
Identification and Prioritization of Concerns in Coal Transportation Now Through 2000

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**Presented at
Symposium on Critical Issues in Coal
Transportation Systems
Washington, DC**

June 14-15, 1978

**Pacific Northwest Laboratory
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ABSTRACT

This review presents the results of issue analysis used to identify and prioritize perceived potential problems that may hinder the development of coal transportation in the United States during the balance of the century. One objective of this effort is to discriminate serious concerns affecting the overall adequacy of coal transportation systems from issues of lesser significance.

The concerns with the highest priority are anticipated to impact coal transportation in the early 1980s. These concerns relate to public acceptance, logistic problems with frozen coal, the impact of slurry pipelines, and sludge transportation. Problems with the potential of impact in the balance of the century include the effects of rate regulations on railroad incentives to haul coal, the safety and environmental impact of advanced slurry systems and congestion on inland waterways.

A second objective of the analysis is to recommend specific actions that may mitigate the consequences of potential problems. The recommendations discussed in this paper include the need for new research, developments and demonstrations, risk assessments and other evaluations to fill possible gaps in the coverage of current programs that address aspects of the above concerns.

Reasons are discussed for considering some familiar issues to be of lower importance than the above concerns. These examples include railroad capital requirements, equipment availability, abandonment policy and sabotage, eminent domain for slurry pipelines, competition for barges at harvest time and potential impacts of the Clean Air Act amendments.

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INTRODUCTION

This paper presents the results of a study⁽¹⁾ being conducted for the Department of Energy (DOE) by Pacific Northwest Laboratory (PNL), to identify and assess the priority of potential problems in coal transportation. The scope of the study includes concerns which may inhibit the continuing development of safe, environmentally acceptable and cost-effective coal transportation systems in the United States between now and the year 2000.

In performing this work, we have found that most issues are analogous to the symptoms of an illness rather than the illness itself. Therefore, instead of dealing directly with issues, we have concentrated on the definition of concerns. In our terminology, the concern statement summarizes a specific potential problem and the perceived anticipated impact of this problem on the transportation system. A single concern may be implied by one or more issues.

The objectives of the study go beyond the conventional limits of issue analysis. The analysis and discussion of issues in the literature and at symposiums usually fall short of resolving controversies or exploring solutions to potential problems. One objective of this project is to rank concerns on the basis of anticipated impact and immediacy. Other objectives are to identify possible gaps in the coverage of related R&D programs, and to recommend appropriate action to mitigate the potential impact of these problems.

A primary purpose of this study is to provide information and perspective that may be used to evaluate future R,D,&D needs and priorities. The following summary of this effort presents our perspective on the implications of more important issues in coal transportation as conditioned by the requirements of the project purpose and objectives.

APPROACH

The identification and prioritization of concerns were based on analysis of current system trends, familiar issues and controversies relating to coal transportation. Additional information and insight were gained from contacts with experts in government and in the electric utility, coal mining and transportation industries. From a large number of issues contributed by these various sources, a total of 24 potentially significant issues were identified as being worthy of further analysis. Assessments were made to

determine the basis for each of the issues and whether they implied a definable impact of coal transportation. This process eliminated or consolidated more issues and generated the smaller number of concerns that are reviewed below.

A PNL panel judged the priorities of concerns by ranking their potential severity and immediacy. The product of the severity and immediacy ranking was taken to indicate the relative importance, and hence, the priority of each concern. Three classes of priority were distinguished:

- 1) Perceived serious concerns requiring action now to minimize their potential impact in the next decade.
- 2) Moderate concerns requiring relatively swift action to minimize their potential impact later in the century.
- 3) Latent concerns which may increase or decrease in priority or change in nature. The trend of these concerns should be monitored, however, new program action does not appear necessary at this time.

A fourth category will be discussed that relates to controversial issues we judge to be inconsequential in their present perspective, and therefore are not priority concerns.

In the above categories, the concern is a potential problem that may cause any deterioration in the capacity, economic viability, safety or environmental impact of coal transportation systems. Some problem issues have been identified by other speakers at this symposium that relate to desirable improvements in system performance and management. To the extent that these problems are being addressed in the routine business of industry and/or ongoing R,D,&D programs sponsored by industry and the government, they are not considered as concerns in this study.

