SYSTEMS, SCIENCE AND SOFTWARE

SSS-R-77-3023
Revision 1

SLURRY PIPELINES;
ECONOMIC AND POLITICAL ISSUES *gub*
A REVIEW

by
William F. Banks

MASTER

Technical Report - Task 2.1
Contract EY-76-C-03-1171

DEPARTMENT OF ENERGY
SAN FRANCISCO OPERATIONS OFFICE
1333 BROADWAY
OAKLAND, CALIFORNIA 94612

30 November 1977

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Abstract

In the controversy surrounding the proposal to grant federal eminent domain to coal slurry pipelines, the fundamental issue is whether, on balance, such a grant is in the national interest. The principal subissues (peripheral issues) of economics, water supply and disposal, energy consumption and conservation, employment, safety, and environmental impact are analyzed. It is found that, as compared with unit trains, which are the only immediate alternative for movement of large quantities of Western coal, the pipelines are not against the national interest, except in the case of employment. It is concluded that, on balance, the pipelines are in the national interest and should be granted the power of federal eminent domain.

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

MASTER

REA

CONTENTS

	<u>Page</u>
Abstract	ii
Preface	iii
1.0 OBJECTIVES	1-1
1.1 Purpose of the Project.	1-1
1.2 Purpose of this Report	1-3
2.0 SUMMARY.	2-1
2.1 Identification of the Fundamental Issue	2-1
2.2 Conclusions	2-5
2.2.1 The Fundamental Issue.	2-5
2.2.2 The Peripheral Issues.	2-6
2.2.2.1 Economic Issues	2-6
2.2.2.2 Other Issues.	2-15
2.3 The Contrary View	2-18
3.0 TECHNICAL DISCUSSION	3-1
3.1 General System Description	3-1
3.2 Existing Coal Slurry Pipelines.	3-4
3.2.1 The Ohio Pipeline.	3-4
3.2.2 The Black Mesa Pipeline	3-4
3.2.3 Proposed Lines	3-12
4.0 TRANSPORT ECONOMICS OF COAL-DERIVED ENERGY	4-1
4.1 Transport Alternatives for Coal-Derived Energy.	4-1
4.2 Cost Trends in Coal Transportation	4-4
4.2.1 Evolution of Railroad Freight Rates for Coal	4-4
4.2.1.1 Volume freight rates.	4-4
4.2.1.2 Pipeline competition	4-5
4.2.1.3 The Transportation Act of 1958	4-5
4.2.1.4 Unit trains	4-6
4.2.2 Susceptibility to Inflation	4-7
4.2.3 Tariff comparison - pipeline <u>vs.</u> railroad	4-20
4.2.4 Cost comparison - pipeline <u>vs.</u> railroad	4-31

CONTENTS, p.2

	<u>Page</u>
4.2.4.1 Costs of slurry pipelines	4-31
4.2.4.2 Costs of rail transport	4-39
5.0 THE CONTROVERSY	5-1
5.1 Coal Movement Capability of the Railroads	5-5
5.2 Economic Health of the Railroads	5-22
5.3 Conditions of Competition	5-26
5.3.1 Prevalence of Competition	5-26
5.3.2 Regulation of Rail-Pipeline Competition	5-37
5.4 Energy Consumption and Conservation	5-38
5.4.1 Energy Consumption in Coal-Water-Slurry Pipelines	5-38
5.4.1.1 Energy consumption in the Black Mesa Pipeline	5-38
5.4.1.2 Energy Consumption in Future	5-46
5.4.1.3 Energy Consumption in Unit Trains	5-50
5.4.2 Quality of Energy Consumed	5-51
5.5 Safety	5-53
5.6 Environmental Effects	5-59
5.6.1 Normal Operation	5-59
5.6.2 Non-normal Operation	5-59
5.6.2.1 Pump failure	5-59
5.6.2.2 Pipe break	5-62
5.6.3 Constructional Impact	5-64
5.6.4 Environmental Conclusions and Recommenda- tions	5-64
5.7 Employment	5-67
5.7.1 Operational Employment	5-67
5.7.2 Constructional Employment	5-68
5.8 Water Movement	5-69
5.8.1 Water Quantities	5-70
5.8.2 Water Sources	5-70
5.9 Subsidy of Pipelines	5-73

REFERENCES

APPENDIX

LIST OF TABLES

	<u>Page</u>
1.1-1 Project Reports	1-2
4.2.2-1 Fixed-variable cost breakdown, slurry pipeline .	4-10
4.2.2-2 Comparison of pipeline and rail operating costs	4-11
4.2.2-3 Anticipated inflation in tariffs	4-13
4.2.2-4 Railroad ton-mile revenue	4-15
4.2.2-5 Railroad labor costs	4-16
4.2.2-6 AAR Index	4-19
4.2.3-1 Preliminary economic comparison: coal slurry pipe line <u>vs.</u> unit train operation	4-21
4.2.3-2 Analysis of unit train-pipeline competition . . .	4-25
4.2.4.1-1 Summary - coal pipeline annual costs	4-34
4.2.4.2-1 Estimated costs of supplies for the Farmington- Los Angeles unit train	4-41
4.2.4.2-2 Route and capacity specification, Farmington-Los Angeles unit train	4-43
5.1-1 Estimates of 1985 coal demand	5-6
5.1-2 Ordinary railroad growth scenario	5-11
5.1-3 Scenario of extraordinary coal traffic growth . .	5-13
5.1-4 Estimate of coal transport equipment.	5-14
5.1-5 Rolling stock requirements	5-15
5.1-6 Railroad service-demand estimate.	5-16
5.1-7 Unit cost of rolling stock - 1975	5-18
5.1-8 Required investment in rolling stock (1975-85) .	5-19
5.4.1.1.3-1 Energy consumed in/chargeable to deslurrifica- tion, Black Mesa.	5-41
5.4.1.1.4-1 Energy consumption - Black Mesa Pipeline . . .	5-44
5.4.1.1.4-2 Adjusted energy consumption - Black Mesa Pipeline	5-45
5.4.1.2-1 ETSI energy estimate	5-47
5.4.1.2-2 Adjusted energy estimate - ETSI pipeline . . .	5-48
5.4.1.2-3 Comparison of adjusted energy comparison . . .	5-49
5.5-1 Transportation mode volumes intercity freight . .	5-54
5.5-2 Rough estimates of nonpassenger, freight-related transportation fatalities (1973)	5-56

LIST OF FIGURES

	<u>Page</u>
2.3-1 Statement of railroad position by James R. Walker	2-19
3.2.2-1 Black Mesa Pipeline, Inc.	3-5
3.2.2-2 Black Mesa Pipeline coal slurry pipeline system .	3-7
3.2.2-3 Black Mesa Pipeline coal preparation plant system	3-8
4.2.3-2 Dependency of crossover year on pipeline tariff .	4-23
4-2-3-3 Tariff-throughput dependence	4-29
4.2.4.1-1 Estimated costs for a 1000-mile (approx.) slurry pipeline.	4-35
4.2.4.2-1 Life-load dependency of rails	4-44
4.2.4.2-2 Comparative costs, unit train and slurry pipeline, Farmington, NM, to Los Angeles	4-46
4.2.4.2-3 General cost-speed dependency for unit trains . .	4-49
5.4.1.1.4 Black Mesa Pipeline - Route and Profile	5-43
5.8.2-1 Water Projections - Missouri River at Sioux City	5-72

1.0 OBJECTIVES

1.1 Purpose of the Project

The work reported here is a part of a project which is being conducted by Systems, Science and Software (S³) under DoE contract EY-76-C-03-1171, "Energy Study of Pipeline Transportation Systems." The basic objectives of the study are the following:

1 - To characterize the pipeline industry and understand its energy consumption, i.e., the patterns of consumption and the quantities and intensities of that consumption in each of the five major pipeline industry segments: gas, oil, slurry, fresh water, and waste water.

2 - To identify opportunities for energy conservation in the pipeline industry, and to recommend the necessary programs of research, development, and demonstration (R,D,&D) to exploit those opportunities.

3 - To characterize and understand the influence of the federal government on the introduction of energy-conservative innovations into the pipeline industry.

4 - To assess the future potential of the pipeline industry for growth and for contribution to the national goal of energy conservation.

The project final report is being published as S³ report SSS-R-77-3020, "An Energy Study of Pipeline Transportation Systems - An Executive Summary." That final report will summarize the results from the seven task reports listed in Table 1.1-1. As shown in the table, this present report is one of those task reports.

TABLE 1.1-1

Project Reports

<u>SSS-R-77-</u>	<u>Title</u>	<u>Associated Task</u>
3020	An Energy Study of Pipeline Transportation Systems - Executive Summary	All
3021	An Economic Model of Pipeline Transportation Systems	1 (partial)
3022	Energy Consumption in the Pipeline Industry	1
3023	Slurry Pipelines - Economic and Political Issues - A Review	2.1
3024	Federal Regulation of the Pipeline Industry	2.2
3025	Efficiency Improvements in Pipeline Transportation Systems	3
3027	The Prospects for Energy Conservation in the Pipeline Industry	<u>4 and 5</u>
3069	S ³ Financial Projection Model - Preliminary User's Manual and System Overview	1 (partial)

1.2 Purpose of this Report

This report presents the results of Task 2.1. The primary objective of this task was to review the controversy surrounding the advent of coal-slurry pipelines. In this report, the issues are identified, the positions of the parties to the controversy are reviewed, and the attempts to resolve the controversy by legislation are summarized.

Slurries other than coal are not treated because no others are expected to capture any significant part of the transportation market in the near term. Any future use of slurries in the interstate transport of other commodities can be expected to raise the same issues, or at least most of them, which presently surround the proposals for coal slurry lines.

2.0 SUMMARY

2.1 Identification of the Fundamental Issue

The growth of coal-slurry pipelines into new markets is prevented by the almost universal refusal of railroads to permit the slurry pipelines to cross their right of way (RoW). In general, the only way for the pipelines to overcome that obstacle is by exercise of the right of eminent domain (ED), and the pipeline promoters and their supporters have been seeking legislation to acquire that right. These efforts have been opposed by the railroads. As with almost any controversy, the debate has expanded to include peripheral issues, in this case those of environmental disruption and impact, water movement, safety, employment, and energy conservation.

There are three requirements for the exercise of eminent domain:

- 1) That the condemned property be taken only for public use.
- 2) That the action be carried out in accordance with due process of law.
- 3) That just compensation be given.

Eminent domain power exists at both state and federal levels. The general principle on which both are justified is that of the public interest. However, the public interest within an individual state is often entirely different from the public interest of the nation as a whole (national interest). This study is directed toward the national interest; analysis of the many and often conflicting interests of the individual states is not attempted here.

The use of eminent domain is not limited to transportation systems or to common carriers. However, for a transportation system to qualify as public use, it is generally conceded that it

must operate as a common carrier, serving without favor all who tender commodities for transport in accordance with its published tariffs. Traditionally, endowment of the federal ED power on a private enterprise has been subject to certain obligations and restrictions. In the case of common carriers, these have included the requirement to operate under federal regulation. The slurry pipeline promoters have accepted this obligation, along with that of operating as a common carrier. Although there are questions as to how well and meaningfully they will apply in practice (see Section 5.3.2 below), there does not appear to be any fundamental principle at issue in how the slurry pipelines will operate after they are built.

It is well at this point to dispel one misconception that has been propagated by the railroads: that historic precedent does not exist for granting federal ED to the slurry pipelines. A railroad vice president testified [Hearings 75, p.833]:

"Nowhere in the history of our Federal Government is there, I believe, an instance in which the Congress has authorized the use of the power of eminent domain for or on behalf of private interests."

He was corrected by Congressman Sam Steiger (R, Arizona),

"In that sentence you have driven your duck to the wrong market, and I can only assume that you have accepted the advice of somebody who hopefully might have jeopardized his future employment with you by virtue of the following information which I am about to lay on you.

"In 1875 the Department of Interior not only granted the power of eminent domain to railroad companies, but the railroads were entitled under that particular authority to acquire the resources from adjacent lands which they were not given: timber, fill, rock, et cetera. So there is example No. 1.

"In 1902, of course, the Secretary of the Interior was authorized to acquire property under eminent domain for irrigation projects specifically to be used by private individuals.

"In 1920 the Federal Power Commission was powered to grant the right of eminent domain that a licensee could not acquire by contract or pledge, land to construct the necessary reservoirs and lines.

"In 1935 the Secretary of Interior was authorized to approve the acquisition by eminent domain to private companies for the purpose of conserving, producing, buying and selling helium.

"In 1938, the same right was granted to natural gas companies.

"In 1953 eminent domain was authorized to facilitate the construction of pipelines for the transportation of oil, natural gas, sulfur or minerals.

"So while you did mitigate your statement with the expression "I believe," I trust you no longer believe."

Witness: "The examples that you have read to me - I appreciate hearing about those."

Congressman Steiger: "I know you do."

Witness: "We are talking about a private use here. This is far different. This is a pipeline which goes from one place to another place, and to grant eminent domain for that corridor, which we have heard so much about this morning, does not seem appropriate if you call it a common carrier. That is our objection to it. It cannot be called a common carrier."

This exchange occurred on September 12, 1975. Precisely six months later, on March 12, 1976, the Association of American Railroads distributed a "Suggested speech ... for general audiences. Reading time: 20 minutes," entitled "Coal Slurry Pipelines: An Unnecessary Risk." Six months after being publicly corrected in Congressional hearings, the Association is exhorting its spokesmen to stand before audiences and make the unqualified statement,

"But to build the pipelines, the promoters are seeking something that would be new - The Federal right of eminent domain. This right has been granted for only one other purpose - the construction of natural gas pipelines."

The reader is left to draw his own conclusions.

The central issue, then, which is, or should be, the basis for resolution of the controversy, is whether it is in the national interest to endow the slurry pipelines with the federal power of eminent domain. If a clear and conclusive finding can

be made that such endowment is not against the national interest, then potential solutions are available to resolve the peripheral issues, and the power should be granted to the pipelines (see the discussion in Section 5.0 below).

The bills that have been introduced in previous Congresses to grant the federal ED power have opened with statements of findings which say, in effect, that it is in the national interest to increase the use of domestic coal and that "in some situations" such use would be "facilitated" by the construction of pipelines. These situations are to be identified by the Secretary of the Interior by issuance of a certificate of public convenience and necessity. The Secretary is directed to consult with other government agencies, to consider "the record as a whole," and to make "independent findings" based on four criteria:

- 1) How the project helps national coal utilization.
- 2) Potential delays if the ED power is withheld.
- 3) Environmental disruption.
- 4) "Water requirements and other impacts" on the coal mining area.

To the pipeline opponents, these statements of findings in the national interest are much too weak to justify passage, and in some powerful Congressional committee, sufficient members have agreed with them because they have prevented the issue from coming to a vote.

It is helpful to contrast the present case with an earlier one, that of gas pipelines. In that case, the need was clear and there was no other practical way to move the gas. Hence, it was not particularly difficult for the Congress to reach a finding of positive national interest. In the present case (discussed in Section 5.1 below), despite some valid questions as to their capability, it seems probable that the railroads can move all the Western coal to market, provided that the public in towns and countryside along the way is willing to accept the consequent continuous disruption of its business and social life.

The basic question, then, is why the national interest is better served by moving a part, perhaps 10%, of the coal by pipeline instead of by rail.

2.2 Conclusions

2.2.1 The Fundamental Issue

The principal conclusion of this study is that, on balance, the national interest is better served by granting the federal power of eminent domain to the slurry pipelines than by its denial. However, the case is by no means conclusive, and the conclusion itself is further subject to two important provisos:

1) Grant of the power should be made with the explicit reservation that it does not imply Congressional sponsorship or endorsement in principle of the use of Western water for slurry pipelines. As discussed in Section 5.8, the water issue with regard to slurry pipelines is a false issue. Even the driest states make some allocation of water, usually that which is non-economic for agriculture, for industrial uses. If a state chooses to assign some of its industrial allotment to slurry pipelines, there is no apparent reason for anyone else to be concerned. If a valid question does arise, it should be debated in another court. To ensure this separation of the issues, however, it is necessary that the Congress, in granting the power, make clear that its intent is not to decree or endorse state water allocations to future pipelines.

2) Since the only realistic scenario by which the pipelines could become wards of the state (a fear professed by the opponents) is that buyers would default on the 30-year contracts to "take or pay for" the coal, the grant of ED power should require a finding that the coal purchase contract is valid and realistic for the amortization life of the project.

The foregoing conclusion is derived from study of all the subissues, called peripheral issues for convenience. As shown in the next section, on some of these issues rail transport makes a better case, and on others, pipeline transport is to be preferred. The conclusion was formulated by subjective balancing of those individual outcomes. Quasi-quantitative balancing processes, e.g., point-scoring techniques, have not been used.

Since the railroads disagree with this conclusion, even with its provisos, it is only fair to hear a complete exposition of their side of the argument. Such a statement, by one of the best qualified railroad spokesmen, will be presented in its entirety in Section 2.3 [Walker 76]. First, however, the analyses of the peripheral issues which led to the conclusion stated above will be presented.

2.2.2 The Peripheral Issues

2.2.2.1 Economic issues

There are a number of economic issues to be considered, including the cost of service, the price of service, the feasibility of financing both transport modes, the relative susceptibility of the modes to inflation, and the possibility of one or both of the modes becoming financial wards of the state.

2.2.2.1.1 The price and cost of service

2.2.2.1.1.1 The price and cost of pipeline service

In the polemic of the debate, much has been made of the proposition that, since the pipeline is much more capital-intensive than the railroad, the pipeline must be much more inflation-resistant. A companion implication has been that, also as a result of this capital intensity, the pipeline cost of service is known at the beginning. However, there

is a trap in this premise, and accordingly it bears examination. The critical point is whether "in the beginning" refers to the beginning of construction or the beginning of operation after construction is complete.

The agreement with one coal user under which ETSI proposes to operate its pipeline provides in part:

- 1 - the contract term will be 30 years,
- 2 - the tariff will consist of a fixed part and an escalatable part,
- 3 - following construction, the previously estimated fixed part of the tariff will be adjusted to final construction costs and capitalized financing costs,
- 4 - following construction, the previously estimated escalatable portion of the tariff will be adjusted to conform to the then forecasted cost of the escalatable elements, and
- 5 - in the event that water from the initial source becomes unavailable, ETSI will develop a new source and provide the needed water, to be paid for by a surcharge on the tariff.

It is seen that neither the price nor the rate of escalation of the price will be firm until it is too late for the buyer to do anything about it. It is also important to note that, since the capital cost is not firm, the effect of an unanticipated construction cost overrun on the buyer is the same as if capital costs were escalating. In some respects, an escalatable construction contract is equivalent to a cost plus percentage contract, which is notorious for cost increases. For that and other reasons, it is prohibited by the Government. If capital cost should double during construction, as is not uncommon under such arrangements, the effect is the same as a 2.33% annual escalation of the fixed charges over the 30-year life of the project.

It is now clear why the critical distinction in the premise stated above is the phrase "in the beginning." At the beginning of operation of the line, after all the costs are incurred and the escalations have been negotiated, the cost of operating the pipeline throughout its life is rather precisely known. If at that time the 30-year purchase contract is valid and realistic, there is little likelihood that the pipeline will become insolvent. However, at the beginning of construction when the user signs the contract, nothing is firm about costs he must later pay. Therefore, he is buying what is called "a pig in a poke."

While this situation is not unknown to business people in these inflationary times, it is a very uncomfortable one. But, as seen below, the pricing situation with the railroads is equally uncomfortable and possibly worse. If a businessman cannot contrive to escape from this situation, the least he strives for is multiple sources of supply. This simple statement contains a primary conclusion regarding the controversy:

1 - The utility industry badly needs a second source of coal transportation service;

2 - therefore, the slurry pipelines should be allowed to compete, and

3 - therefore, the slurry pipelines should be granted federal eminent domain, because without it they cannot compete, unless

4 - it is found that the slurry pipelines would, in some other respect, produce an adverse effect on the national good which would more than offset the benefit of 1 above.

There are some disinterested investigators, notably Rieber and Soo [1976], who strongly question the ability of the pipelines to compete with the unit trains, and who express apprehension at the possibility that they cannot. Their view is discussed in Section 4.2.4.1 below.

2.2.2.1.1.2 The price and cost of unit train service

It has just been seen that a rather well kept secret of the controversy is the indeterminacy of the cost, and therefore the price, of pipeline service. However, an even better kept secret is the true longrun cost, and therefore the price, of unit train service, for the reason that it apparently is unknown even to the railroads themselves. As is further discussed in Section 4.2.4.2, a somewhat surprising conclusion of this study is that the true longrun costs of operating heavy (100-ton cars) unit trains at the speeds (50-60 mph) necessary to compete with pipelines are less accurately known than are the pipeline costs. The gradual realization of these costs may well be responsible for at least some of the pricing behavior of the railroads which their customers find so offensive.

An example of that behavior is described by the City of San Antonio to the Eighth Circuit Court [San Antonio 76]:

"In the spring of 1974, San Antonio advised the railroads of its intention to commit itself to the long-term use of Wyoming coals and of its reliance in making this commitment upon the \$7.90 rate quotation (S.A. 245). The carriers reaffirmed the availability of the \$7.90 rate and reduced it to a proposed tariff format (S.A. 245). Shortly thereafter, the railroads "jacked up" their price by over 40 percent from \$7.90 to \$11.09 per ton because of claimed "cost increases" (S.A. 240). The nature of these tremendous cost increases which accrued in less than one year and which precipitated this dispute was never divulged and has not been explained to this day. (S.A. 241)."

Later, in the same court proceeding, the city says:

"Between the railroads initial proposal in July 1973 (S.A. 79) and their final proposal of May 2, 1974 (S.A. 81), two other problems surfaced. The railroads revoked their proposal to furnish cars and San Antonio was compelled to place orders for \$25 million worth of railroad cars (S.A. 74,75). Additionally, the carriers refused to file any tariffs at all with the Interstate Commerce Commission or to

provide any transportation whatsoever, unless San Antonio entered into a side agreement which would not be submitted to the Commission and which provided for "agreed schedule changes" on an annual basis (Sandgren 3). San Antonio considered such an agreement improper. Faced with the prospect of the improvident expenditure of hundreds of millions of dollars of public monies (S.A. 73) and unable to negotiate, San Antonio sought the protection of the Interstate Commerce Act by its complaint dated May 5, 1975."

After some description of further maneuvering to obtain a conference with the ICC, the city continues:

"The railroads objected to such a conference on the basis that it was unnecessary in light of their new proposed tariff which they had lodged with the Commission in September and wherein they sought to gouge San Antonio with a freight rate of \$16.67 per ton followed by an increase to \$17.34 at the end of one year. Like the earlier leap from \$7.90 to \$11.09, there was no explanation as to how the railroads got from \$12.70 to \$16.67, notwithstanding the fact that each proposed \$1.00 in the rate level would cost San Antonio's rate payers \$3,000,000 annually. Upon protest of San Antonio, the Commission suspended the effectiveness of the proposed \$16.67 tariff."

The result was that the Commission mandated a \$10.93 tariff.

A similar experience was related by the president of Middle South Utilities to the House Interior Committee (Hearings 75, p.744). His testimony is not quoted in this summary, but is presented in Section 5.3.1 below. Also discussed in that section are two different explanations of this behavior, both of which fit all of the observed facts.

First is the cynical view that the railroads are simply stalling for higher prices, which is Mr. Lewis's accusation in his testimony. An apparently equally likely explanation, which also fits the facts, is that the hitherto unknown costs are now being realized. The fact appears to be that the behavior of

rail and roadbed under the duty of 100-ton cars at speeds of 50-60 mph is, or was until very recently, not only unknown but drastically understated. If this hypothesis is true, it leaves the railroads with the delicate problem of somehow maintaining a low profile while rapidly increasing their prices to cover these unanticipated costs and at the same time publicly and loudly pointing to the unrealistically low prices of the past as a basis for denying to the pipelines the opportunity to compete. However, if the hypothesis is untrue, then the explanation may be that the railroads are in fact doing what the utilities accuse them of, stalling for time so that they can charge all that the ICC will allow the traffic to bear.

In this connection it is well to note what is repeatedly stressed in the body of this report - that the railroads are behaving the same as any other industry would under the circumstances. And even if these speculations are true, there is no implication that the railroads are displaying immoral behavior or wrongdoing.

The subject of unit train costs is discussed in Section 4.2.4.2 below. This summary will simply quote the recommendations of a railroad chief engineer [Rougas 75]:

"So far I have given examples of a mixture of traffic and its effects. On another property which was laid with 132-pound rail, and over which nothing but unit trains of 100-ton cars traveled loaded in one direction and empty in the other, and whose cars have 36-inch wheels, their rail on the mainline has accumulated as of last October, 200 million gross tons of traffic. And it is my estimate that the rail will not reach much more than about 275 million gross tons of traffic."

"Briefly, if you're going into unit train operations over a separate track, some of the recommendations I would have are: one, be sure and corner your curves; the unit trains are extremely hard on track on curves. These trains exert lateral forces which the track is not particularly designed to withstand.

"Two, if you can, use a heavy rail section continuously welded.

"Three, use large size tie-plates. With the introduction of high capacity cars, the reason for condemning track is primarily mechanical abrasion. Use of 18-inch long tie-plates on curves is really recommended.

"Four, insure good tie condition. This idea of ties lasting 35 to 40 years, in my opinion in this day and age, is a dream.

"Five, use a good type of ballast if you have practical access to it.

"Six, intensify inspection of track maintenance. You will find after a couple of years, most of your bridges are going to give you a problem at the bearing points.

"Seven, gear for bridge replacement and repair of bridge supporting masonry as railroad bridges generally will not take these kinds of loads.

"When you do go home today, there are two things I would like you to remember. One is that the introduction of 100-ton car unit trains is an entirely new ballgame for railroad right-of-way, maintenance, and unless people realize the newness and have time to prepare for such unit trains, their chances of winning the game may be slim."

At the ICC-mandated tariff of \$10.93, which San Antonio feels is too high, the city may in fact be getting a much better bargain than it realizes.

As is discussed in Section 4.2.4 below, if rail tariff escalation in the next 30 years does not greatly exceed the rate of the last 30 years, i.e., less than 1%, pipelines will be able to move coal cheaper than unit trains in only a few instances where large tonnages (10 million tons/yr and more) are contracted over distances greater than 1000 miles. At the most, pipelines could capture about one-fourth of the future new business.

On the other hand, if the railroads continue their present pricing policy, for whatever reason, pipelines will be economic in more cases. However, that does not mean that they would significantly threaten more than 25% of the new, presently non-existent business, because their application would be limited by water and other factors.

2.2.2.1.2 Financing expanded coal transport capability

2.2.2.1.2.1 Financial health of the railroads

The railroads have tried to make the case that pipelines are against the national interest because they would damage the financial health of the railroads. It is concluded that this case is without merit. Over the 1975-85 decade, it is estimated that the railroad coal tonnage will double, and ton-miles will more than double, if no pipelines are built. Even if all of the four, or possibly five, proposed pipelines are built, they would absorb no more than a fourth of this additional, presently nonexistent business. Other than mismanagement, this study has been able to identify no credible scenario whereby this tremendous burst of prosperity can drive the railroads into insolvency, with or without pipelines. This case against the pipelines, therefore, appears to be without merit.

2.2.2.1.2.2 Financial health of the pipelines

Some investigators have expressed apprehension that the pipeline promoters will unload the pipelines on the securities-buying public after they are built, and that the pipelines will thereafter become bankrupt. However, since the promoters do not guarantee any of the pipeline costs, and the costs will not be known until construction is complete, those costs may prove to be unpleasant surprises for the users. Whatever they may ultimately prove to be, the costs will be borne by

the electricity consumers, not by the pipeline or by the railroad which moves the coal. Parenthetically, it is well to remember what competition does to costs. Other than mismanagement, there appears to be no credible scenario whereby the pipelines will be driven to insolvency. This case against the pipelines, therefore, appears to be without merit.

2.2.2.1.2.3 Conclusions regarding economic issues

In summary, it has been seen that:

1 - While the true, longrun costs of both pipeline and rail service are still unknown, the rail costs are subject to greater uncertainties than the pipeline costs.

2 - Within the precision of available estimates, the pipelines are economic only under certain limited circumstances. However, if present railroad pricing policy continues, the pipelines will be far cheaper.

