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RAIL TRANSPORTATION REQUIREMENTS FOR COAL MOVEMENT IN 1985

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FINAL REPORT

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16. Abstract

This study of transportation requirements for coal movements through 1985 is one of the series conducted for the U.S. Department of Transportation to identify and quantify future transportation requirements for energy materials. This report presents the results of the study.

The primary objectives of the study were to develop a scenario for 1985 coal production and consumption and to project rail coal traffic volumes and equipment and facilities requirements consistent with the scenario. A second objective was to identify the planning processes used by the railroads to identify and prepare for future traffic. The third objective of the study was to identify potential constraints to the institutional issues impacting increases in rail coal traffic and the ability of the railroads to handle it profitably.

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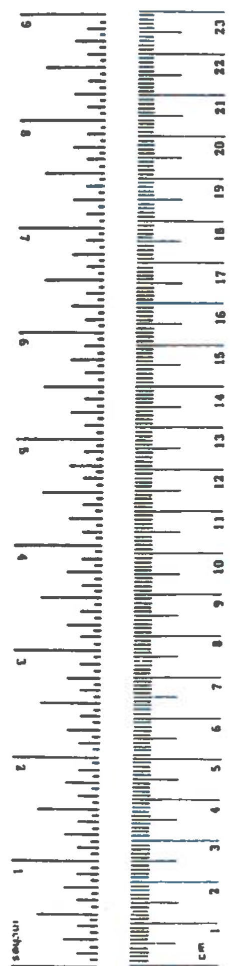
METRIC CONVERSION FACTORS

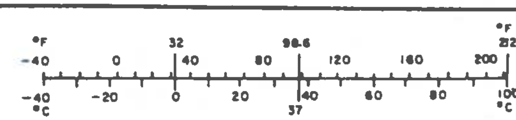
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

This rail-oriented coal transportation study is one of a series of studies conducted for the Department of Transportation to identify and quantify transportation requirements for energy materials. Information provided by these studies will be used by government and industry to examine and shape present and future transportation policies and related resource allocation decisions.

This report documents key findings of Input Output Computer Services, Inc. (IOCS) under Contract DOT-TSC-1282 to the U.S. Department of Transportation, Energy Policy Division and Transportation Systems Center. The Study was performed during 1977 and reflects data available at that time.

In an undertaking that involved so many organizations and complex issues, the debts of the authors to others are quite extensive. Much help was derived from the published and nonpublished reports of others in the energy and transportation fields. We are indebted to the following organizations for providing valuable assistance in collecting and analyzing data and reviewing the report material. Without their help, this study could not have been successfully completed.

Association of American Railroads
Burlington Northern, Inc.
National Coal Association
Norfolk and Western Railroad
Southern Freight Association
Traffic Executive Association - Eastern Railroads
Western Railroad Association
The Family lines
Atchison, Topeka and Santa Fe

PREFACE (continued)

The officials within the rail industry and its associations not only provided valuable insight into complex issues but also freely gave their precious time and help in reviewing and analyzing various parts of the study. In this connection, we would like to thank Mr. Joe Feeney, Mr. Jim Walker, Mr. A. S. Lang, Mr. Gerald J. Robinson, Mr. R. D. Jones, Mr. D. Tolmie, Mr. R. Bateson, Mr. R. Briggs, Mr. K. Hoepner, Mr. D. Hemphill, Mr. E. Seimon, Mr. T. Halpin, Mr. Bates B. Bowers, and Mr. R. Neubauer.

We also appreciate the inspiration and knowledge provided by Dr. David L. Anderson who was Chief, Industry and Policy Analysis Branch, Transportation Systems Center and Technical Monitor for most of the study. Also, we thank Dr. Larry Vance, Technical Monitor for the latter stages of the study. Both men provided advice and guidance and created the environment which allowed successful completion of the project.

Finally, the authors wish to express their gratitude to the many others whose considerable effort helped to bring this project to a successful conclusion.

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EXECUTIVE SUMMARY

INTRODUCTION

Since the U.S. embarked on the effort to become energy self-sufficient, it has been apparent that coal would be an increasingly important energy source. Subsequent events such as the critical shortages of natural gas during the winter of 1976-1977, the continuing public resistance to nuclear power and the ban on commercial development of breeder reactors indicate that the development of coal as the major "new" source of energy will occur. As with any undertaking of its magnitude, the formulation of plans and programs to develop and control the future energy mix in the U.S. is an extremely complex process. One integral part of the process is to determine the requirements for distributing the energy, in this case coal, from its source to points where it will be needed. Information presented in this study, along with others conducted by the U.S. Department of Transportation, Office cf Intermodal Transportation, Energy Policy Division will be a valuable aid in planning future national energy programs and assuring that resources are available to meet national energy goals.

The focus of this study is 1985 Railroad coal transportation requirements and issues.

STUDY PURPOSE AND OBJECTIVES

The purpose of this study is to present information on long range coal transportation requirements and related issues, to those responsible for setting energy policy and developing energy programs. In support of this purpose there are four primary objectives.

- Develop a reasonable forecast of the volume of coal traffic and the traffic patterns in 1985.
- Develop transportation industry estimates of the equipment and facilities required to move the forecast coal tonnage.
- Identify and describe the long range planning processes and tools used by carriers to prepare for the expected increases in coal traffic.
- Identify and describe potential constraints, technologies and institutional considerations which will impact the transportation of coal in the future.

When possible, comparisons are made between 1975 coal traffic and 1985 traffic.

STUDY METHODOLOGY

The approach selected to perform this study was to present a forecast level of coal production and consumption to the railroads through their regional associations and have the railroads estimate the transportation requirements for the forecast coal traffic. The study was designed to implement this approach in three steps. The first step was to identify and analyse coal production and consumption forecasts and the assumptions underlying them. This was accomplished by reviewing the most recent literature on future energy scenarios and by interviewing representatives of industry and government organizations. More than sixty scenarios were reviewed and analyzed in light of industry and government expectations of events influencing future energy developments. These scenarios are discussed in section 4.1. The result of this process was a forecast of coal production and consumption by state for 1985.

The second step was to present the forecast coal production and consumption data to the regional railroad associations. The associations, through their members, prepared the coal flows and transportation requirements based on the coal production and consumption forecasts. These associations are composed of the railroads which operate in the ICC defined Eastern, Southern and Western territories. Since some roads operate in more than one geographic territory, they generally are members of more than one association. Because the information requested from the associations concerns the competitive positions of railroads vis-a-vis each other and with other modes for traffic and their operating strategies, it is of an extremely sensitive nature. Therefore, each association must maintain the confidentiality of its members' information by submitting aggregate data for all member roads participating in the study.

The third step in the study design was to interview major coal carrying railroads to develop information on the long range planning processes they use to identify and prepare for future increases in coal traffic. A second objective of the interview process was to identify and discuss possible constraints, technological developments and institutional factors influencing their ability to generate and properly handle increased coal traffic. In addition to railroads, equipment manufacturers, locomotive manufacturers and other industries involved in the coal distribution process were also contacted to determine their plans and capabilities and to estimate costs for components in the transportation system.

The information gathered through these three steps has been evaluated and analysed and is presented in this report.

STUDY FINDINGS

The findings of this study presented in this report are the result of the best judgement of the authors. They were compiled from the best available data and insights of the railroad, coal, and other industries. It should be kept in mind, when reviewing these results, that they are based on a hypothetical scenario which may or may not represent reality in 1985. There are still many uncertainties surrounding the development of coal as the primary energy source for the U.S. whose resolution will significantly impact the projections presented in this report. Careful observation of future developments is required to gain maximum benefit from these findings.

- The U.S. consumption of energy continues to grow at a rate which cannot be sustained by the current mix of energy sources. Development of alternatives to oil and gas are mandatory. Coal, the most abundant fuel in the country, will most likely fill much of the U.S. energy needs for the future.

- Most forecasts of 1985 coal production project about 1 billion tons. This represents an increase of about 400 million tons over 1975 production. The estimates used in this study were prepared prior to President Carter's National Energy Plan. However, the coal production forecast of 1.1 billion tons for 1985 is very close to that of the President's plan.

- Due to a lack of an acceptable comprehensive national energy plan and conflicting policies within the Federal government, coal producers and consumers face serious obstacles in their efforts to expand coal development. Environmental protection standards for mining and burning coal which recognize the necessity for meeting energy demands economically will resolve many of the problems. Policies in these areas are still in debate in Congress and within the administration.

- Based on the scenario presented to them, the railroads participating in the study project 1985 coal tonnage originated at 799 million tons. These railroads originated 94% of 1975 coal traffic.

- In preparing for this traffic, participating carriers project a total requirement of $6.1 billion for equipment, track, signalling, maintenance facilities and yard facilities. Total freight car requirements are projected at 80,000 cars above the existing fleet at a cost of $2.4 billion at 1976 prices. About 40% of these cars are estimated to be shipper supplied. Many shippers elect to own their own equipment to maintain control of the cars and for financial benefits. Participating carriers estimate locomotive requirements at 3086 units above existing fleets at a cost of $1.5 billion at 1976 prices. The additional locomotives are primarily 3000 horsepower road locomotives with some smaller units for mine run trains. Fixed plant expansion is projected at $2.2 billion. This is primarily for expansion of capacity in track, yards, maintenance facilities and improved signalling. No explicit accounting or assumptions were made about deferred maintenance or previously delayed capital projects. The fixed plant expenditure projections represent requirements to properly handle projected increases in coal traffic.

- The greatest increase in coal traffic is expected in the west. The participating western railroads project an increase in originated coal tonnage of more than 331% to 237 million tons in 1985. This tonnage is projected to require 45,000 new freight cars, 1983 locomotives and $1.9 billion in fixed plant investment.

- Participating eastern railroads project an increase of 122 million tons in 1985 above 1975. This would require 19,700 freight cars and 592 locomotives above the existing fleet. Fixed plant investment is projected at $200 million.

- Participating Southern Territory railroads project an increase of 59 million tons by 1985. This represents an increase of 50% and would require 15,000 new freight cars and 511 locomotives. Fixed plant investment is projected at $114 million

- Coal traffic is currently the largest single commodity carried by railroads. However, it provides only about 18% of total revenues. Increased profitable coal traffic is expected to provide a solid base to improve future financial viability for several railroads. Simultaneously, expansion and improvement of railroad facilities to handle coal traffic will benefit all other traffic.

- The total financial requirement projected for 1985 coal traffic is $6.1 billion. This is broken down to $3.9 billion for locomotives and cars and $2.2 billion for fixed plant. The participating railroads indicated that these funds would be available if forecast coal traffic remains a long term profitable prospect for the railroads. However, uncertainties in government policies regarding future energy development, environmental protection, coal mining and competing modes of transportation may impair the ability of railroads to raise needed capital. In particular, strip mining regulation, power plant emission standards and coal slurry pipeline transportation will have a strong effect on the increase in railroad coal traffic.

- The construction of coal slurry pipelines would have an adverse impact on future increases in rail coal traffic. As currently contemplated, slurry pipelines would remove large volume movements from rail competition for up to 20 years. This could impair the ability of some railroads to raise needed capital. Slurry pipeline issues are more regional than national at this point in time. The principal issues surrounding slurry pipelines are in debate in the U. S. Congress and various state legislatures and are not resolved.

- Most railroads use long range planning processes to identify future traffic and the requirements for handling it. The sophistication and techniques employed vary as do the time horizons used. In general, the carriers depend on customer supplied data and independent forecasts as inputs to the process. Data on coal traffic are available for 5 to 8 years into the future. The techniques used to convert customer data and forecasts into railroad requirements and operations projections range from sophisticated families of computer models to simpler parametric analyses. Long range planning processes are continually evolving on most roads to meet changing requirements and information needs.

- Several areas of potential constraints and institutional issues which impact future rail coal transportation were explored. Participating carriers indicated that some institutional changes would facilitate the profitable handling of future coal traffic. First, more even regulation of modes and reduction of subsidies to competing modes would benefit railroads. This applies particularly to truckers and water carriers. Second, rationalization of coal mining and burning controls with energy requirements would allow increased use of coal. Third, maintenance of an environment in which railroads can raise capital is essential to their future ability to handle increased coal traffic. In addition, several controversial issues were also mentioned. Not all railroads agree on these issues. The ability to make long term contracts for the carriage of coal has been discussed for several years. Such contracts would bind both carrier and shipper to performance of the terms of the contract. Views of this idea vary substantially within the industry. The ability of railroads to provide integrated total transportation service is another controversial issue. Some carriers see benefits in relaxation of laws prohibiting railroads from entering other modes of transportation not normally associated with rail movement.

1985 Coal Forecast

The study design required selection of a 1985 coal production-consumption forecast as the basis for estimating transportation requirements. After review of over 60 forecasts, the Federal Energy Administration (FEA) Reference

Scenario was chosen. The Reference Scenario provided coal production forecasts by supply regions and consumption forecasts by Bureau of Census regions. Consumption data were also provided according to type of consumer. Discussions with the National Coal Association and with utilities about planned capacity expansion through 1985 lead to modification of the forecasts. The resulting production and consumption forecasts are shown by state in Table 1 and in Table 2 respectively. Total 1985 production is projected to be 1.1 billion tons and consumption is projected to be 1 billion tons.

Estimated Coal Traffic - 1985

The railroads participating in this study, through their associations, estimated 1985 coal traffic based on the scenario presented to them. The national projected rail coal traffic in 1985 is 799 million tons originated. This is an increase of 418 million tons above the tonnage originated by the same roads in 1975. Table 3 shows the traffic projections and increases over 1975 by type of traffic and region. The western region is projected to have the greatest growth, from 71 million tons in 1975 to 308 million tons originated in 1985 for the participating railroads. Total coal carried will rise proportionally from 97 million tons in 1975 to 424 million in 1985. Eastern Railroads estimate that they would originate 320.5 million tons in 1985. This is an increase of 62% above 1975. Eastern originated coal will terminate in 35 states. In several states, Indiana, Illinois, Michigan, and Wisconsin, coal from Eastern and Southern areas is facing increasing market penetration by western low sulfur coal.

