Electronically Controlled Pneumatic Brake Systems

Notice of Proposed Rulemaking

Regulatory Analysis

Federal Railroad Administration

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I. EXECUTIVE SUMMARY

The Federal Railroad Administration (FRA) is responsible for the safe and secure movement of rail traffic on the Nation's railroads. Electronically Controlled Pneumatic (ECP) brakes are a tested technology that offers major benefits in freight train handling, car maintenance, fuel savings, and network capacity. Their use could significantly enhance rail safety and efficiency. With the present system (developed in the 1870s), freight train cars brake individually at the speed of the air pressure moving from car to car, along trains that are often well over a mile long. Compared with the potential performance of ECP brakes, this conventional braking system contributes to greater in-train forces, more complex train handling, longer stopping distances, and safety risks of prematurely depleting air brake reservoirs. Current train handling procedures require anticipating draft (pulling) and buff (compressive) forces within the train, particularly on hilly terrain; and any misstep can result in derailment. Current brake systems are very complex and subject to failure, which is a maintenance challenge and a safety concern. These systems are prone to causing undesired emergency applications (UDEs), which can result in delay or even derailment. Current brakes can also stop working on individual cars en route without the locomotive engineer being aware of it.

These challenges are greatly reduced in the ECP brake mode of operation, during which all cars brake simultaneously by way of an electronic signal. ECP brake systems simultaneously apply and release freight car airbrakes through a hard-wired electronic pathway down the length of the train, and allow the engineer to "back off" the braking effort to match the track grade and curvature, without completely releasing the brakes. ECP brakes have the potential to save fuel and reduce emissions, reduce wear/stress on wheels and brake shoes, and reduce the chance of a runaway train. Because of the shorter stopping distances ECP brakes can achieve, in the range of 40 to 60 percent, and the greater control the engineer has on the braking characteristics of the train, the safety benefits of ECP brakes include: reduced or less severe collisions with obstacles on the railroad, including vehicles stuck on grade crossings; reduced or less severe train-to-train collisions; reduced chances of runaway trains; and reduced train-handling accidents, including derailments. ECP brake wiring also provides the train a platform for the gradual addition of other train-performance monitoring devices using sensor-based technology to maintain a continuous feedback loop for the crew on the train's condition.

ECP brakes have not yet been implemented in the United States for different reasons. Primarily, many requirements of existing regulations will be inapplicable to ECP brake-equipped trains, which is why FRA is pursuing this rulemaking. In addition to the regulatory challenges, ECP brakes represent a very extensive investment. Cost-effective applications will require "stand alone" ECP brakes, which will have only limited compatibility with conventional systems. With more than 1 million freight cars and almost 30,000 locomotives that operate in the United States, the logistical conversion of brakes systems is challenging. ECP brakes are a major capital investment (on the order of $6 billion for all locomotives and cars). The majority of costs will fall on car owners (most cars are privately owed by shippers or leasing companies); however, the majority of benefits will fall on the railroads (locomotive operators). Moving from conventional to ECP brakes will be logistically difficult and small railroads will face significant costs downstream. All North American freight railroads would eventually need to convert.

In the interest of safety, the FRA commissioned a report by Booz Allen Hamilton to describe a path to ECP implementation. A copy of this report has been placed in the public docket to this rulemaking at Docket Number FRA-2006-26175. The report suggests that ECP brake technology can return substantial private and public safety benefits. As applied to western coal service, the business case appears to be substantial; and ECP brake implementation in other market sectors appears plausible as the industry gains confidence. Significant capacity savings are associated with ECP brake equipped trains because of their increased velocity. More than 90 percent of the total noncapacity-related savings from ECP brakes lie in three areas: fuel costs, wheel wear, and intermediate brake test elimination (regulatory adaptation). Preliminary financial analyses for the Powder River Basin (PRB) Implementation Plan (unit trains in dedicated service) indicate a 3-year payback, an internal rate of return of 47 percent, and a net present value of almost $700 million. ECP brakes have previously been tested and demonstrated in the United States, and they have been adopted in revenue service by railroads in Canada, Australia, and South Africa. South Africa's Spoornet has embraced ECP brake systems for its huge export coal operations, reporting a 23 percent savings in train energy consumption. Electronic monitoring on Spoornet's ECP brake-equipped trains has increased capacity, reducing turn times by 9 percent. Growth in demand for United States coal and imported goods, coupled with motor carriers' limited ability to expand due to driver shortages and other factors, indicate that North American rail network congestion will be a major concern for the foreseeable future. ECP brake-equipped trains will move more efficiently with increased velocity, resulting in greater network capacity. Increased braking efficiency will support reduced train spacing; and braking performance may provide railroads the opportunity to increase consist lengths, and actually reduce the need to block road crossings for long periods.

To make ECP brake systems a reality, the FRA proposes regulatory relief necessary to initiate investment in this technology. The FRA believes that ECP brake-system implementation would start where the benefits are clearest, on train sets that are usually kept together in operations, namely unit and 'unit-like'[1] trains. High-mileage, dedicated trains that produce a high percentage of traffic lend themselves to early conversion to ECP brakes. Once confidence is established, a transition by market sector should begin. Both the rail industry and the FRA have studied ECP brake safety issues, and a substantial body of standards and analysis is already available.

The FRA's Notice of Proposed Rulemaking (NPRM) will describe safety requirements for ECP brake-equipped trains and regulate the conversion to ECP brakes. As mentioned above, many requirements of existing regulations will be inapplicable to ECP brake-equipped trains. The NPRM addresses acceptance of electronic systems using a performance-based approach. The FRA will work with shippers and railroads to acquire data from initial implementations and validate the business case. Shippers will need reassurance that service will remain stable through carrier provision of ECP brake-equipped locomotives. Locomotive and train crewmembers will need training and experience using this technology to gain the best effect. The adoption of industry interchange standards that make new equipment ECP brake-ready (e.g., more easily and inexpensively converted) will be critical. The Association of American Railroads (AAR) already has proposed standards changes to ECP brake systems (AAR Standard S-4200).

[1] Unit-like train service is based on commodity group and usually travels from the same origination location to the same destination, whereas unit trains are limited to the one set-out and one pick-up of cars en route.

The FRA developed this regulatory analysis in accordance with Executive Order 12866. This document estimates the costs and consequences of the NPRM, as well as its anticipated economic and safety benefits. A copy of this document has been placed in docket number FRA-2006-26175 for this rulemaking. The following is a summary of our findings.

The FRA estimates that ECP brakes will be installed on cars and locomotives in unit and unit-like train service over a ten year period. The time frame for this analysis is 20 years. Both costs and benefits are presented as totals and discounted at both 3% and 7%. The table below presents the estimated 20-year monetary costs associated with unit and unit-like train conversion to ECP brakes on unit trains. Unit and unit-like train traffic represent approximately 61 percent of the revenue carloads that originate in the United States.[2] This service provides the best rate of return and will most likely convert to ECP brakes.

Table 1: 20-Year Monetary Costs Associated with Unit and Unit-like Conversion to ECP Brakes

Total 20-Year Costs and Discounted Costs (at 3% and 7 %)			
	Costs	3 % Discount	7% Discount
Freight Car Costs	$ 1,455,272,000	$ 1,241,376,534	$ 1,022,122,156
Locomotive Costs	$ 485,520,000	$ 414,158,408	$ 341,008,931
Employee Training	$ 196,425,710	$ 161,710,759	$ 96,152,211
Total Costs	$ 2,137,217,710	$ 1,817,245,701	**$ 1,459,283,298**

The FRA's analysis determines that over a 20-year period the discounted costs would be approximately $1.5 billion.

The parties that benefit from ECP brakes include: railroads through more efficient operations; rail shippers and car owners through improved asset utilization and service; railroad employees and the public through improved safety on the railroad and by keeping shipments on the rails that would otherwise burden congested highways; and the national economy and the environment through better utilization of fossil fuels and contributing to transportation capacity. The major benefit of ECP brake use is improved velocity.[3] Because the FRA estimates that only a portion of the fleet will be converted and not the entire fleet, velocity benefits may accrue on a corridor basis, not a network basis. It would not be unreasonable to expect a 1 mph gain in network velocity may be realized if major rail corridors achieve an increase in velocity high enough to affect the national average. Because it is not know if network velocity improvements will be realized, this important benefit is noted, but not included in the total benefit calculation. The benefits resulting from the provisions of this NPRM are benefits related to the regulatory relief proposed in this rulemaking, enhanced safety, and business benefits. The FRA specifically requests public comments on these benefits, and will continue to study these potential benefits before finalizing this rulemaking. The FRA also intends to further quantify these benefits in a follow up study of ECP brakes once implementation begins. We expect technology adopted

[2] 'Freight Commodity Statistics,' 2005, Association of American Railroads.
[3] According to the BAH report, an industrywide equipment savings of $2.5 billion may be realized from a 1 mph gain in network velocity. 'Benefit-Cost Analysis and Implementation Plan for Electronically Controlled Pneumatic Braking Technology in the Railroad Industry,' Booz Allen Hamilton, August 2006, p. III-5.

under this NPRM to reduce fatalities, injuries, and property and environmental damage resulting from brake-related rail accidents. We calculated safety benefits in terms of the decline in the risk of certain accidents and their consequences based on our analysis of accident data. The following table summarizes the benefits associated with the implementation of ECP brakes:

Table 2: 20-Year Benefits Associated with Implementation of ECP Brakes

Total 20-Year Benefits and Discounted Benefits (at 3% and 7 %)			
	Benefits	3% Discount	7% Discount
Regulatory Relief	$ 2,485,337,443	$ 1,726,315,620	$ 1,112,844,715
Rail Accident Risk Reduction	$ 228,105,462	$ 158,224,002	$ 101,783,196
Highway-Rail Accident Risk Reduction	$ 14,036,032	$ 9,736,010	$ 6,263,034
Fuel Savings	$ 2,745,000,000	$ 1,904,052,986	$ 1,224,849,552
Wheel Replacement Savings	$ 1,601,250,000	$ 714,495,572	$ 714,495,572
Total Benefits	$ 7,073,728,937	$ 4,909,026,194	**$ 3,160,236,069**
Not included in benefits:			
Network Velocity Improvement of 1 mph*	Potential Equipment Savings of $2,500,000,000		

*Network velocity improvements may or may not be realized. It is also possible that a 1 mph increase in system velocity may be exceeded. Forecasts are not available for this estimate. This benefit is noted, but not included in the total benefits.

Benefits were estimated by applying effectiveness rates to accident causation codes that may be affected by ECP technology. Probabilities based on accident histories were used to estimate potential safety benefits of ECP brakes. The risk of an accident is assessed from a quantitative standpoint by valuing property damage, fatality and injury rates.

The FRA recognizes that the effectiveness of and, therefore, the benefits to be gained from the use of ECP brakes will vary by circumstances (e.g., train speed and length, track geometry, grade crossings, etc.). Benefit estimates were based on the reduction in risks of historical accidents reoccurring in the future. Forecasting the benefits that would likely result from the proposed rule requires the exercise of judgment and necessarily includes subjective elements.

The costs and benefits shown in the tables above represent our best estimate of the costs and benefits to be realized under the targeted application of ECP brakes to unit and unit-like trains. Potential benefits, which have not been quantified in this analysis due to a lack of data, may equal or exceed benefits that have been quantified.

The proposed rule is estimated to cost approximately $1.5 billion present value (7 percent) over the next 20 years ($1.8 billion discounted at 3 percent). The largest portion of these costs, $1 billion, is the cost to convert freight cars to ECP brakes. This cost is followed by locomotive conversion costs of $340 million. The total benefits of the proposed rule are

approximately $3.2 billion present value (7 percent) over the next 20 years ($4.9 billion discounted at 3 percent). Either the regulatory relief benefits of $1.1 billion or the fuel savings estimated at $1.2 billion almost pay the costs individually. Together, these benefits exceed the costs substantially. Additionally, there are benefits that are not quantified that may also be substantial. If one assumes the benefit of velocity improvements, which are reasonable to achieve, the additional $2.5 billion makes the overall case overwhelming. The expected benefits of ECP braking technology appear to justify the investment, assuming that the conversion is focused first on the high-mileage, unit and unit-like train services that would most benefit from its use. Any further implementation beyond this portion of the fleet is likely to have less impressive net benefits than the scenario analyzed; however, FRA believes that the case is likely to be strong for continued further implementation, especially as ECP brake manufacturers achieve economies of scale and the railroads gain experience with the new braking systems.

II. SUMMARY OF PROPOSED RULE

The proposed rule provides regulatory relief; it does not mandate that railroads adopt ECP brake technology. Railroads that implement this technology will be required to train their employees on the safe operation and maintenance of ECP brake equipment. Due to the logistical challenges of implementing this technology, regulatory relief will be provided from current regulations so that ECP brake-equipped cars and locomotives can be brought into and out of service. The proposed rule will provide for movement of ECP brake equipment in non-ECP brake-equipped trains and non-ECP brake equipment in ECP brake-equipped trains.

The key features of the proposed rule are:

- Relief from certain (Class I (§§ 232.205(a) and (b)), Class IA (§ 232.207), and Class II (§ 232.209) required brake inspections when the train is equipped with an ECP brake system and operating in ECP brake mode.
- Allowing more flexibility regarding the addition of cars to a train including the ability to dispatch trains with only 95 percent operative brakes; and increasing the time a car can be off air before another brake test has to be performed, from 4 hours to 24 hours.
- Flexibility in handling defective equipment with ECP brakes, including movement and tagging.

The railroad industry in the United States consists of more than 500 companies. Of these, 39 are Class I and Class II (regional) rail carriers.[4] Seven privately owned, major freight railroad systems are referred to as Class I railroads. These Class I railroads account for 71 percent of the industry's mileage operated, 89 percent of its employees, and 93 percent of the industry's total freight revenue.[5] The remainder of the privately owned rail system is comprised of 32 regional and more than 500 local (short line or switching and terminal) railroads. For the purpose of this

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[4] Class I railroads, as designated by the Surface Transportation Board, are those railroads with operating revenues of $272 million or more. Regional railroads, referred to as Class II, are those with at least 350 route miles and/or revenue of between $40 million and the Class I threshold.

[5] "Overview of United States Freight Railroads," AAR Policy and Economics Department, February 2005, p.1.

analysis, the regional railroads are referred to as Class II, and all smaller railroads are referred to as Class III. All rail carriers are eligible for regulatory relief in the proposed rule; however, it is anticipated that only four Class I carriers will initially implement ECP brake technology.

Table 3: Rail Carriers Eligible for Regulatory Relief in the Proposed Rule

Number of Rail Carriers by Size
39 large entities
520 small entities
559 total

A. Background

The AAR first investigated advanced braking concepts for freight railroads in 1990. Over the past 15 years, ECP brake technology has progressed rapidly and has been field tested on actual freight trains since 1995 on various railroads.

The FRA has been an active and consistent advocate of ECP brake system implementation. In 1997, FRA participated in an AAR initiative to develop ECP brake standards. In 1999, the FRA funded, through Transportation Technology Center, Inc., a document titled the "Failure Modes, Effects, and Criticality Analysis (FMECA)" of ECP brake systems based on the AAR standards. The FRA also took part in programs to develop and enhance advanced components for ECP brake systems.

During this period, however, the FRA did not initiate regulatory actions affecting ECP brake technology. The development and application of ECP brakes remained the sole responsibility of the brake suppliers and the railroads. Railroad industry progress in implementing ECP brake technology slowed down due to difficulties in identifying an optimal implementation strategy and justifying the required investment.

In 2005, the FRA identified the need for regulatory support to reenergize ECP brake system interest and implementation. The FRA moved to assess industry readiness and the effectiveness of the ECP brake technology. It contracted with Booz Allen Hamilton (BAH), a major consulting firm, to assess the ECP brake technology costs, benefits, and implementation strategies. BAH identified and estimated the costs and benefits from ECP brake implementation. While the cost of implementation was $40,000 per locomotive and $4,000 to retrofit a car, BAH noted that brake manufacturers currently do not expect there to be any significant long-term difference in maintenance cost between ECP and non-ECP brake systems. At the same time, BAH identified benefits that were realized by Quebec Cartier Mining and Spoornet Rail following ECP brake implementation on their respective rail systems. These include: 1) reduced fuel consumption; 2) reduced annual expenditures for wheel replacement and brake shoes; and 3) increased capacity resulting from improved train velocity and better asset utilization. While implementation on a United States railroad would include the same benefits, BAH also identified benefits that could come if FRA would adopt some form of regulatory relief for ECP brake-equipped trains. Most notably, the study identified the elimination of the 1,000-mile intermediate terminal brake test (1,500 miles for extended haul) as a regulation that could be relaxed to afford relief without compromising safety. The FRA agrees with this conclusion. As BAH discusses, such relief would improve train transit times, but it could also improve rail reliability, thereby reducing shipper logistical costs. The BAH study[6] released in 2006 identified and quantified significant business benefits that could be realized with this technology through greater operational efficiencies, and suggested a migration plan that would start with unit train operations, logically focused initially on the Powder River Basin coal service. Since then, FRA has been working with the AAR, railroads, vendors, and the coal sector to generate momentum toward implementing this cost- and, potentially, life-saving technology.

After a thorough analysis of the current state of ECP brake technology and the results of numerous studies and initiatives mentioned above, the FRA concludes that the industry is ready for implementing ECP brake technology. Therefore, the FRA is proceeding with this rulemaking to regulate and support industry conversion to ECP brakes. The FRA's current ECP brake rulemaking activity is a timely and adequate response to the industry's needs and should facilitate the introduction and widespread application of ECP brake technology.

B. Assumptions

This analysis has a foundation based on certain data, estimates, and assumptions. Unless otherwise noted, the following assumptions apply to this analysis and all attached documents. The FRA specifically seeks comments on the following assumptions:

- An initial 10-year implementation will occur only on unit and unit-like train service.

- Unit and unit-like train service includes the following commodities: coal, grain, intermodal[7] containers, motor vehicle parts, ore, and non-metallic minerals.

- The unit-like commodities represent 62 percent of revenue freight carloads originated on United States Class I railroads and 61 percent of all United States carloads originated. This data is based on "Freight Commodity Statistics 2005," an annual publication identifying gross freight revenues, tonnage, and carloads up to the 5-digit STCC level for Class I railroads.

- Only four United States Class I railroads currently operate extended-haul trains. Both the private and social net benefits appear to be greatest on unit and unit-like trains operating over longer distances. The statistics are for these railroads only, which account for the majority of U.S rail freight activity.

- The FRA estimates that approximately 1,312,245 freight rail cars are in service in the United States. Of this group, 363,818 potentially operate in unit and unit-like consists.

[6] Ibid.
[7] Intermodal is freight traffic that moves over more than one transportation mode between shipper and consignee. The miscellaneous mixed shipments category (STCC 46) is mostly intermodal traffic. Some intermodal traffic is also included in commodity-specific categories.

- The FRA estimates that after the final rule is effective, all new cars in unit and unit-like train service will be "ECP ready," thus reducing the cost to retrofit cars.

- The time horizon for the analysis is 20 years.

- All dollars are estimated for the year 2005, unless otherwise noted.

- All findings in this analysis are rounded to the nearest dollar.

- Because costs and benefits accrue in different years, discount rates are applied to future benefits and costs. Two discount rates are used, 3 percent and 7 percent. The discount rate of 7 percent more accurately represents the before-tax rate of return to private capital in the United States economy, and will be emphasized in this analysis.

- The FRA estimates that there are 21,125 locomotives in service on United States Class I railroads, of which approximately 38 percent, or 8,092,[8] are used in unit and unit-like service.

C. Need for Regulatory Action

The proposed rules intend to amend current operating rules and training programs for inspection and operating personnel to reflect and take full advantage of the unique characteristics of ECP brake systems. Additionally, the proposed rules will provide regulatory relief from various existing inspection, testing, and maintenance requirements while proposing alternative inspection, testing, and maintenance requirements more applicable to ECP brake systems. The proposed regulatory relief will provide an incentive for the private sector to invest in ECP brake technology, while simultaneously maintaining safety. A Federal regulation is needed to provide this regulatory relief. While portions of the current regulations would still apply to ECP brake technology, the current Federal regulations governing brake systems were put in place without fully developing provisions related to ECP braking technology. Therefore, the advancement in technology requires the formation of new policies.

1. Market Failure and Regulatory Incompatibility

Executive Order 12866 requires that all new Federal regulations specify the market failure or other specific problem that will be addressed by the rulemaking. A market failure occurs when the market fails to allocate scarce resources to their highest-valued uses.

This can occur for several reasons, such as market power, externalities, or information problems. (OMB Circular A-4 describes each of these in detail. See http://www.whitehouse.gov/omb/circulars/a004/a-4.pdf). Normally in competitive markets, exchanges between self-interested buyers and sellers will allocate resources to their highest-valued uses. To a certain

[8] Costs are estimated using 12,138 locomotives, which equals 1.5 times 8,092 locomotives. Minor differences in calculations may occur because of rounding.

extent, the market for railroad safety is working. In the absence of Federal regulation, railroads certainly have a private incentive to develop and maintain robust breaking systems, as they would suffer the majority of the consequences of any safety accident or incident. In the case of ECP braking systems, where the business case and safety benefits appear to be substantially greater than the cost for the types of unit services studied in this analysis, one might expect fleet penetration to eventually rise to near 100 percent absent some market failure. If, however, a substantial share of those benefits accrue to individuals other than the owners of ECP-braked equipment, then it is conceivable that the purchaser of the equipment might (correctly) not expect private benefits sufficient to justify the expense, especially in the types of services where the business case for these systems is less clear. For example, some of the benefits of avoiding derailments or other accidents, or avoiding time delays due to accidents, are conferred on other trains, motor vehicles, or other individuals. These would constitute "external" benefits that would not be felt by the owner of the equipment. Under such circumstances, the market could yield fewer than the optimal number of ECP brake equipped trains, and regulation could be justified.

