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DEPARTMENT OF TRANSPORTATION

Federal Railroad Administration

49 CFR PART 229

[Docket No. FRA-2004-17645, Notice No. 1]

LOCOMOTIVE CRASHWORTHINESS DESIGN STANDARDS

Notice of Proposed Rulemaking

Regulatory Impact Analysis

Federal Railroad Administration
Office of Safety Analysis
23 June 2004

EXECUTIVE SUMMARY

The Federal Railroad Administration (FRA) is proposing locomotive crashworthiness design standards rule which are intended to mitigate the severity of injuries to crew members to individuals who are involved in future locomotive collisions. This proposed regulation is also intended to decrease the likelihood of any loss in the integrity of fuel tanks which might occur from train incidents/accidents, and any subsequent environmental damage. The benefits from the proposed rule would be realized by requiring new locomotives to be designed and built to standards which provide an increased level of safety to cab occupants over current conventional designs. The proposed requirements for crashworthy locomotives must be met by demonstrating compliance with either the proposed rule's performance standards or an approved design standard.

This analysis includes qualitative discussions and quantitative measurements of costs and benefits of the proposed rule. The costs that would be imposed are primarily from the labor and material costs for the new crashworthiness features found in the proposed rule, and the designing and re-engineering required to implement the proposed safety enhancements. A majority of the savings will accrue from implementation of the requirements that decrease the probability of death, and the mitigation of potential injuries from accidents which involves the collision of locomotives. In addition, savings would also accrue from a decrease in the likelihood of a breached or ruptured fuel tank, and subsequent fuel spill.

For the twenty year period the estimated quantified costs total $81.6 million, and the Present Value (PV) of the estimated quantified costs is $43.9 million. For the twenty year period the estimated quantified benefits total $125.9 million, and the PV of the estimated quantified benefits is $52.4 million. The expected Net Present Value (NPV) of this proposed rulemaking is approximately $8.5 million.

The benefits of this rule would be reduced if railroads implement positive train control (PTC) systems. FRA cannot project that this will occur, since prior industry efforts to introduce advanced train control have not progressed beyond the conceptual stage. Even if railroads do implement PTC during the study period, deployment will be gradual and some benefits related to train-to-train collisions will still be realized. Further, even with full deployment of PTC, raking collisions and highway-rail crossing collisions will continue and may increase in number and in severity.

FRA estimates that over the 19 years that the benefits will accrue from this proposed rule, 48.371 statistical lives will be saved.[1] This means that an equivalent number of lives or injuries will be prevented from occurring during collisions involving locomotives during this time period.[2]

Finally, it is important to note that this proposed rulemaking is a product of the Railroad Safety Advisory Committee (RSAC), a railroad industry stakeholder group assembled to assist in the development of safety regulations (see Section 4.5 for more detail on RSAC). All of its requirements have been agreed to by the members of the Locomotive Crashworthiness Working Group and approved by the full Committee (RSAC). It is also important to note that either directly or indirectly, the RSAC members assessed the benefits against the requirements and burdens. It is fair to conclude from their support that the RSAC members found the potential benefits to outweigh the potential costs of this proposed regulation.

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[1] Given the estimated benefit assessments, FRA estimates that at 100 percent effectiveness of the casualty mitigation would save 5.64095 statistical lives per year. FRA estimates that over the 20 year period of this analysis that there will be the equivalent of 8.575 years of full benefits. Thus, (5.64095 statistical lives)*(8.575 years) = 48.371 statistical lives saved.

[2] It is important to note that prevented injuries and injuries, that have been reduced in severity equal percentages of a statistical lives when utilizing the AIS. Thus, such reductions are accumulated in the estimated lives saved.

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1.0 Introduction

The Federal Railroad Administration's (FRA) proposed locomotive crashworthiness design standards rule is intended to mitigate the severity of injuries to crew members to individuals who are involved in future locomotive collisions. The rule is also intended to decrease the likelihood of any loss in the integrity of fuel tanks which might occur from train incidents/accidents, and any subsequent environmental damage. The benefits from the proposed rule would be realized by requiring new locomotives to be designed and built to standards which provide an increased level of safety to cab occupants over current conventional designs. The proposed requirements for crashworthy locomotives must be met by demonstrating compliance with either the proposed rule's performance standards or an approved design standard.

2.0 Statement of the Problem and Need for Proposed Action

A review and assessment of accidents involving locomotives for 1995 - 97 was conducted, and the analysis of this data reveals an average of over **95** relevant accidents, and approximately **105** casualties, per year. These casualties include locomotive cab crew members who were injured in locomotive accidents, and also those fatally injured. The fatalities were typically caused by loss of occupant space, severe trauma, drowning or fire related injuries.[3] In addition, the railroad industry lost an average of more than **9,200** days per year of employee work time due to these injuries.

While assessing and evaluating train collisions for the Locomotive Crashworthiness and Cab Working Conditions Report to Congress, the FRA determined that the Association of American Railroads' (AAR) industry standard S-580 (1989) represented a significant step on the part of the industry to improve the crashworthiness of locomotives. However, the Report's evaluation also indicated that implementation of selected additional crashworthiness features and incremental improvements in current design features could improve crew survivability in the event of a collision.

The FRA's Railroad Safety Advisory Committee (RSAC) and the Report to Congress have been the impetus to the industry to revise its standard, and for the FRA to promulgate its first standards for locomotive design. Although prompted by federal initiatives, the revision of the industry standard is being conducted concurrently with the rulemaking. Currently, AAR's standards apply only to railroads which are primarily Class I freight railroads. AAR's S-580 is

[3] Averaged normalized statistics are: 0.012895 fatalities per million train miles; 0.1438 injuries per million train miles; and 0.14178 relevant accidents per million train miles.

only one way to demonstrate compliance with the performance standards for major components; FRA will consider other design standards.

Federal Solution

When promulgating new or revised regulations, it is necessary to consider whether the regulation should be at the Federal level or at the State and/or local level. Because the operating characteristics of railroads, FRA has addressed this problem with a Federal solution. 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 many railroads would also be complicated and probably more burdensome. Most large railroads would prefer a uniform Federal Regulation to simplify the compliance and administrative costs. A non-Federal solution would also increase costs for locomotive manufacturers to comply with multiple state regulations.

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 from the labor and material costs for the new crashworthiness features found in the proposed rule, and the designing and re-engineering required to implement the proposed safety enhancements. A majority of the savings will accrue from implementation of the requirements that decrease the probability of death, and the mitigation of potential injuries from accidents which involve the collision of locomotives. In addition, savings would also accrue from a decrease in the likelihood of a breached or ruptured fuel tank, and subsequent fuel spill.

For the twenty year period, the estimated quantified costs total $81.6 million, and the Present Value (PV) of the estimated quantified costs is $43.9 million. For the twenty year period, the estimated quantified benefits total $125.9 million, and the PV of the estimated quantified benefits is $52.4 million. The expected Net Present Value (NPV) of this proposed rulemaking is approximately $8.5 million.[4]

The results of this analysis are limited by the inputs utilized to calculate them, and by guidelines which govern regulatory impact analyses. The results could change significantly towards producing a greater NPV if a higher value of a life saved were utilized, or if the actual marginal costs for the labor and supplies for the new features were to decrease.

[4] Note that investments in improved crashworthiness made during the twenty-year period will return additional benefits in succeeding years, since the useful life of a locomotive is greater than twenty years, accordingly, this analysis is conservative.

The benefits of this rule would be reduced, if railroads implement positive train control (PTC) systems. FRA cannot project that this will occur, since prior industry efforts to introduce advanced train control have not progressed beyond the conceptual stage. Even if railroads do implement PTC during the study period, deployment will be gradual and some benefits related to train-to-train collisions will still be realized. Further, even with full deployment of PTC, raking collisions and highway-rail crossing collisions will continue and may increase in number and in severity.

FRA estimates that over the 19 years that the benefits will accrue from this proposed rule, 48.371 statistical lives will be saved.[5] This means that an equivalent number of lives or injuries will be prevented from occurring during collisions involving locomotives during this time period.[6]

4.0 Background

In 1911, Congress enacted the Locomotive Inspection Act (LIA) to prohibit the use of unsafe locomotives.[7] It also authorized the issuance of standards to ensure that the operation of locomotives poses no unnecessary danger of personal injury.

In 1970, Congress enacted the Federal Railroad Safety Act (FRSA) "to promote safety in every area of railroad operations and reduce railroad-related accidents and incidents."[8] The FRSA grants the Secsretary of Transportation the authority to "prescribe regulations and issue orders for every area of railroad safety," §20103(a). Thus, FRA promulgates and enforces a comprehensive regulatory program to address all areas of railroad safety, including the safety of railroad track, signal systems, rolling stock, operating practices, alcohol and drug testing, locomotive engineer certification, and workplace safety. In Part 229 of Title 49 of the Code of Federal Regulations (CFR), FRA established minimum federal safety standards for locomotives. These regulations

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[5] Given the estimated benefit assessments, FRA estimates that, at 100 percent, effectiveness of the casualty mitigation would save 5.64095 statistical lives per year. FRA estimates that over the 20 year period of this analysis that there will be the equivalent of 8.575 years of full benefits. Thus, (5.64095 statistical lives)*(8.575 years) = 48.371 statistical lives saved.

[6] It is important to note that the totally prevented injuries, and injuries that have been reduced in severity are calculated in percentages of a statistical life (utilizing the AIS). Thus, such reductions are accumulated in the estimated lives saved.

[7] Formerly 45 U.S.C. 22-34, now 49 U.S.C. 20701-20703.

[8] See U. S. C. § 20101.

prescribe inspection and testing requirements for locomotive components and systems, and minimum locomotive cab safety requirements.

4.1 National Transportation Safety Board (NTSB)

The NTSB has demonstrated an interest in locomotive crashworthiness standards dating back to 1970. NTSB Safety Recommendation R-71-44 recommended that FRA and the industry expand their cooperative effort to improve the crashworthiness of railroad equipment. Safety Recommendations R-72-005, R-76-009, R-77-37, R-78-27, R-79-11, R-82-34, R-83-102, and R-87-23 reiterated a recommendation to improve the crash resistance of locomotive cabs. NTSB has classified R-87-23 as "Open - Acceptable Response" based on the adoption by the industry of the AAR Specification S-580 for road locomotives built after August 1, 1990.

In 1992, the NTSB completed a safety study on the subject of locomotive fuel tank integrity. In this study, the NTSB found that there was limited data available, and therefore, it was difficult to evaluate the extent of locomotive fuel tank damage in the railroad industry annually.[9] These findings led to NTSB Safety Recommendations R-92-10 and R-92-11 which recommended the research, and if warranted, performance standards for locomotive fuel tanks.

4.2 Industry Standards and Recommended Practices

In 1989, the AAR adopted Specification (S) 580 which defined minimum standards for collision protection on new road type locomotives built after August 1, 1990. This industry standard required that all locomotives built after this date be equipped with crashworthy features, which include anti-climbers, collision posts, and a strengthened short-hood structure.

In 1995, the AAR adopted the Recommend Practice (RP) 506 which defined minimum performance requirements for diesel electric locomotive fuel tanks. It became effective on all locomotives built after July 1, 1995.[10] Its requirements are performance based which address four load case scenarios, including minor derailment, jack-knifed locomotive, side

[9] "Safety Study: Locomotive Fuel Tank Integrity" NTSB, October 1992, p. 1.

[10] RP-506 was revised and adopted as Standard (S) 5506 in October 2001.

impact and penetration resistance. In addition, spill controls and fueling requirements are also specified.

4.3 Legislation

Congress enacted Section 10 of the Rail Safety Enforcement and Review Act (RSERA) in 1992.[11] This Section of RSERA, entitled "Locomotive Crashworthiness and Working Conditions," required the Secretary of Transportation to assess "the adequacy of Locomotive Crashworthiness Requirements Standard S-580, or any successor standard thereto, adopted by the Association of American Railroads in 1989, in improving the safety of locomotive cabs." In support of this requirement, RSERA also required that the Secretary "conduct research and analysis, including computer modeling and full scale crash testing, as appropriate." The costs and benefits of equipping locomotives with specific crashworthiness features were also to be considered.

4.4 Report to Congress

In response to the Congressional mandate, FRA conducted a study and performed research on the consideration of additional locomotive crashworthiness features. Locomotive Crashworthiness and Cab Working Conditions Report to Congress ("Report"), dated September 1996, outlines the results of these studies.

FRA's research indicated that the current industry standard, i.e., S-580 (1989), represented a significant step on the part of the railroad industry to improve crashworthiness. The Report also found that freight locomotives being built today significantly exceed the S-580 minimum criteria. However, research and analysis demonstrated that this standard could be further improved to reduce casualties without significantly impacting the design or cost of a locomotive. Most of the potential modifications are practical only for newly constructed locomotives. The Report also indicated that in order to maximize benefits of crashworthiness modifications, locomotive crew members must have confidence in them rather than choose to jump from a locomotive that is moving and in imminent danger of being in a locomotive collision.

The Report concluded that the following design modifications warranted further investigation: increase of collision post strength, increase of corner post strength, improvement of anti-climber design, fuel tank design, glazing requirements, and other

[11] Public Law 102-365, September 3, 1992.

features such as emergency lighting provisions. The Report also indicated that more attention needs to be directed in improving fuel tank integrity. Such improvement could not only reduce the loss of fuel in the event of a collision, but also make collisions more survivable for the crew or the fuel tank, and reduce the costs of environmental cleanups. Finally, the Report recommended that improvements of the following crashworthiness features did not merit further investigation: rollover protection, deflection plates, and uniform sill heights.

4.5 Railroad Safety Advisory Committee (RSAC)

RSAC was established to provide advice and recommendations to the FRA on railroad safety matters. The Committee consists of 48 individual representatives, drawn from 27 organizations representing various railroad industry interests, 2 associate representatives from the agencies with railroad safety regulatory responsibility in Canada, and Mexico, and other associate representatives from organizations representing industry personnel with diverse backgrounds.

On June 24, 1997, FRA tasked RSAC with developing recommendations on locomotive crashworthiness. The purpose of the task was to safeguard the health and safety of locomotive crews. RSAC accepted this task, formed a Locomotive Crashworthiness Working Group ("Working Group"), and designated this assignment Task No. 97-1. The general purpose of this Working Group is *"[t]o promote the safe operation of trains and the survivability of locomotive crews where train accidents do occur.*" The purpose was further defined to investigate and develop, if necessary, crashworthiness specifications to ensure the integrity of the locomotive cab in accidents resulting from collisions such as highway-rail crossing accidents, sideswipes, and shifted loads.

The Locomotive Crashworthiness Working Group provided consensus on this NPRM on March 19, 2004. The full committee of the RSAC voted and gave approval for the NPRM on April 14, 2004.

5.0 Summary of Regulatory Change

In its efforts to decrease the risks that locomotive crew occupants are exposed to when operating a train, FRA is proposing requirements which would improve the likelihood that the occupiable space in a locomotive cab be maintained during an accident or collision. Unlike most FRA regulations this proposal is not intended to decrease or eliminate any hazards which could cause accidents, but rather it is intended to reduce the severity of the consequences associated with impact of locomotives with other objects by optimizing the design and construction of locomotive cabs without degrading the ability of the locomotive to serve its intended purpose of providing motive power for train and switching movements. Thus, FRA is proposing to amend its Locomotive Safety Standards, *49 CFR Part 229,* to include a new Subpart D with requirements for the design and maintenance of crashworthy locomotives.

The proposed crashworthiness features are intended to improve the likelihood that cab occupants would survive under specific accident scenarios, and also decrease or mitigate the severity of any injuries involved. These accident scenarios include: 1) head-on collisions; 2) coupled locomotive override resulting from a collision; 3) rear-end collisions; 4) highway-rail grade crossing collisions; and 5) oblique/raking/side collisions. The applicability of the improvements extend to these scenarios and other types of collisions which involve the front-end of a locomotive impacting another object with a significant force, i.e., the immediate and absolute dispersion of energy. The requirements of the proposed regulation vary upon the type of locomotive (e.g., wide-nose, narrow-nose, and semi-monocoque) and whether the design and build of the locomotive meet the performance requirements or the engineering standards.

The proposed requirements include anti-climbers, collision posts, short-hood structures, and underframe strength improvements, or equivalent levels of safety. The proposal also includes interior requirements which are related to the crashworthy features, such as emergency egress, interior configuration, and cab emergency lighting. Finally, the proposed requirements also improve the strength and design of locomotive fuel tanks, which should decrease the likelihood the integrity of a fuel tank would be breached when it is involved in an accident or incident.

6.0 Purpose and Methodology of this Economic Analysis

The purpose of this economic analysis is to provide pertinent information on the economics of the proposed revisions to the Railroad Locomotive Safety Standards, 49 CFR Part 229. For a twenty year period, this analysis assesses the proposed rule's known and foreseeable costs, and benefits, which are anticipated to impact society because of this regulation. The exact twenty year period for which this analysis covers is not specifically set because of uncontrollable factors in the rulemaking process. The costs are assessed in terms of "changes in" the current regulatory burden being placed or removed by these 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 FRA and the United States Department of Transportation (DOT). It is in compliance with the guidelines in DOT's "Regulatory Policies and Procedures,"[12] and Executive Order 12866,

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

"Regulatory Planning and Review"[13] and the Office of Management and Budget's (OMB) recent Circular on "Regulatory Analysis."[14]

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 calculate 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, as well as 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.

Finally, quantitative methodologies, such as this benefit-cost analysis, are a useful way of organizing and comparing the favorable and unfavorable effects of proposed regulations. A benefit-cost analysis does not provide the policy answer, but rather defines and displays a useful framework for debate and review.[15] A benefit-cost analysis, such as this analysis, is intended to be a pragmatic instrument which 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; it also ensures that limited resources will be focused in areas where they will do the most good.[16]

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

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

[15] 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.

[16] 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 Used in Analysis

This economic analysis is based on certain assumptions. Unless otherwise noted, these assumptions apply to this analysis, its exhibits, and appendices.[17] It is important to note that these assumptions have not been agreed to by the RSAC Working Group. Rather, they are mixture of common or similar assumptions that FRA has utilized in other regulatory impact analyses, and are necessary for this analysis. The following assumptions were used in this economic analysis:

- The number of railroad employees who could potentially be affected by this proposed regulation is estimated by FRA to be approximately 70,000.

- The average hourly wage rate for railroad workers for this proposed rule is $27.10.[18] This rate includes benefits and overhead. FRA uses this rate of pay as being the value of the services rendered by a railroad.

- FRA estimates that the production of the new locomotive designs is approximately 700 per year.

- Sunk costs are not factored into this analysis. This analysis is based on "changes in" both the costs and benefits, related to the rulemaking, over a twenty year period of time for both the railroad industry and FRA.

- The Value of Human Life
  Economic research indicates that $3.0 million per statistical life saved is a reasonable estimate of people's willingness to pay for safety improvements.[19]

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[17] To reference most of the numerical estimates, assumptions and inputs see EXHIBIT 1.

[18] Bureau of Labor Statistics for the 12 month period of July 1999 through June 2000, produces an average hourly wage rate for Class I railroads of $17.763333. This rate is rounded up to $17.76. CALCULATION: [$17.76]*[1.0 + .4(benefit load factor)] = $24.864. Since FRA was unable to revise this rate after January 1, 2001, this rate was increased by nine percent to $27.10.

[19] The U.S. Department of Transportation (DOT) estimates the willingness to pay to avoid a fatality to be $3.0 million per life. This value was most recently increased on January 29, 2002.

- 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 benefits/costs streams which 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. A discount rate of .07 is used.[20] The PV calculation for each year is calculated for the mid-point of each year. In other words, it is calculated as if the cost or benefit streams were being spent or received on the 182nd day of the year, rather than the first or last days. Where appropriate, in impact analyses Net Present Values (NPV) are calculated. A NPV is calculated with the following equation:
  NPV = present value of quantified benefit inflows - present value of quantified cost outflows.[21]

- Injuries from jumping: This analysis assumes that the severity of injuries of locomotive cab employees who have jumped from the locomotive prior to an accident would be mitigated, if the employee were to not jump from a locomotive built to the proposed crashworthiness standards. In the past, locomotive crew members have jumped from moving locomotives which are about to be involved in a collision, because they believed that they would have a better chance of surviving by jumping off rather than riding through the collision. It is assumed that locomotive crew members would have full information on the survivability of new crashworthy locomotives in the future, and behave accordingly, before an imminent collision.

- Use of crashworthy locomotives: FRA expects that the railroads which will be purchasing the locomotives built to the proposed standard, will be putting the new locomotive in the lead of the consists as often as possible. As these new locomotives are introduced the percentage of current-fleet locomotives in the lead will be a smaller. FRA estimates that starting in the second year of this analysis, new locomotives will be leading consists 2.5 percent of the time. For years three through, twenty this percentage is expected to be 6, 11, 16, 21, 26, 31, 36, 41, 46, 51, 56, 61, 66, 70, 74, 78, 81, and 84, respectively.

- Cost estimates for the manufacturers' redesigning and engineering for the proposed features, and the labor and supplies for the marginal changes necessary to build the

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[20] Office of Management and Budget Circular No. A-94, Revised Transmittal Memorandum No. 64. Benefit/Cost Analysis of Federal Programs: Guidelines and Discounts, November 10, 1992. Discounting is used in economic analyses to make costs and benefits that occur in different time period comparable.

[21] To see how the discounted costs and benefit totals and streams differ with a 3 percent, i.e., .03, discount rate please refer to Exhibits 6 and 7, respectively.

proposed features are based on input from original equipment manufacturers, the VOLPE Center, and FRA. These estimates are not a straight average of the cost estimates that might have been provided, but rather FRA's best guess given the available information and its knowledge of the situation, and the redesign of other railroad equipment imposed from prior rulemakings. In other words, none of the cost estimates is a direct input by any manufacturer.

8.0 Research and Analysis of Locomotive Crashworthiness

In response to RSERA, FRA established a data base of accidents for the purpose of locomotive crashworthiness. This data base was utilized for the research and assessment in the Report. The data also demonstrated trends in train collisions and associated fatalities and injuries to railroad personnel. The research indicated that a number of crashworthiness features identified in the Act merited further action by FRA, in cooperation with the private sector. Both this research and the Report identified priority safety improvements, which included the implementation of stronger collision posts and full height corner posts.

The RSAC Locomotive Crashworthiness Working Group focused and directed research for specific collision scenarios. The scenarios evaluated included three head-on collision scenarios and two oblique collision scenarios. Each scenario had at least one accident associated with it. Data from the pertinent accidents were utilized for comparison with the analytical models. The purpose of these crashworthiness studies was to decrease the possibility of injuries or fatalities, which are caused by loss of occupant volume and decelerations, and force loads caused by secondary impacts.

