strategies that emphasize mitigation of accident consequences through improved crashworthiness will be required to address the needs identified in this analysis.

While DOT is working on other initiatives that should yield a reduction in train accidents that could affect the transportation of hazardous materials, those initiatives are aimed at accident avoidance in general. Such initiatives alone would only partially address the risk posed by the transportation of PIH materials by railroad tank car. In addition, to rely on such initiatives to achieve the same level of safety improvement that this rule would yield, would require far larger expenditures than currently planned. For instance, future collisions on Class I main lines would be addressed by PTC, however, it would cost approximately $3 billion to implement PTC on those lines and 10% of that amount for annual maintenance. Since a significant portion of PIH materials do not move on Class I main lines, additional investment would be required. Given the significantly lower levels of traffic along some of the lines that PIH is transported on, such investment would not be justified there for the foreseeable future. Further, many PIH releases involve derailments, and derailments with secondary collisions, caused by factors not addressed by PTC. DOT believes there is no more cost effective method to sufficiently address all PIH movements by rail than that proposed in this rule.

15.2 Potential Changes in the Railroad Service Environment

The Department recognizes that other changes occurring in the railroad service environment over the period of this analysis may influence the potential for train accidents and their likely severity. Although FRA has identified many factors that could positively or negatively influence safety performance relevant to tank car catastrophic releases over the next three decades, the Department does not believe that firm conclusions can be drawn regarding the net effects of these factors.

Factors that will drive reductions in risk include:

- Development and deployment of PTC systems, which should be extensively deployed at least on the Class I railroads, by approximately 2020.
- Better prevention and management of fatigue among railroad operating employees through voluntary efforts, and perhaps, statutory changes presently under examination in Congress.
- Continued progress in the development and deployment of wayside detection systems that can identify developing problems with railroad wheels, bearings, brakes, axles, and other car components.
- Reduced derailments from train handling and over-speed conditions if the industry embraces electronically-controlled pneumatic (ECP) brakes.

Factors that may drive increases in risk include:

- Increased density of operations (which, as to a single PIH shipment, would create additional exposure to events such as secondary collisions in multiple-track territory).
- Increased average train speeds made possible by PTC and ECP brakes, raising the potential for breaching less crashworthy tank cars when a train accident occurs.
- Growing exposure to collisions with heavy motor vehicles at highway-rail grade crossings, with subsequent derailment.
- Deteriorating rail infrastructure, particularly fatigued rail and failing bridges, should the industry fail to increase its rate of investment in system replacement from current levels.

- Any increase in intentional acts directed against train movements or rail infrastructure.

Although the major factors likely to influence the level of risk in the service environment over the next three decades can be identified in broad outline, as stated above, the extent to which any single element will be influential is difficult to predict with precision, and in the case of several factors intervening decisions by the industry will be required to determine if they will drive reductions or increases in risk. Accordingly, the Department's best judgment is that requirements for tank car crashworthiness should be proposed and that, if adopted, projected benefits are likely to be realized.

16.0 Conclusion

This analysis includes qualitative discussions and quantitative measurements of costs and benefits of the proposed rule. The costs that would be imposed are primarily labor and material costs associated with incorporating the new crashworthiness features found in the proposed rule, and costs related to the designing and re-engineering required to implement the proposed safety enhancements. In addition, there would be costs associated with transferring current PIH tank cars to other commodity services, and costs associated with the proposed operating restrictions. Finally, there would be costs for the increased traffic or volume of tank cars on rail due to the increased weight, and thus reduced capacity, of the cars. A majority of the savings will accrue from implementation of the requirements that decrease the probability of death, and mitigation of potential injuries from accidents and derailments of trains that involve tank cars loaded with PIH materials. In addition, savings would accrue from a decrease in railroad and other property damages, environmental remediation, track closures, road closures, and evacuations.

The true regulatory impact from this rulemaking would be the DOT proposal minus the AAR proposal. The the true regulatory cost for the DOT proposed alternative is $351 million PV (7%) and with a PV (3%) of $432 million. The true benefits for the DOT proposal would be $666 million PV (7%) and with a PV (3%) of $1.088 billion.

The results of this analysis are sensitive to the various inputs and assumptions used to estimate costs and benefits. For instance, the results could change if the total incremental costs for incorporating the new crashworthiness features were significantly different. Given that this proposed rule contains performance standards and not prescriptive design standards, it is possible that tank car manufacturers may be able to develop compliant designs that are less expensive. Another potential source of uncertainty affecting the level of compliance costs is future demand level for PIH materials. The degree and direction of any such fluctuation(s) over the 30-year period of this analysis is not predictable with any reasonable degree of confidence.

In addition, the value of a statistical life that is used for estimating safety benefits can also affect the overall cost benefit comparison and thus the outcome of this analysis. This analysis shows the differences from using different values for a Value of a Statistical Life (VSL). Specifically, the analysis uses a value of $5.8 million. It also shows what the benefit totals would be if the value was $2.6 million less, i.e., $3.2 million; and $2.6 million more, i.e., $8.4 million.

Other sources of uncertainty can be more readily analyzed. DOT conducted sensitivity analyses varying assumptions related to the value of a statistical life as well as accident severity projections used to estimate the benefits of the proposed rule. The first addresses the uncertainty regarding the consequences from release of PIH materials resulting from train accidents. This analysis is based on the assumption that the consequences of projected incidents will be of the same average severity as those in the past ten years. It does not recognize how fortunate the circumstances surrounding recent past incidents have been. Given the rarity of the occurrence of rail accidents resulting in the release of PIH materials from tank cars, and the high variability in the circumstances and consequences of such events, this sensitivity analysis is useful. The 30-year benefit estimates associated with this scenario are $586,624,122 (PV, 7%) and $926,731,141 (PV, 3%). The second and third sensitivity analyses address the imprecision of assumptions regarding the value of a life, which affect the level of safety benefits (i.e., casualty mitigation) that would result from promulgation of the proposed rule. Casualty mitigation benefits associated with this rulemaking were estimated using a value of statistical life of $5.8 million. Thirty-year benefit estimates associated with values of a statistical life of $3.2 million and $8.4 million would be $562,100,371 (PV, 7%, VSL: $3.2M), $857,000,000 (PV, 7%, VSL: $8.4M).

This analysis provides estimates of what the potential savings could be from accidents or derailments in which PIH tank cars do not lose their integrity as a result of implementing the proposed provisions. Such benefits include lives saved, injuries averted, evacuations avoided, environmental cleanup averted, track and road closures avoided, and property and business damages avoided. Other significant societal benefits are discussed, but their value is translated into monetary terms only to the extent it was possible to do so with the information available. This analysis also includes benefits associated with the fact that the proposed operating restrictions would produce absolute economic (non-accident related) benefits in terms of fuel savings. Finally, this analysis estimates that tank cars built to the proposed standards will have a significantly higher residual value at the end of the period analyzed (more crashworthy cars will likely not be scrapped at the same rate as current cars).

It is important to note, as several commenters at the public meetings relating to this rule have stated, that the tank car is only one component of the rail transportation system, and no single component of the system can provide the entire means to improving tank car safety.

Hazardous materials are essential to the economy of the United States and the well being of its people. These materials are used in water purification, farming, manufacturing, and other industrial applications. The need for 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 safe method of moving large quantities of hazardous materials over long distances.

PHMSA’s proposed rule would require enhanced tank car performance standards for head and shell impacts; operational speed restrictions for all tank cars that transport PIH materials; more stringent operational restrictions for trains hauling tank cars not meeting the enhanced performance standards proposed, but transporting PIH materials and operating in non-signaled territory; and an allowance to increase the gross weight of tank cars that meet the enhanced tank-head and shell standards. The proposed rule would require tank cars that transport PIH materials be designed and manufactured with tank-head puncture resistance systems capable of preventing puncture at 30 mph and shell puncture-resistance systems capable of withstanding the proposed performance tests without loss of lading at a minimum 25 mph impact by a ram car weighing 286,000 pounds. The relevant research undertaken for this rule indicates that in general, the secondary car-to-car impact speed is approximately one-half of initial train speed. Thus, requiring tank cars to withstand head and shell impacts of at least 25 mph and limiting the speed of those tank cars to 50 mph ensures that, in most instances, a tank car would not be breached if involved in a derailment or other similar type of accident. To address higher forces associated with direct impacts in train-to-train collisions, the tank-head would be required to survive an impact at 30 mph.