In addition, as we have discussed above and will discuss in more detail below, current regulations are somewhat incompatible with the widespread deployment of ECP braking systems. The FRA has recognized this incompatibility and is therefore proposing regulatory relief as part of this rulemaking.

Although railroad safety has generally improved in recent years, brake-related accidents continue to be a source of fatalities, injuries, hazardous material releases, evacuations, and significant property damage. These accidents have been caused by a variety of factors, including the blockage of train brake pipe lines, worn or broken brake components, insufficient or inaccurate train handling information, and improper inspection and maintenance.

One particular area where the safety externalities may be of significant concern is coal transportation. The demand for coal in the United States has recently increased. When there is a delay in coal delivery to power plants, the plants must increase the sizes of their inventories, and, therefore, increase their costs. If a delay is not anticipated and the reserve coal inventory runs out, power plants must, if they are able, switch to higher priced gas to generate electricity. These higher prices are passed directly to the consumer in higher electric bills. The seasonal demands of electric utility customers and the manufactured products are what drive the demand for coal nationwide. Coal production in the United States is driven by the Powder River Basin (PRB), which is the largest coal-producing region, accounting for approximately 40 percent of all coal mined in the country.[9] The PRB is the source of reasonably priced, low-sulfur coal for all electric utilities. In the United States today, coal demand is driven by the electric power sector, which accounts for 90 percent of consumption, compared with the 19 percent it represented in 1950. As demand for electricity grew, demand for coal to generate it rose and resulted in increasing coal production.[10] Many electric utilities are located far from the mine and receive several hundred cars of coal a week by train. The increased coal demand, however, has not been met by the railroads in a robust, low-cost way. Currently, major rail lines are near full capacity;

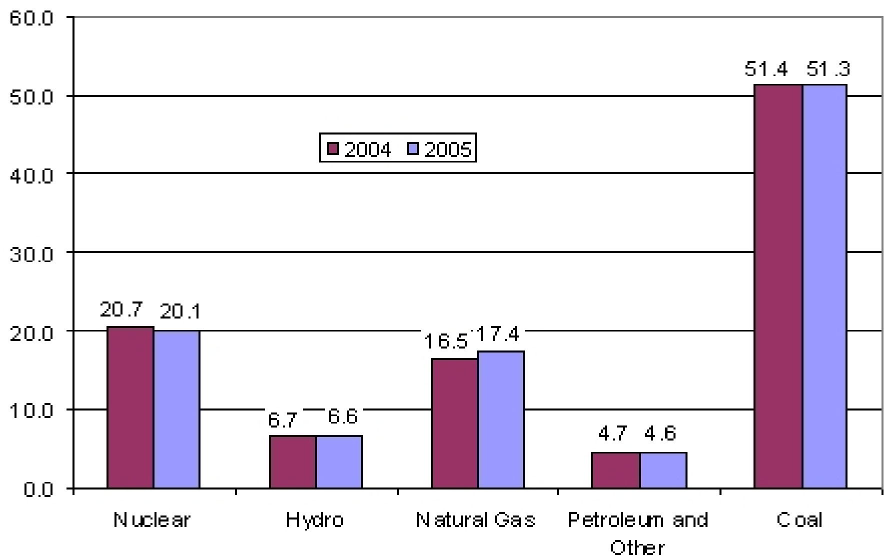
[9] Data are based on Energy Information Administration (EIA) data.
[10] 'Coal Production in the United States – An Historical Overview,' Energy Information Administration, October 2006

therefore, the external costs of an accident, especially in terms of delay on these crowded lines, may be substantial in coal transportation. If an accident occurs on a major route, the delay may cost millions. Owners of the equipment are not necessarily fully burdened by the delay costs, so they don't have incentive to warrant any change on their part voluntarily.

The majority of coal in the United States is moved by railroads exclusively or in multi-modal service with another method of transportation. The recurring problems that the coal industry typically deals with had varying impacts on coal production in 2005. Although many of these issues are related to weather, environmental issues, legal challenges, and global economics, the overriding issue for the United States coal industry in 2005 was transportation of coal from mines to consumers. The one transportation issue that most affected the coal industry in 2005 was the disruption of rail traffic from the PRB due to track maintenance. In mid May of 2005, there were two train derailments on the southern PRB joint line, caused in part by severe weather and coal dust on the rails. This resulted in an extensive program of track repair and replacement that affected the ability of mines in the area to ship coal to consumers throughout the country. After the train derailments in May 2005, PRB coal production in Wyoming and Montana was curtailed for approximately 2 months, returning to pre-derailment levels by July 2005. Although production began increasing after this date, electric utilities in the Midwest continued to experience problems with deliveries through spring 2006.[11] These derailments reverberated throughout all aspects of the coal industry. Several consumers experienced major disruptions in coal shipments that then resulted in precariously low stock levels and led to a major scramble to find other sources of coal to help ease the situation. The Union Pacific railroad instituted an embargo on new southern PRB business, and the spot market price of PRB coal hit record levels in the latter part of 2005. The electric power sector (electric utilities and independent power producers) is the driving force for all coal consumption, accounting for about 92 percent of all coal consumed in the United States [12] Coal continues to be the largest source of power generation in the United States.

[11] 'Deliveries of Coal From the Powder River Basin: Recent Events and Trends,' Infrastructure Security and Energy Restoration, Office of Electricity Delivery and Energy Reliability, United States Department of Energy, 2006.
[12] United States Coal Supply and Demand 2005 Review, Fred Freme, Energy Information Administration, United States Department of Energy

Share of Electric Power Sector Net Generation by Energy Source, 2004 vs. 2005



Source: Energy Information Administration, Form EIA-906, "Power Plant Report."

Limited rail capacity serving the PRB market is causing railroads to fail to deliver the contracted amount of coal to some consumers. In 2005, PRB coal was delivered to electric utilities and independent power producers in 36 states, including Wyoming. The challenges of getting coal to all consumers exist even when there are no disruptions in the production and distribution systems. Changes in velocity, or average train speed, indicate whether or not railroads are improving their capability to meet expected delivery schedules. Delays in coal distribution have been a significant source of concern. Arch Coal, the second largest United States coal producer, reported that railroad delays and missed shipments, along with curtailed production due to flooding in Central Appalachia, cost the company $8 million in the second quarter of 2004.[13]

One of the potentially most significant benefits of conversion of mainline corridors to all-ECP service is enhanced capacity, without the need for major new equipment or infrastructure investment. In addition to the safety benefits (discussed in more detail below), increases in velocity, or higher average train speeds, are possible with the use of ECP brakes. Average train speeds increase in some cases due to higher maximum speeds, but in all cases due to better ability to follow the safe speed limitations. ECP brakes will also reduce or eliminate train delays associated with undesired emergency applications and break-aparts caused by brake-related train handling. According to the BAH report on the ECP brake system for freight service, focusing ECP brake system implementation in the PRB makes both economic and practical sense. PRB coal represented an estimated 26 percent of total Class I revenue ton-miles in 2004, more than a

[13] Coal News and Markets, Week of September 26, 2004, Energy Information Administration.

quarter of all rail traffic.[14] The following chart summarizes the report's quantifiable costs and benefits for the PRB:[15]

Preliminary financials for the PRB Implementation Plan indicate a 3-year payback, an IRR of 47%, and an NPV of almost $700 million

One-Time Costs	Amount ($ million)	Annual Benefits	Amount ($ million)
Locomotive Conversion @ $40,000 per unit	112	Fuel Savings	78
Freight Car Conversion @ $4,000 per car	320	Reduced Wheel Defects	45
		Brake Inspection Savings	45
		Brake Shoe Savings	2
Total	**432**	**Total**	**170**

Source: Booz Allen analysis, using a discount rate of 12%

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This regulation will improve market efficiency by providing reliable and suitable standards and procedures that will support investments in ECP brake technology. ECP brake systems permit more rapid over-the-road movement because trains do not have to be artificially slowed or stopped to meet the recharging and lack of graduated release limitations of conventional air brakes. Greater throughput is achieved even within existing signal block configurations. The efficiencies gained through this technology will improve the efficiency of the entire market. ECP brakes will improve the overall capacity and relieve congestion in the PRB market. The additional safety improvements[16] achieved through the use of ECP brakes will reduce the risk of future derailments that place additional constraints on the coal market.

a. ECP Brake Technology Market Maturity

The United States market for ECP brake systems is mature enough to begin implementation of ECP brake technology. The equipment manufacturers have already made a significant investment in the technology and have completed the preliminary design work and field-testing on ECP brakes. A commitment by the railroad industry to change over to ECP brakes is necessary to inspire additional technological initiatives by the manufacturers.

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[14] Based on 1.66 trillion revenue ton-miles in 2004.

[15] This analysis uses a 7 percent discount rate, while the costs and benefits for the PRB shown use a 12 percent discount rate.

[16] The additional train handling benefits of ECP brakes are discussed further in section II. D. Safety Advantages of ECP Brakes, and the Benefit Estimates section (V. C. 2. a. Rail Equipment Accident/Incident Safety Benefits).

The ECP brake systems available from three United States suppliers can be characterized as: built with the intention of compliance with AAR standards, proven safe through field testing, designed using fail-safe principles, and accommodated industry's need for different implementation schemes. The ECP brake systems manufactured by all three suppliers have been tested in revenue service. There is no evidence of a malfunctioning ECP brake system that resulted in a catastrophic or critical event.

The equipment of all three suppliers relies on the conventional pneumatic emergency brake system as a backup in case of failure of the ECP brake control. Therefore, the ECP brake system does not diminish safety compared to the current safety level of conventional pneumatic brakes. In most cases, ECP brake systems will support enhanced safety even if the electronics fail, because continuous recharging of the brake pipe will ensure availability of an emergency application.

2. Improve the Safety of the Public

a. Technological Safety Advantages of ECP Brakes vs. Conventional Pneumatic Brakes

The technical concept of ECP brakes is significantly more advanced than that of conventional pneumatic brakes, and offers significant improvement in the safety of train operation. Research and deployment experience has shown that ECP brake systems that comply with AAR Standard S-4200 are significantly safer than conventional pneumatic brakes. The main advantage that ECP brake systems have over a conventional pneumatic brake system is that ECP brakes do not use the brake pipe as a signaling medium for commanding a brake application or release. ECP brake systems use an independent electrical communication cable to control the brakes on each car in the train. Such control command configuration is technically superior to the brake pipe command signal. The ECP brake electrical communication cable can provide accurate and instantaneous brake commands throughout the train, whereas the conventional pneumatic brake pipe signal is slow to propagate from the front of the train to the rear car. However, the two-way end-of-train (EOT) device used as part of the conventional brake system allows for an emergency brake application to be implemented from the rear of the train.

The ECP cable-based brake system design concept provides significant safety advantages:

- Instantaneous application of the brakes results in shorter stopping distances, lower in-train forces, and overall improved train handling.
- The stability of the electrical command signal supports graduated application and release of the brakes, which leads to improved train handling and better train operations on grades.
- Continuous brake pipe charging ensures that full brake capacity is available at all times.
- Continuous self-diagnostics of the car-mounted brake system provides real-time brake fault indication to the locomotive engineer.

- The electric communications cable can be multiplexed to provide a platform for establishing additional train management controls including distributed power management, activation and release of handbrakes, hot box detection, etc.; all of these potential features increase the reliability and safety of freight train operation.

ECP brake systems also eliminate some of the undesirable characteristics of conventional pneumatic brake systems that can lead to accidents, including depletion of air from brake pipe, undesired emergency applications, and sticking brakes. Air pressure reduction in a brake pipe, as a means of initiating braking, was a good concept when air brakes were first developed in the 19th century. Today, however, propagating a brake command signal through the brake pipe represents the main limitation of conventional pneumatic brakes. The same brake pipe air used to propagate brake commands also charges reservoirs on each freight car. The brake pipe must be fully charged to restore full braking capacity. Partially depleted air from the brake pipe, which occurs during initial braking, prohibits repeat applications of brakes until the brake pipe can be fully recharged. The brake pipe can be only charged when the brakes are fully released. This characteristic of conventional pneumatic brakes can jeopardize the safe stopping of a train, particularly on steep grades.

b. Safety Advantages of ECP Brakes

The associated safety advantages are:

Shorter stopping distances: Instantaneous application of brakes on all cars of the train leads to a significant reduction in braking distances (from 40 to 60 percent for the longest trains). The locomotive engineer is able to operate the train with more brake control. Simultaneous braking of all cars reduces the in-train forces and avoids damage or premature wear of brake system elements and car components. Lower in-train forces reduce lading damage. Also, the consequences of a collision or derailment are reduced because the brake system can potentially reduce the collision speed or slow the non-derailed portion of the train.

Graduated brake application and release: ECP brake systems overcome a major conventional pneumatic brake deficiency by allowing the engineer to reduce braking effort to a lower level after making an initial application. Conventional pneumatic air brakes can only be operated in direct release. Direct release means that after a brake application, brake effort can be increased but not decreased without fully releasing the brakes. ECP brake systems operate in graduated release and have the ability to increase or decrease the brake application level without fully releasing the brakes. This feature enables the engineer to accurately adjust the braking level to follow the speed limits. Graduated release is especially important when operating on steep grades or undulating terrain.

Continuous brake pipe charging: Since ECP brakes do not use the brake pipe as a brake command medium, the brake pipe is constantly being charged. This feature allows the locomotive engineer to operate the brake system without concern for the state of charge of the brake pipe. Full brake capacity is available at all times, which enhances brake performance and avoids the danger of depleted air, which can occur with conventional pneumatic brakes. With

ECP brake systems, there is no need to apply hand brakes on steep grades to recharge the brake pipe.

Diagnostics and self-tests: The use of an electrical communication cable allows real-time self-diagnostic functions to be incorporated in the brake system. The initial check of brake system conditions on each car, and continuous monitoring of each car's braking functions, allows the locomotive engineer to immediately notice any brake failure. Real-time diagnostics may eliminate the need for some physical inspections of the train and supports the possibility for reduced regulatory requirements for brake inspections and for operating cars with nonfunctioning brakes in the initial terminal consist.

Additional train management controls: The electrical communication cable network can also serve as a platform for additional train management controls, including: distributed power locomotive control, automatic activation of hand brakes, hot bearing detection, and truck oscillation and vibration.

These and other train management features will increase the reliability and safety of train operations.

D. Major Provisions of Proposed Rule

- Proposes requiring ECP brake equipped systems to comply with existing AAR standards and receive AAR approval prior to use.
- Proposes requiring the amendment of current operating rules and training programs for inspection and operating personnel to reflect the unique characteristics of ECP brake systems.
- Proposes regulatory relief from various existing inspection, testing, and maintenance requirements and proposes alternative inspection, testing and maintenance requirements more appropriately applicable to ECP brake systems.
- Proposes requiring ECP braked trains to receive Class I brake inspections by a qualified mechanical inspector and full mechanical inspection (under Part 215) at their initial terminal (similar to existing extended haul trains) and proposes to allow such trains to travel to destination, not to exceed 3,500 miles.
    - Currently, extended haul trains are limited to 1,500 miles between brake inspections and all other trains limited to no more than 1,000 miles between brake inspections. Thus, the proposal would eliminate at least one Class I brake test or two Class IA brake tests on long distance trains, depending on how currently operated.
- Proposes to extend the period that a train or car equipped with ECP brakes could be disconnected from a source of compressed air without being reinspected to 24 hours. Current rule only permits cars to be off-air for 4 hours before needing to be reinspected.

- Proposes modifying all brake pipe service reductions for all brake tests and piston travel limit adjustments for Class I brake tests so they are consistent with how ECP brake systems operate.
- Proposes allowing freight trains operating in ECP mode to depart from an initial terminal with 95 percent operative and effective brakes, instead of the currently required 100 percent operative and effective brakes. Also proposes to permit cars with defective ECP brakes to be moved to a train's destination and permit defective non-brake and conventional pneumatic brake equipment to be hauled to the nearest forward repair location.
    - In order to provide this flexibility, the FRA will need to utilize the statutory exemption provision contained in 49 U.S.C. 20306. This provision permits the FRA to exempt equipment from the specific statutory safety appliance requirements if the requirements preclude the development or implementation of technological improvements. The FRA believes that is the case with ECP brake technology. The provision requires that a public hearing be conducted to receive evidence and that a finding be made on the issue.
- Proposes requirements related to the movement of ECP brake equipped cars in conventional pneumatic brake equipped trains.
- Proposes rules requiring the tagging of defective equipment and procedures for handling ECP brake system repairs. Proposal recognizes the ability of ECP brake systems to continuously monitor and identify defective equipment. Thus, the proposed rule accepts electronic tagging via ECP brake system if certain retention and access criteria met.
- Proposes modified periodic maintenance requirements, including single car brake tests tailored specifically for ECP brake systems. This will reduce the number of single-car tests that must be performed on cars equipped with ECP brakes.

E. General Benefits of Proposed Rule

As stated earlier, the parties that benefit from ECP brakes include: railroads through more efficient operations, rail shippers and car owners through improved asset utilization and service, railroad employees and the public through improved safety on the railroad and by keeping shipments on the rails that would otherwise burden congested highways, and the National economy and the environment through better utilization of fossil fuels and contributing to transportation capacity. The rail carriers will benefit from clearer expectations, minimum performance standards, enhanced planning, and better guidance and direction. ECP brakes apply uniformly and virtually instantaneously throughout the train, provide health status information on the condition of brakes on each car, respond to commands for graduated releases, and entirely avoid runaway accidents caused by depletion of train-line air pressure. ECP brakes shorten stopping distances on the order of 40 to 60 percent, depending on train length and route conditions.[17] In turn, shortened stopping distances mean that some accidents that occur today might be avoided entirely, and some others might be reduced in severity. However, safety analysis confirms that most grade-crossing accidents, in particular, could not be avoided with ECP brakes, because motorist actions become manifest only seconds before the collision.

Safety benefits of regulatory changes can frequently be estimated with some degree of precision. Incident and accident history often provide a basis for estimating fatality, injury, property damage, environmental damage, and similar costs to society that can be avoided by the implementation of new requirements. Models can even estimate the costs to society of high-consequence, low-probability accidents. Benefit estimates can then be balanced against the estimated costs of new requirements to determine whether the changes are justified. In the end, when safety measures are evaluated, an element of judgment is required to determine whether the costs of the measures are justified by the benefits that will accrue. The benefit discussion can be found in Section V, Evaluation of the Benefits and Costs.

The FRA intends to fund a follow-up study on the initial ECP brake equipped trains. The objective of the follow up study is to verify the business benefits following ECP brake implementation. As part of the study, the relevant data items will be collected to compare ECP brake equipped trains and conventional brake equipped trains, and develop supportable conclusions for the business case validation. The study will compare the costs of operating unit and unit-like train sets over the same origination/destination pairs with conventional brakes versus those operating with ECP brakes. Carriers intending to operate ECP brake-outfitted trains will need regulatory relief from FRA and must have the required waiver in place before commencement of operations.

III. ALTERNATIVE REGULATORY APPROACHES

The primary alternative to the regulation proposed by FRA would be to adopt a mandatory requirement to adopt ECP brakes. We will analyze this alternative in more detail below. OMB Circular A-4 recommends that agencies consider many other alternative regulatory approaches. Here, we highlight a few areas where we believe we have adopted flexibilities reflective of the approaches OMB recommends.

A. Different Enforcement Methods

Onsite inspections are the most economically efficient method of enforcement for this regulation. The review and approval of hundreds of brake systems by DOT personnel on an annual basis would be extremely resource-intensive and time consuming. Enforcement of this proposed rule would be conducted in the same manner of enforcement as other brake requirements. During the course of their regular inspections, DOT inspectors will review the technology, physical parts present, and paperwork for compliance with the regulations. As with other regulations, inspectors have the discretion to issue notices of noncompliance, or to recommend civil penalties for probable violation of the regulations. This rulemaking has considered different methods of

[17] 'Benefit-Cost Analysis and Implementation Plan for Electronically Controlled Pneumatic Braking Technology in the Railroad Industry,' Booz Allen Hamilton, August 2006.

enforcing safety requirements, and in fact a significant part of the regulatory relief offered is due to decreased inspection frequency.

B. Different Requirements for Different Sized Firms

The FRA is proposing facilitating the voluntary adoption of ECP braking systems. Although the requirements do not differ by the size of the firm, we believe the costs imposed by this regulation will be more proportionate to the benefits through this voluntary approach. One assumption of this analysis is that only four United States Class I railroads will initially implement ECP brake technology. This assumption is reasonable given the cost of conversion. In practice, we believe the largest Class I carriers will take advantage of this opportunity to adopt ECP; therefore, we believe we have adequately considered firm size when designing these regulations.

C. Informational Measures Rather than Regulation

Standards and regulations are essential to ensure that all carriers work to improve the safety and security of their operating environment. An alternative might be a guidance document published in the Federal Register, which would be instructive to the carriers, but would fail to ensure an improvement in safety or efficiency. The proposed scheme is flexible, allowing each rail carrier to have the same regulatory relief opportunities. Informational measures may also be used in addition to the proposed rule. Such informational measures include tools to assist carriers in predicting the business benefits of ECP technology, and guidance documents detailing best practices throughout the industry. It is anticipated that the ECP brake manufacturers will assist their customers with best practices regarding conversion and training acquired through their overseas experiences.