<u>Scenarios</u>

Through the process of research and modeling of accidents the Working Group established six (6) different accident scenarios:[22]

1) Head-on collision between two freight trains which have locomotives in the lead. In this collision scenario, a trailing locomotive overrides a leading locomotive on one of the trains. The proposed improvements for this scenario are an anti-climber and shelf coupler. An example of this type of accident scenario occurred on August 20, 1996, in Smithfield, West Virginia.[23]

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[22] Arthur D. Little, Inc. 1998. "Locomotive Crashworthiness Design Modifications Study: Final Report."

[23] See FRA Investigation B-5-96.

2) Head-on collision between two freight trains which have locomotives in the lead. In this collision scenario, one colliding locomotive over-rides the other. The proposed improvements for this scenario was a collision post. An example of this type of accident scenario occurred on January 20, 1993, in West Eola, Illinois.[24]

3) The focus of this scenario was to find examples to evaluate the influences of changes in the window structure. For this focus, both scenarios below are examples of loading of the window frame structure which if not sufficient, leads to the destruction of the upper portion of the operator's cab. The first is a rear-end equivalent collision with a flat car; and the second is a highway-rail crossing accident with a log truck.

A. Overtaking collision with locomotive to flat car. The proposed improvements for this scenario cover the window frame structure. An example of this type of accident scenario occurred on August 23, 1996, in Phoenixville, Pennsylvania.[25]

B. Highway-rail grade crossing collision where a lead locomotive strikes a highway truck carrying logs. The proposed improvements for this scenario cover the window frame structure. A relevant example of this type of accident scenario was not referenced.

4) An offset collision where the lead locomotive strikes an object at an oblique angle, such as a trailer, that is fouling the right-of-way of the track that the locomotive is traveling on. The proposed improvements for this scenario are improvements to the short-hood of the locomotive. An example of this type of accident scenario occurred on May 16, 1994, in Selma, North Carolina.[26]

5) An oblique collision where the lead locomotive strikes a freight car in an offset manner, at a switch. The proposed enhancements for this scenario are improvements on the front plate of a locomotive. An example of this type of accident scenario occurred on October 13, 1995, in Madrone, New Mexico.[27]

FRA researchers employed computer modeling to evaluate potential crashworthiness design modifications. The models allowed comparisons of specific improvements with current designs. For instance, the research concluded that a strengthened anti-climber was not effective in

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[24] See FRA Investigation B-2-93.

[25] See FRA Investigation C-50-96.

[26] See FRA Investigation B-5-94.

[27] See FRA Investigation C-64-95.

preventing coupled locomotive override in an in-line locomotive- to- locomotive collision. Shelf couplers were also found not to be effective in preventing coupled locomotive override in an in-line locomotive to locomotive collisions. However, increased collision post strength was found to be beneficial in an in-line locomotive to locomotive collision with leading locomotive override. Increased strength in the window frame structure was also found to be beneficial in collisions with logs at highway-rail grade crossings. Increased strength in the short-hood was found to be beneficial in an oblique collision with a trailer.[28]

Although the FRA research initially analyzed and the RSAC Working Group considered window structure and corner strengthening improvements, this proposed rule does not include them. Overtime, the RSAC recommended against such improvement since a significant portion of the costs but only a small amount of the improvements, were associated with such changes/modifications.

9.0 Risk

FRA has broad statutory authority to regulate all areas of railroad safety.[29] FRA has exercised this authority in a comprehensive regulatory and enforcement program that addresses, among other areas, track, roadbed, rolling stock, signal systems, operating practices, hazardous materials transportation, locomotive engineer qualifications, alcohol and drug use, and workplace safety. Thus, FRA is responsible for the management of most safety and operational risks related to the transportation of goods, raw materials, and passengers on rail.[30] FRA and the Occupational Safety and Health Administration (OSHA) share complementary jurisdiction to regulate health and safety hazards in the workplace of the railroad industry. OSHA standards apply to hazardous working conditions, until another federal agency exercises statutory authority over that working condition.[31] FRA also shares the responsibility for managing the risks associated with highway-rail crossings with the Federal Highway Administration. Historically, FRA's role in managing railroad-related risks has been based on the establishment of national safety standards and monitoring of the industry.

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[28] Arthur D. Little, Inc. "Locomotive Crashworthiness Design Modifications Study: Final Report." October 1998, pp. 67-69.

[29] See 49 U.S.C. § 20101, et seq.

[30] FRA's authority for the oversight and management of railroad risks is statutorily based.

[31] See 29 U.S.C. § 653.

Moving trains from one place to another place poses a "hazard" because there exists the potential to produce bodily injury, death, and property damage. The undesirable consequences to property may include damaged or destroyed rail equipment (e.g., locomotive, cars, track), damaged and/or destroyed lading (e.g., goods on or in cars, including any trailer, container or car that does not belong to the transporting railroad) and/or damage to the immediate environment and associated ecosystems.

The locomotive crashworthiness standards are designed to reduce or eliminate the hazards which are relevant to a locomotive during a collision. They are not being promulgated in this rulemaking for the purpose of reducing or eliminating the hazards which cause the collisions of locomotives. The structure and design of a locomotive present hazards for locomotive cab occupants during collisions. Given the information available today and the advancements in technologies, it is now possible to design and build locomotives safer for the occupants during most collisions. The proposed crashworthiness standards are designed to decrease the risks that locomotive cab crew members are exposed to by a design or structure which does not sufficiently protect the occupant space of the cab.

The data, which FRA attained from the Locomotive Crashworthiness Working Group's "Data/Accident Analysis and Benefit Assessment Task Force" provide some indication of the risks to which locomotive cab crew members are exposed. For the selected time-period, and the set of accidents found to be within the scope of the research and proposed crashworthiness features, .14178 accidents occurred every million train miles, which means that a pertinent accident within the scope of this rulemaking occurred every 7,053,000 train miles. On average, .1438 injuries, and .012895 fatalities occurred every million train miles which is equivalent to one injury occurring every 6,954,000 train miles, and one fatality every 77,549,000 train miles.

The data set utilized to assess benefits for this analysis provides additional information on the probability of occurrence for the different types of accidents. The data set includes 286 accidents over a three-year period of time. Of the accidents which were reviewed highway-rail collisions represented the type of accident scenario with the largest number. This type of accident represented 52.1 percent of the accidents in the final data set. The accident scenario with the next largest representation is the side/oblique/raking collision, which represented 14.7 percent of the accidents. Rear-end collisions, or the equivalent, represented 12.2 percent of the accidents and head-on collisions represented 8 percent of the accidents.

The risk involved in an activity is not just the probability that a hazard will occur. Exposure to the hazards and the severity of the adverse incident, if it occurred, are constituent components of the risk function for a given activity, event, or situation. Thus, Risk could be represented by the following equation:

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

where **F** represents the risk
S represents the severity of the potential adverse event
E represents the level of exposure to the hazards

Exposure

Currently, there are approximately 23,500 locomotives in the United States.[32] FRA estimates that there are approximately 70,000 employees who are considered to be train and engine service employees. These crew members perform the job functions of the locomotive engineer, conductor, fireman, brakeman, and assistant engineer. Some of these job functions, e.g., engineer, require more time in the locomotive cab than others.

The hazards which this rulemaking is seeking to reduce or eliminate are unique. This is because the hazards are inherent in the design of a locomotive and the lack of sufficient protection of cab occupants space.

There are numerous factors that increase the exposure of a locomotive to the possibility of being in an accident. The type of work being performed (i.e., yard switching, road switching or road service), and both the number of railroad crossings (i.e., highway-rail and rail-rail) and the number of switches or interlockings increase the potential exposure. Obviously, these factors are not easily avoided or eliminated, given the need to perform work, conduct commerce, and maintain the current industry infrastructure. Further, they are not the focus of this rulemaking.

The risk of collision between trains and heavy motor vehicles at highway-rail crossings could either increase or decrease during the period that this analysis is conducted for. The categories of motor vehicles that present hazards to trains at highway-rail crossings include both local heavy trucks, such as trash haulers and intercity vehicles, such as gasoline tankers. If these vehicles increase in number at a greater rate than grade separations are provided, locomotive cab exposure will also increase. Increased density on major rail lines will also tend to drive up the risk of train-truck collisions, because of the tendency of drivers to attempt to "beat" trains when conditioned to believe that long delays may ensue after the train's arrival at the crossing.

[32] FRA estimates that there are approximately 23,500 locomotives in the United States which could potentially be affected by this regulation. Approximately 20,000 of these belong to Class I railroads, and regional and shortline railroads have 2,500. FRA also estimates that Amtrak and commuter railroads have 1,000 locomotives.

Severity
The final data set utilized to assess benefits for this analysis also provides information on the different types of casualties which occurred during the accidents. Fatalities represented 8.25 percent of the 315 casualties. Serious injuries represented 3.2 percent of the casualties. Moderate injuries represented 30.8 percent, and minor injuries represented 57.8 percent of the casualties.[33]

Factors, such as closing speed of a collision affect the severity of an accident and its casualties. Actually, any factor which increases the kinetic energy that will be transferred in a collision could potentially affect the severity of an accident. In other words, the number of cars in a train, the total tonnage of a train, the mass of striking object, the mass of object being struck, and speed of the locomotive(s)/train(s) at impact potentially affect casualty severity.

The level of protection needed to protect locomotive cab occupants in a collision is identical to the structural strength needed to protect the cab occupant space at varied energy transfers, at multiple angles of contact. At a certain level of protection, either the functionality of the cab decreases significantly or the cost of the improvements become prohibitive. As the level of protection afforded increases, it is bound by two factors: decrease in functionality of the cab, and cost. This rulemaking attempts to maximize protection afforded cab occupants in a collision (with respect to costs), while allowing designs to maintain functionality of the locomotive itself.

The benefit assessment which the Data/Accident Analysis and Benefit Assessment Task Force performed, indicates that the proposed standards potentially could have had an effect on over 81 percent of the 286 accidents. The benefit assessments conducted by this Task Force on this data set found that the proposed safety enhancements would have these effects: maximum mitigation of the severity of the consequences for 12.2 percent of the accidents; medium/moderate mitigation of the severity of the consequences for 28.3 percent of the accidents; and minimum mitigation of the severity of the consequences for 40.5 percent of the accidents.

10.0 Burdens on Society

The front end structural redesign and build requirements for more crashworthy locomotives in FRA's proposed rule may be accomplished by either meeting specific design requirements or by meeting the performance criteria. In general, both means of achieving improved crashworthiness for locomotives would require improving specific structures or systems composed of or replacing such structures. These specific structures include collision posts, corner posts, short-hood skin,

[33] Serious injuries are classified as AIS-3 injuries. Moderate and minor injuries are classified as AIS-2, and AIS-1 injuries, respectively. FRA's injury severity assessment did not classify any injuries as AIS-4 or AIS-5.

and strength. In addition, other design requirements address improved egress for emergency purposes, emergency lighting, and cab seat securement. Finally, the proposed rule includes requirements which should decrease the likelihood that fuel tank integrity will be compromised, in the event of an accident or incident.

This proposed regulation has front end structure design requirements for three different types or styles of locomotives. The types of locomotives include "wide-nose," "narrow-nose," and "semi-monocoque" locomotives. The wide-nose locomotive also referred to as the "North American Cab" is primarily designed and built for freight service. This style of locomotive design is, by far the most common type ordered and built in the industry. Narrow-nose locomotives are primarily used in train movements which require greater visibility for the cab crew. These types of locomotives are used in assembling freight cars for train movement, changing the position of freight cars for purposes of loading, unloading or weighing, and placement of freight locomotives and freight cars for repair or storage and local freight service. Narrow-nose locomotives are also used in transfer train movements and road switching. The semi-monocoque locomotive design style is structurally an integral car body; the outer skin carries a major portion of the locomotive structural loads. Currently this locomotive design type is primarily built for locomotives used in passenger service. The proposed rule does not limit the use of any type of locomotive construction, but rather outlines performance criteria, where possible, and design requirements for specific traditional locomotive designs.

The crashworthiness requirements in this proposed regulation would not apply to locomotives built without habitable cabs. These types of locomotives are referred to as "slugs" or permanent "B" units. However, the proposed fuel tank requirements would apply to these units. The requirements of the proposed rule would not apply to multiple-unit passenger cars or cab cars. These vehicles will remain subject to structural requirements of the Passenger Equipment Standards, *49 CFR part 238.*

<u>Adoption of Industry Standard</u>

One unique aspect about this proposed regulation is that it involves the incorporation of the AAR S-580 (2004) as an approved model. However, this fact does not change how, or what this analysis assesses as burdens. Since the incorporation by reference of an existing industry standard effectively codifies industry practices already in use, any marginal change in the impact, based on the previous designs and practices, is assessed as a burden.

<u>Anti-climbers</u>

As a result of the research and analysis by the Working Group, the proposed rule specifies design requirements for anti-climbing devices on locomotives. The anti-climber was found to be effective in the prevention of override of rail equipment and highway vehicles on to the locomotive cab. This proposed requirement is not more stringent than the 1989 industry standard, S-580.

Collision Posts
Collision posts are members of the locomotive front end structure projecting upward from the underframe to which they are securely attached. They help provide protection of occupied compartments during a collision by absorbing energy. This structural feature is the primary crash energy-absorbing feature on a locomotive when involved in an in-line train-to-train collision. The research and analysis performed for the Working Group showed that strengthened collision posts would provide additional collision protection to cab occupants. Research also found that collision post strength was effectively limited by the strength of the underframe. Increasing the collision post strength beyond the proposed measure would cause structural failure in ways unintended by the Working Group. In short, the proposed regulation strengthens the 1989 industry standard for collision posts.

Short-Hood Structure
The short-hood is a shell structure that typically consists of multiple materials and thicknesses for the sidewalls, roof plates, and forward facing front plates. During a train-to-train collision, the short-hood crumples, and then will ultimately either fractures or globally collapses. The results of the research conducted for the Working Group concluded that a strengthened short-hood resulted in increased crashworthiness for particular collision scenarios.[34] The research further indicated that the strength of the short-hood could be significantly increased over current designs with modest changes in the material type or thickness.[35] The proposed regulation increases the strength requirements for the short-hood structure from the 1989 industry standard (S-580) for the wide-nose and semi-monocoque types of locomotives designs. The proposed regulation would increase the strength requirement for the short-hood skin, but also would provide flexibility concerning the thickness and type of material utilized.

Underframe Strength
The locomotive underframe serves as a the backbone in conventional locomotive design, and it is the platform upon which superstructures are erected. The proposed rulemaking provides requirements for the strength of the locomotive's underframe. The underframe is designed not to

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[34] Tyrell, D., Severson, K., Marquis, B., Martinez, E., Mayville, R., Rancatore, R., Stringfellow, R., Hammand, R., Perlman, A.B., 1999, "Locomotive Crashworthiness Design Modifications Study," Proceedings of the 1999 IEEE/ASME Joint Railroad Conference, April 13-15, 1999, IEEE Catalog Number 99CH36340, ASME RTD Volume 16.

[35] Tyrell, D.C., Martinez, E.E., Wierzbicki, T., "Crashworthiness Studies of Locomotive Wide Nose Short Hood Designs," Crashworthiness, Occupant Protection and Biomechanics in Transportation Systems, American Society of Mechanical Engineers, AMD Vol. 237/BED Vol. 45, 1999.

fail before the other front end enhancements. The proposed requirements for the underframe differ between the wide-body, narrow nose, and the semi-moncoque locomotive designs. The proposed requirements carry forward exiting industry standards ensuring compatibility of existing and new equipment, and providing the technical foundation for other crashworthiness elements.

Emergency Egress
The proposed rule specifies design considerations for emergency egress of locomotive cabs. The requirements are only general design concepts, since the Working Group concluded that research was lacking in this area. FRA is planning future research in this area for a more specific rulemaking in the future. The proposed rule's emergency egress requirements are not found in the 1989 industry standard, S-580.

Cab Emergency Lighting
The proposed rule has minimal requirements in it for emergency lighting in the locomotive cab. These requirements are similar to those required for passenger equipment in §238.115, with the exception that, in paragraph (b), the required duration for lighting levels in freight locomotive cabs is less to reflect the design distinction between the two types of equipment. Passenger equipment generally has use of an auxiliary power source, making it more convenient to provide ample power when needed. Most freight locomotives have only one power source, and its reliability is important for powering the prime mover. This requirement is to assist crew members in a safe exit from the area during emergencies. The 1989 industry standard (S-580) does not contain a requirement for emergency lighting.

Fuel Tank
In 1990, the NTSB investigated three major accidents involving collisions and derailments of locomotives that resulted in diesel fuel fires from ruptured locomotive fuel tanks. Several crew members were fatally injured in the first two of these accidents, all of whom suffered extensive thermal burns and smoke inhalation. NTSB concluded that smoke and fumes increased the level of hazard in the post-crash phase of the accident, hindering emergency response and rescue activity.[36]

The proposed rule requires that locomotives equipped with external fuel tanks meet the AAR S-5506 (2001) requirements for external fuel tanks. Previously, these requirements were an AAR recommended practice (RP-506), which was found to have a positive effect on ensuring fuel tank structural integrity during accidents and incidents. For locomotives equipped with internal fuel tanks, the proposed rule requires that they meet the requirements of § 238.233, which govern design of fuel tanks for passenger locomotives.

[36] "Safety Study: Locomotive Fuel Tank Integrity" NTSB, October 1992, p. 1.

It is important to note that a large number of locomotives were manufactured with RP-506 compliant fuel tanks. Thus, based on the methodology that FRA follows for conducting regulatory impact analyses, this analysis will only assess costs for the estimated percentage of locomotives that will be built with S-5506 compliant fuel tanks, which would not have been built if it were not for this requirement in the proposed regulation.

10.1 Engineering and Design

The proposed rule will require locomotive manufacturers to redesign current models to meet the new requirements. In order to meet the proposed standards, manufacturers are expected to dedicate resources to the engineering and redesign of current locomotive models. This process can be tricky and time-consuming, given the delicate balance of specifications which result from competing design priorities. For example, maximizing cab corner window size for improved visibility often decreases structural protections in that area. FRA expects that, generally, subsequent redesign of locomotive models will be less costly than the amount of time and expense necessary for the redesign of the first model from each manufacturer.

In addition to the engineering and redesign of current locomotive models it is anticipated that there will also be a one-time cost related to the redesign for drafting and patterns and tools. There will also be one-time fixed costs for plant and equipment modifications which will be necessary to build the redesigned locomotives. 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 $950,000 in the first year of the analysis.

10.1.1 New Locomotive Crashworthiness Design Standards - § 229.207

Based on manufacturers' input and Working Group discussions, FRA estimates that the redesigned locomotive models will require 1,000 hours of engineering time for each. This analysis uses $125 per hour as the cost of locomotive engineering and design time. For the first year of the analysis FRA estimates that approximately six (6) locomotive models will be revised to meet this standard. This is estimated to cost $125,000 per locomotive model. The total cost for the initial six redesigns is estimated to be $750,000, which is assessed in the first year of the analysis.

FRA estimates that, on average one additional locomotive model which is associated with this section's requirement will be designed or redesigned every three years. This is estimated to cost $125,000 every three years. Over the twenty years of this analysis this is an additional cost of $750,000.

10.1.2 Alternative Locomotive Crashworthiness Design - § 229.209

Based on manufacturers' input and Working Group discussions, FRA estimates that an alternative locomotive crashwothy design will require 2,500 hours of engineering time for each locomotive model. This analysis uses $125 per hour as the cost of locomotive engineering and design time. For the first year of the analysis FRA estimates that approximately one (1) alternative locomotive model will be created and submitted to FRA. This is estimated to cost $312,500, which is assessed in the first year of the analysis.

FRA estimates that, on average one additional alternative locomotive design will be created and submitted to FRA every three years. This is estimated to cost $312,500 every three years. Over the twenty years of this analysis this is an additional cost of $1,875,000.

Over the twenty years of this analysis, the total engineering and design costs are estimated to be $4,637,500. FRA calculates the discounted value of this to be approximately $3,268,790.

Although FRA is using the time and cost estimates noted above, it recognizes that the actual time and cost for such redesigns could be less or more than the estimates used. The actual number of hours for the initial redesign could be more or less than the estimates used in this analysis. It is important to recognize that the costs estimates used in this analysis are FRA best guess, given the information and data available.

10.2 Marginal costs: Labor and supplies

This analysis assesses the additional labor and material/supply costs for all new locomotives. The labor and material/supply costs are for the redesigned crashworthy locomotives, but only for the crashworthy improvements. FRA estimates that the marginal costs for the materials and labor which are needed for the manufacturers to perform the crashworthy improvements are $5,200 per locomotive. As noted above in the assumptions section, this estimate is FRA's best guess, given the information and input provided. Over nineteen years, FRA estimates 13,300 locomotives will be produced for railroads operating in the United States, and this is estimated at a total cost of $69,160,000 for the additional crashworthiness features. The discounted value of this cost over the twenty-year analysis is $36,370,000.[37]

Although FRA is using $5,200 as the cost estimate for labor and supplies of the incremental improvements, the actual cost could be less or more than estimated. FRA believes these costs could be as low as $3,000 per locomotive. The cost could also be as high as $8,000 per locomotive. FRA believes that, more than likely, the actual cost will be $5,200 or less. Obviously, this cost estimate is the most significant part of the total cost which is calculated in this analysis.

10.3 Remanufactured Locomotives

The proposed rule includes a definition of "remanufactured locomotive." In § 229.5 of the this rulemaking, the application of the proposed requirements include "remanufactured" locomotives manufactured on or after January 1, 2005. The proposed definition includes locomotives "rebuilt or refurbished from a previously used or refurbished underframe ("deck"), containing fewer than 25 % previously used components (measured by dollar value of the components)." Basically this definition aims to include within the scope of the rule locomotives where: 1) almost the entire locomotive is new; or 2) the usable life of the locomotive is substantially extended. The proposed rule clearly intends to capture new locomotives that are produced on used, old, or refurbished underframes. It is difficult for FRA to estimate the production of the subset of remanufactured locomotives, given the proposed definition.

FRA anticipates both design costs and production costs associated with these impacts. FRA estimates that three rebuild manufacturers will each create or modify one design. FRA also estimates that these three will incur $500,000 for minimal shop retooling. For consistency purposes, FRA utilizes the same cost estimate per locomotive design that is used in Section 10.1 of this analysis. This design cost for each first locomotive design at a manufacturer is $375,000.[38] Total design costs is estimated to cost $1,625,000. It is important to note that FRA feels that this cost estimate is potentially much higher than the

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[37] FRA estimates that over the 19 years of production of locomotives that meet the proposed rule's requirements, there will be approximately 13,300 new locomotive produced and purchased by affected railroads. This estimate is calculated from the assumption that FRA stated in Section 7.0 of this analysis, which notes that production will be 700 per year.

[38] CALCULATION: ($125/hour)*(3,000 hours) = $375,000.

design and retooling costs that this sector of the industry will incur. FRA has assessed this cost spread across the first two years of the analysis.