3 - The additional capability of the pipelines, with the concomitant pressure on prices, will exert a healthy, limiting influence on tariff escalation.

4 - In no case can the pipelines capture enough traffic to damage the railroads. Coal-hauling railroads are destined for a period of booming prosperity, with or without pipelines.

5 - The railroads are shifting much of the burden of financing the expanded capability to their customers, the electric utilities, by forcing them to buy the rolling stock. Many of the utilities are already reaching the limits of their ability to finance new projects, just to build the plants to burn the coal. They are ill-prepared to assume the railroads' financing duties. The pipeline, in offering a new avenue to the capital market, may benefit the utility by relief from this additional burden.

Since the slurry pipelines will offer some economic benefits to significant segments of the nation, and will do no harm to the others, it is concluded that they are in the national economic interest.

2.2.2.2 Other Issues

In Sections 5.4 through 5.9 of this report, a number of additional issues are discussed. For the purposes of this summary, only the principal conclusions are listed below.

2.2.2.2.1 Water supply

An issue that has aroused considerable emotion and inspired much polemic is that of water for the pipelines. It is a conclusion of this study that this is a false issue which has no bearing here. As noted in Section 2.1 above, even the driest state allocates some of its water for industrial use, and if that is what a state wants to do with water which it owns, there is no apparent reason for the federal government to intrude. As also noted above, however, the Congress should not allow itself to be interpreted as decreeing, sponsoring, or even necessarily endorsing, such actions by the states.

Accordingly, it is concluded that eminent domain for slurry pipelines would not adversely impact the national interest by misuse of water.

There is an important footnote to be added to this conclusion. When a pipeline takes water from a deep aquifer, as is being done at Black Mesa and as ETSI proposes, it is important that the water level surrounding the wells be continuously monitored. If the level falls unexpectedly, the withdrawal must be curtailed. Such monitoring is continuously being done at Black Mesa [Levings 76]. However, this proviso is general; it should apply not only to pipelines but to any other large user of water from an aquifer.

2.2.2.2.2 Energy consumption

The existing Black Mesa pipeline consumes far more energy per ton-mile than a diesel-powered unit train. With the benefit of scale and current technology, and with coal far moister than Black Mesa coal as mined, the next pipeline can reduce that disadvantage to about 20% or less (something over 800 Btu/ton-mile for the pipeline and somewhat less than 700 for the unit train).

When the precious character of diesel fuel is recognized, i.e., its petroleum origin) and both train and pipeline are constrained to operate on coal-derived energy, the advantage shifts to about 50% (1200 Btu/ton-mile vs. 800) in favor of the pipeline. Since it is considered better to use 800 Btu of coal than 700 Btu, or even much less, of petroleum energy, it is concluded that the slurry pipelines will have no adverse energy effect on the national interest.

2.2.2.2.3 Employment

The ETSI line is expected to employ 355 people. The addition of approximately 5000 people-years of employment that will be provided by construction of the pipeline, or about 170 people-years/year over the 30-year life of the project, raises this total to 525. The railroad employment is 3-4 times that figure.

The obvious conclusion is that the pipelines will have an adverse effect on national employment.

It is well to add a further note about employment during the construction of the pipeline, since the question arises whether a few totally unsubsidized, billion-dollar pipeline projects may not swing the balance in favor of the pipeline. The answer appears to be negative. It simply does not seem sensible to assign a higher value to the 5000 or so people-years or pipeline construction employment, spread over two years or so, than to the 40,000-50,000 people-years of railroad operating employment, spread over 30 years.

2.2.2.2.4 Safety

As is seen in Section 5.5 below, the pipeline is safer than the railroad by an order of magnitude, even when account is taken of the accidents during pipeline construction. With the certainty of the statistics of large numbers, a decision to move all the Western coal on the railroads will in effect condemn to death over the next 30 years several thousand people who would otherwise survive. Clearly, from the point of view of safety, the pipeline is in the national interest.

2.2.2.2.5 Environmental disruption

In normal operation, the pipeline imposes far less impact on the environment than unit trains. In non-normal operation, the possibility of a large slurry spill, as demonstrated by trillions of ton-miles of experience in oil pipelines, is extremely remote. It nevertheless poses an environmental threat which has not yet been analyzed in detail. However, the means are at hand to defeat that (and any other) threat to any specified level of risk. A possible approach to balancing that risk against the corresponding risk from coal movement by unit train suggested in Section 5.5 is to require that the pipeline defeat its combined environmental and safety threats to the same equivalent level, in terms of human life, as that of the railroad. The analysis performed in this study, though very preliminary and subject to revision under detailed analysis, indicates strongly that the pipeline, when built and operated to the normal standards of the pipeline industry, will be far less undesirable under this criterion than the unit trains.

Accordingly, it is concluded that, from the viewpoint of environmental disruption, the slurry pipelines are in the national interest.

2.3 The Contrary View

When the principal conclusion of this study was first stated in Section 2.1, note was taken that it is contrary to the position of the AAR, and that their side of the case should be heard. Perhaps the best statement of their position is given by James R. Walker, Associate General Counsel of Burlington Northern, Inc. A full reproduction of his statement is therefore presented in Fig. 2.3-1. In addition, Appendix B presents Mr. Walker's letter in which he comments on an early draft of this report. Some of his points have been acknowledged in this present edition, and appropriate deletions and revisions have been made.

The reader who studies the Walker statements before proceeding to the body of the report will be well equipped to filter whatever bias the author has been unable to suppress, and to formulate his own measured judgement.

Fig. 2.3-1 - Statement of railroad position by
James R. Walker, Associate General Counsel,
Burlington Northern, Inc., sheets 1-11.

Vital Speeches of the Day

Coal Slurry Pipelines and National Transportation Policy: A Critical Review

by James R. Walker

INTRODUCTION

In the last two years legislation has been considered in the Congress and in certain states by which to grant the power of eminent domain to coal slurry pipelines. This paper examines these proposals chiefly in terms of public transportation policy, and, briefly, in light of the effects of slurry line operation on natural and economic environments. As a preliminary, it necessarily also deals in short compass with the concept of eminent domain. It offers only a few basic numbers for, unfortunately, most of those which one hears in the pipeline debate are designed to support a thesis rather than to develop sound conclusions. Thus, rather than play the numbers game, I will ask you to do some serious conceptual thinking.

Transportation of coal slurry by pipeline is a relatively new technology, but several proposals are now being promoted by which to employ that means to move huge volumes of coal in some instances more than 25 million tons per year distances of a thousand miles or more. Pipelines thus far announced would originate in the western coal fields and reach various destinations. In order to acquire right of way for their facilities, the promoters claim a need to exercise governmental powers to condemn land. They base their contentions

Editors Note: Long before the Arab oil boycott and the general concern about energy problems, studies were made concerning the feasibility of transporting coal by pipeline. As energy consumption increases (and oil prices rise), more attention is being given to coal. Since most coal must be transported from the place where it is found to the place where it is used, the transport mode, its cost, and its implications are important considerations.

This article addresses a number of important questions. It indicates why these questions must be taken into account if prudent policies concerning coal pipe lines are to be developed.

James R. Walker is Associate General Counsel of Burlington Northern, Inc. This article is based on a presentation made at the Transportation Research Forum in Boston on October 29, 1976.

on assertions that only railroads stand in the way of construction, these companies having generally refused to grant easements to permit track crossings. The railroads respond that their position is designed to focus national attention on the critical policy issues mentioned above. However, various environmental, farm, labor and property owner groups oppose the legislation for reasons of their own. It has been defeated thus far only because of the opposition of these allied groups.

***THE NATURE OF EMINENT DOMAIN: ITS CHARACTERISTICS
CONSIDERED IN TERMS OF SLURRY LINE OPERATION***

While a detailed review of the eminent domain concept is not the purpose of this paper, a brief description of it gives perspective to the issues.

Eminent domain is the power to condemn, to take an individual's property without his consent, subject to the obligation to pay its fair market value. When that power is held by a private instrumentality, it is almost always a result of state legislation. For obvious reasons such extreme power is sparingly conferred. While there are many variations in state law, for the most part this authority is enjoyed only by those private firms whose operation entails the fulfillment of a genuine public purpose: e.g., electric and telephone utilities, petroleum pipelines and railroads. Motor and water and air carriers have not been given this authority, no doubt because they operate largely on or by means of publicly owned facilities. If the test were but peripheral involvement in public carriage, all public carriers would be permitted to condemn; certainly motor, water and even air carriers could advantageously use that power to acquire terminal properties. Yet they do not have that authority. Thus the grant of condemnation powers to private companies is, I think, invariably based on a legislative determination that without those powers these companies, organizations which are impressed with the public interest would be unable to perform functions deemed to be literally essential to the public good. In concrete terms, a farmer or rancher shouldn't be able to stop the people of a nearby city from the enjoyment of electric power by blocking high line construction out of sheer obstinacy or because of his unreasonableness as to price. On the other hand, entrepreneurs in pursuit of a dollar for its own sake obviously should not and will not be permitted to take the householder's or farmer's property so as to facilitate the building of a shopping center, housing subdivision or the like.

Eminent domain is an old concept, being derived from the divine right of kings; hence its sparing application. Even so, it is no exaggeration to say that the whole concept of eminent domain is under challenge. Despite the fact that in one sense individual property rights are being slowly eroded by extensions

of the taxing authority, in another they are being strengthened by the philosophical underpinnings of the environmental movement. Witness the fact that condemnation powers have been widely attacked in the state legislatures and substantially narrowed in some. Even the highway departments are in retreat. The courts are also beginning to take a harder look at old condemnation standards. For example, a North Dakota court recently held that an electric cooperative not a utility corporation could not exercise the statutory condemnation powers clearly stated by the laws of North Dakota when it was the intention to build a wholly interstate transmission line. The rationale was that since the power from a new generating station in North Dakota would be delivered exclusively to Minnesota points, there was no public purpose which would justify the condemnation of the lands of North Dakota citizens.

Notwithstanding the intellectual currents of which I speak, the slurry line proponents continue to lobby aggressively for federal condemnation authority. Bills have been sponsored and defeated in the Congress and in four states as well: Nebraska, Kansas, Oklahoma and Texas. The legislative effort will be renewed and strengthened through an alliance of pipeline construction firms, pipeline suppliers, a major steel company, a financial house and a group of labor unions interested in pipeline construction. As in the past one of their principal arguments will be that since natural gas pipelines have federal eminent domain authority, so also should the slurry lines.

There are major fallacies in this argument:

First, the federal power of eminent domain was not needed to bring into being either natural gas pipelines or our extensive petroleum pipeline system. When, by amendment of the Natural Gas Act in 1947, powers of eminent domain were granted, that grant was but a part of a broad and general plan of almost complete regulation of the natural gas industry. The slurry line promoters and the coal mining industry obviously have no intention of submitting to any comparable legislation.

Second, natural gas can be transported feasibly from one state to another only by means of a pipeline and only by pipeline can distribution be made to the industries' millions of customers. However, the transportation needs of the coal industry can be met and are today being well met, by three other forms of surface transportation, rail, water and highway.

Third, since slurry lines will serve but one origin point and will handle but one commodity to one or a few destination points, they will not be common carriers in any real sense; they can hardly be considered to be impressed with the public interest as are the gas lines, electric utilities and, certainly, the railways. On this premise there is neither legal nor logical rationale nor any

of the traditional bases warranting the grant of powers of eminent domain to slurry lines.

NATIONAL TRANSPORTATION POLICY AND SLURRY LINES

The problem can better be examined in terms of what the national transportation policy is or should be. The U.S. actually has a National Transportation Policy as defined by the Interstate Commerce Act. That definition has long been regarded as less than satisfactory by the Congress, and the Department of Transportation has been attempting to draft new policy for some years. Nevertheless, for purposes of this paper, it is sufficient to proceed on the premise that under existing law and policy the Congress contemplates the development of an economically sound system of common carriage, irrespective of mode, to the end that the public may have the advantage of using whatever for-hire carriage may be needed. Certainly also the strictures against "unjust discriminations" and "undue preferences or advantages" manifests an intention to bring some measure of parity to the transportation charges which shippers are to pay for comparable services.

Perhaps this series of concepts can be encapsulated by suggesting that if we think in terms of coal transport only the question really is: What national policy will permit the greatest number of coal users to obtain their fuel at the least cost? My inquiry, then, is as to whether such a national objective will be furthered if federal powers of eminent domain are granted to the slurry lines and substantial construction and use of these facilities ensues. This in turn requires brief consideration of the physical, financial and operating characteristics of slurry lines, and, if they come into being, the effects which their use will have on all users of energy derived from coal. This examination cannot be confined to those who have the advantage if it is such of slurry line deliveries. It must also embrace an appraisal of the effect of slurry lines service on the overall operations of common carriers, chiefly rail and water since their ability to function as public carriers depends importantly on revenues earned from transportation of coal.

Specific hard data as to construction and operating costs of slurry lines are hard to obtain even though my company participated in a two-year study of the subject with Bechtel Engineering, one of the chief proponents of the slurry scheme. Whatever these costs, there is no disagreement whatever about the fact that the would-be slurry line operators propose a relatively few very large single purpose facilities which will serve essentially one origin point and one or possibly two or three delivery areas. There is certainly no announced plan to build a national coal slurry transport system which will serve all or any large proportion of the country's actual or potential coal users. The clear and stated purpose of the pipeline promoters is to handle the concentrated, large

volume traffic. This is the same business the railroads see as producing for themselves the economies of scale which will enable them to provide coal transport service to all coal users at low rates and, at the same time it will enhance their ability to provide service to all shippers of all commodities. Indeed, new coal traffic has been characterized as the last, best hope of the railroads to avoid nationalization. To them the construction of slurry pipelines and therefore the employment of eminent domain powers would promote "cream-skimming" by essentially private carriers to the detriment of the common carrier system; yet the development of sound systems of true common carriers is one of the express purposes of the National Transportation Policy.

The slurry line proponents make no attempt to rebut this entirely sound contention; rather they attempt to avoid this argument by expressing a willingness to be categorized as common carriers in the face of the fact that they physically cannot perform true common carriage of even the one commodity they plan to handle, given their dedication to one or a few shippers. Such a response has a certain appeal to groups having an energy orientation. I trust that sophistry requires no rebuttal here.

Competition in the Transportation of Energy Fuels

One argument of the slurry people which does hold at least a superficial appeal for some transportation people is the contention that the services of slurry lines are needed to break a railroad "monopoly" that they will provide a needed "rate discipline". In responding, I point out that transportation of coal is but an element, albeit an important one, in the choice which a major energy user makes in deciding what kind of fuel to use, be it petroleum, nuclear or coal. In weighing his basic choices, consideration must be given to major subsidiary choices within each fuel alternative. Thus attention will be given to different coals coming from various regions and from different coals coming from various regions and from different districts, and different mines of particular regions. In short, there is extensive market competition between fuels, and, as to coal, between different coal sources.

Part and parcel of that competition is the related competition between the transportation companies which will move the fuel since transport is a major element in the delivered cost of that fuel. To illustrate, an electric utility system situated in Texas has a choice of coal from the bituminous regions of the Appalachian district which could move to destination by an all water or a rail-water route. It could buy from the coal fields in the San Juan Basin of New Mexico and take deliveries from the Santa Fe Railroad. It could also look to the major coal deposits in southern Wyoming served by the Union Pacific or those in Colorado and Utah reached by the Denver & Rio Grande

Western and its connections. In point of fact some of the Texas utilities are buying Wyoming coal which will move via Burlington Northern and connecting lines. Chicago and North Western also expects to serve as an origin road in this same territory and it can be properly characterized as direct Burlington Northern competition over and above the competition represented by roads reaching other coal fields.

This competition, coupled with technological advancement (as exemplified by modern unit train operations which serve in-motion loading and unloading facilities) has produced remarkably low rates. The charges of the western roads for coal transport are less than one-half of those for other commodities and the Interstate Commerce Commission in a proceeding known as Ex Parte 270, Sub No. 4, has found that the coal rates of western lines are substantially less than those of the east. It seems perfectly clear that existing coal rates are not based on monopoly pricing. Were the contrary so, the Interstate Commerce Commission has abundant authority to provide regulatory protection against excessive rates and it has just exercised it most decisively in the so-called San Antonio coal rate case, Docket 36180. There it required the establishment of a rate of \$10.93 per ton on coal hauled 1644 miles from Wyoming to San Antonio, Texas. This amounts to 6.648 mills per ton-mile for a three-line haul employing shipper owned cars. We regard the rate as too low, and the case is on appeal. The decision was a blow to us, but it must be regarded as an even heavier one to the pipeline proponents whose thesis is that in the long term their rates will be substantially lower than rail rates, because the latter will be forced upward by inflation and their own will remain relatively immune from its effects once construction is complete. It is hardly a sound one in the light of the 12.2 mill rate projected for the Colorado-Gulf line.

THE EFFECT OF SLURRY SYSTEMS ON COMPETITION IN COAL TRANSPORT

Granted the existence of the kind of competition in the transportation of energy fuels described above, what can be expected from superimposing a series of slurry lines on the present transport system? Will rail and barge rates be driven down, as claimed? Will mines, electric utilities, process steam and other commercial energy users having access to slurry lines obtain advantages over their own competitors? More particularly, will electric consumers as a class enjoy lower electric rates? Contrary to what one might expect were the classic competitive equation to apply, the answer to these questions is no.

The special operating characteristics, the special pricing system and the mechanics of financing slurry line construction explain this deviation from the response ordinarily to be expected from the interjection of a new seller in

an existing market. The fact of the matter is that rates offered by present transport modes will not be driven down; they will, on the contrary, trend strongly upward, to the detriment of most steam users and the electric consumers who will depend on coal-fueled electric generation.

In explanation, as had been pointed out, slurry pipeline construction is admittedly feasible only when massive tonnages are to be delivered. The lines now proposed range from an annual capacity of 15 million tons to more than 25 million tons. Thus whatever benefits may be reflected to electric utilities and, ultimately, to electric consumers, they will be confined, relatively speaking, to but a few. Some perspective is brought to this point by noting that the more or less standard unit for a modern large steam electric generating plant is the 750 megawatt facility which will consume perhaps 2 1/2 million tons of coal annually, depending on the grade of the fuel. The largest complexes of electric generating facilities now in being or scheduled for the next few years will consume on the order of 10 million tons annually. It is thus important to note that the original plan of Middle South Utilities to accept delivery of 25 million tons of slurried coal in Arkansas was in effect cut back by the Arkansas Public Utilities Commission to but 5 million tons. That agency refused to authorize more than two generating stations in one area because of its concern that localized consumption of even low-sulphur western coal in such volume would produce violations of local ambient air standards. However, it is not here my purpose to deal with the very real question whether there is a market for deliveries of coal in the quantities visualized by the slurry line promoters; it is but to repeat the point that if there are transportation benefits to be found in slurry line construction, they are not going to be enjoyed by any major segment of the populace or industry.

The implications for existing industrial consumers of electricity or steam vis-a-vis potential new competition who may enjoy cheap energy bears some thought. An old, perhaps exaggerated example of the kind of dislocation which might occur is represented by the establishment of aluminum smelting facilities in the Pacific Northwest when very low hydro-electric power became available on the construction of the Columbia River dams with Federal tax dollars. Of course the avoidance of these kinds of dislocations is one of the reasons why the National Transportation Policy is intended to produce a system of common carriage which will minimize artificial advantages or disadvantages to which segments of the public may be subjected by reason of the development of specialized non-common carrier transportation facilities. In this the National Transportation Policy has not been particularly successful, as witness the proliferation of private carriers on the highways and waterways. But can it be doubted that the nation does need sound, economic

common carriage systems? Can there be any question of the need to appraise the demand of the slurry line people for today's version of the divine right of kings in terms of the effect its grant would have on true common carriage?

Any attempt to quantify the effect of slurry line construction on railroads involves a series of unknowns which revolve around both projected coal transport needs and future rail and pipeline capacity. The usual approach of the pipeline people to this question is the flat assertion that there is going to be so great a new coal transportation need that the railroads can't handle what will be offered them and that, in any event, there is plenty of business for all modes. The flat answer is that they are wrong on both points. In Burlington Northern territory we know pretty well down to a month-to-month basis as to who is going to need what coal and where and when they are going to have to have it through 1980 and in some cases well beyond that date. We also have estimates of the amount of unsold coal available and the production plans of the mining companies. Those who question rail capacity should review a recent study for DOT which makes it clear that we can do the job.

Yet perhaps I haven't fully answered the claims that additional competition is needed and that there is enough business for both the rail and slurry line modes. Why don't we just throw the issue open to competition and let the best carrier win? A portion of the answer revolves around the need for proper transport policy discussed above. The policy question is not posed simply out of concern for railroad corporations as such but is it a sound judgment to permit pipelines to skim off the best of the railroads' developing coal business in light of the fact that the traffic at stake may well represent the last chance of railroads to continue in business as public carriers? To repeat, doesn't the nation need a sound rail system one that can perform service of all kinds for all comers between every origin and destination?

The other aspect of the problem thus raised involves the fact that, as common carriers the railroads have some special obligations which the development of slurry lines may well convert to a railroad disaster. Burlington Northern's problem with Middle South Utilities is illustrative. This is the major utility holding company which plans extensive generating facilities in Arkansas. We have been advised by Middle South that we are to serve as a build-up carrier during the five to seven-year period which will elapse before coal consumption becomes great enough to justify a pipeline. As a common carrier, my company is required to haul that traffic, since it must accept any freight tendered to it for transportation. To do so it will be obligated to invest very large amounts during the next few years to build up a substantial segment of its physical plant and buy locomotives and perhaps the cars needed.

This investment necessarily must be financed with long-term debt. Yet we are told the traffic is going to be diverted to pipeline, leaving the company with no way to meet the unpaid balance. Understandably, we face great skepticism in the financial community when we seek to fund the expansion now needed. The bankers don't seem to agree that there is no risk in the situation, perhaps because the capacity of proposed pipelines will exceed expected coal production in our territory.

Should the eminent domain legislation be passed, we will have no option but to persuade the Interstate Commerce Commission that the rates on all coal must be raised, and I include those portions of the coal traffic which won't lend themselves to pipeline delivery. These, by and large, are deliveries to any of the medium and smaller utilities and to industrial coal users not to the large generating complexes said by some to be the systems of the future. It is not unreasonable to suppose that a further major effect will, over a time, be rate increases for all rail traffic. Hence it is essential for us to make it clear to financial and transportation people that the pipelines are no more than promotional schemes aimed at profits to be earned in the construction and financing of these facilities.

The schemes also militate against the public interest in another respect, for slurry pipelines will monopolize major aspects of the coal transport business instead of offering competition for the railroads. It has been made clear that coal pipelines will be financed on the basis of so-called through-put or "take or pay" contracts. These arrangements, common in the petroleum pipelines business, will lock coal shippers into the use of pipeline services for a long term, perhaps 20 or 30 years. Thus there can and will be no future rate (or other) competition between slurry lines and railroads or other transportation modes. Certainly the rails will not reduce rates in an effort to regain traffic which is already lost beyond recall. That would be true monopoly, the antithesis of competition in the name of which the slurry lines seek governmental powers of condemnation. Space limitations prevents adequate treatment here of the vice of the through-put contract, a vice redoubled in light of the unwillingness (and possibly the legal inability) of the Interstate Commerce Commission to permit employment of the same mechanism by the common carrier railroads. It is perhaps enough for present purposes to remind the reader of the objectives of the national transportation policy and inquire how they square with the monopoly pricing system which admittedly is to be employed by the slurry pipelines.

The Effects of Inflation

It is often argued that since slurry lines are capital rather than labor intensive, they are insulated against the effects of inflation and therefore will

protect consumers against rate increases. I make these points:

- (1) The demand of slurry lines for enormous amounts of capital in times of capital and resource scarcities is hardly a virtue. The railroads can do the job with a very much smaller investment.
- (2) If inflation is the justification for slurry line construction, the prospect of inflation will certainly cause investors in slurry facilities to demand a return that will insulate them against its effects and at the same time produce adequate earnings. In other words, the debt portions of slurry line capital charges will be "front end loaded" and the equity elements will require escalation as with any other variable costs.
- (3) Unless slurry line operations are commenced under rates which are not greatly higher than rail rates, there is doubt that the state public utility commissions will authorize electric generating companies to pass the added expense through to their patrons. To re-employ the example of the 12.2 mill rate for the Colorado-Gulf line versus the rail rate to San Antonio of 6.65 mills, can anyone suppose that the electric consumer will pay or the Texas Utility Commission will authorize a utility to charge electric rates which will include the slurry line charge? It seems most unlikely that anyone will accept this disparity now in the belief that 10, 15 or 20 years from now an overall saving will be effected from the workings of inflation. Another way to look at this proposition is in terms of the customary accounting procedures by which to discount future savings as their realization extends farther and farther into the future. A dollar saved today is worth a lot more than one to be saved 10 years hence. Quantifying tables are everywhere available. This ordinary technique seems to have escaped the attention of our slurry line friends; although I cannot be certain that this is so, for one sees little documentation for their claim of savings.

Other Issues

A number of major miscellaneous points remain to be examined. For example, slurry lines are heavy users of water which is extremely scarce in the west. This is a separate fight. Suffice it to say that the water scarcity alone impairs the prospect that there will be large slurry pipeline operations in the west.

Another but related question is the relative environmental effects of the two modes. Each has its advantages and disadvantages. Still another is the public policy issue implicit in the proposal to employ a capital intensive device for the express purpose of eliminating jobs during what will obviously be a long period of chronic unemployment. These problems cannot adequately-

Coal Slurry Pipelines and National Transportation Policy: A Critical Review

ly be dealt with here. It is enough to say that they are serious, and that anyone concerned with the subject should examine them.

CONCLUSION

The proposal to grant slurry pipelines powers of eminent domain is by no means a simple plan to bring needed competition to the transportation of coal. On the contrary, it raises a great many complex issues of profound importance to the nation. We believe the House Interior Committee acted wisely and well in voting to table this legislation.

3.0 TECHNICAL DISCUSSION

3.1 General System Description

In addition to the normal pipeline system facilities of pump stations, cross-country pipelines and storage tanks, a slurry system requires:

- 1) Handling and crushing equipment to size the material correctly.
- 2) A large quantity of water at the originating end.
- 3) Mixing tanks.
- 4) Facilities at terminal stations to recover the material from the liquid carrier and dry it sufficiently for commercial use.
- 5) A means of disposal.
- 6) Adequate storage of material at the initial and terminal stations to ensure continuous operations with minimal disruption.
- 7) Holding tanks at each pump station for starting flow.

To start, water is supplied from a tank to the pump suction, while incoming slurry is diverted into another tank until design flow is reached. Then the diversion valves are closed simultaneously with the opening of the main line block valve between the diversion points.

In preparing the slurry for shipment, bulk solids of medium to large size particles are carried to the originating station of the slurry pipeline and then reduced in size and mixed with a liquid carrier, usually water. The solid particles stay in suspension if the flow of the slurry in the line is maintained at proper design velocities. Higher velocities cause increased abrasion, in turn causing continued reduction in particle size and increased pumping pressure requirements. When this pumping pressure requirement exceeds the capacity

of the pumps, the resulting velocity reduction allows the particles to settle, possibly forming plugs in low areas of the line.

To ensure a constant supply of water at the origin of the pipeline, it is prudent to install storage tanks for two or three days' supply if water is received by pipeline, or a large, concrete-lined pond if delivery is by channel. The material to be transported must be cleaned before reduction to a range of particle sizes determined through prior tests to be optimum for the type of coal. The optimum sizes vary not only between types of coal, but often between sources of the same type of coal.

Because it is relatively expensive to store coal after it has been reduced in size, the primary storage capacity is maintained at the initial station on the pipeline. Facilities are necessary for working the stored coal to prevent spontaneous combustion and to move the coal to the crushers as required. If the pipeline begins in the immediate vicinity of the mines, the need for bulk storage before crushing is reduced substantially.

To ensure that environmental disruption does not exceed an acceptable level, it may be necessary to install equipment for the control of noise or dust. Measures for the purification and disposal of the used water are also necessary.

The cross-country slurry pipelines are designed and constructed in accordance with existing codes applicable to liquid pipelines. The routes for the lines are selected to minimize slopes greater than the angle of repose for the material in the slurry. This necessity may lengthen the line by requiring deviations from a shorter and straighter route. Line sections that cannot avoid slopes greater than the angle of repose would require additional valving and controls to prevent formation of a long blockage in the pipeline as a result of a long shutdown. Considerations of safety and potential environmental

damage should a spill occur may also influence routing, as discussed in Sections 5.1.3 and 5.1.4 below.