SERIOUS CONCERNS IN THE NEXT DECADE

The most important potential problems have consequences which may lead to inadequate coal transportation in the next decade. These concerns are discussed below with the recommendations for needed action that is not currently provided by programs addressing these problems.

Public Acceptance of Coal Transportation

- The transportation of coal generates many effects that could conceivably cause a deterioration in public acceptance of the system. Reduced public acceptance could lead to new and tighter regulations which might escalate the cost and hinder the development of adequate coal transportation systems.

There is a growing general tendency for some segments of the public to associate undesirable effects with the transport of all energy materials. Coal transportation by rail has been described as causing noise, dust, odors and the interruption of highway traffic at grade crossings. Coal-hauling trucks are considered to cause accelerated deterioration of rural highways. Aesthetically undesirable effects of loading and unloading coal are recognized in all modes of transport.

Segments of the public are already objecting to the interruption of commerce by unit coal trains running frequently through small towns in the western states and of trucks using rural highways. Continued escalation of this concern could result in public pressure for Federal, state and local action to place new restrictions on coal transportation. This could impact the national coal transport system by reducing the capacity of crucial links in the delivery network and increasing overall operating costs. An escalation of public reaction may include physical interference and sabotage, which would be a threat to safe operation of the system. Railroads already experience widespread and costly interference from vandals. If transportation should become an environmental villain in public opinion, vandalism and sabotage may become socially acceptable methods of protest.

To date, efforts directed toward resolution of this concern have concentrated on identifying environmental impacts and a few general solutions. Because increasing levels of public reaction can be anticipated as the volume of coal increases, a new comprehensive program is warranted to evaluate the future consequences of this concern and to establish guidelines for action to solve the potential problem. It should be determined at what level the nuisance effects of coal traffic aggregate into major environmental disturbances as perceived by the public. A priority list should be prepared identifying which effects are tolerable and which are not. The future potential impact of coal traffic on community life along specific routes may need to be evaluated as part of a study of alternative solutions. This study should evaluate solutions and financing mechanisms based on cost/benefit assessments of the alternatives.

A basic approach of the recommended effort should be to involve knowledge of public psychology in system planning and engineering. This concern has a high priority because it is a current and probably growing problem.

Impact of Frozen Coal

- In winter, coal freezing in rail cars, barges and stockpiles may prevent normal delivery schedules from being met. Under prolonged and severe cold weather conditions, this could create a regional shortage of coal during a period of high demand.

Most coal is transported wet; underground operations add water during the mining process and some coal is raised from the mines as a slurry. Western strip-mined coal is usually wetted to control dust during transfer at loading facilities. At temperatures below 40°F with wind chill effects,

this water can freeze in rail hopper cars, barges and even stockpiles. The impact is potentially most severe in the railroad case because railroads carry the bulk of the coal traffic. The standard practice for unloading frozen coal is the use of thawing sheds. Hopper cars are run one or two at a time into heated enclosures. Severe freezes have reduced the unloading rate to as low as two cars/day. This compares to dump rates of 24 cars/hour in normal unloading operations. Frozen coal, therefore, can cause a significant logistic problem by reducing the rate of coal delivery and by slowing the rate of returning empty hoppers to the mines.

Dow Chemical Corporation is developing a freeze conditioning agent (FCA). The purpose of the FCA is to decrease the compressive strength of ice crystals. Testing of FCA began in January 1977, and to date the results appear favorable. Apparently little or no attention is being given to other methods, because the companies which manufacture devices for freeing frozen coal are generally not in the financial position to undertake major research programs. Some companies appear to be willing to do minor development work and custom build installations. Other companies have expressed a desire for joint corporate efforts; however, no one has yet taken the initiative to implement this approach.

In past winters the freezing of coal has restricted the output of several industries. Climatic cycles are suggested in which winters tend to become more severe at the end of centuries. We should therefore plan R&D activities on the assumption that recent severe winter experience may be typical during the balance of the century. A program of innovative research and development is needed now to find faster and cheaper methods of thawing frozen coal.

Impact of Proposed Coal Slurry Pipelines

- Important comparative data still need to be developed before it can be decided that coal slurry pipelines are sufficiently attractive on a whole-system basis to warrant government involvement.