During the public meetings, several commenters noted that the tank car is only one component of the rail transportation system and no single component of the system can provide the entire means to improving tank car safety. PHMSA and FRA are taking a variety of actions to reduce the risk of derailments and collisions and to promote prompt and effective responses that reduce the loss of life and property. Nevertheless, an identified gap must be closed if future catastrophic events are to be prevented.

Finally, it should be noted that quantitative methodologies such as this benefit-cost analysis are a useful way of organizing and comparing the favorable and unfavorable effects of proposed regulations such as this one. A benefit-cost analysis does not provide the policy answer, but rather defines and displays a useful framework for debate and review.[118] Hence, this impact analysis is only one tool which can be utilized when considering such a proposal.

[118] AEI-Brookings Joint Center for Regulatory Studies, "Interests of Amici Curiae: American Trucking Associations, Inc. ET AL., v. Carol Browner, Administrator of the Environmental Protection Agency, ET AL., July 21, 2000, p. 8.

.

Appendix A
Exhibits—Assumptions: Costs and Benefits

EXHIBIT 1 CRITICAL INPUTS and ASSUMPTIONS	
Hourly Rate for Design & Engineering	$150.00 per hour
Hourly rate for average Railroad Employee	$30.05 per hour
Hourly Rate for Tank Car Repairman	$42.00 per hour
Estimated time for manufacturer to Demonstrate Compliance of Design	250 hours
Estimated Number of hours of Design & Eng for the first model	4,540
Approximate Number of Tank cars Affected	15,300
Estimated Cost of Tank Car Improvements - Labor & Supplies	$40,000 per tank car
Estimated Time (per tank car) for reporting at the halfway point	5 minutes per tank car
Estimated Number of Employees requiring training on the new TIH Tank Cars	200 employees
Average Number of Trips per PIH Tank Car	6
Estimated Increase in TIH car loads	1,720 per year
Average length of Car load Haul	723 Miles
Average Tons per Carload	79 tons per carload
Variable Cost per ton-mile (regulatory cost via STB data)	$0.01993
Avg number of Tank Car builders	5
Avg. number of Tank Designs per builder	2

EXHIBIT 2 - COSTS

Tank Car Crashworthiness NPRM Revised: 7 March 2008

Case: DOT Tank Car Seven percent

COSTS

0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 20	Year 30	TOTAL
Build & Maint. Costs													
Design & Eng - New TIH TCs	3,553,750	2,553,750	0	0	0	0	0	0	0	0	0	0	6,107,500
PV	3,321,335	2,230,445	0	0	0	0	0	0	0	0	0	0	5,551,780
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Marginal Production Costs: L	0	0	102,000,000	102,000,000	102,000,000	102,000,000	102,000,000	102,000,000	612,000	612,000	612,000	612,000	625,464,000
PV	0	0	83,262,600	77,815,800	72,726,000	67,962,600	63,515,400	59,364,000	332,867	311,080	158,141	80,397	428,585,922
Compliant Repairs	0	0	0	1,386	2,771	4,157	5,542	6,927	8,313	8,313	8,313	8,313	203,668
PV	0	0	0	1,057	1,976	2,769	3,451	4,032	4,521	4,225	2,148	1,092	66,797
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Training - for Maintenance &	3,333	0	0	0	0	0	0	0	0	0	0	0	3,333
PV	3,115	0	0	0	0	0	0	0	0	0	0	0	3,115
Additional Fuel Charges	0	0	1,242,835	3,802,922	6,214,025	8,699,694	11,184,320	13,670,884	14,913,719	14,913,719	14,913,719	14,913,719	372,916,489
PV	0	0	1,014,526	2,901,249	4,430,600	5,796,606	6,964,476	7,956,454	8,111,572	7,580,643	3,853,705	1,959,172	125,065,411
Increased Shipments of TIH	0	0	978,582	1,957,165	3,915,504	5,873,844	7,831,008	9,789,348	11,747,687	11,747,687	11,747,687	11,747,687	288,794,576
PV	0	0	798,817	1,493,121	2,791,755	3,913,742	4,876,369	5,697,401	6,389,567	5,971,350	3,035,602	1,543,260	95,192,559
Maintenance - marginal incre	0	500,000	500,000	70,097	140,236	210,375	280,472	350,611	420,750	420,750	420,750	420,750	11,308,291
PV	0	436,700	408,150	53,477	99,988	140,173	174,650	204,056	228,846	213,867	108,722	55,273	4,225,615
Inspection of new TIH Tank (	0	0	0	856,800	856,800	1,713,600	1,713,600	2,570,400	2,570,400	856,800	0	0	11,995,200
PV	0	0	0	653,653	610,898	1,141,772	1,067,059	1,495,973	1,398,041	435,511	0	0	7,209,972
Sub-Total	3,557,083	3,053,750	104,721,417	108,688,369	113,129,336	118,501,669	123,014,942	128,388,170	30,272,869	28,559,269	27,702,469	27,702,469	1,316,793,058
NPV of Sub-Total	3,324,450	2,667,145	85,484,093	82,918,357	80,661,216	78,957,662	76,601,404	74,721,915	16,465,414	14,516,676	7,158,318	3,639,194	665,901,171
Other Costs	0	0	0	0	0	0	0	0	0	0	0	0	0
Transfer current TIH to other	0	0	0	5,416,667	5,416,667	5,416,667	5,416,667	5,416,667	5,416,667	0	0	0	32,500,000
PV	0	0	0	4,132,375	3,862,083	3,609,125	3,372,958	3,152,500	2,946,125	0	0	0	21,075,167
Impact of 50 MPH Restrictio	1,404,390	2,808,780	2,808,780	2,808,780	2,808,780	2,808,780	2,808,780	2,808,780	2,808,780	2,808,780	2,808,780	2,808,780	82,859,010
PV	1,312,543	2,453,188	2,292,807	2,142,818	2,002,660	1,871,490	1,749,027	1,634,710	1,527,695	1,427,703	725,789	368,981	33,539,718
Impact of 30 MPH Restrictio	24,331,513	24,331,513	24,331,513	20,276,261	16,221,009	12,165,757	8,110,504	4,055,252	0	0	0	0	133,823,322
PV	22,740,232	21,251,143	19,861,814	15,468,759	11,565,579	8,106,044	5,050,411	2,360,157	0	0	0	0	106,404,140
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	25,735,903	27,140,293	27,140,293	28,501,708	24,446,455	20,391,203	16,335,951	12,280,699	8,225,447	2,808,780	2,808,780	2,808,780	249,182,332
NPV of Sub-Total	24,052,775	23,704,332	22,154,621	21,743,953	17,430,323	13,586,659	10,172,397	7,147,367	4,473,820	1,427,703	725,789	368,981	161,019,024
Other Costs	0	0	0	0	0	0	0	0	0	0	0	0	0
Reporting: 50 %	0	0	0	0	0	26,807	0	0	0	0	0	0	26,807
PV	0	0	0	0	0	17,861	0	0	0	0	0	0	17,861
Demonstration of Complianc	0	281,250	0	0	0	0	0	0	0	0	0	0	281,250
PV	0	245,644	0	0	0	0	0	0	0	0	0	0	245,644
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	281,250	0	0	0	26,807	0	0	0	0	0	0	308,057
PV of Sub-Total	0	245,644	0	0	0	17,861	0	0	0	0	0	0	263,505
0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	29,292,986	30,475,293	131,861,710	137,190,077	137,575,791	138,919,679	139,350,893	140,668,869	38,498,316	31,368,049	30,511,249	30,511,249	1,566,283,446
PV of Total	27,377,225	26,617,121	107,638,714	104,662,310	98,091,539	92,562,182	86,773,801	81,869,282	20,939,234	15,944,379	7,884,107	4,008,175	827,183,700