TABLE 1

1985 Coal Production Forecast

(thousand tons)

STATE	1985 COAL PRODUCTION	STATE	1985 COAL PRODUCTION
Alabama	34,570	Ohio	58,397
Alaska	766	Oklahoma	2,455
Arizona	14,299	Pennsylvania	101,801
Arkansas	632	Tennessee	9,200
Colorado	21,524	Texas	29,202
Illinois	106,830	Utah	17,110
Indiana	43,162	Virginia	39,570
Iowa	663	Washington	3,738
Kansas	1,107	West Virginia	164,814
Kentucky	184,622	Wyoming	183,346
Maryland	4,521		
Missouri	6,641	TOTAL	1,133,918
Montana	58,640		
New Mexico	19,297	TOTAL EAST	747,469
North Dakota	27,011	TOTAL WEST	386,449

[1] The totals for east and west are based on a division along the Mississippi River. This approximates the division between western railroads and eastern and southern railroads. As the data were developed on a state-by-state basis, aggregation by coal mining districts would have introduced inaccuracies from arbitrary allocation. Eastern coal production was not broken down further because of the overlap in areas served by eastern and southern districts.

TABLE 2

Estimated Total Coal Consumption 1985

(Thousand Tons)

CENSUS REGION	ELECTRIC UTILITIES	HOUSEHOLD/ COMMERCIAL	COKE & GAS	ALL OTHER	TOTAL
NEW ENGLAND	987	20	-	696	1,703
Connecticut	4	1	-	210	215
Maine	-	4	-	178	182
Massachusetts	17	15	-	262	294
New Hampshire	935	-	-	32	967
Rhode Island	18	-	-	14	32
Vermont	13	-	-	-	13
MID-ATLANTIC	58,880	254	33,077	26,946	119,157
New Jersey	2,256	5	-	483	2,744
New York	12,004	50	6,408	7,203	25,665
Pennsylvania	44,620	199	26,669	19,260	90,748
SOUTH ATLANTIC	99,771	987	10,180	37,240	148,178
Delaware	2,508	-	-	77	2,585
Florida	12,165	-	-	-	12,165
Georgia	16,812	30	-	1,043	17,885
Maryland	6,572	21	4,256	2,446	13,295
North Carolina	21,255	207	-	5,212	26,674
South Carolina	5,564	128	-	4,620	10,312
Virginia	3,870	354	-	8,141	12,365
Washington, D.C.	79	18	-	574	671
West Virginia	30,946	229	5,924	15,127	52,226
EAST NORTH CENTRAL	194,804	2,111	39,290	94,273	330,478
Illinois	43,556	540	3,596	15,208	62,900
Indiana	41,279	277	15,786	16,111	73,453
Michigan	24,744	246	4,449	15,543	44,982
Ohio	64,959	791	15,181	39,389	120,320
Wisconsin	20,266	257	278	8,022	28,823
EAST SOUTH CENTRAL	87,505	383	9,546	23,044	120,478
Alabama	26,623	19	7,729	8,183	42,554
Kentucky	37,104	187	1,621	7,249	46,161
Mississippi	1,545	-	-	168	1,713
Tennessee	22,233	177	196	7,444	30,050

TABLE 2 (Continued)

CENSUS REGION	ELECTRIC UTILITIES	HOUSEHOLD/ COMMERCIAL	COKE & GAS	ALL OTHER	TOTAL
WEST NORTH CENTRAL	91,558	452	1,177	16,030	109,217
Iowa	13,629	59	–	4,462	18,150
Kansas	16,830	2	–	486	17,318
Minnesota	20,485	166	842	3,420	24,913
Missouri	26,439	111	335	5,446	32,331
Nebraska	6,190	7	–	1,089	7,286
North Dakota	4,898	88	–	1,113	6,099
South Dakota	3,087	19	–	14	3,120
WEST SOUTH CENTRAL	41,399	3	1,019	9,051	51,472
Arkansas	8,448	–	–	392	8,840
Louisiana	4,320	–	–	–	4,320
Oklahoma	11,840	2	–	602	12,444
Texas	16,791	1	1,019	8,057	25,868
MOUNTAIN	84,134	357	3,503	7,371	95,365
Arizona	9,800	–	–	39	9,839
Colorado	18,044	53	1,286	1,709	21,092
Idaho		96	–	1,172	1,268
Montana	7,820	6	–	192	8,018
New Mexico	12,290	–	–	25	12,315
Nevada	12,476	1	–	435	12,912
Utah	10,311	184	2,217	2,139	14,851
Wyoming	13,393	17	–	1,660	15,070
PACIFIC	18,044	14	2,492	1,547	22,097
California	9,000	1	–	123	9,124
Oregon	2,000	6	–	490	2,496
Washington	7,044	7	2,492	934	10,477
EXPORT	–	–	–	–	80,000
TOTAL	677,082	4,581	100,284	216,198	1,078,145

TABLE 3

Projected Increase in National Coal Traffic, 1975-1985

(thousands of tons)

Year/District	Originated & Terminated On Line	Originated & Delivered to Connections	Received From Connections & Terminated On Line	Received From Connections & Delivered To Connections	TOTAL CARRIED
1985 Projections					
Western	112,989	195,031	100,314	15,254	423,588
Southern	116,800	54,000	18,800	9,600	199,200
Eastern	204,017	116,438	71,083	18,679	410,217
Totals	433,806	365,469	190,197	43,533	1,033,005
1975 Totals (1)					
Western	39,478	31,906	26,346		97,170
Southern	66,219	45,373	34,497	(2)	146,089
Eastern	120,541	77,560	101,103		299,204
Totals	226,238	154,839	161,946		543,023
Tonnage Increase	207,568	210,630	71,784		489,982
Percent Increase	91.7	136.0	44.0		90.2

1. Source: Coal Traffic Annual, 1976 Edition, National Coal Association, Washington, D.C.

2. Includes traffic received from connections and terminated on line or delivered to connections.

NOTE: 1975 and 1985 data are for 17 participating carriers which originated 94% of total rail tonnage in 1975.

Southern carriers projected coal traffic of 171 million tons originated and 199 million tons total traffic. Of the originated traffic, 66% will be produced in Illinois and Kentucky. While some western coal is expected to penetrate markets in the southeast; Southern railroads expect the amount of coal traffic received in interchange to decrease by 1985 from 34.5 million tons to 31.4. Growth in traffic originated and terminated on lines of 76% from 1975-1985 indicates that the south will become more self sufficient in coal. Comparisons of coal production and rail originations by state were not possible due to clustering of origins in railroad supplied data.

Equipment and Motive Power

Participating railroads estimate that 1985 coal traffic will require more than 80,000 new coal cars. The western railroads will require the largest addition to their fleets, more than 45,000 cars or about 56% of the total. Most of the new equipment will be 100 net ton capacity equipment. This continues a trend in coal carrying freight cars over the past few years.

The railroads also estimated that 3086 new locomotives would be required. Two types will be used; 3,000 horsepower 6 axle road units for line haul service and 2,000 horsepower units for smaller mine run coal trains in Southern and Eastern territories. Equipment and locomotive manufacturers have the capacity to produce the equipment and motive power. A recent survey performed by the Railway Progress Institute determined that the equipment manufacturers could produce the "normal" annual demand for freight cars and the incremental coal car requirements with present capacity.

Facilities

The projected fixed plant requirements reported here are those which can be attributed to increased coal traffic, and do not include the costs for normal maintenance, or postponed capital investment. They are based on the scenario which underlies the study, and represent additional fixed plant, above that which would be installed for other reasons. Since fixed plant is not single purpose, all traffic would benefit from the projected plant improvements.

Participating carriers projected track, signalling and other fixed plant requirements of over $2.2 billion for estimated 1985 coal traffic. The largest category is track, both new track and improvements to existing lines, at $1.8 billion Improvements to existing lines are the major portion of track requirements, accounting for 12,502 miles of a total 14,516. Signalling requirements are projected at $65.7 million primarily CTC.[1] Railroad yard and maintenance facilities are projected at $288.5 million. The largest investment requirements in fixed plant are in the west. This follows naturally from the largest expected growth in coal traffic. The density on the coal carrying main lines in the western territory is projected to increase dramatically, thus, requiring heavier track structure, better signalling and more locomotive and car maintenance facilities.

No explicit assumption or accounting was made for deferred maintenance or previously postponed capital projects. The criteria used for fixed plant projections was all expenditures directly attributable to increased coal traffic above "normal" maintenance. Carriers were requested to discount projects undertaken for reasons other than increased coal traffic even though such projects could impact the carriers' ability to handle coal traffic. Because of the criteria used to project

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[1] Centralized Traffic Control

fixed plant investment , considerations of deferred maintenance are somewhat academic. The projected expenditures represent the best available estimate of fixed plant requirements to handle increased coal traffic of the magnitude contemplated.

Railroad Planning Processes

Most railroads engage in planning five to ten years into the future. Typically, the planning process begins with traffic forecasts based on customer supplied data and independent forecasts. In the case of coal, the data are generally reliable information for the coming 5-8 years. Various methods are used to convert traffic projections, usually on an origin - destination basis, into operating statistics for each sector of the railroad. Frequently the task involves computer simulations of the rail network and operating policies. Various alternatives for the future operation of the road can be tested using these tools. The result of the planning process is generally a set of programs for car and locomotive acquisitions, track and signalling work, capital requirements and operating considerations for the coming 3-5 years. The five to ten year period plans are of a more general nature. These include identification of major capital projects, estimated capital requirements and forecasts of potential traffic and operating problem areas.

System Constraints and Institutional Issues

There are several areas of institutional and government policy which impact the railroads' ability to increase and efficiently handle coal traffic. Those identified by participating carriers are, first, even treatment of competitive modes. This means collecting full cost from truckers and water carriers and tighter control of these same carriers. Second, the railroad industry, among others, proposes that the current debate of conflicts between environmental, energy and economic policies be resolved into a clear plan designed to fill the energy requirements of the U. S. Third, the railroads will need to raise large amounts of capital over the next ten years. If the environment in which they operate is optimistic relative to energy, environmental and competitive factors, there are no problems foreseen. However, if uneven treatment of competitive modes, unresolved conflicts in government policies or the introduction of new modes cloud the long term coal traffic growth prospects, the railroads' ability to raise needed capital will be impaired. Fourth, the growth in coal traffic will bring a concurrent growth in long heavy trains. These will aggravate perennial grade crossing problems. Some railroads suggest negotiations with local governing bodies prior to their promulgation of ordinances controlling crossings and a government program to eliminate crossings where appropriate. There will need to be some trade-offs made along major coal routes between the need to move coal to markets and disruptions caused at grade crossings. These are best negotiated with full understanding of each party's position and problems. Fifth, improved technology in the design of coal cars, especially hopper cars, to improve their serviceability and discharge capability was recommended. Improved knowledge of track/train dynamics was also identified as an area which would benefit coal movement through potential increases in train speed.

Along with the areas identified above, several controversial issues were raised which might facilitate future coal movement. First, freedom to provide total transportation services, including modes not necessarily associated with rail movement, was suggested. Such ability, now prohibited by law, has been suggested to improve the railroads' competitive position as well as the services offered to shippers.

Second, the ability to make contract rates for coal traffic could facilitate the railroads ability to make long range plans and investments. Contract rates would bind both shipper and carrier to performance of the terms of the contract with ensuing legal liability. Contract rates could put the railroads in an improved competitive position vis a vis slurry pipelines. They would also remove much of the uncertainty surrounding future tonnage and revenues on a segment of traffic. Contract rates are not universally favored. Many carriers are opposed to the concept as being contrary to their best interests and others feel it so unlikely to occur that it is not an issue.

1. INTRODUCTION

Since the U.S. embarked on the effort to become energy self-sufficient, it has been apparent that coal would be an increasingly important energy source. Subsequent events such as the critical shortages of natural gas during the winter of 1976-1977, the continuing public resistance to nuclear power and the ban on commercial development of breeder reactors indicate that the development of coal as the major "new" source of energy will occur. As with any undertaking of its magnitude, the formulation of plans and programs to develop and control the future energy mix in the U.S. is an extremely complex process. One integral part of the process is to determine the requirements for distributing the energy, in this case coal, from its source to points where it will be needed. Information presented in this study, along with others prepared for the U.S. Department of Transportation, Office of Intermodal Transportation Energy Policy Division, will be a valuable aid in planning future national energy programs and assuring that resources are available to meet national energy goals.

The focus of this study is 1985 railroad coal transportation requirements and issues.

2. STUDY PURPOSE AND OBJECTIVES

The purpose of this study is to present information on long range coal transportation requirements and related issues to those responsible for setting energy policy and developing energy programs. In support of this purpose, there are four primary objectives.

- Develop a reasonable forecast of the volume of coal traffic and the traffic patterns in 1985.
- Develop transportation industry estimates of the equipment and facilities required to move the forecast coal tonnage.
- Identify and describe the long range planning processes and tools used by railroads to prepare for the expected increases in coal traffic.
- Identify and describe potential constraints, technologies and institutional considerations which will impact the transportation of coal in the future.

When possible, comparisons are made between 1975 and 1985 coal traffic and requirements.

3. STUDY METHODOLOGY

3.1 Study Approach and Design

The approach selected to perform this study was to present a forecast level of coal production and consumption to the railroads through their regional associations and have the railroads estimate rail coal traffic and the transportation requirements. The study was designed to implement this approach in three steps. The first step was to identify and analyse coal production and consumption forecasts and the assumptions underlying them. This was accomplished by reviewing the most recent literature on future energy scenarios and by interviewing industry and government organizations. More than sixty scenarios were reviewed and analysed in light of industry and government expectations of events influencing future energy developments. These scenarios are discussed in section 4.1. Data on planned capacity expansions and views on future expectations were also solicited from the National Coal Association, various electric utilities, the American Steel Institute and others. These data were used to analyze the scenarios and prepare the coal forecasts used in the study. The result of this process was a forecast of coal production and consumption by state for 1985.