A variety of issues relate to coal slurry pipelines and whether they offer an attractive alternative transportation mode for coal when compared with unit trains operating on a whole-system basis. The bottom-line concern is, however, that Federal and state governments may encourage the development of slurry lines by granting rights of eminent domain and water rights without full consideration of the advantages and disadvantages of the new alternative. Progress dictates that genuine technology advancements should be encouraged at the expense of existing systems. However, the recent study performed by the Congressional Office of Technology Assessment (OTA) has demonstrated that the advantages of slurries versus unit coal trains are highly sensitive to route and system specifications. The OTA study shows out of four cases economic choices favored slurries in two cases and unit trains in the other two cases. These comparisons were constrained by specific assumptions of system capability and scenarios of future conditions. These assumptions leave a number of important areas where sensitivity analysis may change the order of preference of the systems.

Controversy still exists about the whole-system cost/benefit relationships for coal slurry pipelines and their potential impact on railroad operations and financial stability. Further review is needed to bring order to this situation and add important perspective to the fundamental question of whether government should encourage and/or subsidize coal slurry systems. An in-depth energy assessment of slurry and railroad unit train operations is particularly important and has not been emphasized in related program effort to date. We recommend that a comprehensive position paper should be prepared on the whole-system comparison of slurries and unit trains. This is needed to provide a broader data base for proceedings such as those relating to the questions of eminent domain and water rights in which an understanding of the merits of the competing systems is important. This concern does not strictly meet our criterion of having a potentially direct impact on coal transportation in the next decade. However, regulatory decisions are expected in the next two years which will have a far-reaching effect on the future impact of coal slurries in the balance of the century. For this reason the recommended research is a priority item today.

Transportation Preparedness for Sludge Removal

- The lack of future preparedness to transport large amounts of sludge and ash may restrict the use of coal in future environmentally compatible generating stations and plants.

The Clean Air Act and its amendments are intended to protect the environment from the effects of increased coal consumption. The Act contains New Source Performance Standards (NSPS) and the concept of Best Available Control Technology (BACT). Presently 12.3% of the U.S. coal reserves comply with the NSPS of $1.2 \text{ lb SO}_2/10^6 \text{ Btu}$. This percentage will decrease if the NSPS are lowered to $0.2 \text{ lb SO}_2/10^6 \text{ Btu}$ as is presently proposed. Compliance with these standards will likely require the widespread use of SO_2 removal techniques. A current interpretation of the BACT provision, which has yet to be enforced, requires the SO_2 removal systems not only to meet the NSPS but also be the best system existing at the time of installation. With today's technology this implies the mandatory installation of SO_2 scrubbers.

Limestone scrubbers, presently the most accepted SO_2 removal system, generate large amounts of sludge. When combined with the ash collected, and depending on the sulfur content, the quantity of waste requiring disposal may approach one half ton for every ton of coal consumed. Current disposal sites and techniques appear to have adequate capacity to accommodate these waste quantities through the early 1980s. Large increases in coal consumption will accelerate the depletion of present disposal sites and force the expansion of waste disposal systems. This expansion will likely involve increased shipping distances and thus develop an increased dependence on adequate and compatible transportation facilities. The industrial coal consumers in the northeast portion of the U.S. appear to have the least waste storage capacity and are likely to be the first to feel the impact of inadequate waste transportation. Local public acceptance of disposal sites may further complicate the transportation and disposal of sludge. Undesirable characteristics of sludge, as with most wastes, make public acceptance

of disposal sites a major factor in site location. Increases in shipping distance and capacity may become necessary to accommodate potential siting problems.

To date, inadequate attention has been applied to these problems. A comprehensive review of current disposal site capacities should be made and compared with projected disposal requirements in the 1980s. This should be used to identify areas where sludge may be a future transportation problem. In the event that sludge transportation is shown to be needed, a systems approach to planning should be undertaken to assure environmentally acceptable and cost-effective transportation of the sludge. Guidelines should be developed that account for alternative solutions to sludge disposal or subsequent use. This is a priority item today because of the lead time required to assess the magnitude of the potential problem and to implement solutions.

LONGER TERM CONCERNS

This category includes concerns that may impact coal transportation between 1980 and the end of the century. These concerns are lower in priority because their potential impact may occur later; there is more time to address solutions than appears to be available in the above cases.

