THE INFLUENCE OF ENVIRONMENTAL ISSUES ON NORTH AMERICAN RAILROAD TECHNOLOGY

Christopher P. L. Barkan, G. Richard Cataldi & Charles E. Taylor

Association of American Railroads
Research and Test Department
50 F Street, NW
Washington, DC 20001
United States

Tel.: +1 202 639 2276

Abstract: Public policy and government regulations in North America are placing increasing demands on all forms of commerce, including transportation, to reduce their impact on the environment. Providers of transportation are being required to substantially reduce or eliminate the generation of air pollutants, toxic chemicals and other solid and liquid wastes. These demands are having a substantial impact on the development of new technology for application to North American railroads. This growing environmental awareness and regulatory pressure can provide a competitive advantage to railroads vis-a-vis highways, provided the regulations are reasonable, and provided we can meet the challenges they present with cost-effective technology. Trains powered by diesel locomotives, the dominant power source used by North American railroads, are three to four times more energy efficient than trucks, on a net ton-kilometer basis, with comparable advantages in terms of exhaust emissions. Despite this inherent advantage for the rail mode, government regulators at the local and federal level are in the process of formulating regulations that will require substantial reductions in exhaust emissions from both highway trucks and locomotives.

Railroads, along with other industries, are discovering that the most cost-effective approach to a clean environment is often prevention rather than treatment and disposal. Accordingly, North American railroads are examining all operations and processes to identify which generate environmental pollutants, and how such generation can be reduced or eliminated. Some recent examples include the use of stronger tank cars and safer train operating characteristics when transporting chemicals that are particularly harmful to the environment, changes in diesel locomotive design to reduce the incidence of fuel spillage, new technologies for railroad vegetation control and the development of more energy efficient locomotive diesel engines with reduced exhaust emissions. Beyond these examples the AAR is studying opportunities to further reduce pollution in the railroad industry. Although many changes in railroad technology will initially result in increased capital costs for new equipment, these changes are instrumental to the long-term economic health and viability of the North American railroad industry as it enters the 21st century. The use of new, more environmentally sound processes and equipment will result in the reduction of waste and in many cases improved profitability.

INTRODUCTION

Public policy and government regulations in North America are placing increasing demands on all forms of commerce, including transportation, to reduce their impact on the environment. During its first 20 years, the United States Environmental Protection Agency (EPA) focused its attention primarily on "end-of-pipe" approaches to controlling environmental pollution and on the cleanup of spills that had previously occurred. As a result, US industry has expended enormous effort and expense on treatment equipment and environmental cleanup of contaminated sites. These factors have provided an economic incentive to US industry to emphasize prevention of pollution by changing or curtailing activities that can cause new contamination. This change in emphasis is being bolstered by regulatory attention to the actual processes and materials being used by industry. Providers of transportation are being required to substantially reduce or eliminate the generation of air pollutants, solid and liquid wastes, and noise. The combination of economic incentives and regulatory directives is already having a substantial impact on North American railroad technology and this trend will accelerate as we enter the 21st century.

These issues are affecting railroad technology in a variety of ways and the impact on technology ranges from modification of existing designs and practices to whole new technologies to replace approaches that will no longer be considered viable in a more environmentally conscious society. Some specific examples include: use of stronger tank cars and safer train operating characteristics when transporting chemicals that are particularly harmful to environmental health, changes in diesel locomotive design to reduce the incidence of fuel spillage, new technologies for railroad vegetation control, and the development of diesel locomotives with greater energy efficiency and reduced exhaust emissions. Although many of these changes may pose an added economic burden to railways in the short-term, they are expected to make a positive contribution in the longer term in two ways:

1) Use of processes that generate fewer pollutants will reduce the cost of treatment and disposal of wastes and the associated liability, thereby lowering long-term operating costs.
2) The greater efficiencies inherent to rail transportation vis-a-vis highway can provide a competitive advantage to railroads, provided that environmental regulations are reasonable and that we can meet the challenges they present with cost-effective technology.

In this paper we will briefly discuss some specific examples of how environmental issues are affecting change in North American railroad technology.

ENVIRONMENTAL ASPECTS OF RAILROAD ACCIDENTS

Although railroad accidents are generally thought of as a safety issue, there are substantial environmental impacts as well. Spillage of chemicals from tank cars or fuel from locomotive fuel tanks can be harmful to the environment, cause concern among the public, lead to expensive environmental cleanups, and burdensome new regulation of railroad operating practices. Over the interval from 1980 - 1990 US railroads enjoyed a 60% reduction in their train accident rate. However, this decline in accident rate has diminished in recent years. Although further reduction in the train accident rate is desirable and a variety of efforts are underway to accomplish this, it is less clear how to cost-effectively achieve substantial further improvement. Consequently, in some situations it may be more cost-effective to improve the damage resistance of specific

pieces of equipment or components that pose a high environmental risk in accidents. Two recent examples of this include the development of stronger tank cars used to transport halogenated hydrocarbons and strengthening diesel locomotive fuel tanks.