The pumping stations of a slurry pipeline generally consist of multiple units of multicylinder, reciprocating, double-acting piston pumps. They may be driven by prime movers that are diesel or gas engines, or electric motors. In principle, the driver could be a turbine, with the fuel taken from coal being transported through the line. However, the technologies of deslurrification of small quantities and of combustion of coal in turbine combustors are not now available to make this approach practical. However, if the long slurry lines become a reality, coal from the pipeline might offer the best combination of economy and reliability as a power source.

The significant functions of a coal slurry pipeline terminal beyond those of a petroleum liquid terminal are the recovery of the crushed coal from carrier water, drying the coal to acceptable specifications, and disposing of the separated, polluted water.

There are several methods for deslurrification, including settling and centrifuging or filtering. Every method used to date generally results in a carryover of fines with the water, which requires the injection of a thickening agent to reclaim the fines and recirculate them to the centrifuge or filter.

The drying operation requires heat to reduce the moisture content of the material to an acceptable level. This heat can be supplied as bypass heat from a nearby power plant from commercial heaters using gas or other fuel or in the power plant boiler itself. The fuel used in this drying operation, including the penalty on plant heat rate, is included in the assessment of cost or energy consumption of the line in Section 5.4.1.1 below. The material is delivered directly from the terminal to the customer continuously, although storage piles are necessary as with any other power plant.

As noted above, the separated carrier water requires treatment. This is generally done in settling ponds. When the water quality passes the appropriate specification, established by the controlling water authority or the customer, the water is displaced into an adjacent water course or used.

3.2 Existing Coal Slurry Pipelines

3.2.1 The Ohio Pipeline

The first coal slurry lines in the United States of significant size was the 107-mile line owned by the Consolidation Coal Company. It supplied coal to an electric generating plant in Ohio. This line effectively reduced the cost of transportation, forcing the competing railroad to develop efficient unit trains. Eventually, as discussed in Section 4.2.1, the railroad was able to offer tariffs sufficiently low that the pipeline could no longer compete, and it was shut down. It is now maintained on a standby basis.

3.2.2 The Black Mesa Pipeline

The only major coal slurry pipeline now operating in the United States is the Black Mesa Pipeline, owned by the Southern Pacific Railroad. It is the largest and longest yet built. The history and description of the line have been presented [Montfort, 1975] and updated [Montfort, 1977], and are summarized below.

Black Mesa Pipeline, Inc., was organized in 1966 to construct, own, and operate a coal slurry line connecting the Black Mesa, Arizona, coal field to the proposed Mohave Generating Station in southern Nevada, over the route shown in Fig. 3.2.2-1. Black Mesa Pipeline, Inc., is a wholly owned subsidiary of Southern Pacific Pipe Lines, which operates 4200 miles of petroleum products pipelines. These pipeline systems in turn are a part of Southern Pacific Company. In 1967, a 35-year transportation contract was signed with Peabody Coal Company and engineering design began. Shakedown began in August 1970, and by November, commercial operation was in process.

Fig. 3.2.2-1

BLACK MESA PIPELINE, INC.
COAL SLURRY PIPELINE
LOCATION MAP

Black Mesa Pipeline receives coal at a central point in Peabody's strip mine located on the Black Mesa of the Navajo and Hopi Reservations in northeastern Arizona. The pipeline system includes slurry preparation plant, pump stations, pipeline, test loops, control and communication facilities, but not terminal storage and dewatering facilities, which are part of the power plant (Fig. 3.2.2-2). Slurry process water is furnished by the coal company from deep wells. The Black Mesa system cost approximately \$39 million.

Coal is received from the coal company at the preparation plant by a conveyor belt, which delivers 2" x 0" coal into three elevated raw coal bins. Each bin feeds a process line consisting of an impact crusher, a rod mill, a sump and centrifugal sump pump (see Fig. 3.2.2-3). Impactors reduce the coal to 1/4" x 0" by dry crushing, and rod mills pulverize the coal by wet grinding to 8 mesh x 0. Slurry is formed in the rod mills, where water is introduced. From rod mill, sump slurry is pumped into one of four 630,000-gallon storage tanks, which are open-top and equipped with mechanical agitators to maintain slurry suspension. The slurry is transferred from the storage tanks by a centrifugal charge pump into the suction of the mainline high-pressure pumps.

The pipeline system is capable of pumping 660 tons of coal per hour. At 48% solids by weight, flow is 4200 GPM and velocity is 5.8 fps. When lower delivery rates are required, flow is reduced to about 5 fps. Any necessary further reduction is accomplished by inserting water slugs between batches of slurry. Transit time is three days, and line fill includes 45,000 tons of coal.

Four pump stations are required. These are sizeable installations, utilizing the largest piston pumps with electric motor drives and hydraulic couplings for speed control. Three

Mohave Power Plant

Live Slurry Storage

Centrifuges

Pipeline - during construction

System Control Center

Strip Mining Operation

BLACK MESA PIPELINE, INC. COAL SLURRY PIPELINE SYSTEM

Fig. 3.2.2-2

Strip Mining Operation

Initial Crushing

**BLACK MESA PIPELINE, INC.
COAL PREPARATION PLANT
SYSTEM**

Fig. 3.2.2-3

stations have three pumping units installed, with one a spare. The fourth station has four units, with a spare. The three-unit stations operate at about 1000 psi, and the four-unit station at about 1500 psi. Driver horsepower is 1500 and 1750 respectively.

Most of the pipe is 18" diameter and traverses mountainous northern Arizona terrain with elevations varying from 6500 ft to 3800 ft (Fig. 3.2.2-4). The last 12 miles drop another 3000 ft; in this stretch, diameter is reduced to 12" to reduce flow speed. The pipe is a high-pressure steel, welded pipeline and is conventional except that a 16% maximum slope limitation was observed for hydraulic reasons. The line is extensively telescoped, with wall weights ranging from .469" to .219". Even though most of the ditch is rocky, a tape coating system was successfully used, with extensive dirt padding. At the time of construction, it was not known whether the line could be restarted after an extended shutdown. Accordingly, ponds were provided into which the contents could be dumped in case of shutdown.

Early in 1971 the pipeline was shut down twice due to power failures. Particle size gradation (consist) was relatively coarse and difficulties were encountered in restarting sections of the line. On each shutdown, one hard plug was encountered and had to be located and removed. Plugs were specific - about 40 ft in length. To be on the safe side, other sections were restarted and line fills were dumped into station ponds. In the first instance the affected line section was down four and a half days, but subsequent to removing the plug, the section was restarted without difficulty. The consist was adjusted to provide a finer grind and since then, numerous restarts have been accomplished without difficulty. With the benefit of this experience, it is not expected that extensive dumping will occur again. The two important keys to a restartable slurry are a fine grind and a well graded consist.

Pump stations and pipeline operation are supervised from the origin point. The pump stations, which are complex, are operated unattended; however, there are two resident employees at each station to perform maintenance and to be on call. Pumping is "tight lined," i.e., without surge tankage at the stations, which are linked by a solid state, hot, standby, microwave system operation at ~2100 MHz. One link of 109 miles involves use of space diversity antennas to cope with atmospheric fades.

The slurry is delivered at the power plant into large (7,800,000 gallon) storage tanks. The tanks, with 500-hp agitators, are much larger than any such tanks previously built, and have operated satisfactorily. Slurry is withdrawn from tankage by a centrifugal pump and transferred to a battery of 40 centrifuges, where 75% of the water is removed. The resulting wet cake is conveyed to 20 bowl mills for drying and further pulverizing. Dried coal is carried pneumatically to the combustion chambers.

Fifty-two permanent employees operate the pipeline. Of these, about 36 are at the Black Mesa preparation plant. The remainder are technical and administrative personnel located in Flagstaff and at the booster stations. At Black Mesa, Navajo and Hopi Indians are given employment preference under terms of the mining lease. At both Peabody and Black Mesa Pipeline, Indian workers are in the majority.

The system is operated by a four-man shift at Black Mesa. The group includes a Shift Supervisor, a Pipeline Operator in the System Control Room, an Operator-Repairman handling preparation plant and other facilities, and an Operator-Repairman Assistant, primarily doing slurry quality control testing in the Testing Laboratory.

It has been noted earlier that pipelining solids requires considerable testing to determine minimum operating velocities with respect to deposition or bedding and to assure good restart

characteristics. Varying the solids fraction and the size consist affects these important operating characteristics. High capacity test loops are useful here, and Black Mesa has several well instrumented loops, including one 1000-ft long and 24-in in diameter. After determining the desired specification, it is necessary to monitor carefully to assure that specification is consistently met. Solids fraction and density are extremely important, and are monitored by a nuclear density meter mounted outside the pipe. Size consist must be laboriously obtained by sieve analysis every two hours or less.

The slurry is sometimes corrosive and requires some inhibitor, especially in the case of water batches. Careful corrosion monitoring is necessary.

While the pipeline can be shut down and slurry allowed to settle, pump cylinders and valve chambers as well as convolved station piping must be promptly flushed upon shutdown. The slurry tends to pack into dead spots except for those on top of the pipe, which affects valve selection. A conventional gate valve will not function well in slurry service. Ball valves and lubricated plug valves seem best suited for slurry.

Wear is a continuing process in the mainline pumps. Since it is to be expected, it is not a problem. Valves, seats, pistons, rods, and packing are expendable. However, these parts have met and in most cases exceeded expected service life. The system has successfully completed more than six years of operation. While the line is capable of transporting over 5 million tons of coal per year, it has actually averaged only about 4 million tons per year because of lesser burn requirements at the power plant. Pipeline availability has exceeded 99%. The plant engineer at the Mohave Generating Station reports that, of the three major subsystems, coal mine, pipeline, and power plant, virtually all system downtime is due either to the mine or the power station. "That pipeline is always running."

K 5025

Because minimum operating velocity and design throughput velocity are rather close, the pipeline has a relatively small turndown ratio. When the power plant requirement is less than the pipeline turndown, batching is necessary and a dispatching model has been just as useful in this application as on a petroleum line. Flow is measured in gallons per minute, using magnetic flow meters and by timed stroke counts. Gallons per minute and tons per hour are related by specific gravity of solids and percent solids.

3.2.3 Proposed Lines

In addition to the existing Black Mesa line, there are five major coal-slurry pipelines currently proposed. Three of them are considerably longer than Black Mesa, and all are based on moving coal from Western mines to electrical generating plants. Burlington Northern engaged in extensive slurry transportation studies, looking toward the possibility of joining with nonrailroad companies in the pipeline business. They withdrew from the planning, however, saying that rail transportation clearly would be superior to pipelines, and are now battling their former partners.

Energy Transportation Systems, Inc., is a joint venture which was formed by Bechtel Corp., the San Francisco engineering and construction company, and the New York investment firm of Lehman Brothers Corp. The Kansas-Nebraska Natural Gas Company, Inc., later joined the venture.

The proposed ETSI project would carry Wyoming coal on a 1000-mile trip to White Bluff, Arkansas, where the coal would be burned by a subsidiary of Middle South Utilities, Inc. The cost of the pipeline has been estimated at \$750 million, and its sponsors say it would deliver 25 million tons of coal a year for 30 years. Middle South estimates that it would save \$14 billion over the life of the contract, compared with the cost of buying rail-bound coal. The railroads disagree. The cost comparison between rail and pipe modes is discussed further in Section 4.2.4 below.

Several other pipelines have been proposed. Houston Natural Gas Corp. has drawn plans for a Colorado-to-Houston system; another Wyoming-Texas pipeline has been suggested by Brown & Root, Inc., Shell Pipe Line Corp., and Texas Eastern Transmission Corp. A westward line running from Wyoming to Oregon has been proposed by Northwest Energy Company, owner of the Northwest Pipeline Corp., a natural gas firm, and by Gulf Interstate Co. A slurry line has also been proposed to carry coal from Utah to Las Vegas, Nevada, and a major Canadian project has been outlined that would operate from Alberta to Ontario and would cross U.S. territory. A more detailed discussion of these proposed lines can be found in Kiefner [1976].

The companies involved in these projects are among the members of the new Slurry Transportation Association which, along with the National Coal Association and the National Association of Electric Companies, is working for passage of legislation to grant the federal power of eminent domain to slurry pipelines. The opposition campaign is directed by the Association of American Railroads (AAR). The controversy is discussed in Section 5.0 below.

4.0 TRANSPORT ECONOMICS OF COAL-DERIVED ENERGY

4.1 Transport Alternatives for Coal-Derived Energy

As has just been noted, all of the long coal-slurry lines that have been seriously proposed are intended to move coal to electric generating stations from the region that is sometimes called the Western coal axis. This region is a strip, 200 to 500 miles wide, extending from western New Mexico northward to Edmonton, Canada, and beyond. There are five alternatives for transporting this energy:

- 1 - movement of the coal by rail, employing unit trains,
- 2 - gasification at or near the source, and transmission by gas pipelines,
- 3 - electric generation at or near the source, and transmission by extra high voltage (EHV) lines,
- 4 - slurrying the coal in water and movement by pipeline,
- 5 - conversion of a small part of the coal to liquid form, in which the remainder of the coal is then slurried for movement by pipeline.

The first four alternatives listed above have been discussed by Wasp and Thompson [1975]. They conclude that alternative 2, gasification at or near the source, is impractical, primarily because of the environmental, ecologic, and demographic disruptions associated with a 3000-person work force at the remote mine site, along with a 300-MWe generating station and the consumption of 30 million gallons of water per day.

They also conclude that building the electric generating station at or near the source would be undesirable for several reasons. First, water requirements for the cooling towers are difficult to satisfy. The alternative, i.e., dry cooling towers, is about four to six times more expensive than the wet type. Second, there are other environmental and ecological

problems associated with siting large power plants in the Western deserts which recently caused the Southern California Edison Company to abandon, after 12 years, its Four Corners project. Third, the cost of EHV transmission itself is expensive. A 2000-MWe generating station would consume about 6 million tons per year of coal. Wasp and Thompson estimate the cost of EHV power transmission over a 1000-mile distance at between 3.5 and 4.0 mills/kwhr, escalated to 1973. For unit trains and slurry pipelines, they estimate that the costs are approximately equal at 3.0 mills/kwhr, in 1973 dollars. For larger generating stations, they find that the cost of rail (unit train) transport remains constant at about 0.6 cents/ton-mile, while both EHV and slurry pipeline costs decline strongly, but the pipeline maintains its cost advantage over EHV.

Returning to the alternatives mentioned above, some detailed comparisons of unit trains, coal-water slurries, and electric transmission have been performed by Rieber and Soo [1976]. Analyzing in detail the routes shown in Fig. 4.1-1, they developed capital and operating cost estimates, and computed total costs in dollars per ton of coal. They did not directly compare electric transmission with the other two modes, but their results indicate that electric transmission is the most expensive mode. Their comparison of slurry vs. railroad will be further discussed in Section 4.2.4.2 below.

In Report R-3025 of this series (see Table 1.1-1 above), alternative 5 was identified as highly promising, and it was recommended that an in-depth study be performed. It was tentatively concluded that the preferred liquid is methanol, although that determination deserves further study.

Water is scarce in the Western coal regions, and water consumption is therefore important in selecting a transport mode. The water transported per million Btu delivered is approximately as shown below:

	<u>Total</u>	<u>From Minesite</u>
Electric generating station	100 gal	100 gal
Synthetic gas plant	30	30
Coal-water slurry	12	12
Coal-methanol slurry	4	0
Rail	1	negligible

The zero water requirement at the minesite shown for the coal-methanol slurry refers to the possibility of using a small second pipe to return the methanol to the head of the pipeline. That possibility also exists in principle with the water slurry, but the amount of water required renders it uneconomic.

Of course, there is an almost infinite spectrum of combined approaches that might be considered. For example, if it is in fact undesirable to establish a large gasification plant in Wyoming, there may be intermediate locations at which such a plant would be an attractive addition to the local economy, to which the coal could be moved by train and from which the gas could move by pipeline. And the non-water slurry, although attractive in principle, requires an extensive R,D,&D program. Thus, for the present purpose, it is only necessary to address the tradeoff between unit trains and coal-water slurry pipelines.

4.2 Cost Trends in Coal Transportation

Discussion of coal transportation costs appropriately begins with a review of the historical basis of railroad and slurry pipeline freight rates for coal and of the effects on those rates of the introduction of unit trains. Projections that have been made for these rates may then be examined in preparation for a comparison to be made later. The following discussion draws heavily on Campbell and Katell [1975].

All of the proposed slurry lines known to be under serious consideration are designed to move coal from the Western coal axis to markets that are approximately a thousand miles from the mine sites. Therefore, this present discussion considers only such long-distance water-slurry lines, originating in the Western coal fields.

4.2.1 Evolution of Railroad Freight Rates for Coal

4.2.1.1 Volume freight rates

Until the mid-1950's, there were two basic policies of the Interstate Commerce Commission (ICC) which were, or were alleged to be, dominant in the determination of coal freight rates: the use of the carload as the basic unit in establishing rates, and the maintenance of artificially high railroad tariffs to protect the truck lines and barge operators. The carload had been the basic unit for rate determination since the ICC in 1887 condemned the practice of discounting below carload rates for large shipments. The basic concern had been to protect the small shipper from unfair competition. In 1959, the Pocahontas Railroad proposed a discount for large volume coal users, which was subsequently approved. In another case in 1960, the Commission permitted volume rates lower than the carload rate for Appalachian coal destined for the New York harbor area. The acknowledged reason

K-3023

was to compete with oil which moved along the Atlantic coast by water and/or barge. Since this oil was not subject to ICC regulation, the ICC action could possibly be interpreted as a move to protect itself against loss of its influence. By 1966, volume rates had been established for molasses and grain in addition to coal.

4.2.1.2 Pipeline competition

The Ohio line began operation in 1957 and continued for six years, transporting approximately 1.1 million metric tons per year a distance of approximately 107 miles. When the railroads were finally able to meet the pipeline price, the line was mothballed. The device which enabled the railroads to accomplish this was the unit train, which is further discussed in Section 4.2.1.4 below.

4.2.1.3 The Transportation Act of 1958

While the Ohio Pipeline was in operation, other pressures for lower rates were developing. In 1956, the Presidential Advisory Committee on Transportation Policy and Organization had recommended that railroads be given greater freedom in setting rates, and that the ICC role should be to set upper and lower limits. At least partly as an outgrowth of these recommendations, the Transportation Act of 1958 modified Section 15a of the Interstate Commerce Act to provide that rates should not be held to a particular level in order to protect any other transportation mode. In other words, the railroads were no longer required to charge artificially high rates to protect the barges and trucks. Barge operators protested, and since the wording of the Act was somewhat ambiguous, several years and appeals to the Supreme Court were necessary to affirm the principle.

4.2.1.4 Unit trains

The Southern Railway began operating the first common carrier unit train in 1960, hauling coal in Alabama to a power plant. The Kauffield Engineering Co. was retained by several railroads in 1961 to analyze problems in the energy transport market. Their report recommended what were called integral trains, with minimum payloads of 25,000 tons, to be moved at high speeds (50-55 mph). The Reserve Mining Company had demonstrated this concept earlier, in 1957, to move iron ore over a 50-mile private track [Rieber 75, App.F]. During this period, 100-ton aluminum hopper cars were also coming into service for grain hauling in long-dedicated trains.

In general, the term "unit train" refers to a long train with a single type of car, e.g., hoppers, carrying a single commodity, e.g., coal or grain. They load at one or a few points, all in the same general locality and haul to one or a few destinations, e.g., power plants. Specially designed loading and unloading equipment is often used which can fill or empty a 100-ton car in two minutes or less.

With the evolution of this new technique on the one hand and with the passing of the long-standing ICC policies (volume rates prohibited, artificially high rates mandated) on the other, railroads now had both the technique and the freedom to compete with the Ohio Pipeline. The railroad rates fell, and the pipeline went into mothballs.

The pipeline proponents claim that the Ohio Pipeline was responsible for forcing freight rates down all over the country, and that they would not have come down without competition from the Pipeline. The railroads, on the other hand, assert that it was only the combination of the new technique and the freedom to use it that allowed rates to fall, since neither a

pipeline nor anything else could force rates down without those two developments. They further observe that tariffs for unit trains are negotiated on an individual basis, and scoff at the notion that a single 100-mile pipeline could have had any significant effect upon any such negotiations outside its own locality.

- Both of these arguments are plausible, and the outside observer is likely to suspect that the truth lies somewhere between. There must have been negotiations in which the existence of the Ohio Pipeline never crossed the mind of anyone on either side. However, it may be observed that several other pipelines had been proposed, e.g., West Virginia to Detroit and to New York. Thus, it also seems likely that in other negotiations, some of which may have occurred well beyond the borders of Ohio, the competitive threat of a pipeline must have been a factor of some importance.

4.2.2 Susceptibility to Inflation

It is well recognized that slurry pipelines are capital intensive. In addition to the usual pipe and pumping equipment which are major components of any pipeline and which represent very large investments, slurry lines must also include facilities for the following processes:

- 1 - cleaning the coal,
- 2 - sizing the coal,
- 3 - supplying water,
- 4 - providing water storage above ground to contain some portion of the line fill in case of shutdown,
- 5 - deslurrifying and drying the coal, and
- 6 - cleaning and/or disposing of the used water.

It is not necessary to conduct extensive cost studies to recognize that these are large facilities and represent significant capital investments.

Second, a slurry line can operate only over a narrow range of flows. At lower flows, the solid material settles and plugs the line, while at higher flows the particles erode both each other and the pipe walls. Consequently, flows lower than design flow can only be accommodated by pumping pure water part of the time, a process that is wasteful of energy, and expensive. Therefore, a slurry line, unlike an ordinary pipeline, cannot begin operation at a low initial flow and add pump stations later as traffic increases; the entire capital investment must be made before the line ever begins to operate.

On the other hand, as with pipelines in general, the labor-intensity of slurry pipelines is very low. The entire Black Mesa line is operated with 52 people. With an annual throughput of 5.5 million tons/year over a distance of 273 miles, this means that 27.3 million ton-miles of coal transport are accomplished per person-year. Energy Transportation Systems, Inc., aspires to increase that figure to 95 million ton-miles per person-year, i.e., 335 employees to move 25 million tons/year over a 1036-mile distance [Wasp 75], reflecting the effect of large scale.

As will be seen below, estimates by pipeline opponents vary considerably from those of the proponents, but there is no disagreement that the labor intensity of the railroad is almost four times that of the pipeline. However, the high labor intensity of the railroad does not mean that its capital intensity is low. As will be seen later in Section 5.2, the purchase price of rolling stock in a single unit train may easily amount to \$4 or \$5 million, and in Section 2.4.2 it will be seen that to put the roadbeds into condition to withstand use by long, heavy trains moving at high speed will also require large capital investments for some railroads. As the analysis preceding construction of the Black Mesa slurry pipeline showed, a new railroad would entail a higher capital cost than a new

pipeline. However, in the case of existing railroads wherein the capital cost comparison with the pipelines involves primarily the new rolling stock to make up the unit trains plus some investment for roadbed improvement, the capital investment in the new pipeline is much greater than that in the existing railroad. This general principle results in two significant economic differences between the two modes. One such important difference, the employment potential, is discussed later, in Section 5.1.5.

The other important consequence of the foregoing is the differing susceptibilities to inflation which result. The portion of cost which is invariable, and hence not subject to inflation, is much higher with the pipeline than with the railroad. Therefore, the effect of inflation on the pipeline is much less. The relative effects of inflation have been treated by the pipeline proponents Wasp [1975], Montfort and Wasp [1975], and Aude, et al. [1975], and by opponents Armbruster and Candela [1976]. Comparison of their results is instructive. The propensity position will be examined first.

Montfort and Wasp [1975] present the breakdown between fixed and variable costs for the slurry pipeline (Table 4.2.2-1). An independent estimate is shown in Table 4.2.2-2. From the Montfort-Wasp text, it is unclear whether their breakdown is precisely that of the Black Mesa line. However, the implication is clear that these figures are typical for slurry pipelines. Taking the example of a 3% GNP deflator, the corresponding indices for the variable components of pipeline cost are presented as follows:

Power	1.0
Labor	1.3
Supplies	0.7

Using these weights and the breakdown from Table 4.2.2-1 yields an annual overall inflation rate of 0.48% for the pipeline, which Wasp and Montfort apparently round to 0.5%.

TABLE 4.2.2-1
FIXED-VARIABLE COST BREAKDOWN, SLURRY PIPELINE

Fixed Costs	84%
Variable Costs	
Power	6%
Labor	5
Supplies	<u>5</u>
	<u>16%</u>
Total	100%

Source: Montfort and Wasp (1975)

TABLE 4.2.2-2

Comparison of Pipeline and Rail Operating Costs
(Typical Long-distance Movement)

		<u>\$/Ton</u>	
		<u>Pipeline</u>	<u>Railroad</u>
Power/fuel		\$0.74	\$1.16
Labor		0.32	4.17
Supplies		<u>0.68</u>	<u>2.82</u>
	Total	0.74	8.15
	Fixed	<u>7.26</u>	<u>2.85</u>
	Total	\$9.00	\$11.00

- - - - -

Source: Low-Beer (1975)

These authors then assert that "the past ten years has indicated that the correlating coefficient between the GNP deflator and rail rates was 1.8. For example, if we had a GNP deflator of 3%, the rail rate would have gone up 5.4%." As will be seen below in the discussion of Table 4.2.2-3, it has not been possible in this study to confirm this observation. Over a year later, Wasp [1975] uses a somewhat different rationale which relates unit train rates to the AAR index to arrive at a 5.4% inflation rate for unit trains under the condition of 3.6% national inflation rate. As will be clear later, it is preferred for present purposes to continue this discussion using the 3% national rate, for which the Montfort-Wasp estimating methodology would yield 4.5% for the annual inflation in unit train freight rates. Using this figure for the unit trains and the original Wasp-Montfort figure of 0.48% for the pipeline, the adjusted comparative costs are tabulated in Table 4.2.2-2.

It will be seen below that the 4.5% may be either much too high or much too low, depending on whether greater credence is given to continuation of past long-term tariff trends or to recent negotiations [San Antonio 76, Hearings 75, pp.750, 754, 757]. However, there does not appear to be any doubt of the qualitative validity of the proposition that pipelines are much more inflation-resistant than railroads. Yet the argument does not end there, for two reasons. The first relates to the relative initial costs, which will be discussed in the next section.

The second reason is that the same characteristic which makes the pipeline inflation-resistant also makes it innovation-resistant. It represents a large, monolithic facility whose physical configuration would be expensive and difficult to change. As seen above in the case of the slurry pipeline, it also operates only within a rather narrow flow range. These inflexibilities mean that while lifetime costs and inflation effects are known rather precisely at the time the line goes into operation, there

TABLE 4.2.2-3
ANTICIPATED INFLATION IN TARIFFS
(Method of Wasp and Montfort)

<u>Year.</u>	<u>Relative Tariffs (for equal, unity base)</u>	
	Pipeline @ 0.48%	Unit Train @ 4.5%
0	1	1
5	1.0242	1.2462
10	1.0491	1.5530
30	1.1545	3.7453

is at the same time relatively little that can be done over the lifetime to reduce costs and thus offset inflation effects. In the railroad operation, on the other hand, which employs people who may be replaced by machines, equipment which wears out and may be replaced by improved capabilities, and right of way that requires maintenance but is also susceptible to improvement, e.g., welded rails, the opportunities for technological and other improvements appear to be more abundant.

Powerful support for this position can be found in the history of rail freight rates, presented in Table 4.2.2-4. The reader is cautioned that, as indicated on the table, the data are taken from several sources which are not completely consistent between them. The data should therefore not be used for any purpose beyond the present one, which is simply a first order check of the Wasp-Montfort hypothesis. A logarithmic linear regression calculation yields an average inflation rate of 0.74, 1.50 and 1.24% for the U.S., Western, and coal rates. Since these rates are only about a third of the corresponding average increase for the GNP deflator, it is difficult to see how this large net gain in productivity as compared to the GNP could have been achieved without considerable technological innovation.