Unit Train Rates

- If value of service is not considered as a factor in rate prescription by the ICC, the revenue generated by coal carriage may be reduced to the point that railroad management loses the incentive to expand coal-carrying capacity. This could lead to an inadequate coal transportation system which may not be sufficient to serve the anticipated increases in coal demand and production.

Regulation of rail rates for unit coal trains traditionally has been based primarily upon three factors: cost of service, comparative rates, and value of service. The San Antonio Rate Case is a matter of concern to the railroad industry because the ICC indicated a possible departure from its policy of allowing a value-of-service factor in rate-making procedures by the railroads. The ICC decision, affirmed by the Eight Circuit Court of Appeals, prescribed a rail rate for coal based primarily on cost of service plus a revenue factor and suggested that the value of service factor is of minor, if any, importance in determining a just and reasonable rate. The railroads view the implications of this decision as potentially devastating to the rail industry. If railroad rate structures were based on cost of service alone, the amount of revenue generated by coal transport would decline. This, the railroads believe, would result in insufficient capital to invest in new equipment to maintain the development of a viable rail transportation system for coal.

An evaluation should be initiated to determine the impact of the San Antonio case precedent on both the railroads and the consumers of rail-transported coal. While the San Antonio case is not representative of any consistent ICC policy, cases now pending before the ICC may be decided similarly to it. The recommended action warrants early consideration to avoid increasing the potential impacts of the case on the development of the coal transportation system and on the future cost of energy. Further analysis may be needed to provide the ICC with a basis for determining allowable revenue factors which would offer sufficient incentive for the railroads to maintain the development of their coal-carrying capacity consistent with national needs.

Environmental Impact of Advanced Coal Slurry Pipelines

- Anticipated future advances in coal slurry transport involving coal and liquid fuel mixtures may present potentially severe safety and environmental problems in the event of a pipeline rupture or a spill at terminal transfer points.

In addition to water, other carriers such as alcohol or petroleum may be used in future coal slurry pipelines. The liquid fuel carrier can be burned with the coal, and the slurry pipeline can operate without the disadvantage of consuming potential scarce water resources. Slurry pipelines can be shut down and restarted without plugging. Dumping the slurry is not required except in extraordinary cases. If a pipeline break develops, the line would simply be stopped and the break repaired. In case of a single pump outage, the line could be continued at a slower velocity. However, during an extended outage, the contents of the line may be dumped into holding basins spaced along the line. After repairs, the slurry would be pumped back into the pipeline. The possible environmental effects of the above events occurring in a liquid-fuel/coal slurry appear to be potentially more severe than when a water coal slurry is involved.

If the availability of water is a future obstacle to the development of water coal slurry systems, emphasis on alternative liquid fuel coal slurries can be expected to increase. Questions concerning the safety and environmental impact of advanced slurry systems need to be answered before rapid development is started.

We recommend the need for an early evaluation and risk assessment of safety and environment impact concerns relating to the operation of advanced liquid-fuel/coal slurry pipelines. This would provide guidelines for possible R,D&D program requirements that may be necessary. A moderate priority is suggested because the operation of advanced slurry systems appears to be more than a decade into the future.

Congested Waterways

- A continuing increase in inland waterway congestion may impact the future value of barge transportation as an alternative in the transportation of coal.

Approximately 15% of the bulk coal traffic in the U.S. is transported by barge on inland waterways. Since 1970, there has been a steady increase in waterway traffic ton-miles and the number of barges and towing vessels. A study for the Electric Power Research Institute concluded the waterway system has essentially reached its maximum capacity.⁽³⁾ The report is generally considering a worst case situation and disagrees with the opinions of barge operators. Nevertheless, there is already evidence of traffic congestion on inland waterways. A specific example has been the Locks and Dam No. 26 located at Alton, Illinois. Due to its age and deteriorated condition, tows are frequently delayed. Other than slowing traffic, congestion has the potential of causing increased transportation cost, casualty events (groundings, rammings, collisions), and pollution. Because of the relative volumes involved, the long-term effects of congestion would impact the petroleum delivery system to a far greater extent than the potential impact on coal.