EXHIBIT 3 - BENEFITS

Tank Car Crashworthiness NPRM — Revised: 7 March 2008

Case: DOT Tank Car

BENEFITS

0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 20	Year 30	TOTAL
Benefits: Cost Savings													
Casualty Mitigation	0	0	1,967,520	5,900,908	9,836,657	13,772,405	17,691,627	21,641,542	23,609,770	23,609,770	23,609,770	23,609,770	590,225,598
PV	0	0	1,606,087	4,501,803	7,013,536	9,176,554	11,016,576	12,595,377	12,841,354	12,000,846	6,100,765	3,101,547	197,889,019
Environmental Damage Mitigation	0	0	57,727	173,188	300,226	420,251	540,326	660,371	692,750	692,750	692,750	692,750	17,392,589
PV	0	0	47,122	132,125	214,061	280,013	336,461	384,336	376,787	352,125	179,007	91,005	5,853,438
Track closures - Mitigation	0	0	396,651	1,190,000	1,983,635	2,776,651	3,570,143	4,363,635	4,760,000	4,760,000	4,760,000	4,760,000	119,000,714
PV	0	0	323,786	907,851	1,414,332	1,850,082	2,223,128	2,539,635	2,588,964	2,419,508	1,229,984	625,307	39,899,539
Disruption of Electric - mitigation	0	0	11,980	35,951	59,930	83,890	107,865	131,840	143,820	143,820	143,820	143,820	3,595,496
PV	0	0	9,779	27,427	42,730	55,896	67,168	76,731	78,224	73,104	37,163	18,893	1,205,518
Evacuations - mitigation	0	0	104,459	313,464	522,544	731,461	940,504	1,149,471	1,254,005	1,254,005	1,254,005	1,254,005	31,350,012
PV	0	0	85,270	239,141	372,574	487,373	585,652	668,992	682,053	637,411	324,035	164,735	10,511,191
Shelter-in-Place mititgation	0	0	7,081	21,247	35,420	49,581	63,750	77,920	85,000	85,000	85,000	85,000	2,124,997
PV	0	0	5,780	16,210	25,254	33,035	39,697	45,349	46,232	43,206	21,964	11,166	712,481
Property Damage	0	0	160,083	480,250	800,417	1,120,583	1,440,750	1,760,917	1,921,000	1,921,000	1,921,000	1,921,000	48,025,000
PV	0	0	130,676	366,383	570,697	746,645	897,155	1,024,854	1,044,832	976,444	496,386	252,356	16,102,130
Road Closures - Mitigation	0	0	105,145	315,525	525,904	736,270	946,688	1,157,029	1,262,250	1,262,250	1,262,250	1,262,250	31,556,061
PV	0	0	85,830	240,714	374,969	490,577	589,502	673,391	686,538	641,602	326,165	165,818	10,580,247
Minor Accidents: Benefits	0	0	82,799	248,467	414,135	579,793	745,490	911,128	993,987	993,987	993,987	993,987	24,849,526
PV	0	0	67,589	189,555	295,278	386,316	464,217	530,277	540,630	505,244	256,846	130,577	8,331,652
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	2,893,445	8,678,999	14,478,866	20,270,885	26,047,142	31,853,852	34,722,582	34,722,582	34,722,582	34,722,582	868,119,993
NPV of Sub-Total	0	0	2,361,919	6,621,208	10,323,432	13,506,491	16,219,555	18,538,942	18,885,612	17,649,488	8,972,315	4,561,405	291,085,215
Other Benefits	0	0	0	0	0	0	0	0	0	0	0	0	0
Fuel Savings - from Operating Restric	24,339,189	24,339,189	22,716,641	19,471,546	16,226,840	12,980,966	9,737,039	6,490,580	4,867,838	4,867,838	4,867,838	4,867,838	243,394,420
PV	22,747,406	21,257,848	18,543,594	14,854,842	11,569,737	8,649,217	6,063,254	3,777,518	2,647,617	2,474,322	1,257,849	639,474	138,798,305
New TIH TC are more Salvageable	0	0	0	100,000	200,000	200,000	300,000	400,000	500,000	500,000	500,000	500,000	12,200,000
PV	0	0	0	76,290	142,600	133,260	186,810	232,800	271,950	254,150	129,200	65,684	3,990,323
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Safety Benefit for Operating R.	19,097,420	19,097,420	17,505,968	14,323,065	11,140,162	7,957,258	4,774,355	1,591,452	694,452	694,452	694,452	694,452	110,765,037
PV	17,848,449	16,679,687	14,290,122	10,927,066	7,942,935	5,301,921	2,972,991	926,225	377,712	352,990	179,446	91,228	81,359,670
Sub-Total	43,436,609	43,436,609	40,222,610	33,894,611	27,567,002	21,138,224	14,811,394	8,482,032	6,062,289	6,062,289	6,062,289	6,062,289	366,359,456
PV of Sub-Total	40,595,855	37,937,534	32,833,716	25,858,199	19,655,272	14,084,399	9,223,055	4,936,543	3,297,279	3,081,462	1,566,496	796,385	224,148,298
0	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc Societal Benefits	0	0	1,239,534	3,717,709	6,198,859	8,677,034	11,156,696	13,635,466	14,875,000	14,875,000	14,875,000	14,875,000	371,875,298
PV	0	0	1,011,831	2,836,240	4,419,786	5,781,508	6,947,275	7,935,841	8,090,513	7,560,963	3,843,700	1,954,086	124,684,745
G'Ville - Moderate Impact	0	0	926,071	1,852,141	3,705,171	5,556,646	7,408,898	9,261,150	11,113,291	11,113,291	11,113,291	11,113,291	273,202,478
PV	0	0	755,951	1,412,998	2,641,787	3,702,393	4,613,521	5,389,989	6,044,519	5,648,886	2,871,674	1,459,921	90,054,305
Residual Value of Improved TC	0	0	0	0	0	0	0	0	0	0	0	110,160,000	110,160,000
PV	0	0	0	0	0	0	0	0	0	0	0	14,471,402	14,471,402
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	2,165,604	5,569,850	9,904,030	14,233,679	18,565,594	22,896,616	25,988,291	25,988,291	25,988,291	136,148,291	755,237,775
PV of Sub-Total	0	0	1,767,783	4,249,238	7,061,573	9,483,900	11,560,795	13,325,831	14,135,031	13,209,848	6,715,374	17,885,408	229,210,451
0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	43,436,609	43,436,609	45,281,659	48,143,459	51,949,898	55,642,788	59,424,129	63,232,500	66,773,162	66,773,162	66,773,162	176,933,162	1,604,522,359
PV of Total	40,595,855	37,937,534	36,963,418	36,728,645	37,040,277	37,074,790	37,003,405	36,801,315	36,317,923	33,940,798	17,254,185	23,243,199	744,443,964

