TECHNOLOGY DIGEST
Timely Technology Transfer

Economic Analysis of Electric Braking Systems

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Summary

The application of electric braking (EP) systems to the railroad industry's 103,000 car unit train fleet would result in expected annual savings of approximately $503 per year per car and provide a net present savings over twenty years of $112,000,000.

The benefits of EP brakes arise from their inherent ability to continuously communicate with the locomotive and significant improvements in stopping distance. Economic benefits are expected in the following areas:

- Reduction in the time required to perform the Repair Track Air Brake Test and initial terminal test and elimination of the Intermediate Terminal Test,
- Reduction in the incidence of broken knuckles caused by train action and the associated train delays and accidents,
- Reduction in the number of accidents caused by slack action,
- Reduction of the number of accidents caused by brake system failures,
- Elimination of the need for an End-Of-Train device,
- Reduction of the number of brake/thermal-caused wheel removals,
- Reduction in the number of train delays caused by brake system failures, and
- Improved equipment utilization as a result of the ability of trains to operate significantly faster with current block spacing.

The level of benefits assumes conformance with the Draft Performance Requirements developed by the AAR Research and Test Department in conjunction with railroad and supply industry representatives for testing EP freight car brake systems.

The savings are sufficient to justify continued effort by the industry in accelerating the development, testing and implementation of EP brake systems.

Association of American Railroads
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INTRODUCTION AND CONCLUSIONS

The existing freight train air brake system depends on a pneumatically transmitted signal to activate the train brakes. The AAR Research and Test Department has worked with railroad and supply industry representatives to develop performance requirements for testing electric brake systems. These brake systems would be electrically controlled and pneumatically activated.

The implementation of this new brake system will ultimately depend on the economic cost and benefit in freight service. Because cars equipped with this new brake system would be limited to use in dedicated electrically braked trains, this system will first be applied to cars in fixed consist unit train service. Therefore the analysis presented in this report applies to the approximately 103,000 freight cars currently in unit train service.

The projected Net Present Savings to the industry over 20 years is $112,000,000. This savings is sufficient to justify continued effort by the industry to accelerate the implementation of EP braking systems.

SYNOPSIS OF APPROACH

The AAR Research and Test Department held a series of Town Meetings to discuss the development of performance specifications for EP brakes. At each meeting the participants were divided into three subgroups to discuss car performance, locomotive and economic issues. The Economics Group was chaired by R. Cartwright of the AAR Car Engineering Committee. This group formulated the areas and magnitudes of expected savings, based on reasonable estimates of costs associated with braking that would be reduced or eliminated, and provided guidance and advice throughout the economic analysis.

The net present value (NPV) of the expected savings was computed assuming a ten year phase-in period to equip all 103,000 freight cars currently in unit train service. Both costs and benefits are assumed to phase in at the same rate because these brakes must be put into service in train sets. Thus there is not a significant lag between the investment and the onset of the projected savings.

The savings are summarized in the following sections by broad categories. Each section will provide an estimate of projected savings in that area.

Repair Track Air Brake Test

The Repair Track Air Brake Test must be performed each time a car is on a repair track. The Economics Group estimates that the time to perform the single car test will be reduced by seventy-five percent with EP brakes. This is the result of the self-diagnostic capabilities of the system reducing the currently extensive brake valve test to a leak test. The current test requires .753 hours at a cost of $56.81 at the January, 1994 AAR billing rate of $75.44 per hour. The average freight car is on a repair track 1.6 times per year. Since this analysis is for unit trains only, a more conservative estimate of once per year is used. This results in an annual per-car savings of $42.61.

Intermediate Brake Test

An intermediate Air Brake Test must be performed after each 1000 miles of train movement. The constant feedback of brake system function to the locomotive engineer available with EP brake systems eliminates the need for this test. The cost of each intermediate brake test is approximately $450 per train. Further, a unit train traveling 80,000 miles per year will require a minimum of 50 such tests each year. Therefore, assuming unit trains with a length of 100 cars and regulatory relief, the annual savings from the elimination of the intermediate brake test is $225 per car.

Initial Terminal Test

An Initial Terminal Test is required by the Federal Railroad Administration before any train leaves its initial terminal. This test consists in part of pumping air into the brake system to achieve the required brake line pressure. A brake application is then made to assure that all shoes on the train apply. The air pressure is then increased to release the brakes. Each car is inspected for the test. The EP brake system will allow a greater volume of air to be pumped into the brake system reducing the time to perform this test. A brake system model provided by New Hampshire University predicts a reduction of ten minutes per 100 car train to perform this test. Again, assuming fifty tests per year, and a delay cost of $.045 per minute, this results in an annual savings of $0.22 per car.