The impact of congestion on coal transportation could be the diversion of some of the traffic to other modes. In the long term, railroad, truck, and potentially also slurry modes are expected to absorb the coal traffic that may be diverted from the waterways. There is a potential problem associated with short-term responsiveness of competitive modes to congestion. Stockpiling can cushion day-to-day variability in supplies, however, alternative modes were not able to accommodate the coal traffic immobilized by the freezing of the Ohio river system in the winter of 1976/77.

This concern does not appear to be significant on the national scale because of the relatively small volume of coal transportation involved. However, the concern is worthy of further review to determine if local impacts may develop that are not covered by alternative supply routes.

LATENT CONCERNS

We designate latent concerns and their related issues as those which may, with equal probability, increase or decrease in priority or change in nature during the balance of the century. These concerns do not appear to be serious at present and may be resolved in the future by influences now at work or by alternatives that can be anticipated to develop. The following problem issues are examples that should be kept under review to determine their future evolution as conditions change.

Eminent Domain for Slurry Pipelines

It has been suggested that a major obstacle facing coal slurry pipeline development is the difficulty of acquiring rights-of-way. Currently, coal slurry pipelines have no Federally-granted power of eminent domain, although eight states have extended the right. The lack of the right of eminent domain may be important because railroads have generally refused to sell easements to slurry pipeline companies in the hope of preventing a competitive mode of coal transportation. However, pipeline organizers may ultimately

prevail without Federal power by purchasing subsurface rights to property underlying railroad rights-of-way. Energy Transportation Systems, Inc., (ETSI) has apparently purchased these subsurface rights and successfully tested the practice in state courts. The eminent domain issue appears to be a relatively small component of the whole system concern, discussed above, that relates to the promotion of slurry pipelines.

Railroad Abandonment Policy

The abandonment of unprofitable railroad lines is a viable method of protecting the financial health of the national railroads. The ICC can grant permission to abandon specific lines after an exhaustive investigation and hearings. Before it grants this permission, the ICC investigates the social, economic, and environmental ramifications of the proposed abandonment. The ICC process appears to be complete in considering everything from historical value to the future growth needs of affected communities.

At least one case of premature or unofficial abandonment appears to have taken place in anticipation of ICC approval. The 25-mile line supplying the Potomac Electric Power Company (PEPCO) plant at Morgantown, Maryland, experienced frequent derailments, which impacted the reliability of coal delivery. In this case, the railroad's decision to decrease track maintenance anticipated the power company's intention of changing to oil fuel at that particular plant. As a result of the oil embargo in 1973, PEPCO changed this decision and continued to use the Morgantown plant as a primarily coal-fired station, and again required reliable service on the railroad link to the source of fuel. A possible concern is suggested by this example, which however, is expected to be a rare event.

Sabotage Potential

A scenario in the escalation of public reaction to the transportation of coal and other energy materials may involve acts of physical interference, including sabotage. It would take a massive effort organized at the level of a guerilla war to significantly disrupt railroad service. This has been demonstrated by the size of past military efforts needed to interdict supply lines during wartime. Railroad vulnerability appears to be less than that of pipelines because of the redundant routes and rapid repair capabilities possessed by the railroads. Slurry pipelines could be put out of action for long periods especially during freezing weather. This could be a severe impact on plants that have no alternative service.

Action against individual barges and trucks would have, at the most, transitory impact on local coal supplies. The common practice of stockpiling and supply system flexibility mitigate the potential impact of sabotage. Also attacks against plants and equipment at fixed sites would probably be more attractive from a potential saboteur's point of view. For the above reasons, the threat of sabotage to coal transportation appears less important than in the transportation of other energy materials.

Dependence on Diesel Fuel

Coal transportation by railroad, waterway and by truck depends on diesel fuel for motive power. This is considered by some to be a significant potential vulnerability and future problem. In the event of a future long-term embargo or shortage of petroleum products, diesel fuel is expected to be allocated on a priority basis. If the national use and dependence on coal continues to increase, coal transportation would qualify as a high priority for fuel allocation. Development of strategic fuel storage and the anticipated future production of synthetic fuels tend to mitigate this concern.