IV. AN EXAMINATION OF ALTERNATIVE APPROACHES

A. Evaluation of Alternative Regulatory Approaches

Analyzing all possible combinations of provisions is impractical. The FRA is not mandating the use of ECP brakes. ECP brakes are a major capital investment (on the order of $6 billion for all locomotives and cars). This analysis assumes only four United States Class I railroads will implement this technology on the portion of their operations where it produces the greatest returns, although it is possible that additional Class I and Class II carriers adopt the technology within the time period of analysis. The proposed rule provides reliable and suitable standards and procedures that can support investments in ECP technology for revenue service.

B. Different Levels of Stringency

The benefits and costs associated with a regulation will increase with the level of stringency. Alternative levels of stringency are presented to further describe the relationship between stringency options and the benefits and costs. The costs and resulting benefits are proportionate with the number of cars and locomotives converted to ECP brakes. If the proposed regulation were mandatory (i.e., more stringent) all cars and locomotives in the United States would require conversion to ECP brakes. The more stringent, mandatory rule would require a percentage of the entire locomotive and freight car fleets would have to be converted to ECP brake technology each year on a gradual basis. There are some 29,000 freight locomotives in the United States fleet, and approximately 1.4 million freight cars in service.[18] Equipping this entire fleet with ECP brakes at a cost of $40,000 per locomotive and $4,000 per freight car would total approximately $6.8 billion.[19] To put this number in context, it is more than the combined annual capital expenditures of all the Class I railroads.[20] The operating realities of the rail industry are such that, for a significant number of freight cars, overlay operation will be unavoidable for some time. Overlay is defined here as the capability of a freight car to operate in either conventional or ECP brake service.[21]

Even if the investment were spread over 20 years, at a rate of $350 million per year, it would require $42 million in annual net benefits over 20 years for each investment installment to achieve even a relatively modest return of 12 percent. Realizing such sizeable benefit streams from an undifferentiated approach to ECP brake system installation is highly unlikely, as the operational difficulties of making ECP brake-equipped locomotives available for ECP brake converted cars, and vice-versa, means that few trains would actually operate in the ECP brake mode until the majority of the fleet was converted. Thus, near-term costs may outstrip more distant benefits, especially in the absence of regulatory relief.[22] Additionally, all 559 railroads and thousands of car owners would incur conversion costs. The expected benefits of ECP braking technology appear to justify the investment, provided that the conversion is focused first on the high-mileage, unit and unit-like train services that would most benefit from its use, and that subsequent conversions incorporate lessons learned.

An example of a less stringent alternative would involve the granting of waivers in lieu of a rule. This alternative may not spur investment in ECP brake technology. Waivers would not afford the regulatory certainty the proposed rule provides. Waivers are not permanent and can be rescinded. Companies are not likely to make investments in ECP brakes with the additional uncertainty and increase in risks that would be present absent a regulation.

C. Status Quo (Do Nothing)

The baseline continues the status quo. This is a “no action” baseline and the benefits and costs are compared with this alternative. If the proposed rule is not adopted, rail carriers are not provided regulatory relief nor required to produce or retain certain operational data. This may

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[18] The car count includes about 100,000 cars owned by non-Class I railroads in the United States and another 100,000 cars owned by Canadian-based railroads that are also operated within the United States.
[19] This is before making three adjustments: (1) for inflation; (2) for economies of ECP manufacturing scale and implementation experience not yet factored into the per-unit costs used here; and (3) to reflect that some portion of road locomotives, perhaps as high as 20-25 percent, operate as permanent trailing locomotives, and require only an ECP run-through cable at minimal cost, not full cab conversion.
[20] ‘Benefit-Cost Analysis and Implementation Plan for Electronically Controlled Pneumatic Braking Technology in the Railroad Industry,’ Booz Allen Hamilton, August 2006, p. I-9.
[21] Ibid.
[22] Keeping ECP locomotives available for ECP freight cars has been one of the chief obstacles in railroad experiments to date with ECP. In addition, one study estimated that, even after 99 percent of all freight cars were equipped with ECP, the probability of randomly assembling a 100-car all-ECP train would be only 37 percent. (Study by New York Air Brake as cited in Leonard McLean’s paper to the September 2001 Chicago meeting of the Air Brake Association.)

also occur if the railroads decide not to implement this technology. The railroads have limited resources and numerous competing technologies that may result in the adoption of other technologies in lieu of ECP brakes.

V. EVALUATION OF THE BENEFITS AND COSTS

A. Scope of Analysis

This analysis focuses on benefits and costs accruing to citizens and residents of the United States. The time frame of this analysis is 20 years, a sufficient time frame to encompass all the important benefits and costs likely to result from this rule.

The proposed rule may affect Mexican and Canadian rail carriers. This regulation may affect the same rail carriers already required to comply with all existing regulations because they operate within the United States. The costs associated with the proposed regulation are based on shipments within the United States and associated carriers. No additional carriers are affected by this regulation.

B. Baseline

The best assessment of the way the world would look absent the proposed regulation will resemble the present. The baseline assumes no change in the regulatory program. Although railroads work toward safety and efficiency improvements, the development of this technology may take place more slowly and less consistently absent this proposed regulation.

C. Discounting

The benefits and costs of the proposed regulation occur in different time periods; therefore, discounting is used to account for the fact that resources available in a given year are worth more than the identical resources in a later year. The discount rates currently used are 3 percent and 7 percent in real terms. The discount rate of 7 percent is emphasized because it is an estimate of the average before-tax rate of return to private capital in the United States economy. It is a broad measure that reflects the returns to real estate and small business capital as well as corporate capital. It approximates the opportunity cost of capital, and it is the appropriate discount rate whenever the main effect of a regulation is to displace or alter the use of capital in the private sector.

D. Benefit Estimates

The primary source of safety benefits would result from the avoidance of a portion of the fatalities, injuries, and property damage that result from accidents. Accidents often result in fatal or very serious injuries, evacuations, railroad equipment damage, and environmental damage.

The safety benefits of the proposed rule are measured in terms of the reduction in the risk of an accident. The number of potential accidents is a function of exposure. Clearly, the greater the traffic volume, the greater the likelihood of exposure and number of potential accidents.

Because there is no reason to believe traffic growth rates will significantly change, it is assumed they will remain constant. It is assumed the ratio of accidents to exposure will remain constant in the absence of change.

Description of benefits and costs that cannot be quantified:

Potential benefits, which have not been quantified in this analysis due to a lack of data, may equal or substantially exceed the benefits that have been quantified. For example, train accidents affect the surrounding areas in which they occur and can affect whole communities. Local emergency response personnel and equipment will bear the expense associated with an accident. The costs of medical treatment for those near the accident site could be substantial, and associated road closures also produce significant economic impact to travelers and the communities nearby. The potential for hazardous material releases can significantly exacerbate these accidents. This benefit may be high in the case of a hazardous material release or modest if there is no release. Should a hazardous material release impact a river or stream, the consequences to wildlife in the area could also be severe and lasting. The costs associated with these types of accidents could be extremely high and, as these types of costs (potential benefits) have not been calculated in this analysis (due to a lack of data), the benefit estimations are conservative.

An additional benefit that cannot be quantified is the flexibility provided in the relief to the current regulation by proposing a performance standard. Flexibility can be extremely beneficial to the regulated community. Under current regulations when a car or train is “off air” (or not connected to a source of compressed air), a reinspection is required. With ECP brakes, that car or train could be disconnected from a source of compressed air for 24 hours before requiring reinspection. This regulatory change could potentially change operations. The FRA anticipates that the savings could be substantial, but without data, this benefit cannot be quantified.

The FRA requests comments and information regarding how often under the proposed rules that railroads expect cars will be off air for more than 4 hours, but less than 24 hours.

Wiring the train will provide a platform for the gradual addition of other train performance monitoring devices using sensor-based technology to maintain a continuous feedback loop on train condition for the crew and any centralized monitoring. Although adding additional sensors will incur additional costs, the platform provided by ECP permits additional benefit options to the owners and operators of rail equipment. This important benefit of ECP brakes could be substantial, but is not possible to quantify at this time.

Another benefit that cannot be quantified is allowing freight trains operating in ECP brake mode to depart from an initial terminal with 95 percent operative brakes compared to conventional trains that are required to have 100 percent operative brakes. This time-saving benefit is substantial because after a train is put together and a car with inoperable brakes is found, the train must be taken apart to remove the defective car and put back together again. Reassembling a train can be an extremely time-consuming process, and therefore a very costly process. The loss in efficiency can be substantial if it causes a domino effect and delays other trains. The

FRA does not have data regarding how often this occurs, and cannot quantify this benefit; however, at this time, we are studying this issue.

Reduced train crew fatigue is also possible with ECP brakes because of continuous monitoring and the automatic stop of the train if operative brakes fall below 85%. If a brake application is incorrect, the engineer can immediately correct the brake pressure because of the ECP brake feature of graduated release. While no definitive data has yet been compiled, ECP braked trains are far easier to operate. They do not require the engineer to closely monitor the train brake system pressure level, as the system is always fully charged. Thus, the engineer can safely and efficiently brake the train. The engineer can concentrate on the operating environment in which the train is located, rather than also having to prepare for likely brake pressure levels miles ahead.[23]

An additional benefit in the proposed rule that cannot be quantified is allowing cars with defective ECP brakes to be moved with the train to destination. The proposed rule permits conventional brake equipment to be hauled to the nearest forward repair location. In ECP brake equipped trains, the engineer knows both the status and the location of all operative and inoperative brakes on the train. This information is not available to engineers on trains equipped with conventional brakes. Currently, defective equipment must be hauled to the nearest repair facility, which may be in the opposite direction of the train's destination. The benefits of this relief are likely to be great. However, the FRA lacks data regarding how often these situations occur, and therefore cannot quantify this benefit.

The FRA seeks comments and information regarding how often trains currently require reassembly at their initial terminals to ensure 100 percent effective and operative brakes or cut-outs en route to ensure 85 percent effective and operative brakes. The FRA also requests to know whether commenters feel other percentages higher or lower than those proposed here better balance the costs and the benefits of these provisions.

The proposed rule recognizes the ability of the ECP brake system to continuously monitor and identify defective equipment and to accept electronic tagging via the ECP brake system if certain criteria are met. This benefit allows the train to continue moving, whereas currently the crew must walk the train to inspect the defective car(s). This saves time and reduces safety risks associated with walking the length of the train, especially during inclement weather.

Under the existing regulations, the conventional pneumatic brake system's EOT device can lose communication for 16 minutes and 30 seconds before the locomotive engineer is alerted. After the message is displayed, the engineer must restrict the speed of the train to 30 mph or stop the train if a defined heavy grade is involved. Per the regulations, railroads must calibrate conventional two-way EOT devices every 365 days and would likely incur additional maintenance and cost expenses while replacing its batteries. Further, conventional EOT devices are heavy and present a potential for personal injury when applied to the rear of the train.

[23] 'Benefit-Cost Analysis and Implementation Plan for Electronically Controlled Pneumatic Braking Technology in the Railroad Industry,' Booz Allen Hamilton, August 2006.

By contrast, an ECP-EOT device uniquely monitors both brake pipe pressure and operating voltages and sends an EOT Beacon every second from its rear unit to its head end unit (HEU) on the controlling locomotive. The HEU will initiate a full service brake application should brake pipe pressure fall below 50 psi or an emergency brake application should a communication loss occur for five consecutive seconds or the electrical connection break. An ECP-EOT device may not require calibration and its battery, only a back-up for the computer, is charged by the train line cable and is much lighter in weight than the conventional EOT device battery. Physically the last network node in the train, the ECP-EOT device also contains an electronic train line cable circuit–a 50 ohm resistor in series with 0.47 micro-farad capacitor–and must be connected to the network and transmit status messages to the HEU before the train line cable can be powered continuously, resulting in a shorter interval where there is potential to lose the brake signal. This ensures that the brake system is much quicker than the conventionally braked train, thus ensuring the train will stop before a minor problem becomes a significant problem.

The FRA requests comments and information regarding the ECP end-of-train device savings.

The aforementioned benefits cannot be quantified, but still represent significant benefits. However, the most significant benefit is the potential for increased train velocity and capacity gains. These gains are possible because with ECP brakes longer trains are possible, higher average train speeds are possible, shorter restarting times after train stops, train handling issues are significantly reduced, and train brake system recharge times are practically eliminated.

Longer trains are possible with ECP brakes. The use of electrical signals instead of air pressure for brake applications allows the brake pipe to be maintained at full pressure at all times. The uniform braking and constant pressure reduces end-of-train pressure problems and in-train forces that restrict current train lengths.

Higher average train speeds are possible, in some cases due to higher maximum speeds, but in all cases due to better ability to follow the safe speed limitations. The ability to perform a graduated release allows the engineer to reduce the brake application whenever it is too severe. Thus, there is no need to travel any distance at too slow a speed because of the inability to make a brake release.[24]

Shorter restarting times after train stops are also achievable under ECP brake operations. With the current brake technology, the auxiliary reservoirs on each car of the train must be recharged, and the brakes reset and ready before starting the train, if braking will soon be required. Thus, in areas of known descending grades there is a waiting period before the train can proceed after stopping en route.[25]

With ECP brakes, the brake pipe pressure is not lowered to signal a brake application. Instead, electric signal transmitted down the train on a wire indicates the brake application. The brake

[24] Ibid, p. II-6.
[25] Ibid, p. II-6.

pipe remains charged at 90 psi and continues to supply the reservoirs during braking. Hence, there is no downtime needed for recharge after braking.[26]

The information currently available suggests that additional substantial benefits not included in the $3.2 billion referenced above may be realized. The most significant benefit of conversion of mainline corridors to all-ECP brake service is enhanced capacity, without the need for major new equipment or infrastructure investment. Although the FRA cannot predict the specific effect that ECP brakes will have in increasing velocity across the national rail network, the FRA believes that the adoption of ECP brake technology will increase train speed and this hypothesis is supported by the BAH analysis. Given sharply growing demand for rail freight service, and based on the enhanced features that ECP brake systems offer, including (1) reduced stopping distances, (2) shorter start times, (3) reduction of undesired emergencies, (4) continuous brake pipe charging, (5) graduated brake application and release, (6) self-diagnostic train management, and (7) potential increase in the total number of cars per train, an increase in average train velocity will likely result. For instance, the BAH report cites a Union Pacific Railroad (UP) estimate that, for each 1 mph (or 5 percent) improvement in its overall system average velocity, UP saves 250 locomotives and 5,000 freight cars that would otherwise be required. At a cost of $2 million per locomotive and an average of $50,000 per freight car, this savings represents $750 million for UP alone. The UP fleet is representative of the industry's Class I railroads and comprises approximately one-third of all Class I railroad owned locomotives and one-fourth of all Class I railroad owned freight cars. Assuming that other Class I railroads have similar equipment utilization rates, it could be possible to extrapolate the $750 million in UP savings to the other Class I railroads, which could result in a $2.5 billion in savings from a 1 mph increase in network velocity. Any savings realized would increase accordingly if there are speed gains of greater than 1 mph.

However, the unit and unit-like trains covered by this analysis only cover a portion of the industry-wide train total. Given that unit coal trains, which are among the slowest moving trains on any given network, could experience velocity gains significantly greater than 1 mph and that all Class I railroads transport a significant amount of coal on their main lines, this estimate is likely a lower bound estimate. Thus, due to the number and variability of factors that would determine the actual level of savings realized due to network velocity improvements, such benefits are not included in the total benefits. The expected benefits of ECP braking technology appear to justify the investment, provided that the conversion is focused first on the high-mileage, unit and unit-like train services that would most benefit from its use.

The FRA requests comments regarding the velocity improvements on mainline corridors.

1. Effectiveness

a. The Effectiveness Metric for Public Health and Safety Rulemakings

The public safety effectiveness metrics used include the number of lives saved and the proposed rule's impact on morbidity (in this case, nonfatal injury) as well as premature death.

[26] Ibid, p. II-6.

b. Number of Lives Saved (Fatality Risks)

Measurements of willingness to pay for reductions in the risk of premature death are used in the calculation of the value for the projected reduction in the risk of premature mortality. The United States Department of Transportation estimates the "willingness to pay" to avert a fatality to be $3 million. The "willingness to pay" estimate is based on the amount individuals are willing to pay to avoid a fatality. This value incorporates all aspects of well being, including foregone labor and non-labor income, leisure time, and pain and suffering of relatives and friends. This amount has no application to an identifiable individual or to very large reductions in individual risks. This does not suggest that any individual's life can be expressed in monetary terms. The sole purpose is to help describe better the likely benefits of this regulatory action.

c. Potential Injuries Averted (Nonfatal Health and Safety Risks), Impact on Morbidity

A traumatic injury that can be treated effectively in the emergency room without hospitalization or long-term care is different from a traumatic injury resulting in paraplegia. Severity and duration of an impaired health state is necessary before the task of monetization can be performed. Data on the severity of injuries resulting from brake-related accidents suggest these injuries are typically quite severe. The value of an injury is calculated using the Abbreviated Injury Scale (AIS) developed by the Association for the Advancement of Automotive Medicine. The AIS categorizes injuries into the six levels of severity presented below. The AIS also assigns values to these categories based on the "willingness to pay" approach discussed above.

AIS Level	**Value**	**Fraction of Value of Life**	**Example of Injury**
AIS 1 - Minor	$6,000	0.0020	Superficial abrasion or laceration of skin, digit sprain, first-degree burn, head trauma with headache or dizziness (no other neurological signs).

An AIS 1 injury is simple, and may not require professional medical treatment. Recovery is usually rapid and complete.

AIS 2 - Moderate	$46,500	0.0155	Major abrasion or laceration of skin, cerebral concussion (unconscious less than 15 min.), finger or toe crush/amputation, closed pelvic fracture with or without dislocation.

An AIS 2 injury almost always requires treatment, but is not ordinarily life-threatening or permanently disabling.

AIS 3 - Serious	$172,500	0.0575	Major nerve laceration; multiple rib fracture (without a flail chest); abdominal organ

			contusion; hand, foot, or arm crush/ amputation.

An AIS 3 injury has the potential for major hospitalization and long-term disability, but is not generally life-threatening.

AIS 4 - Severe	$562,500	0.1875	Spleen ruptures, leg crushes, chest wall perforations, and cerebral concussions with other neurological signs (unconscious less than 24 hrs.).

An AIS 4 injury is often permanently disabling, but survival is probable.

AIS 5 - Critical	$2,287,500	0.7625	Spinal cord injury, extensive/deep laceration of kidney or liver, extensive second- or third-degree burns, cerebral concussions with severe neurological signs.

An AIS 5 injury usually requires intensive medical care. Survival is uncertain.

AIS 6 - Fatal	$3,000,000	1.0000	One that will probably eventually lead to death, massive destruction of the cranium, skull, and brain.

2. Distributional Effects

The rail equipment owners and operators will bear the immediate costs of this rule. The majority of the direct costs will fall on car owners (most cars are privately owed by shippers or leasing companies); however, the majority of benefits will fall on the railroads (locomotive operators). The FRA expects that car owners will likely spread the cost of ECP brake implementation via higher prices. The primary benefit of reduced risk accrues to railroad employees and the general public. Benefits of risk reductions depend on the degree of exposure to risk. Historical accident data is used to estimate safety benefits. These benefits are substantial when considering the totality of risk and not just the cost of an event.

E. Methods of Estimating Benefits

Safety benefits are addressed using recent railroad accidents. To address the benefits, the cost of accidents is estimated based on standard United States Department of Transportation estimates for the value of a statistical life set at $3 million. The AIS scale is used in conjunction with the statistical value of life to determine the value of injuries. The result is the benefit value of avoiding the risk of a similar accident.

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

1. Historical Accident Data

An example of a brake-related accident is a 1996 accident in Cajon Pass in California; an out-of-control train coming down a hill killed two people, injured 32 more, and released hazardous materials causing the evacuation of the surrounding area. A 20-mile segment of a main highway was closed for 5 days, requiring approximately 89,000 vehicles a day to find alternative routes. This example is illustrative, and was not used to calculate ECP brake benefits.

While the FRA has taken other specific actions to prevent a repeat of this particular accident, and has therefore not included reduction in risk of this accident in the estimated benefits for this rule, these accidents illustrate the type of danger posed by an out-of-control train. Whether caused by a brake system failure or other reasons, a train that loses its ability to control its speed poses a tremendous risk to life and property. The rule being analyzed at this time will help to prevent this type of accident (out-of-control train) because ECP brakes do not depend on the brake pipe to transmit the brake command.[27]

ECP brake system benefits are calculated using both highway-rail grade crossing accidents (Form F 6180.57) and Rail Equipment Accident/Incident (Form F 6180.54) from the 5-year period of 2001-2005. The FRA specifically used recent data to account for regulatory changes and changes in crossing characteristics, including the upgrading of crossing warning devices.

The number of potential accidents is a function of exposure (rail and highway traffic volume at grade crossings and freight traffic). Clearly, the greater the traffic volume, the greater the exposure and number of accidents. Traffic volumes are continuously growing along with freight traffic volumes. Although growth in traffic may increase the benefits of the rulemaking by increasing number of trains that are safer to operate, volumes may at some point increase to the point where congestion becomes a larger issue, offsetting a portion of the business benefits of this rule. The magnitude of the impact of the probability of accidents as a result of ECP brake utilization depends on the effectiveness of ECP brakes in reducing accident probability and the number of accidents expected absent ECP brake utilization. Absent the proposed regulatory relief, we assume that accidents in the future will be similar to accidents in the past, resulting in similar levels of safety risks. The frequency and type of fatalities, injuries, and vehicle damages in the future will mirror the past, all other factors being equal.