EXHIBIT 4 - COSTS

Tank Car Crashworthiness NPRM — Revised: 7 March 2008

Case: Industry Standard — Seven percent

COSTS

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 20	Year 30	TOTAL
Build & Maint. Costs													
Design & Eng - New TIH TCs	1,600,000	0	0	0	0	0	0	0	0	0	0	0	1,600,000
PV	1,495,360	0	0	0	0	0	0	0	0	0	0	0	1,495,360
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Marginal Production Costs: L & S	0	37,400,000	37,400,000	37,400,000	37,400,000	37,400,000	37,400,000	37,400,000	37,400,000	37,400,000	336,600	336,600	343,332,000
PV	0	32,665,160	30,529,620	28,532,460	26,666,200	24,919,620	23,288,980	21,766,800	20,341,860	19,010,420	86,977	44,218	229,533,686
Compliant Repairs	0	0	154	308	616	924	1,232	1,540	1,848	2,155	2,772	2,772	63,899
PV	0	0	126	235	439	616	767	896	1,005	1,096	716	364	19,957
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Training - for Maintenance & Ins	3,333	0	0	0	0	0	0	0	0	0	0	0	3,333
PV	3,115	0	0	0	0	0	0	0	0	0	0	0	3,115
Additional Fuel Charges	0	828,457	2,535,079	4,142,285	5,799,647	7,456,114	9,113,028	10,769,942	12,426,856	14,084,963	14,913,719	14,913,719	365,430,744
PV	0	723,574	2,069,385	3,160,149	4,135,148	4,968,009	5,674,682	6,268,106	6,758,967	7,159,387	3,853,705	1,959,172	121,226,693
Increased Shipments of TIH	0	652,584	1,305,168	2,610,336	3,915,504	5,220,672	6,525,840	7,831,008	9,136,177	10,441,345	11,747,687	11,747,687	282,592,384
PV	0	569,967	1,065,409	1,991,425	2,791,755	3,478,534	4,063,641	4,557,647	4,969,166	5,307,335	3,035,602	1,543,260	92,055,318
Maintenance - marginal increase	0	500,000	500,000	70,097	140,236	210,375	280,472	350,611	420,750	420,750	420,750	420,750	11,308,291
PV	0	436,700	408,150	53,477	99,988	140,173	174,650	204,056	228,846	213,867	108,722	55,273	4,225,615
Inspection of new TIH Tank Cars	0	0	0	856,800	856,800	1,713,600	1,713,600	2,570,400	2,570,400	856,800	0	0	11,995,200
PV	0	0	0	653,653	610,898	1,141,772	1,067,059	1,495,973	1,398,041	435,511	0	0	7,209,972
Sub-Total	1,603,333	39,381,041	41,740,401	45,079,826	48,112,803	52,001,685	55,034,172	58,923,501	61,956,030	63,206,013	27,421,528	27,421,528	1,016,325,851
NPV of Sub-Total	1,498,475	34,395,401	34,072,689	34,391,400	34,304,429	34,648,723	34,269,779	34,293,478	33,697,885	32,127,617	7,085,723	3,602,287	455,769,716
Other Costs	0	0	0	0	0	0	0	0	0	0	0	0	0
Transfer current TIH to other ser	0	0	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	0	0	32,500,000
PV	0	0	2,947,750	2,754,917	2,574,722	2,406,083	2,248,639	2,101,667	1,964,083	1,835,528	0	0	20,549,028
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	0	0	32,500,000
NPV of Sub-Total	0	0	2,947,750	2,754,917	2,574,722	2,406,083	2,248,639	2,101,667	1,964,083	1,835,528	0	0	20,549,028
Other Costs	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Demonstration of Compliance	0	281,250	0	0	0	0	0	0	0	0	0	0	281,250
PV	0	245,644	0	0	0	0	0	0	0	0	0	0	245,644
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	281,250	0	0	0	0	0	0	0	0	0	0	281,250
PV of Sub-Total	0	245,644	0	0	0	0	0	0	0	0	0	0	245,644
	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1,603,333	39,662,291	45,351,512	48,690,937	51,723,914	55,612,796	58,645,283	62,534,612	65,567,141	66,817,124	27,421,528	27,421,528	1,049,107,101
PV of Total	1,498,475	34,641,045	37,020,439	37,146,316	36,879,151	37,054,806	36,518,418	36,395,144	35,661,968	33,963,144	7,085,723	3,602,287	476,564,388

EXHIBIT 5 - BENEFITS

Tank Car Crashworthiness NPRM Revised: 7 March 2008

Case: Industry Standard

BENEFITS

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 20	Year 30	TOTAL
Benefits: Cost Savings													
Casualty Mitigation	0	196,728	590,309	983,642	1,377,099	1,770,556	2,164,013	2,557,470	2,950,927	3,344,383	3,541,466	3,541,466	86,764,447
PV	0	171,823	481,869	750,421	981,872	1,179,721	1,347,531	1,488,447	1,605,009	1,699,950	915,115	465,232	28,777,179
Environmental Damage Mitigatic	0	5,772	17,317	28,862	40,407	51,951	63,496	75,041	86,586	98,130	103,913	103,913	2,545,822
PV	0	5,042	14,136	22,019	28,810	34,615	39,539	43,674	47,094	49,880	26,851	13,651	844,371
Track closures - Mitigation	0	39,663	118,988	198,314	277,639	356,964	436,290	515,615	594,941	674,266	714,000	714,000	17,492,679
PV	0	34,641	97,130	151,293	197,957	237,845	271,678	300,088	323,588	342,729	184,498	93,796	5,801,788
Disruption of Electric - mitigatior	0	1,198	3,595	5,992	8,389	10,785	13,182	15,579	17,976	20,372	21,573	21,573	528,529
PV	0	1,047	2,935	4,571	5,981	7,186	8,209	9,067	9,777	10,355	5,574	2,834	175,297
Evacuations - mitigation	0	10,449	31,347	52,245	73,143	94,041	114,939	135,837	156,735	177,633	188,101	188,101	4,608,390
PV	0	9,126	25,589	39,858	52,151	62,660	71,573	79,057	85,248	90,291	48,605	24,710	1,528,462
Shelter-in-Place mititgation	0	708	2,125	3,541	4,958	6,374	7,791	9,207	10,624	12,040	12,750	12,750	312,369
PV	0	619	1,734	2,702	3,535	4,247	4,851	5,359	5,778	6,120	3,295	1,675	103,603
Property Damage	0	16,009	48,027	80,037	112,052	144,067	176,082	208,097	240,112	272,127	288,163	288,163	7,059,870
PV	0	13,982	39,205	61,060	79,893	95,992	109,646	121,112	130,597	138,322	74,461	37,855	2,341,547
Road Closures - Mitigation	0	10,518	31,553	52,589	73,624	94,660	115,695	136,730	157,766	178,801	189,338	189,338	4,638,696
PV	0	9,186	25,757	40,120	52,494	63,072	72,043	79,577	85,809	90,885	48,925	24,873	1,538,514
Minor Accidents: Benefits	0	8,281	24,843	41,406	57,968	74,530	91,092	107,655	124,217	140,779	149,075	149,075	3,652,270
PV	0	7,233	20,280	31,588	41,331	49,659	56,723	62,655	67,561	71,558	38,521	19,584	1,211,347
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	289,327	868,105	1,446,627	2,025,278	2,603,929	3,182,580	3,761,231	4,339,882	4,918,533	5,208,379	5,208,379	127,603,072
NPV of Sub-Total	0	252,698	708,634	1,103,632	1,444,023	1,734,998	1,981,793	2,189,036	2,360,462	2,500,090	1,345,845	684,210	42,322,107
Other Benefits	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	0	0	0	0	0	0	0	0	0	0	0
PV of Sub-Total	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc Societal Benefits	0	123,946	247,892	495,784	743,676	991,568	1,239,459	1,487,351	1,735,243	1,983,135	2,231,250	2,231,250	53,673,053
PV	0	108,254	202,354	378,233	530,241	660,681	771,811	865,638	943,799	1,008,028	576,555	293,113	17,484,158
G'Ville - Moderate Impact	0	78,686	157,373	314,745	472,160	629,490	786,863	944,236	1,101,608	1,258,981	1,416,495	1,416,495	34,074,042
PV	0	137,449	128,463	240,119	336,650	419,429	489,980	549,545	599,165	639,940	366,022	186,081	11,168,463
Residual Value of Improved TC	0	0	0	0	0	0	0	0	0	0	0	60,588,000	60,588,000
PV	0	0	0	0	0	0	0	0	0	0	0	7,959,271	7,959,271
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	281,319	#REF!	810,529	1,215,836	1,621,058	2,026,322	2,431,587	2,836,851	3,242,116	3,647,745	64,235,745	148,335,096
PV of Sub-Total	0	245,704	330,817	618,353	866,891	1,080,111	1,261,791	1,415,184	1,542,963	1,647,967	942,577	8,438,465	36,611,892
0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	570,646	#REF!	2,257,156	3,241,114	4,224,987	5,208,902	6,192,818	7,176,733	8,160,648	8,856,124	69,444,124	275,938,168
PV of Total	0	498,402	1,039,452	1,721,984	2,310,914	2,815,109	3,243,583	3,604,220	3,903,425	4,148,058	2,288,422	9,122,674	78,933,999

EXHIBIT 6 - COSTS

Tank Car Crashworthiness NPRM — Revised: 13 March 2008 — **THREE PERCENT Discount Rate**