The second step was to present the forecast coal production and consumption forecasts to the regional railroad associations. These associations, through their members, prepared the coal flows and transportation requirements based on the forecasts of 1985 coal production and consumption. These associations are composed of the railroads which operate in the ICC defined Eastern, Southern and Western territories. Some roads operate in more than one geographic territory and are members of more than one association. The railroads participating in the study are shown in Table 3-1 grouped according to the association

TABLE 3-1

Participating Railroads

EASTERN RAILROAD ASSOCIATION	
Bessemer and Lake Erie	(BLE)
Chessie System	(CO, BO, WM) *
Consolidated Rail Corporation	(CR)
Norfolk and Western	(NW)
Pittsburgh and Lake Erie	(PLE)
SOUTHERN RAILROAD ASSOCIATION	
Family Lines	(LN, SCL, CCO) **
Southern Railway System	(SOU)
Illinois Central Gulf	(ICG)
WESTERN RAILROAD ASSOCIATION	
Atchison, Topeka and Santa Fe	(ATSF)
Burlington Northern	(BN)
Chicago and North Western	(CNW)
Denver and Rio Grande Western	(DRGW)
Elgin, Joliet and Eastern	(EJE)
Missouri Pacific	(MP)
Southern Pacific	(SP)
Union Pacific	(UP)
Western Pacific	(WP)

* Chesapeake and Ohio, Baltimore and Ohio, Western Maryland

** Louisville and Nashville, Seaboard Coast Line, Clinchfield through which they participated. (Figure 3-1 shows the geographic definition of the operating territories.) Because the information requested from the associations concerns the competitive positions of railroads vis a vis each other and with other modes for traffic and their operating strategies, it is of an extremely sensitive nature. Therefore, each association must maintain the confidentiality of its members' information by submitting aggregate data for all member roads participating in the study.

The third step in the study design was to interview major coal carrying railroads to develop information on the long range planning processes they use to identify and prepare for future increases in coal traffic. A second objective of the interview process was to identify and discuss possible constraints, technological developments and institutional factors influencing their ability to generate and profitably handle increased coal traffic. In addition to railroads, equipment manufacturers, locomotive manufacturers and other industries involved in the coal distribution process were also contacted to determine their plans and capabilities and to estimate costs for components in the transportation system.

The information gathered through these three steps has been evaluated and analysed and is presented in this report.

3.2 Aggregation of Industry Estimates

The data supplied by the railroads consists of estimates of the coal tonnage to be originated by participating members of each association and the equipment and facilities required to handle these flows. The tonnage estimates are based on forecasts of coal production and consumption in 1985

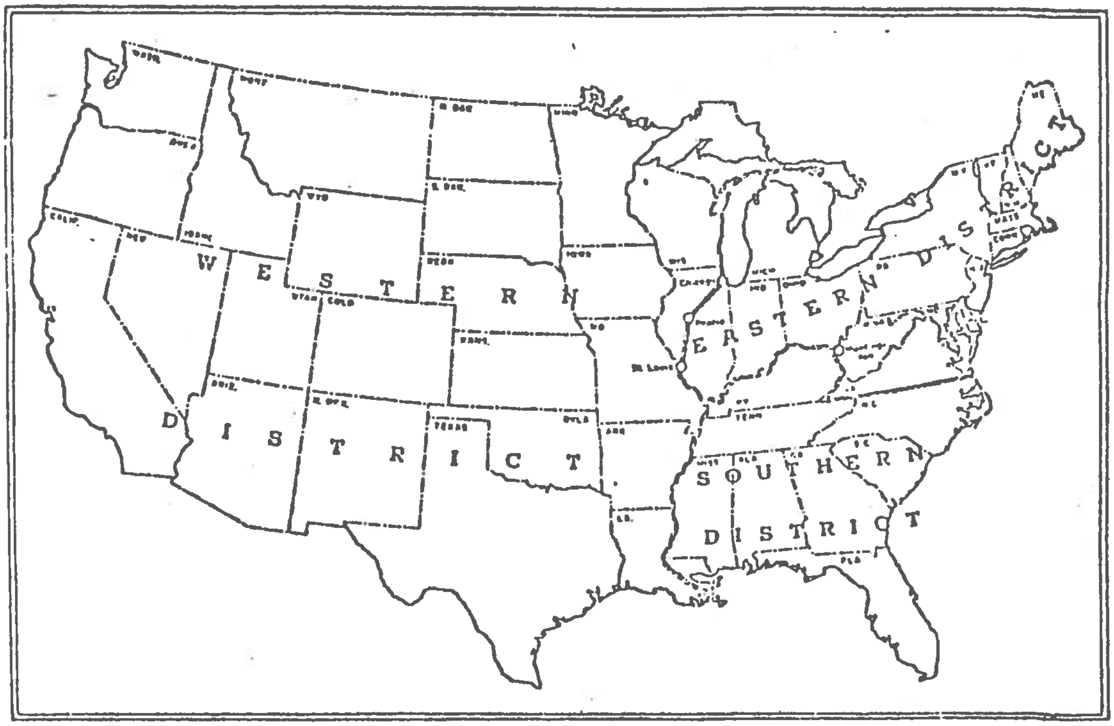

Figure 3-1. ICC Defined U.S. Railroad Districts

for each state. Several factors in this process dictate that these estimates be aggregated and evaluated. First, the time frame of the forecasts, 1985, requires that the estimates be based on information containing significant uncertainty regarding actual movements by individual carriers. There is competition among carriers serving each coal producing region and competition among regions to serve consumption markets. Therefore, the total estimates of all regions may include double counting. Double counting occurs when more than one railroad projects that it will carry coal to a particular market. This is not a serious problem. The result of such duplication would be "over-preparedness" by the carriers. For example, if two railroads project coal traffic to the same market and take appropriate steps to prepare for it, one or both will create some excess capacity. There is also expected to be some short haul truck and conveyor transportation to "mine mouth" consumption points. The percentage of coal production which will be consumed by utilities and coal conversion plants located close to mines and the resulting transportation impacts can not be estimated accurately. At one time, mine-mouth consumption plants were expected to be a major factor in the northern great plains region. However, environmental challenges to the construction of utility plants and technological problems in coal conversion processes have blocked the development of these facilities. The greatest problem is the availability of the large amounts of water required for these plants compared with the relatively small amounts needed to export coal. Questions have also been raised about the relative costs of transporting coal and electricity.

Second, the coal forecasts which form the basis for the study and the data available to the participating carriers are from different sources and were developed at different times.[1] Therefore, some inconsistencies are to be expected. In order to assess the extent of such inconsistencies, state production and state consumption estimates were to be compared with total rail and water carrier originations and terminations for each state. This analysis was frustrated by grouping of origin states and destination states in carrier supplied data. When originations from a single state appeared to exceed the expected tonnage, based on historical market shares, the carriers were requested to verify their projections. This process resulted in some modification in the estimates of originated tonnage. However, in other cases, the carriers were able to support their projections. Further, as all of the data used in the study - production, consumption, and transportation - are forecasts subject to uncertainty, it is not essential that all the projections meet absolute standards of comparability. The value of this study stems from the use of the best data available to those involved in the production, use and transportation of coal. These data have been aggregated and evaluated and represent the basis for the findings in this report.

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[1] The forecasts used in this study were developed in late 1976 from public documents and interviews. The railroads have continuing access to their customers' plans as well as their own industry analysts. The results of the differing sources have not appeared substantially different.

4 1985 COAL PRODUCTION AND CONSUMPTION

The transportation requirements estimates in this study are based on forecasts of coal production and consumption. This forecast represents an estimate selected from many forecasts and scenarios which have been developed since the original Project Independence* reports. Agencies of the Federal Government such as the Federal Energy Administration (FEA) and Bureau of Mines (BOM), States and private organizations have produced estimates, under various scenarios, of future supply and demand for energy. In all of these forecasts coal plays a significant role. The following sections describe forecasts of coal production and consumption for 1985 in the context of total energy, general supply and demand characteristics and other factors.

4.1 National Energy Outlook and Other Scenarios

4.1.1 Total Energy

In 1975, the U.S. consumed 73 quadrillion BTU[1] of energy. The sources of this energy were oil 46%, gas 30%, coal 18%, nuclear and other sources about 6%. Of the oil consumed, 37% was imported. In the years from 1960 to 1974, U.S. energy consumption grew nearly 65%, approximately the same growth in 14 years as in the preceding 40 years. Demand for electricity grew at a rate 175% of that for total energy

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* Project Independence has been renamed National Energy Outlook.

1 British Thermal Unit, the amount of heat required to raise one pound of water one degree fahrenheit.

demand. During this period petroleum became the largest single source of energy. Gross energy inputs[2] are divided among the sectors of the economy as follows: Household and Commercial 19%, Industrial 29%, Transportation 25%, and Electric generation 27%. This translated into 557 million tons of coal, 6 billion barrels of petroleum products, 22 trillion cubic feet of natural gas, 1.9 trillion kilowatt hours of utility electricity (distributed).[3] The trends in energy use were substantially altered in 1975; demand for oil was about 3 million barrels per day lower than continuation of pre-embargo trends would have yielded and coal began to increase its share of energy consumption.

The most important sector in terms of coal consumption is electrical generation. This sector consumed nearly 400 million tons of coal in 1974 and is expected to consume more than 435 million tons in 1976. U.S. electrical generating capacity is currently 482 gigawatts (10^9 watts) of which 186 gigawatts are coal fired, 150 gigawatts oil and gas, 37 gigawatts nuclear and 109 gigawatts other. The largest expected growth is in coal and nuclear plants in most forecasts. If utility industry plans are carried out on schedule,[4] generating capacity in 1985 would be 806 gigawatts, a 67% increase. Coal fired capacity would increase to 318 gigawatts, oil and gas to 170, nuclear to 177[5] and other to 139. There

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2. 1974
3. U.S. Department of the Interior, Bureau of Mines.
4. There is little likelihood of this occurring due to postponements caused by lack of demand and financial problems.
5. The Nuclear Regulatory Commission estimate now sets nuclear generating capacity at about 155 gigawatts by 1985.

is great uncertainty in these estimates. In the last two years, growth in demand for electricity has been substantially below previous levels. Consequently, many utilities have postponed or cancelled planned capacity addition. There are continued problems with the installation of nuclear power plants which have recently resulted in a temporary licensing suspension. Financial constrains have also hampered utility expansion plans.

The second most important coal consuming sector is the industrial sector composed primarily of use by the steel industry, and other industries using coal as a boiler fuel and coal derivatives as raw material. Exports may be considered as industrial use since most export coal is metallurgical or premiumu quality coking coal. There are two main issues involved in the future use of coal for industrial purposes. The Environmental Protection Agency has ruled that coke ovens and industrial boilers must meet clean air standards. This ruling has cast doubt on the future expansion of these uses until technology becomes available to meet EPA requirements. One method the steel industry has available is the use of electric furnaces which would reduce direct use of coal. A second issue is the competition between utilities, industry and coke production for available low-sulfur Appalachian coal. This coal is generally of metallurgical grade yet it is now being used by utilities for mixing with high-sulfer high-BTU coal to meet EPA requirements. The increased demand by utilities may reduce the attractiveness of this coal for industrial uses through price increases. Some growth is, however, expected in use of metallurgical coal by the steel industry. Efforts by the FEA to promote large industrial boiler conversion to coal have not met with much success. There have been considerations in both Congress and the Administration of mandatory conversion programs. If these programs are effected, estimates of coal consumption in 1985 range as high as 2 billion tons.

The transportation, household and commercial sectors do not substantially affect the consumption of coal. In 1974, they consumed only about 9 million tons.[6] The only effects of these sectors are secondary from the conversion from oil and gas to electricity.

4.1.2 Historical Perspectives

At the turn of this century, coal supplied 90% of U.S. energy consumption. Since that time, coal has been increasingly displaced by other fuels. The major markets for coal also changed during this time period. Railroads, retail sales and industrial uses at one time consumed nearly all coal production. Today, electrical generation is the largest market for coal, with industrial use, exports, and coke and gas plants dividing the remainder. Retail sales and railroad use are relatively insignificant. Utility consumption of coal represents the only growth market during the past 20 years with the exception of some growth in exports. Even in the utility sector, however, coal has been losing its market share - primarily to fuel oil and to a lesser extent to nuclear power. Some areas of the country have shown a drastic decline in utility coal consumption between 1960 and 1974. For instance, in 1960, coal produced 50% of electrical generation

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6. Transportation sector consumption is zero.

in New England. In 1974, it produced 7%. Similarly in the Middle Atlantic region, coal decreased from 69% to 43%, in the South Atlantic region from 66% to 55%. Even in the East North Central region, which produces substantial amounts of coal, the utility share dropped 11.5% between 1960 and 1974 with oil and nuclear power increasing about equally. The major factors influencing the decline in the coal market share are the availability of cheap foreign oil, especially after the lifting of oil import quotas, and development of commercially viable nuclear power. The eastern seaboard, New England and the Middle Atlantic states, converted to cheap, easy to handle, low sulfur imported oil. Space heating throughout the country converted to oil, gas, and more recently, electricity. The industrial sector similarly converted to these fuels from former dependence on coal. The OPEC oil embargo, declining domestic oil and gas production and higher prices have caused changes in the fuel use patterns and stabilized oil and gas conversions.

4.1.3 Coal Demand Characteristics

Due to the specialized equipment required to use coal as boiler fuel (its primary use), the market for coal is fixed at any given point in time. That is, there is a coal burning capacity in place with only a few facilities able to shift to coal from other fuels on short notice. Therefore, a decrease in the price of coal will not result in substantial increased demand in the short term. Utilities owning both coal and non-coal burning capacity are able to shift their generating load to the coal fired plants, increasing demand somewhat. However, these shifts are marginal in terms of total tonnage. The demand for coal is primarily a function of long-term utility capacity planning. Demand for electricity grew at about 7% per year until 1974. For the past two years the growth has been very small, about 2% per year. The future pattern in demand for electricity is one of the questions in the demand picture for coal.