There are two distinct types of train freight operations: carload freight and unit train operations. For the purposes of this analysis, “unit-like” operations will be used to describe current unit trains allowed to have one pickup and set-out and operations that lend themselves to unit train service but may have more pickups and set-outs. Carload freight is handled in multiple trains in

[27] See ‘Safety Advantages of ECP Brakes’ earlier in this analysis for a more technical explanation.

route, possibly with 3 to 4 handlings between pickup and delivery. Carload freight is switched through classification yards and usually travels through multiple yards per trip. Pickup and delivery occurs as individual cars or small blocks of cars. These commodities are often priced, marketed and managed as individual carload lots. Empty carload freight cars are unlikely to return to the original loading customer. The following chart from the BAH report explains the differences between unit train operations and carload freight operations:

Carload freight lacks many of the operational efficiencies that unit trains possess, resulting in more equipment to deliver fewer revenue train miles[28]

	Unit Train Operations	Carload Freight
Requirements	Scheduled long-haul mainline movement	Extensive gathering, sorting, delivery, storage
Pricing	Sophisticated yield management to maximize revenue contribution from each contract	Blizzard of contracts, tariffs, spot quotations requiring extensive marketing and administrative support
Turnaround	Scheduled cycle times, as for coal moving to utilities in dedicated train sets	Complicated train makeup, power assignment, crew calling and intermediate terminal burdens
Network Performance	Generally maximizes overall system fluidity	Can lead to reduced velocity, increased terminal dwell times, greater numbers of cars on line
Customer Service	Large, sophisticated customers operating under long-term contracts	Diverse customer base requiring extensive marketing, operating and administrative support
Overall Complexity	Maximizes what the network does best – predictable line-haul movement of large, scheduled trains	Maximizes what the network is least suited to – last-mile type gathering, delivery and enroute sorting of diverse loose carloads

Coal, grain, intermodal containers, motor vehicle parts, non-metallic minerals, and ore are all market segments that have characteristics suitable for unit and unit-like train operations described in the table above. Typical coal traffic operations transport high volumes of coal from a mine source to a power plant. Grain operations carry the commodity from grain elevator or other storage facilities to processing plants. Motor vehicle parts are transported from manufacturer or port to receiving facilities. Non-metallic minerals and ore (e.g. rock) are transported from quarry to processing plant. All of these traffic movements involve one commodity transported in repetitive high volume operations.

The FRA does not know which of the trains involved in the historical accidents are long-haul, high-mileage trains that the BAH report identified as candidates for early conversion to ECP brakes. However, by using the 2005 Freight Commodity Statistics published by the AAR, approximately 61 percent of all carloads originated in the United States lend themselves to unit-like train service. The following commodities were used to calculate unit-like trains: coal, intermodal, grain, ore, non-metallic minerals, and motor vehicle parts.[29] Because these

[28] ‘Benefit-Cost Analysis and Implementation Plan for Electronically Controlled Pneumatic Braking Technology in the Railroad Industry,’ Booz Allen Hamilton, August 2006.

[29] Freight Commodity Statistics, Association of American Railroads, 2005.

commodities account for 61 percent of originating carloads, the accident pool (2001-2005 accidents) will be multiplied by .61 in an effort to capture the portion of those selected accidents that may have ECP brake-equipped trains. Over time, other market sectors will convert to ECP brakes as the rate of conversion to ECP brakes increases in the industry. The FRA estimates that a reasonable timeline for conversion of unit-like train movements to ECP brakes is 10 years. Thus, partial safety benefits will accrue up to a period of 10 years, with full benefits accruing from years 11 to 20 for unit-like train service. As mentioned, during the first 10 years of conversion, the rate of conversion will likely increase as more trains are converted; however, FRA does not have information to determine what that rate of conversion will be. Thus, benefits are increased at a constant rate for the first 10 years.

2. Benefit Summary

Brake systems are a key component for controlling train speed. Train accidents caused by a loss of control are often the most serious accidents, and often have severe consequences for both the train crew and the surrounding communities. Not only does derailed railroad equipment itself pose a significant hazard, but also fires and releases of hazardous materials can threaten lives and property near the accident site. When a brake system loses the ability to control train speed or stop the train, the results can be truly catastrophic. ECP brakes significantly improve train handling, stopping distance, throughput, efficiency, and safety. The safety benefits include: reduction in the risk of fatalities and injuries, reduction in the risk of property damage, reduction in the risk of an environmental spill which would require cleanup, and reduction of track out of service time. Business benefits of ECP brakes include the operational latitude provided to implement ECP brakes. This latitude is provided in the form of regulatory relief.

a. Rail Equipment Accident/Incident Safety Benefits

ECP brakes have a significant positive impact on rail safety by reducing stopping distances, improving train handling, allowing continuous charging of brake reservoirs, and supporting graduated release of brakes. Improved train handling and graduated release of the brakes will reduce the chances of runaway trains and resulting derailments. Continuous charging of brake reservoirs provides the ability to stop the train at all times, removing the threat of premature depletion of air from the system. Improved train handling reduces the risk of derailments caused by in-train forces because brakes apply evenly and simultaneously. With conventional brake technology, the first cars in the train (the cars at the head of the train) begin to brake first, then braking is initiated progressively back through the train. If braking is not performed carefully, the cars in the rear of the train will run in as the slack adjusts (compressing the train). This condition could cause excessive forces that could cause a car to derail. ECP brake-equipped cars practically eliminate this risk by braking simultaneously so that slack run-in is minimized or eliminated.

ECP brakes are easier to operate then conventional brakes and reduce the chance of engineer error. Operating a train with conventional brake technology is a complex task, requiring extensive knowledge and experiences with various types of trains, knowledge of the rail line over which the train is running, and constant pre-planning of train speed and braking options several miles ahead. Because of the slow application and release times for conventional braking, engineers must plan their moves well in advance. On grades, the locomotive engineer is constantly watching gauges, monitoring speed, air brake pressure, and dynamic brake effort, to control train speed. On level track, the locomotive engineer must use proper train handling techniques to ensure that the train can stop short of a red signal before entering a track that another train is occupying. The engineer is constantly making judgments on how much brake pressure to apply.

Conventional air brake systems operate in direct release. Braking effort can be increased as needed. Once a brake application is made, however, the braking effort can be cannot be decreased without completely releasing the brakes. This feature of conventional air brakes can cause the locomotive engineer to decide on less pressure when braking assuming, perhaps unwisely, that braking effort can always be added if needed. The brake application process is simplified with ECP brakes because ECP brake effort can be increased or decreased at will. The engineer does not need to worry about applying too much braking effort, because he can partially reduce the brake effort at any time.

Reduction of undesired emergencies (UDEs) is another significant benefit of ECP brake technology. UDEs can occur randomly, forcing the braking system into emergency. When the system goes into emergency, engineers have no control over the situation and in-train forces can cause derailments. UDEs are virtually eliminated using ECP brakes.

One characteristic of train handling that affects the ability of trains to negotiate railroad tracks are in-train forces – also referred to as "draft" (stretching) forces and "buff" (compressive) forces within the train. Trains are subject to derailment depending on grade, curvature, control manipulation (use of the throttle, independent brake, dynamic brake, and automatic braking system), and other factors. Braking is accomplished by dynamic braking, by use of the automatic brake, and by use of the independent brake. Dynamic braking is a process by which the traction motors are electrically converted to generators. The current they develop is then dissipated through resistor grids. Because dynamic brakes are only present on locomotives, the retarding force usually starts from the head end of a train.[30]

The automatic brake is applied by the operation of a brake valve in the locomotive and controls the application, and release, of brake shoes against the wheels of a train. Once automatic brakes are applied, retardation is applied to each individual car and there is no steady state concentration of braking forces in the train.[31] The independent brake controls brake applications on the locomotive only. As with dynamic braking, use of the independent brake causes retardation forces to concentrate at the front of the train.

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[30] Where mid-train auxiliary power is used, the forces from dynamic braking will "spike" behind each set of locomotives and where a rear pusher locomotive stays on a train as it moves down the crest of a hill, the effect of its braking action, whether dynamic or not, will tend to slack ahead of the locomotive.

[31] Brake application is not instantaneous throughout the train because the air "signal" that moves down the brake pipe travels at the speed of sound, rather than the speed of light (the way an electric signal does). The signal can take more than 1 minute to travel the length of a 100-car train. While the brakes are applying, forces tend to concentrate at the head of the train, although mid-train power, helper engines, and two-way end-of-train brake devices, each of which can initiate a brake application from its location, are able to establish steady-state braking significantly faster than with head-end power alone.

Starting or stopping trains too fast can cause excessive in-train forces. Many of the problems occur during braking, either by using the locomotive dynamic brake or by using conventional train brakes. Excessive train forces can cause a train to separate, cause a rail to turn over, or cause a car to climb over the head of the rail. Steady state forces are those that are applied for a relatively long period of time such as the pull up a grade or the compressive forces of descending a grade under dynamic braking. High steady state forces can cause three problems. One problem is train separation when the train breaks in two. Another problem is string-lining, where the pull of the locomotive through a curve combined with the resistance of heavy trailing tonnage (cars) stretches the train into a straight line and derails on the inside of the curve. A third is buckling. Buckling (the opposite of string-lining) occurs when a braking locomotive combined with the push of momentum from heavy trailing tonnage rail cars causes the cars to jackknife and derail.

Track is designed to withstand normal lateral forces, but excessive in-train forces can result in lateral forces higher than the track can resist. Transient forces are primarily the result of train operations over changing grades or during acceleration or deceleration. Problems with pulling (draft) forces and pushing (buff) forces can occur on any train. For example, trains operating in territory with rolling hills can experience significant draft and buff force peaks at virtually any point in the train, which, if they become high enough to overcome the forces holding the train on the track, can lead to derailments.[32] Trains are constantly in a state of flux as they move over the railroad under various grades and curves and locomotive engineers are constantly adjusting for these conditions.

ECP brakes reduce these in-train forces and reduce the risk of accidents caused by these forces. ECP brake systems also control the brake application rate. Once the car receives the brake signal, air pressure is applied to the cylinder at a controlled rate so that all cars in the train have the same brake cylinder pressure at any point in time during the buildup. This further reduces in-train forces caused by differences in braking effort during cylinder pressure buildup.

Constant charging of brake reservoirs is possible using ECP brakes because, under normal conditions, the brake pipe acts exclusively as the brake reservoir supply pipe. The brake application is signaled electrically, and not by reducing brake pipe pressure. Therefore, the brake pipe can continuously supply the reservoirs. Conventional air brakes cannot be charged unless they are released. This causes operational issues when traversing a heavy grade where brakes cannot be released without losing control of the train. The brake reservoirs are always charged regardless of whether the air brakes are applied or released.

Graduated release is an important feature for long freight trains using ECP brakes. Graduated release is the ability to reduce the brakes to a lower braking level after making a brake application. Graduated release makes it possible to adjust the braking effort to the exact level required to follow the safe speed limits. When using conventional brakes, the locomotive engineer cannot reduce the braking level without completely releasing and resetting the brakes, which can only be done safely at very low speeds. In many cases, this leads to a forced stop.

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[32] 'Safe Placement of Train Cars: *A Report*,' United States Department of Transportation, Federal Railroad Administration, June 2005, pp. 4-8.

The characteristics of the conventional brake system may lead to the locomotive engineer making less of a brake application than needed because it is always possible to add more brake cylinder pressure, but not to reduce it once applied.[33]

It is clear that the stopping distance of the longest, heaviest trains with ECP brakes would be reduced by as much as 40-60 percent, compared to conventional brakes. For a long coal train with a current stopping distance of almost 2 miles,[34] that reduction represents a material improvement in safety and potential avoidance, or reduction in severity, of collisions with other trains, obstructions, or-in limited circumstances-users of highway-rail grade crossings.

One measure of the safety benefits of ECP, albeit incomplete, is the reported damage and injuries from rail accidents in the FRA's database that have cause codes associated with conventional brake failures or human error associated with brake-related train handling.[35] The FRA determined that the risk of some rail equipment accidents/incidents would be reduced by the use of ECP brakes. The FRA's internal experts identified accidents described by 50 cause codes (see Appendix A) that will potentially be reduced by ECP brakes.

The experts also determined effectiveness rates for each cause code. Each cause code has three effectiveness rates, a minimum, maximum, and best estimate effectiveness rate. For the 5-year period ending in December 2005, there were a total of 20,401 accident reports.[36] However, there can be more than one report for the same accident. The National Inspection Plan data (see Appendix B) was used to avoid duplicate reports for the same accident and for increased accuracy. According to the National Inspection Plan data, there were over 16,000 rail equipment accidents. A data sort by the TYPE field (Type of Accident) and all highway-rail crossing accident types were deleted because highway-rail accidents will be handled separately in this analysis.[37] The remaining accidents were sorted by the TYPEQ field (Type of Consist) to delete accidents that involved any of the following: passenger trains, commuter trains, a single car, a cut of cars, light locomotives, maintenance/inspections cars, and specialty maintenance of way equipment. Additionally, the remaining accidents are reduced by 39 percent based on freight commodity statistics and the estimated portion of traffic that will be converted to ECP brakes. These accidents were deleted because the equipment involved will probably not be converted to ECP brakes within the time limits specified in this analysis. The final accident pool consisted of 2,189 accidents where the accident cause was attributed to one of the 50 cause codes listed in Appendix A. The annual average number of accidents was determined by dividing the 2,189 by five for the 5-year period.

The information available to FRA on the value of property damage significantly understates the true value of the damages resulting from railroad accidents. The property damage estimates provided by the railroad(s) in the aftermath of an accident are only for "railroad property damage" (equipment, track, and structures). Although we have increased those figures to

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[33] 'Benefit-Cost Analysis and Implementation Plan for Electronically Controlled Pneumatic Braking Technology in the Railroad Industry,' Booz Allen Hamilton, August 2006.
[34] The coal train is operating at top speed.
[35] Data are based on Booz Allen analysis of FRA's Office of Safety Analysis Accident/Incident Web site.
[36] Data are from the Rail Equipment Accident/Incident (Form F 6180.54) reports from the 5-year period of 2001-2005.
[37] 16,434 accidents – 1,066 highway-rail crossing accidents = 15,368 accidents.

account for chronic under-reporting of these damages, the figures used in this analysis still do not include the costs of individual or community health expenses, the closure of adjacent roads, or any of the other potential costs that are borne by society after a railroad accident.[38] The FRA has no information on the extent of these expenses, and has no data upon which to reliably make an estimate, but it is clear that these expenses are often substantial. The benefits included in this regulatory analysis underestimate the true benefits because of this exclusion.

A group of FRA experts, who also selected the appropriate cause codes, also assigned three effectiveness rates to each cause code. The effectiveness rates represent a minimum, maximum, and best estimate of potential risk reduction of a similar accident occurring in the future with ECP brakes. The three effectiveness rates for each cause code were multiplied by each of the 2,189 accidents to derive values for accident damage, and fatality and injury rates. This produced the following values per accident:

Rail Equipment Accident/Incident Values			
	Minimum Estimate	Best Estimate	Maximum Estimate
Accident Damage[39]	$34,166.54	$41,257.52	$47,684.86
Fatality Rate (@ $3,000,000)[40]	0.0010	0.0015	0.0020
Injury Rate (@ $367,500)[41]	0.0211	0.0304	0.0395
Total Accident Value	$44,941.26	$56,942.80	$68,247.13

The annual average number of accidents multiplied by 61 percent equals 267.06 accidents per year. Benefits accrue with installation at a rate of the average installations per year. Year 1 is the first year that the rule becomes effective. The FRA estimates that a reasonable timeline for conversion of unit-like trains to ECP brakes is 10 years. Thus, partial benefits from prevented accidents will accrue from years 1 to 10, with full benefits starting at year 11. Benefits are assumed to increase at a constant rate, but will occur with a time lag following implementation of ECP brakes. Over the course of a year, trains that are equipped with ECP brakes early in the year will supply nearly full benefits by the end of the year. Trains that are equipped with ECP brakes toward the end of the year will only supply benefits for part of the year (although the cost of conversion will be incurred immediately). Recognizing that some benefits will be gained for only part of the year, the midpoint, or 5 percent of the benefits are accounted for in a year, rather than 10 percent as the 10-year implementation period might suggest. Each subsequent year will account for 5 percent of the benefits for trains equipped in that year, plus 10 percent of the benefits for the cars equipped in the previous year (which would be providing full benefits after the year of conversion). The following table summarizes the benefits that will accrue in a 20-year period.

[38] The damage estimates were multiplied by 1.5 for consistency with previous FRA brake related accident analysis work.
[39] A multiplication factor of 1.5 is included to compensate for underreporting and for consistency with FRA's Regulatory Evaluation of Power Brake Regulations, November 22, 2000.
[40] The Department of Transportation set the statistical value of a life at $3,000,000.
[41] The midpoint of the AIS scale is used to value injuries absent more data regarding the severity of injuries in the accidents.

Rail Equipment Accident / Incident Benefits					
Year	Rate	Accidents per Year	Accidents * Min. Accident Value	Accidents * Best Estimate Accident Value	Accidents * Maximum Accident Value
1	0.05	13.3529	$ 600,096	$ 760,352	$ 911,297
2	0.15	40.0587	$ 1,800,288	$ 2,281,055	$ 2,733,891
3	0.25	66.7645	$ 3,000,481	$ 3,801,758	$ 4,556,485
4	0.35	93.4703	$ 4,200,673	$ 5,322,461	$ 6,379,080
5	0.45	120.1761	$ 5,400,865	$ 6,843,164	$ 8,201,674
6	0.55	146.8819	$ 6,601,057	$ 8,363,867	$ 10,024,268
7	0.65	173.5877	$ 7,801,250	$ 9,884,570	$ 11,846,862
8	0.75	200.2935	$ 9,001,442	$ 11,405,273	$ 13,669,456
9	0.85	226.9993	$ 10,201,634	$ 12,925,976	$ 15,492,050
10	0.95	253.7051	$ 11,401,826	$ 14,446,679	$ 17,314,645
11	1	267.058	$ 12,001,922	$ 15,207,031	$ 18,225,942
12	1	267.058	$ 12,001,922	$ 15,207,031	$ 18,225,942
13	1	267.058	$ 12,001,922	$ 15,207,031	$ 18,225,942
14	1	267.058	$ 12,001,922	$ 15,207,031	$ 18,225,942
15	1	267.058	$ 12,001,922	$ 15,207,031	$ 18,225,942
16	1	267.058	$ 12,001,922	$ 15,207,031	$ 18,225,942
17	1	267.058	$ 12,001,922	$ 15,207,031	$ 18,225,942
18	1	267.058	$ 12,001,922	$ 15,207,031	$ 18,225,942
19	1	267.058	$ 12,001,922	$ 15,207,031	$ 18,225,942
20	1	267.058	$ 12,001,922	$ 15,207,031	$ 18,225,942
Sums			$ 180,028,835	$ 228,105,462	$ 273,389,126
PV (7%)			**$ 80,330,870**	**$ 101,783,196**	**$ 121,989,271**

The resulting benefits of a 20-year reduction in risk of rail equipment accidents/incidents are $80 million to $122 million at a present value of 7 percent. In addition to preventable accidents, reductions in accident severity are an important benefit of ECP brakes. If a train with ECP brakes can significantly reduce its speed prior to an otherwise unavoidable collision, this could reduce the level of injuries and property damage compared to current outcomes with conventional brakes.

b. Highway-Rail Grade Crossing Accident/Incident Benefits

In addition to reportable train accidents, the FRA separately estimated the potential benefits of ECP brake technology in reducing highway-rail grade crossing accidents. These are collisions between the train and motor vehicles, physical obstructions, and other highway users on the roadway, sidewalks, and other paths at the crossing. While many variables may determine whether a grade crossing accident occurs, the most significant factor affecting the decrease in these accidents from using ECP brakes is the reduction in the required stopping distance, compared to a non-ECP brake-equipped train. In general, the faster application of brakes on ECP brake-equipped train decreases the stopping distance of the train. Therefore, ECP brakes will likely avoid some accidents. Given the large mass of the train relative to the object it collides with, however, there will likely be little effect on reducing the severity of accidents. Even at low speeds, the large mass of the train results in considerable force in a collision.

In brief, the monetized safety benefits from potentially prevented accidents are displayed below:

Summary of Monetized ECP Brake-Prevented Grade Crossing Accidents					
	Vehicle Damages	Fatalities	Injuries	Fatalities & Injuries	Total
Total	$1,429,515	$8,300,880	$4,305,637	$12,606,517	$14,036,032
Total, PV @ 7%	$637,866	$3,703,945	$1,921,223	$5,625,168	**$6,263,034**
Total, PV @ 3%	$991,575	$5,757,856	$2,986,579	$8,744,436	$9,736,010

ECP brakes will change the incentives facing the locomotive engineer that approaches an obstruction at a grade crossing. With conventional brakes, an engineer who makes an emergency brake application in an attempt to avoid a collision risks derailing the train because of the resulting in-train forces. After an emergency brake application, the engineer will also have to stop and check the train, adding to the trip time. Knowledge of the risk of derailment, in combination with the delay and need to check the train, may influence or delay the decision to apply the brakes. With ECP brakes, the electronic signal permits all the train cars to brake simultaneously, reducing in-train forces and the chance of a derailment. By not having to physically check the train after an emergency brake application, the amount of time lost will also be reduced. ECP brakes also will add the ability of graduated brake release, permitting the engineer to reduce the brake pressure without having to fully release the brakes first. With graduated release, the engineer can lessen the stopping effort without a time penalty to reset the brakes. The primary benefit of graduated release will be improved train handling, by being able to follow slow orders and other track speed limits more easily and closely, but it may also affect grade crossing accidents. Given the variety of operating conditions and the relative youth of this technology, it is difficult to predict at this time how graduated release may affect grade crossing accidents.