Case: DOT Tank Car

COSTS

	0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 20	Year 30	TOTAL
Build & Maint. Costs		0	0	0	0	0	0	0	0	0	0	0	0	0
Design & Eng - New TIH TCs		3,553,750	2,553,750	0	0	0	0	0	0	0	0	0	0	6,107,500
PV		3,450,243	2,407,154	0	0	0	0	0	0	0	0	0	0	5,857,397
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV		0	0	0	0	0	0	0	0	0	0	0	0	0
Marginal Production Costs: L & S		0	0	102,000,000	102,000,000	102,000,000	102,000,000	102,000,000	102,000,000	612,000	612,000	612,000	612,000	625,464,000
PV		0	0	93,344,449	90,625,679	87,986,096	85,423,394	82,935,334	80,519,742	469,047	455,385	338,850	252,136	528,534,113
Compliant Repairs		0	0	0	1,386	2,771	4,157	5,542	6,927	8,313	8,313	8,313	8,313	203,668
PV		0	0	0	1,231	2,390	3,481	4,506	5,468	6,371	6,186	4,603	3,425	121,661
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV		0	0	0	0	0	0	0	0	0	0	0	0	0
Training - for Maintenance & Insp.		3,333	0	0	0	0	0	0	0	0	0	0	0	3,333
PV		3,236	0	0	0	0	0	0	0	0	0	0	0	3,236
Additional Fuel Charges		0	0	1,242,835	3,802,922	6,214,025	8,699,694	11,184,320	13,670,884	14,913,719	14,913,719	14,913,719	14,913,719	372,916,489
PV		0	0	1,137,370	3,378,847	5,360,272	7,285,857	9,093,875	10,791,922	11,430,124	11,097,207	8,257,364	6,144,255	224,673,897
Increased Shipments of TIH		0	0	978,582	1,957,165	3,915,504	5,873,844	7,831,008	9,789,348	11,747,687	11,747,687	11,747,687	11,747,687	288,794,576
PV		0	0	895,541	1,738,916	3,377,548	4,919,252	6,367,327	7,727,802	9,003,624	8,741,383	6,504,410	4,839,892	172,821,095
Maintenance - marginal increase		0	500,000	500,000	70,097	140,236	210,375	280,472	350,611	420,750	420,750	420,750	420,750	11,308,291
PV		0	471,298	457,571	62,280	120,969	176,186	228,049	276,776	322,470	313,078	232,959	173,343	7,086,479
Inspection of new TIH Tank Cars		0	0	0	856,800	856,800	1,713,600	1,713,600	2,570,400	2,570,400	856,800	0	0	11,995,200
PV		0	0	0	761,256	739,083	1,435,113	1,393,314	2,029,097	1,969,998	637,540	0	0	9,584,371
Sub-Total		3,557,083	3,053,750	104,721,417	108,688,369	113,129,336	118,501,669	123,014,942	128,388,170	30,272,869	28,559,269	27,702,469	27,702,469	1,316,793,058
NPV of Sub-Total		3,453,479	2,878,452	95,834,931	96,568,208	97,586,359	99,243,282	100,022,405	101,350,807	23,201,633	21,250,778	15,338,185	11,413,050	948,682,248
Other Costs		0	0	0	0	0	0	0	0	0	0	0	0	0
Transfer current TIH to other service		0	0	0	5,416,667	5,416,667	5,416,667	5,416,667	5,416,667	5,416,667	0	0	0	32,500,000
PV		0	0	0	4,812,638	4,672,464	4,536,373	4,404,246	4,275,967	4,151,424	0	0	0	26,853,112
Impact of 50 MPH Restriction		1,209,390	2,418,780	2,418,780	2,418,780	2,418,780	2,418,780	2,418,780	2,418,780	2,418,780	2,418,780	2,418,780	2,418,780	71,354,010
PV		1,174,165	2,279,932	2,213,526	2,149,055	2,086,461	2,025,690	1,966,689	1,909,407	1,853,793	1,799,799	1,339,220	996,505	46,234,990
Impact of 30 MPH Restriction		24,331,513	24,331,513	24,331,513	20,276,261	16,221,009	12,165,757	8,110,504	4,055,252	0	0	0	0	133,823,322
PV		23,622,828	22,934,785	22,266,781	18,015,195	13,992,385	10,188,630	6,594,582	3,201,254	0	0	0	0	120,816,439
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV		0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV		0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total		25,540,903	26,750,293	26,750,293	28,111,708	24,056,455	20,001,203	15,945,951	11,890,699	7,835,447	2,418,780	2,418,780	2,418,780	237,677,332
NPV of Sub-Total		24,796,993	25,214,717	24,480,308	24,976,888	20,751,310	16,750,693	12,965,517	9,386,627	6,005,217	1,799,799	1,339,220	996,505	193,904,541
Other Costs		0	0	0	0	0	0	0	0	0	0	0	0	0
Reporting: 50 %		0	0	0	0	0	26,807	0	0	0	0	0	0	26,807
PV		0	0	0	0	0	22,450	0	0	0	0	0	0	22,450
Demonstration of Compliance		0	281,250	0	0	0	0	0	0	0	0	0	0	281,250
PV		0	265,105	0	0	0	0	0	0	0	0	0	0	265,105
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV		0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV		0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total		0	281,250	0	0	0	26,807	0	0	0	0	0	0	308,057
PV of Sub-Total		0	265,105	0	0	0	22,450	0	0	0	0	0	0	287,555
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		29,097,986	30,085,293	131,471,710	136,800,077	137,185,791	138,529,679	138,960,893	140,278,869	38,108,316	30,978,049	30,121,249	30,121,249	1,554,778,446
PV of Total		28,250,472	28,358,274	120,315,239	121,545,096	118,337,669	116,016,426	112,987,923	110,737,434	29,206,851	23,050,578	16,677,405	12,409,556	1,142,874,344

EXHIBIT 7 - BENEFITS

Tank Car Crashworthiness NPRM — Revised: 13 March 2008 — **THREE PERCENT Discount Rate**