For production of locomotives which will be affected by the definition in this proposed rule, FRA uses an estimate of 40 locomotives per year. This impact is anticipated to affect the production for years 2 - 20 of this analysis. FRA estimates that this cost will be $208,000 per year. The total discounted value of this over the twenty year analysis is $2,078,000.

FRA requests input and comments on the production estimates and design costs from firms which are involved in the remanufacturing of locomotives.

10.4 Compliant Repairs

FRA anticipates that the proposed crashworthy locomotive design standards will be more expensive to repair after damage has occurred in an accident or incident. When a crashworthy part or section of the locomotive has to be repaired after an accident, the repair process and methods must meet the quality and standards of the original design and construction of the locomotive. This is necessary to ensure the integrity of the crashworthy features.

To determine how many locomotives would be involved in collisions that might require compliant repairs each year, the average accident rate is utilized. The accident data indicates that the average number of accidents/million train miles is .14178131. When this rate is multiplied by the estimated number of train miles for 2007, an accident rate could be found. FRA estimates that the extra costs for ensuring that the repairs are compliant with the design, structure, and strength requirements, is $2,500, per accident.[39] This cost is also calculated as a percentage of the fleet that locomotives with these incremental safety features represents. This is equivalent to the phase-in percentage that is utilized for benefit in this analysis.[40] In the first year, (i.e., the second year of the analysis), this is estimated to cost $6,918 and, in the second year, it is estimated to cost $16,604.

[39] Note: this is a cost estimate per accident. Some accidents might involve more than one affected locomotive.

[40] FRA estimates that starting in the second year of this analysis, new locomotives will be leading consists 2.5 percent of the time. For years three through twenty this percentage is expected to be 6, 11, 16, 21, 26, 31, 36, 41, 46, 51, 56, 61, 66, 70, 74, 78, 81, and 84, respectively.

This impact is estimated to total $2,373,000 for the twenty-year period of this analysis. The discounted value of this total for the 20 years is $988,000.

10.5 Regulatory Compliance Requirements

10.5.1 Validation of crashworthiness design.

The criteria for FRA approval of locomotive crashworthiness designs are stipulated in this sub-part, where it provides the validation requirements. FRA notes that the petitioning entity is responsible for bearing the burden of validating that designs for locomotives subject to this subpart are in compliance with the standards. The validation process includes proper documentation of competent engineering analysis.

FRA anticipates that the validation process would include classic closed-form structural analysis and peer review of submitted standards. FRA estimates that the validation process would require 10 hours of professional time and 40 hours of administrative assistance per locomotive design. It is anticipated that most of this time is for the paper-work and administrative part of validating a locomotive design. All necessary engineering design work would be incurred in the design phase and in that cost. It is anticipated that initially 7 locomotive designs will be submitted for validation and approval, and then about two every three years. This is estimated to total $11,480, or $1,640 per locomotive design.[41] The total discounted cost for the validation process over the twenty year period is $21,000. It is important to note that these cost estimates are related to only the validation process. Additional costs are assessed for the approval process and for the engineering and design process involved in the redesign of each locomotive model.

10.5.2 Petitions for FRA approval of new or alternative locomotive crashworthiness design

§ 229.207(b) of the proposed rule stipulates the process for FRA approval procedure for alternate locomotive design standards. This section itemizes the procedures which are to be followed when seeking FRA approval of locomotive

[41] CALCULATION: (7 designs)*[(10 hours)*($100/hour) + (40 hours)*($16)] = $11,480.

crashworthiness designs. This procedure is similar to the approval procedures currently used by FRA in other contexts, such as in § 238.21.

FRA estimates that this process will cost approximately $10,000 per locomotive design. Initially, there should be approximately 11 locomotive designs submitted, which will total $70,000. In addition, there will probably be two additional locomotive designs submitted for approval every 3 years. For the twenty year period of this analysis, the total cost is approximately $190,000, discounted to the PV of $128,200.

10.5.3 § 229.213 Locomotive manufacturing information.

In § 229.213 of the proposed rule, each railroad which is operating a locomotive that is subject to the proposed crashworthiness requirements must provide, within two business days upon request of FRA, the build date of the locomotive, the name of the manufacturer, and the design specification to which the locomotive was built. FRA needs this information for locomotive verification and/or enforcement purposes. It is important for FRA to be able to rapidly determine whether a locomotive is subject to the requirements of this proposed rule. It is also important to be able to identify what standard a locomotive was built to when it is involved in an accident.

FRA also believes such identification on locomotives would be one method of communicating that a locomotive has the enhanced safety features. This is because the benefits of this rule may not be fully realized, if the occupants of the locomotive are not made aware of the safety features incorporated in the locomotive design. Obviously, this is just one method of identifying the safety features to the locomotive occupants. There are other means of communicating or identifying this information as well.

FRA anticipates that the simplest and most cost effective means to satisfy this paperwork requirement is to provide a plate/badge or engraved section on the locomotive with the appropriate information. This would eliminate the need for the railroad to locate the information and provide it to the FRA, since it will be readily available and easily accessed. FRA also does not think this should impose a significant burden for the manufacturers or railroads. Since December 31, 1979, each new locomotive has been certified and identified by a permanent badge or tag which notes the compliance with Part 210, Railroad Noise Emission Compliance

Regulations.[42] FRA estimates that this would cost approximately $10 per locomotive. For the twenty year period of this analysis, the total cost is approximately $133,000 and the discounted value of approximately $70,000.

10.5.4 § 229.215 Retention and inspection of designs.

In §§ 229.215(a) and 229.215(b) of the proposed rule each manufacturer or remanufacturer of a locomotive subject to this regulation is required to retain all records of locomotive designs for the locomotives which it owns that are subject to the requirements of this subpart. Each owner or lessee of a locomotive subject to the regulation shall also retain all records of repair or modifications to crashworthiness features. These records may be stored by and through a third party. FRA anticipates that a third party entity, such as the AAR, would actually maintains these designs.

In § 229.215(c) of the proposed rule, each custodian of records referred to above shall, if requested, to make available for inspection and duplication all records of locomotive designs for locomotives it owns which are subject to this subpart. This requirement is expected to have very little, if any, burden on the railroad industry. In some cases, FRA would request to see or attain a copy of the design from the third party entity which will be charged with their storage.

10.6 Locomotive Fuel Tanks

The proposed rule requires that locomotives equipped with external fuel tanks meet the AAR S-5506 (2001) requirements for external fuel tanks. Previously, these requirements were an AAR recommended practice, RP-506. For locomotives equipped with internal fuel tanks, the proposed rule requires that they meet the requirements of § 238.233, which governs design of fuel tanks for passenger locomotives.

All Class I railroads purchase new locomotives from original equipment manufacturers with RP-506 compliant fuel tanks. However, some smaller railroads may purchase new locomotives or remanufactured locomotives that might be considered "new" based on this proposed rule and some or most of these, do not have RP-506 compliant fuel tanks. FRA

[42] See § 210.27. If the information required in this proposal were to be added to this badge or tag, the cost for this burden could possibly decrease from the $10 per locomotive estimated.

does not know exactly how small of a number of locomotives would be impacted by this requirement. FRA is assuming that the number is so small that it does not warrant assessing a cost and benefit to it. For the preparation of the final rule's impact analysis, FRA would request information that either confirms this or finds to the contrary.[43]

10.7 Government Costs

In order to assist with compliance with this regulation, it will be necessary for FRA to review submissions from manufacturers and approve design standards. FRA also anticipates that it will have to respond to questions and issues raised by the manufacturers during the design phase and initial production.

This analysis does not anticipate any net increases in the resources necessary for the FRA to implement and enforce this proposed rule. FRA will reallocate current resources to perform the necessary review, approvals, inspections and enforcement actions. Therefore, FRA will not hire any new federal employees because of the promulgation of this regulation.

10.7.1 § 229.207 Approval of design standards.

It is estimated that the FRA staff consisting of engineers and safety specialists will need approximately 120 hours per locomotive design to review and approve each locomotive model/design during the approval process. FRA estimates that initially 11 locomotive designs will be submitted for approval. In the second year of the analysis, this is estimated to cost the FRA $642000.[44] In addition, FRA estimates that approximately one additional design will be submitted for approval every three years. This is estimated to cost $6,000. The total cost for the approval of the locomotive designs by FRA for the entire analysis is $174,000, and the discounted value of this for the 20 year period is $134,900.

10.7.2 Regulatory Compliance: Design, Build - Manufacturing Process

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[43] It is important to note that if this is not a very small number of locomotives, then there would not only be costs associated with the requirement, but also proportional benefits which would be phased in.

[44] CALCULATION: (7 loco designs)*($50.00/hour)*(120 hours) = $42,000.

In order to assist manufacturers and railroads in purchasing new locomotives, and to assure compliance with the proposed regulation, FRA estimates that its engineers and safety specialists will have to spend a total of 400 hours in the first year of this analysis providing assistance, direction and regulatory clarifications. In the second year of this analysis it is estimated that this assistance will be decreased to approximately 300 hours. In years three through twenty, FRA estimates that only 80 hours per year will be necessary for regulatory compliance issues related to this proposed rulemaking.

FRA assesses the cost of the time of its engineers/safety specialists at $50.00 per hour. The total cost for FRA's efforts in the regulatory compliance area are estimated to be $107,000, and the discounted value of this for the twenty year period is $69,257.

10.7.3 Regulatory Compliance: Inspection

FRA inspectors will, on occasion, inspect locomotives to verify that they are in compliance with this proposed regulation. This inspection/verification process would depend on how a railroad or manufacturer chooses to identify its compliance with the proposed crashworthiness requirements, but the regulation says it must be fairly easily identifiable. Per § 229.213, locomotives in compliance with this proposed regulation should be identifiable with build date, name of the manufacturer, and, if appropriate, the design specification to which the locomotive is built.

FRA anticipates that inspection of locomotive design standard compliance would become a customary part of a locomotive inspection by an FRA inspector. It is also expected to be an extremely minor burden and in fact, small enough not to quantify in this analysis.

10.8 Potential Cost Concerns

Multiple Locomotive Oriented Rulemakings - Limited Resources

There are potential cost considerations, which are based on the broader impact of multiple rulemakings, all impacting the railroad industry within a similar time-frame. In 1998, the Environmental Protection Agency (EPA) promulgated the final rule on Emission Standards for Locomotives. After January 1, 2002, newly manufactured locomotives have to meet the Tier 1 requirements in this EPA rule. In 1999, the FRA promulgated new requirements for passenger equipment. These requirements became effective on equipment manufactured on or after July 12, 1999. The addition of a significant rulemakings such as this proposed locomotive crashworthiness rule, and potential proposed rules, involving other locomotive cab working conditions, could place a drain on the engineering resources at the locomotive manufacturers.

Such "big picture" impacts and subsequent ramifications should be minimal over the long-term. However, in the short and near-term, this could force one or more manufacturers to abandon a market for a particular locomotive design. If only one manufacturer is left to bid on supplying the locomotive for one market/sector, then it would in a sense have a monopoly. Monopoly power would permit the only supplier to charge a premium price. Given known economic principles, FRA is confident that such an issue would not remain an issue over the long-term. There are high entry costs to enter the market for locomotives and locomotive type equipment, but there are also several manufacturers that produce equipment for use in other countries. Such manufacturers have already incurred some of the entry costs (e.g., fixed facilities, assembly facilities, and design modifications) to produce locomotives for the North American marketplace.

In the short-term, it is possible that all locomotive manufacturers might elect to remove their companies from the production of a type of locomotive that represents a small percentage of their total production. Since the production of freight locomotives designed for road service is the primary production model for manufacturers, it could be the production of passenger locomotives or switching locomotives, which are produced in lower numbers, that are eliminated by one manufacturer. A temporary monopoly on the production of a low volume locomotive model, such as a passenger locomotive, might produce an unintended ramification. Some railroads might elect to rebuild older locomotives to meet their short-term needs. This could serve to reduce the potential benefits that might accrue from this proposed regulation.[45] However, since FRA is proposing a standard that is highly compatible with existing designs and with existing industry designs and with the American Public Transportation Association (APTA) standards, FRA does not foresee any detrimental impacts.

Locomotive Weight: Additional Fuel Costs

The requirements in this proposed rulemaking might involve an increase in locomotive structural weight. For some locomotive models this additional weight could be off-set with equal reduction in ballast weight. However, for some locomotive models where there is no ballast weight to counter the additional weight, there will be a net increase in

[45] FRA requests that any comments on this issue, or any other related to this analysis, include sufficient information and data to calculate a burden and, where appropriate, references should be provided.

locomotive weight. In addition, if there is an increase in net weight for a locomotive, then it could potentially decrease the tonnage a locomotive/train could pull.

If there is a net increase in weight for some locomotive models, then potentially there could be an increase in the fuel costs to operate the locomotives. FRA has not assessed any costs or impacts for additional fuel costs in this analysis. However, FRA seeks input and comments on any potential impact this issue could have on the railroad industry. If there is an impact, then is it more than a nominal amount? If so, how much is the net weight increase, and how much is the expected fuel increase per train mile? How many and which types of locomotives is this anticipated to impact?

FRA has also not assessed any costs or burdens for a potential decrease in the tonnage that a locomotive/train could pull. FRA also seeks input and comment on any potential impact that this could have on the railroad industry.

11.0 Benefits

The proposed locomotive crashworthiness standards are designed to reduce or eliminate the hazards which are relevant in a locomotive during a collision. They are not being promulgated in this rulemaking for the purpose of reducing or eliminating the hazards which cause the collisions of locomotives. Thus, the rulemaking's purpose is to decrease or eliminate the likelihood that the locomotive, or parts of it, become hazardous to its crew during and immediately following a collision. An intended ramification of this process is a decrease in the severity of the unfortunate and negative consequences of locomotive collisions in the railroad environment.

The primary benefits expected to accrue from this proposed regulation are reductions in the number and severity of casualties. It is expected that more fatalities would end up becoming injuries, and severe injuries would be less severe. In addition, some injuries which are minor in nature might be reduced in severity to the point that they would no longer be required to be reported to the FRA. FRA also anticipates savings from less severe damages to locomotives involved in the accidents, and fewer breached fuel tanks. Thus, savings should accrue from a reduction in the number of fuel spill clean-ups. Railroads should also see a small savings from a reduction of reported fuel spills and casualties. Finally, the government should accrue small savings from the elimination of producing crashworthiness reports, and a reduction in the responding to correspondence on the issue of crashworthy locomotives.

Accident data is utilized to predict future benefit assessments from the requirement to build and operate crashworthy locomotives. It is important to note that the statistics generated by the benefit assessment are intended to be representative of the hazards and risks that locomotive crew members face in the locomotive cab when they are involved in a collision. Pre-S-580 locomotives pose hazards to these crew members in such situations. Many of their cab structures were neither specifically designed to resist the energy loads of most accidents, nor to protect the occupant space of the cabs. Newer locomotives which meet the AAR's S-580 (1989) requirements present less risk to the crew members, and the proposed requirements reduce these risks even further.

Data

The RSAC's Locomotive Crashworthiness Working Group established the Data Analysis & Benefit Assessment Task Force ("Task Force") to conduct a review of past accidents. This collection and review of accidents provides the basis of a data set of potential accidents which could have been mitigated by the proposed features in the NPRM. The data and accidents that were reviewed and assessed were for the time-period of 1995 - 1997. At the time that this review was conducted, this was the most recent data available.

1995 - 2002 Data Trend Assessment

In order to determine the significance of the data assessments performed by the Task Force, FRA reviewed more recent accident files that covered the time-period 1995 - 2002. This less detailed review has been used to revise the potential benefits that were originally estimated for the 1995 - 1997 time-period.[46]

Data Normalization

In order to standardize the accident statistics used in the benefit calculations of this analysis, the statistics were normalized by converting them to "data/statistic item" per train mile. Thus, the benefit assessment for each statistic was adjusted to reflect the estimated savings in casualty severity mitigation per train mile, locomotive damage mitigation per train mile, and environmental clean-up savings per train mile. "Exhibit 4" reflects the statistics for the three years of data utilized, and also shows the normalized statistics.

In order to effectively estimate the benefits in future years, the train miles for future years are estimated by calculating the average change in train miles over a period of time. This analysis averaged the change in train miles from one year to another for the period of time of 1994 to 2002. These years were chosen because they produced a more conservative estimate of the increase in train miles which is approximately 1.35 percent. If the calculation was performed with the addition of 1993, then the estimated increase would be larger. Given the average increase in train miles the train miles, were predicted for the years 2003, 2004, 2005, 2006 and 2007.[47] It is estimated that the train miles for 2007 would be 779,513,370.

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[46] The Data Trend Assessment can is summarized in Appendix C.

[47] Exhibit 5 shows how the average increase in train miles is calculated and what the estimates are for future train miles.

Benefit Reductions

All of the benefits narrated and quantified below have been reduced by 25 percent. This reduction is due to the elimination of the window-frame/corner structural requirement and the down-ward trend of accidents which could potentially be further mitigated by the proposed crashworthiness features. This downward trend also includes a general decrease over time of the negative impacts of these accidents. To see more on this assessment, please refer to Appendix C.

11.1 Casualty Severity Mitigation

The methodology utilized in this analysis is based on research which indicates that improving the crashworthiness of locomotives will decrease the probability of a fatality or injury. FRA expresses this as a probability that the severity of a casualty is mitigated. Thus, when collisions occur involving these locomotives, FRA anticipates fewer fatalities would occur and any injuries, which might occur, to be less severe.

This analysis utilizes a casualty severity mitigation estimate as its primary benefit, which is calculated on an annual basis. Once fully phased in, this benefit is estimated to total $17,671,500 per year. Since there will still be some locomotives in service that lack the incremental safety improvements, FRA expects that this benefit will be only 84 percent phased in by the twentieth year of this analysis.

The casualty severity mitigation benefit is produced from the data set and assessments produced by the Data Analysis and Benefit Assessment Task Force of the Locomotive Crashworthiness Working Group. This Task Force reviewed accidents from 1995, 1996, and 1997 derived from FRA's accident/incident reporting database. First, the Task Force determined if an accident came within the scope of the NPRM, and the research accident scenarios. Then, the accident was assessed to determine any potential benefit the improved features would provide in the same scenario. It was classified as either "maximum" potential benefit, "medium" potential benefit, "minimum" potential benefit, or "no" potential benefit.[48]

Relevant injuries were assessed for estimated injury severity levels utilizing the Abbreviated Injury Scale (AIS).[49] The AIS utilizes a system that assesses injuries with a numerical percentage of a statistical life. This provides a means of aggregating all

[48] Appendix B provides a detail description of the data collection and review, and benefit assessment process.

[49] Appendix A 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.

casualties as statistical lives. The equivalent percentage of a life that an injury is assessed varies with the severity and location of the injury.

For accidents which were assessed with maximum mitigation, an effectiveness rate of eighty-five percent is applied. This means that, on average, 85 percent of the severity of the casualties, which occur from the accidents assessed at maximum potential benefit, would be mitigated on future accidents. For accidents which were assessed with medium potential benefit, an effectiveness of sixty-five percent is applied, and accidents which were assessed as having minimum potential benefit, an effectiveness rate of thirty-five percent is applied.[50]

From the benefit assessment for the three years of accident data, FRA estimates the average annual casualty severity reduction benefit to be $15,230,565. When this statistic is normalized using annual train miles this savings becomes $0.0226699 per train mile.[51] As noted above, the estimated train miles for the year 2007 would be 779,513,370.[52] From this estimate FRA estimates that the benefit for mitigating casualty severity is $17,671,500. The estimated savings from casualty severity mitigation is phased in starting in the third year of the analysis, at four percent. Once the phase-in percentage has been applied to this, the savings is estimated to be $324,950 for the first year. In the twentieth year of the analysis, FRA estimates this savings to be $10,918,307. The aggregate of the discounted value this savings over the 20 year analysis is $46,407,672.

It is important to note that, based on the size of this benefit, it is the most significant part of the total benefits, which are estimated to accrue from the implementation of this rulemaking. However, unlike the marginal costs for the additional labor and supplies to produce the incremental improvements in crashworthiness, this benefit is based on accident data. This benefit also represents the monetary quantification of the primary goal of this rulemaking.

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[50] The assessments cover only the pool of accidents which could be mitigated by the proposed improvements. During the data analysis and benefit assessment process the Task Force removed from the data set many accidents in which the potential benefit assessment was found to be none or unknown.

[51] See Exhibit 4.

[52] See Exhibit 5.

11.2 Locomotive Damage Severity Mitigation

One of the secondary benefits from this proposed rulemaking is a savings from a mitigation in the severity of damages to locomotives from collisions. The methodology utilized in this analysis is based on the assumption that increasing the crashworthiness of locomotives will also decrease the amount of damage which occurs to locomotives and their trains during collisions. Thus, there is an anticipated savings from a reduction in the costs to repair locomotives after collisions.

This anticipated savings is not equivalent or similar to the additional costs associated with compliant repairs of the proposed safety features. FRA expects that the increased structural strength of the locomotive will, on average, decrease the overall damage, which would have occurred to the locomotive, without these incremental improvements. These prevented damages will not necessarily be the same parts or areas of the locomotive as the compliant repairs would be. The compliant repairs are expected to be parts or areas, such as a rip or tear in the short-hood nose skin. A compliant repair would entail proper welding to ensure that the repaired spot or location has equivalent integrity to the rest of the short-hood nose skin. In part the reduction of such damages occurs because the collision posts would have prevented penetration further into the cab and the destruction or damage of such parts.

The determination of the average amount of locomotive damages was part of the benefit assessment process performed by the Locomotive Crashworthiness Working Group's Data Analysis and Benefit Assessment Task Force. Accidents from 1995, 1996, and 1997 were reviewed. During this process, it was first determined whether each accident was within the scope of the NPRM and the accident scenarios. Next, the team examined the potential benefit the improved features would provide in the same scenario. Each accident was assigned a benefit level of either "maximum" potential benefit, "medium" potential benefit, "minimum" potential benefit, or "no" potential benefit. The Task Force found 22 accidents where the actual locomotive damage was itemized separately in addition to the total equipment damage provided on the accident report. From these accidents the average amount of locomotive damage was calculated as a percentage of the total equipment damages. As a result, locomotive damages comprise roughly 63 percent of the average total equipment damage reported on an FRA Form 6180.54.

FRA applies an effectiveness rate of twelve percent for accidents which were assessed with maximum mitigation. This means that, on average, eleven percent of the damages from accidents classified as "maximum mitigation" would be mitigated on future accidents. For accidents classified as "medium mitigation," an effectiveness of eight percent is applied, and those classified as "minimum mitigation," an effectiveness rate of five percent is applied.