Competition for Barges at Harvest Time

The issue that coal transportation by barge can be affected by the availability of barges at harvest time is not an apparently significant potential problem. While the situation may exist, it should be local in effect and another challenge to induce competition by other modes. As a generally predictable seasonal event the concern should be routinely manageable with appropriate planning, stockpiling and the use of alternative transport modes.

Impact of Requiring Scrubbers on Coal-Fired Plants

Concern has been expressed that the EPA's potential interpretation of the most recent amendment of the Clean Air Act may require the use of scrubbers on all coal-fired generating plants. The potential consequences of the Act are far-reaching and include a possible impact on the overall growth in coal demand. Other effects may be a reversal in the current shift to the use of western coal and drastic changes in coal flow patterns. We expect an equilibrium to evolve in which the overall effect may be a slower rate of growth than the present Administration's goal.⁽⁴⁾ There is the basis for confidence (see below) that transportation would be available to meet optimistic scenarios of growth in coal demand. Therefore, we can also anticipate that the transportation industry could meet less optimistic demands.

PERCEIVED CONCERNS

Problem issues in this category have been the focus of controversy but are judged here to be unsubstantiated or inconsequential. The following are two examples that in their present perspective should be put to rest.

Railroad Capital Requirements

- Railroads offer a lower rate of return on investment capital than most industries. Because of this, the necessary capital for locomotive and car building, track maintenance and plant expansion needed to transport the projected increase in coal

traffic may not be readily obtainable. This may limit the future coal carrying capacity of the railroad industry and impact the ability to supply the future demand for coal on a national level.

This concern is raised by experts inside and outside the railroad industry. Several historic precedents and anticipated future scenarios suggest that this concern should not critically affect coal transportation. Capital generally follows the opportunity for profit. We expect the longer term implications of the San Antonio case to be managed in a manner that continues to encourage railroad management interest in expanding coal capacity. With continued management initiative, the potential of new coal business revenue on all but totally dilapidated or bankrupt railroads can be expected to generate investment from capital sources in the free market. Utilities are increasingly providing hopper cars for dedicated unit train service and inter-road leasing and improved equipment utilization are methods commonly used to increase capacity. The government will, in a last resort, assist financially troubled corporations (as, for example, in cases such as Conrail, Amtrack and Lockheed) when the public interest is involved. A shift to alternative modes of transport would be encouraged if railroad service became inadequate. This concern appears to be controlled by normal business investment decisions and in the case of an emergency by precedented government action.

Availability of Railroad Hoppers and Locomotives to Haul Future Coal Traffic

- There has been controversy about whether the projected demands for coal transportation will exceed manufacturers' ability to build hopper cars and locomotives fast enough to provide the necessary service.

An original basis for this concern was the Bureau of Mines' projection of the number of hopper cars required to handle an anticipated 1.2 billion ton coal demand in 1985. There are several sources that indicate a future shortage of hopper cars is not anticipated.⁽⁵⁾ With the improved equipment utilization provided by unit train operation, a car production rate of approximately 15,000 hopper cars and 1000 locomotives per year should be adequate. Current industry capacity exceeds these rates by significant margins.

The pacing items controlling the increase in coal traffic are mine development and construction of utility generating plants. The lead time for these activities greatly exceeds that for increasing railroad capacity. A conclusion, therefore, is that this concern appears to be unfounded.

SUMMARY REMARKS

There are several reasons why we are optimistic about the future adequacy of coal transportation in the United States. Competitive transport modes are either in operation or available with current technology to meet projected growth in coal demand. In general, the development of transportation capacity requires less lead time than the lead time required to develop new mines and bring plants on line. Coal consumers can isolate themselves from significant variability in supply by stockpiling coal and other forms of anticipatory management. The potential problems in coal transportation that can be identified today are being addressed by a broad range of industry and government-sponsored effort. It is reasonable to expect the eventual solution of these problems. It does not appear, therefore, that transportation will be a critical impedance in the national coal supply system unless a remarkable change occurs in the political or social order of the nation.

While we recognize that the conclusions of this study may be controversial, a major purpose of this paper is to encourage others to consider the value of our approach. The concern statement and appraisal methodology emphasizes the consequences and priorities of potential problems on a whole-system basis. This approach can be an aid in focusing attention on serious concerns and in planning effort that addresses anticipated problems in an orderly and timely manner.

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