One of the factors that determine the time the locomotive engineer has to react to a motor vehicle or other obstruction is the sight distance approaching a grade crossing. ECP brakes will have limited effectiveness in locations that lack enough distance to allow the engineer sufficient reaction time. Curved track, for example, will limit sight distance and reduce the time the engineer has to react if he/she spots an obstruction blocking the crossing. High train speeds will also limit reaction time. The FRA feels that at speeds greater than those on track class 1 (maximum train speed of 10 mph) or track class 2 (maximum speed 20 mph), the engineer will not have enough reaction time to prevent a collision, even with ECP brakes. For estimating benefits, only selecting accidents that occur on track classes 1 and 2 will account for the engineer’s lack of reaction time at higher train speeds. These selection criteria should reduce the potentially preventable set of accidents enough to account for the decreased reaction time on curved track as well.

Another fundamental factor affecting grade crossing accidents is motorists' behavior. Especially in urban areas with much vehicle and train traffic, impatient drivers are sometimes tempted to try to beat the train as it approaches a crossing. This behavior is usually unpredictable and happens suddenly, providing little time for the engineer to apply the brakes. ECP brakes will not offer any advantage over conventional brakes in these types of accidents because of the limited reaction time available.

To estimate the safety benefits of ECP brakes in potentially preventing grade crossing collisions, a set of relevant past accidents is selected. Assuming that accidents in the past are a good predictor of the type of accidents that will happen in the future, this accident pool is extrapolated over a standard 20-year period of analysis to estimate the number of potentially preventable accidents in the future. ECP brakes will likely only prevent some portion of these accidents. To estimate the effectiveness of ECP brakes in preventing accidents, the advantage of shorter stopping distances is used as an effectiveness measure. In order to monetize the potential benefits, fatalities are accounted for at the standard DOT value of a statistical life, and injuries are accounted for using the Abbreviated Injury Scale (AIS).

Grade Crossing Accident Data

This analysis uses grade crossing accidents reported on FRA Form 6180.57, for the years 2001 through 2005 as the starting point to determine accidents that are potentially preventable with ECP brakes (FRA data available at http://safetydata.fra.dot.gov/officeofsafety/). From this initial data set, several categories of accidents were deleted because ECP brakes would not be effective in some types of accidents. For example, accidents in which the rail equipment was struck by the highway user, identified by the field "typacc" of value 2, were deleted. These accident selection criteria are listed in the table below with the corresponding fields and values from the Form 6180.57 database.

Grade Crossing Accident Deselecting Criteria		
Field Name	Definition	Deleted Values
Typacc	circumstance of accident	2=rail equipment struck by highway user
Position	position of highway user	3=moving over crossing
Typeq	type of consist	2=passenger train, 3=commuter train, 5=single car, 6=cut of cars, 7=yard/switching, 8=light loco's, 9=maint/inspec car, A=special MoW equipment
Typtrk	type of track	4=industry
Rrequip	RR equipment involved	2=train (units pushing), 3=train (standing), 4=cars moving, 5=cars standing, 6=light loco's (moving), 7=light loco's (standing), 8=other, A=train pulling (RCL), B=train pushing (RCL), C=train standing (RCL)

Trkclas	FRA track class	track classes 3 to 9, X

The remaining accident pool was further qualified to focus on unit and unit-like train traffic. BAH identified long-haul, high-mileage trains as the most likely candidates for conversion to ECP brakes. The FRA estimates that 61 percent of all freight traffic is unit and unit-like train traffic (using freight commodity data). Thus the accident pool is reduced by an additional 39 percent. The resulting counts of accidents, fatalities, injuries and vehicle damages are shown below.

Qualified Grade Crossing Accidents for Unit-Like Trains, 2001 - 2005				
Track Class	Accidents	Fatalities	Injuries	Vehicle Damage
Track Class 1	75.03	0	12.20	$150,000
Track Class 2	240.95	1.83	46.97	$770,000
Total	315.98	1.83	59.17	$920,000

To extrapolate these safety measures to a 20-year period, sample average annual counts are first calculated by simply dividing by 5 years, e.g., average annual accidents for track class 1 are 15.006 (75.03 accidents ÷ 5 years = 15.006 accidents per year). Other average annual amounts are calculated in the same way. For amounts over a 20-year period, the average annual count is multiplied by 20. For track class 1 accidents, the equivalent number of accidents is 300.12 (15.006 accidents per year x 20 years = 300.12 accidents over 20 years).

The FRA does not expect that using ECP brakes will prevent these entire qualified grade crossing accidents. In instances where the engineer has a chance to apply the brakes before a potential collision, ECP brakes will help reduce accidents by reducing stopping distances. This decrease in stopping distance, in comparison to conventional brakes, is used as an estimate of the effectiveness of ECP brakes in preventing collisions. The effectiveness rate is defined as the rate at which ECP brakes will reduce non-ECP brake accidents and ranges between 0 and 1, with 0 being not effective at all, and 1 being totally effective [i.e., Accidents with ECP = (1-Effectiveness Rate) x Accidents without ECP]. To find the number of *prevented* accidents with ECP brakes, the Accidents with ECP brakes is subtracted from the Accidents without ECP brakes (Prevented Accidents = Accidents without ECP brakes - Accidents with ECP brakes). Stop-distance simulation data provided by New York Air Brake Corp. (NYAB) shows that the effectiveness rate for loaded trains at 10 mph is 0.564 or 56.4 percent, and for empty trains is 61.5 percent. For trains traveling at 25 mph, the effectiveness rates are 45.1 percent loaded and 55.7 percent empty. These rates are for full-service brake applications on 100 car trains. As the grade crossing accident data is not categorized by loaded or empty, the FRA assumes that one-half of the trains will be loaded and one-half will be empty. Using 100-car trains seems appropriate, as the effectiveness rate will be applied to unit-like trains. Continuing the example with track class 1 accidents, the 300.12 accidents are divided in one-half to represent loaded and empty trains (300.12 ÷ 2 = 150.06). Applying the effectiveness rate for loaded trains yields 65.426 accidents with ECP brakes [65.426 = (1- 0.564) x 150.06]. Finally, the number of prevented accidents is 84.634, the difference between accidents without ECP brakes and accidents with ECP brakes (150.06 - 65.426 = 84.634).

The table below lists the number of prevented accidents that can be expected over 20 years, after applying effectiveness rates for loaded and empty trains.

ECP Brake-Prevented Grade Crossing Accidents for Unit-Like Trains, 20-Year Period				
Track Class	Accidents	Fatalities	Injuries	Vehicle Damage
1. Track Class 1	176.920	0	28.768	$ 353,700
1a. Loaded	84.634	0	13.762	$ 169,200
1b. Empty	92.287	0	15.006	$ 184,500
2. Track Class 2	485.756	3.690	94.692	$1,552,320
2a. Loaded	217.337	1.651	42.367	$ 694,540
2b. Empty	268.418	2.039	52.325	$ 857,780
Total	662.676	3.690	123.460	$1,906,020

For benefit estimating purposes, this approach to estimate grade crossing accidents preventable with ECP brakes assumes that the speed of the train at the time of collision is evenly or uniformly distributed among the population of accidents. For example, for accidents on track class 1, it is assumed that the same number of accidents occur at a train speed of 10 mph, as occur at a train speed of 9 mph, as occur at a train speed of 8 mph, and so on until a train speed of 1 mph. Similarly, on track class 2 an equal number of accidents are assumed to occur at a train speed of 25 mph down to 1 mph. The assumption for track class 2 may be less accurate, as the range of speeds is not as "tight" as for track class 1, and the variance in train speeds at impact may be higher.

Monetized ECP Brake-Prevented Grade Crossing Accidents

Absent the proposed regulatory change, the FRA expects that the accidents in the future will approximate accidents in the past, resulting in similar levels of safety risks. The frequency and type of fatalities, injuries, and vehicle damages in the future will mirror the past, all other factors being equal.

For scheduling benefits, the FRA does not have data regarding which of the particular trains involved in the grade crossing accidents are long-haul, high-mileage trains that the BAH report identified as candidates for early conversion to ECP brakes. These trains are used, for example, in coal and intermodal movements. Over time, other market sectors will convert to ECP brakes as the rate of conversion to ECP brakes increases in the industry. The FRA estimates that a reasonable timeline for conversion of unit-like trains to ECP brakes is 10 years. Thus, partial benefits from prevented accidents will accrue from years 1 to 10, with full benefits starting at year 11. Benefits are assumed to increase at a constant rate, but will occur with a time lag following implementation of ECP brakes. Over the course of a year, trains that are equipped with ECP brakes early in the year will supply about full benefits by the end of the year. Trains that are equipped with ECP brakes toward the end of the year will only supply benefits for part of the year (although the cost of conversion will be incurred immediately). Recognizing that some benefits will be gained for only part of the year, the midpoint, or 5 percent of the benefits are accounted for in a year, rather than 10 percent as the 10-year implementation period might suggest. Each subsequent year will account for 5 percent of the benefits for trains equipped in that year, plus 10 percent of the benefits for the cars equipped in the previous year (which would be providing full benefits after the year of conversion). The schedule of annual accident data, calculated by dividing the 20-year accidents by 20 and applying the ECP brake conversion rates, is presented in the following table.

Schedule of ECP Brake-Prevented Grade Crossing Accidents							
	Accidents		Fatalities		Injuries		
Rule Year	Track Class 1	Track Class 2	Track Class 1	Track Class 2	Track Class 1	Track Class 2	Convert Rate
1	0.442	1.214	0	0.009	0.072	0.237	0.05
2	1.327	3.643	0	0.028	0.216	0.710	0.15
3	2.212	6.072	0	0.046	0.360	1.184	0.25
4	3.096	8.501	0	0.065	0.503	1.657	0.35
5	3.981	10.930	0	0.083	0.647	2.131	0.45
6	4.865	13.358	0	0.101	0.791	2.604	0.55
7	5.750	15.787	0	0.120	0.935	3.077	0.65
8	6.635	18.216	0	0.138	1.079	3.551	0.75
9	7.520	20.645	0	0.157	1.223	4.024	0.85
10	8.404	23.073	0	0.175	1.366	4.500	0.95
11	8.846	24.288	0	0.184	1.438	4.735	1
12...20	8.846	24.288	0	0.184	1.438	4.735	1
Total	132.691	364.316	0	2.767	21.576	71.019	1

In order to monetize the accident data presented above, fatalities are accounted for at the DOT value of a statistical life of $3 million, generally used in DOT analyses. Injuries are accounted for following the assignment in the FRA’s Use of Locomotive Horns at Highway-Rail Grade Crossings rule. As that rule concerned grade crossing accidents, it seems an appropriate guide to use for valuing grade crossing injuries. The train horn rule used the AIS scale, which accounts for different levels of bodily harm as percentages of the value of a statistical life. For train speeds less than or equal to 25 mph, injuries were valued at AIS level 2, Moderate Injury, representing 1.55 percent of the value of a life or $46,500. For train speeds greater than 25 mph, injuries were valued at AIS level 5 at $2,287,500. For ECP brakes, the data was limited to track classes 1 and 2, and no injuries were found to occur at speeds greater than 25 mph. Thus all injuries are valued at AIS level 2. For estimating monetary benefits these life and injury values are multiplied by the annual accident data above. Vehicle damages are scheduled using the conversion rate.

Monetized Schedule of ECP Brake-Prevented Grade Crossing Accidents							
	Vehicle Damages		Fatalities		Injuries		
Rule Year	Track Class 1	Track Class 2	Track Class 1	Track Class 2	Track Class 1	Track Class 2	Total
1	$884	$3,881	$0	$27,670	$3,344	$11,008	$46,787
2	2,653	11,642	0	83,009	10,033	33,024	140,360
3	4,421	19,404	0	138,348	16,721	55,039	233,934
4	6,190	27,166	0	193687	23,410	77,055	327,507
5	7,958	34,927	0	249,026	30,098	99,071	421,081
6	9,727	42,689	0	304,366	36,787	121,087	514,654
7	11,495	50,450	0	359,705	43,475	143,103	608,228
8	13,264	58,212	0	415,044	50,164	165,118	701,802
9	15,032	65,974	0	470,383	56,852	187,134	795,375
10	16,801	73,735	0	525,722	63,540	209,150	888,949
11	17,685	77,616	0	553,392	66,885	220,158	935,735
12...20	17,685	77,616	0	553,392	66,885	220,158	935,735
Total	265,275	1,164,240	0	8,300,880	1,003,270	3,302,367	14,036,032
Total, PV @ 7 percent	118,369	519,497	0	3,703,945	447,670	1,473,553	6,263,034
Total, PV @ 3%	184,006	807,568	0	5,757,856	695,912	2,290,667	9,736,010

Total safety benefits are over $6 million when discounted at a 7 percent discount rate, and about $10 million if discounted at 3 percent. Nominal 20-year benefits are about $14 million.[42]

In addition to the monetary benefits, ECP brakes may aid in preventing grade crossing accident in several other ways. The advantages of easier train handling may lead to less engineer fatigue, improved confidence and other human factors types of improvements that are difficult to quantify. More experience with ECP brakes will help describe these types of benefits.

To account for the uncertainty in the benefits, resulting from variability in some of the assumed inputs, a range of benefits is calculated. As a general guide, a range of ± 15 percent around the benefit estimate should account for this uncertainty. Allowing for uncertainty in the assumptions, benefits discounted at 7 percent range from about $5 million to $7 million, with an analysis estimate of $6 million.

c. Environmental Cleanup

The environmental cleanup portion of the benefit assessment covers the determination of environmental cleanup costs. The FRA Accident/Data Analysis and Benefit Assessment Task Force reviewed Accidents from 1995, 1996, and 1997. This Task Force reviewed accidents, which were assessed, 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 "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 accidents 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, the FRA found that the average cleanup cost of a fuel spill was $129,260. This amount adjusted to 2005 dollars[43] is equal to **$157,286**. The FRA is waiting for comments and has not included this in the benefits for the proposed rule, but will include this benefit in the analysis of the final rule.

The FRA would like comments and information regarding the environmental cleanup cost estimate for accidents.

d. Regulatory Relief Benefits

The proposed rule will revise brake regulations in Part 232 to accommodate ECP brake technologies. The proposed rule provides regulatory relief from various existing inspection, testing, and maintenance requirements and proposes alternative inspection, testing and maintenance requirements more appropriately applicable to ECP brake systems. ECP systems reduce automatic brake inspection costs.

[42] See benefit chart in executive summary on p. 6.
[43] Calculation made with the CPI inflation calculator located at www.bls.gov.

The proposed rule also modifies periodic maintenance requirements, including single-car brake tests, in order to tailor the requirements more specifically for ECP brake systems. Due to the ECP brake system's ability to continuously monitor the condition of a car's air brakes, FRA believes that less frequent single car air brake tests are justified on ECP equipment. Railroads may retrofit ECP brake systems on existing cars equipped with conventional pneumatic brake systems. Accordingly, the performance of a single car air brake test is required prior to returning the car to revenue service after the application of the ECP brake system. Most railroads already require this when installing a new brake system, thus the cost of this test is not avoided with ECP brake systems. The self-monitoring capabilities of ECP brake systems may eliminate the need to perform single car air brake tests on a time-specific basis. This will reduce the number of single-car tests that must be performed on cars equipped with ECP brakes. Freight cars with conventional brakes receive a single-car air brake test every time they are on the repair track if they haven't received one within a year. It has been estimated by the AAR that more than 99 percent of cars will be on a repair track every 2 years. The FRA estimates that ECP cars will avoid a single car air brake test at installation, then once every 5 years after that. This estimate is conservative, and it is possible that these cars may avoid up to 2.5 single car air brake tests every 5-year period. Because this estimate is so conservative, this benefit will be taken at the beginning of the 5-year period. The cost of the single car air brake test is either $89.22 for a manual test or $100.85 for an instrument test. The FRA used the average value of these two tests, $95.04, to calculate this benefit. The following table summarizes the single car air brake test benefits:

Benefits of Avoiding One Single Car Air Brake Test at Installation, Then Once Every 5 Years After Installation

Year	Rate	Car Installation	Single Car Air Brake Tests Avoided	Total Annual Benefits
1	0.05	18191	18191	$ 1,728,863.14
2	0.15	54573	36382	$ 3,457,726.27
3	0.25	90955	36382	$ 3,457,726.27
4	0.35	127336	36382	$ 3,457,726.27
5	0.45	163718	36382	$ 3,457,726.27
6	0.55	200100	54573	$ 5,186,589.41
7	0.65	236482	72764	$ 6,915,452.54
8	0.75	272864	72764	$ 6,915,452.54
9	0.85	309245	72764	$ 6,915,452.54
10	0.95	345627	72764	$ 6,915,452.54
11	1	363818	72764	$ 6,915,452.54
12	1	363818	72764	$ 6,915,452.54
13	1	363818	72764	$ 6,915,452.54
14	1	363818	72764	$ 6,915,452.54
15	1	363818	72764	$ 6,915,452.54
16	1	363818	72764	$ 6,915,452.54
17	1	363818	72764	$ 6,915,452.54
18	1	363818	72764	$ 6,915,452.54
19	1	363818	72764	$ 6,915,452.54
20	1	363818	72764	$ 6,915,452.54
Sums				$ 117,562,693.25
PV7%				**$ 56,317,267.92**

The proposed rule allows ECP brake-equipped trains to travel to destination, not to exceed 3,500 miles. Extended haul and other trains are currently limited to 1,500 miles and 1,000 miles, respectively, between brake inspections. Thus, the proposal would eliminate, conservatively, at least one Class I brake test or two Class IA brake tests on a long distance train, depending on current operations. Trains with conventional brakes that meet FRA's extended haul requirements are given 1,500 miles between intermediate terminal brake inspections. These requirements limit the number of times a train on extended haul can pick up or set out cars en route, and impose additional recordkeeping. Many long-haul unit trains are extended haul trains. The FRA estimates that there are 40,000 extended haul trains that operate each year.

The single largest cost savings in the brake inspection category appears to be the elimination of the 1,000-mile intermediate terminal brake test (Class IA test) for trains operating in the ECP brake mode. Under current regulations, conventionally braked trains are required to stop at a terminal for inspection every 1,000 miles, where the brakes on each car are inspected to determine whether they are fully functioning. This requirement is not only expensive in terms of direct inspection cost, but, more importantly, in terms of overall train delay as trains have to be pulled from over-the-road service to queue in congested terminals awaiting inspection.

With ECP brake systems, there is constant wire-based monitoring of the brake condition on all cars and hence no need to pull over and physically inspect the brakes every 1,000 miles after initial terminal departure. More than 10 years ago, the AAR calculated the cost of the intermediate brake test to be $450 per train, including both the direct and delay costs of the inspection.[44] To reflect current costs as confirmed in the BAH report, we assume that this cost is at least 10 percent greater 10 years later, or $500 per train.[45] The Class I test is substantially more involved and is estimated to cost $1,000 per train, including out-of-service time. Using the AAR fact book, the Freight Commodity Statistics, waybill data, and information provided by one Class I carrier, approximately 178,071 trains travel more than 1,000 miles to destination and 88,045 (including the 40,000 extended haul trains) travel more than 1,500 miles to destination each year. Of the 88,045 trains that operate over 1,500 miles, it is assumed that 25 percent of these operate over 2,000 miles and will receive relief from an additional Class IA test. The long-haul, unit and unit-like trains are assumed to convert to ECP brake systems. There are approximately 14,000 cycle trains that operate each year that are estimated to receive relief from one Class I brake test. A cycle train is a train that operates in continuous loop(s) without a destination. The following table summarizes regulatory relief benefits for the Class I and Class IA brake tests:

[44] "Economic Analysis of Braking Systems," Thomas S. Guins, November 1994 (TD94-021).
[45] 'Benefit-Cost Analysis and Implementation Plan for Electronically Controlled Pneumatic Braking Technology in the Railroad Industry,' Booz Allen Hamilton, August 2006, p. III-4.