From the benefit assessment and the three years of accident data, FRA estimates the average annual savings from a reduction in repair cost for locomotives damaged in collisions to be $1,380,263, per year. Normalizing using annual train miles, this savings translates to $0.02312125 per train mile.[53] The estimated savings from mitigated locomotive damages is phased in starting in the third year of the analysis. This benefit is initiated at four percent. From this estimate, the FRA estimates that the total savings for reduced damages to locomotives involved in train collisions is $1,600,385, per year. After accounting for the phase-in percentage, this savings is estimated to be $29,429 for the first year in which locomotives that meet the proposed standard will be operating. In the twentieth year of the analysis this savings is estimated to be $988,808. The aggregate of the discounted value this savings over the 20 year analysis is $4,202,873.

11.3 Environmental Clean-up Mitigation

NTSB has documented many instances of locomotive fuel tanks that ruptured during collisions. In 1991, the NTSB investigated 29 locomotive derailments, 56 percent of which involved diesel fuel spills. In 1997, NTSB investigated passenger train derailments which involved locomotives equipped with "integrally situated" fuel tanks. NTSB found this fuel tank design outperformed that of frame-suspended fuel tanks.[54]

Since improved fuel tank design as required by this proposed rule will likely result in fewer fuel spills, a savings will be realized from averted fuel clean-up costs. The data set used to assess the estimates for future casualty and locomotive damage reduction demonstrated an average of 21 fuel spills per year. A thorough analysis of the FRA accident/incident database for fuel spills was not conducted, and it likely would not have produced an accurate assessment of the number of fuel spills per year which potentially could be eliminated by this proposed rule. FRA's Form 6180.54 "Rail Equipment Accident/Incident Report" does not have a designated field for reporting a fuel spill. Therefore, fuel spills are only recorded when they are noted in the "narrative" block.

The third part of the Benefit Assessment covers the determination of environmental clean-up costs. Accident/Data Analysis and Benefit Assessment Task Force reviewed Accidents from 1995, 1996, and 1997. This Task Force reviewed accidents which were assessed,

[53] See Exhibit 4. Train miles for 1994 - 2002 were reviewed and the average annual increase was estimated to be 1.35 %. Hence, the estimated train miles for the year 2007 would be 779,513,370 (see Exhibit 5).

[54] National Transportation Safety Board (NTSB), "We Are All Safer." July 1998.

and a data set was established. Then the accidents were assessed as to the potential benefit the improved features would provide in the same scenario. Each accident was assessed as either "maximum" potential benefit, "medium" potential benefit, "minimum" potential benefit or "no" potential benefit. The final data set included 286 accidents and 46 of these had fuel tank breaches. In addition, 22 other accidents, which were not included in the data set had fuel tank breaches. From the accidents where data was provided or noted, an average of 1.5 locomotives per accident (for the 68 accident with breached fuel tanks) had fuel tank spills, and the average number of gallons spilled was 1,836. Based on environmental clean-up costs which were found in the review of some accidents that involved fuel spills, FRA found that the average clean-up costs of a fuel spill was $129,260.

All Class I railroads currently purchase new locomotives from original equipment manufacturers with S-5506 compliant fuel tanks. However, some smaller railroads may purchase new locomotives or re-manufactured locomotives that are new from the deck up without RP-506 compliant fuel tanks. FRA does not know exactly how small of a number of locomotives would be impacted by this requirement. FRA is assuming that the number is so small that it does not warrant assessing a benefit and cost for it. For the preparation of the final rule's impact analysis, FRA would request information that either confirms this or finds to the contrary.[55]

11.4 Reduction in Lost Work Days

In the data set of accidents which was collected by the Data/Accident Analysis and Benefit Assessment Task Force, an average of 9,266 lost work days per year were found, which were due to injuries incurred in collisions involving locomotives. This average number of lost work days pertains only to locomotive crew members who were injured in locomotives involved in collisions which were included in the data set. Once this proposed rule is finalized and effective, the number of lost work days should decrease due to a decrease in injury severity. To calculate the benefit for this savings, FRA has assumed that the proposed rule would be about 60 percent effective in reducing the number of lost work days. This benefit is phased in according to the number of new locomotives built and utilized in the lead position of trains. Thus, this analysis estimates that approximately 5,520 loss work days could be saved per year, once the benefit is fully phased in. Since most employees are not injured severely enough to prevent their return to work, only 50

[55] It is important to note that, if this is not a very small number of locomotives, then there would not only be phased in proportional benefits associated with the requirement but also proportional costs.

percent of the average railroad employee wage rate is utilized in calculating this benefit. This reduced wage rate would cover the benefits, overhead, and training for the additional employees needed to replace the injured locomotive crew members. It is important to note that this savings is not for the lost wages of the workers who are unable to work because of an injury sustained in a locomotive collision, but rather the savings from the overhead cost the railroad would incur for having to hire additional or supplemental workers. To calculate this savings FRA used the assumption that the average work-day consists of 10 hours for locomotive cab crew members.

FRA estimates that this benefit will total $747,960 per year, once fully effective.[56] In the first year of the benefit (i.e., the second year of the analysis), the value of this benefit is estimated to be $11,700. In the twentieth year of the analysis, the value of this benefit is $392,700. The discounted aggregate value of this savings, over the twenty-year analysis, is $1,658,000.

11.5 Reduction in Reporting to Government Entities

Fuel Spills

FRA anticipates that the proposed provisions of this rule will lead to a reduction in reporting to government entities. This anticipated reduction includes a decrease in the number of diesel fuel spills that the railroads are required to report to the National Response Center (NRC) operated by the U.S. Coast Guard.[57]

All Class I railroads purchase new locomotives from original equipment manufacturers with RP-506 compliant fuel tanks. However, some smaller railroads may purchase new locomotives or re-manufactured locomotives that are new from the deck up without RP-506 compliant fuel tanks. FRA does not know exactly how small of a number of locomotives would be impacted by this requirement. FRA is assuming that the number is so small that it does not warrant assessing a cost and benefit. Therefore, FRA is not assessing any quanitfied benefit for this reduction in reporting.

Locomotive Crew Injuries

Injuries to railroad workers in the workplace are reported on FRA Form 6180.55a on a monthly basis. FRA assumes that this proposed regulation will result in a reduction of

[56] CALCULATION: (5,520 days)*(10 hours)*($27.10 * .5) = $747,960.

[57] The Clean Water Act requires that diesel fuel spill be reported to the Environmental Protection Agency (EPA) through the NRC.

such reportable injuries. This analysis estimates a reduction in the severity of injuries and the number of casualties, in general. Some injuries, which are minor in nature, would be reduced in severity to the level of not being reportable. FRA estimates that for the 18 years that benefits are assessed in this analysis, the number of injuries reported will be reduced by two in the first year, and by three, four, six, and eight in the 2nd, 3rd, 4th, and 5th years, respectively. In the 6th through 19th years, it is estimated to be reduced by 9, 11, 13, 15, 17, 18, 20, 22, 23, 24, 25, 27, 28, and 28, respectively. FRA estimates that reporting a workplace injury consumes 21 minutes of railroad time, per injury. This estimate is for the entire process of reporting this issue to the proper authorities. Therefore, it includes the time spent in the reporting chain and any paperwork burden time. Thus, the anticipated savings is $9.49 per injury averted and not reported.[58] The discounted aggregate value of this savings over the twenty-year analysis is $1,215.

11.6 Government Savings

11.6.1 Reduced Correspondence

FRA receives correspondence on the lack of, or the need for, federal regulations. It is estimated that the FRA received twenty-five letters of correspondence in 1999. These letters come from Members of Congress and the general public. In most cases, the correspondence come from locomotive crew members or their representatives.

FRA estimates that it takes approximately four hours for the process of responding to a correspondence. Responses are usually written by FRA safety specialists, then reviewed by senior managers, and signed by the Federal Railroad Administrator. For each piece of correspondence answered, the government savings is estimated to be $218.80. FRA estimates that five pieces of correspondences will be eliminated the first year of the new locomotive designs (second year of the analysis), ten the second year, twelve the third year, fourteen the fourth year, and sixteen the fifth year. It is further estimated that the number will be eighteen in the sixth year, twenty in the seventh year, twenty-two in the eighth year, and twenty-four in the ninth year. For the tenth through the nineteenth years of the new designs, the savings is estimated to be twenty-five correspondences. The discounted aggregate value of this savings over the twenty-year analysis is $40,201.

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[58] CALCULATION: [(21 minutes/hour)/(60 minutes/hour)] * ($27.10/hour) = $9.49 per fuel spill.

11.6.2 Reduced Reporting

FRA anticipates that one of the ramifications from this proposed rulemaking would be a reduction in reporting to government entities of fuel spills and injuries, by railroad industry entities. However, FRA is not assess a quantifed benefit for the government saving associated with these reductions. The breached fuel tanks savings are currently accruing since most large railroads already purchase locomotives with S-5506 compliant fuel tanks, and the savings from the very small number that do not is considered to be very small. FRA is not assessing any savings for the reduced injury reporting either.

11.6.3 Crashworthiness Reports Eliminated

In 1992, FRA began instructing field inspectors to investigate all accidents involving either a collision of two trains or a collision of one train with an object weighing ten tons or more. These reports were necessary because the FRA accident reports for locomotive collisions did not contain the data necessary to support crash modeling. The collection of data from these inspections have assisted the FRA in preparing the Report to Congress and this rulemaking.

This proposed rule is the culmination of several years of data collection, analysis and reports, including locomotive crashworthiness reports. Thus, the need for the Agency to continue to conduct and produce locomotive crashworthiness reports should be eliminated with this rulemaking. It is estimated that these reports required approximately 10 hours of FRA inspector time, per report. FRA estimated that prior to this rulemaking it produced approximately 30 crashworthiness reports per year. Thus, the anticipated government savings is $320 per crashworthiness report eliminated.[59] FRA also estimates that each crashworthiness report requires about two hours of railroad time. Therefore, each report that is eliminated it is estimated to save the railroad industry $51 each. The discounted aggregate value of this savings over the twenty-year analysis is $121,362.

[59] CALCULATION: [(10 hours)] * ($32/hour) = $320, per crashworthiness report.

11.7 Potential Benefit Concerns

Underestimated Number of Fuel Tank Breaches

As noted in Section 11.3, a number of fuel spills occur which are not reported to FRA. The benefits that are assessed for environmental clean-up savings are based on accidents occurring in 1995 - 97, which were screened by the data review task force. A specific search for fuel tank spills, and fuel tank breaches was not conducted. FRA's Form 6180.54 "Rail Equipment Accident/Incident Report" does not have a designated space or block for reporting a fuel spill. Thus, the full set of all potential fuel tank spills and fuel tank breaches was not found for the data search period. Given the data collection process and the consistency in reporting of fuel spills, it is not possible to find a complete and accurate data set for this issue. Thus, the data set of fuel tank spills which was collected is a subset of the potential total for the given time-period. Therefore, the average number of fuel spills, which is utilized in this analysis, is smaller than it potentially could be.

Underestimated Injury Severity Savings

The potential savings from a mitigation of injury severity could also be larger. The potential exists for sparks to occur during a collision and when mixed with released diesel fuel, that a fire could also occur. For the data search years (1995 - 1997), 11 fires were found which were diesel fuel related in nature. Thus, if the number of breached fuel tanks decreases, then the potential of a fire could occur would also decrease. The likelihood that an injury or fatality which could occur from such a fire, would also decrease.

In addition, the Casualty Severity Mitigation Benefit is partially based on FRA's interpretation of injury reports and the assessments of the appropriate AIS injury severity code for each one. Since FRA personnel conducted the assessments of AIS severity for each injury and the information on some of the injury reports was limited and not very specific, the AIS levels were assessed at conservative or lower severity levels. This basically means that when an injury report related to a pertinent collision was non-specific on the type or location of the injury and no other information was obtained, then it was most likely assessed with an AIS-1 severity level, a minor injury. In reality, more specific information would sometimes have enabled such an injury to be assessed as an AIS -2 or AIS -3. Thus, FRA made conservative assessments that are most likely on the low end of the scale or conservative. In other words, if FRA was lacking information on an injury then it was assumed that the injury was minor in nature, i.e., AIS-1. If FRA had had more information on these injuries then the annual casualty severity mitigation benefit would most likely have been larger.

Increased Locomotive Exposure to Trucks at Highway Crossings

The risk of collision between trains and heavy motor vehicles at highway-rail crossings could either increase or decrease during the period for which this analysis is conducted.

The categories of motor vehicles that present hazards to trains at highway-rail crossings include both local heavy trucks, such as trash haulers and intercity vehicles, such as gasoline tankers. If these vehicles increase in number at a greater rate than grade separations are provided, locomotive cab exposures will also increase. Increased density on major rail lines will also tend to drive up the risk of train-truck collisions, because of the tendency of drivers to attempt to "beat" trains when conditioned to believe that long delays may ensue after the train's arrival at the crossing. There is a greater likelihood that locomotive exposure to truck traffic at highway-rail crossings will increase than decrease.

12.0 Results

For the twenty year period, the estimated quantified costs total $81,572,600, and have a PV of $43,888,400. For this period ,the estimated quantified benefits total $125,851,000, and have a PV of which is $52,428,900.

Based on the estimates, assumptions, and calculations utilized in this analysis, the benefits will exceed the costs on a yearly basis in the eighth year of the analysis in terms of both non-discounted and discounted costs. The 8th year of the analysis is only the 7th year of production for locomotives that would have the incremental improvements in safety.

The NPV of this analysis is a positive $8.5 million. This means that, according to this analysis and the methodology it utilizes for the given twenty year period, the discounted value of the estimated benefits exceed the discounted value of the estimated costs by $8.5 million. In addition, it is important to note that the non-discounted benefits exceed the non-discounted costs by $44.3 million. This phenomenon exists largely because the benefits are phased-in and are therefore, smaller in the early years of the analysis. However, the costs are largest in the early years and then are somewhat consistent throughout the remaining years of the analysis. Thus, starting in the eighth year, the benefits are greater than the costs and continue to grow larger every year. The discounting of these value streams puts a greater weight on the earlier years of the analysis.

13.0 Sensitivity Issues

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 calculations are largely driven by the number of new locomotives produced annually and the estimated marginal cost increase for the proposed features. The 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.

Issues which the outcome of this analysis could be sensitive to include potential cost concerns that have not been included or quantified in this analysis. One of these issues is the potential impact that multiple locomotive-oriented rulemakings could have on the cost of re-designing and producing locomotives. In 2004, FRA believes that the likelihood that this is a serious cost concern has decreased from since the early stages of this rulemaking. The potential exists for a manufacturer to leave one sector of the locomotive market because of the demand on engineering and design resources. Another cost concern is the potential for the additional weight of the improved crashworthiness features. If additional weight is significant or not off-set by a reduction of dead weight in the locomotive, then the fuel costs could increase. Finally, potential cost concerns exist in the locomotive rebuild market related to the definition of what is considered to be a "new" locomotive.

The results of this analysis could also be sensitive to potential benefit concerns, which are noted earlier in this analysis. There is a possibility that the "injury severity mitigation savings" could be underestimated. The AIS assessments used to calculate this benefit were based on very limited information. In most cases, additional information would increase the severity and therefore potentially increase the value of the severity reduction. FRA also believes that the potential savings for the proposed crashworthiness features would be increased because of higher exposure to heavy motor vehicles at highway-rail crossings.

This analysis is also sensitive to the estimated production of locomotives. A decrease in the estimated production would decrease both the estimated costs, and the estimated benefits. However, such a variance would probably affect the benefits slightly more than the costs. This is because benefits are phased in according to the estimated production, and a decrease in the production estimated for the earlier years would decrease the estimated benefits for every succeeding year. The cost would primarily decrease for the years where the production estimate is decreased.

Finally, the risk of a train-to-train collision would be significantly reduced by fully deployed Positive Train Control (PTC). However, there is no current commitment to deploy such a system by any major railroad, and previous estimates of the time during which deployment of advanced train control would progress have proven inaccurate. From this primary case, FRA must assume that the benefits of PTC are not realized within the period of this analysis.[60]

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[60] Note that the implementation of PTC would decrease the potential benefits for train-to-train accidents, i.e., head-on and rear-end collisions. However, it would have very little or no impact on any highway-rail collisions, and oblique and side-collisions.

Economic analyses, such as this RIA, are also sensitive to two common variables, i.e., the interest rate and value of a life. The sensitivity to these key variables was demonstrated by Hahn (2004).[61] Basically, the lower the interest rate is, the higher the net-benefits. Studies and analyses have used values for a statistical life that range from $0.7 million to $16.3 million.[62] A survey of government regulations between 1996 and 2003 used a range of $1.6 million to $7 million.[63] Also, if a higher the value was used for the statistical value of a life, then the net-benefits would also be higher. The vice-versa is also true for both of these variables.

Locomotive Life Cycle
FRA believes that there is a great amount of validity and merit to the results of an analysis for a period greater than 20 years. Most locomotives have a minimum useful life of 30 to 35 years, and the average life span for a locomotive is probably over 40 years. Thus, an analysis which assesses the entire streams of costs and benefits of the average life cycle for locomotives would provide a better picture of the true net value in implementing the proposed incremental crashworthiness improvements in locomotive designs.

14.0 Conclusion

FRA's proposed locomotive crashworthiness rule is intended to mitigate the severity of future casualties to locomotive crew members involved in locomotive collisions. It is also intended to decrease the likelihood of fuel spills, which might occur from train accidents, and any subsequent environmental damage.

Utilizing the methodology described in this analysis, the proposed rule is estimated to have a NPV of positive $8.5 million for the given twenty-year period following the effective date of the final rule. This result is limited by the inputs used to calculate it and by guidelines which govern regulatory impact analyses. The results could change significantly towards producing greater net benefits, if the interest rate used for discounting purposes was adjusted downwards from 7 percent. The results could also change significantly towards a higher positive NPV, if a higher

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[61] Robert Hahn, et al, "Reviewing the Government's Numbers on Regulation." AEI-Brookings Joint Center, (Publication 04-03), January 2004.

[62] Cass R. Sunstein, "Are Poor People Worth Less Than Rich People? Disaggregating the Value of Statistical Lives," AEI-Brookings Joint Center, (Working Paper 04-05), January 2004, p. 10.

[63] Ibid, pp. 7 - 9.

value of a life saved were utilized, or if the actual marginal costs for the labor and supplies for the new features were to be less than the estimated $5,200 per locomotive.

FRA estimates that, over the 19 years that the benefits will accrue from this proposed rule, 48.371 statistical lives will be saved.[64] This means that an equivalent number of lives or injuries will be prevented from occurring for collisions involving locomotives during this time period.[65]

It is important to note that this proposed regulation has been developed, crafted, and recommended to FRA by the RSAC's Locomotive Crashworthiness Working Group. This group consists of members from FRA, the NTSB, labor unions, original equipment manufacturers, and railroad management. Thus, all of the major stakeholders in the railroad industry were well represented and involved in the recommendations to the FRA regarding the improved safety features for this proposed rule. Such involvement is both a tacit and outright endorsement of the proposed and improved crashworthy features for locomotives.

Finally, 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.[66] Hence, this impact analysis is only one tool that can be utilized when considering such a proposal.

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[64] Given the estimated benefit assessments, FRA estimates that a 100 percent effectiveness for casualty mitigation would save 5.64095 statistical lives per year. FRA estimates that, over the 20 year period of this analysis, there will be the equivalent of 8.575 years of full benefits. Thus, (5.64095 statistical lives)*(8.575 years) = 48.371 statistical lives saved.

[65] It is important to note that prevented injuries and injuries that have been reduced in severity equal percentages of a statistical lives when utilizing the AIS. Thus, such reductions are accumulated in the estimated lives saved.

[66] 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.