Coal demand is expected to grow somewhat due to utilities replacing existing capacity as it becomes obsolete or uneconomic to operate. However, the largest portion of coal demand growth is expected to come from new generating capacity. The Regional Electric Reliability Councils expect growth to resume in the 1975 to 1985 period at an annual rate of 6.2% only slightly below historic rates. Other sources suggest rates of 5.5% and lower. At a growth rate of 5.5%, utility coal consumption would be 8 million tons less than the Reliability Councils' estimate by 1980. The other major consumers of coal are industrial users and exports. Industrial uses include use as boiler fuel and in the steel industry. The steel industry uses primarily anthracite and metallurgical quality bituminous coal, neither of which is generally used as a primary boiler fuel.

The price of coal, relative to oil and nuclear power, has an impact on the demand for coal in the long run. Utilities will base planning decisions on the expected price of available fuel. If oil or nuclear power appear less expensive than coal, and fuel supplies can be assured, under contract, the utility will probably plan oil-fired or nuclear generating capacity. However, once coal-fired capacity is installed, the price of coal will have relatively little effect on short-term demand. This is due to the trade practice of purchasing fuel supplies on very long-term contracts. Most, if not all, contracts, executed in today's market, have escalator or renegotiation clauses included which simultaneously allow the price of coal to rise to offset cost increases and allow the utility improved information on how costs will vary. Therefore while the price of coal for new contracts and existing contracts may rise, the demand will remain stable for the duration of the contract period except under extraordinary circumstances.

4.1.4 Coal Supply Characteristics

Coal is not a homogeneous commodity. It has ranges of values on a variety of scales. Some of the quality scales are BTU/lb., volatile content, grind (hardness), ash content and sulfur content. Coals vary from anthracite to bituminous to sub-bituminous to lignite in different sections of the country and may even vary within a particular coal field. Each type of coal requires a particular boiler configuration for optimal burning. Therefore, the substitutability of coal from one region for that of another is limited. There are three principal coal producing regions: the eastern or Applachian coal region, the midwest and the western region. The coal and mining methods vary from region to region. **The Appalachian region produces most** of the coal in the U.S. In 1972, the Appalachian coal fields produced 65%, the Mid-west 26%, and the West 8%. Appalachian coal tends to be high BTU/lb. coal but also high in sulfur content. Western coal is lower in BTU and in sulfur content. The low sulfur content and relatively low price per ton have stimulated increased demand for western coal in the past few years.

Most coal produced in the U. S. is sold on long-term contract. These contracts vary in length from 5 to 30 years with the average around 20 years. The reasons for this are straightforward. First, opening a coal mine, whether deep or surface, requires a large investment in land and equipment. Mine operators are not likely to make such large investments on speculation. Second, utilities must design and build their boilers to meet fuel specifications in terms of sulfur content, heat rate, grindability, ash content and other factors. The utility must have an assured supply of fuel to meet its demand for the life of the plant. Similarly, because of the regulated nature of the utility industry, utilities must know in advance the cost of fuel for pricing purposes. According to industry sources, in the current atmosphere of uncertainty about EPA regulations and other government policies, mine operators only begin development of new mines after negotiating a contract covering substantially the life of the mine.

The lead-time for both mines and utility plants ranges from four to seven years. A recent survey of mine operators indicates plans to develop approximately 500 million tons of new coal mine capacity by 1985. Production in the west is expected to grow more rapidly than in the east. Planned new mines and major expansions of existing mines indicate new production in the west of 275 million tons and in the east of 224 million.[7] The division between surface and deep mining is 315 million tons and 193 million tons respectively. The actual new capacity additions which are developed by 1985 may be less than planned due to

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7. The east total includes 83 million tons of metallurgical coal. The west total includes 2 million tons metallurgical. Source: National Coal Association.

uncertainty about new regulations on surface mining and pollution controls. Much of the eastern mine expansions are in areas which produce relatively high sulfur content coal. If the full impact of the air quality standards is felt, in terms of expiration of variances, requirements for stack gas scrubbers on all plants, and non- deterioration in its strictest application, the eastern coal may be unburnable given current scrubber technology or the demand for western coal may be reduced. Similarly, if strip mining laws are enacted which severely limit the ability of coal operators to strip coal economically, future generating capacity may be designed for other fuels - oil or nuclear. One other major factor affecting the opening of new mines is the growth in demand for electricity. Many utility plants planned to come on-line in the 1976-1985 time period have been postponed or cancelled due to lack of demand, financial difficulties or licensing problems related to site location or environmental considerations. If these factors continue to prevail, the growth of coal production will also be postponed beyond 1985.

4.1.5 Factors Influencing Future Coal Use

The factors which will influence the future consumption of coal as a primary energy source can be grouped into three categories. The first group is governmental policies and regulations. These consist of environmental regulations on the mining and burning of coal as boiler fuel; coal land leasing policies and the need for a national energy policy.

The second group of factors consists of technological developments. The most influencial technological factor over the next ten years will be the acceptability of nuclear power generating plants. FEA has estimated that for every thousand megawatts of nuclear capacity installed in the future, coal consumption estimates decrease by about 2.8 million tons per year. Stated another way, for each 10% change in the nuclear capacity estimate, 1985 coal consumption changes about 40 million tons. This illustrates the direct trade-off nature of power plant fuel selections. If nuclear power shows promise of becoming socially acceptable by 1985 or 1990, some utilities may defer expanding capacity in coal fired plants or possibly plan nuclear facilities for future needs. If the problems currently besetting nuclear power generation persist or worsen, new coal fired capacity will probably be installed where possible.

Other technological developments related to coal are the developments of commercially viable, competitively priced synthetic gas and liquid fuel from coal. This could conceivably consume significant tonnages of coal. Most likely coal consumption for synthetic fuel will be minor by 1985 due to the long testing and development period required to bring synthetic fuel on the market. With massive Federal involvement, however, these fuels would reach commercial viability more rapidly, although 1985 production would still be small. More efficient utility boiler design and fuel utilization may reduce the consumption of coal per unit of electricity produced. However, these techniques are not widespread today and are expected to have little effect by 1985. Other forms of energy such as geothermal, solar or nuclear fusion will have marginal impacts on coal consumption by 1985. These energy sources have not reached a technological level where they are viable for commercial application or are restricted to limited regions of the country.

The third group of factors are market factors. The relative price of fuels still is a dominant factor in the fuel selection process. The price of fuels on an as burned basis, including handling, pollution control costs, ash removal and other factors, varies from region to region. In order for coal to penetrate successfully the New England or Pacific fuel markets, the price of oil or nuclear power would need to rise to very high levels or the fuels to become unavailable. However, in most of the central U.S., coal is competitively priced with oil and may be more acceptable, socially, than nuclear power. The market mechanism can be short circuited by government regulations such as FEA orders to utilities requiring the use of coal or by very strict environmental requirements which increase the cost of using coal. Proposed taxes on coal mining (severance taxes) at the State or Federal level can also reduce the cost competitive position of coal in the market for future utility capacity.

4.1.6 Forecasts

The most comprehensive analysis of future energy scenarios has been performed by FEA and published in the 1976 National Energy Outlook. The analysis of future energy supply and demand is performed using updated versions of the Project Independence Evaluation System (PIES) models. These models and the assumptions underlying them are described in the Project Independence Report published by FEA, November 1974, and in the 1976 National Energy Outlook also published by FEA. While this report is not the appropriate vehicle for a detailed description of these models, a brief outline of the concepts is provided as contrast with approaches used by others. Basically, PIES is comprised of econometric models - a demand model, a collection of supply models and an integrating model based on a perfectly competitive energy economy - which seek equilibrium supply and demand solutions based on market clearing prices. Many of the variables used in the models can be altered to predict results of uncertainties, government policies and other exogenous occurrences.

Of more interest in the context of transport requirements are the variables in the scenarios which affect coal production[8] forecasts. Ten FEA scenarios and their associated coal forecasts are displayed in Table 4-1. As can be seen from Table 4-1, the coal forecast does not move in coincidence with total energy forecasts. Rather, the coal forecasts appear to track with a different set of variables. In some cases, the differences are difficult to explain, i.e., the Reference Case has lower total BTU forecast but a higher coal forecast than the accelerated supply scenario. Both scenarios use the same demand scenario. Similarly, the highest and lowest coal forecasts share virtually the same total energy forecast. The variables affecting coal forecasts are primarily those affecting electrical generation fuel choices. Synthetic fuel production and substitution of coal for natural gas

8. Coal production was chosen rather than consumption because it is felt that consumers tend to hold inventories more than producers and, therefore, excess production would require transportation. Exports also require transportation to ports.

TABLE 4-1

Coal Scenarios 1985

SCENARIO	TOTAL ENERGY INPUTS (quadrillion BTU)		COAL PRODUCTION (million tons)	
	$13 oil	$16 oil	$13 oil	$16 oil
1 Reference Case (BAU Supply + Demand)	98.9	97.3	1039	1085
2 Conservation Case (BAU supply)	93.1	92.5	1006	1096
3 Accelerated Case (with conservation)	96.1	96.6	1013	1018
4 Accelerated Supply Case (without Conservation)	101.8	101.1	1017	1027
5 $7.50 Regulation Case (BAU demand)	101.3	99.7	975	1022
6 $9 Regulation Case (BAU demand)	101.1	99.5	995	1024
7 Electrification Case (Accelerated coal-nuclear supply)	101.6	100.5	1250	1280
8 Regional limitaiton Case (with conservation demand)	91.9	90.7	925	1084
9 Regional limitation (BAU demand)	98.1	96.0	958	1158
10 Supply Pessimism Case (?)	100.2	98.7	910	959
11 BOM(1)	103.5		923	

(1) Oil prices do not apply.

SOURCE: 1976 National Energy Outlook, Federal Energy Admistration; and Energy Through the Year 2000, Bureau of Mines.

as industrial boiler fuel also affect the coal forecasts.

In the electrical generation sector, the variables most affecting coal are demand for electricity, nuclear capacity, oil prices and environmental regulations. The PIES models are based on relative total cost of using coal in competition with other fuels. For instance, the cost of nuclear power generation and coal fired generation are very close. Therefore, increases in the cost of burning coal, due to requirements for stack gas desulfurization or high environmental costs for mines, would shift generation capacity to nuclear or oil fired plants reducing the demand for coal. The two other factors, coal for gas substitution and synthetic fuel production, are non-price variables. They are exogenous demands specified as inputs to the scenarios based on policy assumptions. The treatment of important issues in the different scenarios is shown in Table 4-2. The forecast coal consumption under various scenarios is shown in Table 4-3.

Several organizations other than FEA have made energy forecasts to 1985. One of these was prepared by the Bureau of Mines, U.S. Department of the Interior, and published in United States Energy Through the Year 2000 (Revised), December 1975. This forecast is based on analysis of historical trends in energy use, gross national product, energy supply, and judgment. The results of this method are not radically different from a number of FEA scenarios, however, the method is. While the PIES models are primarily price based, the Bureau of Mines (BOM) model does not explicitly take price into consideration. The assumptions used in making the forecast cover the same areas as those used by FEA, although not always in the same way. For instance, BOM assumes an evolutionary increase in the utilization of fuel (i.e., more efficient boilers) while FEA varies utility plant load factors. Also, BOM uses only one scenario to produce one forecast while

TABLE 4-2

1985 Coal Scenarios

Treatment of Issues

ISSUE \ SCENARIO	REFERENCE CASE	REGIONAL LIMITATION CASE	REGULATION CASE $9	CONSERVATION CASE	ACCELERATED CASE	BUREAU OF MINES
Technology	Small amounts of synthetic fuels available, insignificant solar + geothermal energy	Synthetic fuels not available insignificant solar + geothermal energy	insignificant	insignificant	commercially viable solar and geothermal energy, tertiary oil recovery	Federal R+D support for synthetics development solar, fusion not significant
Stripmining	low land reclamation charges	30% severance tax on western coal and high land reclamation charge on all coal	low land reclamation charges	low land reclama² tion charges	low land reclamation charges	moderate regulation with reclamation, no production deterrent
Air Pollution	scrubbers for high sulfur coal only	only low sulfur coal with stack scrubbers	scrubbers for high sulfur coal only	scrubbers or low sulfur coal	scrubbers or low sulfur coal	emission standards will be met
Federal Leasing	current situation	reduced oil leasing	current situation	current situation	optimistic	accelerated leasing of offshore, shale, coal and geothermal lands
Price Controls	deregulation of new gas and decontrol of old oil	-	all domestic oil-gas regulated including intrastate gas	decontrol old oil, deregulate new gas	decontrol old oil and deregulate new gas	complete deregulation of oil and gas
Nuclear Power	will grow to almost 26% of electric generation 8% of total BTU	moratorium on nuclear plant construction 6% of total BTU	8.7% of total BTU	7.7% of total BTU	9% of total BTU	35% of electrical generation 11% of total BTU
Boiler Fuel Conversion	current FEA program conversion	current FEA program conversion	current FEA program conversion	conversion of plants currently able under existing FEA program	conversion of plants currently able	-

TABLE 4-3

Coal Consumption Under Various Scenarios
1985, $13 Oil Imports
(Million Tons)

Sector	Reference	$9.00 Regulation	Regional Limitation	BAU Supply With Conservation	Accelerated Supply With Conservation	Electrification
Household/Commercial	5	5	5	5	5	5
Industrial	224	218	219	217	208	284
Electrical Generation	715	679	640	655	673	841
Synthetics	16	16	16	16	53	53
Exports	80	80	80	80	80	80
Total	1,040	998	960	973	1,019	1,263

SOURCE: 1976 National Energy Outlook, Federal Energy Administration

FEA has fifty-four scenarios and forecasts. The base FEA scenario, called the Reference Case, and the Bureau of Mines scenario are presented below.