Case: DOT Tank Car

BENEFITS

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 20	Year 30	TOTAL
Benefits: Cost Savings													
Casualty Mitigation			2027666.636	6081296.702	10137359.92	14193423.14	18232454.29	22303116.42	24331513	24331513	23,609,770	23,609,770	590,225,598
PV	*0*	*0*	*1,855,602*	*5,403,153*	*8,744,576*	*11,886,768*	*14,824,654*	*17,606,286*	*18,648,079*	*18,104,931*	13,072,157	9,726,913	355,560,337
Environmental Damage Mitigation			7083.05	21250	300226.4608	420250.7652	540325.5	660371.4174	85000	85000	692,750	692,750	17,392,589
PV	*0*	*0*	*6,482*	*18,880*	*258,978*	*351,953*	*439,334*	*521,303*	*65,145*	*63,248*	383,559	285,404	10,493,586
Track closures - Mitigation			396650.8	1190000	1983634.8	2776650.8	3570142.8	4363634.8	4760000	4760000	4,760,000	4,760,000	119,000,714
PV	*0*	*0*	*362,992*	*1,057,300*	*1,711,101*	*2,325,401*	*2,902,853*	*3,444,694*	*3,648,144*	*3,541,887*	2,635,497	1,961,057	71,688,706
Disruption of Electric - mitigation			11980.206	35950.6854	59929.794	83890.206	107865	131839.794	143820	143820	143,820	143,820	3,595,496
PV	*0*	*0*	*10,964*	*31,942*	*51,696*	*70,257*	*87,704*	*104,076*	*110,226*	*107,016*	79,630	59,252	2,166,001
Evacuations - mitigation			104458.6165	313463.6299	522543.8835	731461.1165	940503.75	1149471.143	1254005	1254005	1,254,005	1,254,005	31,350,012
PV	*0*	*0*	*95,594*	*278,508*	*450,751*	*612,587*	*764,716*	*907,403*	*961,090*	*933,097*	694,312	516,633	18,885,882
Shelter-in-Place mititgation			249.9	749.91	1250.1	1749.9	2250	2750.1	3000	3000	85,000	85,000	2,124,997
PV	*0*	*0*	*229*	*666*	*1,078*	*1,466*	*1,829*	*2,171*	*2,299*	*2,232*	47,062	35,019	1,280,142
Property Damage			160083.3333	480250	800416.6667	1120583.333	1440750	1760916.667	1921000	1921000	1,921,000	1,921,000	48,025,000
PV	*0*	*0*	*146,499*	*426,696*	*690,446*	*938,471*	*1,171,462*	*1,390,084*	*1,472,287*	*1,429,404*	1,063,611	791,427	28,931,277
Road Closures - Mitigation			105145.425	315524.6325	525903.84	736270.425	946687.5	1157028.84	1262250	1262250	1,262,250	1,262,250	31,556,061
PV	*0*	*0*	*96,223*	*280,340*	*453,649*	*616,615*	*769,744*	*913,369*	*967,410*	*939,233*	698,877	520,030	19,009,990
Minor Accidents: Benefits			0	0	0	0	0	0	0	0	993,987	993,987	24,849,526
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	550,347	409,509	14,969,842
											0	0	0
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0	0	0
Sub-Total	0	0	2813317.967	8438485.559	14331265.46	20064279.68	25780978.84	31529129.18	33760588	33760588	34,722,582	34,722,582	868,119,993
NPV of Sub-Total	*0*	*0*	*2574584.472*	*7497485.124*	*12362275.48*	*16803518.36*	*20962295.05*	*24889385.72*	*25874679.54*	*25121048.09*	19,225,052	14,305,244	522,985,763
Other Benefits											0	0	0
Fuel Savings - from Operating Restric	0	0	0	0	0	0	0	0	0	0	4,867,838	4,867,838	243,394,420
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	2,695,204	2,005,485	183,812,103
New TIH TC are more Salvageable				0.6	1.2	1.2	1.8	2.4	3	3	500,000	500,000	12,200,000
PV	*0*	*0*	*0*	*1*	*1*	*1*	*1*	*2*	*2*	*2*	276,838	205,993	7,278,933
	0	0	0	0	0	0	0	0			0	0	0
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0	0	0
											0	0	0
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0	0	0
Safety Benefit for Operating R.	18568323.4	18568323.4	17020963.12	13926242.55	10831521.98	7736801.417	4642080.85	1547360.283	675211.76	675211.76	694,452	694,452	110,765,037
PV	*18,027,498*	*17,502,426*	*15,576,592*	*12,373,286*	*9,343,366*	*6,479,449*	*3,774,437*	*1,221,500*	*517,494*	*502,421*	384,501	286,105	95,437,329
Sub-Total	18568323.4	18568323.4	17020963.12	13926243.15	10831523.18	7736802.617	4642082.65	1547362.683	675214.76	675214.76	6,062,289	6,062,289	366,359,456
PV of Sub-Total	*18027498.45*	*17502425.68*	*15576592.43*	*12373286.66*	*9343367.046*	*6479450.389*	*3774437.998*	*1221502.391*	*517495.89*	*502423.1942*	3,356,543	2,497,583	286,528,366
											0	0	0
Misc Societal Benefits			926070.539	2777544.82	4631241.758	6482716.039	8335301.649	10187220.46	11113291	11113291	14,875,000	14,875,000	371,875,298
PV	*0*	*0*	*847,486*	*2,467,813*	*3,994,950*	*5,429,173*	*6,777,363*	*8,041,886*	*8,517,412*	*8,269,332*	8,235,927	6,128,303	224,025,576
G'Ville - Moderate Impact			82828.93671	165657.8734	331395.2658	496993.5	662661.3133	828329.1266	993987	993987	11,113,291	11,113,291	273,202,478
PV	*0*	*0*	*75,800*	*147,185*	*285,864*	*416,224*	*538,804*	*653,891*	*761,808*	*739,620*	6,153,160	4,578,529	163,491,281
Residual Value of Improved TC											0	110,160,000	110,160,000
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0	45,384,461	45,384,461
											0	0	0
	0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0	0	0
Sub-Total	0	0	1008899.476	2943202.693	4962637.024	6979709.539	8997962.962	11015549.59	12107278	12107278	25,988,291	136,148,291	755,237,775
PV of Sub-Total	*0*	*0*	*923285.9403*	*2614997.472*	*4280814.291*	*5845396.855*	*7316167.304*	*8695776.565*	*9279220.442*	*9008951.886*	14,389,087	56,091,293	432,901,318
											0	0	0
TOTAL	18568323.4	18568323.4	20843180.56	25307931.4	30125425.67	34780791.84	39421024.46	44092041.45	46543080.76	46543080.76	66,773,162	176,933,162	2,816,347,959
PV of Total	18027498.45	17502425.68	19074462.84	22485769.26	25986456.82	29128365.6	32052900.35	34806664.68	35671395.87	34632423.17	36,970,681	72,894,120	1,242,415,447

EXHIBIT 8 - COSTS

Tank Car Crashworthiness NPRM Revised: 13 March 2008 **Three Percent**

Case: Industry Standard

COSTS

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 20	Year 30	TOTAL
Build & Maint. Costs	0	0	0	0	0	0	0	0	0	0	0	0	0
Design & Eng - New TIH TCs	1,600,000	0	0	0	0	0	0	0	0	0	0	0	1,600,000
PV	1,553,398	0	0	0	0	0	0	0	0	0	0	0	1,553,398
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Marginal Production Costs: L & S	0	37,400,000	37,400,000	37,400,000	37,400,000	37,400,000	37,400,000	37,400,000	37,400,000	37,400,000	336,600	336,600	343,332,000
PV	0	35,253,087	34,226,298	33,229,416	32,261,569	31,321,911	30,409,623	29,523,905	28,663,986	27,829,112	186,367	138,675	286,445,149
Compliant Repairs	0	0	154	308	616	924	1,232	1,540	1,848	2,155	2,772	2,772	63,899
PV	0	0	141	274	531	774	1,001	1,215	1,416	1,604	1,535	1,142	37,415
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Training - for Maintenance & Ins	3,333	0	0	0	0	0	0	0	0	0	0	0	3,333
PV	3,236	0	0	0	0	0	0	0	0	0	0	0	3,236
Additional Fuel Charges	0	828,457	2,535,079	4,142,285	5,799,647	7,456,114	9,113,028	10,769,942	12,426,856	14,084,963	14,913,719	14,913,719	365,430,744
PV	0	780,900	2,319,956	3,680,367	5,002,826	6,244,378	7,409,726	8,501,892	9,524,150	10,480,535	8,257,364	6,144,255	219,043,153
Increased Shipments of TIH	0	652,584	1,305,168	2,610,336	3,915,504	5,220,672	6,525,840	7,831,008	9,136,177	10,441,345	11,747,687	11,747,687	282,592,384
PV	0	615,123	1,194,414	2,319,250	3,377,548	4,372,231	5,306,105	6,181,870	7,002,119	7,769,341	6,504,410	4,839,892	168,187,704
Maintenance - marginal increase	0	500,000	500,000	70,097	140,236	210,375	280,472	350,611	420,750	420,750	420,750	420,750	11,308,291
PV	0	471,298	457,571	62,280	120,969	176,186	228,049	276,776	322,470	313,078	232,959	173,343	7,086,479
Inspection of new TIH Tank Cars	0	0	0	856,800	856,800	1,713,600	1,713,600	2,570,400	2,570,400	856,800	0	0	11,995,200
PV	0	0	0	761,256	739,083	1,435,113	1,393,314	2,029,097	1,969,998	637,540	0	0	9,584,371
Sub-Total	1,603,333	39,381,041	41,740,401	45,079,826	48,112,803	52,001,685	55,034,172	58,923,501	61,956,030	63,206,013	27,421,528	27,421,528	1,016,325,851
NPV of Sub-Total	1,556,634	37,120,408	38,198,380	40,052,842	41,502,526	43,550,592	44,747,818	46,514,756	47,484,138	47,031,210	15,182,635	11,297,306	691,940,904
Other Costs	0	0	0	0	0	0	0	0	0	0	0	0	0
Transfer current TIH to other ser	0	0	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	0	0	32,500,000
PV	0	0	3,304,678	3,208,425	3,114,976	3,024,249	2,936,164	2,850,644	2,767,616	2,687,006	0	0	26,502,502
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	3,611,111	0	0	32,500,000
NPV of Sub-Total	0	0	3,304,678	3,208,425	3,114,976	3,024,249	2,936,164	2,850,644	2,767,616	2,687,006	0	0	26,502,502
Other Costs	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Demonstration of Compliance	0	281,250	0	0	0	0	0	0	0	0	0	0	281,250
PV	0	265,105	0	0	0	0	0	0	0	0	0	0	265,105
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	281,250	0	0	0	0	0	0	0	0	0	0	281,250
PV of Sub-Total	0	265,105	0	0	0	0	0	0	0	0	0	0	265,105
	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1,603,333	39,662,291	45,351,512	48,690,937	51,723,914	55,612,796	58,645,283	62,534,612	65,567,141	66,817,124	27,421,528	27,421,528	1,049,107,101
PV of Total	1,556,634	37,385,513	41,503,058	43,261,267	44,617,503	46,574,841	47,683,982	49,365,400	50,251,754	49,718,216	15,182,635	11,297,306	718,708,511

.