DAMAGE RESISTANT TANK CARS FOR CHEMICALS HARMFUL TO THE ENVIRONMENT

In the past five years tank car design standards for various chemicals have received a great deal of attention in North America, in particular because of the potential for some chemicals to harm the environment when spilled. The AAR conducted a risk analysis of chemicals that are commonly transported by rail and have the potential to cause an expensive environmental cleanup if spilled. We found that a over a ten year period a small group of chemicals, accounting for less than one percent of the hazardous materials traffic, accounted for over fifty percent of the railroads' accident caused environmental risk. Typical practice for most of these chemicals was that they were shipped in the minimum specification tank car permitted by regulation. The AAR conducted statistical analyses of railroad accident rates, the damage performance and cost of various designs of tank cars, and the cost to cleanup various chemicals when spilled in railroad accidents. These analyses enabled us to estimate the liability under the current shipping practices, and the reduction in liability that was possible if a more damage resistant tank car were to be used. A cost-benefit analysis revealed that the additional capital and operating cost of stronger tank cars was more than offset by the avoided cost of environmental cleanup of spills. The results were used as a basis to develop an agreement between railroads and chemical shippers regarding a stronger specification tank car to transport the most environmentally pernicious of the chemicals. The Government is also using the analysis in their consideration of development of regulations for improved packaging for these chemicals. Depending on the final specification developed for transportation of these chemicals, the net reduction in future environmental liability could be as high as $8 million per year.

The railroads have also been working with the tank car and chemical industries to develop comprehensive methodologies and computational tools for evaluating the risk to both human health and the environment that results from rail transportation of chemicals. A state-of-the-art quantitative risk assessment (QRA) computer model has been developed for this purpose. This model will enable the industries to conduct objective analyses of the risk associated with any particular chemical, shipped along any particular route under a variety of conditions. The model breaks new ground because it allows the user to assess environmental as well as human health risk, and it allows the user to quantitatively assess the effectiveness of various options to reduce risk. The QRA model provides the industries with a tool that will provide better information on which to base management decisions regarding the most effective allocation of safety resources.

MORE DAMAGE RESISTANT LOCOMOTIVE FUEL TANKS

Another environmental risk posed by railroad accidents is spillage of diesel fuel from locomotive fuel tanks. Recently, the AAR analyzed data on the frequency of these accidents and on the amount of fuel spilled as a result. Combined with data on the cost incurred by the railroads to clean up these spills, we were able to develop an estimate of the nationwide impact of locomotive fuel tank spillage in terms of total gallons lost and the cost of cleanup. We found that US railroads probably spend approximately $5 million annually to clean up fuel spilled in accidents. Detailed analysis of the causes of these spills revealed that there are at least nine different causes of fuel leakage from locomotives in accidents. These include overflow valves, broken fuel lines and broken sight gauges; however, fuel tank punctures are by far the largest source of leakage in

accidents, accounting for over 90 percent of the fuel lost on one railroad. Consequently, the greatest opportunity for improvement lies in increasing the puncture resistance of locomotive fuel tanks. The AAR is developing a performance specification for a more damage resistant locomotive fuel tank for use on new locomotives. A principal feature of the new design is a thicker tank that incorporates a system of skid protection to deflect objects that might puncture the tank.

ALTERNATIVE METHODS OF VEGETATION CONTROL

Railroad vegetation control is as important as ever in terms of maintaining a well drained, safe, high quality roadbed. Advances in chemical herbicide technology have led to effective products that rapidly degrade after application leaving no residual effect. Nevertheless, public sentiment opposing the use of chemical herbicide treatments along railroad rights of way is increasing and railroads need to consider alternative approaches. Various local governments have banned the use of herbicides at specific localities scattered around North America; however, the problem has become acute in the state of Alaska where a moratorium on chemical vegetation control has been in existence throughout the state for several years. In the Canadian province of British Columbia, CP Rail has also been banned from using herbicidal treatments in many areas. In response, CP Rail has developed an experimental system of vegetation control that uses high pressure steam to kill plants growing on the right of way. This system has been used over many of CP Rail's lines in British Columbia and was tested on the Alaska Railroad last year as well. These tests have proven that the concept is effective. Unfortunately, the experimental system is generally not cost competitive with chemical treatment. However, CP Rail staff believe that a production model can be developed that would be both faster and more economical to operate, thereby making the system an economically competitive alternative to chemical treatment. If CP Rail can develop an economical system based primarily on steam it will have great promise for the industry.