4.1.7 Reference Case

The FEA Reference Case represents the base for comparison of variable changes and policy effects in other FEA scenarios. The Reference Case consists of "Business as Usual" supply and demand conditions. Business as usual refers to the level of government intervention in the energy conservation area and assumes that none of the conservation legislation proposed in 1975 and early 1976 will be enacted. Along with the assumption of non-intervention by government, each scenario is specified by a set of conventions which determine the supply of each energy source. These conventions are described in detail for each fuel in The 1976 National Energy Outlook, Appendix E, and are both more detailed and more technical than required here. However, a brief description of the coal convention is useful.

The coal supply convention has two states - Regular and Restricted. Under the regular convention, scrubbers would be required only where high sulfur coal is burned with low sulfur coal without scrubbers as an alternative. All new, and some existing plants can choose between low sulfur coal and high sulfur coal with scrubbers. All other existing plants burn the least cost coal. Surface mine reclamation costs would be $.25 per ton both in the east and west. Under the Restricted convention, all new plants would require scrubbers and only low sulfur coal would be allowed. The surface mine reclamation cost would rise to $.40 to $1.40 per ton in the west and $.85 to $2.10 per ton in the east. The Restricted convention also includes a severance tax of 30% of mine mouth price for western coal. The reference scenario uses three imported oil prices - $8, $13, $16 per barrel - with the $13 case being the basis for all comparisons. The Reference scenario coal consumption forecast is shown in Table 4-4. As can be seen from this table, electric utilities will consume the majority of coal production. Regional coal prices in 1985 for the electric utility sector are shown in Table 4-5 with predicted contract prices. As can be seen, areas which are currently heavy coal users will continue as such. However, projected growth is expected in areas such as West South Central where coal has not been a traditional boiler fuel. (This development can be seen both in planned utility capacity and in the fact that FEA issued orders to several utilities in the region requiring that their new plants burn coal.)

The coal supply forecast for 1985 under the Reference scenario is shown in Table 4-6 with mine mouth prices and type of mining. This shows the greatest growth occurring in the Western Northern Great Plains states. Surface mining will continue to grow more rapidly than deep mining in both the East and the West.

The Reference scenario does not take into account the governmental policy questions concerned with stripmining legislation, coal land leasing and environmental controls. Similarly, transportation, labor and capital are all assumed to be available in sufficient quantities that they do not represent a constraint to coal production or consumption.

4.1.8 The Bureau of Mines Scenario

The Bureau of Mines (BOM) Scenario was developed using a different methodology than those developed by

TABLE 4-4

1985 Coal Consumption Reference Scenario, $13 Oil Imports

(million tons)

Sector	1974	1985	Absolute Increase	Compound Annual Percent Growth Rate
Electric Utilities	388	715	+327	5.7
Household/Commercial	9	5	- 4	-5.5
Industrial	64	124	+ 60	6.2
Coke and Gas	90	100	+ 10	1.0
Synthetics	-	16	+ 16	-
Exports	60	80*	+ 20	2.6
Total	611	1,040	+429	5.0

* Assumed values; not estimated endogenously by model.

SOURCE: 1976 National Energy Outlook, FEA.

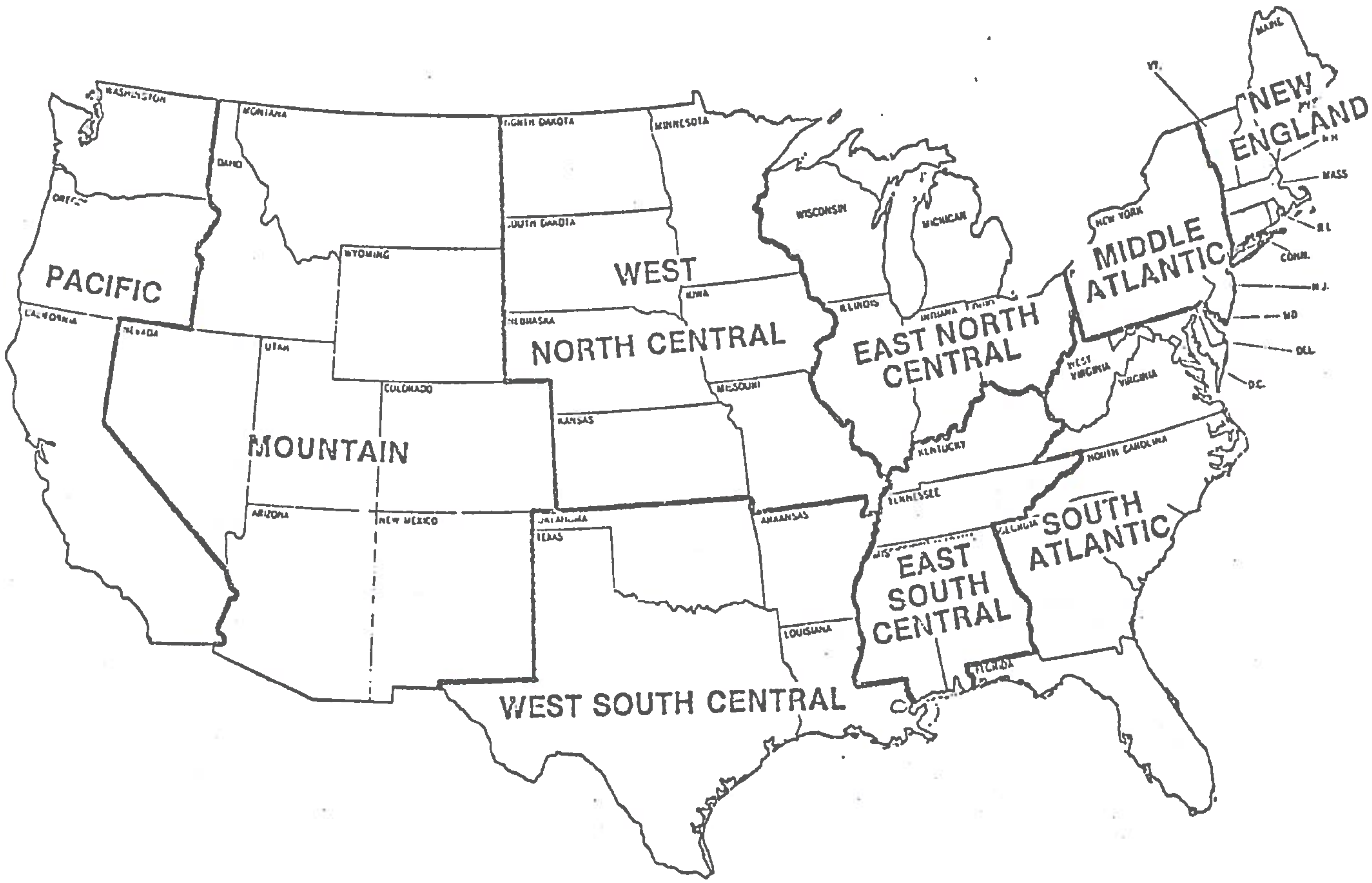

Figure 4-1. Census Regions

SOURCE: 1976 National Energy Outlook, FEA

TABLE 4-5

Long-Term Contract Delivered Coal Prices to the Electric Utility Sector

1985 Reference Scenario, $13 Oil Imports

($/million BTU, 1975 dollars)

Regions	1985 Low Sulfur	1985 High Sulfur	Average Contract Price, August 1975*
Northeast	1.40	.90	1.21
Middle Atlantic	1.25	.75	1.05
South Atlantic	1.25	.80	1.01
East North Central	1.15	.65	.80
East South Central	1.15	.60	.77
West North Central	.95	.65	.57
West South Central	1.00	.70	.24
Mountain	.55	.45	.32
Pacific	--	.80	.59

* Source: FPC Form 423.

SOURCE: 1976 National Energy Outlook, FEA

TABLE 4-6

Coal Production by Region -- Reference Scenario, $13 Oil Imports

(million tons)

	1974	1980	1985	1990
Northern Appalachia	171	163	183	199
Central Appalachia	184	269	297	322
Southern Appalachia	20	24	25	24
Midwest	135	96	156	176
Total East	510	552	661	721
Central West	9	9	9	10
Gulf	8	17	21	21
Eastern Northern Great Plains	8	14	31	45
Western Northern Great Plains	35	185	274	464
Rockies	14	16	19	21
Southwest	14	5	21	21
Northwest	4	1	4	4
Alaska	1	*	*	*
Total West	93	247	379	586
National	603	799	1,040	1,307

* Less than 500,000 tons.

Prices by Region and Coal Type -- 1985 Reference Scenario, $13 Oil Imports ($/Ton FOB Mine, 1975 Dollars)

Region	Low Sulfur Coal	High Sulfur Coal
Northern Appalachia	24.90	12.90
Central Appalachia	24.10	12.60
Southern Appalachia	26.00	14.50
Midwest	22.80	10.80
Central West	-	11.35
Gulf	-	4.80
Eastern Northern Great Plains	6.30	4.40
Western Northern Great Plains	4.90	3.80
Rockies	10.00	-
Southwest	8.00	4.40
Northwest	-	5.40
Alaska	6.60	-

SOURCE: 1976 National Energy Outlook, FEA.

FEA. The scenario is specified in terms of energy inputs and consumption as it relates to Gross National Product (GNP), population and energy conversion efficiency. Conversion efficiency has to do with the energy loss in converting from primary sources, such as coal, to secondary sources, such as electricity. Table 4-7 shows historical trends in energy, economic and demographic indicators used in preparing this scenario. Tables 4-8 and 4-9 show 1974 actual and projections to 2000 of energy consumption by each sector of the economy. Table 4-11 summarizes the sources of energy supply. The forecast is based on annual growth rates of 3.8% and 1.1% for GNP and population (1974-1985) respectively. Other assumptions used are that strip mining will be allowed but environmental protection will be required; the Federal government will lease offshore oil areas at an accelerated rate, and will lease western coal lands, oil shale lands and "known geothermal resource areas"; the government will support research and development of coal gasification and liquification and development of commercially viable methods for controlling sulfur oxide emissions from coal burning. Increases in the efficiency of energy utilization is assumed even though conversion losses are expected to rise substantially due to increased end use of secondary energy sources (see Table 4-11). The major technological event expected is the introduction of the breeder reactor. This event is tentatively scheduled for 1985, however, delays are continuing and the probability of introduction by the target date is low. (If the breeder reactor is not commercially viable by 1986, it may still have an impact on future utility capacity selections through perceptions of increased future fuel supplies). Solar energy is not

TABLE 4-7

Selected United States Economic Demographic, and Energy Indicators

(1947-1975)

Year	Gross energy input 1/ (Quadrillion Btu)	Net energy input 2/ (Quadrillion Btu)	Population (Millions)	Gross National Product (Billion $ 1958)	Gross Energy per GNP (Thousand Btu)	Gross energy per capita (Million Btu)	Net energy per capita (Million Btu)	Conversion Efficiency (Percent) 3/
1947	33.0	29.2	144.1	309.9	106.4	229.0	202.8	88.5
1948	33.9	29.1	146.6	323.7	104.7	231.2	198.6	85.8
1949	31.5	27.3	149.2	324.1	97.2	211.1	182.7	86.5
1950	34.0	29.7	152.3	355.3	95.7	223.2	194.8	87.3
1951	36.8	32.1	154.9	383.4	96.0	237.6	206.9	87.1
1952	36.5	31.6	157.6	395.1	92.4	231.7	200.6	86.6
1953	37.6	32.6	160.2	412.8	91.1	234.7	201.1	85.7
1954	36.3	31.2	163.0	407.0	89.2	222.7	191.5	86.0
1955	39.7	34.3	165.9	438.0	90.6	239.3	206.7	86.4
1956	41.7	35.8	168.9	446.1	93.5	246.9	211.7	85.7
1957	41.7	35.6	172.0	452.5	92.2	242.2	206.9	85.4
1958	41.7	35.5	174.9	447.3	93.2	238.4	202.8	85.1
1959	43.1	36.4	177.8	475.9	90.6	242.4	205.0	84.6
1960	44.6	38.2	180.7	487.7	91.4	246.8	211.5	85.7
1961	45.3	38.7	183.8	497.2	91.1	246.5	210.6	85.8
1962	47.4	40.5	186.5	529.8	89.5	254.1	217.2	85.5
1963	49.3	42.0	189.2	551.0	89.5	260.5	222.0	85.2
1964	51.2	43.6	191.8	581.1	88.1	266.9	227.3	85.5
1965	53.3	45.3	194.3	617.8	86.3	274.3	233.1	85.0
1966	56.4	47.6	196.6	658.1	85.7	286.9	242.1	84.4
1967	58.3	49.4	198.7	675.2	86.3	293.4	248.6	84.7
1968	61.7	52.2	200.7	706.6	87.3	307.4	260.1	84.6
1969	65.0	54.4	202.7	725.6	89.6	320.7	268.4	83.7
1970	67.1	56.0	204.9	722.5	92.9	327.5	273.3	83.6
1971	68.7	57.0	207.0	746.3	92.0	331.9	275.4	83.0
1972	72.1	59.5	208.8	792.5	91.0	345.3	285.0	82.6
1973	74.7	61.3	210.4	839.2	89.0	355.0	291.3	82.1
1974	73.1	59.9	211.9	821.2	89.0	345.0	282.7	81.9
1975 e/	72.2	NA	213.4	NA	NA	338.0	NA	NA

e/ Estimated.

1/ Gross energy is the total of inputs into the economy of the primary fuels (petroleum, natural gas, and coal, including imports) or their derivatives, plus the generation of hydro and nuclear power converted to equivalent energy inputs.

2/ Net energy is the sector inputs (household and commercial, transportation, and industrial), and consists of direct fuels and purchased electricity.

3/ The conversion efficiency factor is the percent of total gross energy going into the final consuming sector.

SOURCE: United States Energy through the Year 2000 (Revised), Bureau of Mines, U. S. Department of the Interior.