It is also instructive to examine the net escalation of railroad labor costs for the same period (see Table 4.2.2-5). The average annual escalation of the logarithmic regression line is negative, i.e., productivity growth was greater than inflation. The average rates calculated here are those which, compounded over the period, produce the observed total change along the regression line.

As noted earlier, the data of Tables 4.2.2-4 and 4.2.2-5 have not been derived through careful research, since in-depth study of inflation in railroad rates is beyond the scope of

TABLE 4.2.2-4

Railroad Ton-Mile Revenue

	<u>Year</u>	Revenue, ¢/Ton-Mile		<u>Coal</u>	<u>GNP Deflator</u>
		<u>All</u>	<u>West</u>		
		<u>U.S.</u>	<u>West</u>		
0	1939	0.973	1.021	-	-
1	1940	0.955	-	2.22	-
5	1944	0.949	0.972	-	-
11	1950	1.341	-	3.09	80.2
16	1955	1.370	1.342	3.24	90.9
21	1960	1.417	-	3.40	103.3
26	1965	1.266	1.256	3.13	110.0
31	1970	1.428	1.374	3.41	135.2
36	1975	2.041	1.913	-	-
Avg.annual growth of re- gression line		0.00736	0.01495	0.01237	0.01250

Note: Data taken from several sources which are not completely consistent. Results, therefore valid for first-order comparisons.

TABLE 4.2.2-5

RAILROAD LABOR COSTS

	<u>1950</u>	<u>1955</u>	<u>1960</u>	<u>1965</u>	<u>1970</u>	<u>1973</u>
Employee Compensation, \$ $\times 10^6$	4645	5045	4957	4887	5646	7294
Ton-Miles, $\times 10^9$	592	627	575	706	771	858
Labor \$ Per 1000 Ton-Miles	7.851	8.041	8.62	6.92	7.32	8.50
Logarithmic Regression line	7.955	7.912	7.870	7.828	7.786	7.761

Regression line annual growth = -0.00099

Source: Statistical Abstract of U.S., 1975, Page 581.

this project. However, this approximate analysis is adequate to suggest two conclusions. First, to whatever extent the past constitutes a guide to the future, projections of future average annual inflation in rail rates in the range of 3 to 5% appear to be without basis. A more reasonable figure would appear to be in the neighborhood of 1%. Second, even if 1% is a more appropriate figure than 3%, it is still much more than can be expected for the pipeline inflation.

Stated equivalently, the pipeline proponents appear to have a valid point that pipeline tariffs are inherently more inflation-resistant than rail tariffs, but they are far overstating their case when they project future rail inflation in the neighborhood of 5% and attempt to justify it by history. Straightforward projections of both overall and coal freight rates from the past 25 years suggest a figure of approximately 1%.

Finally, it must be noted that if one examines only data of the last few years, one finds a much higher inflation rate, although one must select data points carefully to justify a rate above 3%. From this it could be argued that only the last five years' data should be considered and the previous 20 years' experience disregarded. However, a 30-year projection based on only three to five years of data is highly suspect unless evidence can be adduced to show that the particular conditions of the recent past are likely to hold far into the future.

Such evidence may be found in the pleadings before the Eighth Circuit Court [San Antonio 76]. (see Section 5.3.1 below). In this case and in every other that responses were obtained from over 20 inquiries made in the course of this study, the railroads have, according to the prospective customer, refused to negotiate except on the basis that rates be tied to their AAR price index throughout the life of the contract. The 5-year history of the index is given in Table 4.2.2-6. The regression line growth is 12.9% per year. When this railroad policy is taken into account, it is concluded that the favorable history of the past is indeed a thing of the past, as

exemplified in Tables 4.2.2-4 and 4.2.2-5. It seems highly probable that unit train rates will escalate at 10-15% per year.

Returning now to the question of pipeline escalation, it is interesting to examine the conditions under which ETSI proposes to operate its pipeline. For the convenience of the reader, the following two paragraphs are repeated from Section 2.2.2.1 above. The ETSI agreement with one coal user provides in part:

- 1 - the contract term will be 30 years,
- 2 - the tariff will consist of a fixed part and an escalatable part,
- 3 - following construction, the previously estimated fixed part of the tariff will be adjusted to final construction costs and capitalized financing costs,
- 4 - following construction, the previously estimated escalatable portion of the tariff will be adjusted to conform to the then forecasted cost of the escalatable elements, and
- 5 - in the event that water from the initial source becomes unavailable, ETSI will develop a new source and provide the needed water, to be paid for by a surcharge on the tariff.

It is seen that neither the price, nor even the rate of escalation of the price, will be firm until it is too late for the buyer to do anything about it. It is also important to note that, since the capital cost is not firm, the effect upon the buyer is the same as if capital costs were escalating. In some respects, an escalatable construction contract is equivalent to a cost-plus-percentage contract. This type of contract is notorious for cost increases; for that and other reasons it has long been prohibited for Government contracting.

TABLE 4.2.2- 6

AAR Index

<u>Year</u>	<u>Index</u>
1972	145.6
1973	163.5
1974	186.8
1975	212.6
1976	234.1

Source: AAR Yearbook of Railroad Facts, 1977

If capital cost should double during construction, as is not uncommon under such arrangements, the effect is the same as a 2.33% annual escalation of the fixed charges. Seen in this light, the pipeline resistance to inflation appears to have been greatly overstated in Table 4.2.2-3 above.

4.2.3 Tariff comparison - pipeline vs. railroad

From the foregoing, it is clear that whatever the future inflationary effects prove to be, they will operate more strongly on the rail mode of coal transport than on the pipeline mode. It follows that the rail mode can only win the long-term cost competition if its initial cost is significantly lower than that of the pipeline. The pipeline opponents, Armbruster and Candela [1976] present an analysis to show which mode results in the lower cost for a variety of combinations of initial costs and inflation rates.

They consider a 25 million ton/year competition between a 1000-mile pipeline and a unit train operation which must haul the coal 1300 miles between the same two destinations. Variable costs of 25% for the pipeline and 80% for the railroad were considered and the results of both 3% and 5% inflation of the variable portion of costs were computed. In view of the discussion of the preceding section, it is unfortunate that calculations for cases in the range of 10-15% were not also performed. Some of their results, along with the results of additional analysis performed as part of this study, are presented in Table 4.2.3-1. The crossover year is the one in which the cumulative cost by rail transport exceeds that by pipeline.

The columns headed "EPV" show the year in which the cumulative costs on the utility company books, for the rail case, exceed those for the pipeline case. The columns headed "IPV" include present value of the foregone interest cost on the higher charges during the early years in the pipeline case.

TABLE 4.2.3-1
PRELIMINARY ECONOMIC COMPARISON
COAL SLURRY PIPELINE VERSUS UNIT TRAIN OPERATION

Initial Tariff				Initial Unit Tariff Difference		Crossover Year ***			
1300-Mile Rail		1000-Mile Pipe				3 Percent		5 Percent	
Trip	Unit	Trip	Unit			Escalation		Escalation	
\$ ton	Mills ton	\$ ton	Mills ton	Mills ton-mile	Percent	EPV*	IPV**	EPV*	IPV**
8	6.15	9	9	2.85	46	21	>30	10	15
		10	10	3.85	63	28	>30	17	29
		11	11	4.85	79	>30	>30	24	>30
		12	12	5.85	95	>30	>30	30	>30
9	6.92	10	10	3.08	45	15	~27	9	13
		11	11	4.08	59	25	>30	16	27
		12	12	5.08	73	>30	>30	22	>30
10	7.69	11	11	3.31	43	13	22	9	12
		12	12	4.31	56	23	>30	14	23
11	8.46	12	12	3.54	42	12	~19	8	10

Conditions (1) Throughput: 25 million tons/year

(2) Distance: 1000 mile pipeline, 1300 mile unit train

(3) Variable Cost Component: 25 percent for pipeline, 80 percent for rail

*Excludes present value of early higher pipeline cost.

**Includes present value, discounted at 10 percent pa.

*** Year in which present values of cumulative rail cost exceeds cumulative pipeline cost.

Ten percent is the interest rate assumed for this latter adjustment. The effect is to defer the crossover event significantly.

In an attempt to define more generally the conditions of competition, some of the values from Table 4.2.3-1 have been plotted in Fig. 4.2.3-2. The ordinate is the crossover year when the cumulative costs, discounted to present value, become equal. The abscissa is the initial pipeline tariff in \$/ton. From the lower plot, for the case of 5% escalation, it is seen that the railroad must enjoy an initial cost advantage of more than \$2/ton to be competitive with pipeline tariffs to below \$10/ton. Because of the additional 30% distance by rail, however, the equivalent difference in terms of mills/ton-mile is of the order of four. For example, at a pipeline tariff of \$10/ton, which is 10 mills/ton-mile for the 1000 miles of pipe, the rail tariff which reflects a \$2 initial advantage, i.e., \$8/ton, represents only 6.15 mills/ton-mile over the 1300-mile railroad haul, a difference of 3.85 mills/ton-mile. This is the upper left-hand point in the lower plot of Fig. 4.2.3-2, and is seen to correspond to a crossover in the 27th year.

Now, in the light of the earlier discussion of the pricing policies of both the railroad and the pipeline, it is clear that 5% is much too low for the inflatable portions of both, at least for the duration of those policies. Accordingly, it would be very interesting to repeat the analysis for rates in the range of 10-15%. However, this would require reruns of the Hudson Computer Code, followed by repeat of the analysis presented here, for which funds were not available. However, from inspection of the last four columns of Table 4.2.3-1, and from Fig. 4.2.3-2, it is apparent that the higher the rate, the sooner the pipeline overtakes the railroad. The rails' hope lies in maintaining a low inflation, which is contrary to their own policy, under which unit train tariffs must be tied to the AAR inflation index.

Fig. 4.2.3-2 - Dependency of crossover year on pipeline tariff

It is now of interest to examine some actual unit train rates. Regarding these, Campbell and Katell [1975] have the following to say (the information in their Table 4 is contained in Table 4.2.3-2 which follows).

"Freight charges for unit train service are quite different from the traditional coal rate structures 'made on an origin group and destination basis' (34). Rates for unit trains are individually negotiated and have no fixed relationship to those applicable to other origin or destination points. When the rates were first negotiated, some relationship seems to have existed between single-car and multiple-car shipments. One example of this is the reference in 1959 to Lake Cargo rates from Illinois, Indiana, and western Kentucky fields that range 'from 80.1 to 87.8 percent of the corresponding single-car rate' (38). But, as a general rule, no such relationship exists among the current unit train rates. In fact, unit train rates are now in effect for coal moving from the Western mines to markets in the Midwest over routes where no effective single-car rates had formerly existed. For such routes, the unit train rates were the first coal rates actually published.

"This new variety of rates typically specifies a minimum trainload and annual minimum tonnage, along with the rate per ton from the point of origin to a designated destination. Table 4 has representative rates from Western mines to plants farther west and in the Midwest. The territory through which the traffic flows and the length of distances covered influence the levels of the rates charged. Large-volume shipments in terms of trainloads and annual tonnages that move over relatively level or otherwise favorable territory are likely to have the lowest rate per ton-mile. This is consistent with rates noted in Table 4, such as from Colstrip to Cohasset and from York Canyon to Kaiser." (These cases are numbered 1 and 3, respectively, in Table 4.2.3-2.

"One major constraint is that the rates must not require a designated portion of a shipper's freight to be a part of the negotiated agreement. This was confirmed in a case that involved the shipment of carpeting from Amsterdam, New York, with the lower rates conditioned upon agreement 'by the shipper during the year of at least 80 percent of its traffic from and to those points.' The Commission ruled that 'the proposed rate was unjust

TABLE 4.2.3-2

Analysis of Unit Train - Pipeline Competition

Case	1 Orig./ Dest.	2 Effective Date	3 Minimum Megatons Per Year	4 Rail Tariff \$/Ton	5 Rail Distance Miles	6 7 Unit Tariff Mills/Ton-Mile		8 9 Pipeline-Competitive Condition	
						When Contracted	Escalated to 1975	Throughput Megatons Per Year	Throughput Ratio (PCTR)
1	Wyo./ Ca.	6/73	1.67	3.10	600	5.17	5.48	25	15
2	Mont./ Minn.	8/73	4.25	3.42*	773	4.42	4.69	> 50	> 12
3	N.M./ Ca.	1/74	1.90	6.80*	1069	6.36	6.75	18	20
4	Wyo./ Minn.	8/73	0.20	6.09	1105	5.51	5.85	25	125
5	Mont./ Ill.	7/73	3.30	8.62	1168	7.38	7.03	11	3
6	Mont./ Ill.	1/73	1.35	8.53*	1265*	6.74	7.15	12	9
7	Wyo./ Tex.	8/75	Unknown	6.16	943	6.53	6.93	15	Unknown
8	Wyo/ Tex	10/76	3.00	10.93**	1644	6.48	6.27	10	3.3

*Tonnage-weighted average of several figures.

**Mandated by ICC (see Section 5.3.1)

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

and unreasonable in that it constituted a destructive competitive practice' (29, 35). In 1964 a decision involving unit train coal rates noted that the particular rates in question did not create contract rates such as the Commission has condemned in the disallowed rates on carpeting (36).

"The Commission made a pointed distinction between minimum annual volumes, even when these constitute a significant portion of the output, and minimum percentages of the total amount to be shipped. The minimum percentage was ruled to be a 'destructive competitive practice' that might 'substantially lessen competition or tend to create a monopoly.' The minimum loads and minimum tonnages do not restrict other shipments, provided total output from the mine is above the minima or could be increased above them."

Table 4.2.3-2 presents actual cases reported by Campbell and Katell, plus an additional case (7) reported by Armbruster and Candela [1976], and the San Antonio case (ICC 76, San Antonio 76), case 8. In cases 2 and 3, several tariffs have been negotiated for the same haul and averaged, weighting by tonnage. In case 6, two destinations were involved in the same contract. The tariffs in column 4 represent the tonnage-weighted figures in these cases. In columns 4, 6 and 7, the unit tariffs are quoted and then adjusted for escalation.

The escalation adjustment in column 7 was made by simply using the 3% annual rate that is the lower of the rates considered in Table 4.2.3-1 and Fig. 4.2.3-2. As noted earlier, this may well be too low an inflation factor. Case 7 of the table represents an actual tariff which became effective in 1975, and which suggests that no inflation occurred between 1973 and 1975. In any case, the inflation figure used is one that the pipeline opponents Armbruster and Candela seem to consider appropriate.

It is naturally of interest to see how the adjusted actual tariffs in column 7 compare with those which the pipeline proponents project. For that purpose, column 8 displays the throughput at which the pipeliners claim cost competitiveness. The derivation of these values can be understood from an examination of Fig. 4.2.3-3. This figure was prepared from two sources. The curves of tariffs for pipeline and rail are those of the pipeline proponent Wasp [1975]. The points are the actual (adjusted) rail tariffs from Table 4.3.2-2, column 7.

Noting first the Wasp curves of pipeline cost in the upper righthand portion of the figure, it can now be seen how the pipeline-competitive throughput figures in column 8 of Table 4.2.3-2 were developed, i.e., by interpolating between the pipeline curves on Fig. 4.2.3-2 for the appropriate distances. Taking case 5 as an example, one enters Fig. 4.2.3-3 at an initial tariff of 7.83 mills/ton-mile, then moves horizontally to an interpolated point corresponding to 898 miles (1168 rail miles divided by the circuitry handicap factor of 1.3 gives 898 pipe miles) between the pipeline curves for 1000 miles and the curve for 500 miles. The corresponding throughput is approximately 11 megatons/year, which is 3.3 times the actual case 5 throughput. This latter is defined as the pipeline-competitive throughput ratio (PCTR) and is presented in the last column of Table 4.2.3-2.

Turning now to the points on Fig. 4.2.3-2, the first conclusion that immediately emerges is that estimates of railroad costs prepared by pipeliners are susceptible to significant error. However, a possible vindication of these estimates will be seen in Section 4.2.4.2, when the true, longrun costs of unit train operations are discussed. In any case, it is not necessarily surprising to find inaccuracies in the pipeliners estimate of railroad costs and should not induce the inference that associated estimates of pipeline costs are likely to suffer the same degree of inaccuracy.

Fig. 4.2.3-3 - Tariff-throughput dependence

The perhaps less immediately striking but more significant conclusion emerging from Fig. 4.2.3-2 is that all of the unit train operations examined are safe from pipeline competition until their throughput requirements increase at least severalfold. Taking the best rail case, 4.25 megatons over 773 miles (case 2, Table 4.2.3-2), the pipeline-competitive point is so far out of the figure in the right-hand direction that one can only surmise what the pipeline throughput would have to be, but it is certainly greater than 50 megatons/year (Table 4.2.3-2, column 8, line 2). Even for the worst rail case, i.e., highest rail tariff, the competitive throughput is 12 megatons/year and the PCTR is 9 (Table 4.2.3-2, columns 8 and 9). However, when the true longrun costs of unit train operations are known, some of these conclusions will change.

The significance of the PCTR is now clear. It is the factor by which throughput must increase before the pipeliner, by his own estimates, can compete with the unit train. With that definition of the PCTR in mind, two important conclusions that emerge from columns 11 and 12 can be formulated:

1 - Unit train operations of the type exemplified in Table 4.2.3-2 are not in danger of extinction as a result of pipeline competition. And it follows that, since these operations are believed to be generally representative, the pipelines do not threaten the existence of unit trains. Moreover, since pipelines do not threaten the existence of unit trains, they do not threaten the existence of the railroads, despite statements to that effect by railroad spokesmen. Such statements appear to merit nothing more than dismissal as a ploy.

2 - The limited applicability of conclusions based on averages has been emphasized earlier, and although pipelines cannot be said to pose any threat to the existence of the rail industry, they nevertheless constitute a very real threat to some highly lucrative portions of the rail market. The

prospective capture of this high-volume, higher density traffic by the pipelines is characterized by the railroads as "skimming the cream." Whether there is in fact any cream is open to question, because as has been seen from Fig. 4.2.3-3 above, the rail tariffs are virtually independent of distance and throughput. On the other side of the question, the argument advanced by pipeline proponents that there will be "enough business for everybody" appears vacuous. There may not be any cream involved, but 25 billion ton-miles of freight per year is certainly a ripe plum in anyone's vernacular, and the reaction of the railroad to its prospective capture by a competitor is certainly understandable.

4.2.4 Cost comparison - pipeline vs. railroad

Both parties to the controversy have challenged the true cost to the nation as a whole of the other transport mode, recognizing the distinction between tariff (short-run selling price) and long-run cost. Pipeline opponents point to the cost growth of the Alaska pipeline by approximately a factor of 10 as a warning of what might happen with slurry lines. On the other hand, the proponents point to the record of the railroads which culminated in large costs being assumed by the taxpayers, and further to the tax burden of Amtrak, which is a direct result of the deliberate decision by the railroads to drive away their passengers and leave the United States as the only advanced nation in the world without adequate rail-passenger service. They also allude to uncertainties in the true costs of operating unit trains at conditions which far exceed, in terms of severity, their previous experience.

4.2.4.1 Costs of slurry pipelines

The discussion to follow will examine the following four areas of vulnerability in the financial soundness of slurry pipelines:

- 1 - capital costs,
- 2 - financing costs,
- 3 - operating costs, and
- 4 - throughput projection.

The first two are of course known exactly when construction is completed and the securities are sold. As was seen in the preceding section, however, no firm price for these two elements is provided at the time that the buyer agrees to buy the pipeline services. The operating costs have been seen to be small in relation to the capital charges. This leaves the prospective buyer of pipeline services with two major problems:

- 1 - to estimate the cost of construction, over which he has no control, and
- 2 - to assure the throughput, both as to source and consumption, over 30 years.

Earlier, in Section 4.2.3, the capital intensiveness of pipelines in general, and of slurry lines in particular, was discussed. This intensiveness is the reason that the tariff projections in Figure 4.2.3-3 display such strong sensitivity to throughput. Thus, the capital cost of the slurry pipeline is the principal determinant of long-run total cost.

The capital costs which were used by Wasp in deriving the 1975 estimates in Figure 4.2.3-3 were based on design studies of the 1040-mile ETSI-proposed pipeline. The 1975 estimate for the ETSI line was \$750 million, and the 1977 estimate, as reported in the Wall Street Journal, is \$955 million.

These estimates were prepared by the Bechtel engineering organization and the strength of that organization underlies the ETSI cost estimate. Bechtel has designed and constructed slurry pipelines, for coal and other commodities, in several United States and foreign locations. It is difficult to see

how more credibility could be accorded any other organization on the basis of experience and general competence.

The question of bias is of course another matter. Bechtel, working through its 40% interest in ETSI, is promoting the pipeline, which if it materializes, means a billion-dollar project for Bechtel, so that Bechtel undeniably has a vested interest, with its inevitably consequent bias.

It is now interesting to compare the Bechtel estimate with some others. Table 4.2.4-1, which reproduces Table 8 from Armbruster and Candela, lists 35 cost estimates for coal-slurry pipeline annual costs. Items 12 through 22, representing lines in the 900 - 1040 mile range, are plotted in Fig. 4.2.4-1. It is seen that the other curve and the 11 single-point estimates are all higher than the ETSI estimate. The obvious question is why Bechtel believes that it can build the pipeline so much cheaper than anyone else. It may further be noted that some of the estimates, numbered 17 - 22, are of academic origin, whereas the others were developed by engineering organizations whose estimating competence must be accepted. Interestingly, the estimates by engineering firms are, with one exception in the five, much higher than the ETSI-Bechtel estimate, while the academic estimates are all quite close to the Bechtel estimate.

Two reasonable but opposite interpretations may be placed on this circumstance. The cynic will suggest that Bechtel has allowed its natural bias, as promoter of the project, to influence its estimates, and that view must certainly be accorded due consideration. It is expressed by Rieber and Soo (1976) as follows:

"The logical question is why the promoters are interested in its construction. One answer, of course, is that they sincerely believe that the pipeline will prove to be the low cost operation. Another answer is provided by Eastern U.S. railroad history in the first third of the 1800's. It will be recalled that railroads then were

Table 4.2.4.1-1

SUMMARY - COAL PIPELINE ANNUAL COSTS

ITEM ON FIGURES	COAL THROUGHPUT TONS PER YEAR (MILLIONS)	DISTANCE MILES	TOTAL ANNUAL COST (MILLIONS)	TOTAL ANNUAL COSTS CENTS/TON MILE	REFERENCES & REMARKS
1	25.0	300	70.7	0.95	C.A.C.* - 50% debt--50% equity
2	9.1	453	60.3	1.50	Bureau of Mines - all equity
3	18.2	453	115.8	1.44	" " " " " "
4	4.5	500	38.9	1.73	Ebasco Svcs. - initial costs--80% debt; 20% equity
5	9.0	500	77.7	1.73	" " " " " " " "
6	18.0	500	169.0	1.86	" " " " " " " "
7	25.0	500	238.0	1.90	" " " " " " " "
8	9.1	574	69.2	1.36	Bureau of Mines - all equity
9	18.2	574	137.9	1.35	" " " " " "
10	25.0	700	133.4	0.76	C.A.C.* - 50% debt; 50% equity
11	10.0	775	-	1.10	Gulf Interstate - Northwest (orig. concept) 60% water recycle
12	4.5	900	82.5	2.04	Ebasco Svcs. - initial costs--80% debt; 20% equity
13	9.0	900	112.7	1.39	" " " " " " " "
14	18.0	900	249.9	1.54	" " " " " " " "
15	25.0	900	331.6	1.47	" " " " " " " "
16	15.0	951	-	1.22	Gulf Interstate-Houston Natural Gas
17	25.0	1,000	-	0.60	Proj. Indep., 1974-\$6.15/ton cost-1000 ml. system
18	25.0	1,000	147.0	0.59	Bureau of Mines - 75% debt; 25% equity
19	25.0	1,000	202.7	0.81	" " " " - all equity
20	9.1	1,020	90.2	1.01	" " " " " "
21	18.2	1,020	167.7	0.94	" " " " " "
22	25.0	1,040	180.6	0.69	C.A.C.* - 50% debt; 50% equity
23	25.0	1,200	-	0.76	" - costs not recorded
24	2.0	1,200	48.1	2.14	C.T.C.** - 12% cost of money; 75% debt; 25% equity;
25	4.0	1,200	71.8	1.59	25 year depreciation, costs escalated 30%
26	6.0	1,200	88.7	1.30	" " " " " " " "
27	8.0	1,200	94.6	1.03	" " " " " " " "
28	10.0	1,200	114.0	1.00	" " " " " " " "
29	15.0	1,200	147.0	0.86	" " " " " " " "
30	25.0	1,250	-	1.00	Brown and Root, Inc.
31	40.0	1,250	-	0.90	" " " " " "
32	4.5	1,500	115.0	1.70	Ebasco Svcs. - initial costs--80% debt; 20% equity
33	9.0	1,500	166.6	1.23	" " " " " " " "
34	18.0	1,500	387.1	1.43	" " " " " " " "
35	25.0	1,500	419.0	1.22	" " " " " " " "

*Center for Advanced Computation

Source: Armbruster and Candela (1976),
Table 8

THROUGHPUT - MILLION TONS PER YEAR

Source: Armbruster and Candela (1976)

Figure 4.2.4.1-1 Estimated costs for a 1000-mile (approximately) slurry pipeline.

built by construction companies backed by promoters who sold railroad bonds and stocks (often with the full faith and credit of the states involved) to individuals and investment houses here and abroad as well as to the cities and towns through which the railroad was to pass. The construction companies were paid as the work progressed, the promoters earned commissions on the securities sold. By and large these early roads went bankrupt as did those who operated on them. Nine states defaulted on their full faith and credit obligations after a vain appeal to the federal government which invoked a form of state's rights. An engineering-construction company is not an obvious candidate to sink a very large sum of money into a project with a payout period of 30 years and a rate return governed by a regulatory agency. They can do better than that. A well known investment house is an even more unlikely candidate. A probable scenario if the line is built is the almost immediate divestiture of the Bechtel-Lehman Brothers interest in ETSI by the issuance of public shares. Both then will have capitalized their investment. And, history may repeat itself.

"The pipeline is relatively capital intensive, the railroads are relatively labor intensive. The latter may change with different work rules and with unit train operation, the former cannot. The result is that the former may be a victim of its fixed charges, throughput, and debt structure and the latter to inflation."

If opposition to the pipeline is to be based on the possibility of this scenario, it would seem equivalent to the argument that the pipeline should not be allowed to compete with the railroad because the pipeliners may prove to be of the same dastardly ilk that the railroaders have already proved themselves to be. Rather than undertaking an escape from the circularity of that argument, it seems prudent to avoid it entirely and examine the denouement visualized by the last sentence quoted above. Repeating the quotation, "The result is that the former [i.e., pipeline] may be a victim of its fixed charges, throughput and debt structure...." The fixed charges and debt structure

will be known at the completion of construction. They may at that point prove a bitter disappointment to the user who has contracted to pay them through the tariff. Nevertheless, these charges are known at that time, and will be borne by the coal consumer. Since the throughput is firmly contracted, the project could encounter unexpected difficulties from that point only in rising nonfixed costs, which were seen earlier to lie in the neighborhood of 15-20% of total costs. While certainly unfortunate, this would not constitute a debacle. It is extremely difficult to see how "history may repeat itself," leaving the pipelines in bankruptcy. Nor is it easy to see how any states are likely to default on their full faith and credit obligations since the concept has not even been proposed.

At the same time, if the throughput cannot be contracted in advance, then a single-purpose pipeline of this magnitude, which cannot be used for anything else, is extremely suspect. Clearly, the nature of the 30-year contract for the coal deserves careful scrutiny.

Of the two interpretations of the circumstance described previously, i.e., that the Bechtel estimate is below the range of other engineering estimates, and instead falls in line with the academics, the interpretation first examined was the one which infers that the Bechtel estimate is low because of the Bechtel proponency. It is also important to recognize that the opposite interpretation may be equally consistent with the observed facts. That is, the Bechtel proponency may be because the Bechtel organization, being the most experienced in the world with this type of system, perceives what less experienced firms do not perceive, i.e., that it can construct and operated the line at a cost which is profitable. This is simply the process that is repeated over and over in the American economy: the entrepreneur perceives an opportunity to produce something cheaper and/or better than the competition, and he sets about promoting it.

Since both of these opposite interpretations are consistent with the observed facts, further discussion is useless for this study.