LOCOMOTIVE EMISSIONS AND ENERGY EFFICIENCY

Undoubtedly, the environmental issue that is currently having the greatest impact on North American railroad technology is the drive to improve the energy efficiency and reduce the amount of airborne emission of pollutants from diesel electric locomotives. Diesel powered locomotives are the dominant power source used by North American railroads, and on a net ton-kilometer basis they average three to four times more energy efficient than trucks and enjoy a comparable advantage in terms of exhaust emissions. Despite this inherent advantage for the rail mode, government regulators at the local and federal level are in the process of formulating regulations that will require substantial reductions in exhaust emissions from both highway trucks and railroad locomotives. Railroads and locomotive manufacturers will have to achieve substantial reductions in locomotive exhaust emissions in the coming years to meet the regulatory requirements.

Over 99 percent of the more than 20,000 locomotives in the U.S. are diesel-electrics, which burn approximately 13×10^9 liters of diesel fuel oil per year. This much energy use results in a significant contribution to air pollution in some metropolitan areas. The best way to reduce railway-caused air pollution is through improved efficiencies in operations and equipment design. This reduces both pollution and costs, thus making the railways more competitive and profitable. From 1980 to 1990, the US Class I freight railroads increased their revenue ton-kilometers per liter of fuel consumed by over 41 percent. This translated into a 25 percent reduction in global warming gases while the railroads moved 13 percent more ton-kilometers of freight.

the result of a cooperative energy research program of liers, that developed a variety of technologies and e implemented throughout the industry. Some of the ght cars, lower-resistance axle bearings, conversion of at cars to containers on stack cars, wheel flange-rail liesel engines, ac traction, improved train handling, niques, and improved track structure. Because most of nal changes are only partially implemented, we expect to nergy efficiency for many years to come. In spite of the ution from efficiency improvements, air quality regulators rimarily from the exhaust stack. The principal pollutant rogen (NOx), which is a precursor of ozone--smog. The y 2 to 4 percent of the total NOx generated in many U.S. rs consider this amount to be a "significant" contribution ways are not significant generators of other pollutants, ur dioxide, carbon monoxide, and hydrocarbons. The about 0.1 to 0.5 percent.

gulatory plan for locomotives that will probably go into unusual in that it will require railways to retrofit engines Ox by approximately 33 percent. New engines will have nt lower NOx limits than the level that typical locomotive the NOx limit for new engines will be lowered again and te matter limit. The railways are working with EPA to try issions reduction is obtained without raising the cost of t that freight traffic shifts to the highways. The AAR, rers are working together to develop retrofit kits for the et the EPA requirements, remain reliable, and not lose manufacturers are working on their own to design new yond.

clude increased aftercooling capacity for turbocharged timing, and either electronic fuel injection or improved for some engines are: higher pressure fuel injectors, nt piston rings, and changes in the piston crown shape. o include all of the above technologies, plus a general system aimed at reduced NOx and particulate matter wer and reliability required for future railway competitive- ions may require some kind of exhaust catalyst. It is t be allowed in mobile applications in the future, so that develop commercially acceptable alternatively fueled ant future, AAR, railroads, manufacturers, and the US h the National Laboratories are attempting to form ne mover technologies. Alternatives in the early stage of heels, alternative-fueled diesel engines, and oxygen

this paper represent just a few of the opportunities pact on the environment while at the same time elimi- un a study to identify and evaluate further opportunities industry with particular attention on car and locomotive

servicing and repair facilities. Although many of the changes to railroad technology discussed in this paper will result in increased capital costs, they will be essential and indeed instrumental to the long-term economic health and viability of the North American railroad industry. Railroads recognize that the use of new, more environmentally sound processes and equipment will result in reduction of waste and in many cases improved profitability. Regulators must recognize that railroads are a part of North America's solution to environmental problems and that it is not in the public interest to impose regulations that do not take into account the industry's ability to absorb the costs. Cost increases to the railroad industry could shift traffic to less environmentally friendly modes of transportation such as trucks, thereby resulting in a net increase in the pollutants emitted to the environment. Working together, railroads and regulators can develop solutions to environmental challenges facing the industry so that the public interest is served through orderly development of a safe, environmentally sound and economical rail transportation system for North America.