Class I and Class IA Brake Test Relief												
Year	Rate	Cycle Trains	Cycle Train Relief	Extended Haul Trains	Extended Haul Relief	Trains > 2,000 Miles	>2,000 Miles Relief	Trains 1,500 < 2,000 Miles	1,500-2,000 Mile Train Relief	1,000-1,500 Miles Trains	1,000-1,500 Miles Relief	Class I & IA Annual Relief
1	0.05	700	$ 700,000	2000	$ 2,000,000	601	$ 600,550	1802	$ 900,850	4501	$ 2,250,650	$ 6,452,050
2	0.15	2100	$ 2,100,000	6000	$ 6,000,000	1802	$ 1,801,650	5405	$ 2,702,550	13504	$ 6,751,950	$ 19,356,150
3	0.25	3500	$ 3,500,000	10000	$ 10,000,000	3003	$ 3,002,750	9009	$ 4,504,250	22507	$ 11,253,250	$ 32,260,250
4	0.35	4900	$ 4,900,000	14000	$ 14,000,000	4204	$ 4,203,850	12612	$ 6,305,950	31509	$ 15,754,550	$ 45,164,350
5	0.45	6300	$ 6,300,000	18000	$ 18,000,000	5405	$ 5,404,950	16215	$ 8,107,650	40512	$ 20,255,850	$ 58,068,450
6	0.55	7700	$ 7,700,000	22000	$ 22,000,000	6606	$ 6,606,050	19819	$ 9,909,350	49514	$ 24,757,150	$ 70,972,550
7	0.65	9100	$ 9,100,000	26000	$ 26,000,000	7807	$ 7,807,150	23422	$ 11,711,050	58517	$ 29,258,450	$ 83,876,650
8	0.75	10500	$ 10,500,000	30000	$ 30,000,000	9008	$ 9,008,250	27026	$ 13,512,750	67520	$ 33,759,750	$ 96,780,750
9	0.85	11900	$ 11,900,000	34000	$ 34,000,000	10209	$ 10,209,350	30629	$ 15,314,450	76522	$ 38,261,050	$ 109,684,850
10	0.95	13300	$ 13,300,000	38000	$ 38,000,000	11410	$ 11,410,450	34232	$ 17,116,150	85525	$ 42,762,350	$ 122,588,950
11	1	14000	$ 14,000,000	40000	$ 40,000,000	12011	$ 12,011,000	36034	$ 18,017,000	90026	$ 45,013,000	$ 129,041,000
12	1	14000	$ 14,000,000	40000	$ 40,000,000	12011	$ 12,011,000	36034	$ 18,017,000	90026	$ 45,013,000	$ 129,041,000
13	1	14000	$ 14,000,000	40000	$ 40,000,000	12011	$ 12,011,000	36034	$ 18,017,000	90026	$ 45,013,000	$ 129,041,000
14	1	14000	$ 14,000,000	40000	$ 40,000,000	12011	$ 12,011,000	36034	$ 18,017,000	90026	$ 45,013,000	$ 129,041,000
15	1	14000	$ 14,000,000	40000	$ 40,000,000	12011	$ 12,011,000	36034	$ 18,017,000	90026	$ 45,013,000	$ 129,041,000
16	1	14000	$ 14,000,000	40000	$ 40,000,000	12011	$ 12,011,000	36034	$ 18,017,000	90026	$ 45,013,000	$ 129,041,000
17	1	14000	$ 14,000,000	40000	$ 40,000,000	12011	$ 12,011,000	36034	$ 18,017,000	90026	$ 45,013,000	$ 129,041,000
18	1	14000	$ 14,000,000	40000	$ 40,000,000	12011	$ 12,011,000	36034	$ 18,017,000	90026	$ 45,013,000	$ 129,041,000
19	1	14000	$ 14,000,000	40000	$ 40,000,000	12011	$ 12,011,000	36034	$ 18,017,000	90026	$ 45,013,000	$ 129,041,000
20	1	14000	$ 14,000,000	40000	$ 40,000,000	12011	$ 12,011,000	36034	$ 18,017,000	90026	$ 45,013,000	$ 129,041,000
sums			$ 210,000,000		$ 600,000,000		$ 180,165,000		$ 270,255,000		$ 675,195,000	$ 1,935,615,000
PV 7%			$ 93,704,337		$ 267,726,678		$ 80,391,628		$ 120,590,789		$ 301,279,524	**$ 863,692,957**

Additional regulatory flexibility is provided by the proposed rule. The removal of defective equipment en route, known as set-outs,[46] is eliminated. The defective equipment is allowed to remain in the train consist to destination. ECP brake systems monitor in real-time the inoperative car(s), thus eliminating the safety concern that exists in conventionally braked trains. Train crews of trains equipped with ECP brakes have the ability to monitor the condition and the location of defective car(s). Switching defective cars reduces safety; it is just as safe to keep the car(s) in an ECP brake-equipped train. ECP brake-equipped trains will not be required to stop and set out a defective car. This will save time that is estimated at a cost of $300 per set-out. This estimate includes labor and train delay costs. The FRA estimates, on average, half of trains must stop en route for one set-out. The number of ECP brake equipped trains annually, as estimated above is 178,071 + 14,000 unit trains = 192,071 trains per year. Half of these trains will avoid one set-out valued at $300 each.

The FRA requests comments and information on the cost per set-out.

The following chart summarizes these en route set-out benefits:

[46] A set-out is setting a defective car(s) out of the train consist along a siding, etc.

Regulatory Flexibility Benefits for Set-Outs				
Year	Rate	Unit-like Trains	Number of Set-Outs	Cost of Set-Outs
1	0.05	9604	4802	$ 1,440,533
2	0.15	28811	14405	$ 4,321,598
3	0.25	48018	24009	$ 7,202,663
4	0.35	67225	33612	$ 10,083,728
5	0.45	86432	43216	$ 12,964,793
6	0.55	105639	52820	$ 15,845,858
7	0.65	124846	62423	$ 18,726,923
8	0.75	144053	72027	$ 21,607,988
9	0.85	163260	81630	$ 24,489,053
10	0.95	182467	91234	$ 27,370,118
11	1	192071	96036	$ 28,810,650
12	1	192071	96036	$ 28,810,650
13	1	192071	96036	$ 28,810,650
14	1	192071	96036	$ 28,810,650
15	1	192071	96036	$ 28,810,650
16	1	192071	96036	$ 28,810,650
17	1	192071	96036	$ 28,810,650
18	1	192071	96036	$ 28,810,650
19	1	192071	96036	$ 28,810,650
20	1	192071	96036	$ 28,810,650
Sums				$ 432,159,750
PV7%				**$ 192,834,490**

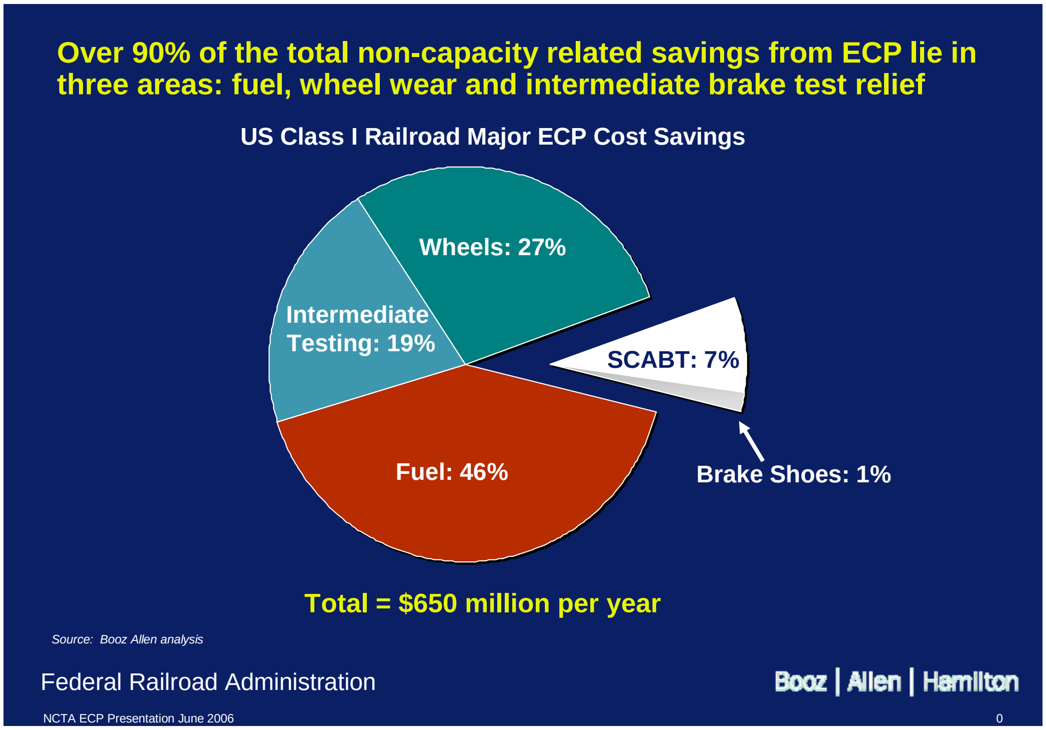
Total regulatory relief benefits for the 20-year period of this analysis, conservatively estimated, equal $2,485,337,443. The present value of the total regulatory relief benefits, discounted at 7 percent equals **$1,112,844,715**. The following chart summarizes the annual benefits for each aspect of monetized regulatory relief for the 20-year period:

Regulatory Relief Benefits					
Year	Rate	Set-Out Relief	Single Car Air Brake Test Relief	Class IA & Class I Relief	Total Regulatory Relief
1	0.05	$ 1,440,533	$ 1,728,863	$ 6,452,050	$ 9,621,446
2	0.15	$ 4,321,598	$ 3,457,726	$ 19,356,150	$ 27,135,474
3	0.25	$ 7,202,663	$ 3,457,726	$ 32,260,250	$ 42,920,639
4	0.35	$ 10,083,728	$ 3,457,726	$ 45,164,350	$ 58,705,804
5	0.45	$ 12,964,793	$ 3,457,726	$ 58,068,450	$ 74,490,969
6	0.55	$ 15,845,858	$ 5,186,589	$ 70,972,550	$ 92,004,997
7	0.65	$ 18,726,923	$ 6,915,453	$ 83,876,650	$ 109,519,025
8	0.75	$ 21,607,988	$ 6,915,453	$ 96,780,750	$ 125,304,190
9	0.85	$ 24,489,053	$ 6,915,453	$ 109,684,850	$ 141,089,355
10	0.95	$ 27,370,118	$ 6,915,453	$ 122,588,950	$ 156,874,520
11	1	$ 28,810,650	$ 6,915,453	$ 129,041,000	$ 164,767,103
12	1	$ 28,810,650	$ 6,915,453	$ 129,041,000	$ 164,767,103
13	1	$ 28,810,650	$ 6,915,453	$ 129,041,000	$ 164,767,103
14	1	$ 28,810,650	$ 6,915,453	$ 129,041,000	$ 164,767,103
15	1	$ 28,810,650	$ 6,915,453	$ 129,041,000	$ 164,767,103
16	1	$ 28,810,650	$ 6,915,453	$ 129,041,000	$ 164,767,103
17	1	$ 28,810,650	$ 6,915,453	$ 129,041,000	$ 164,767,103
18	1	$ 28,810,650	$ 6,915,453	$ 129,041,000	$ 164,767,103
19	1	$ 28,810,650	$ 6,915,453	$ 129,041,000	$ 164,767,103
20	1	$ 28,810,650	$ 6,915,453	$ 129,041,000	$ 164,767,103
Sums		$ 432,159,750	$ 117,562,693	$ 1,935,615,000	$ 2,485,337,443
PV7%		**$ 192,834,490**	**$ 56,317,268**	**$ 863,692,957**	**$ 1,112,844,715**

<u>Business Benefits</u>

Capacity benefits from ECP brakes have been documented in the preliminary business case developed in South Africa by Spoornet and similar benefits for North America can be expected and were estimated in the BAH study. South Africa's Spoornet has embraced ECP brakes for its huge export coal operations, reporting savings in train energy consumption of 23 percent. Electronic monitoring on Spoornet's ECP brake-equipped cars and locomotives have increased capacity, reducing turn times by 9 percent.

Growth in demand for United States coal and for Asian import goods, coupled with limits on motor carriers' ability to expand due to driver shortages and hours-of-service changes, indicate that North American rail network congestion will be a major concern for the foreseeable future. BAH's ECP Brake System for Freight Service Final Report to FRA suggests that significant industry wide equipment savings from a 1 mph gain in network velocity may be reasonable to expect. An example of growing North American capacity demand is the PRB, where BNSF and UP serve over a joint line with capacity of 130 trains per day, each approaching 2 miles in length. The report broke out the major benefits into a few main categories. Two of the categories will be quantified in this analysis, intermediate air brake test relief and single car air brake test relief (SCABT). These benefits are significant and will greatly assist the industry in the implementation of ECP brake technology. The BAH Report quantifies these business benefits for Class I railroads as follows:



The rail network capacity and operational benefits of ECP brakes will impact a broad range of onboard locomotive and dispatch operations. Better braking performance will provide railroads the opportunity to increase consist lengths. Train dispatchers can decrease the spacing between consists due to increased braking efficiency. And engineers can operate their trains more effectively knowing that their air supply will not need as frequent charging and that their stopping distances are reduced.

Increased braking efficiency will afford dispatchers new operational decisions in train routing and railroads in schedule generation that will impact rail network capacity. Increased braking efficiency will allow engineers to maintain speed for longer distances within blocks. This increased speed will reduce route time, allowing an increase in the number of trains that can be scheduled for a given day. Railroads will need to identify “bottlenecks” en route to maximize increased throughput capacity potential. Alternate routings will need investigation to assess their capacity impact in light of the increased unit-train performance. Simulation provides a platform to gather data to predict impact of ECP brakes in railroad operations and capacity. The FRA intends to commission a follow up study to verify the business benefits of ECP brakes. The analysis is also likely to show that the net benefits decrease from Class I/unit trains to Class II and Class III railroads that carry carload freight rail traffic.

e. Track Delay, Rerouting, and Associated Out-of-Service Expenses

The costs associated with a single main track out of service are extremely high. All traffic must be rerouted over other track. If the company does not have trackage rights over alternate track, the distances could be large. Larger distances have higher associated costs. If trackage rights do exist, the company has to pay the equivalent of a toll to use track it does not own. Alternate track may not be available at any price. Track utilization in the United States is extremely high; it is estimated at over 90 percent. When traffic is rerouted it slows up other traffic and has far-reaching effects on the system. It is frequently estimated that blocking a single main line for 1 hour costs approximately $1 million. Obviously, this amount depends on numerous factors. Unless other comments are received, FRA intends to use $1 million per hour in the final regulatory analysis.

The FRA would like comments on the value of track out-of-service time for ECP trains.

f. Fuel Savings

The diverse operating benefits of ECP brake systems discussed previously in the Rail Equipment Accident/Incident Benefits section, such as graduated brake release and elimination of power braking and unnecessary train stops and starts, are expected to yield sizeable dollar benefits in reduced fuel consumption and associated reduction in emissions. The Class I railroads spent more than $6 billion on diesel fuel in 2005.[47] ECP brakes are estimated to save 5 percent of fuel spending, which is consistent with the experience of Quebec Cartier Mining's ECP brake operations in Canada.[48] According to the 'Freight Commodity Statistics' report, ECP brake unit-like commodity revenue freight originated carloads on the four Class I railroads account for 61 percent of all United States carloads originated. Therefore, approximately 61 percent of fuel spending is spent hauling these unit and unit-like commodities.

2005 Fuel Spending	6,000,000,000
ECP commodity usage	x .61
	3,660,000,000
5 percent Fuel Savings	x .05
Annual Savings	**$183,000,000**

[47] Total fuel spending will continue to escalate. Indeed, if the recent hedged fuel price of one major Class I of $1.70 per gallon, 40 cents below the non-hedged price, is applied to the 2004 level of Class I fuel consumption of 4.1 billion gallons, the resulting fuel bill approaches $7 billion.

[48] 'Benefit-Cost Analysis and Implementation Plan for Electronically Controlled Pneumatic Braking Technology in the Railroad Industry,' Booz Allen Hamilton, August 2006, p. III-2.

Fuel Savings		
Year	Rate	Fuel Savings
1	0.05	$ 9,150,000
2	0.15	$ 27,450,000
3	0.25	$ 45,750,000
4	0.35	$ 64,050,000
5	0.45	$ 82,350,000
6	0.55	$ 100,650,000
7	0.65	$ 118,950,000
8	0.75	$ 137,250,000
9	0.85	$ 155,550,000
10	0.95	$ 173,850,000
11	1	$ 183,000,000
12	1	$ 183,000,000
13	1	$ 183,000,000
14	1	$ 183,000,000
15	1	$ 183,000,000
16	1	$ 183,000,000
17	1	$ 183,000,000
18	1	$ 183,000,000
19	1	$ 183,000,000
20	1	$ 183,000,000
Sum		$ 2,745,000,000
PV 7%		**$ 1,224,849,552**

The above savings are included in the benefit chart in the Executive Summary on pages 3-4.

g. Wheel Savings

Wheels are but one component of a freight car that could provide maintenance savings under ECP brake operation. Wheel damage is reduced due to more uniform braking and better train handling. One of the ways in which ECP brakes contribute to a reduction in premature wheel wear is by lowering the average brake friction temperature on the wheels through more consistent braking. Excessive buildup of heat in the wheels is a major contributor to wheel failure. The sheer magnitude of industry expenditure on wheel replacements warrants singling them out as a significant benefit of conversion to ECP brake systems. A recent study by the Transportation Technology Center, Inc. (TTCI) found that the rail freight industry spends 37 percent of its annual freight car repair cost of $1.5 billion on wheel replacements—representing $555 million. These data are for calendar year 2000, and the costs are undoubtedly higher now.[49] Wheelsets need to be replaced because they are either worn out or damaged. Brake-related failures were found to reduce the life of wheelsets by more than 50 percent.

Per wheelset replacement costs are now at least $1,250, and could range as high as $1,500. Even using the lower end of this range ($1,250), the resulting 25-percent increase in per-unit wheel replacement costs translates into a conservative estimate of $700 million in annual wheel repair

[49] 'Benefit-Cost Analysis and Implementation Plan for Electronically Controlled Pneumatic Braking Technology in the Railroad Industry,' Booz Allen Hamilton, August 2006, p. III-3.

expenditures when applied to the year 2000 data. Assuming that ECP brakes would eliminate half of all brake-related wheel defects, this would translate into $175 million annually for the entire freight car fleet. Heavy-haul, high-mileage cars would account for a disproportionately high share of these savings. [50] Using the same adjustment of 61 percent for ECP brake-related savings, the annual savings for the entire fleet of $175 million (.61) = $106,750,000. The 20-year wheel savings discounted at 7 percent equals **$714,495,572**. The following table summarizes these benefits:

Wheel Replacement Savings		
Year	Rate	Wheel Replacement Savings
1	0.05	$ 5,337,500
2	0.15	$ 16,012,500
3	0.25	$ 26,687,500
4	0.35	$ 37,362,500
5	0.45	$ 48,037,500
6	0.55	$ 58,712,500
7	0.65	$ 69,387,500
8	0.75	$ 80,062,500
9	0.85	$ 90,737,500
10	0.95	$ 101,412,500
11	1	$ 106,750,000
12	1	$ 106,750,000
13	1	$ 106,750,000
14	1	$ 106,750,000
15	1	$ 106,750,000
16	1	$ 106,750,000
17	1	$ 106,750,000
18	1	$ 106,750,000
19	1	$ 106,750,000
20	1	$ 106,750,000
Sum		$ 1,601,250,000
PV 7%		**$ 714,495,572**

These savings are included in the benefit chart in the Executive Summary on pages 3-4.

F. Cost Estimates

1. Cost Estimate of Regulation

The cost of implementing new ECP braking technology is financially expensive and logistically challenging. To facilitate the adoption of ECP brakes in the rail industry, regulatory flexibility is necessary. To provide assistance with the logistical challenges of ECP brake implementation, current regulations must be modified. The proposed regulation is needed to address the new technology once implemented. Specifically, because ECP brake technology provides constant

[50] Ibid.

monitoring of the train's brake system, which is not available under the existing technology, certain air brake tests currently required will no longer be necessary.

This analysis will address the costs of implementing this new technology on the most likely implementation course the rail industry will pursue. A train operating with ECP brakes must be in a train consist that not only has an ECP locomotive but also has almost all rail cars equipped with ECP brakes. Some trains operate in unit service where the train and locomotives stay together for most of the train operation. The most practicable way to implement ECP brakes initially is in unit and unit-like train operations. This analysis assumes that initial implementation will occur on unit and unit-like train service. The time frame for this analysis is 20 years. A 10-year implementation on unit and unit-like train service is a primary assumption in this analysis. There are seven Class I railroads, 32 regional railroads, and 523 local railroads.[51] Only four United States Class I railroads are assumed in this analysis to take advantage of this technology. It is not anticipated that any other United States railroads will initially take advantage of this technology because of the costs, although costs are proportional to size of fleets. The large railroads are estimated to have more equipment per carrier than the smaller railroads. The majority of local railroads do not interchange with unit-like trains. For the purposes of this analysis, it is assumed that no other railroads will take advantage of this rule, even though all railroads are subject to the same regulatory relief the rule provides.

An important determinate of costs is the amount of equipment that must be converted. It is assumed that in year 1, the year the final rule is effective; all new equipment coming into the fleet—both locomotives and cars—is ECP brake compatible. There will be a sustained rate of introduction of ECP brake compatible equipment into the fleet—without incurring the cost of retrofitting existing equipment—until conversion is complete. Both locomotives and cars are estimated to have 10-year implementation schedules. The costs used in this analysis are $4,000 per freight car and $40,000 per locomotive. The $4,000/$40,000 cost estimates are over and above the current cost of conventional brakes and include installation labor. The conversion costs mentioned above are based on small production volumes for ECP brake equipment and limited installation experience. When the decision is made to begin phased implementation, production will ramp up and more formalized installation arrangements will be initiated. Such volume-based conversion can be expected to reduce, perhaps significantly, the current ECP brake costs for both freight cars and locomotives. All other things equal, the expected decline in conversion costs due to economies of scale and experience will cause the net benefits in this analysis to be understated. While the direction of the anticipated change in costs is clear, it is impossible to project with accuracy the magnitude of the cost decline under large-scale implementation. The FRA specifically requests comments on this issue. In terms of maintenance, brake manufacturers do not presently expect there to be any significant long-term difference in maintenance costs between ECP and non-ECP brake systems, so the cost issue is primarily a one-time installation cost consideration. BAH discussions with Quebec Cartier Mining, which has been running heavy-haul ECP brake equipped trains of up to 180 cars in North America since 1998—including in harsh winter conditions—confirm this conclusion.[52] Training costs for both train crews and inspectors are estimated for all 20 years of this analysis.