Another basis for professed skepticism, somewhat related to the first, is the hypothetical parallel with the Alaska pipeline, whose cost escalated by what has been alleged to approach a factor of 10 between conception and realization. This study has not been able to identify an apparent basis for such a parallel. The extremely difficult conditions in Alaska are totally unrelated to construction of pipelines in the Lower 48 states. The only experience that appears relevant to the ETSI and other proposed slurry lines was accumulated in building pipelines across the same territory, Wyoming to Arkansas, which is generally easy terrain for pipeline construction. And that is precisely the kind of experience on which Bechtel, and any other competent engineering company, bases its estimates.

Still another point in question is the fact that a slurry pipeline of this magnitude has never been built. It is understandable that the layman sees this as a question of potentially serious import. Under scrutiny, however, the seriousness is not apparent. The proposed ETSI line is to be 38 inches in diameter and 1000 miles long. Many pipelines of 38-inch and larger diameter have been built. There is nothing about the construction of the proposed line, except for the pumps, that has not been done, on the same or larger scale, many times and for thousands of miles. The only components of the system that depart from earlier experience in any significant way are the pumps.

It would be possible, even practical, to build the ETSI line using the identical pumps that proved themselves in seven years of service at Black Mesa. If that were done, it could be asserted that the system would contain no new technology, and accordingly, the objection that new technology inevitably entails risk would be nullified. In fact, the ETSI engineers, for reasons

of economy, plan to use larger and more advanced pumps, which constitutes the introduction of new technology. However, this fact does not imply any significant financial risk. Even if the newer style pumps failed completely and had to be replaced by the older pumps, the replacement cost would be small in relation to the total cost of the system. This is not to imply that the ETSI management, operating people, or engineers, would be indifferent to the necessity to revert to the older pumps. It would certainly be an onerous burden, a delay, and an expense. However, it would not threaten the financial soundness of the system.

It is concluded that while it is certainly reasonable to question the ETSI cost estimate, the uncertainty in that estimate provides no basis to say that the line should not be built. The possibility that the line would evolve into a financial debacle and become a burden on the taxpayers appears to be remote, provided that the requisite 30-year throughput can be assured at the outset.

As was noted in the beginning, the foregoing discussion has been confined to the ETSI system, because it is the most advanced of the proposed systems and is being vigorously promoted. If it can be brought to successful fruition, it appears highly likely that at least one or two other large systems will follow. At the same time, however, it seems equally clear that even under the most favorable circumstances, there will not be more than a very few such systems unless some completely unexpected changes in the national rail system and in the national patterns of energy consumption should occur in the years ahead.

4.2.4.2 Costs of rail transport

Because of the complexity of rail operations, there is no highly precise methodology for separating and calculating the cost of moving one particular commodity out of many. This is in contrast to the single-purpose pipeline,

where the costs associated with transporting that commodity can be computed with high accuracy. Another contrast is found in the capital intensity of the two types of systems, as has already been discussed. It was noted there that the pipeline costs are known rather precisely at the time that the line goes into operation, whereas the projection of rail costs into the future involves many uncertainties. These uncertainties influence not only the susceptibility to inflation that was discussed earlier, but also the basic cost of the service itself.

Some pipeline proponents have advanced the argument that whether by intentional design or by virtue of these uncertainties, there is evidence to suggest that the unit train tariffs are underpriced. The result, if true, would be that shippers of other commodities are subsidizing coal movement.

Consider now the two mutually exclusive circumstances under which this situation might obtain, i.e., if the railroads are underpricing coal traffic, they are doing it either intentionally or unintentionally. If intentionally, hence illegally, then presumably it is to forestall the pipelines. In that case, the pipelines have already forced a decline in coal tariffs, although to the detriment of shippers of other commodities. Interesting as the consequences of that circumstance may be, they are beyond the scope of this study.

The other possibility is that if the railroads are underpricing coal traffic, they are doing so unintentionally as a result of the uncertainties in the true cost of unit train operations. An in-depth exploration of that possibility is beyond the scope of this study; hence only a first order analysis of a single aspect of this very complex question will be attempted here.

In the estimates of unit train costs developed by Rieber and Soo, et al. [1975, 1976], a cost element of \$200,000 per year is provided for rail. (item 5 in Table 4.2.4.2.1). This element is assumed to be the replacement rail for the route described

Table 4.2.4.2-1

Estimated Costs of Supplies for the
Farmington-Los Angeles Unit Train

<u>Detail - Supplies</u>	<u>Million Dollars</u>
Locomotive repair (98)	2.15
Car repair (1890)	1.80
Road and Shops and Machinery:	
1. Road and Buildings:	
Ties	0.62
Bridges, trestles	0.36
Building, Shops	0.20
Fence and Signals	<u>0.05</u>
	1.23
2. Stationary	0.02
3. Chemicals and Track	0.41
4. Stone, glass, ballast	0.20
5. Metal Products:	
Rail	0.20
Tools	<u>0.01</u>
	0.84
6. Miscellaneous Supplies	0.20
7. Shop Machinery	0.15
8. Electrical Equipment	0.26
9. Roadway Machines	0.16
10. Signal and Interlock	0.30
11. Miscellaneous Repairs	0.04
12. Power, Light, Water	<u>0.05</u>
	1.16
Total R&S&M	<u>3.23</u>
Total Supplies	7.18

Source: Rieber and Soo (1976), Table 2.4.

in Table 4.2.4.2-2. At a cost of \$290/ton [Engineering News Record, August 11, 1977], this would allow for 690 tons/year of replacement rail. Disregarding the 100 miles of gathering line, the amount of in-place, 155-lb rail in the 850 miles of main line is

$$\frac{850 \text{ mi} \times 1760 \frac{\text{yd}}{\text{mi}} \times 2 \times 155 \frac{\text{lb}}{\text{yd}}}{2000 \frac{\text{lb}}{\text{ton}}} = 232,000 \text{ tons},$$

so that the rail would be replaced on the average of

$$\frac{232,000}{690} = 336 \text{ years}.$$

If 132-lb rail is used, the amount required is 197,400 tons and the replacement time is 286 years. Obviously, either the allowance is grossly inadequate, or there is a fundamental error in this analysis.

Fig. 4.2.4.2-1 shows the general shape of the life-load dependence function [Steffes 76] as at least one investigator hypothesizes it. Steffes is quoting Alhf of the Illinois Gulf Central, and does not offer an explanation of the self-healing mechanism which operates in the 100-125 ton range to apparently hold the life expectancy curve almost level over that range. Such a mechanism is difficult to hypothesize.

The mechanics of rail failure are summarized by Reiner [1970]. For wheels of large diameter on rails heavy enough, the flexural fatigue does not determine rail life; for curves gentle enough, abrasive wear does not govern. This leaves surface fatigue, which Reiner shows to be inversely proportional to the square of load, for which there is no self-healing. The resources available for this study did not permit the research necessary to resolve this contradiction between Reiner and Steffes. Apparently, research has not been sufficient to enable good projections of rail life under the loading of 100-ton cars.

Table 4.2.4.2-2

Route and Capacity Specification,
Farmington-Los Angeles Unit Train

Route: Farmington, NM to Los Angeles, CA
(850 miles plus 100 miles gathering)

Facility Name: Coal Unit Train and Rail Line

Prime Input: 25 million tons medium rank bituminous/year

Other Input: Electricity, diesel oil

Prime Output: 25 million tons medium rank bituminous/year

Other Output: Shipment - 30 mph loaded, 60 mph empty (30-60)

Days/Year of Normal Operation: 274

Description and Size:

- 10,500 ton unit trains. (18 trains)
- Each train made up of 105 hopper cars each with a capacity of 100 tons.
- Coal storage area, feeders, conveyors, and loadout bin and chute with loading capacity of 3,200 tons/hour.
- Round trip distance: 850 miles (100 mile gathering)
- Normal round trip cycle time: 48.5 hours.
- 5 3,000 hp diesel locomotives per train.

Source: Rieber and Soo (1976), Table 2.2.

Source: Steffes (1976)

Fig. 4.2.4.2-1 - Life-load dependency of rails

Qualitatively, the experience of a railroad chief engineer [Rougas 75] is enlightening; repeating from Section 2.2.2.1.2:

"So far I have given examples of a mixture of traffic and its effects. On another property which was laid with 132-pound rail, and over which nothing but unit trains of 100-ton cars traveled loaded in one direction and empty in the other, and whose cars have 36-inch wheels, their rail on the mainline has accumulated as of last October, 200 million gross tons of traffic. And it is my estimate that the rail will not reach much more than about 275 million gross tons of traffic."

Now, if this experience is at all typical, and if the tare-to-payload ratio of the cars in the Rieber-Soo example is 0.9 and if 132-lb rail was used, then the life of the rail in the example would be not much more than

$$\frac{275 \times 10^6 \text{ gross tons}}{25 \times 10^6 \frac{\text{net tons}}{\text{yr}} \times 1.9 \frac{\text{gross tons}}{\text{net tons}}} = 5.8 \text{ years.}$$

And if the cost of rail was \$290/ton, the cost of replacement would be

$$\frac{197,400 \text{ tons}}{5.8} \times 290 = \$9.85 \text{ million/year.}$$

The difference in ton-mile cost due to the difference between this figure and the \$200,000 in Table 4.2.4.2-1 is

$$\frac{(9.85 - 0.2) \times 10^6 \$}{25 \times 10^6 \text{ tons} \times 850 \text{ miles}} \times 1000 \text{ mills/\$} = 0.45 \text{ mills/ton-mile.}$$

When this adjustment is made in the typical results of Rieber and Soo (Fig. 4.2.4.2-2), it is seen that the pipeline is competitive with the rail, even at the best rail condition, i.e., zero bottleneck. If the foregoing concatenation of hypotheses

Source: Rieber and Soo (1976), Figure 5.1(a).

Figure 4.2.4.2-2. Comparative costs, unit train and slurry pipeline, Farmington, NM, to Los Angeles.

is reasonable and typical, this result would appear to require a reversal of the Reiber-Soo conclusion:

"... a slurry pipeline is definitely superior where a railroad is not available. However, even if 15 percent new road is to be built and operation includes a 10 percent bottleneck at a 10 mph speed limit and a mileage saving less than 30 percent, the unit train is still likely to be the cost effective choice."

It would appear that rail movement would almost never be more cost-effective than pipeline.

The cost of rail is of course only one of a number of elements in the cost of railroad maintenance. Continuing the repetition of Rougas' quotation from Sect.2.2.2.1.2:

"Briefly, if you're going into unit train operations over a separate track, some of the recommendations I would have are: one, be sure and corner your curves; the unit trains are extremely hard on track on curves. These trains exert lateral forces which the track is not particularly designed to withstand.

"Two, if you can, use a heavy rail section continuously welded.

"Three, use large size tie-plates. With the introduction of high capacity cars, the reason for condemning track is primarily mechanical abrasion. Use of 18-inch long tie-plates on curves is really recommended.

"Four, insure good tie condition. This idea of ties lasting 35 to 40 years, in my opinion in this day and age, is a dream.

"Five, use a good type of ballast if you have practical access to it.

"Six, intensify inspection of track maintenance. You will find after a couple of years, most of your bridges are going to give you a problem at the bearing points.

"Seven, gear for bridge replacement and repair of bridge supporting masonry as railroad bridges generally will not take these kinds of loads.

"When you do go home today, there are two things I would like you to remember. One is that the introduction of 100-ton car unit trains is an entirely new ballgame for railroad right-of-way, maintenance, and unless people realize the newness and have time to prepare for such unit trains, their chances of winning the game may be slim."

From consideration of these and other factors, Steffes [1976] concluded that the optimum speed for a typical 1200-mile unit train operation would be "... in the 15 to 25 mile range. High speeds of 40 to 50 mph will prove uneconomical." He sees the cost-speed dependency generally as shown in Figure 4.2.4.2-3. He also observes

"Finally, we are not convinced that the 100-ton coal cars are the most economical. It is our opinion that the railroads may be understating their cost of maintenance of ways and structures with the use of these heavier cars."

Further study of railroad maintenance would be beyond the scope of this study. However, from this brief examination of rail life expectancy, it seems extremely likely that the true costs of replacement rails for unit trains is presently unrecognized and hence, understated. Moreover, it appears that the same conclusion applies to ties and ballast.

It is further necessary to recognize the point made by Rougas, and also discussed by Steiner, that rail life is sensitive to curvature. Therefore, a high level of unit train activity may require that curvatures be extended. In some cases, this may require construction of completely new roadbeds. In any case, it is much more than a straightforward process of upgrading roadbed.

In summary, then, several significant conclusions have emerged.

Source: Steffes (1976)

Figure 4.2.4.2-3. General cost-speed dependency for unit trains.

First, the true longrun cost of operating unit trains, of the sizes, speeds, tonnages, and frequencies necessary to displace a large pipeline is unknown at this time, even to the railroads themselves.

Second, it appears highly likely that the true, longrun cost of such trains is presently understated.

Third, although the need for right-of-way upgrading and bottleneck elimination is generally recognized, much more than straightforward upgrading is likely to be required in many cases, e.g., curve and/or grade correction. The railroad advertisement which proclaims that they can move all the coal with "yesterday's dollars" appears to be a gross overstatement.

Finally, although the true cost of rail transport may ultimately prove to be slightly lower than pipeline transport, the a priori uncertainty in the cost, as of 1977, is greater in the case of the railroad than in the case of the pipeline.

5.0 THE CONTROVERSY

Understandably, railroads which haul, or aspire to haul, significant amounts of coal are almost without exception strongly opposed to the threat of pipeline competition. Therefore, they do not usually grant permission for slurry pipelines to cross their property. And almost everywhere that a slurry pipeliner wants to lay his line, he encounters a railroad across his path. To overcome these obstacles, the pipeline interests have sought legislation granting the federal power of eminent domain to the pipelines. At the adjournment of the 94th Congress, all such efforts have failed although the defeating vote margins have become smaller with time. The battle is is being fought again in the 95th Congress, and if necessary in the 96th and later Congresses, and the pipeline proponents are confident of ultimate success.

Thus, at first sight, the fundamental issue in this controversy appears to be whether it is in the national interest to endow the slurry pipelines with the federal power of eminent domain (ED). However, in the course of the following discussion, it will become necessary to state the issue the other way. The conclusion will emerge that the slurry pipelines meet the appropriate criteria for exercising the ED power, and therefore they should be granted the power unless it can be shown that such endowment would be contrary to the national interest.

Campbell (1976) presents an excellent discussion of the origin and meaning of eminent domain. He quotes the generally accepted definition, "The right or power to take private property for public use; the right of the sovereign, or those to whom power has been delegated, to condemn private property for public use, and to appropriate the ownership and possession thereof for such use upon paying the owner a due compensation." He further notes that the Fifth Amendment to the Constitution

provides, "nor shall private property be taken for public use, without just compensation," and that the Fourteenth Amendment provides that "No state shall deprive any person of life, liberty, or property, without the process of law."

Thus, the basic requirements for the exercise of eminent domain are:

- 1) That the condemned property be taken only for public use;
- 2) That the action be carried out in accordance with due process of law;
- 3) That just compensation be given.

The question of whether a private business enterprise can legally exercise the power of eminent domain was settled affirmatively by the Supreme Court in 1897.

The use of eminent domain is not limited to transportation systems or to common carriers. However, for a transportation system to qualify as public use, it is generally conceded that it must operate as a common carrier, serving without favor all who tender according to the terms of its published tariffs.

Now, there is a question whether a pipeline, which serves only one or a few users of large quantities of a single commodity, moved between one or a few origins to one or a few destinations, is in fact a common carrier, and hence whether condemnation of property for such a purpose can truly be said to be "for public use." The railroads have naturally attempted to emphasize this point.

However, there is a equally valid question as to the true common carrier status of those unit trains which are owned by the electric utility which consumes the coal. Here, the same general conditions apply by virtue of which the railroads challenge the common carrier status of the pipeline. That is,

the unit train serves only one or a few users of huge quantities of a single commodity, between one or a few origins and one or a few destinations. There are only two significant differences.

First, in the case of unit trains, other commodities are moved by the railroad over the same RoW in railroad-owned rolling stock in the true common carrier mode. With slurry pipelines, as with all other pipelines which have operated for years in what has at least been legally blessed as common carrier status, this additional traffic cannot be accomodated.

Second, in the case of the pipeline, the user has not yet been asked to provide any of the capital investment or equipment. This is not to say, of course, that in the future electric utilities might not be approached by pipeline promoters who propose to provide RoW and to install and operate pipe and pumps which the utilities must pay for.

It is a conclusion of this study that the question of true common carrier status is legalistic and not substantial. Unit trains comply with the law as it exists, and the pipeline promoters propose to do the same.

Before leaving this subject, it is necessary to recognize the point that is made by the railroads, that they are much more heavily regulated than the pipelines. If true, as it may well be, then it would seem that the law should be changed. However, that subject is beyond the scope of this present study.

Returning to the discussion of eminent domain, the power may be exercised at the federal, state, or lower levels of government. In this study, only the federal power is treated, though it is noted that similar battles are fought in state legislatures. The power may also be exercised directly by a government agency, or by a private business to whom the power has been granted.

Earlier, in the summary section (2.1) of this report, an exchange was quoted from congressional hearings in which Congressman Steiger corrected a railroad executive who said that federal eminent domain had not previously been authorized for private interests. The historic uses of the federal ED power which were identified by Congressman Steiger have only been upon the grounds that such action is in the national interest, i.e., will on balance inure to the national good. In the cases of pipelines companies, the obvious inference is that previous Congresses, in granting the power, considered that status as a common carrier or regulated utility was a sufficient condition to serving a public use and, therefore, presumably being at least consistent with the interest. As was discussed above, it appears that slurry pipelines can in fact qualify as common carriers, and therefore meet the criterion of public use. It is concluded here that the ED power should be granted to the slurry pipelines, unless it can be shown that such action would be contrary to the national interest. The remainder of this chapter will be devoted to a search for issues upon which such a showing might be made.

5.1 COAL MOVEMENT CAPABILITY OF THE RAILROADS

Among the first questions to be asked is whether the railroads can in fact move all the coal, because if they cannot, slurry pipelines would obviously not be against the public interest. The next question concerns the size of the job to be done.

A number of projections have been published of coal demand. Rifos and White (1976) have tabulated some of these, including their own, which are listed in Table 5.1-1, where it is seen that the geometric mean of all those estimates is approximately 1.3×10^9 tons. United States coal production for 1975 is estimated (Stat. Abs. 76, p. 710) at 6.46×10^8 tons, so that the total coal traffic is expected to double over the 1975-1985 decade.

Now, upon examination of the necessary physical plant and equipment to accomodate this ten-year doubling of coal traffic, it has been concluded that it is certainly not impossible for the railroads to accomplish the entire movement. The railroads can, in the time available, acquire the capability to do the job. It is, therefore, impossible to make a case for granting ED power to the pipelines upon the basis that there is no other way to get the coal to the users.

However, the question is not this simple for several reasons. First, as will be seen, the job is a very, very difficult one, in terms of sheer physical magnitude, and the pipelines offer to relieve some of the resulting pressures at extremely critical points.

Second, the burden of financing the task is extremely heavy and falls almost entirely upon three or four railroads.

Third, these few railroads will be forced to shift some of the burden to the electric utility industry, by requiring that the utilities purchase the rolling stock. And

TABLE 5.1-1

ESTIMATES OF 1985 COAL DEMAND (MILLIONS OF TONS)

MANALYTICS, INC. (1)	1,514
High-Demand Scenario	1,514
Low-Demand Scenario	1,242
NATIONAL PETROLEUM COUNCIL (2)	
<u>U.S. Energy Outlook - An Initial Appraisal,</u> <u>1971-1985, NPC</u>	1,001
FEDERAL ENERGY ADMINISTRATION	
<u>Project Independence - Coal Task Force Report,</u> <u>November 1974</u>	
Business as Usual	1,100
Accelerated Demand	2,063
DEPARTMENT OF THE INTERIOR, (2) BUREAU OF MINES	
L. Westerstorm	2,000
DEPARTMENT OF THE INTERIOR (2)	
<u>U.S. Energy - A Summary Review</u>	1,000
<u>U.S. Energy - Through Year 2000</u>	980
ATOMIC ENERGY COMMISSION (2)	
<u>Understanding the Energy Dilemma</u>	1,075
BATTELLE MEMORIAL INSTITUTE (2)	1,708
NATIONAL ACADEMY OF ENGINEERING	
<u>U.S. Energy Prospects - An Engineering Viewpoint,</u> <u>NAE, Washington, D.C., May 1974</u>	1,260
Arithmetic Mean	1,358
Geometric Mean	1,309

(1) Rifas and White (1976)

(2) Quoted in Interstate Commerce Commission, Investigation of Railroad Freight Rate Structure - Coal, Ex Parte No. 270.

the utility industry generally has all the problems that it can reasonably handle in financing new power plants to burn the coal. The added burden of financing the rolling stock further compounds their difficulties.

Before further pursuing the question of financing of the new coal traffic, it is convenient to review the physical magnitude of the task. Stephen Ailes, president of the Association of American Railroads, addressed the question (Hearings, 75, p. 913) thus: "It is not, however, difficult to demonstrate the absurdity that railroads could not handle a projected doubling of coal production over the next 10 years.

"We know that the railroads carried 391 million tons of coal in 1974.

"We know that coal represented 13.6 percent of all rail ton-miles.

"Thus, if coal ton-miles doubled while other traffic remained the same, the result would be only a 13.6 percent increase in total rail traffic spread over 10 years. Admittedly, the increase would affect individual railroads unevenly but, if the slurry pipeline proponents are trying to say that a 13.6 percent increase in traffic, spread over a decade, would place an unbearable strain on this industry, that, I submit, is foolishness - especially in the light of the fact that total rail traffic has grown 15 percent in the past three years alone."

"Naturally, the rail industry does not expect total rail traffic to remain the same over the next 10 years. Our projections - and the government's - call for a 50 percent increase over the next decade. And let me emphasize that this projection was made - and plans to keep pace with it begun - before the energy crunch occurred.

"Now, let us assume that the coal portion of total rail traffic increases by 100 percent instead of 50 percent. That would mean that our projections are off by about 7 percent - that the increase in total rail traffic would be 57 percent instead of 50 percent. I think you will agree this is a manageable variation.

"A recently released report by the National Coal Association estimates increased production by 1985 of about 578 million tons more than was produced in 1974 - if a number of conditions involving the availability of capital equipment restrictions and other factors are met.

"The annual average of the increases charted for the 12-year period is about 48 million tons. The largest increase projected is about 91 million tons in 1979.

"In present service involving both unit trains and other service, 12,000 cars can handle 25 million tons of coal a year. This means that, if the railroads maintain their present 67 percent share of the traffic, they would need to add about 15,485 cars per year to meet the average increase. To meet the largest increase projected in any one year, they would need to add 29,280 cars.

"There is now a backlog of 19,373 hopper cars on order and total car orders during 1974 amounted to 27,086, as already noted.

"Moreover, greater use of unit train service - which is highly likely - would reduce car needs still further. Using the type of unit train service operated today by some railroads, 4,000 cars could handle 25 million tons per year.

"A report prepared by Peat, Marwick, Mitchell & Co. for the Federal Energy Administration, the Commerce Department and the Department of Transportation assumed even greater

coal production increases and nevertheless concluded that railroads could do the job.

"I cite these facts to make clear that - based on performance in the recent past and at present - there are no grounds for the supposition that railroads could not provide the equipment needed to handle even the largest of coal production increases.

"Nor would time be a problem. According to a background paper prepared by the Congressional Research Service, entitled, Factors Affecting Coal Substitution for Other Fossil Fuels in Electric Power Production and Industrial Uses, a lead-time of four to five years is needed to bring on stream a new surface or underground coal mine.

"Thus, railroads would have plenty of advance notice - even if the construction of new track were required - since the waiting periods for rail equipment at their worst were only half the time required to add a new mine. (Now the waiting period has dropped from two years to 10 months.)

"Also relevant to the subject of equipment capacity is the fact that railroad car utilization has been improving steadily, thus reducing the number of cars needed for the future. In 1974, net ton-miles per serviceable car day were 1,645 - a 16 percent improvement over 1970. A factor in this improved efficiency is the increasing use of unit trains which achieve the highest amounts of transportation - and unit trains are extremely well-suited to the kind of high-volume coal movements we are talking about.

"Let me give you an example: one railroad formerly used 2,400 open top hoppers to ship three-and-a-half million tons of coal a year from Eastern Kentucky to Northern Illinois. It is now using 892 cars in unit train service to deliver the same amount. Because of the regularity and volume

of coal shipments, it is clear that further advances in average utilization are likely in the next decade.

"Now let us consider the figure of 25 million tons. That is the claimed yearly capacity of a 38-inch coal slurry pipeline.

"One double-track railroad, with Centralized Traffic Control, has the theoretical capability of handling 300 million tons of coal each year - the capacity of 12 coal slurry pipelines.

"Lest you misunderstand the use of the word "theoretical", let me hasten to point out that I am not talking about something on a futuristic drawing board. There are now 20,731 miles of double-track railroad in the national rail system. And Centralized Traffic Control - or a more advanced system - is being used on more than 41,125 miles of the system. I said, "theoretical", because it does not seem likely - even with the most optimistic of projections - that any single line of railroad would be called upon to handle 300 million tons of coal.

"In fact, 25 million tons of coal per year is not a particularly large amount for today's railroads. Mr. Menk's railroad, the Burlington Northern, routinely operates with trains carrying 10,000 net tons over 1,000 route miles with a five-day turnaround. A simple calculation would indicate that 25 million tons could be handled on this basis by dispatching a train about every three-and-a-half hours - not particularly heavy traffic."

To analyze this position, it is convenient to identify a baseline scenario that would result from a simple projection of past trends without the ordinary increase. Table 5.1-2 presents this scenario, which for convenience is termed the ordinary railroad growth scenario, and shows approximately what would result if the 1965-75 trends were to

TABLE 5.1-2

ORDINARY RAILROAD GROWTH SCENARIO
 (BASELINE SCENARIO OF COAL TRAFFIC, CONTINUATION
 OF 1965-1975 TRENDS)

	<u>1975</u>	<u>1985</u>
Total Rail Ton-Miles $\times 10^{-9}$	1,000	1,500
Coal Rail Ton-Miles $\times 10^{-9}$	140	210
Coal Hauled by Rail mtons/yr	400	530
Total Coal Production mtons/yr	600	800
Average Coal Haul, Miles	350	400
Total Hopper-Car Fleet	360,000	540,000
Hopper-Cars, Coal	192,000	292,000

continue through 1975-85. The identifying characteristics of this scenario are:

1. A 50 percent increase in total ton-miles per decade.
2. Coal is 14 percent of total ton-miles.
3. A 33 percent increase in coal production per decade (527×10^6 tons in 1965 to 646×10^6 in 1975 to 800×10^6 in 1985).
4. Two-thirds of the coal moved by rail.
5. An increase in average hopper car capacity from 81 to 90 tons.

When this scenario is modified by the requirement of a 100 percent increase in coal production, as required by the projections in Table 5.1-1, and by the longer haul (600 miles instead of 400) due to western coal, the result is the extraordinary growth scenario presented in Table 5.1-3. This scenario shows that total rail traffic would increase from about 1000×10^9 ton miles in 1975 to about 1800×10^9 ton miles in 1985, an increase of 80 percent in 12 years or an average growth of about 5 percent per year. The increase in coal rail traffic is, of course, far greater, increasing over 400 percent, and the requirement for equipment is seen to increase almost proportionately.

The growth requirement can also be expressed in terms of the rolling stock requirement. Table 5.1-4 presents the basis for the estimation of equipment required in 1985. Estimates of hopper cars and locomotives per million tons of coal transported were obtained from data presented in the four independent reports cited. The first five columns quote information. From this and other information, the fifth estimate on the chart was developed, and all of them were then averaged at the bottom of the chart. The resulting rolling-stock requirement is shown in Table 5.1-5. They are derived using the equipment requirements in Table 5.1-6.