EXHIBIT 1 INPUTS and ASSUMPTIONS Revised: 23 June 2004

Marginal production cost per locomotive (labor & materials)	$5,200	per locomotive
Hourly rate for Administrative Assistance	$16.00	per hour
Hourly rate for Average Railroad Employee	$27.10	per hour
Locomotive Production	700	per year
Hourly rate for Federal Inspectors	$32	per hour
Hourly rate for Engineering and Design work	$125	per hour
Estimated number of hours for an OEM to redisign standard - 229.207	1,000	hours
Estimated number of hours for an OEM to create alternative Loco design	2,500	hours
Estimated Value of Locomotive Damage Severity Mitigation*	$1,569,536	per year
Estimated Value of Casualty Severity Mitigation*	$17,330,646	per year
Average percentage of loco damage (from equip. damage reported)	0.63037	
Estimated cost of Locomotive identification - manufacture date	$10	per locomotive
Estimated additional cost for compliant repair after a collision	$2,500	
Hourly rate for FRA engineers/safety specialists	$50.00	per hour
Average number of accidents per train mile	0.00000014178131	
Estimated number of Train Miles for 2005	780,717,075	
Estimated average number of days absent for Loco Crew in accidents	9,266	
Estimated time to report an injury	21	Minutes
Estimated time for the government to receive and record a fuel spill	10	Minutes

* Estimated value determined with data and benefit assessments established by the Accident/Data Analysis and Benefit Assessment Task Force

EXHIBIT 2 - COSTS
Locomotive Crashworthiness -NPRM

Revised: 23 June 2004

COSTS

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Manufacturing Costs										
Design & re-engineering	2,012,500			437,500			437,500			437,500
PV	*1,945,484*	*0*	*0*	*345,231*	*0*	*0*	*281,838*	*0*	*0*	*230,038*
Marginal Production Costs		3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000
PV	*0*	*3,288,740*	*3,073,616*	*2,872,324*	*2,684,500*	*2,509,052*	*2,344,888*	*2,191,280*	*2,048,228*	*1,913,912*
Compliant Repairs - 229.205		6,918	16,604	30,440	44,276	58,113	71,949	85,786	99,622	113,458
PV	*0*	*6,251*	*14,020*	*24,020*	*32,654*	*40,057*	*46,350*	*51,643*	*56,057*	*59,656*
Remanufactured "New" Locomotives		208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000
PV	*0*	*187,928*	*175,635*	*164,133*	*153,400*	*143,374*	*133,994*	*125,216*	*117,042*	*109,366*
Remanfctrd "New" Loco Design Cost	437,500	437,500								
PV	*422,931*	*395,281*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sub-Total	2,450,000	4,292,418	3,864,604	4,315,940	3,892,276	3,906,113	4,357,449	3,933,786	3,947,622	4,398,958
PV of Sub-Total	*2,368,415*	*3,878,200*	*3,263,271*	*3,405,708*	*2,870,554*	*2,692,484*	*2,807,069*	*2,368,139*	*2,221,327*	*2,312,972*
Other Costs										
229.207 & 209 Validation	11,480			3,280			3,280			3,280
PV	*11,098*	*0*	*0*	*2,588*	*0*	*0*	*2,113*	*0*	*0*	*1,725*
Approval procedures (design)	70,000			20,000			20,000			20,000
PV	*67,669*	*0*	*0*	*15,782*	*0*	*0*	*12,884*	*0*	*0*	*10,516*
229.213 Loco manufacturing Info.		7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
PV	*0*	*6,325*	*5,911*	*5,524*	*5,163*	*4,825*	*4,509*	*4,214*	*3,939*	*3,681*
229.215 Maint & inspect of Designs										
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sub-Total	81,480	7,000	7,000	30,280	7,000	7,000	30,280	7,000	7,000	30,280
NPV of Sub-Total	*78,767*	*6,325*	*5,911*	*23,894*	*5,163*	*4,825*	*19,506*	*4,214*	*3,939*	*15,921*
Government Costs										
Approval Process	42,000			12,000			12,000			12,000
PV	*40,601*	*0*	*0*	*9,469*	*0*	*0*	*7,730*	*0*	*0*	*6,310*
Regulatory Compliance: Desgn & Build	20,000	15,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
PV	*19,334*	*13,553*	*3,378*	*3,156*	*2,950*	*2,757*	*2,577*	*2,408*	*2,251*	*2,103*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sub-Total	62,000	15,000	4,000	16,000	4,000	4,000	16,000	4,000	4,000	16,000
PV of Sub-Total	*59,935*	*13,553*	*3,378*	*12,626*	*2,950*	*2,757*	*10,307*	*2,408*	*2,251*	*8,413*
TOTAL	2,593,480	4,314,418	3,875,604	4,362,220	3,903,276	3,917,113	4,403,729	3,944,786	3,958,622	4,445,238
PV of Total	*2,507,117*	*3,898,077*	*3,272,560*	*3,442,228*	*2,878,666*	*2,700,066*	*2,836,882*	*2,374,761*	*2,227,517*	*2,337,306*

EXHIBIT 2 - (Continued)

Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	TOTAL
		437,500			437,500			437,500		4,637,500
0	*0*	*187,775*	*0*	*0*	*153,300*	*0*	*0*	*125,125*	*0*	3,268,790
3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	69,160,000
1,788,696	*1,671,852*	*1,562,288*	*1,460,368*	*1,364,636*	*1,275,456*	*1,192,100*	*1,113,840*	*1,041,040*	*972,972*	36,369,788
127,295	141,131	154,968	168,804	182,640	193,709	204,779	215,848	224,149	232,451	2,372,940
62,553	*64,822*	*66,512*	*67,724*	*68,472*	*67,876*	*67,065*	*66,049*	*64,107*	*62,134*	988,022
208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	3,952,000
102,211	*95,534*	*89,274*	*83,450*	*77,979*	*72,883*	*68,120*	*63,648*	*59,488*	*55,598*	2,078,274
										875,000
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	818,213
										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*	*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*	*0*	*0*	*0*	0
3,975,295	3,989,131	4,440,468	4,016,804	4,030,640	4,479,209	4,052,779	4,063,848	4,509,649	4,080,451	80,997,440
1,953,460	*1,832,208*	*1,905,849*	*1,611,542*	*1,511,087*	*1,569,515*	*1,327,285*	*1,243,537*	*1,289,760*	*1,090,705*	*43,523,086*
		3,280			3,280			3,280		31,160
0	*0*	*1,408*	*0*	*0*	*1,149*	*0*	*0*	*938*	*0*	21,019
		20,000			20,000			20,000		190,000
0	*0*	*8,584*	*0*	*0*	*7,008*	*0*	*0*	*5,720*	*0*	128,163
7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	133,000
3,440	*3,215*	*3,004*	*2,808*	*2,624*	*2,453*	*2,293*	*2,142*	*2,002*	*1,871*	69,942
										0
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0
										0
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0
7,000	7,000	30,280	7,000	7,000	30,280	7,000	7,000	30,280	7,000	354,160
3,440	*3,215*	*12,996*	*2,808*	*2,624*	*10,610*	*2,293*	*2,142*	*8,660*	*1,871*	*219,124*
		12,000			12,000			12,000		114,000
0	*0*	*5,150*	*0*	*0*	*4,205*	*0*	*0*	*3,432*	*0*	76,898
4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	107,000
1,966	*1,837*	*1,717*	*1,605*	*1,518*	*1,402*	*1,310*	*1,224*	*1,144*	*1,069*	69,257
										0
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0
										0
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0
4,000	4,000	16,000	4,000	4,000	16,000	4,000	4,000	16,000	4,000	221,000
1,966	*1,837*	*6,867*	*1,605*	*1,518*	*5,606*	*1,310*	*1,224*	*4,576*	*1,069*	*146,155*
3,986,295	4,000,131	4,486,748	4,027,804	4,041,640	4,525,489	4,063,779	4,074,848	4,555,929	4,091,451	81,572,600
1,958,865	*1,837,260*	*1,925,712*	*1,615,955*	*1,515,229*	*1,585,731*	*1,330,887*	*1,246,903*	*1,302,996*	*1,093,645*	*43,888,364*

EXHIBIT 3 - BENEFITS
Locomotive Crashworthiness -NPRM

Revised: 23 June 2004

BENEFITS

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Benefits:										
Casualty Severity -Mitigation		324,950	779,879	1,429,778	2,079,678	2,729,577	3,379,476	4,029,375	4,679,274	5,329,174
PV	*0*	*293,592*	*658,530*	*1,128,238*	*1,533,762*	*1,881,497*	*2,177,058*	*2,425,684*	*2,633,028*	*2,802,080*
Loco Damage - Mitigation		29,429	70,629	129,487	188,344	247,202	306,060	364,917	423,775	482,632
PV	*0*	*26,589*	*59,639*	*102,178*	*138,904*	*170,396*	*197,164*	*219,680*	*238,458*	*253,768*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sub-Total	0	354,378	850,508	1,559,265	2,268,022	2,976,779	3,685,535	4,394,292	5,103,049	5,811,806
PV of Sub-Total	*0*	*320,181*	*718,169*	*1,230,416*	*1,672,666*	*2,051,894*	*2,374,222*	*2,645,364*	*2,871,486*	*3,055,848*
Other Benefits										
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Reduction in Loss Work Days		11,687	28,049	51,422	59,837	98,170	121,544	144,917	168,291	191,665
PV	*0*	*10,559*	*23,684*	*40,577*	*44,130*	*67,668*	*78,298*	*87,240*	*94,697*	*100,777*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Reduction in Reporting -casualties		19	28	38	57	76	85	104	123	142
PV	*0*	*17*	*24*	*30*	*42*	*52*	*55*	*63*	*69*	*75*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sub-Total	0	11,706	28,077	51,460	59,894	98,246	121,629	145,022	168,414	191,807
PV of Sub-Total	*0*	*10,576*	*23,708*	*40,607*	*44,172*	*67,721*	*78,353*	*87,303*	*94,767*	*100,852*
Govn't Savings										
Elimination of Crashwrthnss Rprts	11,226	11,226	11,226	11,226	11,226	11,226	11,226	11,226	11,226	11,226
PV	*10,852*	*10,143*	*9,479*	*8,564*	*8,279*	*7,738*	*6,990*	*6,758*	*6,317*	*5,903*
Reduced Correspondence		1,000	2,000	2,400	2,800	3,200	3,600	4,000	4,400	4,800
PV	*0*	*904*	*1,689*	*1,831*	*2,065*	*2,206*	*2,242*	*2,408*	*2,476*	*2,524*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sub-Total	11,226	12,226	13,226	13,626	14,026	14,426	14,826	15,226	15,626	16,026
PV of Sub-Total	*10,852*	*11,046*	*11,168*	*10,395*	*10,344*	*9,944*	*9,232*	*9,166*	*8,793*	*8,426*
TOTAL	11,226	378,310	891,811	1,624,351	2,341,942	3,089,450	3,821,990	4,554,540	5,287,089	6,019,639
PV of Total	10,852	341,803	753,045	1,281,419	1,727,182	2,129,558	2,461,807	2,741,833	2,975,045	3,165,126

EXHIBIT 3 - (Continued)

Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	TOTAL
5,979,073	6,628,972	7,278,871	7,928,771	8,578,670	9,098,589	9,618,509	10,138,428	10,528,367	10,918,307	111,457,717
2,938,116	3,044,687	3,124,092	3,181,023	3,216,143	3,188,146	3,150,062	3,102,359	3,011,113	2,918,463	46,407,672
541,490	600,348	659,205	718,063	776,920	824,006	871,092	918,179	953,493	988,808	10,094,078
266,088	275,740	282,931	288,087	291,267	288,732	285,283	280,963	272,699	264,308	4,202,873
										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	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	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
										0
0	0	0	0	0	0	0	0	0	0	0
6,520,563	7,229,320	7,938,076	8,646,833	9,355,590	9,922,596	10,489,601	11,056,606	11,481,861	11,907,115	121,551,795
3,204,205	3,320,426	3,407,022	3,469,110	3,507,411	3,476,877	3,435,344	3,383,322	3,283,812	3,182,772	50,610,546
										0
0	0	0	0	0	0	0	0	0	0	0
215,039	238,412	261,786	285,160	308,534	327,233	345,932	364,631	378,655	392,679	3,993,639
105,670	109,503	112,359	114,406	115,669	114,662	113,293	111,577	108,295	104,963	1,658,028
										0
0	0	0	0	0	0	0	0	0	0	0
161	171	190	209	218	228	237	256	266	266	2,874
79	78	81	84	82	80	78	78	76	71	1,215
										0
0	0	0	0	0	0	0	0	0	0	0
215,200	238,583	261,976	285,368	308,752	327,460	346,169	364,887	378,920	392,945	3,996,513
105,749	109,581	112,440	114,490	115,751	114,742	113,370	111,655	108,371	105,034	1,659,243
11,226	11,226	11,226	11,226	11,226	11,226	11,226	11,226	11,226	11,226	224,520
5,516	5,156	4,818	4,504	4,068	3,934	3,677	3,435	3,211	3,001	122,343
5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	78,200
2,457	2,297	2,146	2,006	1,812	1,752	1,638	1,530	1,430	1,337	36,747
										0
0	0	0	0	0	0	0	0	0	0	0
										0
0	0	0	0	0	0	0	0	0	0	0
16,226	16,226	16,226	16,226	16,226	16,226	16,226	16,226	16,226	16,226	302,720
7,973	7,453	6,964	6,510	5,880	5,686	5,314	4,965	4,641	4,337	159,090
6,751,989	7,484,129	8,216,278	8,948,428	9,680,568	10,266,282	10,851,996	11,437,719	11,877,007	12,316,285	125,851,028
3,317,927	3,437,460	3,526,427	3,590,109	3,629,042	3,597,305	3,554,029	3,499,942	3,396,824	3,292,143	52,428,879

EXHIBIT 4 Average Benefits, and Benefits/Train Mile *Revised: February 18 2004*

Year	Damages	Casualties	$$ Value of Damages/Train Mile	$$ Value of Casualties/Train Mile
1995	$1,483,549	$19,748,745	0.002214838	0.029483528
1996	$1,390,683	$14,865,323	0.002072791	0.022156525
1997	$1,266,555	$11,077,628	0.00187162	0.016369685
Average	$1,380,263	$15,230,565	0.002053083	0.022669913

EXHIBIT 5 TRAIN MILES

Year	Train Miles	Percentage change From Previous Year
1993	613,974,000	
1994	655,083,000	6.70%
1995	669,823,000	2.25%
1996	670,923,000	0.16%
1997	676,716,000	0.86%
1998	682,895,000	0.91%
1999	712,453,000	4.33%
2000	722,876,000	1.46%
2001	711,550,000	-1.57%
2002	728,790,000	2.42%
Average increase for 1994 - 2002		1.35%

Year	Estimated Train Miles - Future
2003	738,663,497
2004	748,670,758
2005	758,813,595
2006	769,093,845
2007	779,513,370

EXHIBIT 6 - COSTS usings a 3 % discount Rate
Locomotive Crashworthiness -NPRM — Revised: 23 June 2004

COSTS

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Manufacturing Costs										
Design & re-engineering	2,012,500			437,500			437,500			437,500
PV	*1,953,876*	*0*	*0*	*388,714*	*0*	*0*	*355,727*	*0*	*0*	*325,539*
Marginal Production Costs		3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000
PV	*0*	*3,431,028*	*3,331,110*	*3,234,104*	*3,139,900*	*3,048,427*	*2,959,648*	*2,873,452*	*2,789,769*	*2,708,488*
Compliant Repairs - 229.205		6,918	16,604	30,440	44,276	58,113	71,949	85,786	99,622	113,458
PV	*0*	*6,521*	*15,195*	*27,046*	*38,193*	*48,668*	*58,501*	*67,720*	*76,352*	*84,423*
Remanufactured "New" Locomotives		208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000
PV	*0*	*196,059*	*190,349*	*184,806*	*179,423*	*174,196*	*169,123*	*164,197*	*159,415*	*154,771*
Remanfctrd "New" Loco Design Cost	437,500	437,500								
PV	*424,756*	*412,383*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sub-Total	2,450,000	4,292,418	3,864,604	4,315,940	3,892,276	3,906,113	4,357,449	3,933,786	3,947,622	4,398,958
PV of Sub-Total	*2,378,632*	*4,045,990*	*3,536,653*	*3,834,670*	*3,357,517*	*3,271,291*	*3,542,998*	*3,105,370*	*3,025,536*	*3,273,221*
Other Costs										
229.207 & 209 Validation	11,480			3,280			3,280			3,280
PV	*11,146*	*0*	*0*	*2,914*	*0*	*0*	*2,667*	*0*	*0*	*2,441*
Approval procedures (design)	70,000			20,000			20,000			20,000
PV	*67,961*	*0*	*0*	*17,770*	*0*	*0*	*16,262*	*0*	*0*	*14,882*
229.213 Loco manufacturing Info.		7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
PV	*0*	*6,598*	*6,406*	*6,219*	*6,038*	*5,862*	*5,692*	*5,526*	*5,365*	*5,209*
229.215 Maint & inspect of Designs										
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sub-Total	81,480	7,000	7,000	30,280	7,000	7,000	30,280	7,000	7,000	30,280
NPV of Sub-Total	*79,106*	*6,598*	*6,406*	*26,903*	*6,038*	*5,862*	*24,620*	*5,526*	*5,365*	*22,531*
Government Costs										
Approval Process	42,000			12,000			12,000			12,000
PV	*40,777*	*0*	*0*	*10,662*	*0*	*0*	*9,757*	*0*	*0*	*8,929*
Regulatory Compliance: Desgn & Build	20,000	15,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
PV	*19,417*	*14,139*	*3,661*	*3,554*	*3,450*	*3,350*	*3,252*	*3,158*	*3,066*	*2,976*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sub-Total	62,000	15,000	4,000	16,000	4,000	4,000	16,000	4,000	4,000	16,000
PV of Sub-Total	*60,194*	*14,139*	*3,661*	*14,216*	*3,450*	*3,350*	*13,009*	*3,158*	*3,066*	*11,905*
TOTAL	2,593,480	4,314,418	3,875,604	4,362,220	3,903,276	3,917,113	4,403,729	3,944,786	3,958,622	4,445,238
PV of Total	*2,517,932*	*4,066,727*	*3,546,720*	*3,875,789*	*3,367,005*	*3,280,504*	*3,580,628*	*3,114,053*	*3,033,967*	*3,307,657*

EXHIBIT 6 - (Continued)

Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	TOTAL
		437,500			437,500			437,500		4,637,500
0	0	297,916	0	0	272,633	0	0	249,498	0	3,843,902
3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	3,640,000	69,160,000
2,629,609	2,553,023	2,478,658	2,406,477	2,336,370	2,268,302	2,202,273	2,138,100	2,075,819	2,015,359	50,619,915
127,295	141,131	154,968	168,804	182,640	193,709	204,779	215,848	224,149	232,451	2,372,940
91,960	98,987	105,525	111,600	117,230	120,712	123,895	126,787	127,828	128,701	1,575,844
208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	3,952,000
150,263	145,887	141,638	137,513	133,507	129,617	125,844	122,177	118,618	115,163	2,892,567
										875,000
0	0	0	0	0	0	0	0	0	0	837,139
										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	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	0	0	0	0
3,975,295	3,989,131	4,440,468	4,016,804	4,030,640	4,479,209	4,052,779	4,063,848	4,509,649	4,080,451	80,997,440
2,871,832	2,797,897	3,023,736	2,655,589	2,587,107	2,791,264	2,452,012	2,387,063	2,571,763	2,259,223	59,769,366
		3,280			3,280			3,280		31,160
0	0	2,234	0	0	2,044	0	0	1,871	0	25,315
		20,000			20,000			20,000		190,000
0	0	13,619	0	0	12,463	0	0	11,406	0	154,362
7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	133,000
5,057	4,910	4,767	4,628	4,493	4,362	4,235	4,112	3,992	3,876	97,346
										0
0	0	0	0	0	0	0	0	0	0	0
										0
0	0	0	0	0	0	0	0	0	0	0
7,000	7,000	30,280	7,000	7,000	30,280	7,000	7,000	30,280	7,000	354,160
5,057	4,910	20,619	4,628	4,493	18,869	4,235	4,112	17,268	3,876	277,023
		12,000			12,000			12,000		114,000
0	0	8,171	0	0	7,478	0	0	6,843	0	92,617
4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	107,000
2,890	2,806	2,724	2,644	2,567	2,493	2,420	2,350	2,281	2,215	85,412
										0
0	0	0	0	0	0	0	0	0	0	0
										0
0	0	0	0	0	0	0	0	0	0	0
4,000	4,000	16,000	4,000	4,000	16,000	4,000	4,000	16,000	4,000	221,000
2,890	2,806	10,895	2,644	2,567	9,971	2,420	2,350	9,124	2,215	178,029
3,986,295	4,000,131	4,486,748	4,027,804	4,041,640	4,525,489	4,063,779	4,074,848	4,555,929	4,091,451	81,572,600
2,879,779	2,805,612	3,055,251	2,662,862	2,594,167	2,820,104	2,458,667	2,393,525	2,598,155	2,265,314	60,224,419

EXHIBIT 7 - BENEFITS using a 3 % discount rate
Locomotive Crashworthiness -NPRM

Revised: 23 June 2004

BENEFITS

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Benefits:										
Casualty Severity -Mitigation		324,950	779,879	1,429,778	2,079,678	2,729,577	3,379,476	4,029,375	4,679,274	5,329,174
PV	*0*	*306,294*	*713,699*	*1,270,344*	*1,793,951*	*2,285,966*	*2,747,818*	*3,180,829*	*3,586,290*	*3,965,385*
Loco Damage - Mitigation		29,429	70,629	129,487	188,344	247,202	306,060	364,917	423,775	482,632
PV	*0*	*27,739*	*64,636*	*115,048*	*162,468*	*207,027*	*248,854*	*288,069*	*324,789*	*359,122*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sub-Total	0	354,378	850,508	1,559,265	2,268,022	2,976,779	3,685,535	4,394,292	5,103,049	5,811,806
PV of Sub-Total	*0*	*334,034*	*778,334*	*1,385,391*	*1,956,418*	*2,492,993*	*2,996,672*	*3,468,898*	*3,911,079*	*4,324,507*
Other Benefits										
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Reduction in Loss Work Days		11,687	28,049	51,422	59,837	98,170	121,544	144,917	168,291	191,665
PV	*0*	*11,016*	*25,668*	*45,688*	*51,616*	*82,215*	*98,826*	*114,399*	*128,982*	*142,616*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Reduction in Reporting -casualties		19	28	38	57	76	85	104	123	142
PV	*0*	*18*	*26*	*34*	*49*	*64*	*69*	*82*	*95*	*106*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sub-Total	0	11,706	28,077	51,460	59,894	98,246	121,629	145,022	168,414	191,807
PV of Sub-Total	*0*	*11,034*	*25,694*	*45,722*	*51,665*	*82,279*	*98,895*	*114,481*	*129,076*	*142,722*
Govn't Savings										
Elimination of Crashwrthnss Rprts	11,226	11,226	11,226	11,226	11,226	11,226	11,226	11,226	11,226	11,226
PV	*10,899*	*10,582*	*10,273*	*9,974*	*9,684*	*9,402*	*9,128*	*8,862*	*8,604*	*8,353*
Reduced Correspondence		1,000	2,000	2,400	2,800	3,200	3,600	4,000	4,400	4,800
PV	*0*	*943*	*1,830*	*2,132*	*2,415*	*2,680*	*2,927*	*3,158*	*3,372*	*3,572*
PV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sub-Total	11,226	12,226	13,226	13,626	14,026	14,426	14,826	15,226	15,626	16,026
PV of Sub-Total	*10,899*	*11,524*	*12,104*	*12,107*	*12,099*	*12,081*	*12,055*	*12,020*	*11,976*	*11,925*
TOTAL	11,226	378,310	891,811	1,624,351	2,341,942	3,089,450	3,821,990	4,554,540	5,287,089	6,019,639
PV of Total	10,899	356,591	816,132	1,443,220	2,020,182	2,587,353	3,107,622	3,595,399	4,052,131	4,479,153

EXHIBIT 7 - (Continued)

Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	TOTAL
5,979,073	6,628,972	7,278,871	7,928,771	8,578,670	9,098,589	9,618,509	10,138,428	10,528,367	10,918,307	111,457,717
4,319,402	4,649,428	4,956,547	5,241,869	5,506,305	5,669,877	5,819,390	5,955,211	6,004,117	6,045,139	74,017,860
541,490	600,348	659,205	718,063	776,920	824,006	871,092	918,179	953,493	988,808	10,094,078
391,183	421,072	448,886	474,726	498,674	513,488	527,028	539,329	543,758	547,473	6,703,368
										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	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	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
										0
0	0	0	0	0	0	0	0	0	0	0
6,520,563	7,229,320	7,938,076	8,646,833	9,355,590	9,922,596	10,489,601	11,056,606	11,481,861	11,907,115	121,551,795
4,710,585	5,070,500	5,405,433	5,716,594	6,004,979	6,183,365	6,346,418	6,494,540	6,547,875	6,592,612	80,721,228
										0
0	0	0	0	0	0	0	0	0	0	0
215,039	238,412	261,786	285,160	308,534	327,233	345,932	364,631	378,655	392,679	3,993,639
155,348	167,218	178,263	188,525	198,035	203,918	209,295	214,180	215,939	217,415	2,649,163
										0
0	0	0	0	0	0	0	0	0	0	0
161	171	190	209	218	228	237	256	266	266	2,874
116	120	129	138	140	142	143	150	151	147	1,920
										0
0	0	0	0	0	0	0	0	0	0	0
215,200	238,583	261,976	285,368	308,752	327,460	346,169	364,887	378,920	392,945	3,996,513
155,465	167,337	178,392	188,663	198,175	204,060	209,439	214,331	216,091	217,562	2,651,083
11,226	11,226	11,226	11,226	11,226	11,226	11,226	11,226	11,226	11,226	224,520
8,110	7,874	7,644	7,422	7,206	6,996	6,792	6,594	6,402	6,215	167,014
5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	78,200
3,612	3,507	3,405	3,306	3,209	3,116	3,025	2,937	2,851	2,768	54,765
										0
0	0	0	0	0	0	0	0	0	0	0
										0
0	0	0	0	0	0	0	0	0	0	0
16,226	16,226	16,226	16,226	16,226	16,226	16,226	16,226	16,226	16,226	302,720
11,722	11,381	11,049	10,727	10,415	10,111	9,817	9,531	9,253	8,984	221,780
6,751,989	7,484,129	8,216,278	8,948,428	9,680,568	10,266,282	10,851,996	11,437,719	11,877,007	12,316,285	125,851,028
4,877,772	5,249,218	5,594,875	5,915,985	6,213,569	6,397,536	6,565,674	6,718,402	6,773,219	6,819,158	83,594,091

APPENDIX A - Abbreviated Injury Scale

Revised: 30 January 2004

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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 (formally 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 multiply-injured patients.