End-Of-Train Device

The End-of-Train (EOT) device is used to monitor the brake pipe pressure on the last car of a train and communicate that pressure to the locomotive via radio. In the future, the EOT must also be capable of initiating a brake application from the rear of the train. The EP brake continually monitors the brake cylinder pressure on every car in the consist and transmits that information to the locomotive via the train communication line. This constant monitoring of the air brake system far exceeds the current function of the EOT. Further, the EP brake system does not rely on a pneumatic signal to initiate an emergency application, obviating this requirement of the EOT Device. The elimination of all braking system related functions of the EOT device leaves only the current function of a marker light.

The replacement of the current EOT device with a rear end marker light will save significant capital and maintenance costs. The cost of a two-way EOT device is approximately $7000 and the cost of a marker light is $500. The normal life of an EOT device is four years. Thus, assuming 100 car trains the annual savings resulting from the elimination of the EOT device is $16.25 per car.

The annual maintenance cost for an EOT has been estimated by several railroads as one half the purchase price. This yields an annual per car maintenance savings of $32.50.

Slack Action

With an EP brake system, the brakes on all of the cars in the consist are applied simultaneously. This will result in a significant reduction in the slack action within the train when the brakes are applied. The reduction in slack action will result in fewer broken coupler knuckles and the associated train delays and accidents.

The Economics Group estimates that EP brakes will result in a twenty percent reduction in the number of broken knuckles. The annual maintenance cost for replacement of broken knuckles is $8 million. Thus, a twenty percent reduction allocated to the current fleet of 1.3 million cars results in an annual per car savings of $1.23.

The 160,000 broken knuckles per year resulted in $309,000 in FRA reportable accident costs in 1992. Using a 2.5 multiplier to account for costs other than damage to track and equipment, and 1.3 million cars in the fleet, a twenty percent reduction is broken knuckles results in an estimated $0.62 per car savings.

The reduction in slack action will also reduce the number of slack action caused derailments. The Economics Group estimates this savings at twenty percent. Slack action caused 83 derailments in 1992 at an FRA reportable cost of $2.5 million. Using the above assumptions, a twenty percent reductions in these accidents would result in an annual savings of $4.81 per car.

Brake/Thermal Wheel Removals

The improved control of freight train braking will reduce the number of wheels damaged as a result of stuck brakes and overbraking of freight cars. The Economics Group estimates that a minimum of a twenty percent reduction in brake/thermal wheel removals can be expected using EP brakes. The range of brake-caused wheel removal costs per mile for unit train cars in the Car Maintenance Cost Data Base is from approximately $.001 to $.004 per car mile. Using an estimate of $.002 per mile to recognize the reduction in wheel failures resulting from the continued introduction of heat-treated, curved-plate wheels, 80,000 miles per car per year and a twenty percent reduction yields an expected annual savings of $32 per car.

Brake System Caused Train Delays

Two significant causes of train delays, undesired emergencies and stuck valves, will be virtually eliminated with the use of EP brake systems. Both of these problems are caused by failures of the current brake valve to properly interpret changes in train line pressure. Since the EP system does not depend on the train line to transmit signals, the Economics Group estimates that a minimum of ninety percent of these delays will be eliminated. There are an estimated26,000 such train delays each year. Since each incident causes a 45 minute delay at $.045 per train-minute, the annual savings per year is negligible ($0.04 per car year).

Retainer Valve

The retainer valve is used to maintain brake applications down long, steep grades. The use of EP brake system will obsolete this valve. The industry spends $1.5 million annually to maintain retainer valves or $1.15 per car per year.

Increased Train Speed

Because brakes are applied instantly on all cars with EP brake systems, resulting in significantly shorter stopping distances, trains will be able to run significantly faster within the same block spacing. Work by the AAR Research and Test Department suggests that this increase is in the range of 20 MPH for typical main line territory. Using the Train Energy Model, the estimated time savings on a 1000 mile trip is 2.7 hours of running time. Assuming 25 percent of this is actually realized due to other factors such as congestion, increased fuel consumption and additional locomotive requirements, the savings in equipment costs for an 80,000 mile per year unit train of 100 cars is approximately $146.26 per car per year.

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