TABLE 5.1-3

SCENARIO OF EXTRAORDINARY COAL TRAFFIC GROWTH (TO MEET
TABLE 5.1-1 PROJECTIONS)

	<u>1975</u>	<u>1985</u>
Non-Coal Rail Ton-Miles $\times 10^{-9}$	860	1,290
Total Coal Production, m-tons/yr	650	1,300
Coal Hauled by Rail, m-tons/yr	420	870
Average Coal Haul, Miles	350	600
Coal Rail Ton-Miles $\times 10^{-9}$	140	522
Total Rail Ton-Miles $\times 10^{-9}$	1,000	1,770
<u>Non-Coal Rail Equipment</u>		
Hopper Cars	168,000	248,000
Locomotives		
<u>Coal Rail Equipment</u>		
Hopper Cars	192,000	716,000
Locomotives	1,920	7,160

TABLE 5.1-4

ESTIMATE OF COAL TRANSPORT EQUIPMENT - 1985

	Coal Capacity M-tons/yr	Distance (one-way) Mile	Hopper Car Capacity Tons	No. of Hoppers	No. of Loco's	Hoppers/ M-tons	Loco/ M-tons
Dept. of Interior ⁽²⁾	25	1,000	100	5,500	220	220	8.8
Burl. Northern ⁽²⁾	142.1	(1,460)	n/a	24,208	992	170	7.0
Mamalytics, Inc. Inc. ⁽³⁾	1,242	673	81.3	212,900	10,645	171	8.6
Assoc. Am. Railroads ⁽⁴⁾	25	(290)	(75)	12,000	--	480	20.0
This study	25	300	75	12,000	500	480*	20.0*
	25	1,000	100	5,500	220	220	8.8
Average:	25	650	85	9,000	360	360	14.0

(1) Hearings (1975), p. 351

(2) Hearings (1975), p. 933

(3) Rifas and White (1976)

(4) Hearings (1975), p. 913

* Estimated 1975 actual practice.

TABLE 5.1-5

ROLLING STOCK REQUIREMENTS
(FOR COMMODITIES HAULED IN HOPPER CARS)

	<u>1975</u>	<u>1985</u>
<u>Non-Coal Rail Equipment</u>		
Hopper Cars	168,000	235,000 ⁽¹⁾
Locomotives	4,000	5,600
<u>Coal Rail Equipment</u>		
Hopper Cars	192,000	288,000
Locomotives	8,000	11,200
<u>Total Rail Equipment</u>		
Hopper Cars	360,000	523,000
Locomotives	12,000	16,800

(1) Scaled by ratio of non-coal car miles.

TABLE 5.1-6
RAILROAD SERVICE-DEMAND ESTIMATE

	<u>1975</u>	<u>1985</u>
Non-Coal Rail Car-Loadings $\times 10^{-6}$	22.6 ⁽¹⁾	29.4 ⁽¹⁾
Non-Coal Rail Car-Miles $\times 10^{-9}$	12.5 ⁽¹⁾	17.7 ⁽¹⁾
Non-Coal Rail Ton-Miles $\times 10^{-9}$	860.0	1290.0
Total Coal Output, Tons $\times 10^{-6}$	600.0	1200.0
Coal Hauled by RR, Tons $\times 10^{-6}$	400.0	800.0
Average Tons Coal/Car	81.3 ⁽²⁾	90.0
Average Coal Haul, Miles	290.0 ⁽¹⁾	650.0 ⁽¹⁾
Coal Rail Car-Loadings $\times 10^{-6}$	4.92	8.89
Coal Rail Car-Miles $\times 10^{-9}$	1.43	5.78
Coal Rail Ton-Miles $\times 10^{-9}$	116.0	520.0
Total Rail Car-Loadings $\times 10^{-6}$	27.5	38.3
Total Rail Car-Miles $\times 10^{-9}$	13.9	23.5
Total Rail Ton-Miles $\times 10^{-9}$	976.0	1810.0

(1) Rifas and White (1976)

(2) Coal Traffic Annual (1974)

Table 5.1-7 presents published data on the cost of new coal transport equipment, together with typical values used in this study.

The investment in rolling stock required by the forecasted capacity increase is shown in Table 5.1-8 for three cases. Case 1 is the estimated cost to deliver new equipment for the entire requirement, while Case 2 is the investment for only the increment in capacity between 1975 and 1985. Case 3 is based on new equipment for the increment, and refurbishment for the 1973 fleet, this representing the financial requirement to be met, i.e., \$16 billion over ten years.

This estimate represents only rolling stock. It does not include the extensive new trackage and/or new right-of-way necessary over various route sections, in some cases simply to meet the capacity requirement and in other cases to eliminate bottlenecks. Since this question of railroad capability is not central to this study, the subject of facilities expansion has not been pursued. However, it seems likely to be significant in magnitude, possibly as large as the rolling stock requirement. Thus, capital requirement is seen to be of the order of \$20 to possibly \$30 billion. To place this requirement in perspective, it may be noted that it is of the same order as the Apollo moon program, and two or three times as great as the Alaska pipeline. This comparison is valid in the financial sense and in no other. Apollo and Alyeska involved extremely difficult technology developments, hostile environments, and tight time schedules, none of which particularly applies to railroad building. It is no more fair to compare the railroad building task to Alyeska than it is to compare the ETSI pipeline with Alyeska. Nevertheless, it is useful to recognize that the financial problems of coal movement are far greater than those of the Alaska pipeline.

TABLE 5.1-7
UNIT COST OF ROLLING STOCK - 1975

	<u>Hopper Cars</u>	<u>Locomotives</u>
Interior Department	\$26,000	\$450,000
Burlington Northern	33,000	600,000
This Study	30,000	500,000

TABLE 5.1-8

REQUIRED INVESTMENT IN ROLLING STOCK - 1975-1985

(Billions of Dollars)			
	<u>Hopper Cars</u>	<u>Locomotives</u>	<u>Total</u>
Total New 1985 Fleet	15.7	8.4	24.1
New Growth Increment	4.9	2.4	7.3
New Growth Plus Refurbishment	10.3	5.4	15.7

The enormity of this burden is even more impressive when one reflects that it will fall upon only a few companies: three or four railroads and a dozen or so utility companies. These latter will be forced to purchase or finance the rolling stock in which their coal will be delivered. At the same time, it is important to recall that the upper limit upon the number of pipelines which could be in operation within this same 75-85 decade is four, or possibly five at most. At an average cost of about a billion dollars each, then, pipeline construction could relieve the tremendous financial burden upon the railroads, and perhaps even more importantly, upon the electric utility industry, by ~ 15 to 25 percent. It might even be remarked that the railroads, rather than opposing the pipelines, should rather be grateful for their assistance. In any case, it is now easy to see one of the reasons why the utilities are so receptive to the pipeline entrepreneurs. If the entrepreneurs are successful, the utilities will avoid some of the difficult financial burden of financing railway rolling stock.

Some additional perspective on the impact of the slurry pipeline alternative can be gained by considering the unit train equivalent of a pipeline. A typical pipeline has a length of 1,000 miles and a capacity of 25 m-tons/yr (similar to the ETC project now underway). The unit train requirement for the same delivery would be:

	<u>Number</u>	<u>Cost, Millions</u>
Hopper Cars	5,500	\$165
Locomotives	220	<u>\$110</u>
		\$275

Two comments are in order. First, this investment is about one-fourth of that required for a 1,000 mile, 25 million-

ton pipeline. Thus, when right-of-way and other facility requirements are considered, it is seen that the capital investment, for an already existing railroad, is of the order of one-half that for a pipeline.

Second, if this investment is compared to the total investment in rolling stock required if the railroads are to meet the 1985 commodity tonnage target, it is seen that a typical pipeline will reduce the total required investment in rolling stock only by about 1.7 percent.

Thus, while the foreseeable number of pipelines can only have a small effect in reducing the total investment requirement upon the railroads and the electric utilities, they would help relieve the pressure on the western coal transport problems. Thus, to the friendly observer, they can be regarded as a means of bringing new financing and management resources to bear on the problem.

In summary, it appears that if coal production is to be doubled by 1985, an enormous financial burden will be placed on the railroad industry to provide the required transport capacity. While, as was discussed above, the railroads are certain to receive at least three-fourths of this new business whether pipelines are built or not, it seems only prudent from a national energy policy viewpoint to develop alternatives which will bring different technology, new sources of financing, and added management talent to solve the total coal transport problem, unless somehow such action would injure the railroad. This latter question will now be addressed.

5.2 ECONOMIC HEALTH OF THE RAILROADS

It seems self-evident that the transportation needs of the nation cannot be served without a healthy railroad network. Armbruster and Candela [1976] discuss the costs and other consequences to the public of shifting large tonnages from the railroads to the highways. Additionally, a reasonable case can certainly be made that the rail network is needed for the national defense, as is also argued by the same writers.

However, accepting the necessity for a healthy railroad industry, the outside observer who is approaching the subject for the first time is likely to have difficulty with the concept that the coal haulers, or any other business, can be driven into bankruptcy by a 75% increase in their business.

Probably the most authoritative discussion of this question is found in the testimony of Stephen Ailes, President of the Association of American Railroads [Hearings 75, p.912]. His statement addresses several areas of concern, and after making a convincing case for the ability of the railroads to handle the Western coal traffic, he discusses pipeline impact on railroad financial health:

". . . and the areas where most new coal production seems likely to occur are served by railroads in sound condition.

"This is not to say that there are not problems - and problems relating to finances - in the railroad industry. The rail legislation to which I referred earlier attests to the wide recognition of the industry's need. However, it should be emphasized that the confirmation of long term increases in coal traffic, which have historically been profitable operations, will provide the incentives to the financial community, in most cases, to offer equipment financing. Railroads which might have difficulty obtaining investment funds for other worthy purposes will not encounter such difficulty in obtaining capital for profitable operations. In addition, the lead time on mine openings and the need of mine operators for a commitment as to markets provide potential investors with assurance of a safe investment in an atmosphere of virtually guaranteed coal traffic.

"Mr. Chairman and members of the committee, you hold the key in all of this. It is called H.R. 1863. If the Federal power of eminent domain is not granted to coal slurry pipeline builders, then it will be safe to assume that the railroads will obtain this desirable and profitable new business."

The opposition observes that what Mr. Ailes has just said is that if Congress will grant to the railroads a guaranteed monopoly of the Western coal traffic, then in that "atmosphere of virtually guaranteed coal traffic" they will be able, without difficulty, to borrow the money to move that traffic. For the present discussion subject, i.e., pipeline impact on railroad finance health, it is only important to note that, although Mr. Ailes makes the perfectly sound statement that if the railroads are guaranteed the Western coal traffic, they and their customers will benefit financially, he does not say the opposite. He does not say that if they lose some minor portion of that traffic, they will perish.

Rhetorical statements to this effect, i.e., the peril in allowing some part of coal traffic to go elsewhere, and expressions of concern as to its possibility, have been encountered, but no objective evidence was adduced to support them. It is therefore concluded that the impact of the pipelines on the railroads, while not insignificant, will not be disastrous either.

This is not to imply that all of the railroad industry is healthy now. Indeed, the opposite is quite obviously true of the Eastern bankrupts. However, most of the Western coal traffic is destined to be carried (whether pipelines are built or not) by some of the wealthiest business organizations in the world, e.g., Burlington Northern, Union Pacific, and Santa Fe. Some of this coal, however, will undoubtedly be carried by railroads, e.g., the Rock Island and the Chicago and Northwestern, whose financial condition must be characterized as ranging from extremely poor to speculative at best. It is far from clear that the national interest will be well served by foregoing the benefits offered by the pipelines in order to subsidize or otherwise

assist these poorer railroad companies with their financing, and there is no basis at all to subsidize the extremely wealthy ones. It may be observed also that if subsidizing any of the Western railroads is in fact in the national interest, there are other options besides forcing 100% of the Western coal traffic on them and upon the communities through which they operate.

It is well to state the converse. The projected doubling of the present 400 million-ton annual coal traffic represents about a 13.6% increase in railroad traffic [Hearings 75, p.913], and if all the proposed pipelines were built, they could absorb no more than about 100 tons of this new traffic, so that the fractional increase in total rail traffic would be 10.2%. If it should in fact prove true that the difference between 10.2% and 13.6% increase in future, presently non-existent business is necessary to preserve the wealth of the Burlington Northern and the other Western giants, and if it should further prove true that the preservation of the wealth of these selected companies is somehow related to the health of the rest of the railroad industry, it must be recognized that in voting eminent domain to the pipelines, Congress is effectively decreeing a future railroad subsidy of some kind. A persuasive case can then be made that the companion issues of railroad health and eminent domain should be addressed and resolved together. As stated earlier, however, the present conclusion is that the hypotheses of the above proposition are false, and therefore so is its conclusion. The two issues of eminent domain and railroad health would be better addressed separately.

In summary, it is concluded that the argument that pipelines will threaten the financial health of the rail industry is without merit. A similar conclusion was reached by the financial analyst, Anthony Low-Beer [1976]. He concluded,

"On balance, we believe that even if proposed legislation enabling the ICC to issue slurry pipelines eminent domain permits is passed, it would not have a major near-to-intermediate-term impact on railroads (specifically BN) and only a moderately significant effect longer term. Due

to a series of complex legal procedures that potential pipeline builders are required to undertake, we doubt that most, if any, pipeline projects would be ready for start-up before 1983-84. Even then, we do not believe that slurry lines will capture more than a relatively small share of the Western coal transportation market because they are only economic in certain areas. (In addition, there appears to be enough water only for one or two lines.) Thus, we do not believe that the passage of the legislation would materially hurt railroads' access to capital markets. . . ."

However, the discussion of financial impact cannot justly be left at that point. In arriving at that conclusion, the issues of railroad competition and monopoly pricing have been raised but not addressed, and some facts of railroad life must be recognized.

5.3 CONDITIONS OF COMPETITION

5.3.1 Prevalence of Competition

In the preceding section, the term monopoly was not used. However, the pipeline proponents are wont to observe that Mr. Ailes' "atmosphere of virtually guaranteed coal traffic" is the same as a monopoly. However, the term is so broad that it is useful only as rhetorical polemic; it is not appropriate as analytical description.

The term monopoly in the economic context means the absence of competition. Thus, the broad use of the term to paraphrase Mr. Ailes' reference to "virtually guaranteed coal traffic" as "monopoly" is wrong. The railroads are both quick and correct to point out such guarantee of all traffic to the railroads does not mean all competitive aspects of coal traffic pricing are thereby forever eliminated.

The public has little awareness of the competition between different railroads themselves. If someone were inclined to perform the necessary research, probably hundreds of cases could be cited in which two or more railroads have competed bitterly for traffic. Indeed, it was abuses arising from this competition which led to the original anti-trust and regulatory legislation. And this competition is not restricted to railroads whose lines are parallel or approximately so. An aggressive railroad management which has access to both ends of a profitable haul will try to offset a competitor's more direct routing.

This competitive atmosphere means that the staff of the Association of American Railroads (AAR) sometimes finds itself in the delicate position of ensuring that they do not become an information channel between competitors. They sometimes have a security problem in collecting and analyzing statistics for this reason. Moreover, the AAR does not involve itself directly in pricing matters, primarily to avoid any suggestion of anti-trust violations.

The point just made of course is that the simplistic terms "monopoly" and "monopoly pricing" are too broad, and the issue is one of degree. Even accepting the validity of that point, however, it is also obvious that the degree of competition will be greater in the presence of slurry pipelines than in their absence. And there must certainly be cases where the absence of competition leads to very high prices. As a possible example of the latter, consider the experience of the City of San Antonio, as related by the City to the Eighth Circuit Court [San Antonio 76]. Excerpts from that testimony were quoted earlier in the summary section of this report. An expanded quotation follows:

"In evaluating the delivered price of competing coals from various geographic regions, San Antonio used a railroad transportation price factor of 5 mills per ton mile which was furnished by petitioners and which was the general going rate in effect in 1972 (S.A. 78). Thus, for a 1000 mile haul, the approximate projected rail freight rate for planning purposes would be \$5.00 per net ton (1000 x \$0.05). Among the potential sources of coal being considered by San Antonio were coals from mines in Campbell County, Wyoming, some 1644 rail miles north of San Antonio. The railroads offered to transport Wyoming coals to San Antonio for \$7.90 per ton in San Antonio's freight cars and for \$9.80 per ton in the railroads' cars. These proposed rates were at levels which were consistent with the then published and going rate levels for unit train coal transportation in the West (S.A. 71).

"In the spring of 1974, San Antonio advised the railroads of its intention to commit itself to the long term use of Wyoming coals and of its reliance in making this commitment upon the \$7.90 rate quotation (S.A. 245). The carriers reaffirmed the availability of the \$7.90 rate and reduced it to a proposed tariff format (S.A. 245). Shortly thereafter, the railroads "jacked up" their price by over 40 percent from \$7.90 to \$11.09 per ton because of claimed "cost increases" (S.A. 240). The nature of these tremendous cost increases which accrued in less than one year and which precipitated this dispute was never divulged and has not been explained to this day (S.A. 241). The refusal of the railroads to explain their pricing (S.A. 13) or to offer prices on other than a take-it-or-leave-it basis (S.A. 51, 240-41) deeply disturbed San Antonio (S.A. 13,73)."

Later, in the same court proceeding, the City says,

"Between the railroads initial proposal in July 1973 (S.A. 79) and their final proposal of May 2, 1974 (S.A. 81), two other problems surfaced. The railroads revoked their proposal to furnish cars and San Antonio was compelled to place orders for \$25 million worth of railroad cars (S.A. 74,75). Additionally, the carriers refused to file any tariffs at all with the Interstate Commerce Commission or to provide any transportation, whatsoever, unless San Antonio entered into a side agreement which would not be submitted to the Commission and which provided for "agreed schedule changes" on an annual basis (Sandgren 3). San Antonio considered such an agreement improper.

"Faced with the prospect of the improvident expenditure of hundreds of millions of dollars of public monies (S.A. 73) and unable to negotiate, San Antonio sought the protection of the Interstate Commerce Act by its complaint dated May 5, 1975.

"In the early phases of the proceedings before the Commission, San Antonio encountered the same sort of frustrations and lack of progress it had met with in its attempts to negotiate with the railroads. The carriers filed petitions with the Commission to delay and/or defer a decision on San Antonio's complaint contending that the case was somehow "premature." Attempts by San Antonio to discover relevant railroad operating data were either resisted or ignored by the carriers. Having made no progress whatsoever toward a determination of its complaint in the first six (6) months after filing and with the actual movements only a year away, San Antonio successfully petitioned to have the case heard under the Commission's Modified Procedure."

And again later,

"In spite of the repeated pleas of San Antonio that it required a freight rate by October 1, 1976, it appeared unlikely in September of 1976 to San Antonio that the Commission would reach a determination in time for the commencement of the scheduled coal traffic. Accordingly, San Antonio petitioned for a conference at which it intended to offer a compromise rate arrangement for use pending the Commission's decision and/or that the Commission issue an immediate final order resolving the issues before it. The railroads objected to such a conference on the basis that it was unnecessary in light of their new proposed tariff which they had lodged with the Commission in September and wherein they sought to gouge San Antonio with a freight rate of \$16.67 per ton followed by an increase to \$17.34 at the end of one year. Like the earlier leap from \$7.90 to \$11.09,

there was no explanation as to how the railroads got from \$12.70 to \$16.67, notwithstanding the fact that each proposed \$1.00 in the rate level would cost San Antonio's rate payers \$3,000,000 annually. Upon protest of San Antonio, the Commission suspended the effectiveness of the proposed \$16.67 tariff."

The result of all this was a Commission order fixing the rate at \$10.93. This is the example that was seen earlier, in Table 4.2.3-2 and Fig. 4.2.3-3. Figure 5.2.1-1 is a replica of Fig. 4.2.3-3, with the addition of the \$16.67 tariff first published by the railroads. The result is interesting.

First, it is seen that the tariff the railroads attempted to charge greatly exceeded any other. In fact, it is so high that it tends to vindicate the 1975 estimates by Wasp of probable freight rates, and thereby to mitigate the denigration of his estimating accuracy which may have been imputed in Section 4.2.3.

Second, it may be observed that the tariff mandated by the Commission, though still too high in the eyes of San Antonio, nevertheless would appear to be in line with other rates, which were freely negotiated and were not mandated by the Commission.

Third, in Section 4.2.4.2 above, the technical problems arising from the destructive effects of unit trains on tracks, ties, and ballast, and the possible requirements for completely new roadbed to replace certain curves and grades were discussed. When in the future these effects and their consequent costs are finally known with good engineering precision, it may well develop that San Antonio is getting a rare bargain at the mandated rate. It seems entirely possible that the San Antonio rate, and all of the others, must ultimately be raised to the higher levels proposed by the railroads to cover their costs.

It would be interesting to research the conditions under which the other tariffs in Fig. 5.2.1-1 were negotiated, to try to establish the degree to which they may have been influenced

by competitive pressures. Such effort is beyond the scope of the present study. However, it is well to note that if the attempt of the carriers to charge an extremely high price in the San Antonio case is an indication of what may be expected in a future without pipelines, all of the careful analysis and discussion of railroad inflation presented earlier in Section 4.2.2 loses its relevance. Thus the possibility emerges that

1) If the pipelines are precluded, the railroads may increase their tariffs so rapidly that the pipelines would have been far more economical carriers, but

2) If the pipelines are enabled, the railroad tariffs may be restrained, by either the presence or the threat of the pipelines, to levels at which the pipelines are in fact profitable only in rare cases, but

3) If the pipelines are enabled, and by their presence or threat, act to restrain railroad tariffs, the funds that the railroads must have to upgrade their facilities and properly serve the public must be subsidized by some other means.

This is the crux of the economic argument. In the preceding section, it was concluded that eventuality 3 is very unlikely. It appears much more probable that among the railroads, the rich will become richer and the poor will become poorer, independent of anything done about pipelines.

It is important to emphasize that the representativeness of the San Antonio case, and of the other points in Fig. 5.2.1-1, has not been examined, and thus any conclusions at this point must be speculative. Nor has the railroad side of the case been heard. Taking these points in order, it is well to review the experience of another prospective coal shipper.

Floyd Lewis, president of Middle South Utilities [Hearings 75, p.744) testified on 12 September 1975:

"At this point, I would like to make very clear that while the railroads have been energetically opposing the enactment of legislation which would provide a way to acquire right-of-way for a slurry pipeline when the particular project satisfies stringent standards to determine that it is in the public interest, they have stalled about entering into contracts for rail movement of western coal to our part of the country. We have been negotiating with the Burlington Northern and the Missouri Pacific, which would be the originating and delivering railroads in moving Wyoming coal to Arkansas, since November 15, 1972, and we still do not have a firm quotation from them. Since that date there have been numerous meetings with representatives of the railroads, letters and telephone calls - numbering about 40 contacts in total.

"On September 20, 1974, we wrote to the Missouri Pacific, with a copy to the Burlington Northern, providing certain information they had requested and confirming our previous oral acceptance of the proposed tariff as it then stood. We asked in that letter that they send us the appropriate documents so that we could sign them. We are still waiting. We are advised that none of the utilities in our area who have contracted for low-sulfur western coal have been able to get the railroads to contract for transportation on reasonable terms in the last 18 months."

Later, Mr. Lewis was questioned by Congressman Taylor:

"Mr. Taylor. Of course your plans for moving the coal rests on these pipelines. What are your options? Suppose the pipeline is not built?

Mr. Lewis. I assume at some point the railroads will tell us how much they will charge us to move that coal and we will move it by rail and our customers will simply have to pay the cost of whatever it turns out to be.

We would very much appreciate the railroads telling us what the costs will be. We have been negotiating with these railroads since November 1972, and they still have not told us what the price is going to be. They upped it several times in the negotiations but we still do not have a quote from them that they are willing to sign a contract on."

And later by Congressman Vigorito:

"Mr. Vigorito. Another point. It is hard for me to believe that in several years you have not been able to get any commitments. It sounds like they don't even want to sit down and talk to you; is that correct?

Mr. Lewis. They will sit down and talk and promise you something by the 15th of next month, and 3 months later you are still calling them, and saying when are we going to

get it? It may sound unreasonable, and I agree that it is unreasonable, and I would like for you to pursue it with them if any of those representatives of the railroads show up here.

I can assure you we have been industrious in our pursuing the subjects with the railroads to the extent that, as I said in my statement, in September of 1974 we wrote them a letter in which we said this confirms our acceptance of your proposal, will you please provide us with the documents to sign?

A year later we are still waiting for the documents. If that is unreasonable, if it sounds unreasonable, I can only agree with you. It is unreasonable.

Mr. Vigorito. I would like very much for you to submit the correspondence and the answers that you have received from the railroads on this subject.

Mr. Lewis. We will be very pleased to do it, sir.

Mr. Vigorito. So would the committee please make a note of that so we can follow that on through.

Mr. Eckhardt. In the absence of objection, the committee will receive such information and documents and place the same in the record."

The response was given by J. A. Austen of Mopac [Hearings 75, p.982]:

"While it is true that representatives of Missouri Pacific and Burlington Northern have been involved in a number of past discussions concerning possible rate levels to cover the proposed coal movements, under various assumed conditions, I believe there are certain misunderstandings which could easily be cleared up between the parties.

First of all, our rates, like those of any common carrier, are made via tariff publication, not by contract. Therefore the discussions which have taken place really concern the rate level which the railroads would be willing to publish to cover specific types of operations under various stated conditions, operating and otherwise. I find that during past negotiations several rate levels have been discussed, each assuming certain definite conditions. Recently, both railroads, Missouri Pacific and Burlington Northern, have been making further studies and evaluations in order to aid them in arriving at rate levels which, under given terms and conditions, would be both attractive to the users and profitable to the railroads. Where, as here, very heavy volumes, very substantial amounts of equipment, and alternative methods of operating are involved, such evaluations can be most complex and very time consuming.

The feature to be emphasized, however, is that I believe the two railroads now have at their disposal all of the necessary studies and data to enable them to readily arrive at definite rate proposals based on any feasible conditions and operations. I can assure this Committee and the shipper interests that we are not only willing but anxious to sit down with Middle South and/or System Fuels, Inc., at the earliest mutually convenient time in order to discuss and work out any remaining details and to provide definite rate quotations which those parties state they are seeking."

An earlier circulation draft of this report invited further enlightenment on this issue, to which the AAR responded in part:

"Like any common carrier railroads provide transportation service under tariff provisions, not pursuant to contracts or quotations.

"Thus, when the electric utility executive spoke of an alleged failure to provide a quotation he was presumably referring to an alleged failure to indicate what rate and related tariff provisions the railroads would be willing to attempt to publish. Obviously, to provide such an indication - particularly in a new transportation area such as this involving the necessity of agreement between two major participating rail systems on a number of elements, each of which called for underlying studies - requires a great deal of factual information.

"The utility witness states that the railroads did not provide a quotation from 1972 to 1975. This is incorrect.

The fact is that, when the railroads believed they had sufficient facts and that adequate studies had been made on the basis thereof, they did provide a quotation. This took the form of a joint verbal proposal made on behalf of BN and MP in June, 1973. That proposal was predicated upon the facts as the railroads then understood them. Unfortunately, those facts soon changed and it became necessary to withdraw or abeyance the previously given quotation.

"The railroads were given to understand that the utility was considering four different locations. In June 1973, we learned, from a Wall Street Journal article, that the selected site was Redfield and that four generating units would be placed in operation at that location. The quotation provided in June 1973 was based upon those facts, including the understanding that the movement would be exclusively by BN-MP over a long term with approximately 10 million tons to move annually.

"Subsequently, the utility for the first time injected the possibility of a C&NW-MP route. Also, in July 1974, the utility began to talk in terms of only 5 million tons per year.

"The reason for this significant change in potential volume was apparently the unwillingness of the Arkansas Commission to approve the four-generator proposal, that Commission subsequently giving official approval for the construction of only two such operating units. In the meantime, the railroads had also learned of the proposal to construct a slurry pipeline. In other words, the original quotation had contemplated an all-rail operation involving the handling of approximately 10 million tons per year over a period of at least 15 to 20 years; but the changing factual situation included injection by the utility of a much smaller annual volume figure, as well as the possibility that the handling by rail would be only on an interim basis pending completion of the pipeline. Understandably, it became necessary for the railroads to make some additional studies predicated upon those changed facts. This should not be particularly difficult to understand when it is remembered that very sizeable expenditures by the railroads would be required in order to put this type of operation into effect and that one important consideration going into the measure of the proposed rail rate involves the reasonably anticipatable movement, over which those expenditures could be amortized or recovered. By reason of the basic factual changes which had occurred since the formulation of the original quotation, that long-term quotation was withdrawn or abeyanced. This was done before the utility had given any indication of its being acceptable. In the meantime further studies and analyses based on the changed factual elements were progressed by the railroads, and they had been largely completed by September 1975.