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

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[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.

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 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 1injury 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 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 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.

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[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 Safety Administration and the Centers for Disease Control) 1989, p.71.

[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.

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

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 $3.0 Million for the value of life per 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. $3.0 Million) times the "fraction of life value." The monetary value of AIS 1 through 5, are $6,000; $46,500; $172,500; $562,500; and $2,287,500; 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 - B

Accident Data Collection and Analysis & Benefit Assessment

Revised: 2 November 2000 C:\wpdata\...\Data-ben-assmnt-Appndx-1.wpd

The Federal Railroad Administration (FRA) conducted research on the crashworthiness of locomotives in different accident scenarios. This research was conducted to support the efforts of the FRA's Railroad Safety Advisory Committee (RSAC) which was established to provide advice and recommendations to the FRA on railroad safety matters. The RSAC established the Locomotive Crashworthiness Working Group to address potential locomotive crashworthiness features.

The Locomotive Crashworthiness Working Group established the Data Analysis & Benefit Assessment Task Force to conduct a review of past accidents. This collection and review of accidents provides the basis of a data set of potential accidents which could have been mitigated by the proposed features in the NPRM.

The purpose of this appendix is to provide a detailed description of the data/accident collection, review and analysis, and benefit assessment process for these accidents. Rather than providing a detail description of the work performed by the task force, this document provides the details of how the data collection and review, and the benefit assessment of each accident were conducted. In addition, it provides an explanation of additional steps which were necessary to complete the economic analysis which the FRA conducted independently.

Data Collection and Review

In order to ensure the collection of all relevant accidents, the initial data query screened out very few accidents from the data set of all accidents for the selected time period of 1995, 1996, and 1997. "Explosion-detonation," and "Fire/violent rupture" accident types were removed from the data set. In addition, accidents which involved Type of Equipment Consist of "Single Car," "Cut of cars," and "Maint/inspection car" were also removed.[1] In total, two mutually exclusive data queries were run from FRA's accident database. The first one contained all accidents which involved a locomotive that derailed, and had equipment damage equal to or greater than $10,000, or involved a casualty. The second query involved accidents which involved a locomotive that did not derail.[2]

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[1] "Type of Accident/Incident" is block 7 on Form FRA F 6180.54, and "Type of Equipment Consist" is block 25.

[2] This data query was so large that it was further narrowed down in size. For accidents with equipment damage greater than $50,000, all accidents were reviewed. However for

The Task Force reviewed the set of potential accidents from each data query. Accidents which were categorized as "derailments," "obstruction," and "other impacts" were included in the data set reviewed by the Task Force. The hand review of such categorized accidents ended up being advantageous since some of the accidents were actually rear-end, and side collisions which could potentially be mitigated by the proposed features.

Accidents were reviewed to ensure that they could fit into one of the six scenarios chosen by the Working Group. Accidents where the locomotive did not strike an object were removed, and some others were removed because of excessively low speeds. The narrative block from the accident report, and any information from a casualty report or highway-rail crossing report assisted in the review. In general the accidents were analyzed to determine what, if any, affect the proposed features would have on the accident scenario if it were to be repeated, but with a new crashworthy locomotive. In the end the review of the data queries reduced the data set of accidents to 286 for the specified time period.[3]

Type of Accident or equivalent	Number for Time Period
Head-on	23
Rear-end	35
Side/oblique/raking	42
Highway-rail	149
Other	37
Fuel Tank Integrity Only[4]	22
Fuel Tank Integrity - Total[5]	68

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accidents where the equipment damage was between $10,000 and $50,000, only accidents which included a casualty were selected for review.

[3] The final data/accident set can be referenced in EXHIBIT B-1.

[4] Twenty-two accidents were found to have fuel tank integrity issues, but no crashworthy mitigation potential. This could be because of lack of sufficient information on the accident or because it was a true derailment.

[5] Forty-six accidents out of the 286 were found to also have fuel tank integrity issues. Thus, a total of 68 accidents were found to have fuel tank integrity issues.

Injury Severity Assessment

In order to assess potential injury severity mitigation the FRA independently estimated the severity for all pertinent injuries. FRA utilized the Abbreviated Injury Scale (AIS) to provide ratings for injury severities. This scale utilizes 6 levels of severity, with the first being a minor injury and the sixth level being a fatality.[6]

To estimate the severity of each injury the FRA considered numerous factors. First, the type or description of the injury was reviewed. To assist in estimating the severity of an injury the number of lost work days were reviewed. Because of the limited information available from most accidents, this number provided some assistance in being a surrogate for severity. Finally, the location of an injury was also utilized to assist in estimating severity. The AIS bases the levels of severity on their likelihood of being a fatality. Thus, major injuries to the head and/or torso were estimated to be more severe. In general FRA tended to rate the severity of these injuries more conservatively with lower AIS levels. One reason for this was lack of information, and the use of vague or unspecific injury descriptors on the casualty reports. It is important to note that only injuries that occurred to locomotive cab crew members were considered to be valid, and potentially mitigated in this assessment and the Regulatory Impact Analysis (RIA). This means no injuries or fatalities of passengers on trains, occupants of highway vehicles, or operators of other rail equipment were considered to be potentially mitigated by this rule. This also includes members of locomotive crews that were not involved in the collision. In other words, locomotive crew members which are injured on a train that is rear-ended by the locomotive of another train were not considered to be relevant because that locomotive was not involved in the actual collision.

AIS Level	Descriptor	Number of Injuries[7]
AIS - 1	Minor	182
AIS - 2	Moderate	97
AIS - 3	Serious	10
AIS - 4	Severe	0
AIS - 5	Critical	0
AIS - 6	Fatality	26

Benefit Assessment

After the data set of the accidents where the severity could be mitigated was established, the Task Force reviewed each accident to assess the potential benefit. The accidents were reviewed and assessed as to the potential benefit the improved crashworthy features would provide in the same

[6] Please refer to Appendix A for further explanation on the AIS and its use.

[7] Total number of injuries for each AIS level for the entire time period, i.e., 1995, 1996 and 1997.

scenario. Each accident was then assessed as either "maximum" potential benefit, "medium" potential benefit, "minimum" potential benefit, or "no" potential benefit. In addition, some accidents were kept in the data set and labeled "unknown," with expectations that additional information could be found to fully assess them.

Numerous factors were utilized to determine the benefit assessment rating for each accident. One consideration that was looked at, was how well the accident fit the scenarios that the research and modeling had been focused on to determine the requirements for the proposed features. The benefit assessment rating was assessed at a higher level if the affected locomotive was pre-S580 (1989) in design. The logic here was that the S580 (1989) designed locomotives were already accruing a certain level of benefits, and therefore the marginal increase in potential benefits is less. Additional factors which were considered in the assessment of potential benefits included the closing speed for the accident, and the severity of the casualties. Low closing speeds or closing speeds which were extremely high, were assessed with a lower benefit assessment. The logic in this case was that such scenarios were at the edge or outside of the window of maximum mitigation available from the ability of the equipment to absorb energy loads without collapsing. Finally, additional information such as the number of cars, the total tonnage, the number of cars derailed, and the total equipment damages were also looked at when determining a benefit assessment.

Benefit Assessment Level	Number of Accidents[8] With This Rating
Maximum	35
Medium	81
Minimum	116
None	43
Unknown[9]	11

It is important to note that during the data review, analysis and benefit assessment process numerous reports and information were utilized. In addition to the Rail Equipment Accident/Incident Report, casualty reports, and highway-rail crossing reports were reviewed. Where pertinent FRA investigations, locomotive crashworthiness reports, and NTSB investigations were utilized. Finally, for some accidents additional information was provided by the relevant railroad(s).

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[8] Number does not include accidents with only breached fuel tank potential.

[9] Accidents with a benefit rating of "unknown" are assessed with zero benefits in the calculation of all benefit assessments.

EXHIBIT B - 1.1

1997 Revised: 18 October 2000

Date	Type of Acc /Collision	Locomotive Type	1st Loco Year	Speed (Closing)	Injuries	Days Absnt	Fatalities	Egress/ Jumped	Fuel Spill	Benefits Assessed
Mar. 4 97	Derailmnt	SD-50	1984	19	2	98	0		No	Minimum
Nov. 3 97	Derailmnt	SD40-2	1976-71	10	0	0	0		No	None
Feb. 15 97	RR Xing	GP40-2	1972	20	1	74	0		No	Minimum
Mar. 13 97	Head on	GP40-2	1972	15	1	27	0		No	Minimum
May 14 97	Head on	GP40	1968	23	2	24	0		Yes	Medium
Jun. 22 97	Head on	SD60	1986	61	2	334	2	Jumped	Yes	None
Aug. 20 97	Head on	Dash8-40C	1986	58	1	237	2		Yes	Medium
Oct. 23 97	Head on	Dash8 -40C	1992	18	1	132	0	Jumped	Yes	Maximum
Oct. 25 97	Head on	Dash8 -39B	1987	13	4	473	0	Jumped	Yes	Maximum
Jun. 7 97	Rear end	SD40-2	1981	31	2	110	1		No	Maximum
Aug. 31 97	Rear end	SD90/43MAC	1997	23	2	53	0		Yes	Minimum
Aug. 23 97	Rear end	C44AC	1997	22	2	249	0		Yes	Minimum
Sep. 29 97	Rear end	GP40-2	1977	29	0	0	1	Jumped	Yes	Maximum
Oct. 9 97	Rear end	C30-7	1979	24	2	12	0		No	Medium
Oct. 29 97	Rear end	SD40-2	1979	25	0	0	0		Yes	Medium
Nov. 22 97	Hd on/r.end	SSB	1953	9	2	29	0		No	Minimum
Nov. 3 97	Rear end	Dash9-44CW	1994	24	2	36	0	Jumped	No	Maximum
Feb. 5 97	Hgwy-rail	Dash8-P40B	1993	44	2	707	0		Yes	Medium
Feb. 14 97	Hgwy-rail	GP38-2	1980	18	3	365	0		No	None
Feb. 5 97	Hgwy-rail	GP16	1981	20	0	0	0		No	Minimum
Mar 21 97	Hgwy-rail	DASH8-40C	1989	49	3	297	0		No	Medium
Apr 11 97	Hgwy-rail	Dash8-40C	1992	49	0	0	0		Yes	Medium
Jul. 12 97	Hgwy-rail	B36-7	1985	3	2	130	0		No	Minimum
Jul 9 97	Hgwy-rail	C36-7	1989	45	1	365	0	Jumped	No	Medium
Aug. 1 97	Hgwy-rail	GP30	old	23	0	0	0		No	Minimum
Aug. 24 97	Hgwy-rail	C30-7	1981	30	2	196	0		No	Medium
Sep. 15 97	Hgwy-rail	Dash8-P40B	1993	76	1	142	0		No	Maximum
Oct. 9 97	Hgwy-rail	Dash8-P40B	1993	75	2	14	0		No	None
Oct. 13 97	Hgwy-rail	SD40-2	1974	49	3	192	0		No	*Unknown*
Oct. 21 97	Hgwy-rail	SD40-2	1979	23	1	93	0		No	Medium
Nov. 3 97	Hgwy-rail	Dash9-44CW	1994	35	1	60	0		No	*Unknown*
Nov. 19 97	Hgwy-rail	GP7M	1976	30	2	10	0		No	Medium
Nov. 9 97	Hgwy-rail	GP60	1991	36	0	0	0		No	Minimum
Nov. 4 97	Hgwy-rail	GP50	1980	62	2	148	0		No	Medium
Apr. 26 97	Derailment	SD40-2P	1972-76	40	0	0	0		No	Medium
May 13 97	Obstruction Imp	Dash8-40CW	1991	30	1	46	0		No	Minimum
Jul. 31 97	Side/Raking	SD-60	1989	42	2	160	0		Yes	Maximum
Jul. 21 97	Side Collsn	SD40-2	1977	13	1	70	0		Yes	Maximum
Aug. 24 97	Side Collsn	SD40	1966-71	5	0	0	0		Yes	Medium
Dec. 14 97	RR Xing	Dash8-41CW	1990	13	1	0	0	Jumped	Yes	Maximum
Mar. 14 97	*Derailment*	*GP40*	*1971*	*55*	*0*	*0*	*0*		*Yes*	*Maximum*
Apr. 28 97	*Derailmnt*	*SD40-2*	*1978*	*45*	*0*	*0*	*0*		*Yes*	*Maximum*
Apr. 13 97	*Derailment*	*SD60I*	*1994*	*5*	*0*	*0*	*0*		*Yes*	*Unknown*
May 2 97	*Derailment*	*Dash9-40CW*	*1997*	*38*	*0*	*0*	*0*		*Yes*	*Maximum*
Oct. 21 97	*Derailment*	*F3*	*1977*	*2*	*0*	*0*	*0*		*Yes*	*Maximum*
Oct. 28 97	*Side Collsn*	*GP60*	*1991*	*4*	*0*	*0*	*0*		*Yes*	*Maximum*

Accidents utilized only for fuel tank related issues are in italics.

EXHIBIT B - 1.2

1997 (Continued)

Date	Type of Acc /Collision	Locomotive Type	1st Loco Year	Speed (Closing)	Injuries	Days Absnt	Fatalities	Egress/ Jumped	Fuel Spill	Benefits Assessed
Jan. 15 97	Derailment	SD40-2	1980	25	1	45	0		No	Minimum
Apr. 24 97	Obstrctn Impct	Dash9-44CW	1994	60	0	0	0		No	Minimum
Aug. 29 97	Other Impacts	MK1500D	rebuild	6	0	0	0		No	None
Feb. 5 97	Rear End Cllsn	C36-7	1979	13	0	0	0		No	Minimum
Jul. 8 97	Rear End Cllsn	Alco RS20M	1975	10	1	0	0		No	Minimum
Jul. 10 97	Rear End Cllsn	GP9E	1956	18	2	10	0		No	Minimum
Jan. 27 97	Hgwy-rail	F59H	1993 ?	75	0	0	0		No	Minimum
Feb. 17 97	Hgwy-rail	Dash8-P40B	1993	79	0	0	0		No	Minimum
Apr. 28 97	Hgwy-rail	F59PHI	1994	75	0	0	0		No	Minimum
Jun. 26 97	Hgwy-rail	GP30	1963	55	0	0	0		No	Minimum
Aug. 1 97	Hgwy-rail	C36-7	1985	69	0	0	0		??	Minimum
Aug. 27 97	Hgwy-rail	Dash9-40CW	1996	43	1	180	0		No	Medium
Aug. 31 97	Hgwy-rail	F59PHI	1994	79	0	0	0		No	Minimum
Sep. 27 97	Hgwy-rail	Dash8-40C	1987	40	2	68	0		No	Maximum
Sep. 29 97	Hgwy-rail	Dash9-P42B	1997	68	1	9	0		No	Minimum
Oct. 17 97	Hgwy-rail	Dash8-40CW	1992	45	0	0	0		No	Minimum
Nov. 14 97	Hgwy-rail	AC4400CW	1995	38	0	0	0		No	Minimum
Nov. 15 97	Hgwy-rail	Dash8-40CW	1991	60	2	146	0		No	Minimum
Dec. 16 97	Hgwy-rail	AC4400CW	1996	46	0	0	0		No	Minimum
Dec. 30 97	Hgwy-rail	Dash9-P42B	1997	79	2	6	0		No	Minimum
Jan. 5 97	Side Collsn			15	1	0	0		No	Minimum
Apr. 19 97	Side Collsn	SD42L	1979	13	0	0	0		No	Minimum
Jul. 2 97	Side Collsn	SD40-2	1979	73	1	0	1		Yes	Maximum
Nov. 25 97	Side Collsn	GP40-2	1972	5	0	0	0		No	Minimum
Feb. 21 97	Rear End Cllsn	SD45T-2	1987	18	2	702	0	Jumped	No	Medium
Nov. 2 97	Rear End Cllsn	GP40-2	1975	13	1	96	0		No	Medium
Jan. 9 97	Hgwy-rail	F59PHI	1994	79	0	0	0		No	None
Jan. 18 97	Hgwy-rail	Dash8-P40B	1993	79	0	0	0		No	Minimum
Feb. 3 97	Hgwy-rail	F40PH	1976-81	40	0	0	0		No	None
Feb. 5 97	Hgwy-rail	SD40-2	Rebuild	42	0	0	0		No	None
Feb. 15 97	Hgwy-rail	Dash9-P42B	1997	59	1	9	0		No	Minimum
Mar. 20 97	Hgwy-rail	SD60	1986	41	0	0	0		No	None
Mar. 25 97	Hgwy-rail	ATLO 839		54	0	0	0		No	None
Apr. 1 97	Hgwy-rail	Dash9-P42B	1996	75	2	18	0		No	Minimum
Apr. 6 97	Hgwy-rail	SD40-2	1981	45	0	0	0		No	None
Apr. 29 97	Hgwy-rail	OLD		20	0	0	0		No	None
May 9 97	Hgwy-rail	Dash8-40CW	1990	40	0	0	0		No	Minimum
May 15 97	Hgwy-rail	SD70 Mac	1995	48	0	0	0		No	Minimum
Jun. 3 97	Hgwy-rail	Dash8-P40B	1993	60	0	0	0		No	Minimum
Jun. 11 97	Hgwy-rail	Dash8-40BW	???	60	0	0	0		No	Minimum
Jul. 3 97	Hgwy-rail	GP40-2	1972-93	43	1	53	0		No	Medium
Jul. 26 97	Hgwy-rail	Dash8-40B	1989	40	1	111	0		No	Medium
Aug. 14 97	Hgwy-rail	Dash8-P40B	1993	48	2	132	0		No	Medium
Sep. 10 97	Hgwy-rail	Dash8-41CW	1991	30	1	200	0		No	Medium
Sep. 24 97	Hgwy-rail	C36-7	1985	42	1	365	0		No	Medium
Oct. 1 97	Hgwy-rail	SD-60	1986	47	1	141	0		No	Medium
Oct. 9 97	Hgwy-rail	GP40	1971-66	27	0	0	0		No	None
Oct. 14 97	Hgwy-rail	Dash8-P40B	1993	70	0	0	0		No	Minimum
Oct. 27 97	Hgwy-rail	GP40-2	1978	35	0	0	0		No	None
Nov. 10 97	Hgwy-rail	SD40-2	1978	40	1	140	0		No	Medium
Nov. 11 97	Hgwy-rail	Dash8-P40B	1993	59	1	34	0		No	Minimum
Dec. 13 97	Hgwy-rail	SD42-L	1979	50	1	41	0		Yes	Medium
Nov. 29 97	Side Collsn	GP38-2L	1972	??	1	30	0		No	Minimum

EXHIBIT B - 1.3

1996

Revised: 19 October 2000

Date	Type of Acc /Collision	Locomotive Type	1st Loco Year	Speed (Closing)	Injuries	Days Absnt	Fatalities	Egress/ Jumped	Fuel Spill	Benefits Assessed
Jan. 19 96	Derailmnt	GP7	1950-52	25	3	295	0		No	Minimum
Jan. 12 96	Derailmnt	GP38-2	1979	40	2	126	0	Jumped	No	NONE
Feb. 01 96	Derailmnt	GP60M	1990	45	1	363	2	Jumped	Yes	Minimum
Feb. 08 96	Other impct	GP38-2	1972-74	40	2	281	0		No	Minimum
Feb. 21 96	Derailmnt	AC4400CW	1995	68	1	365	2		No	NONE
Feb. 09 96	Derailmnt	GP50L	1985	30	2	134	0		No	Minimum
Mar. 29 96	Obstrct Imp.	SD70-MAC	1996	48	0	0	0		No	Minimum
Mar. 22 96	Derailmnt	SD60	1989	45	0	0	0		No	*Unknown*
Mar. 15 96	Obstrctn Imp.	Dash8-40C	1990	24	3	172	0		No	*Unknown*
Apr. 23 96	Obstrctn Imp.	Dash8-P40B	1993	79	0	0	0		No	Minimum
Apr. 21 96	Derailmnt	GP38	1971	23	1	59	0		No	Medium
Jun. 26 96	Derailmnt	Unknown		5	1	56	0		No	*Unknown*
Jul. 22 96	Derailmnt	SD40T-2	1979	30	1	279	0		No	Minimum
Dec. 29 96	Derailmnt	SD40-3	1996	12	1	50	0		No	Minimum
Feb. 14 96	Head on	Dash8-39B	1987	47	3	506	0	Jumped	Yes	Medium
May 24 96	Head on	SD60M	1993	22	4	578	0	Jumped	Yes	Medium
Jul. 12 96	Head on	SD42L	1979	28	3	221	0	Jumped	Yes	Maximum
Jul. 02 96	Head on		old	12	2	0	0		No	Medium
Aug. 20 96	Head on	AC4400CW	1994	45	2	730	2		Yes	Medium
Oct. 04 96	Head on	Dash8-39B	1985	47	3	209	0	Jumped	Yes	Maximum
Oct. 11 96	Rear End	DASH9-44CW	1994	15	2	450	0		Yes	Medium
Oct. 11 96	Side/Raking	DASH9-44CW	1993	15					Yes	Medium
May 29 96	Rear End	GP10	1968-74	24	2	99	0	Jumped	No	Maximum
Dec. 13 96	Rear End	AC4400CW	1996	22	0	0	0		No	Minimum
Jan. 16 96	High-Rail	F40PH	1987-88	49	2	66	0		Yes	Medium
Apr. 23 96	High-Rail	SD45-2	1966	50	1	66	0		Yes	Maximum
Apr. 23 96	High-Rail	GP50(??)	1980(??)	40	1	252	0		No	Maximum
Jun. 26 96	High-Rail	AC4400CW	1995	40	0	0	0		No	Minimum
Jun. 14 96	High-Rail	GP35M	1964	16	1	16	0		No	Medium
Jul. 17 96	High-Rail	GP59	1989	18	0	0	0		Yes	Medium
Aug. 12 96	High-Rail	Unknown		20	0	0	0		No	Minimum
Aug. 27 96	High-Rail	F40PH	1976-81	57	0	0	0		No	Minimum
Aug. 07 96	High-Rail	GP40-2	1982	39	2	12	0		No	Medium
Sep. 09 96	High-Rail	SD40-2	1978	54	1	113	0		No	Maximum
Sep. 24 96	High-Rail	B-36-7	1985	67	1	135	1		No	Maximum
Sep. 10 96	High-Rail	GP38-2L	1976	40	2	357	0		No	Minimum
Nov. 26 96	High-Rail	B30-7	1980	15	2	156	0		No	Minimum
Apr. 29 96	Raking Collsn	SD60-I	1994	55	2	84	0		No	Minimum
May 29 96	Raking Collsn	SD40-2	1971-76	9	1	114	0		No	Minimum
May 23 96	Side//Raking	GP38-2	1974	40	1	257	0		No	Maximum
Jun. 25 96	Obstrctn Imp.	M420R	1974-75	13	1	7	0		No	Minimum
Feb. 09 96	Side Collsn	GP40PH-2A	1993	71	1	57	2		Yes	Medium
Apr. 12 96	Side Collsn	GP10	1971-77	37	2	98	0		Yes	Maximum
Jul. 19 96	Side Collsn	DASH8-40-CW	1990	36	1	61	0		Yes	Minimum
Oct. 07 96	Side Collsn	GP60	1993	20	0	0	0		No	Minimum
Jan. 13 96	*Other Imp.*	*C30-7*	*1978*	*0*	*0*	*0*	*0*		*Yes*	*Maximum*
Feb. 16 96	*Side Collsn*	*F40PH*	*1976-81*	*30*	*N/A*	*N/A*	*N/A*		*Yes*	*Maximum*
Feb. 06 96	*Derailmnt*	*SD40-2*	*1980*	*60*	*N/A*	*N/A*	*0*		*Yes*	*Maximum*
Feb. 18 96	*Derailmnt*	*SD45*	*1967-71*	*26*	*0*	*0*	*0*		*Yes*	*Medium*
Jun. 08 96	*Derailmnt*	*SD40-3*	*Rebuild*	*18*	*0*	*0*	*0*		*Yes*	*Maximum*
Aug. 30 96	*Rear End Cllsn*	*SD45-2*	*1982*	*15*	*0*	*0*	*0*		*Yes*	*Maximum*
Sep. 09 96	*Derailmnt*	*GP38*	*Unknown*	*35*	*0*	*0*	*0*		*Yes*	*Maximum*
Oct. 29 96	*Other Imp.*	*GP11*	*1979-81*	*2*	*0*	*0*	*0*		*Yes*	*Maximum*
Dec. 18 96	*Derailmnt*	*FP45*	*1982-83*	*47*	*0*	*0*	*0*		*Yes*	*Maximum*