TABLE 4-8

United States Consumption of Energy Resources by Major Sources and Consuming Sectors, 1974 Preliminary and Projected to the Year 2000

(Trillion Btu)

Consuming Sector	Coal	Petroleum	Natural Gas	Oil Shale	Nuclear Power	Hydropower and Geothermal	Total Gross Energy Inputs	Synthetic Liquids Distributed	Synthetic Gas Distributed	Utility Electricity Distributed	Total Net Energy Inputs
1974											
Household & Commercial	291	6,390	7,116	--	--	--	13,797	--	--	3,687	17,484
Industrial 1/	4,208	6,044	11,129	--	--	34	21,415	--	--	2,665	24,081
Transportation	2	17,608	664	--	--	--	18,274	--	--	16	18,290
Electrical generation	8,668	3,448	3,328	--	1,173	3,018	19,635	--	--	--	--
Synthetic gas	--	--	--	--	--	--	--	--	--	--	--
Synthetic liquids	--	--	--	--	--	--	--	--	--	--	--
Total	13,169	33,490	22,237	--	1,173	3,052	73,121	--	--	6,368	59,855
1980											
Household & Commercial	100	7,600	8,000	--	--	--	15,700	--	110	5,790	21,600
Industrial	4,800	7,500	10,000	--	--	--	22,300	--	--	3,600	25,900
Transportation	--	20,700	600	--	--	--	21,300	--	--	60	21,360
Electrical generation	12,250	5,100	2,000	--	4,550	3,800	27,700	--	--	--	--
Synthetic gas	--	140	--	--	--	--	140	--	--	--	--
Synthetic liquids	--	--	--	--	--	--	--	--	--	--	--
Total	17,150	41,040	20,600	--	4,550	3,800	87,140	--	110	9,450	68,860
1985											
Household & Commercial	100	7,880	8,500	--	--	--	16,480	120	210	7,810	24,620
Industrial	4,930	8,370	9,500	--	--	--	22,800	130	240	5,620	28,790
Transportation	--	23,040	600	--	--	--	23,640	360	--	80	24,080
Electrical generation	15,700	6,200	1,500	--	11,840	3,850	39,090	--	--	--	--
Synthetic gas	520	140	--	--	--	--	660	--	--	--	--
Synthetic liquids	--	--	--	870	--	--	870	--	--	--	--
Total	21,250	45,630	20,100	870	11,840	3,850	103,540	610	450	13,510	77,490
2000											
Household & Commercial	--	7,960	9,000	--	--	--	16,960	940	1,940	14,740	34,580
Industrial	5,910	10,370	9,000	--	--	--	25,280	1,230	2,260	14,680	43,450
Transportation	--	28,170	600	--	--	--	28,770	3,330	--	100	32,200
Electrical generation	20,700	4,700	1,000	--	46,080	6,070	78,550	--	--	--	--
Synthetic gas	6,000	--	--	--	--	--	6,000	--	--	--	--
Synthetic liquids	2,140	--	--	5,730	--	--	7,870	--	--	--	--
Total	34,750	51,200	19,600	5,730	46,080	6,070	163,430	5,500	4,200	29,520	110,230

1/ Miscellaneous and unaccounted energy assigned to this sector. For 1974 this was 219 trillion Btu of petroleum products.

SOURCE: United States Energy through the Year 2000 (Revised), Bureau of Mines

TABLE 4-9

United States Consumption of Energy Resources by Major Sources, 1974 Preliminary and Projected to the Year 2000 (in standard physical units)

Consuming Sector	Coal million short tons 1/	Petroleum million barrels 2/	Natural Gas billion cubic feet	Oil Shale million barrels equivalent	Nuclear Power billion kWh	Hydropower & Geothermal billion kWh	Synthetic Liquids distributed million barrels	Synthetic Gas distributed billion cu. ft.	Utility Electric distributed billion kWh
1974									
Household & Commercial	10.9	1,115.0	6,970	--	--	--	--	--	1,080
Industrial 3/	154.9	1,137.1	10,900	--	--	3	--	--	781
Transportation	.1	3,274.7	650	--	--	--	--	--	3
Electrical generation	390.6	554.0	3,260	--	110	291	--	--	--
Synthetic gas	--	--	--	--	--	--	--	--	--
Synthetic liquids	--	--	--	--	--	--	--	--	--
Total	556.5	6,080.8	21,780	--	110	294	--	--	1,864
1980									
Household & Commercial	4	1,376	7,770	--	--	--	--	120	1,695
Industrial	185	1,358	9,700	--	--	--	--	--	1,057
Transportation	--	3,750	580	--	--	--	--	--	17
Electrical generation	547	924	1,940	--	427	343	--	--	--
Synthetic gas	--	25	--	--	--	--	--	--	--
Synthetic liquids	--	--	--	--	--	--	--	--	--
Total	736	7,433	19,990	--	427	343	--	120	2,769
1985									
Household & Commercial	3	1,427	8,250	--	--	--	22	230	2,290
Industrial	190	1,516	9,220	--	--	--	23	270	1,647
Transportation	--	4,174	580	--	--	--	65	--	23
Electrical generation	704	1,123	1,460	--	1,139	391	--	--	--
Synthetic gas	26	25	--	--	--	--	--	--	--
Synthetic liquids	--	--	--	157	--	--	--	--	--
Total	923	8,265	19,510	157	1,139	391	110	500	3,960
2000									
Household & Commercial	--	1,442	8,740	--	--	--	170	2,160	4,320
Industrial	228	1,878	8,740	--	--	--	225	2,510	4,302
Transportation	--	5,103	580	--	--	--	605	--	28
Electrical generation	941	851	970	--	5,120	605	--	--	--
Synthetic gas	300	--	--	--	--	--	--	--	--
Synthetic liquids	91	--	--	1,040	--	--	--	--	--
Total	1,560	9,274	19,030	1,040	5,120	605	1,000	4,670	8,650

1/ Includes anthracite, bituminous, and lignite.
2/ Petroleum products refined and processed from crude.
3/ Miscellaneous and unaccounted energy assigned to this sector. For 1974 this was 37.9 million barrels of petroleum product.

SOURCE: United States Energy through the Year 2000 (Revised), Bureau of Mines

TABLE 4-10

United States Gross Consumption of Energy Resources by Major Sources, 1974 Preliminary and Projected to the Year 2000

	1974	1980	1985	2000
Petroleum				
Million barrels	6,080.8	7,433	8,265	9,274
Trillion Btu	33,490	41,040	45,630	51,200
Percent of total gross inputs	45.8	47.1	44.1	31.3
Natural Gas				
Billion cubic feet	21,780	19,900	19,510	19,030
Trillion Btu	22,237	20,600	20,100	19,600
Percent of total gross inputs	30.5	23.6	19.4	12.0
Coal (all ranks) 1/				
Million short tons	556.5	736	923	1,560
Trillion Btu	13,169	17,150	21,250	34,750
Percent of total gross inputs	18.0	19.7	20.5	21.3
Oil Shale				
Million barrels	--	--	157	1,040
Trillion Btu	--	--	870	5,730
Percent of total gross inputs	--	--	.8	3.5
Hydropower & Geothermal				
Billion kWh	291	343	391	605
Trillion Btu	3,052	3,800	3,850	6,070
Percent of total gross inputs	4.1	4.4	3.8	3.7
Nuclear Power				
Billion kWh	110	427	1,139	5,120
Trillion Btu	1,173	4,550	11,840	46,080
Percent of total gross inputs	1.6	5.2	11.4	28.2
Total Gross Energy Input				
Trillion Btu	73,121	87,140	103,540	163,430

1/ Does not include coal exports.

SOURCE: United States Energy through the Year 2000 (Revised), Bureau of Mines

TABLE 4-11

Conversion Efficiencies and Losses for the Secondary Energy Sources, 1974 Preliminary and Projected to the Year 2000[1]

(Trillion Btu)

	1974	1980	1985	2000
Electrical Sector				
Inputs	19,635	27,700	39,090	78,550
Output	6,368	9,450	13,510	29,520
Losses	13,267	18,250	25,580	49,030
Conversion Efficiency, percent	32.4	34.1	34.6	37.6
Synthetic Liquid Sector				
Inputs	--	--	870	7,870
Output	--	--	610	5,500
Losses	--	--	260	2,370
Conversion Efficiency, percent	--	--	70.1	70.0
Synthetic Gas Sector				
Inputs	--	140	660	6,000
Output	--	110	450	4,200
Losses	--	30	210	1,800
Conversion Efficiency, percent	--	78.6	68.2	70.0
Total				
Inputs	19,635	27,840	40,620	92,420
Output	6,368	9,560	14,570	39,220
Losses	13,267	18,280	26,050	53,200
Conversion Efficiency, percent	32.4	34.3	35.9	42.4

1/ Secondary energy sources are electricity, synthetic liquids, and synthetic gas.

SOURCE: United States Energy through the Year 2000 (Revised), Bureau of Mines

a major factor and nuclear fusion is considered too far in the future for inclusion. The BOM scenario does not specify regional energy supply or demand breakdowns.

The coal forecasts in both the FEA and BOM scenarios are based on growth rates of relevant variables, assumed choices by consumers and other indirect estimating procedures. There are data available on the plans of coal producers and the electric utilities on their plans for the future. While these data share some of the uncertainties of the scenarios described above, they represent the best estimate available at this time (1977) of the future production and consumption of coal.

4.2 Industry Estimates

Several major surveys of coal producers and electric utilities have been conducted in the past year. The methods used by all of these are generally the same, direct contact with coal producers and utility companies. The Federal Power Commission (FPC) also collects data on coal deliveries to utilities and future contracts on a regular basis. The FPC data are collected under statutory authority while the other studies depend on voluntary participation. For this reason, there may be differences in the completeness of the data.

4.2.1 Coal Production

Two studies were conducted by the survey method in 1976 of planned new coal mining capacity through 1985 One was performed by the National Coal Association.[9] The other was performed under contract to FEA.[10] These studies indicate that additions and expansions of coal mine capacity from 1975 to 1985 will be between 400 and 500 million tons. The expansion in the western regions is expected to be between 230 and 275 million tons with eastern capacity additions ranging from 180 and 230 million tons. The total production capacity in 1985 assumes no significant mine retirements. Discussions with the National Coal Association indicate that some slippage can be expected in the dates for mine expansion. The procedures gear production capacity additions to the start up date for their customers' facilities. When power plants are delayed,

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9. A Study of New Mine Additions and Major Expansion Plans of The Coal Industry, National Coal Association, Washington, D.C., 1976.

10. Final Report Coal Mine Expansion Study, May 1976, Submitted to the Office of Coal, Federal Energy Administration, prepared by ICF Incorporated.

the mine expansion may also be delayed. There are also small mine operators who produce only when the price of coal is high and stop production when prices fall. The production capacity of these operators is difficult to judge at any given time.

4.2.2 Electric Utilities

The Presidential Task Force on Power Plant Acceleration of the Federal Energy Administration prepared a report on the status of significant power plants.[11] This report was not intended to compile data on all future power plants in the U.S. at a particular time period. It is a listing of the current (July 1976) status of major[12] power plants in planning or under construction. As such, it provides a guide to the future geographic distribution of generating stations and the mix of fuels. The report provides information for each project on the utility company, capacity, fuel type, on-line dates, slippage and types of problems encountered, if any. The report was used, with average annual coal consumption rates per megawatt of capacity, as an aid to estimating the geographic distribution of utility sector coal consumption in 1985.

A second report was produced by the FPC on the status of coal contracts and utility generating plans.[13] This

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11. Status: Significant U.S. Power Plants In Planning or Construction, Presidential Task Force on Power Plant Acceleration, Federal Energy ADministration, Washington, D.C. 20461, July 1, 1976.
12. Major power plants are defined as larger than 200 megawatts originally planned to come on line prior to 1990, and generally not gas or oil fired.
13. Status of Coal Supply Contracts For New Electric Generating Units 1976-1985, Staff Report by the Bureau of Power, Federal Power Commission, Washington, D.C., January, 1977.

report was compiled from data submitted by all utilities covering their planned capacity, fuel type, fuel source and contract status in compliance with FPC reporting requirements. These data represent the utilities' current plans and firm commitments. Table 4-12 represents the projected generating mix for 1975, 1980, and 1985 with the resulting fossil fuel requirements for the nation as a whole. Table 4-13 shows regional utility coal demand for 1975 and 1985. The projections in this report differ somewhat from those used as a basis for the study. There are two reasons for this. First the study forecast is tied to the FEA Reference Case Scenario with only minor modifications; and second, the FPC data are more recent than those used to prepare this study. In both the FPC projections and the forecast used in the study, there are uncertainties about the timing of generating capacity installation, the types of coal which will be used and the prospects for nuclear power generation.

4.2.3 The Study Forecast

The 1985 forecasts of coal consumption and production used in this study are based on the FEA Reference Case Scenario. However, information in the reports on electric utility and coal mine capacity expansion conflicted with some aspects of the scenario. The principal conflicts were in the geographic distribution of utility coal consumption. The Reference Scenario projected 1985 New England utility coal consumption at 15 million tons. Discussions with utilities in New England indicated that there are no coal fired plants currently planned which could come on line by 1985. Increases in capacity are expected to be nuclear plants. Similar discrepancies were noted in the Northern

TABLE 4-12

Projected Generation Mix, 1980 and 1985,
In Billion Kilowatt-Hours

Type Generation	1975 Actual		1980		1985	
	kwh	%	kwh	%	kwh	%
Coal	852.7	44.50	1227	46.87	1690	48.47
Oil	288.6	15.06	465	17.76	465	13.34
Gas	299.6	15.64	255	9.74	205	5.88
Nuclear	171.4	8.94	380	14.51	807	23.14
Hydro	300.5	15.68	285*	10.89	300	8.60
Other	3.4	0.18	6	0.23	20	0.57
Total	1916.2	100.00	2618	100.00	3487	100.00

* Median conditions; 1975 was an above-normal hydro year.

SOURCE: Status of Coal Supply Contracts for New Electric Generating Units 1976 - 1985, Bureau of Power, Federal Power Commission, January, 1977.