"Thus, when it was stated, on September 16, 1975, that existing misunderstandings could be easily cleared up by a meeting of the parties, that referred to the situation as of that 1975 date. In no way does this mean that any and all differences could have been easily rectified during the prior years when the factual picture was continuously changing and the rail studies had not been completed."

After some further discussion of the wording of the question in the circulation draft, the statement continues:

"Interestingly, there have been recent occurrences which support the validity of the railroads spokesman's September 1975 opinion that then-existing misunderstandings could easily be cleared up through meetings of the parties.

"Such meetings have subsequently taken place, and BN and MP have recently advised the utility that they were willing

to reinstate the long-term quotation and have also given the utility additional quotations or proposed tariffs on both a five-year basis and a one-year basis. The utility presently has those three plans under consideration and will presumably notify the railroads of its reactions thereto in due course."

When this statement is compared with the Lewis testimony, the two most significant dates in the sequence appear to be:

1 - September 1974, when the utility wrote to the railroads providing the previously requested information and confirming their previous oral acceptance of the railroads' proposed (presumably proposed orally, according to the AAR statement) tariff.

2 - September 1975, when the necessary railroad studies "had been largely completed" and the situation was such that "on September 15, 1975, (that) existing misunderstandings could easily be cleared up."

To the buyer, passage of a year without confirmation of an already agreed upon rate, and without any indication that confirmation was ever coming, constitutes stalling. To the seller, the year is a reasonable period in which to conduct the necessary studies, even after all the necessary information is finally at hand, and there is no point in a continuing dialog while the studies are in process.

To the believer in the American system of business enterprise, it is difficult to identify any villain in the piece. To place the railroads in that role, one must side with the buyer on two basic points. First, the railroads must be accused of stalling. But more important, the position must be taken that there is something immoral about stalling. There is certainly nothing illegal about it, and every competent negotiator does it when it is in his best interest. Furthermore, no competent negotiator ever admits that he is stalling, but that does not disqualify him from service as a deacon in any church.

The railroads explain the passage of a year by pointing to the necessity to conduct exhaustive, time-consuming studies. Earlier, Section 4.2.4.2 of this report briefly discussed some of the engineering questions and unknowns related to extremely large, extremely frequent, unit train operations. In that section, it was concluded that the true, longrun cost of unit train operations is unknown and probably understated at present. In addition to technical publications of the kind referred to there, the reader of railroad business literature finds continuing discussion of the technical problems and associated costs of such operations [Railway Age 71, Welty 73, Business Week 75, Welty 77, Railway Age 77]. If the assessment in Section 4.2.4.2 is sound, then the railroads are in the ambivalent position of having to rapidly raise unit train tariffs to cover the unexpectedly high costs of operations previously contracted at unrealistic rates. At the same time, they are pointing to those same unrealistically low historical rates as a reason for denying the pipelines the right to do business.

Thus, there are two rational explanations for the railroad behavior; both of which fit the observed facts: they may have been simply stalling for higher prices, or they may have been studying the technical problems and trying to determine their true costs. It appears quite possible that they were doing both. Although loath to admit it, they probably know that unit train costs, over the long run, will be much higher than were earlier anticipated, and they are therefore industriously studying the costs, meanwhile employing all the tactics available to increase prices and attempting to convince the world that pipelines would be an evil. Their problems in this regard are compounded by the fact that, under regulations, they are required to cover their costs, and if anyone, competitor, customer, or general public, could show that rates had been knowingly set artificially low, the railroad would be subject to punitive action.

5.3.2 Regulation of Rail-Pipeline Competition

The pipeline proponents make the point that they propose to submit to ICC regulation, and that they therefore offer to compete with the railroads on an equal basis. The railroads vociferously deny this. They point to the fact that pipelines and railroads operate under totally different sets of ICC regulations, and they refer to pipelines as "lightly regulated." They further insist that the railroad regulators must share equal blame with the railroad management for previous bankruptcies and the virtual demise of passenger service. In this study, it has not been possible to perform research into comparative regulation of the two industries.

The railroads make a second point relative to the injustice of competition under ICC regulation. To fill the role of a true common carrier, the railroads are required to move almost any commodity, to supply many services which are only marginally profitable or even unprofitable, and to bear many expenses. The pipeline, on the other hand, proposes to move only a single commodity from one destination to another (or several) destinations and for a single purpose. By contrast, the pipeline reasonably expects to make a profit on every pound of freight that is handled.

It has not been possible in this study to perform the necessary research on which to formulate a judgement. Qualitatively, it would seem, however, that a newcomer to the transportation business, given a choice, would prefer to compete as a pipeline rather than as a railroad.

5.4 ENERGY CONSUMPTION AND CONSERVATION

It was concluded in the introduction to this chapter that the ED power should be granted to the slurry pipelines unless it can be shown to be contrary to the national interest to do so. If the energy consumption of the pipelines is inordinately high, such a case might be made. It is therefore of interest to compare the energy consumption of the two modes. As will be seen, it is also necessary to examine both the quantity and the quality of their relative energy consumption.

5.4.1 Energy Consumption in Coal-Water-Slurry Pipelines

Under another task of this study, the energy consumption of pipelines, including slurry lines, has been studied in some detail, and the results have been presented in report R-3022 (see Table 1.1-1 above) of this series. In that report, particular attention was given to the Black Mesa Pipeline because the first study objective was to estimate energy consumption in the existing pipeline industry, and the existing slurry pipeline industry in this country consists of the Black Mesa line. In the following discussion, earlier analysis is repeated and updated, with such adjustments as are appropriate to a comparison with rail transport.

5.4.1.1 Energy Consumption in the Black Mesa Pipeline

In analyzing energy consumption in the Black Mesa pipeline, it is necessary to consider the three distinct operations:

1. Extraction of the water from the ground and delivery to the pipeline head. These operations are conducted by the Peabody Coal Company.
2. Slurrification and transportation of the coal. These operations are conducted by the Black Mesa Pipeline, Incorporated.

3. Deslurrification and consumption of the coal. These operations are conducted by the Southern California Edison Company.

5.4.1.1.1 Energy in Slurry Water

Water for the Black Mesa pipeline is taken from wells near the head of the line. The depth of the lift varies between 2000 and 2200 feet. Taking 2100 feet as an average and allowing another 200 feet for friction and velocity brings the total head to about 2300 feet.

The proportion of (bone-dry) coal to water averages 48 to 52 [Montfort, 1977]. The moisture content of the coal is specified by contract at 10.74 percent, and the content of the asmined coal averages very close to this figure. Thus, a ton of contract coal contains

$$2000 \times (1 - 0.1074) = 1785$$

lb. of dry coal. As noted, the slurry proportions vary, but average about 48% dry coal to 52% water. Thus, a ton of contract coal entering the slurrier emerges as

$$\frac{1785}{0.48} = 3719$$

lb. of slurry, of which 2000 lb. is the original contract coal and 1719 lb. is water which must be added to form the slurry.

In the earlier work reported in R-3022, 22 percent was taken for the efficiency of electric generation and transmission grid. Readers have challenged that figure as too low. Giving the benefit of any doubt to the pipeline by use of 30 percent, and also taking 70 percent for the pump-motor efficiency, the energy investment in the water per ton of coal is

$$\frac{1719 \times 2300}{778 \times 0.7 \times 0.3} = 24,200 \text{ Btu/Ton}$$

5.4.1.1.2 Energy in Pipeline Operation

The Black Mesa pipeline operation requires 22 Kw-hr per ton of coal at the station meter [Montfort, 1977]. Again allowing 30 percent efficiency for the electric grid yields

$$\frac{22 \times 3413}{0.3} = 250,300 \text{ Btu/ton}$$

of coal transported. Again, this is energy entering the boiler at the generating station.

5.4.1.1.3 Energy in Deslurrification

Deslurrification energy must be carefully calculated. There are many operations involved, as can be seen from Table 5.4.1.1.3-1. Some of these operations would be required with dry coal, though sometimes to a different degree. The Southern California Edison engineers have calculated that the energy consumed in deslurrification is about 63,000 Btu/ton of coal. This energy is electrical power to the motors which drive the equipment. The energy which must be input to the boiler to supply this power is, for a station heat rate of 11,100 Btu/Kw hr [Dina, 1977],

$$63,000 \times \frac{11,100}{3412} = 204,953 \text{ Btu/ton.}$$

Additionally, the steam cycle efficiency suffers under the requirement to reduce the moisture from the 32 percent to which it is reduced in the initial separation to the 10.74 percent contract value [Dina, 1976]. Taking

$$1173.8 - 34.08 = 1135.7 \text{ Btu/lb}$$

of water as the sensible and latent enthalpy to heat the

TABLE 5.4.1.1.3-1

ENERGY CONSUMED IN/CHARGEABLE TO DESLURRIFICATION, BLACK MESA

Active Storage

Booster pumps to active storage
Agitators
Slurry transfer pumps
Water pump to primary treatment
Water pump to evaporation pond

Boiler Fuel Preparation

Centrifuges
Pulverizer mills
Steam cycle efficiency loss, 32 percent
moisture vs. 10.74 percent
Clariflocculator agitators
Underflow pump
Underflow injection pump

Reslurry from Inactive Storage

Conveyor motors
Vibrator motors
Reslurry pump, primary
Reslurry pump, final

moisture between the approximate conditions of 70F entering and 280F stack gas exit,

$$1135.7 (0.32-0.1074) \times 2000 = 482,900 \text{ Btu/ton}$$

5.4.1.1.4 Black Mesa Energy Intensity

The energy components described above are summed on Table 5.4.1.1.4-1. In 1976, the line transported 4,174,694 tons of coal. The energy intensity is obtained by dividing the energy per ton by the 273 mile length of the pipeline.

$$1,053,000/273 = 3857 \text{ Btu/ton-mile.}$$

Two of the energy components in the table require explanation. First, the pumping energy is that required to add approximately 7500 feet of head to the slurry as it moves through the pipe. However, it is seen from Figure 5.4.1.1.4-1 that the line falls 2600 feet from its head to its critical elevation, which is about 12 miles from its terminal. Thereafter, the free gravity energy can only be used to move 12 miles, and the line is choked to 12 inches in diameter to slow the speed of descent. Thus, for the purpose of an equal elevation comparison with other transport modes, it is necessary to use

$$186,000 \times \frac{7500 + 2600}{7500} = 250,480 \text{ Btu/ton}$$

for the pumping energy.

Second, an estimated 80 percent of the energy for slurry preparation and other operations is used in grinding the coal, which would be necessary if the coal were transported in any other way, and therefore cannot fairly be charged to transportation. If allowance is made for that fact, only about

$$155,000 \times 0.2 = 31,000 \text{ Btu/ton}$$

TABLE 5.4.1.1.4-1

ENERGY CONSUMPTION - BLACK MESA PIPELINE

(Btu/ton of Coal)

Slurry Water Supply		24,000
Pipeline Operation		
Pumping energy	186,000	
Slurry preparation & other operations	<u>155,000</u>	
		341,000
Deslurrification		
Initial separation	205,000	
Moisture correction, 32 to 10.74 percent	<u>483,000</u>	
		<u>688,000</u>
	Total	1,053,000

Source: Hearings (1975), p. 1207

Figure 5.4.1.1.4-1 Black Mesa Pipeline - Route and Profile

would be charged to transportation. When these adjustments are made, the adjusted energy consumption given in Table 5.4.1.1.4-2 is obtained.

To obtain the energy intensity on this adjusted basis, the length from the head of the line to the initial elevation, approximately 261 miles is used. The result is

$$\frac{993,000}{261} = 3805 \text{ Btu/ton-mile.}$$

It must be recognized that all of the energy chargeable to the slurry pipeline mode of transport is still not in the calculation. For example, about a million dollars worth of chemicals per year are required in the deslurrification process. Some energy is required to manufacture those chemicals, but the amount has not been determined, and thus is not included in the calculation. It is believed to be insignificant.

5.4.1.2 Energy Consumption in Future Pipelines

The energy intensity in future slurry pipelines will be less than in Black Mesa by an order of magnitude, for reasons which will become evident in the following development. It is convenient to begin with the projected energy consumption in the proposed ETSI pipeline, which is shown in Table 5.4.1.2-1. When these figures are adjusted on the same basis as that used in Table 5.4.1.1.4-2, except that a gravity boost of 5000 ft is taken, the estimate shown in Table 5.4.1.2-2 is obtained. In Table 5.4.1.2-3, these results are rearranged to provide a direct comparison with the Black Mesa figures from Table 5.4.1.1.4-2. A dramatic, nearly fivefold reduction in EI is evident. The largest single factor results from the fact that Black Mesa moves some of the driest coal in the West, i.e., only 10.74% moisture. Western coal generally has much higher moisture content, often above 30%. The ETSI line will move coal having 26% moisture, which gives it an immediate advantage of 347,000 Btu/ton. Other significant

TABLE 5.4.1.1.4-2

ADJUSTED ENERGY CONSUMPTION - BLACK MESA PIPELINE

(Btu/ton of Coal)

Slurry water supply		24,000
Pipeline operation		
Pumping energy	250,000	
Other operations	<u>31,000</u>	
		281,000
Deslurrification		
Initial separation	205,000	
Moisture correction	<u>483,000</u>	
		<u>688,000</u>
	Total	993,000

TABLE 5.4.1.2-1

ETSI ENERGY ESTIMATE

(25 million tons coal/yr, 100 mi)

	<u>Energy</u>	
	$10^6 \frac{\text{kwhre}}{\text{yr}}$	$10^{12} \frac{\text{Btu}}{\text{yr}}$
Electric energy		
Slurrification	301	
Pumping	502	
Dewatering	146	
Water supply	<u>40</u>	
Subtotal	989	
Less grinding credit	<u>-226</u>	
Net electric energy	763 =	2.60
Steam energy		<u>1.50</u>
Total energy		4.1

TABLE 5.4.1.2-2

ADJUSTED ENERGY ESTIMATE - ETSI PIPELINE

(25 million tons coal/yr, 1000 mi)

	<u>Energy</u>	
	$10 \frac{\text{6kwhre}}{\text{yr}}$	$\frac{\text{Btu}}{\text{ton}}$
Electric energy from grid ($\eta = 0.22$)		
Slurrification, net	340	47,000
Pumping	3,952	539,000
Water supply	182	25,000
Electric energy from customer power plant lines, initial separation (station heat rate = 11,100 Btu/kwhre)	475	65,000
Moisture correction, 32 to 26 percent		<u>136,000</u>
		812,000

TABLE 5.4.1.2-3

COMPARISON OF ADJUSTED ENERGY COMPARISON
(Btu/ton of coal)

		Black Mesa 273 mi 4×10^6 tons <u>1976 technology</u>	ETSI 1000 mi 25×10^6 tons <u>1977 technology</u>
Slurry water supply		24,000	25,000
Pipeline operation			
Pumping energy	250,000		539,000
Other operations	<u>31,000</u>		<u>47,000</u>
		281,000	586,000
Deslurrification			
Initial separation	205,000		65,000
Moisture correction	<u>483,000</u>		<u>136,000</u>
		<u>688,000</u>	<u>201,000</u>
Total		993,000	812,000
Length of pipeline (mi) (to critical elevation)		260	1,000
Energy intensity (Btu/ton-mi)		3819	812

economies are seen to result from greater distance (factor of 4), greater scale (factor of 6), and newer technology.

5.4.1.3 Energy Consumption in Unit Trains

Zandi (1974) has calculated the energy intensity of a 40 mph train which would substitute for the Black Mesa Pipeline, using the Davis formula from the Manual for Railway Engineering. He obtains a result of 544 Btu/ton-mile. He apparently takes credit for a 3900-ft free gravity drop. To compare with the preceeding pipeline calculations, it is necessary to correct for this drop. If the tare-to-payload ratio is 0.9, then the altitude correction, based upon railroad mileage,

$$\frac{1.9 \times 2000 \times 3900}{778 \times 330} = 58 \text{ Btu/ton-mile}$$

Zandi does not correct for losses in transit. A blow-out phenomenon is often seen that results in a significant amount of coal being aerodynamically removed from the top of the load near the front of the car. Quantitative data on the phenomenon has not been found in the course of this study, although one discussion at a technical meeting indicated that losses of a few percent are not uncommon with fully-loaded, fast-moving unit trains. A one-percent loss of Black Mesa coal would be equivalent to about 100 Btu/ton-mile, based on railroad mileage. With reasonable values for these corrections and adjusting to the pipeline mileage basis, the energy intensity of a unit train to replace the Black Mesa Pipeline would probably be of the order of 700 Btu/ton-mile. This is lower than the actual pipeline by a factor of five, and lower than the projected ETSI line by about 15%.

It is concluded that, even when the pipeline is given the benefit of reasonable doubt, the railroad is still somewhat more energy efficient.

5.4.2 Quality of Energy Consumed

The issue of US dependency upon the OPEC oil cartel has received public attention since the embargo of 1973. Moreover, the desirability of increased usage of coal has been given strong emphasis by the President during 1977. Thus, while the foregoing analysis has concluded that coal-water slurry pipelines are generally somewhat more energy-intensive than unit trains, it is necessary at the same time to recognize the difference in the quality of the energy consumed by each.

The railroads consume a more precious form of energy, i.e., diesel fuel, than coal. Reference to Table 5.4.1.2-3 of the preceding section shows that, for the future pipelines, about three-fourths of the energy (slurry water supply and pipeline operation) will come from the electric grid, while the remainder comes from the coal itself. In many cases, most of the electric grid energy is likely to be coal-derived, and the percentage will increase in the future.

A way of adjusting for the qualitative difference in the kinds of fuel used is to reduce them to the same economic basis. Railroad diesel fuel could probably be made from coal at about twice its present, OPEC-based price. This cost largely reflects a conversion efficiency of something less than 60 percent. So, if it were decided to operate both systems on coal or coal derived fuel, the energy intensity of the railroad, instead of the approximately 700 Btu/ton-mile calculated earlier, would be about

$$\frac{700}{0.6} = 1167 \text{ Btu/ton-mile}$$

which would then compare with the 812 Btu/ton-mile for the future pipeline. Thus, when the two modes are reduced to a common, coal-derived basis, the pipeline has possibly a 50 percent advantage.

Another way of adjusting for the quality of energy consumed would be to electrify the railroad. In that case, power conversion efficiency of the railroad would fall from approximately 40% for the diesels to something less than 30% that was hypothesized for the electric grid. Instead of about a 15% advantage over the pipeline, the rail would fall to about a 15% disadvantage.

These differences do not appear highly significant. The pipelines may ultimately yield some saving in energy, but only after the railroads have been converted to a coal-derived economy, i.e., coal-derived diesel fuel or electrification, both of which are far in the future. It is therefore concluded that energy consumption provides no compelling reason to withhold from slurry pipelines the power of eminent domain.

5.5 SAFETY

It is instructive and in fact necessary, to discuss the question of slurry pipeline safety against the backdrop of experience provided by the oil pipeline statistical experience. Qualitatively, there is no basis to expect that future experience with slurry lines will be significantly different than past experience with oil lines, except that the slurry, being non-flammable and non-toxic, will be the less dangerous of the two.

Before examining safety statistics, it is well to first establish a framework of usage, for which purpose Table 5.5-1 was prepared. The significant point to note is that oil pipelines carry a volume of intercity freight equal to that carried by trucks and almost two-thirds that of the railroads. With that in mind, it is now instructive to consider some safety statistics.

It seems certain that anyone who studies the statistics of transportation accidents and fatalities in the Statistical Abstracts of the U.S. will conclude that the liquid pipeline is by far the safest mode of commodity transportation. This is evident from the fact that even the pipeline opponents, e.g., Armbruster and Candela, p. 137, have reached this conclusion. Unfortunately, it is not possible to extract figures from the statistics so as to support this conclusion, quantitatively and precisely. There are two principal difficulties.

First is the fact that the passenger-related and non-passenger-related fatalities are not separated in the particular tables contained in the statistical abstracts, and it would be a manifestly improper comparison which placed pipeline accidents into juxtaposition with passenger-related accidents. And although this difficulty might well be resolved by further research of the data base, such research

TABLE 5.5-1

TRANSPORTATION MODE VOLUMES INTERCITY FREIGHT - 1973

<u>Ton-Miles</u>	<u>Rail</u>	<u>Oil Pipeline</u>	<u>Truck</u>	<u>Inland Water</u>	<u>Air</u>	<u>Total</u>
× 109	858.0	50.7	505.0	358.0	3.9	2.231
%	38.44	27.72	22.64	16.02	0.18	100.0

Source: Statistical Abstract of U.S., 1975, Table 936, Page 562.

was not appropriate for this study, as will be seen in what follows. Instead, from the tables in the abstracts and from other sources as quoted by Armbruster and Candela, the crude estimates of non-passenger, freight-related fatalities were generated which are displayed in Table 5.5-2.

The figures of importance in this table are, of course, the railroad and pipeline fatalities. Table 974, p. 581, reports 1916 fatalities in 1973 on Class I and II railroads, including those at grade-crossings. Table 987 identifies 1185 fatalities as train-related, occurring at Class I railroad crossings, and that is the figure in the table for public fatalities. Table 986 breaks the 1916 total into the following categories:

Train	149
Train Services	1704
Non-Train	<u>63</u>
Total	1916

The categorization is not explained, so it is assumed that the train figure of 149 contains passenger and crew fatalities. Deleting that entire number, along with the non-train figure of 63 then is giving the benefit of doubt to the railroad. Then, reducing the train service figure of 1704 by the ratio of freight ton-miles to total (freight plus passenger) ton-miles, leaves the 1700 which appears in the table. The oil pipeline figure was obtained by multiplying the 13 deaths per million reported in Armbruster and Candela, p. 137, for 1963-68 by the ton-miles in Table 5.5-2. The figures for the other modes were similarly derived by cross-correlation between tables in the abstract, without further research. They are of course only passing interest in the present discussion. The unit figure was not calculated for air transport because there did not appear to be any non-passenger, freight-related fatalities in 1973, and even if there were, the ton-miles are so small as to render comparison meaningless.

TABLE 5.5-2

ROUGH ESTIMATES OF NON-PASSENGER, FREIGHT-RELATED TRANSPORTATION
FATALITIES - 1973

	<u>Rail</u>	<u>Oil Pipeline</u>	<u>Truck</u>	<u>Inland Water</u>	<u>Air</u>	<u>Total</u>
All Fatalities	1700	7	1500	300	0	
Fatalities Per Trillion Ton-Miles	2000	14	900	800	NA	
Public Fatalities	1185	0	?	?	0	

Caution - These estimates are very crude, derived only for the purpose,
and by the methodology, explained in the text.

As has been noted above, the pipeline opponents Armbruster and Candela, observe (p. 137) that fatalities in normal operation of slurry pipelines are likely to be negligible, noting that the slurry, not being flammable, can reasonably expect no more than the 13 deaths per million ton-miles experienced by petroleum pipelines in the period 1963-1968. They then discuss the possibility that if the pipeline could cause the railroad to lose "coal traffic and deteriorate (or not improve) so that it lost an additional 12 million tons of current or new non-coal freight to trucks, the 12 billion truck miles so generated would kill 85 people, using national figures". They go on to conclude that, after making some adjustments both ways, it is possible that, on balance, no lives would be saved.

With all due courtesy and respect to those authors, that scenario does not appear to warrant serious consideration. As was discussed in Section 5.2 above, nowhere has any objective evidence been found to support the hypothesis that building slurry pipelines can result in deterioration of the railroads, let alone to the point that coal traffic would be shifted to the highways and streets in any significant quantities.

Returning then to the relative safety of the two principal alternatives for moving the Western coal, i.e., railroad and pipeline, some approximations can be derived. If all the proposed slurry pipelines described by Kiefner (1976) were built, they would result in about 92 million tons per year and about 80 billion ton-miles. Rail movement between the same origins and destinations would be about 112 billion ton-miles. To the extent that the Table 5.4-2 figures would be applicable, they would foretell about 224 deaths per year by rail and about 1.2 deaths per year by pipeline.

Additionally, it is necessary to consider the casualties during construction. The Department of Labor statistics, quoted in the 1976 Statistical Abstract, p. 389, indicates a fatality rate for non-building contract construction of 5.9 per hundred people-years. From the 1977 Pipeline Economics issue of the Oil and Gas Journal, the later fraction for nine large pipelines was taken, a regression line was calculated on diameter as the independent estimate for 38 inch line is 29.7 percent, so that for a billion-dollar project, the total labor should be of the order of \$300 million. At \$30/hour, fully burdened, this would result in 10^7 people-hours, or 5000 people-years. At a 5.9 per 100 person-year fatality rate, the pipeline construction will kill about 300 people, or the equivalent of about 10 people per year when averaged over the life of the project.

Before leaving this subject, some cautionary remarks are in order. First it is to be noted that while the discussion here has treated only fatalities, a conclusive analysis should also treat injuries. Second, some estimate would also be needed of the economic costs involved, i.e., the dollar costs of injuries and fatalities. And finally, it is again noted that the estimates in Table 5.5-2 are very crude, though adequate for the illustrative purpose of this discussion. They indicate that when the longer rail mileage is taken into account, the fatalities by rail may approach 200 times that of a pipeline operation. Even if the true figure is only one-tenth of that, the point is still demonstrated that rail movement will result in many more deaths than movement by pipeline.

5.6 ENVIRONMENTAL EFFECTS

The general area of environmental effects must be examined under three sets of circumstances - during normal and non-normal operation, and during construction.

5.6.1 Normal Operation

It seems safe to say that, under normal operation, no other transportation mode approaches the pipeline in its environmental compatibility. One can stand directly over a buried pipeline without even being aware that millions of tons per year of freight are passing within a few feet of oneself.

Also, if as is usually the case with liquid lines, the power consumed is electric, then the environmental impact of the associated energy conversion process is thereby transferred from the RoW to the power plant location. The environmental effects of this characteristic may be either good or bad. For example, it may be easier for the environment to assimilate the railroad diesel exhaust when it is spread over more than a thousand miles than to assimilate all of the equivalent electric generating station emissions when concentrated at one or two locations.

5.6.2 Non-Normal Operation

There are only two equipment failures which lead to significant environmental impacts. They are a pump failure and a line break. Their impacts are briefly discussed in this and the next section, followed by some general conclusions in Section 5.6.4.

5.6.2.1 Pump Failure

In this discussion, reference to a pump failure means any unplanned cessation or severe diminution of the pumping function, for any reason. The important consequence is that

if the slurry remains idle in the line for an extended period, a hard plug may form at a sag in the line. When the Black Mesa line was built, the formation of such plugs was not a well-understood phenomenon. Therefore, holding ponds were provided at each pump station into which three times the contents up the upstream section of the line could be diverted in event of a pump/power failure. The purpose of the factor of three was to provide capability to deal with as many as three successive shutdowns if they should occur prior to disposal of the line contents from the first shutdown.

Some opposition arguments have attempted to make a major issue of this requirement. While the ability to divert the flow into the ponds is not questioned, the neighbors of the pipeline and others concerned with the environment quite reasonably ask assurance that the slurry can and will be re-injected, even after an indefinite holding period. In the course of this study, some considerable attention has been given to this question. The principal conclusion is that, although the provision of holding ponds was proper and prudent for Black Mesa, they are unnecessary for future pipelines, except at the first station. There are several reasons supporting this conclusion.

First, the Black Mesa experience has shown that following a cessation of pumping, a holding period of several weeks will be available before the formation of hard plugs. The key elements of plug prevention are

- 1) A well-graded consist, so that when flow ceases, when flow ceases, the slurry settles soft and stays soft, and
- 2) A fine grind.

These requirements impose costs because additional treatment during slurrification, additional pumping energy and additional separating work are all required, and these costs are

reflected in the Black Mesa operating experience which is discussed here and in other reports of this series.

During its first year of operation, Black Mesa experienced several power failures. It was found that with the consist then being used, flow could be resumed without difficulty within a few days. However, in one instance, a hard plug formed after 4 1/2 days.