EXHIBIT 9 - BENEFITS

Tank Car Crashworthiness NPRM Revised: 13 March 2008 **Three Percent**

Case: Industry Standard

BENEFITS

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 20	Year 30	TOTAL
Benefits: Cost Savings													
Casualty Mitigation	0	196,728	590,309	983,642	1,377,099	1,770,556	2,164,013	2,557,470	2,950,927	3,344,383	3,541,466	3,541,466	86,764,447
PV	0	185,435	540,217	873,953	1,187,898	1,482,813	1,759,540	2,018,890	2,261,639	2,488,535	1,960,824	1,459,037	52,003,795
Environmental Damage Mitigation	0	5,772	17,317	28,862	40,407	51,951	63,496	75,041	86,586	98,130	103,913	103,913	2,545,822
PV	0	5,441	15,848	25,643	34,855	43,508	51,628	59,238	66,361	73,018	57,534	42,811	1,525,882
Track closures - Mitigation	0	39,663	118,988	198,314	277,639	356,964	436,290	515,615	594,941	674,266	714,000	714,000	17,492,679
PV	0	37,386	108,891	176,199	239,494	298,952	354,743	407,031	455,972	501,717	395,324	294,159	10,484,536
Disruption of Electric - mitigation	0	1,198	3,595	5,992	8,389	10,785	13,182	15,579	17,976	20,372	21,573	21,573	528,529
PV	0	1,130	3,290	5,324	7,236	9,033	10,718	12,298	13,777	15,159	11,944	8,888	316,783
Evacuations - mitigation	0	10,449	31,347	52,245	73,143	94,041	114,939	135,837	156,735	177,633	188,101	188,101	4,608,390
PV	0	9,849	28,687	46,419	63,094	78,758	93,456	107,231	120,124	132,176	104,147	77,495	2,762,117
Shelter-in-Place mititgation	0	708	2,125	3,541	4,958	6,374	7,791	9,207	10,624	12,040	12,750	12,750	312,369
PV	0	668	1,944	3,146	4,277	5,338	6,335	7,268	8,142	8,959	7,059	5,253	187,224
Property Damage	0	16,009	48,027	80,037	112,052	144,067	176,082	208,097	240,112	272,127	288,163	288,163	7,059,870
PV	0	15,090	43,952	71,112	96,657	120,654	143,171	164,274	184,026	202,488	159,549	118,719	4,231,456
Road Closures - Mitigation	0	10,518	31,553	52,589	73,624	94,660	115,695	136,730	157,766	178,801	189,338	189,338	4,638,696
PV	0	9,914	28,876	46,724	63,509	79,276	94,071	107,936	120,914	133,045	104,832	78,005	2,780,282
Minor Accidents: Benefits	0	8,281	24,843	41,406	57,968	74,530	91,092	107,655	124,217	140,779	149,075	149,075	3,652,270
PV	0	7,806	22,735	36,788	50,004	62,418	74,066	84,983	95,202	104,753	82,539	61,417	2,189,051
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	289,327	868,105	1,446,627	2,025,278	2,603,929	3,182,580	3,761,231	4,339,882	4,918,533	5,208,379	5,208,379	127,603,072
NPV of Sub-Total	0	272,718	794,439	1,285,310	1,747,023	2,180,750	2,587,729	2,969,150	3,326,158	3,659,850	2,883,753	2,145,783	76,481,125
Other Benefits	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	0	0	0	0	0	0	0	0	0	0	0
PV of Sub-Total	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc Societal Benefits	0	123,946	247,892	495,784	743,676	991,568	1,239,459	1,487,351	1,735,243	1,983,135	2,231,250	2,231,250	53,673,053
PV	0	116,831	226,856	440,497	641,501	830,422	1,007,794	1,174,129	1,329,919	1,475,639	1,235,389	919,245	31,944,058
G'Ville - Moderate Impact	0	78,686	157,373	314,745	472,160	629,490	786,863	944,236	1,101,608	1,258,981	1,416,495	1,416,495	34,074,042
PV	0	74,169	144,018	279,647	407,290	527,188	639,792	745,388	844,291	936,800	784,279	583,577	20,279,521
Residual Value of Improved TC	0	0	0	0	0	0	0	0	0	0	0	60,588,000	60,588,000
PV	0	0	0	0	0	0	0	0	0	0	0	24,961,454	24,961,454
	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	202,632	405,264	810,529	1,215,836	1,621,058	2,026,322	2,431,587	2,836,851	3,242,116	3,647,745	64,235,745	148,335,096
PV of Sub-Total	0	191,000	370,874	720,144	1,048,791	1,357,610	1,647,585	1,919,517	2,174,210	2,412,439	2,019,668	8,438,465	77,185,033
	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	491,959	1,273,370	2,257,156	3,241,114	4,224,987	5,208,902	6,192,818	7,176,733	8,160,648	8,856,124	69,444,124	275,938,168
PV of Total	0	463,719	1,165,314	2,005,454	2,795,813	3,538,360	4,235,314	4,888,667	5,500,368	6,072,289	4,903,421	10,584,248	153,666,158

Appendix B
Abbreviated Injury Scale

The Abbreviated Injury Scale (AIS) was "[f]irst published in 1971 under the joint sponsorship of the American Medical Association; the Society of Automotive Engineers; and the Association for the Advancement of Automotive Medicine (formerly the American Association for Automotive Medicine)." The AIS was originally developed for impact injury assessment. The evolution of trauma care systems and trauma registries in the 1980s fostered a need for expanding the AIS to facilitate the coding of penetration trauma. Through revisions, the scope of injuries has been broadened. The AIS is based on anatomical injury. There is only one AIS score for each injury for any one person. The AIS scores injuries and not the consequences of the injuries. This principle was employed so that the AIS can be used as a measure of the severity of the injury itself and not a measurement of impairments or disabilities that result from the injury. AIS is not simply a ranking of expected mortality from an injury. Were this the case, there would be no way to distinguish the majority of minor and moderate injuries since they pose little or no threat to life.[1] The purpose behind the AIS is to provide a "consistent scale for collecting, categorizing, and analyzing injury-severity data."[2] The AIS is based on the "threat-to-life" posed by injuries and not on cost-based criteria which does not always correlate well to the cost of an individual accident.[3] Although empirical data show that the AIS correlates well with the probability of death at the serious and life-threatening levels (AIS $\geq$ 3), other factors are also considered in AIS severity. Also death rates vary significantly within each AIS value for the most severe injury depending upon the AIS value for the second most severe injury.[4] The AIS is a system that was designed as a predictor of mortality, and not as a measure of disability.[5] The AIS is a consensus-derived, anatomically-based system that classifies individual injuries by body region on a 6-point ordinal severity scale ranging from AIS 1 (minor) to AIS 6 (currently untreatable). The AIS does not assess the combined effect of patients with multiple injuries.

The threat-to-life approach in the AIS is analogous to the "willingness-to-pay" approach to valuing human life. "The willingness-to-pay method values human life according to the amount individuals are willing to pay for a change that reduces the probability of death. This approach assumes an individual perspective and incorporates all aspects of well-being, including labor and non-labor income, and the value of leisure, pain and suffering."[6] The savings society gains

---

[1] "The Abbreviated Injury Scale," 1990 revision, pp. 1-2.

[2] Nelson S. Hartunian, et al. The Incidence and Economic Costs of Major Health Impairments. (Lexington Books: Lexington, MA) 1981, pp. 261, 263.

[3] Ted R. Miller, Alternative Approaches to Accident Cost Concepts. (Technical report conducted by the Granville Corporation for the Federal Highway Administration), 1984, p.19.

[4] 'The Abbreviated Injury Scale', 1990 revision, pp. 2-3.

[5] L. B. Larsen, "The Abbreviated Injury Scale as Measurement of Bicyclists Minor Injuries" Journal of Traffic Medicine. Vol. 23, No.1 (1995), pp. 11-15.

[6] Dorothy P. Rice, Ellen J. MacKenzie & Associates. Cost of Injury in the United States, A Report to Congress. (Produced by the University of California, San Francisco and The John Hopkins University for the National Highway Traffic Satey Administation and the Centers for Disease Control) 1989, p. 71.

through injury prevention and control, "includes increased tax revenues; reduced transfer payments in Medicare, food stamps, unemployment compensation, etc.; reduced private insurance payments; and reduced costs for administering transfer payment and insurance programs." Thus, the AIS assesses how much individuals are willing to spend on injury risk reduction and the potential savings to society from this reduction.[7] Inclusive in the individual willingness to pay are the values for "lost quality of life," pain and suffering, lost wages and fringe benefits, and loss household production.[8]

The severity of an "injury" can range from a mere scratch to irreparable damage. Quite obviously people would attach a greater value to avoiding more severe injuries. The range of injuries must be divided into a manageable number of levels to estimate specific values for injury prevention. The AIS categorizes injuries into levels ranging from AIS 1 -- minor, to AIS 5 -- critical. AIS 6 is equivalent to a fatality. The research techniques on willingness to pay to avoid injury relies on a panel of experienced physicians to relate injuries in each AIS level to the loss of quality and quantity of life involved. Avoiding a minor injury involving only a few days of discomfort equates to only a tiny fraction of a value for saving a life, while preventing a severe injury with permanent disability could be deemed nearly equivalent to preventing a death.