[51] 'Railroad Facts,' Association of American Railroads, 2006, p.3.
[52] 'Benefit-Cost Analysis and Implementation Plan for Electronically Controlled Pneumatic Braking Technology in the Railroad Industry,' Booz Allen Hamilton, August 2006, p. III-3.

a. *Freight Car Conversion Costs*

The potential freight car fleet (units) to be converted to ECP brake technology dwarfs by nearly 25 to 1 the locomotive pool needing conversion.[53] For freight car conversion, an average of $4,000 per car is estimated for total conversion costs. Certain types of freight cars will cost more to convert and certain cars will cost less. Some intermodal cars, depending on their length, can cost two to three times this amount.[54] A conversion timeframe of 10 years is assumed. Using a combination of the "Freight Car Commodity Statistics" report, and information from one of the four United States Class I railroads assumed to implement ECP brakes, it is estimated that approximately 363,818 cars will be converted to ECP brakes for unit-like service. The total costs for freight car conversion is $1,455,272,000. The 20-year present value of this cost discounted at 7 percent is **$1,022,122,156**. The following table summarizes these costs:

Freight Car Conversion Costs				
Year	Rate	Cars Equipped	Cars Equipped Annually	Costs per Year
1	0.1	36,382	36,382	$ 145,527,200
2	0.2	72,764	36,382	$ 145,527,200
3	0.3	109,145	36,382	$ 145,527,200
4	0.4	145,527	36,382	$ 145,527,200
5	0.5	181,909	36,382	$ 145,527,200
6	0.6	218,291	36,382	$ 145,527,200
7	0.7	254,673	36,382	$ 145,527,200
8	0.8	291,054	36,382	$ 145,527,200
9	0.9	327,436	36,382	$ 145,527,200
10	1	363,818	36,382	$ 145,527,200
11	1	363,818		
12	1	363,818		
13	1	363,818		
14	1	363,818		
15	1	363,818		
16	1	363,818		
17	1	363,818		
18	1	363,818		
19	1	363,818		
20	1	363,818		
Sums			363,818	$ 1,455,272,000
PV 7%				**$ 1,022,122,156**

[53] The number of locomotives that will need conversion to ECP is 8,092 (38 percent of United States Class I railroad locomotive fleet) times 1.5, equals 12,139 locomotives.
[54] Intermodal cars referred to as "3-packs" require two-car control devices, and cars referred to as "5-packs" require three-car control devices. Both "3-packs" and "5-packs" require additional wiring that costs approximately $1,500.

b. Locomotive Conversion Costs

An important determinant of costs is the number of locomotives that must be converted. Approximately 38 percent of locomotives are used in the movement of unit-like commodities.[55] Most locomotive pools have a relatively free-running nature in which realizing high levels of locomotive utilization is more important than dedicating expensive power to specific trains or corridors. For locomotive ECP brake conversion, additional ECP brake-equipped locomotives must be equipped than the corresponding number for freight cars conversion. Although dedicating power to specific ECP brake corridors is possible, this analysis estimates that the locomotives needed are 1.5 times the number of locomotives used in unit-like service. Therefore, the number of locomotives that will need conversion to ECP brakes is 8,092 (38 percent of United States Class I railroad locomotive fleet) multiplied by 1.5, which equals 12,139 locomotives. As stated earlier, the average cost per locomotive is estimated at $40,000.[56] The total cost of conversion, not including maintenance, is $485,520,000, or discounted at 7 percent is **$341,008,931**.

The FRA seeks comments on the maintenance of ECP brake systems for locomotives.

The following chart summarizes the locomotive conversion costs:

Locomotive Conversion Costs				
Year	Rate	Locomotives Equipped	Locomotives Equipped Annually	Costs per Year
1	0.1	1,214	1,214	$ 48,552,000
2	0.2	2,428	1,214	$ 48,552,000
3	0.3	3,641	1,214	$ 48,552,000
4	0.4	4,855	1,214	$ 48,552,000
5	0.5	6,069	1,214	$ 48,552,000
6	0.6	7,283	1,214	$ 48,552,000
7	0.7	8,497	1,214	$ 48,552,000
8	0.8	9,710	1,214	$ 48,552,000
9	0.9	10,924	1,214	$ 48,552,000
10	1	12,138	1,214	$ 48,552,000
11	1	12,138		
12	1	12,138		
13	1	12,138		
14	1	12,138		
15	1	12,138		
16	1	12,138		
17	1	12,138		
18	1	12,138		
19	1	12,138		
20	1	12,138		
Sums			12,138	$ 485,520,000
PV 7%				**$ 341,008,931**

[55] Data extrapolated from information received from 'Railroad Facts,' 2006 Edition, and one United States Class I railroad, and the '2005 Freight Commodity Statistics' report.
[56] Different locomotive configurations can have different costs, as low as $30,000 to as high as $50,000. Because it is not known exactly which locomotives will be converted, the average of $40,000 is used in this analysis.

c. Training Costs

The FRA estimates that the Class I carriers will incorporate ECP training into existing locomotive engineer and inspector training programs. An initial training template that all of the railroads can modify to suit their individual operations will be needed. In accordance with other freight brake regulations, a template is developed among the railroads. This initial template is estimated to cost approximately $300,000. This estimate is consistent with previous freight rail brake training estimates. The FRA assumes all inspectors need training as well as half of the engineers and conductors. There are 29,940 inspectors (maintenance of equipment and stores employee group) and 68,307 engineers and conductors (transportation, train and engine employee group), according to the 2006 edition of 'Railroad Facts.' Assuming only half of train crews will need training; the total number of people needing training is 64,094. The average wages per employee hour are $25.68, according to the 2006 edition of 'Railroad Facts.' Multiplying this hourly wage by 1.4 to load the rate derives an hourly loaded rate of $35.95. Training will be proportional to fleet conversion for the first 10 years, and training will occur on an annual basis for years 11-20. Inspectors will require 8 hours of initial training followed by 1-hour annual training. Train crews will require 24 hours of initial training and 8 hours of annual training. The total 20-year cost of initial and recurring training is $196,425,710, or discounted at 7 percent is equal to **$96,152,211**.

The FRA requests comments on training estimates.

The following chart summarizes these training costs:

Total 20-Year Training Costs

Year	Rate	Inspectors Initially Trained per Year	Aggregate Total Inspectors Trained	Inspectors' Initial Training Costs	Engineers and Conductors Trained Initially per Year	Cumulative Engineers and Conductors Trained	Engineer and Conductor's Initial Training Costs	Sum of Initial Training Costs	Annual Inspector Training	Annual Engineer and Conductor Training	Sum of Initial and Reccurring Training Costs
1	0.1	2994	2994	$ 861,122	3415	3415	$ 2,946,971	$ 4,108,093			$ 4,108,093
2	0.2	2994	5988	$ 861,122	3415	6831	$ 2,946,971	$ 3,808,093	$ 107,640	$ 982,324	$ 4,898,057
3	0.3	2994	8982	$ 861,122	3415	10246	$ 2,946,971	$ 3,808,093	$ 215,281	$ 1,964,647	$ 5,988,021
4	0.4	2994	11976	$ 861,122	3415	13662	$ 2,946,971	$ 3,808,093	$ 322,921	$ 2,946,971	$ 7,077,985
5	0.5	2994	14970	$ 861,122	3415	17077	$ 2,946,971	$ 3,808,093	$ 430,561	$ 3,929,295	$ 8,167,949
6	0.6	2994	17964	$ 861,122	3415	20492	$ 2,946,971	$ 3,808,093	$ 538,201	$ 4,911,618	$ 9,257,913
7	0.7	2994	20958	$ 861,122	3415	23908	$ 2,946,971	$ 3,808,093	$ 645,842	$ 5,893,942	$ 10,347,877
8	0.8	2994	23952	$ 861,122	3415	27323	$ 2,946,971	$ 3,808,093	$ 753,482	$ 6,876,266	$ 11,437,841
9	0.9	2994	26946	$ 861,122	3415	30739	$ 2,946,971	$ 3,808,093	$ 861,122	$ 7,858,589	$ 12,527,805
10	1	2994	29940	$ 861,122	3415	34154	$ 2,946,971	$ 3,808,093	$ 968,763	$ 8,840,913	$ 13,617,769
11	1		29940			34154			$ 1,076,403	$ 9,823,237	$ 10,899,640
12	1		29940			34154			$ 1,076,403	$ 9,823,237	$ 10,899,640
13	1		29940			34154			$ 1,076,403	$ 9,823,237	$ 10,899,640
14	1		29940			34154			$ 1,076,403	$ 9,823,237	$ 10,899,640
15	1		29940			34154			$ 1,076,403	$ 9,823,237	$ 10,899,640
16	1		29940			34154			$ 1,076,403	$ 9,823,237	$ 10,899,640
17	1		29940			34154			$ 1,076,403	$ 9,823,237	$ 10,899,640
18	1		29940			34154			$ 1,076,403	$ 9,823,237	$ 10,899,640
19	1		29940			34154			$ 1,076,403	$ 9,823,237	$ 10,899,640
20	1		29940			34154			$ 1,076,403	$ 9,823,237	$ 10,899,640
Sums				$8,611,223			$29,469,711	$ 38,380,934	$ 15,607,842	$ 142,436,935	$ 196,425,710
PV 7%				$6,048,163			$20,698,292	$ 27,026,828	$ 7,304,391	$ 66,659,769	**$ 96,152,211**

2. Total 20-Year Costs

The total 20-year costs are summarized in the following table:

ECP Brake COSTS					
Year	Rate	Freight Car Costs	Locomotive Costs	Training Costs	Total Costs
1	0.1	$145,527,200	$48,552,000	$4,108,093	$198,187,293
2	0.2	$145,527,200	$48,552,000	$4,898,057	$198,977,257
3	0.3	$145,527,200	$48,552,000	$5,988,021	$200,067,221
4	0.4	$145,527,200	$48,552,000	$7,077,985	$201,157,185
5	0.5	$145,527,200	$48,552,000	$8,167,949	$202,247,149
6	0.6	$145,527,200	$48,552,000	$9,257,913	$203,337,113
7	0.7	$145,527,200	$48,552,000	$10,347,877	$204,427,077
8	0.8	$145,527,200	$48,552,000	$11,437,841	$205,517,041
9	0.9	$145,527,200	$48,552,000	$12,527,805	$206,607,005
10	1	$145,527,200	$48,552,000	$13,617,769	$207,696,969
11	1			$10,899,640	$10,899,640
12	1			$10,899,640	$10,899,640
13	1			$10,899,640	$10,899,640
14	1			$10,899,640	$10,899,640
15	1			$10,899,640	$10,899,640
16	1			$10,899,640	$10,899,640
17	1			$10,899,640	$10,899,640
18	1			$10,899,640	$10,899,640
19	1			$10,899,640	$10,899,640
20	1			$10,899,640	$10,899,640
Sums		$1,455,272,000	$485,520,000	$196,425,710	$2,137,217,710
PV (7%)		$1,022,122,156	$341,008,931	$96,152,211	**$1,459,283,298**

3. Sensitivity Analysis

The purpose of sensitivity analysis is to acknowledge the underlying uncertainty of estimates. Sensitivity analysis will convey how sensitive predicted costs are to changes in assumptions. Partial sensitivity analysis will show how costs change when a single assumption is varied while holding all others constant.

a. Cost per Car

The cost per car has the largest effect on the costs of the rule. The FRA believes the best estimate for cost per freight car is $4,000. It is possible that economies of scale can occur even before the final rule is issued. It is possible that the average cost per car for conversion used in this analysis, $4,000, could be as low as $3,500. Because this cost is the primary determinant of total costs, freight car cost will be evaluated at both $3,500 and $4,500. The following charts summarize the total freight car costs for 20 years, at a 10-year implementation rate, at $3,500 and $4,500:

Freight Car Conversion Costs at $3,500 / Car				
Year	Rate	Cars Equipped	Cars Equipped Annually	Costs per Year
1	0.1	36,382	36,382	$ 127,336,300
2	0.2	72,764	36,382	$ 127,336,300
3	0.3	109,145	36,382	$ 127,336,300
4	0.4	145,527	36,382	$ 127,336,300
5	0.5	181,909	36,382	$ 127,336,300
6	0.6	218,291	36,382	$ 127,336,300
7	0.7	254,673	36,382	$ 127,336,300
8	0.8	291,054	36,382	$ 127,336,300
9	0.9	327,436	36,382	$ 127,336,300
10	1	363,818	36,382	$ 127,336,300
11	1	363,818		
12	1	363,818		
13	1	363,818		
14	1	363,818		
15	1	363,818		
16	1	363,818		
17	1	363,818		
18	1	363,818		
19	1	363,818		
20	1	363,818		
Sums			363,818	$ 1,273,363,000
PV 7%				**$ 894,356,886**

Freight Car Conversion Costs at $4,500 / Car				
Year	Rate	Cars Equipped	Cars Equipped Annually	Costs per Year
1	0.1	36,382	36,382	$ 163,718,100
2	0.2	72,764	36,382	$ 163,718,100
3	0.3	109,145	36,382	$ 163,718,100
4	0.4	145,527	36,382	$ 163,718,100
5	0.5	181,909	36,382	$ 163,718,100
6	0.6	218,291	36,382	$ 163,718,100
7	0.7	254,673	36,382	$ 163,718,100
8	0.8	291,054	36,382	$ 163,718,100
9	0.9	327,436	36,382	$ 163,718,100
10	1	363,818	36,382	$ 163,718,100
11	1	363,818		
12	1	363,818		
13	1	363,818		
14	1	363,818		
15	1	363,818		
16	1	363,818		
17	1	363,818		
18	1	363,818		
19	1	363,818		
20	1	363,818		
Sums			363,818	$ 1,637,181,000
PV 7%				**$ 1,149,887,425**

b. 5-Year Implementation Rate

Benefits and costs vary by how fast or slow the industry implements ECP brake technology. The FRA assumes that a 10-year implementation period is reasonable, but the implementation period could vary and therefore change the time when benefits are expected to occur. In addition to a 10-year period, benefits and costs are estimated for 5-year and 15-year implementation periods.

Several factors could affect the rate of implementation. The AAR already has in place standards for approving ECP brake technology, which eases the approval process for suppliers of ECP brakes, and should improve the rate of implementation. A railroad's availability of funds for investing in ECP brake technology will determine whether it can purchase ECP brakes. A railroad may also select to place its funds in alternative investments. Thus, a railroad's finances and resource decisions will determine how fast or slow it employs ECP brakes; the rate will vary by railroad. Future demand for train operations that will benefit from using ECP brakes is another factor that will determine the rate of conversion to ECP brakes. As mentioned, coal, intermodal, and other unit-like train operations are the best candidates for using ECP brakes. As demand for these operations increase, the demand for ECP brakes will likely rise as well. Demand for these operations will increase the rate of conversion. Further, in the past, the industry has shown some hesitation to adopting ECP technology. Until additional experience with the technology helps to verify the operational benefits of ECP brakes, the industry may be slow to adopt ECP brakes. It is assumed that as field experience with ECP brakes increases, the rate of implementation will increase. To determine how changing the implementation period will affect the costs and benefits, the following additional cost and benefit schedules are presented. Note that the accidents are assumed to occur as before, over 20 years, extrapolated from 5-year sample data. The overall method is the same as used for the 10-year implementation period.

If a decision is made to invest in ECP brakes at a faster rate and a faster conversion is possible, benefits and costs will accrue at a faster rate. The total costs increase $27,249,099 due to additional recurring training costs; the present value (7 percent) of the total costs increases $251,200,464 due to the shorter implementation time. All costs and all benefits calculated at this faster implementation rate appear in the following tables:

ECP Brake COSTS With 5-Year Implementation					
Year	Rate	Freight Car Costs	Locomotive Costs	Training Costs	Total Costs
1	0.2	$291,054,400	$97,104,000	$7,916,187	$396,074,587
2	0.4	$291,054,400	$97,104,000	$9,796,115	$397,954,515
3	0.6	$291,054,400	$97,104,000	$11,976,043	$400,134,443
4	0.8	$291,054,400	$97,104,000	$14,155,971	$402,314,371
5	1	$291,054,400	$97,104,000	$16,335,899	$404,494,299
6	1			$10,899,640	$10,899,640
7	1			$10,899,640	$10,899,640
8	1			$10,899,640	$10,899,640
9	1			$10,899,640	$10,899,640
10	1			$10,899,640	$10,899,640
11	1			$10,899,640	$10,899,640
12	1			$10,899,640	$10,899,640
13	1			$10,899,640	$10,899,640
14	1			$10,899,640	$10,899,640
15	1			$10,899,640	$10,899,640
16	1			$10,899,640	$10,899,640
17	1			$10,899,640	$10,899,640
18	1			$10,899,640	$10,899,640
19	1			$10,899,640	$10,899,640
20	1			$10,899,640	$10,899,640
Sums		$1,455,272,000	$485,520,000	$223,674,809	$2,164,466,809
PV (7%)		$1,193,380,505	$398,145,572	$118,957,685	**$1,710,483,762**

ECP Brake Benefits With 5-Year Implementation						
Year	Total Regulatory Relief Benefits	Best Estimate Value of Rail Accident Risk Reduction	Highway-Rail Accident Risk Reduction	Fuel Savings	Wheel Replacement Savings	Total Benefits
1	$17,242,891	$1,520,703	$ 93,574	$ 18,300,000	$ 10,675,000	$47,832,168
2	$48,270,948	$4,562,109	$ 280,721	$ 54,900,000	$ 32,025,000	$140,038,777
3	$75,841,278	$7,603,515	$ 467,868	$ 91,500,000	$ 53,375,000	$228,787,661
4	$103,411,608	$10,644,922	$ 655,015	$ 128,100,000	$ 74,725,000	$317,536,544
5	$130,981,938	$13,686,328	$ 842,162	$ 164,700,000	$ 96,075,000	$406,285,427
6	$146,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$452,659,869
7	$150,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$456,659,869
8	$154,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$460,659,869
9	$158,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$464,659,869
10	$162,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$468,659,869
11	$164,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$470,659,869
12	$164,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$470,659,869
13	$164,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$470,659,869
14	$164,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$470,659,869
15	$164,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$470,659,869
16	$164,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$470,659,869
17	$164,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$470,659,869
18	$164,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$470,659,869
19	$164,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$470,659,869
20	$164,767,103	$15,207,031	$ 935,735	$ 183,000,000	$ 106,750,000	$470,659,869
Sums	$2,797,255,200	$266,123,039.15	$16,375,370.45	$ 3,202,500,000	$1,868,125,000	$8,150,378,609
PV 7%	$1,331,620,504	$128,243,468.71	$7,891,215.71	$ 1,543,270,022	$ 900,240,846	**$3,911,266,057**

c. 15-Year Implementation Rate

If a decision is made to implement ECP at a slower rate of 15 years, the costs and benefits will accrue at a slower rate. The total costs decrease $27,249,099 due to a reduction in recurring training costs; the present value (7 percent) of the total costs decreases approximately $203,135,128 million due to the longer implementation time.