Second, the Black Mesa experience has shown that, even when hard plugs do form, they can be located and relieved in a matter of hours or a few days at most, as was done in the case of the hard plug mentioned above. The line is uncovered and tapped upstream and downstream and pressure differential waves are generated until a small penetration occurs. Thereafter, the plug material is rapidly removed by the flowing stream. The operation involves digging a couple of holes three or four feet deep to uncover the pipe, and the moving and operation of some mechanical equipment to and in the field. To the operator, such interruptions are a worrismatic nuisance and a possible loss of revenue, but they are not in any sense a debacle or catastrophe, and they result in no significant environmental disruption.

It is well to note that holding tanks are required at each pump station for starting and other normal operations. It is also necessary to provide a holding pond at the first station which can contain the linefill to that point, in the event that the slurrification process malfunctions and injects an out-of-specification consist. As long as the operator knows that the consist conforms to specifications, he need not dump the line, even under an extended flow cessation. If the consist deviates outside specification, he can then divert the non-conforming slurry into the holding pond at the first station.

Some of the opponents have attempted to make an issue of the disposal of slurry that may be diverted into the ponds.

When the Black Mesa flow was diverted to the ponds, it was allowed to dry and sold in place. The buyers loaded the dry coal into trucks and hauled it away. Appropriate assurances must of course be obtained, before the future lines are built, that the operators will make similar disposal of any diverted slurry and will not allow it to dry and blow away in the wind.

5.6.2.2 Pipe Break

Pipe breaks in pipelines are very rare. When they do occur, they usually are caused by a bulldozer or other excavating equipment and thus may be classified as human error failures. Precautions are available and are generally taken against all failure modes. Precautions against human error-induced-failures usually consist of signs at intervals along the right of way. More extreme measures could include patrolling the right of way or fencing critical parts of it. Precautions at stream crossings are taken, both in design and operation. It is nearly always possible, at some expense, to bury the pipe below the stream bed, to tunnel or encase it in concrete. Where that is not economic, surveillance is called for, and there are professional engineering organizations which specialize in such work, which they perform on a contract basis.

Use of these precautions is of course a matter of economics. The possibility of failure could be reduced to virtually zero, but at great cost, by burying the pipe 20 feet deep, tunneling under all stream crossings, fencing, and patrolling the entire right of way. To arrive at a judgement as to a reasonable, justifiable cost, it is necessary to make some comparisons, both with other pipelines and with the alternative transport mode, i.e., rail.

5.6.2.2.1 Comparison with Other Pipeline Spills

In qualitative effect, compared with breaks in oil and gas lines, the consequences of a break in a slurry line would appear to be no worse and in many cases much better. While superficially there might appear to be little to choose between the undesirability of having crude oil or coal slurry smeared over the countryside, analysis will show that the slurry spill would be much less undesirable because the land can be returned to cultivable or naturally vegetated condition easier and quicker. Gasoline and natural gas, of course, evaporate rapidly or escape to the atmosphere, but present severe fire hazards, and analysis will show that, on balance, the slurry spill will certainly be the less undesirable than a gasoline spill, and in many cases preferable to a gas line break.

It is well to acknowledge the extremist position, which holds that the slurry line should be required to make provision for a pipe break, presumably by provision of block valves and holding ponds at appropriate intervals. However, in view of the foregoing conclusions, it is difficult to find logic in that position. Experience in the 150,000 mile of existing oil pipelines have shown such precautions are unnecessary and since slurry spills are less undesirable than oil and gasoline spills, such provisions are unnecessary for slurry lines.

5.6.2.2.2. Comparison with Railroad Spills

In the case of a break in a 1000-mile pipeline carrying three-quarter of a million tons of coal, the spilled quantity would be the linefill back to the nearest upstream block valve. A reasonable spacing for such valves is ten miles, so that the spill would be of the order to 7500 tons of coal and an approximately equal amount of water. Derailment and complete overturn of a unit train would spill a maximum of about 10,000 tons of coal in chunk form. Which of these were less undesirable would depend upon where the spill occurred. Derailment of a 10,000-

ton coal train while passing through a town at 60 miles per hour might result in much more environmental damage and personal injury than a pipeline broken by a bulldozer out on the prairie. The pipeline would not be routed through a town or city in any case. Also, by careful routing and RoW construction, it can be insured that a spill would not flow down into a town, though at a cost.

5.6.3 Constructional Impact

Since the pipeline would, in the ordinary course of events, be routed around cities and towns, the environmental impact of its construction is taken by the countryside. Pipeline construction in general is one of the least obtrusive forms, partly because it moves. Even at points of unusually severe impact, such as road or river crossings, the intense activity is completed in a few days, or weeks at most and the crew has disappeared over the horizon much sooner than with a new highway for example. Except in the antic tundra, the construction wounds are rapidly healed by natural processes, provided of course that appropriate measures for coverage and backfill are taken.

5.6.4 Environmental Conclusions and Recommendations

While it is not within the scope of this study to assess in depth or in detail the environmental impact of slurry or other types of pipelines, some general conclusions and observations can be made.

1) It is concluded that the countermeasures are at hand to defeat the identifiable environmental threats to almost any prescribed level of risk. Quite naturally of course, the lower the level of prescribed risk, the greater the cost of the countermeasures. The open question then is the acceptable level of risk. Once the level has been fixed, the pipeline engineer

can, for any specific proposed pipeline, design a system which defeats the threat to that level of risk, estimate its cost, and perform an economic analysis to establish whether the return on investment (RoI) is acceptable to the prospective investor.

2) This study does not include sufficient examination of environmental effects to develop specific, detailed suggestions as to risk. However, since the competition is between pipelines and unit trains, it seems clear that the pipeline should be constrained to an equivalent unit-train level of overall impact. It has been seen above that even a major pipeline spill would probably pose no more severe an environmental threat than would a unit train overturn. Experience with the nation's 150,000-mile oil pipeline network over many years has shown that the probability of a major spill is so remote as to be negligible. Train derailments, on the other hand, are common occurrences, although most derailments would not spill an entire train and some do not spill any significant amount. For the case of a major spill, it is not possible to say, without much more study, which mode poses the greater risk.

3) With regard to daily environmental impact, the pipeline is the clear and obvious winner. The burden of daily passage through towns and cities of several trains an hour, moving 50 or 60 miles per hour, generating noise levels well over 100 dba, blocking roads and streets for hours of each day, and spilling thousands of tons of coal per year along the RoW is not to be taken lightly.

4) It appears that under the National Environmental Policy Act (NEPA) (see Report SSS-R-77-3024 of this series) the basic governmental machinery may already exist to prescribe and enforce acceptable levels of risk for slurry pipelines. Under this Act, environmental impact statements must be prepared, published, debated and approved. This process appears to be providing adequate environmental protection for other large

projects, and there is no reason why it should not be adequate for that purpose in the case of slurry pipelines. If, for any reason, it is found that it does not adequately protect in this case, then possible extension of this machinery to cover the slurry pipelines should be studied, and appropriate recommendations for the congress should be developed.

5) In view of (3), it appears both possible and reasonable to separate the questions of environmental impact and eminent domain for slurry pipelines. Stated differently, it would seem reasonable for both opponents and proponents to agree to settle the environmental issues in another court and debate the issue of eminent domain without further reference to the former.

6) The suggestion in (4) above should naturally be subject to the proviso that the environmental impact and risks would be judged equal for pipelines and unit trains. While this study is intended to develop recommendations to the DoE, not the Congress, it nevertheless seems appropriate to suggest that this proviso could be stated in a form acceptable to both parties and included in the proposed law generating the ED power. In that way, the issues could be debated separately, each upon its own merits.

7) A critical part of the task just recommended in (6) above is establishment of the acceptable risk level. Such a development is beyond the scope of this study, but a method of approach is recommended. It was seen in the preceeding section that the safety margin of the pipeline over the railroad is such that, if all the presently proposed pipelines were built, many people's lives, possibly over 200, would be saved each year. (As we noted there, this estimate is very crude, and does not include the lives that will be lost in constructing the pipeline, but if the true figure is twenty instead of 200, the conclusions and recommendations stated here are not significantly modified.) It would then seem reasonable to fix the acceptable level of risk for the pipeline at the same figure.

5.7 EMPLOYMENT

The potential employment effects of building slurry pipelines are felt in two quite different ways: the short-term effect during construction, and the long term effect during operation. They are discussed here in the reverse order. A more extensive review of employment estimates has been presented by Nelson. (1976).

5.7.1 Operational Employment

It has been seen in Section 4.2.2 above that the labor intensity of slurry pipelines, as with pipelines in general, is very low, with current projections approaching 100 million ton-miles per employee-year. In terms of relative employment between the pipeline and the railroad, there are different opinions as to the magnitudes of the two labor forces to accomplish the equivalent movement of coal. However, both sides agree that the railroad labor force is three to four times greater than that of the pipeline. As a long-term provider of jobs, the railroad far excels the pipeline. Quite naturally, this argument is advanced by the railroad labor unions in opposing the pipeline (Hearings 75, pp. 862-912).

The pipeline proponents' rejoinder is that if the pipeline is the cheapest mode of transport, than a refusal to build it in order to keep people working at unnecessary and obsolete jobs is nothing more than a variation on the ancient theme of featherbedding.

Now, an in-depth analysis of the broad public-policy question of providing jobs is clearly beyond the resources of this study, whose present purpose is only to summarize the controversy. It is of present interest, therefore, only to note the circularity of the argument that may evolve.

If ED power is granted to the pipeline because it is in the national interest to do so;

And if it is in the national interest because the pipeline moves the coal at lesser cost than the railroads;

And if the pipeline costs less because it eliminates several thousand jobs;

And if there are no other suitable jobs available for those displaced people;

And if the nation is committed to supporting the fraction of those people who are thus rendered unemployed,

Then it could be argued that the cost of that public support should be deducted from the gross cost savings of the pipeline before the construction of the pipeline can be declared to be in the national interest.

5.7.2 Constructional Employment

If contrary to the foregoing and as is sometimes the case, the public concern is not so much with long-term employment, over thirty years or more, but with the immediate provision of jobs, then billion-dollar pipeline construction projects, which will be financed entirely with private funds, have an obvious and offsetting attraction. It is therefore not surprising to find the construction unions supporting the pipeline and opposing the railroad unions (Hearings 75, p 687).

Again, a quantitative analysis of the employment impacts of the two transport modes is beyond the resources of this study and is therefore not attempted.

5.8 WATER MOVEMENT

The questions of slurry pipeline water supply, movement, purification, and disposal are often treated as parts of the broader issue of the pipeline's environmental impact. In the present instance, however, partly for convenience, they are discussed separately.

It is sometimes argued that water problems should not even be considered in debating the issue of federal eminent domain for slurry lines. The states historically managed their own water, so the argument goes, and there is no reason why they should not do so in the case of slurry pipelines. Parenthetically, it may be noted that that is precisely what happened in the case of the ETSI line. ETSI made arrangements with Wyoming for the necessary water. Therefore, the argument continues, there is no reason for the federal government to become involved.

Moreover, even in the arid states, some allocation is made of water for industrial use, and it should be left to the people of that state to decide whether they want to assign some portion of that allocation to slurry pipelines or to some other industrial use.

Seen in this light, the question of water usage by slurry pipelines is stripped of much of its emotionalism.

It is a conclusion of this study that the question of water for slurry pipelines still has an important bearing upon the issue of federal eminent domain. If the Congress, with full knowledge of the problems and issues surrounding water supply, endows the slurry lines with federal eminent domain without any recognition of the water issue, that action would surely be construed as a congressional endorsement of the principal using water for slurry lines in the arid West. The only way to avoid such an implied endorsement would appear to be by an

explicit statement in the act that the water questions must be resolved by the state involved in each case, and that has not been proposed. In the absence of such a provision in the act, it is difficult to see how the congress can reach a finding that eminent somain for the slurry pipelines is not contrary to the national interest, unless it has concluded that the water can in fact be allocated from other uses without adverse effect upon the public interest.

5.8.1 Water Quantities

It was seen in Section 3.0 above that coal slurries generally operate most efficiently at mixtures of about half water and half coal by weight. Thus, every million tons of coal that is slurried requires about 750 acre-feet of water. There is naturally strong concern about long-term commitments to export such quantities of water from the state.

It is not always easy to place this requirement into perspective. The ETSI proponents tend to disparage its importance by noting that their 25 million ton line will only require the same amount of water that one five-thousand-acre farm would consume. The opponents note that if 100 million tons of coal per year were moved by slurry from Wyoming, the water requirement would be enough to cover all the 263,000 acres of wheat which were harvested in that state in 1973 to a depth of about three and a half inches. Neither comparison is of course appropriate unless the water is diverted from agricultural use, which is not likely to be the case.

5.8.2 Water Sources

The two primary potential sources of water are surface water from the Missouri River and ground water from the Madison Limestone. ETSI has purchased from the state of Wyoming 20,000 acre-ft per year, to be taken from the latter. The opposition

to further such allocations is strenuous and is based, in part, upon the current state of ignorance regarding the geology of the aquifers, the nature of water movement through them, and the rate of recharge. With regard to the latter, a recent USGS estimate is described by Hudson (1976):

"...Recharge to the Madison Limestone in north-eastern Wyoming is estimated to be about 100,000 acre-ft per year, and most enters in the outcrop in the Black Hills of South Dakota to the east and in the Big Horn Mountains of Wyoming to the west. Some recharge appears to be rejected and returns to the surface as springs. It is estimated conservatively that 70,000 to 80,000 acre-ft may be produced annually from the Madison without affecting existing wells, particularly near the eastern and western boundaries of the Basin..."

If this estimate is correct, the Madison could supply all the water needed for all the pipelines that have been proposed from the Powder River Basin. However, it is in fact only an estimate, yet to be confirmed by long-term observations. It therefore would seem prudent to ensure that if the ETSI line is built with the Madison formation as its water source, the formation should be monitored during operation of the pipeline. This is exactly what has been done at Black Mesa since its inception (Levings 77).

The potential availability of surface water from the Missouri River has been studied by the state of Wyoming. One of the unpublished studies contains the projection shown in Figure 5.8.2-1. It is seen that the committee which studied the problem proposed a 3 million-acre-foot-per-year allocation for industrial use. Allotment of 100,000 acre feet or less to cool transportation appears reasonable.

Figure 5.8.2-1. Water projections - Missouri River at Sioux City.

5.9 SUBSIDY OF PIPELINES

It has been observed (Hearings 75) that there is nothing to prevent the pipelines from simply buying the necessary right of way. Obviously, the pipeline interests are unwilling to do this, at least while the possibility of obtaining the power still exists. It is therefore clear that the pipeliners are convinced that the cost to them will be significantly lower with the eminent domain power than without it. Thus, the eminent domain power has a significant cash value to them. This simple conclusion is of course confirmed by the magnitude of their expenditures in lobbying for the new law.

It is further argued that since the eminent domain power has a cash value, the granting of the power is therefore a form of subsidy. This viewpoint is the converse of the one examined in the previous section. If withholding the ED power from the pipelines is the chosen mechanism for subsidizing the railroads, then granting the power constitutes subsidy of the pipelines.

The rebuttal is, of course, that characterization of the eminent domain power as a subsidy is improper in either case, since it does not cost the taxpayers anything. And even if the eminent domain power were properly characterized as a subsidy, it would be among the least painful of the many that the taxpayers have underwritten. Neither is it underwritten by the property owners, because the terms of the power require that they receive fair reimbursement for the use of their property. And anything more than fair is unfair.

The pipeliners' position, then, is that they do not ask for any subsidy, only for the eminent domain power, which requires that they pay fair value for what they receive. They further acknowledge that granting of the power imposes certain public duties and obligations, including ICC regulation and the capability to function in some degree as a common carrier, and they profess willingness to accept those duties and obligations.

It is concluded that the ED power is not a subsidy in any accepted sense of the term, and the granting of the power to the slurry pipelines is, from that point of view, not against the national interest.

REFERENCES

- Armbruster, F. E. and Candela, B. F., "Research Analysis of Factors Affecting Transportation of Coal by Rail and Slurry Pipeline," Hudson Institute, Quaker Ridge Road, Groton-on-Hudson, New York, Report HI-2409-RR, April 1976.
- Aude, T. C., T. L. Thompson, and E. J. Wasp, "Slurry Pipeline Systems for Coal, Other Solids Come of Age," Oil and Gas Journal, July 21, 1975.
- Breithaupt, Harry J., Jr., "Eminent Domain--Coal Slurry Pipelines," Statement before the Senate Committee on Interior and Insular Affairs on Amendment No. 1175 to S. 2652, June 11, 1974.
- Brief of Intervenor-Respondent, submitted to the Eighth Circuit Court, No. 76-1899, San Antonio (1976).
- Business Week, "A Railroader's Bad Day at Black Mesa," August 4, 1975.
- Campbell, T. C., "Coal Slurry Pipelines: Eminent Domain and Water Issues," U. S. Department of the Interior, Bureau of Mines, presented at the International Symposium on Freight Pipeline, December 5-8, 1976, Washington, D. C.
- Campbell, T. C. and S. Katell, "Long-Distance Coal Transport: Unit Trains or Slurry Pipelines," Bureau of Mines Circular/1975, IC 8690.
- "Coal Production & Transportation: The Next Five Years," Transcript of a Conference sponsored by Professional Lease Management, February 26-28, 1975.
- Dina, M. L., "Operating Experiments at the 1580 Mw Coal Slurry Fired Mohave Generating Station," presented to International Conference on Slurry Transportation, Battelle Memorial Institute, Columbus, Ohio, February 1976.
- Dina, M. L., Private Communication, February 22, 1977.
- Hearings before the Committee on Interior and Insular Affairs, House of Representatives, 94th Congress, Serial No. 94-8.

Hudson, Hugh H., Presentation before the Southwest Regional Energy Council Legislative Conference on Greater Coal Utilization, Dallas, Texas, August 5, 1976.

Input Output Computer Services, Inc, "Rail Transportation Requirements for Coal Movement in 1980," Study performed for Department of Transportation, 1976.

Kiefner, J. J., "Review of Slurry System Projects in the U. S.," Proceedings of the Conference on Slurry Transportation, Battelle Memorial Institute, 3-4 February 1976.

Levings, Gary W., "Progress Report on the Black Mesa, Arizona, Ground-Water Monitoring Program," Proceedings of the Second International Technical Conference on Slurry Transportation, Las Vegas, Nevada, March 2-4, 1977.

Low-Beer, Anthony, "Burlington Northern (BNI, NYSE)," Memorandum from the Research Department of L. F. Rothschild & Co., New York, New York, November 14, 1975.

Low-Beer, Anthony, "Railroad Industry: Impact of Coal Slurry Pipelines," Memorandum from the Research Department of L. F. Rothschild & Co., New York, New York, January 23, 1976.

Miller, Michael P., "Intercity Freight Fuel Utilization at Low Package Densities - Airplanes, Express Trains and Trucks," Proceedings of the Third National Conference, Effects of Energy Constraints on Transportation Systems, sponsored by Energy Research & Development Administration, Schenectady, New York, August 1976.

Montfort, J. G. and E. J. Wasp, Coal Transportation Economics, May 1974.

Montfort, John G., Private Communication, February 10, 1976.

Nelson, Ava S., "The Environmental and Political Implications of the Pipeline Transport of Coal," Environmental Studies Senior Thesis, University of Pennsylvania, May 10, 1976.

Railway Age, "But Who Will Pay the Piper?", March 14, 1977.

Railway Age, "What Unit Trains Do to Track," April 12, 1971.

Reiner, I. A., "The Effects of Jumbo (Heavy and High Cube) Cars on the M & W Expenses," Prepared for the AAR Accounting Division's 1970 Annual Meeting, held in New Orleans on May 25-27, 1970.

Rieber, M., et al., "The Coal Future: Economic and Technological Analysis of Initiatives and Innovations to Secure Fuel Supply Independence", Center for Advanced Computation, University of Illinois at Urbana-Champaign, May 1975 (sponsored by NSF).

Rieber, Michael, et al., "Route Specific Cost Comparisons: Unit Trains, Coal Slurry Pipelines and Extra High Voltage Transmission," Prepared for Science and Public Policy Program, University of Oklahoma (Subcontract No. 158-376), May 1976.

Rifas, Bertram E., and Sally J. White, "Coal Transportation Capability of the Existing Rail and Barge Network, 1985 and Beyond," Prepared for Electric Power Research Institute, Palo Alto, California, September 1976.

Soo, S. L., and L. Ballard, "Cost of Transportation of Coal: Rail vs. Slurry Pipeline," Department of Mechanical and Industrial Engineering, University of Illinois at Urbana-Champaign, Urbana, Illinois, June 1975.

State Water Resource Management System Facility, Report on, "West River Aqueduct, South Dakota," Prepared by Division of Resource Management, Department of Natural Resource Development, September 1976.

Statistical Abstracts of the United States, 1975 (and other years), published by Bureau of the Census.

Steffes, Dale W., "A Study of the Optimum Speed of a Coal Unit Train," Planning & Forecast Consultants, February 1976.

Walker, James R., "Coal Slurry Pipelines and National Transportation Policy: A Critical Review," The Logistics and Transportation Review, Volume 12, Number 4, 1976.

Wasp, E. J. Private Communication, February 9, 1977.

Wasp, E. J., "Progress with Coal Slurry Pipelines (Comparison with Unit Trains)," Paper presented at American Mining Congress, San Francisco, September 30, 1975.

Wasp, E. J. and T. L. Thompson, "Slurry Pipelines-Energy Movers of the Future," Oil and Gas Journal, 71, No. 52, December 24, 1973.

Welty, Gus, "For the BIG Cars, What Kind of Track?" Railway Age, March 14, 1977.

Welty, Gus, "Unit-Trains: Traffic by the Trainload," Railway Age, September 1973.

Zandi, I., and S. K. Kyong, "Solid Pipeline Conserves Energy," Transportation Research, Vol. 8, Pergamon Press, 1974.

APPENDIX

Letter from James R. Walker, Associate
Counsel, Burlington Northern, Inc.,
Feb. 28, 1977

BURLINGTON NORTHERN

Frank S. Farrell
Vice President-Law

Herbert B. Krenzel
General Counsel
Curtis H. Berg
Sr. Associate General Counsel
—Commerce

James R. Walker
John C. Smith
Reginald Ames
Louis A. Harris
Associate General Counsel

Harold K. Bradford, Jr.
Richard V. Wicks
Byron D. Olsen
Richard M. Gleason
Barry McGrath
Robert L. Bartholic
Assistant General Counsel

Donald C. Knickerbocker
George A. Morrison
Assistant General Counsel—Taxes

Peter M. Lee
William R. Power
James W. Becker
Nicholas P. Moros
Thomas W. Spence
Ralph S. Nelson
Attorneys

Dr. William F. Banks
Systems, Science and Software
P. O. Box 1620
LaJolla, Calif. 92038

February 28, 1977

Dear Dr. Banks:

A copy of the circulation draft of your paper entitled "Slurry Pipelines - Economic and Political Issues - Review" has been forwarded to me by the Association of American Railroads with the request that I send you my comment. Perhaps this is because the topic is one on which I have been working for some years now on behalf of the Burlington Northern. In any event, I bring a transportation lawyer's point of view to the controversy but of course have had the help of many specialists. As being illustrative of the kind of work I have done there is enclosed an article which was the outgrowth of a presentation I made to the Transportation Research Forum in Boston last fall.

By way of further preface I think it fair to say that thus far you have done an excellent job of analyzing the economics and the engineering technicalities involved; yet I am in fundamental disagreement with you on one basic point, namely, your attachment of at least some credence to the argument that slurry pipelines will defeat the "monopoly pricing" of the railroads. To this point I refer you to the mentioned article, to the enclosed testimony of L. W. Menk during the House Interior Committee hearings on H.R. 1863 (your reference C) and to my own statement before the Oklahoma Legislature which was prepared for delivery March 2, 1977.

I'm not going to be able to give you a detailed critique of your draft just now but among the points I'd like to make are the following:

At page 2-1 you say that the growth of coal slurry pipelines into new markets is "prevented by the almost universal refusal of railroads to permit the slurry pipelines to cross their

BURLINGTON NORTHERN

Dr. Banks

2/28/77

Page 2

right of way and that in general the only way for pipelines to overcome that obstacle is the exercise of the right of eminent domain." It seems to me that these statements are over-broad. One major railroad, the Missouri Pacific, authorized numerous crossings of its line. Other western roads have refused. No demands have been made of eastern or southern roads of which I am aware. The Black Mesa pipeline was of course constructed after the negotiation of rights to cross at least two points on the Santa Fe. In addition some railroads operate over rights of way which, as the name implies, are but naked easements. A series of lawsuits is now pending by which to settle the entitlement of slurry pipelines to cross rail rights of way of this character. However, the real point is that the action of the railroads is not one of sheer obduracy; it is instead intended to compel all concerned to look at the national transportation issues inherent in this scheme to exploit a special transportation situation at the expense of true common carriers and the shippers who depend upon them.

Also at page 2-1 you attempt to summarize the legal principles involved in the eminent domain right. I should say first that while there have been grants of Federal eminent domain, by and large it is not employed for any carrier purpose except for natural gas pipelines. To this point see the treatment afforded by my article and I think you might also like to look at what Tom Campbell had to say in his recent paper on the subject. I'll get it into the mail later in the week. Have in mind, however, that Dr. Campbell is not a lawyer and I am sure he would be the first to say that he has not exhausted the complexities of the subject. Moreover, I believe that you are obscuring the real issue when you say at page 2-2 that the central issue is whether it is in the "national interest to endow the slurry pipelines with the Federal power of eminent domain." Are you speaking of the national interest in a sound overall transportation policy or are you speaking of the much narrower national interest which some perceive in assuring the making of massive deliveries of coal to the very few points which conceivably could burn the large volumes the slurry lines will handle? Should you not also speak of the state interests in the problem? Texas, Oklahoma, Kansas and Nebraska are now considering whether the authority should be granted at the state level and it is at the state level that carrier

BURLINGTON NORTHERN

Dr. Banks

2/28/77

Page 3

eminent domain authority has traditionally been conferred. Thus I would like to see you re-phrase your summary so as to cast the question in terms of the public interest in a proper national transportation policy and at the same time identify the fact that state issues are involved as well.

At page 2-3 you quote at length from the testimony of Floyd Lewis of Middle South Utilities and in the reference portion of your paper you allude to the hearings before the Committee on Interior and Insular Affairs from which the Lewis material was taken. I suggest that you will wish to examine the record in greater detail and refer in particular to the prepared statement of Mr. L. W. Menk which begins at page 917 (duplicated by the enclosure). Note in particular his Exhibit W which consists of a letter to the Chairman of the Committee describing the efforts of Middle South to whipsaw the railroads and the dilemma with which the latter were faced in anticipating how they could meet their common carrier obligations in the face of Middle South's stated intention to abandon rail service in a few years in favor of pipeline deliveries. This exhibit appears also at page 952 of the official hearing record. I trust this evidence will answer the question you ask as to how a serious customer can be denied "the courtesy of a quotation for three years."

I am repeating myself, but Mr. Menk's letter (Ex. W) serves to point out what I conceive to be the fundamental deficiency in your study, namely, the misconception expressed at page 2-8, namely, that "a persuasive case might be made that slurry pipelines are in the national interest because they are the only effective means in sight to limit somewhat the railroad monopoly pricing of western coal traffic. * * * " The only monopoly involved in the pricing of coal transportation is a monopoly which would be created by the through-put contracts which the coal slurry pipelines acknowledge they will employ if these facilities are built. To this point I invite your examination of another enclosure, an agreement consisting of two letters exchanged by ETSI and the City of Wichita. As to whether there is indeed a railroad monopoly in the transportation of coal, I refer you to my Oklahoma statement. Finally, were there actually monopoly pricing the public has ICC protection to rely upon, as to which see my paper and the discussion of the San Antonio rate case.

BURLINGTON NORTHERN

Dr. Banks

2/28/77

Page 4

In the rush to get away for the Oklahoma hearings, I can say no more except to mention that your accident statistics are not appropriate to coal train operations, as to which our experience is several times better than is true of conventional trains.

Oh, I nearly forgot - on the assumption you have not seen it I'm enclosing a copy of a DOT staff study which, a year ago, examined many of the same problems with which you are now dealing. The bibliography is worth noting also. When you've had a chance to examine all these materials I would be glad to discuss the subject with you should you wish to do so. If you'll let me know what your time limitations are perhaps I'll be able to give your paper closer examination respecting technical details as I recall noting some points when I first read it a week or so ago which do not occur to me now.

Very truly yours,

J. R. Walker

JRW/dt
Encl.