- An AIS 1 injury would be one in which the injury is simple, and may not require professional medical treatment. Recovery is usually rapid and complete.

- An AIS 2 injury would be one in which the injury almost always requires treatment, but is not ordinarily life-threatening or permanently disabling. Examples include finger or toe crush/amputation.

- An AIS 3 injury would be one in which the injury has the potential for major hospitialization and long-term disability, but is not generally life-threatening. Examples include hand, foot or arm crush/amputation.

- An AIS 4 injury would be one in which the injury is often permanently disabling, but survival is probable.

- An AIS 5 injury would be one that usually requires intensive medical care. Survival is uncertain.

---

7 Rice, pp. 103, 109.
8 Ted R. Miller, et al. "Railroad Injury: Causes, Costs, and Comparisons with other Transport Modes," Journal of Safety Research, (Winter 1994), pp. 185, 186.

The best current estimates for the willingness to pay to avoid an injury are shown below in respect to the value for preventing a fatal injury.

AIS Level Severity	Descriptor	Fraction of Life Value
AIS 1	**Minor**	**0.0020**
AIS 2	**Moderate**	**0.0155**
AIS 3	**Serious**	**0.0575**
AIS 4	**Severe**	**0.1875**
AIS 5	**Critical**	**0.7625**
AIS 6	**Maximum (Fatal)**	**1.0000**

The FRA uses $5.8 Million for the value of life per the policy of the U. S. Department of Transportation. Thus, the values of AIS 1, ..., AIS 5 can be determined by multiplying the "value of a life" (i.e. $5.8 Million) times the "fraction of life value." The monetary value of AIS 1 through 5, are $11,600, $89,900, $333,500, $1,087,500; and $ 4,422,500; respectively.

The following are complications in dealing with injuries that should be recognized:

- o Different accident types in different modes tend to have different patterns of associated injuries. In most cases the less severe injury levels tend to be more numerous, but the pattern may vary.
- o Different safety measures may prevent different patterns of injuries. Accident prevention measures will, of course, prevent injuries in the pattern associated with the type of accident.
- o Injury data are often spotty and rarely reported in AIS levels. Injuries are often reported as whether there was time lost, whether the victims were carried from the scene, whether they required subsequent hospitalization, days absent, restricted days, etc. Minor injuries may not be reported at all.

# # #

.

Appendix C
Loss of PIH Product in Head and Shell Punctures, Cracks & Tears[1]

	Date / Location	USA	Train Speed	Method of Operation	Fatal	Injured	Spec	Gals Lost	Cause of Loss	Type of Accident
	Chlorine (1965-2005)									
	11/18/67 Waterford, AL		30	Dark	0	0	105A500 W	10,000	Shell rupt, top fittings damaged by fire[2]	Undetermined
	12/11/71 Corbin, LA		33	Dark	0	0	105A500 W	3,500	Head crack <8"	Derailment
	3/3/73 Loos, BC	No	40	Dark[3]	0	1	105A500 W	2,800	Head tear <8"	Derailment
	2/26/78 Youngstown, FL		40	Dark	8	138	105A500 W	17,000	Head punc. 8 to 18"	Derailment
	4/8/79 Milligan, FL		30	Dark	0	1[4]	105A500 W	8,500	Head tear 8 to 18"	Derailment
	11/10/79 Mississauga, ON	No	55	CTC	0	0	105A500 W	15,500	Head punc. 8 to 18"	Derailment
	9/7/86 Collins, MS		45	Dark	0	4	105A500 W	17,000	Head punc. <8" [Tear 3x3/16"][5]	Derailment
	4/11/96 Alberton, MT		38	TCS	1	150	105A500 W	11,700	Head crack >18" [Shell puncture][6]	Derailment
	6/28/04 MacDona, TX		45	TCS	3	66	105J500 W	10,000	Head puncture [Tear][7]	Side Collision - Struck Train
	1/6/05 Graniteville, SC		47	Dark - TWC	9	631	105J500 W	9,200	Shell puncture	Collision - Striking Train

[1] Information extracted from the RSI-AAR Railroad Tank Car Safety Research Test Project.
[2] Appears not to belong in data set, account likely fire rather than mechanical damage.
[3] Given the year of the accident and the remote location it is suspected that the method of operation may have been time table/train orders, information provided by Transport Canada.
[4] Several cars also released anhydrous ammonia in this incident.
[5] Homer Taber, Manager Fleet Engineer, American Railcar Industries, stated at the 12/14/06 PHMSA/FRA public meeting the cause of loss was a "tear 3x3/16"."
[6] Homer Taber, Manager Fleet Engineer, American Railcar Industries, stated at the 12/14/06 PHMSA/FRA public meeting the cause of loss was a "shell puncture."
[7] Homer Taber, Manager Fleet Engineer, American Railcar Industries, stated at the 12/14/06 PHMSA/FRA public meeting the cause of loss was a "tear."

	Date / Location	USA	Train Speed	Method of Operation	Fatal	Injured	Spec	Gals Lost	Cause of Loss	Type of Accident
Chlorine summary – Median speed: 40 mph; Avg. speed: 40.3 mph Percent U.S. Incidents in Dark Territory: 60%; Dark % total train miles: 12.1% Total fatal (% of total chlorine): 21 (100%); Total injured (% of total chlorine)[8]: 991(96%)										
Anhydrous Ammonia (112J340W, 112S340W, 105J300W, 1981-2005)[9] (reverse chronological order)										
	1/18/02 Minot, ND		41	Dark-TWC	1	333	105J300 W	29,776	Head tear >18"	Derailment
							105J300 W	29,447	Head punc. 8 to 18"	
							105J300 W	29,473	Rupture shell and head	
							105J300 W	29,006	Rupture head sep'd from shell	
							105S300 W	29,213	Shell rup. w/separation	
							105J300 W	29,481	Shell rup. w/separation	
							105J300 W	29,528	Shell rup. w/separation	
							105J300 W	14,700	Shell rupture	
	2/2/01 Red Deer, AB	No	4	Industry	1[10]	0	112J340 W	32,800	Shell rupture	Derailment
	9/23/99 Britt, ON	No	35	CTC	0	3	112J340 W	24,762	Head punc.<8"[11]	Derailment
	7/24/99 Katka, ID		20	TCS	0	0	105S300 W	19,688	Head punc. 8 to 18"	Derailment
	2/28/96 Randall, MN		50	TCS	0	3	112J340 W	15,000	Shell rupture	Derailment
	1/5/96 Saline County, IL		58	TCS	0	1	105S300 W	10,505	Shell rupture	Derailment
	7/6/92 Julliard, TX		40	Dark - TWC	0	2	112S340 W	33,900	Head punc. 8 to 18"	Derailment

[8] Remainder of injuries were in losses from valves and fittings, etc.
[9] The retrofit mandated by RSPA Docket No. HM-144 was required to be completed 12/31/80. This table addresses accidents after that date involving retrofitted cars authorized for this service.
[10] Corrected to 1 fatality and 0 non-fatal based on information from Transport Canada.
[11] Half head shield.

	2/20/89 Bordulac, ND		39	Dark - TWC	0	2	112S340W	30,000	Shell rup.w/separation	Derailment
							112J340W	30,000	Shell rup. & multiple top fittings broken	
							105S300W	15,000	Shell rupture	
	11/25/88 Fruitvale, TX		35	TCS	0	0	112S340W	30,000	Shell rupture [Head puncture][12]	Derailment

Anhydrous Ammonia Summary - Median speed: 39 mph; Avg. speed: 35.7 mph

Percent U.S. Incidents in Dark Territory: 33.3% Dark % total train miles: 12.1%

Total fatal (% of total ammonia): 2 (100%); Total injured (% of total ammonia): 340 (100%)

[12] Patrick Student, Manager Technical Research, Union Pacific Railroad, stated at the 12/14/06 PHMSA/FRA public meeting the cause of the loss was a "head puncture."