EXHIBIT B - 1.4

1996 (Continued)

Date	Type of Acc /Collision	Locomotive Type	1st Loco Year	Speed (Closing)	Injuries	Days Absnt	Fatalities	Egress/ Jumped	Fuel Spill	Benefits Assessed
Jan. 26 96	Other Imp	GP38-2	1973	15	1	45	0		No	Minimum
Mar. 27 96	Obstrct. Imp.	????	???	50	0	0	0		No	Unk/none
Apr. 30 96	Derailment	GP39M	1990	38	1	160	0		No	Minimum
Jun. 29 96	Obstrct. Imp.	B36-7	1983	45	0	0	1	Egress	No	Maximum
Jun. 21 96	Head-on Cllsn	Dash8-40C	1990	20	0	0	0		No	Minimum
Jan. 31 96	Rear End Cllsn	SD50	1985	32	0	0	0		No	Minimum
Apr. 19 96	Rear End Cllsn	GP40L	1968-69	22	2	220	0	Jumped	No	Maximum
Aug. 23 96	Rear End Cllsn	SD60M	1993	25	0	0	0		No	Minimum
Jan. 18 96	Hgwy-rail	GP40M	1988	50	1	121	0		No	Medium
Feb. 25 96	Hgwy-rail	F40PH	1976-81	70	0	0	0		No	Minimum
Mar. 6 96	Hgwy-rail	GP40	1971	42	0	0	0		No	Minimum
Mar. 18 96	Hgwy-rail	Dash8-P32BWH	1991	74	1	90	0		Yes	Max->Fuel, Med->other
Apr. 9 96	Hgwy-rail	Dash9-44CW	1994	35	1	127	0		No	Medium
May 23 96	Hgwy-rail	F59PH	1992	79	0	0	0		No	None
Jun 4 96	Hgwy-rail	B36-7	1985	35	0	0	0		No	Minimum
Jun 20 96	Hgwy-rail	SD40-2	Rebuild	58	1	60	0		No	Maximum
Aug. 29 96	Hgwy-rail	GP40-2	1980	50	0	0	0		No	Minimum
Sep. 12 96	Hgwy-rail	AC4400CW	1995	50	2	405	0		No	Minimum
Sep. 24 96	Hgwy-rail	Dash8-40CW	1991	45	1	45	0		No	Medium
Jan. 8 96	Oblique Cllsn	Dash8-40CW	1993	59	0	0	0		No	Minimum
Apr. 6 96	Raking Cllsn	SD40-2	1978	44	0	0	0		No	None
Mar. 24 96	Obstrct. Imp.	F40PH	1976-81	79	0	0	0		No	None
Jul. 23 96	Other Impct	GP39-2	1981	12	1	36	0		No	Unknown
Mar. 8 96	Rear-End	GP38-2	1973	20	1	60	0		No	Minimum
May 17 96	Rear-End	SD40M	Rebuild	18	1	346	0		No	Medium
Feb. 13 96	Hgwy-rail	Unknown	ATLO	69	0	0	0		No	Unk/None
Mar. 5 96	Hgwy-rail	Dash8-P40B	1993	70	0	0	0		No	None
Mar. 26 96	Hgwy-rail	GP35	1965	39	1	308	0		No	Medium
Apr. 30 96	Hgwy-rail	Dash9-44CW	1994	35	0	0	0		No	None
Jul. 5 96	Hgwy-rail	SD40T-2	1979	57	2	592	0		No	Medium
Jul. 18 96	Hgwy-rail	Unknown	???	60	1	9	0		No	Unknown
Sep. 3 96	Hgwy-rail	Dash8-P32BWH	1991	60	1	60	0		No	Minimum
Sep. 5 96	Hgwy-rail	SD40-2	1966-71	18	0	0	0		No	None
Sep. 7 96	Hgwy-rail	Dash8-P40B	1993	78	0	0	0		No	None
Sep. 11 96	Hgwy-rail	GP50	1980	40	1	0	0		No	Minimum
Sep. 18 96	Hgwy-rail	F40PH	1976-81	78	0	0	0		No	Minimum
Oct. 2 96	Hgwy-rail	SD60M	1989	47	0	0	0		No	Minimum
Oct. 5 96	Hgwy-rail	GP40	1978	33	0	0	0		No	Minimum
Oct. 8 96	Hgwy-rail	Dash8-P40B	1993	30	2	90	0		No	Minimum
Oct. 31	Hgwy-rail	SD40-2	1980	29	0	0	0		No	Minimum
Nov. 15 96	Hgwy-rail	GP59	1986	59	2	340	0		No	Medium
Dec. 5 96	Hgwy-rail	F40PH	1976-81	79	0	0	0		No	Minimum
Dec. 5 96	Hgwy-rail	SD40-2	1973	45	1	0	0		No	Minimum
Dec. 8 96	Hgwy-rail	SD45T-2/B	1973	58	0	0	0		No	Minimum
Jul. 31 96	Side Collsn	SW1500	1968-73	6	1	104	0		No	Medium

EXHIBIT B - 1.5

1995 Revised: 19 October 2000

Date	Type of Acc /Collision	Locomotive Type	1st Loco Year	Speed (Closing)	Injuries	Days Absnt	Fatalities	Egress/ Jumped	Fuel Spill	Benefits Assessed
24 Jan. 95	Head on	GP40	1970	29	3	124	0	Jumped	Yes	Maximum
30 Jan. 95	Head on	Dash8-39C	1986	45	5	258	0	Jumped	Yes	Maximum
12 Jan. 95	Head on	Dash8-40CW	1989	50	3	330	1	Jumped	No	Maximum
21-May-95	Head on	Dash8-40CW	1990	22	1	0	0		No	Minimum
5 Aug. 95	Head on	GP7	1979	30	1	0	0		No	Minimum
7 Nov. 95	Head on	??		10	0	0	0		No	None
13-Jan-95	Obstrctn Imp	GP20	1955-53	40	2	730	0		N	Maximum
10 Mar. 95	Rear End	GP40-2		13	2	0	0		No	None
6 Mar. 95	Rear End	Dash9-43CW	1993	38	2	100	0	Jumped	Yes	Medium
27 Apr. 95	Rear End	GP38	1969	36	1	248	2		Yes	Maximum
25 May. 95	Rear End	Dash9-44CW	1994	17	2	107	0	Jumped	No	Medium
1 May. 95	Rear End	SD60M	1991	17	1	0	0		No	Minimum
6 Jun. 95	Rear End	GP38	1970	27	0	0	0		No	Medium
8 Aug. 95	Head on	GP38-2	1974-83	9	1	6	0		No	Minimum
14 Oct. 95	Rear End	SD60M	1986	22	0	0	0	Jumped	No	Medium
18 Nov. 95	Rear End	Dash8-41CW	1991	46	2	240	1	Jumped	Yes	Medium
22 Dec. 95	Raking	Dash8-40CW	1994	63	3	170	3		Yes	Medium
30 Dec. 95	Rear End	Unknown		5 (?)	1	0	0		No	*Unknown*
7 Feb. 95	High-rail	GP38-2	1973	18	1	89	0		No	Medium
11 Mar. 95	High-rail	SD40-2	1973	50	0	0	0		No	Minimum
8 Mar. 95	High-rail	GP38-2	1974	35	4	212	0		Yes	Minimum
2 Mar. 95	High-rail	F40-PH	1976 - 81	79	0	0	0		No	None
10 May. 95	High-rail	Dash8-32B	1989	42	2	255	0		No	Minimum
18-Jun-95	High-rail	Dash8-39B	1987	47	0	0	0		No	Minimum
7 Aug. 95	High-rail	GP38-2	1979	25	3	105	0		Yes	Maximum
30 Aug. 95	High-rail	SD40-2	1974-78	38	0	0	0		No	Minimum
22 Sep. 95	High-rail	Dash8-40BW	1992	48	1	0	0		No	Minimum
12 Sep. 95	High-rail	GP35	1978-85	15	0	0	0		No	None
29 Sep. 95	High-rail	GP40	1970	38	2	4	0		Yes	Medium
27 Oct. 95	High-rail	GP28M	1992	40	1	64	0		No	Medium
16 Oct. 95	High-rail	SD9	1952-55	18	2	33	0		No	Maximum
29 Oct. 95	High-rail	C30-7	1979-80	40	1	358	0		No	Medium
7 Dec. 95	High-rail	GP40-2P	1994	40	1	13	0		No	Minimum
20 Jan. 95	Side Collsn	GP-7	1969-81	36	1	0	0		N	None
14 Jan. 95	Side Collsn	GP40-2	1972-93	10	1	253	0		N	Medium
14 Feb. 95	Side Collsn	SD40-M	1968	25	0	0	0		N	Minimum
8-Apr-95	Side Collsn	SD50	1986	45	2	64	0		N	Medium
8-May-95	Side Collsn	Dash8-40CW	1993	51	3	454	0		N	Medium
15-Jun-95	Side Collsn	SW1500	1968-70	5	0	0	0		Yes	Medium
27-Jun-95	Side Collsn	SD40-2	1972-75	23	1	125	0		N	Medium
13-Aug-95	Side Collsn	C30-7	1980	26	2	30	0	Jumped	Yes	Medium
13-Oct-95	Side Collsn	Dash8-40CW	1993	68	4	1222	0		N	Maximum
5-Oct-95	Side Collsn	GP39-2	1975-77	5	1	197	0		N	Minimum
2-Oct-95	Side Collsn	SD70-MAC	1995	35	2	113	0	Jumped	Yes	Minimum
20-Dec-95	Side Collsn	Dash8-40CW	1990	93	2	365	1		Yes	Medium
8-Jan-95	*Obstrctn Imp*	*GP38-2*	*1973*	*35*	*N/A*	*N/A*	*0*		*Yes*	*Maximum*
18-May-95	*Derailment*	*SD40-2*	*1976*	*28*	*0*	*0*	*0*		*Yes*	*Maximum*
7-Aug-95	*Derailment*	*OLD*		*12*	*0*	*0*	*0*		*Yes*	*Minimum*
17-Aug-95	*Derailment*	*SD45-2*	*1969*	*2*	*0*	*0*	*0*		*Yes*	*Maximum*
10-Sep-95	*Derailment*	*SD40*	*1980-81*	*10*	*0*	*0*	*0*		*Yes*	*Maximum*
16-Nov-95	*Derailment*	*GP38AC*	*1971*	*10*	*0*	*0*	*0*		*Yes*	*Maximum*
20-Nov-95	*Derailment*	*MP15AC*	*1975*	*7*	*0*	*0*	*0*		*Yes*	*Maximum*
18-Jan-95	Obstrctn Imp	SD40-2	1978	35	1	0	0		N	None
20-Mar-95	Derailment	Dash8-40C	1987	48	2	422	0		N	Minimum
14-Apr-95	Obstrctn Imp	SD60M	1992	25	2	150	0		N	None
17-May-95	Derailment	GP38	1970	35	1	65	0		N	None
14-May-95	Derailment	Unknown		35	0	0	0		N	*Unknown*
19-Jul-95	Obstrctn Imp	F40PH	1976-81	40	0	0	0		N	Medium
2-Jul-95	Obstrctn Imp	Unknown		40	0	0	0		N	Minimum
29-Jul-95	Derailment	SD40-2	1979	40	3	90	0		N	Medium
15-Oct-95	Derailment			5	1	20	0		N	Minimum
8-Dec-95	Derailment	SD40-2	1976-71	8	1	45	0		N	*Unknown*

EXHIBIT B - 1.6

1995 (Continued)

Date	Type of Acc /Collision	Locomotive Type	1st Loco Year	Speed (Closing)	Injuries	Days Absnt	Fatalities	Egress/ Jumped	Fuel Spill	Benefits Assessed
Jan. 9 95	Obstrctn Imp	C30-7	1979	45	2	575	0		No	Medium
Feb. 20 95	Other Imp	Dash8-40C	1992	49	0	0	0		No	Minimum
May 27 95	Head-on Cllsn	SD40-2	1972-83	23	0	0	0	Jumped	No	Medium
Jan. 17 95	Side Collsn	SD42E	1973	25	2	6	0		No	Medium
Feb. 15 95	Raking Collsn	F40PH	1976-81	58	2	361	0		No	Medium
Apr. 29 95	Raking Collsn	SW1001	1979	3	1	20	0		No	None
May 25 95	Side Collision	GP38-2	1981	51	1	194	0		No	Medium
Nov. 23 95	Oblique/Raking	TR4B	1950	8	0	0	0		No	None
Feb. 3 95	Hgwy-rail	Dash8-P40B	1993	99	1	74	0		No	Minimum
Feb. 24 95	Hgwy-rail	B23-7	1981	50	0	0	0		No	Minimum
Apr. 25 95	Hgwy-rail	GP40	1966	35	1	8	0		No	Medium
Apr. 28 95	Hgwy-rail	SD40-2	1966-71	30	0	0	0		No	Minimum
May 10 95	Hgwy-rail	SD40-2	1974	45	2	128	0		No	Medium
May 18 95	Hgwy-rail	GP40R	Rebuild	40	1	3	0		No	Medium
Jul. 12 95	Hgwy-rail	SD45-2	1986-88	49	0	0	0		No	Minimum
Jul. 19 95	Hgwy-rail	SD60M	1991	42	2	131	0		No	Minimum
Aug. 17 95	Hgwy-rail	SD40-2	1972	58	0	0	0		No	Minimum
Sep. 6 95	Hgwy-rail	F59PHI	1994	75	0	0	0		No	None
Sep. 21 95	Hgwy-rail	F40PH	1976-81	81	1	59	1		No	Maximum
Oct. 12 95	Hgwy-rail	Dash8-39B	1987	60	1	173	0		No	Medium
Oct. 19 95	Hgwy-rail	Unknown	???	30	0	0	0		No	Unknown
Nov. 14 95	Hgwy-rail	Dash8-40C	1989	48	0	0	0		No	Minimum
Dec. 7 95	Hgwy-rail	Dash8-40BW	1990	66	0	0	0		No	Minimum
Oct. 15 95	Rear-End Cllsn	SD40M	Rebuild	42	0	0	0		No	None
Nov. 24 95	Other Imp.	SD9	1970-89	8	2	2	0		No	None
Feb. 9 95	Head-on Cllsn	SD45	1982-85	11.3	1	32	0	Jumped	No	Minimum
Mar. 2195	Rear-End Cllsn	Dash8-39B	1987	10	1	173	0		No	Minimum
Dec. 2 95	Rear-End Cllsn	Dash9-44CW	1994	8	1	1	0		No	None
Jan. 16 95	Hgwy-rail	Dash8-39B	1987	45	0	0	0		No	Minimum
Feb. 4 95	Hgwy-rail	Dash8-40C	1987	35	0	0	0		No	Minimum
Feb. 13 95	Hgwy-rail	C30-7	1979	24	0	0	0		No	None
Mar. 20 95	Hgwy-rail	GP40-2	1978	50	3	264	0		No	Maximum
Mar. 24 95	Hgwy-rail	Dash8-40C	1992	42	2	160	0		No	Minimum
Apr. 20 95	Hgwy-rail	GP60	1991	54	0	0	0		Yes	Max->FT, Min->other
May 4 95	Hgwy-rail	SD40-2	1978	43	0	0	0		Yes	Max->FT, Med->other
May 22 95	Hgwy-rail	SD60M	1990	69	2	9	0		No	Minimum
May 25 95	Hgwy-rail	B23-7	1981	25	0	0	0		No	Medium
Jun. 12 95	Hgwy-rail	GP38-3ML	1983	50	1	31	0		No	Medium
Aug. 9 95	Hgwy-rail	SD60M	1990	42	0	0	0		No	Minimum
Aug. 21 95	Hgwy-rail	C36-7	1985	45	2	377	0		No	Maximum
Sep. 19 95	Hgwy-rail	GP40-2	1972	45	1	89	0		No	Medium
Sep. 26 95	Hgwy-rail	C36-7	1985	47	0	0	0		No	Medium
Oct. 30 95	Hgwy-rail	F40PH	1976-81	59	1	0	0		No	Medium
Nov. 13 95	Hgwy-rail	Dash8-P40B	1993	70	0	0	0		No	None
Nov. 20 95	Hgwy-rail	SD40-2P	1978-80	40	2	19	0		No	Medium
Dec. 8 95	Hgwy-rail	CF7	1977	25	0	0	0		No	None
Dec. 8 95	Hgwy-rail	GP38-2	1980	49	1	299	0		No	Maximum
Oct. 25 95	Side Cllsn	SD40-2	1981	3	1	89	0		No	None

APPENDIX - C
Train Accidents involving Locomotives - Trend Assessment (1995 - 2002)

The Federal Railroad Administration (FRA) conducted a review and assessment of train accidents from 1995 - 2002. The purpose of this appendix is to provide a description and review of the data/accident collection that FRA conducted for purposes of assessing the trend of train accidents that could potentially be mitigated by improved crashworthiness features. Another purpose of this appendix is to determine the variance in the accident trends from the findings of the FRA/RSAC's original data/accident analysis which was conducted on accidents for 1995 - 1998.[1]

Data Collection and Review

FRA queried its accident/incident database for the period of time 1995 - 2002. This query scanned FRA F 6180.54 "Rail Equipment Accident/Incident Reports" for the specified time-period. These reports are filed by the railroads as specified by 49 CFR Part 225.

In order to ensure that the data set only picked up the larger or more significant accidents the data query selection required that the "equipment" damages meet or exceed $500,000 and/or involve an employee fatality. Accidents were reviewed to ensure that they could fit into one of the six scenarios chose by the Working Group. In general the data query and the accident review met the same criteria that the larger more detailed data/accident analysis that was conducted and document in Appendix B. For example, accidents where the locomotive did not strike an object were removed. Accidents and/or injuries were included or removed based on the narrative block and pertinent casualty reports. The accidents that remained can be reviewed in Table C -2.

It is important to note that during the data review process additional reports and information were utilized if necessary. In addition to the Rail Equipment Accident/Incident Report, casualty reports[2] were also reviewed.

Limitations of this Assessment

Because of the criteria used to query the original data set for this assessment, there are several potential limitations to its findings. Since one of the variables was equipment damage that met or exceeded $500,000, only the most severe highway-rail crossing accidents ended up in this trend assessment. The potential crashworthiness features could also be helpful in mitigating injuries and damages for accidents that had less than $500,0000 of equipment damage or did not

[1] Please reference Appendix B.

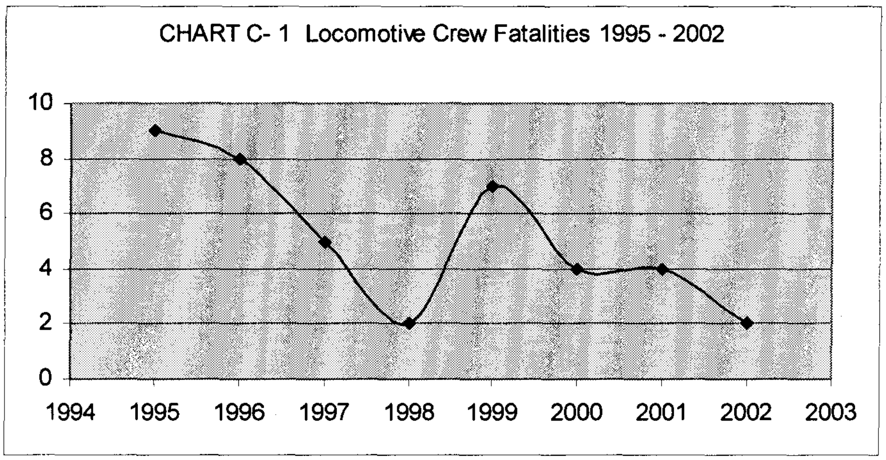
[2] Form FRA F 6180.55A.

involve a fatality. In general less severe train accidents that either did not have a fatality or had equipment damages of less than $500,000 were also not included in this trend assessment.