TABLE 4-13

Regional Coal Demand for New Units

Scheduled for Service 1976-1985

	1975	1985		
	Shipments to Utilities (1000 Tons)	Total Demand For New Units (1000 Tons)	Quantities Assured For New Units (1000 Tons)	% Assured
Eastern Regions				
New England	1,274	-	-	-
Middle Atlantic	45,037	18,100	7,300	40.3
East North Central	144,742	47,004	23,623	50.3
South Atlantic	79,216	23,792	8,377	35.2
East South Central	70,830	23,249	12,063	51.9
Sub Total	341,099	112,145	51,363	45.8
Western Regions				
West North Central	43,471	67,330	56,775	84.3
West South Central	9,146	124,207	95,343	76.8
Mountain	32,856	52,889	38,364	72.5
Pacific	4,200	1,200	1,200	100.0
Sub-Total	89,403	245,626	191,682	78.0
Total	430,502*	357,771	243,045	67.9

*Of the 430.5 million tons of coal delivered to the utilities in 1975, 406 million tons were consumed; 24.5 million tons were added to stock piles.

SOURCE: Status of Coal Supply Contracts for New Electric Generating Units 1976 - 1985, Bureau of Power, Federal Power Commission, January, 1977.

Great Plains and Pacific regions. In the case of the Great Plains area, the scenario underestimated actually planned capacity. After discussions with FEA, utilities and DOT, the Reference Scenario coal forecasts were modified to reflect the new information. The resulting forecasts were prepared on a state by state basis. The forecasts used in the study are shown in Tables 4-14 and 4-15. It should be noted that these forecasts are not certainties even though they reflect the plans of producers and consumers. Many unresolved factors will change those plans over time.

TABLE 4-14

1985 Coal Production Forecast

(thousand tons)

STATE	1985 COAL PRODUCTION	STATE	1985 COAL PRODUCTION
Alabama	34,570	Ohio	58,397
Alaska	766	Oklahoma	2,455
Arizona	14,299	Pennsylvania	101,801
Arkansas	632	Tennessee	9,200
Colorado	21,524	Texas	29,202
Illinois	106,830	Utah	17,110
Indiana	43,162	Virginia	39,570
Iowa	663	Washington	3,738
Kansas	1,107	West Virginia	164,814
Kentucky	184,622	Wyoming	183,346
Maryland	4,521		
Missouri	6,641	TOTAL	1,133,918
Montana	58,640		
New Mexico	19,297	TOTAL EAST	747,487
North Dakota	27,011	TOTAL WEST	386,431

[1] The totals for east and west are based on a division along the Mississippi River. This approximates the division between western railroads and eastern and southern railroads. As the data were developed on a state-by-state basis, aggregation by coal mining districts would have introduced inaccuracies from arbitrary allocation. Eastern coal production was not broken down further because of the overlap in areas served by eastern and southern districts.

TABLE 4-15

ESTIMATED TOTAL COAL CONSUMPTION 1985

(Thousand Tons)

CENSUS REGION	ELECTRIC UTILITIES	HOUSEHOLD/ COMMERCIAL	COKE & GAS	ALL OTHER	TOTAL
NEW ENGLAND	987	20	-	696	1,703
Connecticut	4	1	-	210	215
Maine	-	4	-	178	182
Massachusetts	17	15	-	262	294
New Hampshire	935	-	-	32	967
Rhode Island	18	-	-	14	32
Vermont	13	-	-	-	13
MID-ATLANTIC	58,880	254	33,077	26,946	119,157
New Jersey	2,256	5	-	483	2,744
New York	12,004	50	6,408	7,203	25,665
Pennsylvania	44,620	199	26,669	19,260	90,748
SOUTH ATLANTIC	99,771	987	10,180	37,240	148,178
Delaware	2,508	-	-	77	2,585
Florida	12,165	-	-	-	12,165
Georgia	16,812	30	-	1,043	17,885
Maryland	6,572	21	4,256	2,446	13,295
North Carolina	21,255	207	-	5,212	26,674
South Carolina	5,564	128	-	4,620	10,312
Virginia	3,870	354	-	8,141	12,365
Washington, D.C.	79	18	-	574	671
West Virginia	30,946	229	5,924	15,127	52,226
EAST NORTH CENTRAL	194,804	2,111	39,290	94,273	330,478
Illinois	43,556	540	3,596	15,208	62,900
Indiana	41,279	277	15,786	16,111	73,453
Michigan	24,744	246	4,449	15,543	44,982
Ohio	64,959	791	15,181	39,389	120,320
Wisconsin	20,266	257	278	8,022	28,823
EAST SOUTH CENTRAL	87,505	383	9,546	23,044	120,478
Alabama	26,623	19	7,729	8,183	42,554
Kentucky	37,104	187	1,621	7,249	46,161
Mississippi	1,545	-	-	168	1,713
Tennessee	22,233	177	196	7,444	30,050

TABLE 4-15 (Continued)

ESTIMATED TOTAL COAL CONSUMPTION 1985

(Thousand Tons)

CENSUS REGION	ELECTRIC UTILITIES	HOUSEHOLD/ COMMERCIAL	COKE & GAS	ALL OTHER	TOTAL
WEST NORTH CENTRAL	91,558	452	1,177	16,030	109,217
Iowa	13,629	59	–	4,462	18,150
Kansas	16,830	2	–	486	17,318
Minnesota	20,485	166	842	3,420	24,913
Missouri	26,439	111	335	5,446	32,331
Nebraska	6,190	7	–	1,089	7,286
North Dakota	4,898	88	–	1,113	6,099
South Dakota	3,087	19	–	14	3,120
WEST SOUTH CENTRAL	41,399	3	1,019	9,051	51,472
Arkansas	8,448	–	–	392	8,840
Louisiana	4,320	–	–	–	4,320
Oklahoma	11,840	2	–	602	12,444
Texas	16,791	1	1,019	8,057	25,868
MOUNTAIN	84,134	357	3,503	7,371	95,365
Arizona	9,800	–	–	39	9,839
Colorado	18,044	53	1,286	1,709	21,092
Idaho		96	–	1,172	1,268
Montana	7,820	6	–	192	8,018
New Mexico	12,290	–	–	25	12,315
Nevada	12,476	1	–	435	12,912
Utah	10,311	184	2,217	2,139	14,851
Wyoming	13,393	17	–	1,660	15,070
PACIFIC	18,044	14	2,492	1,547	22,097
California	9,000	1	–	123	9,124
Oregon	2,000	6	–	490	2,496
Washington	7,044	7	2,492	934	10,477
EXPORT	–	–	–	–	80,000
TOTAL	677,082	4,581	100,284	216,198	1,078,14

4.3 Uncertainties and their Effects

There are many uncertainties associated with the forecasts of future coal use and with the estimates of transportation requirements. These uncertainties stem from government policy decisions yet to be made, technological developments and market factors.

4.3.1 Government Policy

Most of the uncertainties in government energy policies are well known. The most pervasive policy question outstanding is that of environmental limitations on mining and burning coal. The forecast of coal production used in this study requires that coal production increase by more than 40 million tons per year from 1975 through 1985. The increases in production from 1974-1976 have been in the range of 24 million tons per year (average). While it is likely that production will increase more rapidly after 1980, the current shortfall is partially attributable to environmental problems in mining and burning coal.

Due to an apparent ambivalence to coal development on the part of the federal government and Congress, there has been little solid action to reduce the uncertainties in the long term market outlook for coal. The net result is delays in construction of coal burning facilities and coal mines.

4.3.2 Technology

Technological developments over the next few years will have a substantial impact on the mix of fuels used in the U. S. These developments center on the development of nuclear energy, coal burning and mining technology and alternate energy sources. There is direct competition between nuclear power and coal for electrical generating capacity. Therefore, should nuclear power become socially acceptable, many utilities may shift their expansion or replacement capacity away from using coal. Commercial development of the fast breeder reactor may have a similar result.

Since fuel selection by utilities, and others, is basically still an economic one, the cost of burning coal is still the dominant factor in the competition among energy sources. Government regulations may change factors in the economic equation. Such changes will have a significant impact on future coal consumption, both regionally and in total. If clean air standards are enforced, efficient methods of burning coal and cleaning stack gas will be necessary. The present technology for desulfuring stack gas is not sufficient to allow burning much of the eastern coal at economic costs. If this technology does not advance at a rapid rate, nuclear power will be the most likely choice of utilities faced with strict air quality standards and those distant from low sulfur coal sources.

There are some technological developments in coal burning which may reduce the cost of burning coal. One such prospect is magnetohydrodynamics. This system depends on the development of fluidized bed combustion or some other high temperature combustion technique. The resulting efficiency in electrical generation could be as high as 50% from a given quantity of coal. This system will probably not be commercially available until the year 2000. However, its development may encourage construction of coal fired generating facilities in the interim.

4.3.3 Market Factors

When all is said and done, the future use of coal as a primary energy source will depend largely on its competitive position in the marketplace for fuels. It is in this area where the uncertainties of technology, government policy and costs have their impact. Even if government policies promoting coal use are promulgated and the technologies required to mine and burn coal are developed, the cost to the user will determine where and how much coal is consumed. Therefore, the potential producers and consumers of coal must see a reasonable certainty that coal will be the least expensive fuel for substantially the life of their facilities in order to undertake the investment in coal fired plants. Similarly, transportation companies must be reasonably assured of their markets for transportation services before they can make major investments in equipment and facilities for distributing coal.

5. FINDINGS

5.1 National Transportation Requirements

5.1.1 Overview

In 1975 the Class I railroads of the U. S. originated 1.4 billion tons of freight. Coal was the largest single commodity making up nearly 30% of total tonnage, almost three times the next largest commodity. Similarly, the railroads are the primary mode for hauling coal. In 1975, railroads moved about 66% of coal transported. Coal traffic provided about 13% of rail revenues in 1975. These statistics indicate the interdependence of the railroads and the coal industry. Many railroads are looking forward to the increase in profitable coal traffic forming the base on which their profitability and future economic viability of the industry will be established.

5.1.2 1985 Coal Traffic

The traffic estimates in this study are premised on the scenario described in Section 4. Participating railroads have estimated that by 1985 annual originated coal traffic will be 799 million tons. The production estimate for 1985 is 1.1 billion tons which indicates that railroads are projecting a market share of 73%. This represents a 7% increase compared with the historical trend of about 66%. The net increase in coal originated by participating carriers is 418 million tons or 110%. Production and traffic patterns indicate a continuing shift in flows with greater tonnage originating in western states flowing to eastern and south-western markets. Table 5-1A shows projected national increases in rail traffic for 1985 over 1975, while Table 5-1B shows a comparison in the distribution of originated coal tonnage.

TABLE 5-1A

Projected Increase in National Coal Traffic, 1975-1985

(thousands of tons)

Year/District	Originated & Terminated On Line	Originated & Delivered to Connections	Received From Connections & Terminated On Line	Received From Connections & Delivered To Connections	TOTAL CARRIED
1985 Projections					
Western	112,989	195,031	100,314	15,254	423,588
Southern	116,800	54,000	18,800	9,600	199,200
Eastern	204,017	116,438	71,083	18,679	410,217
Totals	433,806	365,469	190,197	43,533	1,033,005
1975 Totals (1)					
Western	39,478	31,906	26,346		97,170
Southern	66,219	45,373	34,497 (2)		146,089
Eastern	120,541	77,560	101,103		299,204
Totals	226,238	154,839	161,946		543,023
Tonnage Increase	207,568	210,630	71,784		489,982
Percent Increase	91.7	136.0	44.0		90.2

1. Source: Coal Traffic Annual, 1976 Edition, National Coal Association, Washington, D.C.

2. Includes traffic received from connections and terminated on line or delivered to connections.

NOTE: 1975 and 1985 data are for 17 participating carriers which originated 94% of total rail tonnage in 1975.

TABLE 5-1B

Comparison of 1975 and 1985 Distribution of Originated Coal Tonnage

Region	(000) 1975 Tons Originated	% of U.S.	(000) 1985 Tons Originated	% of U.S.
West	71,384	18.7	308,020	38.5
South	111,592	29.3	170,800	21.4
East	198,101	52.0	320,455	40.1
U.S.	381,077	100%	799,275	100%

Source: Coal Traffic Annual, National Coal Association, July 1976.

between 1975 and 1985. The production estimates and rail originations are from different sources compiled at different times and do not necessarily coincide. There are two possible reasons for the discrepancies. First, there is competition among suppliers for markets which may lead to more than one origin area estimating production for the same market. Second, the reporting by mine operators in the study underlying the production estimates may not be complete in some cases. In other cases, the reporting may be long range capacity of mines rather than expected output in 1985. One result of the competition between regions and between carriers in each region is that the railroads would be "over-prepared" for actual traffic. With each carrier developing estimates of future traffic based on capturing part of the competitive market, somewhat more capacity and equipment would be planned than actually needed.

The rail originations are based on the best estimates of the participating railroads of their expected levels of traffic given the study scenario. They have cautioned that several factors, currently unresolved, could have substantial impacts on these estimates. Most of these factors are well known and have been discussed in previous sections. They relate to the controversies over mining and burning coal. One of the more significant factors is the possibility of the construction of coal slurry pipelines. If these are built as currently proposed, the rail originated tonnages in western states could be substantially reduced. Slurry pipelines would carry large tonnage flows which would otherwise move by unit train. Slurry pipeline issues are discussed in more detail in Section 5.1.6.

Railroad revenue from coal traffic in 1975 was $2.1 billion, about 13% of total rail revenue. This averages $5.25 per ton. Estimates of the rate levels for coal in 1985 vary from slight increases to as much as 30%. The general consensus of the rail industry is that coal rate increases will follow cost trends in labor, fuel and inflation in the economy as a whole. New rates for traffic moving on routes not currently under tariffs will be at levels indicated by the cost and market conditions at the time they are implemented. In general, however, unit train coal rates will follow somewhat different paths than rates on traffic subject to general rate increases.