ECP Brake COSTS With 15-Year Implementation					
Year	Rate	Freight Car Costs	Locomotive Costs	Training Costs	Total Costs
1	0.0667	$ 97,018,133	$ 32,368,000	$ 2,838,729	$ 132,224,862
2	0.1333	$ 97,018,133	$ 32,368,000	$ 3,265,372	$ 132,651,505
3	0.2000	$ 97,018,133	$ 32,368,000	$ 3,992,014	$ 133,378,148
4	0.2667	$ 97,018,133	$ 32,368,000	$ 4,718,657	$ 134,104,790
5	0.3333	$ 97,018,133	$ 32,368,000	$ 5,445,300	$ 134,831,433
6	0.4000	$ 97,018,133	$ 32,368,000	$ 6,171,942	$ 135,558,075
7	0.4667	$ 97,018,133	$ 32,368,000	$ 6,898,585	$ 136,284,718
8	0.5333	$ 97,018,133	$ 32,368,000	$ 7,625,227	$ 137,011,361
9	0.6000	$ 97,018,133	$ 32,368,000	$ 8,351,870	$ 137,738,003
10	0.6667	$ 97,018,133	$ 32,368,000	$ 9,078,513	$ 138,464,646
11	0.7333	$ 97,018,133	$ 32,368,000	$ 9,805,155	$ 139,191,289
12	0.8000	$ 97,018,133	$ 32,368,000	$ 10,531,798	$ 139,917,931
13	0.8667	$ 97,018,133	$ 32,368,000	$ 11,258,441	$ 140,644,574
14	0.9333	$ 97,018,133	$ 32,368,000	$ 11,985,083	$ 141,371,217
15	1.0000	$ 97,018,133	$ 32,368,000	$ 12,711,726	$ 142,097,859
16	1.0000			$ 10,899,640	$ 10,899,640
17	1.0000			$ 10,899,640	$ 10,899,640
18	1.0000			$ 10,899,640	$ 10,899,640
19	1.0000			$ 10,899,640	$ 10,899,640
20	1.0000			$ 10,899,640	$ 10,899,640
Sums		$ 1,455,272,000	$ 485,520,000	$ 169,176,611	$ 2,109,968,611
PV (7%)		$ 883,632,815	$ 294,804,961	$ 77,710,395	**$ 1,256,148,170**

ECP Brake Benefits With 15-Year Implementation						
Year	Total Regulatory Relief Benefits	Best Estimate Value of Rail Accident Risk Reduction	Highway-Rail Accident Risk Reduction	Fuel Savings	Wheel Replacement Savings	Total Benefits
1	$5,888,125	$456,211	$31,193	$5,490,000	$3,202,500	$15,068,029
2	$18,090,316	$1,520,703	$93,578	$18,300,000	$10,675,000	$48,679,597
3	$29,139,931	$2,585,195	$155,964	$31,110,000	$18,147,500	$81,138,590
4	$38,611,030	$3,497,617	$218,349	$42,090,000	$24,552,500	$108,969,497
5	$49,660,646	$4,562,109	$280,735	$54,900,000	$32,025,000	$141,428,490
6	$61,862,837	$5,626,601	$343,120	$67,710,000	$39,497,500	$175,040,058
7	$72,486,511	$6,539,023	$405,506	$78,690,000	$45,902,500	$204,023,540
8	$83,536,127	$7,603,515	$467,891	$91,500,000	$53,375,000	$236,482,533
9	$94,585,742	$8,668,008	$530,277	$104,310,000	$60,847,500	$268,941,526
10	$104,056,841	$9,580,429	$592,662	$115,290,000	$67,252,500	$296,772,433
11	$116,259,032	$10,644,922	$655,048	$128,100,000	$74,725,000	$330,384,001
12	$128,461,223	$11,709,414	$717,433	$140,910,000	$82,197,500	$363,995,570
13	$137,932,322	$12,621,836	$779,819	$151,890,000	$88,602,500	$391,826,476
14	$148,981,938	$13,686,328	$842,204	$164,700,000	$96,075,000	$424,285,469
15	$160,031,553	$14,750,820	$904,589	$177,510,000	$103,547,500	$456,744,462
16	$164,767,103	$15,207,031	$935,735	$183,000,000	$106,750,000	$470,659,869
17	$164,767,103	$15,207,031	$935,735	$183,000,000	$106,750,000	$470,659,869
18	$164,767,103	$15,207,031	$935,735	$183,000,000	$106,750,000	$470,659,869
19	$164,767,103	$15,207,031	$935,735	$183,000,000	$106,750,000	$470,659,869
20	$164,767,103	$15,207,031	$935,735	$183,000,000	$106,750,000	$470,659,869
Sums	$2,073,419,687	$190,087,885	$11,697,044	$2,287,500,000	$1,334,375,000	$5,897,079,616
PV 7%	$879,431,404	$80,365,091	$4,946,570	$967,106,057	$564,145,200	**$2,495,994,322**

VI. SPECIALIZED ANALYTICAL REQUIREMENTS

A. Analysis of Impacts on Small Entities

The purpose of this section is to provide information and further detail on the assessment of the impacts on small entities by the proposed Electronically Controlled Pneumatic Brake System requirements. This section is also intended to fulfill the requirements found in the Regulatory Flexibility Act.[57] Further, this document illuminates the thought processes of the Federal Railroad Administration (FRA) during the rulemaking and its efforts to minimize the adverse economic impact on small entities and to ensure sufficient outreach to these entities.

This initial Analysis of Impacts on Small Entities concludes that this proposed rule would not have a significant economic impact on a substantial number of small entities. In order to determine the significance of the economic impact for the final rule's Regulatory Flexibility Act (RFA) requirements, the FRA invites comments from all interested parties concerning data and information regarding the potential economic impact caused by this proposed rule. The FRA will consider the comments and data it receives—or lack of comments and data—in making a decision on the RFA at the final rule stage.

The *factual basis* for the certification that the proposed rule will not have a significant economic impact on a substantial number of small entities is that the rule is voluntary. Therefore, the rulemaking does not impose direct costs on small railroads, and the analytical requirements of the FRA do not apply. Even given the voluntary nature of the rulemaking, the FRA estimates that only four Class I railroads will take advantage of the proposed rule. The proposed rule will not affect small railroads. As will be explained in greater detail later in this document, all of the 523 small railroads will have no economic impact from the rule.

In addition to its conclusion that this rule will not have a significant economic impact on a substantial number of small entities, the FRA further concludes that the proposal will not have a noticeable impact on the *competitive position* of small entities, or on the small entity segment of the industry as a whole.

The small entity segment of the railroad industry faces little in the way of intramodal competition. Small railroads generally serve as "feeders" to the larger railroads, collecting carloads in smaller numbers and at lower densities than would be economical for the larger railroads. For smaller railroads that carry unit and unit-like commodities, often they operate the train with the locomotives and cars without ownership of the equipment. They transport those cars over relatively short distances and then turn them over to the larger systems which transport them relatively long distances to their ultimate destination, or for handoff back to a smaller railroad for final delivery. Although there are situations in which their relative interests may not always coincide, the relationship between the large and small entity segments of the railroad industry are more supportive and codependent than competitive.

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[57] 5 U.S.C. § 601, et seq.

It is also extremely rare for small railroads to compete with each other. As mentioned above, small railroads generally serve smaller, lower density markets and customers. They exist, and often thrive, doing business in markets where there is not enough traffic to attract the larger carriers which are designed to handle large volumes over distance at a profit. As there is usually not enough traffic to attract service by a large carrier, there is also not enough traffic to sustain more than one smaller carrier. In combination with the huge barriers to entry in the railroad industry (need to own right-of-way, build track, purchase fleet, etc.), small railroads rarely find themselves in competition with each other. Thus, even to the extent that the proposed rule may have an economic impact, it should have no impact on the intramodal competitive position of small railroads. Additionally, the suppliers of ECP brakes are not small entities.

The FRA does recognize that small entities may in some cases, be involved in specific route segments for trains that originate or terminate on a Class I railroad. In these cases, the cars involved are more likely than not to be shipper owned or provided from the Class I fleet. Mutual support arrangements and shared power practices are likely to ensure that the smaller railroad will not require ECP-equipped locomotives for this service.

To the extent the FRA has included grain unit train service in these estimates, and to the extent doing so is not warranted by the practicalities of particular shipping practices (as where carloads are collected at grain elevators on branch lines), the FRA would anticipate that ECP brakes will not be used in that service. Since grain cars are used heavily only during certain seasons of the year (in contrast to year-round services), removing any portion of grain service from the analysis would tend, at worst, to reduce costs more than benefits.

The FRA encourages small entities that could potentially be impacted by this proposed rule to participate in the public comment process by submitting comments on this assessment or this rulemaking to the official US Department of Transportation (DOT) docket for this rulemaking.[58]

1. Rationale for Choosing Regulatory Action and Legal Authority

In an effort to understand why electronically controlled pneumatic brake (ECP) systems were not implemented in the industry, the FRA commissioned a report and performed research on ECP brakes. <u>Benefit Cost Analysis an Implementation Plan for Electronically Controlled Pneumatic Braking Technology in the Railroad Industry</u> ("the report"), dated August 2006, elaborates the results of these studies. The Report found that it is not cost effective to implement this technology on smaller railroads. Most of the potential benefits have a higher rate of return on unit and unit-like service. Smaller railroads primarily handle mixed freight.

2. Small Entities Affected

The United States Small Business Administration (SBA) stipulates in its "size standards" a for-profit railroad business firm may not have more than 1,500 employees for line-haul operating

[58] http://dms.dot.gov/

railroads, and 500 employees for switching and terminal establishments to be considered a small entity.[59] "Small entity" is defined in 5 U.S.C. 601 as a small business concern that is independently owned and operated, and is not dominant in its field of operation. SBA's size standards may be altered by Federal agencies upon consultation with SBA and in conjunction with public comment.

Pursuant to that authority, the FRA has published a final policy that classifies "small entities" as being railroads that meet the line haulage revenue requirements of a Class III railroad.[60] Currently, the revenue requirements are $20 million or less in annual operating revenue. The $20 million limit is based on the Surface Transportation Board's (STB) threshold of a Class III railroad carrier, which is adjusted by applying the railroad revenue deflator adjustment.[61] The same dollar limit on revenues is established to determine whether a railroad shipper or contractor is a small entity. The FRA is using this definition of "small entity" for regulatory flexibility purposes in this rulemaking.

For this rulemaking, there are approximately 523 small railroads that could potentially receive regulatory relief.[62] However, railroads are not mandated to convert to ECP technology. Regulatory relief provides an incentive for most long-haul services to convert. Smaller railroads do not operate over 1,000 or 1,500 miles and would not benefit economically by converting to this technology. Hence, the FRA does not expect this proposed regulation to impact any small railroads. FRA estimates that in aggregate, small railroads own approximately 2,500 locomotives.

The only non-railroad businesses that potentially could be impacted by the requirements in this proposed rule are ECP brake manufacturers, i.e., original equipment manufacturers (OEM) and re-manufacturers. The primary manufacturers (OEMs) of ECP brakes are large corporations. The FRA does not believe that these companies would be considered small entities.[63]

3. Reporting, Recordkeeping, and Other Compliance Requirements

The major reporting or recordkeeping requirements in this proposed rulemaking are for ECP brake manufacturers. In addition there is a requirement for stenciling identification of piston travel for ECP cars. Railroads are required to develop procedures for single car air brake test and the handling of defective equipment, including the identification of repair locations. Records of the testing and calibration of end-of-train devices is required. Locomotive engineer training on ECP equipment requires forms and certifications. However, since no small railroads are

[59] Public Law 102-365, September 3, 1992.
[60] RSAC was established to provide advice and recommendations to the FRA on railroad safety matters. The Committee consists of 48 representatives, drawn from among 27 organizations representing various railroad industry interests, including both the AAR, which represents large railroads, and the ASLRRA that represents the small and medium railroads.
[61] "Table of Size Standards," United States Small Business Administration, January 31, 1996, 13 CFR Part 221.
[62] See 68 FR 24891 (May 9, 2003).
[63] The FRA seeks comments, information and data that would substantiate that there either are or are not secondary equipment manufactures that would be considered small entities and impacted by this proposed regulation.

anticipated to purchase ECP technology, these requirements are not anticipated to impact any small entities.

4. Impacts

The impacts from this proposed regulation are primarily a result of the cost to convert to ECP technology. These costs include locomotive crew and inspector training, freight car conversion costs, and locomotive conversion costs. Again, since no small railroads are expected to convert to ECP technology, these impacts are not anticipated to impact any small entities.

The Regulatory Analysis for this rulemaking estimates that the total non-discounted costs over 20 years are $2.1 billion. The present value (PV) for this cost total is $1.5 billion for the 20-year period. The FRA estimates there will be no impact to the small railroads for the time-period of this analysis. As noted above, the regulatory analysis contains more details on the individual impacts of each section of the proposed rule.

5. Alternative Treatment for Small Entities

Since the FRA does not anticipate that this proposed rule would impose any burdens on small entities, there is no alternative treatment proposed for small entities.

6. Outreach to Small Entities

On September 21, 2006, the FRA had a meeting of the Railroad Safety Advisory Committee (RSAC) including the American Shortline and Regional Railroad Association (ASLRRA) where Booz Allen Hamilton provided a briefing on their Report.[64] The FRA indicated at the RSAC meeting an intention to issue a proposed rule. Since that RSAC meeting, there have been numerous opportunities for small entities to raise concerns. None have been raised. The FRA assumed that the regulatory relief benefits would not apply to railroads that operate fewer than 1,000 miles. The FRA would like to take this opportunity to solicit comments from small entities that would be interested in implementing this technology.

7. Conclusion

The FRA's proposed ECP brake requirements are intended to improve safety and efficiency of railroad operations. This Small Entity Impact Assessment and Evaluation concludes that this proposed rule would not have an economic impact on any small entities. In order to determine the significance of the economic impact for the final rule's regulatory flexibility assessment

[64] RSAC was established to provide advice and recommendations to the FRA on railroad safety matters. The Committee consists of 48 representatives, drawn from among 27 organizations representing various railroad industry interests, including both the AAR, which represents large railroads, and the ASLRRA that represents the small and medium railroads.

(RFA), the FRA invites comments from all interested parties concerning the potential economic impact on small entities caused by this proposed rule. The Agency will consider the comments and data it receives—or lack of comments and data—in making a decision on the RFA for the final rule.

Executive Order No. 13272, "Proper Consideration of Small Entities in Agency Rulemaking," requires a Federal agency, inter alia, to notify the Chief Counsel for Advocacy of the Small Business Administration (SBA) of any of its draft rules that would have a significant economic impact on a substantial number of small entities, to consider any comments provided by the SBA, and to include in the preamble to the rule the agency's response to any written comments by the SBA unless the agency head certifies that including such material would not serve the public interest.[65] Since FRA has determined that this proposed rule would not have significant impact on a substantial number of small entities, no notification to SBA has been provided for this purpose.

B. Analysis of Unfunded Mandates

Pursuant to Section 201 of the Unfunded Mandates Reform Act of 1995 (Pub. L. 104-4, 2 U.S.C. § 1531), each Federal agency "shall, unless otherwise prohibited by law, assess the effects of Federal regulatory actions on State, local, and tribal governments, and the private sector (other than to the extent that such regulations incorporate requirements specifically set forth in law)." Section 202 of the Act (2 U.S.C. § 1532) further requires that "before promulgating any general notice of proposed rulemaking that is likely to result in the promulgation of any rule that includes any Federal mandate that may result in expenditure by State, local, and tribal governments, in the aggregate, or by the private sector, of $120,700,000 or more (adjusted annually for inflation) in any 1 year, and before promulgating any final rule for which a general notice of proposed rulemaking was published, the agency shall prepare a written statement" detailing the effect on State, local, and tribal governments and the private sector. The proposed rule, if enacted, may result in the expenditure, in the aggregate, of $120,700,000 or more in any one year. However, those expenses are not mandated and would only be incurred by the private sector if it wishes to take advantage of the regulatory relief provided by the proposed rule. Although the preparation of such a statement is not required, the analytical requirements under Executive Order 12866 are similar to the analytical requirements under the Unfunded Mandates Reform Act of 1995 and, thus, the same analysis complies with both analytical requirements.

[65] See 67 FR 53461 (August 16, 2002).

Appendix A

ECP BRAKE CAUSE CODES				
Cause Code	DESCRIPTION	Minimum	Best Estimate	Maximum
E00C	Knuckle Broken or Defective	**34%**	**40%**	**46%**
E03C	Obstructed brake pipe or connections (closed angle cock, ice, etc.)	**74%**	**87%**	**100%**
E03L	Obstructed brake pipe or connections (closed angle cock, ice, etc.) (Locomotive)	**74%**	**87%**	**100%**
E04C	Other brake components damaged, worn,broken, or disconnected	**26%**	**30%**	**35%**
E05C	Brake valve malfunction (undesired emergency)	**74%**	**87%**	**100%**
E06C	Brake valve malfunction (stuck brake, etc.)	**74%**	**87%**	**100%**
E08C	Hand brake (including gear) broken or defective	**10%**	**15%**	**20%**
E09C	Other brake defects, cars (Provide detailed description in narrative)	**26%**	**30%**	**35%**
E66C	Damaged flange or tread (flat)	**43%**	**50%**	**58%**
E67C	Damaged flange or tread (build up)	**81%**	**90%**	**95%**
E6AC	Thermal crack flange or tread	**10%**	**15%**	**20%**
E69C	Other wheel defect (CAR) (Provide detailed description in narrative)	**10%**	**15%**	**20%**
E99C	Other mechanical and electrical failures, (Car) (Provide detailed description in narrative)	**10%**	**15%**	**20%**
H008	Improper operation of train line air connections (bottling the air)	**74%**	**87%**	**100%**
H019	Failure to release hand brake on car(s) (railroad employee)	**10%**	**15%**	**20%**
H099	Use of brakes, other (Provide detailed description in narrative)	**26%**	**30%**	**35%**
H401	Failure to stop train in clear	**10%**	**15%**	**20%**
H499	Other main track authority causes (Provide detailed description in narrative)	**10%**	**15%**	**20%**
H501	Improper train makeup at intitial terminal	**68%**	**80%**	**92%**
H503	Buffing or slack action excessive, train handling	**81%**	**90%**	**95%**
H504	Buffing or slack action excessive, train make-up	**81%**	**90%**	**95%**
H505	Lateral drawbar force on curve excessive, train handling	**81%**	**90%**	**95%**
H506	Lateral drawbar force on curve excessive, train make-up	**68%**	**80%**	**92%**
H507	Lateral drawbar force on curve excessive, car geometry (short car/long car combination)	**26%**	**30%**	**35%**
H508	Improper train make-up	**68%**	**80%**	**92%**
H509	Improper train inspection	**43%**	**50%**	**58%**
H510	Automatic brake insufficient (H001)	**74%**	**87%**	**100%**
H511	Automatic brake excessive (H002)	**81%**	**90%**	**95%**
H512	Automatic brake, failure to use split reduction (H003)	**81%**	**90%**	**95%**
H513	Automatic brake, other improper use (H004)	**81%**	**90%**	**95%**
H514	Failure to allow air brakes to fully release before proceeding (H005)	**74%**	**87%**	**100%**
H517	Dynamic brake insufficient (H009)	**10%**	**15%**	**20%**
H518	Dynamic brake excessive (H010)	**10%**	**15%**	**20%**
H519	Dynamic brake, too rapid adjustment (H011)	**43%**	**50%**	**58%**
H520	Dynamic brake, excessive axles (H012)	**43%**	**50%**	**58%**
H521	Dynamic brake, other improper use (H013)	**43%**	**50%**	**58%**
H522	Throttle (power) improper use (H014)	**43%**	**50%**	**58%**
H523	Throttle (power) too rapid adjustment (H015)	**15%**	**20%**	**25%**
H525	Independent (engine) brake, improper use (except actuation) (H023)	**43%**	**50%**	**58%**
H526	Failure to actuate off independent brake (H024)	**43%**	**50%**	**58%**
H599	Other causes relating to train handling or makeup (Provide detailed description in narrative)	**10%**	**15%**	**20%**
H699	Speed, other (Provide detailed description in narrative)	**10%**	**15%**	**20%**
H702	Switch improperly lined	**10%**	**15%**	**20%**
H999	Other train operation/human factors (Provide detailed description in narrative)	**10%**	**15%**	**20%**
M308	Highway user deliberately disregarded crossing warning devices	**10%**	**15%**	**20%**
M399	Other causes (Provide detailed description in narrative)	**10%**	**15%**	**20%**
M401	Emergency brake application to avoid accident	**10%**	**15%**	**20%**
M402	Object or equipment on or fouling track (motor vehicle - other than highway rail crossing)	**10%**	**15%**	**20%**
M404	Object or equipment on or fouling track - other than above (for vandalism, see code M503)	**10%**	**15%**	**20%**
M599	Other miscellaneous causes (Provide detailed description in narrative)	**10%**	**15%**	**20%**

Appendix B

ACCIDENT/INCIDENT RECORD EXTRACTION PROCESS USED TO SUPPORT NATIONAL INSPECTION PLAN (NIP) ANALYSES

1. Because the FRA Accident/Incident file for a calendar year contains multiple records for a number of its entries, it is desirable to find an identifier for each accident, and apply that identifier to its records. The identifier used in this record extraction process is the concatenation of the following file fields:
    a. IYR3
    b. IMO3
    c. RR3
    d. INCDTNO3
2. The process used to support NIP analyses begins by appending together the incident files for a user specified range of years. Before appending them together, the annual files are processed to insert the accident keys into a newly created key field inserted into each file. The appended year incident file is sorted in ascending order by record key and descending order by JointCD field values.
3. A second file containing distinct accident keys is then extracted from the appended year incident file, and is sorted in ascending key order.
4. The record extraction process begins by selecting the appended year incident file records that contain the first accident key file entry.
5. If there is only one record associated with the first key, and the RR2 field is empty, that record will represent the key's accident in the extraction process output file.
6. If there is only one record associated with the first key, the RR2 field is not blank, and the RAILROAD and RR3 field entries are equal, the record will still be used, but the value in the RAILROAD field will be changed to the value in the RR2 field, the RR2 field will be made blank, and the JointCD entry will be set to zero (0).
7. When the number of appended file records associated with the accident key exceeds one, they will be screened by the following criteria applied sequentially.
8. If incident cause is equipment related, and the RAILROAD field entry does not equal its RR3 counterpart, the record will be selected to represent the key's accident.
9. If the incident cause is equipment related, the RAILROAD and RR3 field entries match, and the RR2 field is blank, the record will again be selected.
10. If the incident cause is related to human factors, and the RAILROAD and RR3 entries do not match, the record will be selected.
11. If the incident cause is related to human factors, the RAILROAD and RR3 entries do match, and the RR2 field entry is blank, the record will be selected.
12. If incident cause is track or signal related, and the RAILROAD and RR3 entries match, the record will be selected.
13. If incident cause falls in the FRA's Miscellaneous Cause category, and the record's JointCD entry equals 1, the record will be selected.
14. If multiple records have been extracted for the accident key, and the first record is not selected to represent the key's accident, process the next extracted record through the

criteria appearing in steps 7 through 14. Continue with succeeding records until one of the records is selected, or until the last record is reached.

15. The final record, if reached, will be subjected to further screening but, except for limited editing of certain of its fields that may occur, will be used to represent the accident. It should be noted that that record would have a JointCD entry equal to 1.
16. Processing of the first accident key is now complete. Returning to step 5, the process will then be repeated for each entry in the accident key file until a record is selected for each key and its related accident.