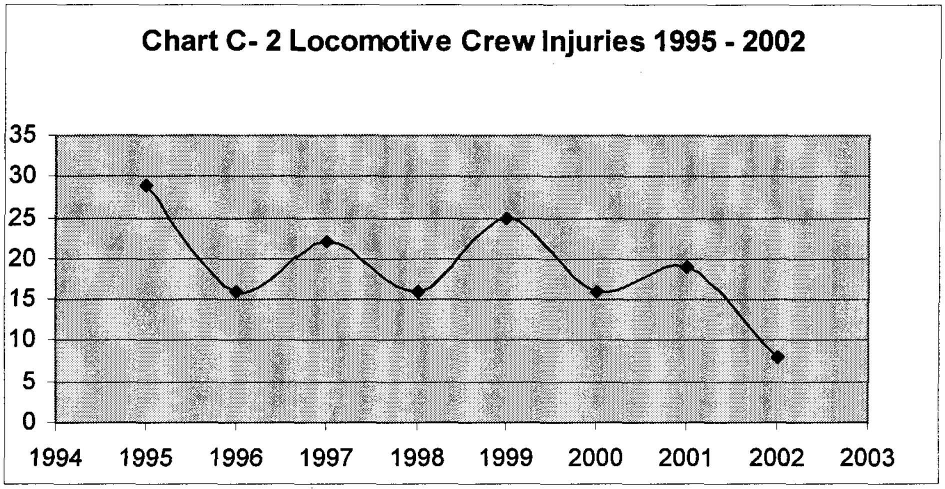
Findings

Table C-2 provides the findings of the trend assessment. Basically the average number of fatalities for the original data analysis period (found in Appendix B) is 7.33, and the average for 1998 - 2002 is 3.17. The average number of injuries for the 1995 - 1997 time-period is 22.33, and the average for 1998 - 2002 is 14. The average yearly amount of locomotive damage for the 1995 - 1997 time-period is $17,531,396, and the average for 1998 - 2002 is $10,753,745.[3]

Charts C - 1, C - 2, and C - 3 (below) provide a graphical representation of this trend assessment. Chart C- 1 provides the locomotive crew fatalities over the 1995 - 2002 time-period, and Chart C - 2 provides the locomotive crew injuries for the time-period. Chart C - 3 provides the locomotive damages for the same specified time-period.



[3] Note: The estimated locomotive damage is calculated by multiplying the reported equipment damages by .63037. In FRA's Accident Data Collection and Analysis & Benefit Assessment (see Appendix B) 22 accidents were found where the actual locomotive damage was itemized separately in addition to the total equipment damage provided on the accident report. From these accidents the average amount of locomotive damage was calculated as a percentage of the total equipment damages. .



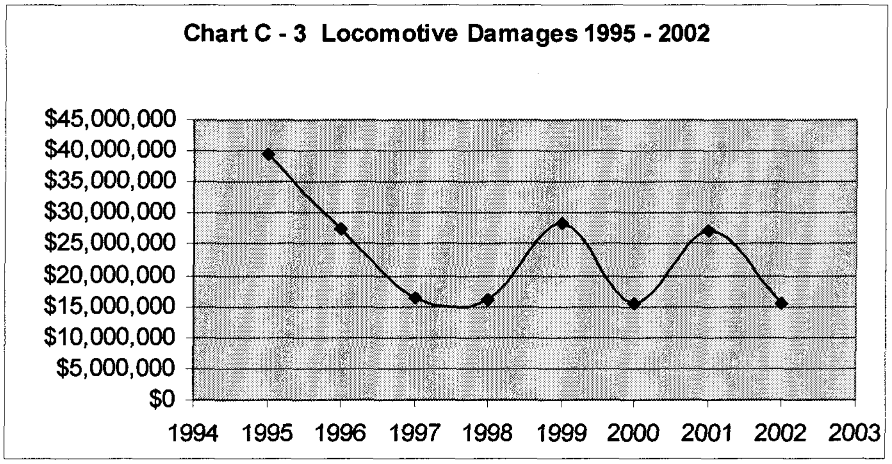


TABLE: C - 1

Accident Data: 1995 - 2002

YEAR	Estimated Locomotive Damage	Number of Loco Crew Injuries	Number of Loco Crew Fatalities
1995	$39,532,101	29	9
1996	$27,411,431	16	8
1997	$16,490,309	22	5
1998	$16,131,131	16	2
1999	$28,227,566	25	7
2000	$15,393,955	16	4
2001	$27,189,440	19	4
2002	$15,414,424	8	2
Avg. for 1995 - 1997	$27,811,280	22.33	7.33
Avg. for 1998 - 2002	$17,059,419	14.00	3.17

TABLE C - 2

Locomotive Crashworthiness: Data/Accident Trend Assessment 1995 - 2002

Revised: 24-Mar-04

Date of Accdnt/Incnt	Type of Accident	Equipment Damage	Employee Injuries	Employee Fatalities
1995				
12-Jan-95	Head-on Collision	$1,531,361	3	1
24-Jan-95	Head-on Collision	$719,749	3	0
30-Jan-95	Head-on Collision	$1,709,537	5	0
6-Mar-95	Rear-end Collision	$1,250,000	2	0
27-Apr-95	Other Impacts	$250,000	1	2
1-May-95	Rear-end Collision	$1,456,000	1	0
2-May-95	Hwy-Rail Impact	$1,018,500	0	0
8-May-95	Side Collision	$21,105,505	3	0
21-May-95	Head-on Collision	$1,050,000	1	0
25-May-95	Rear-end Collision	$711,600	2	0
2-Jul-95	Obstruction Impact	$560,500	0	0
21-Sep-95	Hwy-Rail Impact	$300,000	1	1
18-Nov-95	Rear-end Collision	$2,630,000	2	1
20-Dec-95	Side Collision	$1,200,000	2	1
22-Dec-95	Raking Collision	$4,039,349	3	3
		$39,532,101	***29***	***9***
1996				
1-Feb-96	Derailment	$3,672,294	1	2
9-Feb-96	Derailment	$1,200,000	2	0
9-Feb-96	Side Collision	$1,900,000	1	2
14-Feb-96	Head-on Collision	$1,880,000	3	0
22-Mar-96	Derailment	$500,000	0	0
23-Apr-96	Hwy-Rail Impact	$849,543	1	0
12-May-96	Side Collision	$771,850	0	0
29-Jun-96	Obstuction Impact	$75,200	0	1
20-Aug-96	Head-on Collision	$6,829,400	2	2
23-Aug-96	Rear-end Collision	$5,266,550	0	0
9-Sep-96	Hwy-Rail Impact	$500,000	1	0
24-Sep-96	Hwy-Rail Impact	$1,310,044	1	1
4-Oct-96	Head-on Collision	$1,459,000	3	0
13-Dec-96	Derailment	$635,250	0	0
29-Dec-96	Derailment	$562,300	1	0
		$27,411,431	***16***	***8***
1997				
5-Feb-97	Hwy-Rail Impact	$1,285,000	2	0
21-Mar-97	Hwy-Rail Impact	$2,096,076	3	0
26-Apr-97	Derailment	$1,017,000	0	0
7-Jun-97	Rear-end Collision	$704,022	2	1
2-Jul-97	Head-on Collision	$2,174,714	1	1
31-Jul-97	Derailment	$1,259,062	2	0
20-Aug-97	Head-on Collision	$3,140,300	1	2
23-Aug-97	Rear-end Collision	$545,000	2	0
15-Sep-97	Hwy-Rail Impact	$600,000	1	0
29-Sep-97	Rear-end Collision	$201,500	0	1
9-Oct-97	Hwy-Rail Impact	$900,000	2	0
25-Oct-97	Head-on Collision	$1,147,000	4	0
4-Nov-97	Hwy-Rail Impact	$1,420,635	2	0
		$16,490,309	***22***	***5***
1998				
16-Mar-98	Hwy-Rail Impact	$563,302	1	0
25-Mar-98	RR crossing Collision	$569,148	2	1
31-Mar-98	Other Impacts	$1,345,000	0	0
29-Apr-98	Rear-end Collision	$1,123,000	0	0
5-May-98	Hwy-Rail Impact	$3,147,700	2	0
27-May-98	Hwy-Rail Impact	$554,950	1	0
12-Jun-98	Hwy-Rail Impact	$1,212,231	1	0
26-Jun-98	Side Collision	$839,664	2	0
16-Jul-98	Hwy-Rail Impact	$670,500	0	0
21-Jul-98	Other Events	$2,179,020	3	0
4-Aug-98	Hwy-Rail Impact	$500,000	1	0
12-Sep-98	Rear-end Collision	$2,643,618	2	0
1-Oct-98	Hwy-Rail Impact	$205,000	1	1
13-Nov-98	Rear-end Collision	$577,998	0	0
		$16,131,131	***16***	***2***

TABLE C - 2 (continued)

Date of Accdnt/Incnt	Type of Accident	Equipment Damage	Employee Injuries	Employee Fatalities
1999				
17-Jan-99	Rear-end Collision	$1,607,500	0	2
15-Mar-99	Hwy-Rail Impact	$9,500,000	1	0
23-Mar-99	RR Crossing Collision	$1,115,600	2	0
8-Apr-99	Hwy-Rail Impact	$1,107,802	4	0
15-Apr-99	Rear-end Collision	$893,265	1	0
5-May-99	Head-on Collision	$782,503	2	0
21-May-99	Hwy-Rail Impact	$700,000	1	0
1-Jul-99	Side Collision	$1,000,000	3	0
5-Jul-99	Head-on Collision	$840,000	2	0
8-Jul-99	Hwy-Rail Impact	$2,462,000	2	0
11-Aug-99	Rear-end Collision	$474,000	0	2
13-Sep-99	Rear-end Collision	$341,849	1	1
20-Sep-99	Rear-end Collision	$868,000	2	0
23-Oct-99	Rear-end Collision	$100,000	0	0
4-Nov-99	Hwy-Rail Impact	$600,000	2	0
6-Nov-99	Hwy-Rail Impact	$1,645,573	1	1
17-Nov-99	Head-on Collision	$3,069,474	1	1
18-Nov-99	Side Collision	$1,120,000	0	0
		$28,227,566	***25***	***7***
2000				
4-Jan-00	Hwy-Rail Impct	$636,000	1	0
28-Jan-00	Hwy-Rail Impct	$1,056,830	2	0
7-Feb-00	Hwy-Rail Impct	$1,060,000	0	0
21-Jun-00	Hwy-Rail Impct	$651,765	2	0
26-Jun-00	Hwy-Rail Impct	$46,000	2	1
18-Jul-00	Head-on Collision	$515,000	0	0
21-Jul-00	Side Collision	$1,000,000	0	0
9-Aug-00	Hwy-Rail Impct	$1,249,017	0	0
26-Aug-00	Other Impacts	$776,429	1	1
25-Sep-00	Other Events	$511,424	2	0
10-Oct-00	Other Impacts	$500,000	0	0
24-Oct-00	Hwy-Rail Impct	$1,500,000	2	0
31-Oct-00	Rear-end Collision	$3,554,145	1	1
4-Nov-00	Hwy-Rail Impct	$1,259,000	1	0
4-Nov-00	Side Collision	$553,345	0	0
30-Nov-00	Hwy-Rail Impct	$25,000	1	1
27-Dec-00	Hwy-Rail Impct	$500,000	1	0
		$15,393,955	***16***	***4***
2001				
14-Jan-01	Side Collision	$702,000	0	0
17-Jan-01	Obstruction Impct	$1,000,000	0	0
17-Feb-01	Rear end Collision	$809,828	2	1
27-Feb-01	Hwy-Rail Impact	$750,000	0	0
26-Jan-01	Rear end Collision	$1,350,569	1	0
10-Aug-01	Side Collision	$800,000	0	0
18-Aug-01	Rear end Collision	$1,003,347	2	0
30-Aug-01	Obstruction Impct	$1,185,566	0	0
7-Sep-01	Rear end Collision	$809,381	1	0
11-Sep-01	Side Collision	$597,000	1	0
13-Sep-01	Side Collision	$3,790,000	2	0
15-Sep-01	Head-on Collision	$248,000	0	2
20-Nov-01	Rear end Collision	$1,716,017	2	0
21-Nov-01	Side Collision	$1,209,269	2	0
23-Nov-01	Hwy-Rail Impact	$1,173,380	0	0
6-Dec-01	Side Collision	$1,172,770	2	0
7-Dec-01	Head-on Collision	$3,039,548	1	1
13-Dec-01	Rear end Collision	$5,182,765	2	0
15-Dec-01	Side Collision	$650,000	1	0
		$27,189,440	***19***	***4***
2002				
1-Jan-02	Side Collision	$517,610	1	0
23-Apr-02	Head-on Collision	$3,512,354	2	0
14-May-02	Hwy-Rail Collision	$621,000	1	0
28-May-02	Head-on Collision	$6,418,153	3	1
16-Jun-02	Rear-end Collision	$789,341	0	0
17-Jun-02	Side Collision	$150,000	0	0
19-Jun-02	Rear-end Collision	$1,851,522	1	0
16-Jul-02	Other Impacts	$11,000	0	1
1-Aug-02	Hwy-Rail Collision	$503,782	0	0
15-Sep-02	Rear-end Collision	$1,039,662	0	0
		$15,414,424	***8***	***2***

APPENDIX - D

Alternatives Considered for Locomotive Crashworthiness Design Standards NPRM

Revised: 9 August 2004

The Office of Management and Budget (OMB) has produced guidelines and best practices for economic analyses of regulatory actions required by Executive Order 12866. This document prescribes that an economic analysis should show that the agency considered the different alternative approaches to the problem being addressed. Federal agencies should also provide reasoning for the selecting of the proposed regulatory action over such alternatives.[1] Thus, the purpose of this appendix is to demonstrate the FRA's consideration of alternatives and some of the deliberations that led to the selection of the proposals in the NPRM.

The FRA is proposing a locomotive crashworthiness design standards rule that is intended to mitigate the severity of future locomotive crew casualties who are involved in locomotive collisions. The proposed rule is also intended to decrease the likelihood of any loss in the integrity of fuel tanks which might occur from train incidents/accidents, and any subsequent environmental damage. The benefits from the proposed rule would be realized by requiring new locomotives to be designed and built to standards which provide an increased level of safety to cab occupants over current conventional designs. The proposed requirements for crashworthy locomotives must be met by demonstrating compliance with either the proposed rule's performance standards or an approved design standard.

This appendix provides a discussion of alternatives that FRA considered during the rulemaking process and alternatives that the Railroad Safety Advisory Committee (RSAC) discussed and considered during working group meetings. These alternatives are discussed and the costs are provided in a quantitative manner or described in a relative manner. FRA requests comments, if warranted, that would provide greater clarity to this appendix and its discussion of alternatives considered.

I. General Discussion

The locomotive crashworthiness NPRM is a product that was developed in a quasi-participatory process, i.e., the RSAC. Stakeholders of the different constituencies were represented in a consensus building process that developed the recommendations for the NPRM. Thus, the

[1] "Economic Analysis of Federal Regulations Under Executive Order 12866." http://www.whitehouse.gov/OMB/inforeg/riaguide.html , January 11, 1996;
"Circular A-4: Regulatory Analysis." September 17, 2003. http://www.whitehouse.gov/omb/circulars/a004/a-4.pdf .

consideration of alternatives and the cost and benefits associated with such alternatives was discussed and sometimes extensively labored over. Additional discussions on the deliberations that the Locomotive Crashworthiness Working Group had on the proposed rule and potential alternatives can be found in the preamble of the NPRM.

In general it should be noted that the status quo was not considered to be sufficient to ensure the safety of locomotive cab crews. It should also be emphasized that the proposed requirements are flexible and in some instances permit varying means of accomplishing the same requirement. One of the goals of the proposed rule is to mitigate hazards and risks that locomotive cab crew members are exposed to during a collision.

The proposed regulatory actions have been selected over other alternatives usually because they provide the flexibility in achieving the intended goals of the proposed regulation. Thus, in most instances the proposed regulatory action achieves the most benefit for the least cost.

II. Alternatives

In general the selected alternative provides the choice of building a crashworthy locomotive that either meets the proposed performance standard or an approved design standard, i.e., AAR's S-580 (2004). This provides great flexibility for equipment manufacturers and railroads, since they can either build a locomotive to an approved design standard or that meets the performance requirements.

1. Status Quo: No Locomotive Crashworthy Design Improvements

For this proposed rulemaking the "status quo" alternative would be no Federal regulation for the design requirements of crashworthy locomotives. This alternative would provide no costs, no assurance that locomotives would be built to be more crashworthy, and therefore, not very much of the anticipated benefits from the selected alternative would accrue.

2. Selected Alternative: Proposed Locomotive Crashworthy Design Standards Regulation

FRA is proposing requirements which would improve the likelihood that the occupiable space in a locomotive cab be maintained during an accident or collision. Thus, FRA is proposing to amend its Locomotive Safety Standards, *49 CFR Part 229* to include a new Subpart D with requirements for the design and maintenance of crashworthy locomotives.

The proposed crashworthiness features in the selected alternative are intended to improve the likelihood that cab occupants would survive under specific accident scenarios, and also decrease or mitigate the severity of any injuries involved. The requirements of the proposed regulation vary upon the type of locomotive (e.g., wide-nose, narrow-nose, and semi-monocoque) and whether the design and build of the locomotive meet the performance requirements or the engineering standards.

The proposed requirements include anti-climbers, collision posts, short-hood structures, and underframe strength improvements, or equivalent levels of safety. The proposal also includes interior requirements which are related to the crashworthy features, and these are: emergency egress, interior configuration, and cab emergency lighting. Finally, the proposed requirements also improve the strength and design of locomotive fuel tanks which should decrease the likelihood the integrity of a fuel tank would be breached when it is involved in an accident or incident.

A.) Crashworthy Features Considered

The Working Group examined a list of crash survival concepts that FRA had previously assembled in its Report to Congress. The Working Group assembled a task force which discussed each concept in light of the accidents reviewed. There was general agreement among task force members about the continued need for braced collision posts, corner posts, and the utilization of crash energy management principles to minimize secondary collisions within the locomotive cab. The task force also discussed the variance of underframe sill heights, the frequency of locomotive roll-over occurrences, and the concept of crash refuges, but ultimately agreed with FRA's Report to Congress that these features held little promise as effective locomotive crashworthiness features and that further use of resources in pursuit of these concepts was not warranted. The task force then discussed collision post strength, wide-nose locomotive cabs and cab corner strength as well as locomotive front end strength up to the window level. The task force felt that these concepts required further development in order to further mitigate the consequences from the reviewed accidents, which included side/oblique collisions, coupled locomotive override, and shifted load collisions.

In all, the RSAC Working Group considered the following locomotive crashworthiness features:

-*Shelf couplers:* An industry representative reviewed the "shelf coupler" concept with the Working Group and traced its development from concept to the current status. Every freight car has a bottom-shelf E head coupler. This is the new standard. Double shelf (top- and bottom-shelf) couplers are mandated by FRA on tank cars used to haul hazardous materials. These shelves limit vertical motion between two coupled couplers to approximately ±7¼ inches (184 mm). Passenger cars are typically equipped with tightlock couplers which keep the coupler faces at the same height. These couplers have demonstrated their effectiveness in preventing override for their respective equipment. During the discussion it was pointed out that a top shelf might assist in preventing override in a rear-end collision although it would require that a coupling actually occur for the shelf to be effective. However, type-F couplers commonly applied to locomotives already incorporate a top shelf feature. After deliberations, the Working Group decided not to pursue the concept of double shelf couplers as effective crashworthiness improvements. It was further noted that the coupling of MU cables and the air hoses between locomotives would be made more difficult if shelf couplers were required on locomotives. The potential for such coupler designs in preventing locomotive to locomotive override in a head-on collision was nonetheless evaluated.

-Interlocking anti-climber: The anti-climber design employed by the Canadian National (CN) railroad was evaluated. This design incorporates thicker webs and flanges than typical North American designs, and also includes exposed flanges running the width of the anti-climber.

-Stronger collision posts: Preliminary designs of collision posts with strengths up to the strength of the main underframe structure of the locomotive were developed and evaluated. Principal modifications were the addition of flanges and tapering the collision post.

-Stronger window area structure: Increased cab strength above the short hood was evaluated. Modification included the use of thicker sheet metal for the window frame members. After discussions the Working Group decided not to require this feature.

-Stronger short hood: The influence of short hood strength on locomotive crashworthiness in an oblique collision was evaluated. Modifications evaluated included thickness of the short hood and the material used to make the short hood.

-Front plate: Increased front plate strength was considered as a potential modification for increased locomotive crashworthiness in an oblique collision with a freight car. The modification considered consisted of increased front plate thickness.

The results of the study indicate that strengthened collision posts and short hoods resulted in increased crashworthiness for particular collision scenarios. Shelf couplers were found not to be effective in preventing coupled locomotive override. (Shelf couplers are potentially effective in preventing freight car override of a locomotive, however, this scenario was not evaluated). Due to the fracture that occurs as the CN anti-climber design longitudinally crushes, this design was found to be ineffective in supporting the vertical forces that occur during locomotive-to-locomotive override, consequently allowing such overrides to occur. For an oblique collision of a locomotive with an empty hopper car, in which the locomotive is principally engaged below the underframe, modifications to the locomotive are not likely to influence the outcome of the collision.

B. Alternative crashworthiness designs

A party seeking changes to a design standard that has not been approved by FRA, should follow the procedures for approval of new design standards, paragraph (b), or the procedures for approval of alternative design standards provided in §229.209. This section proposes procedures to be followed when seeking FRA approval of an alternative locomotive crashworthiness design. These procedures are similar to approval procedures currently used by FRA in other contexts, e.g., § 238.21.

FRA envisions the possibility that a railroad or locomotive manufacturer will desire to explore innovative locomotive designs which do not satisfy AAR S-580 (2004) or any other current FRA-approved design standard. In such case, FRA has provided a procedure in this section whereby it would assess the design directly against the performance criteria of Appendix D. This section outlines the procedures to be used to obtain FRA approval for such a design. Overall, FRA expects that submission of petitions for alternative locomotive crashworthiness designs will be a rare occurrence.

In the event that a truly innovative alternative design is submitted for FRA approval (i.e., not close to satisfying a previously-approved design standard), FRA would require full validation of its crashworthiness per Appendix D. However, if a proposed alternative design varies only slightly from a previously-approved design standard, FRA would require only validation of those features which are different, in lieu of proof of satisfaction of all Appendix D performance criteria.

C. Locomotive Short-hood Skin: Minimum Thickness

The approved design standard which is proposed in Appendix E of Part 229, also includes at one item of flexibility. This design standard provides that the minimum thickness of the locomotive's short-hood skin is determined by a formula which allows for less thickness for stronger materials. Basically thinner high strength steel may be utilized where thickness varies inversely with the square root of the yield strength. Hence a manufacturer or railroad may choose to use less material for a substance that has a higher yield strength.

III. Summary/Conclusion

This appendix demonstrates that FRA and the RSAC considered numerous alternatives during the rulemaking process. This appendix concludes that the flexible alternatives were not only considered, but inserted in the proposed regulation. It is clearly the intention of this proposed regulation to allow a locomotive manufacturer to build or railroad to purchase a locomotive that either meets the general performance standard or an approved design standard, such as the AAR's S-580 (2004).

APPENDIX - E

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Revised: August 2004

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