5.1.3 Equipment and Motive Power

The national railroad car fleet numbers 1.7 million[1] freight cars including 15 thousand caboose cars. Of this total, 350 thousand are open top hoppers[2] owned by major coal carrying roads and 164 thousand are gondolas. Shippers and leasing companies own another 15,000 cars in these categories. Open hoppers and gondolas are equipment types generally used for coal. New car deliveries to the railroads of open top hoppers have averaged about 13,000 per year over the past ten years. Deliveries of open hoppers and gondolas in 1975 and 1976 were 28,325 and 23,335 respectively. Industry sources state that much of the increase in these car types over the ten year average is attributable to railroad expectations of increased coal traffic. Considering these production rates, the 9,000 car per year estimated requirement for 1985 coal traffic is easily within the capabilities of the car producers at current production rates. The trend in coal cars has been toward larger cars, primarily 100 ton capacity. Therefore, even though the number of cars in the total fleet has not grown, the capacity has increased steadily to the present average of about 80 tons per car. The participating railroads estimate that the coal traffic projections for 1985 will require 80,389 cars above existing fleets. Table 5-2 shows the aggregate equipment requirements for handling the increased coal traffic. This requirement represents a net increase in the national fleet of about 9,000 cars per year. The total investment, including 1,034 cabooses, will be $2.4 billion at 1976 prices or annual costs of about $268 million.

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1 Source: AAR. Includes cars owned by railroads and others.

2 Source: <u>Coal Traffic Annual</u>

TABLE 5-2

Projected 1985 Equipment Requirements for Coal Traffic

TYPE	NUMBER
Open hopper	53,495
Gondola	26,671
Other	223
TOTAL	80,389
Cabooses	1,034

NOTE: Projected equipment above existing fleets.

Equipment manufacturers indicate that present and planned production capacity is sufficient to handle the fleet expansion. A recent survey of eight private coal car builders and two locomotive makers performed by the Railway Progress Institute supports this conclusion. This survey found that car builders can produce more than 65,000 coal cars per year if necessary. This is more than triple the highest forecasts of car requirements and over six times the estimate in this report. Similarly, locomotive manufacturers have production capacity to produce more than 1,600 units per year. This capacity also exceeds the most optimistic forecasts by a sizeable margin. Besides the production capacity of the car building industry, some railroads, such as UP and N&W, build their own cars. These carriers have programs designed to substantially meet their forecast car requirements. This is a depressed center gondola called a Teoli car after its designer. It is also known as a "bathtub" car. The car was developed by Canadian Pacific Railroad and has been used successfully for several years in Canada. The car is designed for unit train service where its design should facilitate improved utilization.

The locomotive fleet of the Class I railroads at year end 1975 was 27,667 diesel and 167 electric.[3] The actual number in coal traffic service is difficult to estimate as most railroads do not dedicate motive power. The exception to the generality is in some unit train operations, where motive power is assigned to a specific service. A recent study including 19 major coal carrying roads estimates that,

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[3] Source: AAR. Excludes those owned by Amtrak and Auto-Train Corp.

in 1974, 3,817 locomotives (3,000 horsepower equivalents) were in coal service.[4] The most popular locomotives for coal service are 3,000 horsepower, six axle, diesel electric units. While the basic locomotive is standard, each railroad orders units to its own specifications.

Participating railroads estimate that 3,086 new locomotives would be required to handle projected 1985 coal traffic. This is a net addition to the locomotive fleet of 265 per year. The average annual locomotive delivery rate for the ten years 1965-1975 has been over 1,100 units. Rebuilding programs have added an average of about 150 previously retired units per year for the past 5 years. The locomotives required represent an investment of $1.5 billion or an average of $167 million per year at 1976 prices. The sum of car and locomotive investment through 1985 for coal traffic is $3.9 billion or $433 million per year (average). This compares with total average annual equipment investment of about $930 million[5] over the past 5 years.

5.1.4 Facilities

The facilities requirements for which participating railroads made estimates are track, signalling, yards and maintenance facilities. These are the principal components of the railroads' fixed plant. Because of the time frame of the study, estimates were not made for the individual components of each facility such as ties, rail, etc. Instead, estimates are based on types of facilities and needed improvements and expansion.

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[4] Rail Transportation Requirements for Coal Movement in 1980, prepared for U. S. Department of Transportation by Input Output Computer Services, Inc., April 1976.

[5] Source: Association of American Railroads.

5.1.4.1 Track

The participating railroads have estimated that $1,853 million would be invested in track to facilitate increased coal traffic. The estimates made for this study represent the levels and categories of investment required to efficiently handle the incremental coal traffic forecast for 1985. As the forecasts are based on a scenario which may or may not represent reality in 1985, the investment projections should not be construed as actual plans or requirements which must be met. They are estimates made under uncertainty. Table 5-3 shows the breakdown between categories of track investment. The mainline routes of the rail network serve all commodities and cannot be considered dedicated. The investments made will benefit all traffic by improving the efficiency of operations. Generally, the mainline routes required to handle 1985 coal traffic are in place. As Table 5-3 shows, most of the expected investment will be in "upgrading" existing lines. For the purposes of this study, upgrading is defined as performing maintenance at a level higher than "normal", including installation of heavier rail, more ties per mile, improved roadbed, modification of grade crossings and similar work. The second largest category is double track with sidings third. These three items are methods of increasing the line capacity of the railroads. Upgrading permits running heavier trains and higher speeds. Double track and increased length and frequency of sidings allow running more trains per day on given lines. Together, these improvements, with others, are geared to handle increased traffic density on coal carrying routes.

TABLE 5-3

Investment in Track for 1985 Coal Traffic

TYPE	MILES	Cost at 1976 Prices (thousands of $)
Main Lines	142 (1,2)	$9,000
Branch Lines and Spurs	414 (1)	197,918
Sidings	463 (1)	64,250
Double Tracks	995 (1)	182,900
Upgrading (4)	12,502 (1)	413,390 (3)
Unspecified		986,000 (5)
TOTAL	14,516	$1,853,458

1. Includes: 127 miles of mainlines
   62 miles of branches and spurs
   263 miles of sidings
   453 miles of double track
   6,800 miles of upgrading
   2,268 miles of CTC signalling for
   aggregate cost of $986 million.

2. Includes 4 miles of second mainlines for which cost estimates are included in expansion of existing yards on Table 5-4.

3. Includes $128,200,000 for which no mileage estimate was made.

4. Upgrading is defined as maintenance of way above normal levels, including installation of heavier rail, more ties per mile, improved roadbed, modification of grade crossings, etc., which can be attributed to increased coal traffic.

5. Includes all items in Note 1.

5.1.4.2 Signalling

Signalling is one of the primary factors affecting the capacity of a rail line. There are four basic signalling systems in use: (1) train order only; (2) manual block and train order; (3) automatic block (ABS); and (4) central traffic control (CTC). Each improvement in signalling increases the number of trains per day which can be safely run on the line. Estimates of the number of trains per day which can be safely operated on a track segment of specific configuration vary. There is no unanimously accepted capacity number for a given type of railroad line. A study presented in testimony before the U. S. Senate calculated the capacity of rail line categories for a railroad typified by light high speed trains. While the results of the study have not been accepted by all members of the railroad community, the illustration of capacity increases from signalling improvements is informative. Railroads whose traffic generally moves in heavy trains experience lower line capacity than those with light trains. It is not considered safe to run 10,000 net ton coal trains at 70 miles per hour by most railroads. General mixed freight trains can be run at these speeds. The following discussion is illustrative of the relative improvements attributed to signalling systems. General acceptance of the absolute values for capacity is not implied.

There is no dispute of the fact that better signalling improves safe operating capacity. A single track railroad[6] with ABS could, theoretically, handle more than 60 trains

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[6] Source: Statement of John D. Sward, Senior Market Analyst, The Atchison, Topeka & Santa Fe Railway Company, before the Subcommittee on Water Resources of the Senate Committee on Environmental and Public Works, 95th Congress, First Session, April 19, 1977. The values presented are based on assumptions of light high speed trains. The values have not been accepted by some coal carrying railroads, however, the principles have.

per day. This would require placing train order stations closer together than is really economical, about every 7 - 10 miles. Therefore, with train order stations about 25 miles apart, sufficient sidings (7 - 10 miles apart), and an average speed of 20 miles per hour, the safe operating capacity of the single track line is about 30 - 50 trains per day. This is an increase of 10 - 25 trains per day over the capacity of a manual block system on the same line.

The next step in signalling systems is CTC. In this system, signalling and switches at sidings are controlled from a central location. With CTC, the increase in capacity and efficiency comes from the reduction of delay and elimination of intermediaries in the transmission of train orders and other operating changes. A single track railroad can theoretically handle from 60 to 100 trains per day; double track railroad, up to 200 trains per day. The practical capacity varies from the theoretical depending on traffic volume, train speed, and individual railroad operating practices.

Virtually all the estimated improvements in signalling are for CTC systems on mainline routes. The remainder is ABS* and miscellaneous. Table 5-4 shows the estimated aggregate signalling investments by type.

*Automatic Block Signals

TABLE 5-4

Projected Signalling Requirements for 1985 Coal Traffic

TYPE	MILES	(thousands of dollars) Cost at 1976 Prices
CTC	3,221 (1,2)	$56,800 (3)
Automatic Block	636 (4)	
Other	75 (5)	8,895 (6)
TOTALS	3,932	65,695

NOTE:

1. Includes 2,268 miles of CTC signalling for which the cost was aggregated with track work. Total cost at 1976 prices is estimated at $986,000,000 and is shown as unspecified on Table 5-3.

2. Includes 200 miles for which no cost estimate was made.

3. Includes $14,900,000 for which no mileage estimate was made.

4. No cost estimate was made.

5. No cost estimate made.

6. Includes $3,200,000 for which no mileage estimate was made.

5.1.4.3 Yard and Maintenance Facilities

Relatively modest investments in yard facilities are estimated for 1985 coal traffic. This is due to the majority of increased coal traffic moving in unit trains. One of the basic advantages of unit trains is avoiding yards except for inspections, fueling and crew changes when necessary. Due to the size of mining operations in the east and south, i.e., many small mines, many non unit train operations will still be used in 1985. Several proposals have been made, by railroads and others, to create central accumulation points in areas where small mines operate. These facilities would receive coal by truck or rail from mines and ship by unit train or trainload to take advantage of the superior operation of these systems.

There are some yard requirements for unit trains especially where more than one railroad is involved. In some cases, locomotives must be switched when unit trains are interchanged. In others, helper locomotives are necessary to move the trains over steep grades. These units generally operate out of yards. There are also requirements for 500 mile locomotive inspections and for car inspection. These functions are generally performed at yards where facilities for performing the require work are available. The increased car and locomotive fleets will require some expansion in maintenance facilities. Additional train servicing facilities, such as fueling stations, will also be required. Some maintenance facilities will be dedicated to unit train servicing, fueling, maintenance, etc. Most, however, will be general purpose facilities.

Participating carriers estimated that $288,465,000 in yard and maintenance facilities would be required to handle increased coal traffic in 1985. Much of this expenditure would be expansion of existing facilities. The exact proportion can not be calculated due to grouping in the data. Table 5-5 shows the type, number and cost at 1976 prices for projected yard and maintenance facilities. The total includes $11,000,000 of additional maintenance of way equipment required to meet projected increases in maintenance of track and structures. This increase will result from higher traffic density on coal carrying routes.

5.1.5 Finances

The total investment required to move the coal traffic projected for 1985 is $6,145.6 million. This will be investment made above the "normal" investment in plant and equipment for all traffic other than coal and for the level of coal traffic currently moving by rail. Under ICC accounting rules, part of the "investment" required would be expensed annually under maintenance of way and structures. This primarily relates to upgrading of track. Track improvements are expensed except where the material installed is better than that replaced. For instance, when 115 pound per yard rail is replaced with 132 pound per yard rail, 13% of the cost of the new rail is added to the assets of the railroad. The remainder is maintenance of way. When new rail facilities are built, the total expenditure is capitalized. Thus, new yards, maintenance facilities and signalling systems are investments.

The financial condition and capital raising ability of railroads varies from bankrupt to very solid. However, the rate of return in the industry is low and the cost of capital for fixed plant investment is high. The cost of equipment debt through trust certificates is 7 - 8 %. The cost of revenue bonds for fixed plant improvements is in excess of 10%.

TABLE 5-5

Projected Yard and Maintenance Facility Requirements for 1985 Coal Traffic

Item	Number	Cost at 1976 Prices (thousands of dollars)
New Yards	2	$26,000 (1)
Expansion of Existing Yards	11 (3)	41,715 (2)
Locomotive Maintenance Facilities	6 (4)	3,750
Car Maintenance Facilities	10 (5)	56,000 (6)
Maintenance of Way Equipment		11,000
Unspecified		150,000 (7)
TOTAL		$288,465

NOTES:

1. Includes $15,000,000 of combined new yards and expansion of existing yards for which the number of facilities was not estimated.

2. Includes unknown amount for second main tracks and $215,000 for which the number of facilities was not estimated.

3. Includes 2 yards for which no cost estimate was made and 2 yards which were grouped with other facilities for an aggregate cost of $150,000,000, included under unspecified

TABLE 5-5 (Continued)

4. Includes 2 facilities which are included in the unspecified cost of $150,000,000.

5. Includes 3 facilities whose cost is included in unspecified.

6. Includes both car and locomotive facilities, number unspecified, at a cost of $50,000,000.

7. Includes: expansion of 2 yards
   2 locomotive facilities
   3 car facilities for aggregate cost of $150,000,000.

Even the investment tax credits allowed by the federal government are not enough to substantially lower the cost of investment capital, for the simple reason that most railroads do not have sufficient income to use the tax credits accruing to them. The railroad industry is so capital intensive that on a base of $312.5 million ordinary income in 1976 the industry invested nearly 1.7 billion in new equipment and fixed plant. The relationship between investment and income has been similar for many years. Total investment in railroad equipment and plant was $2.5 billion in 1976 including investment by other than Class I railroads. A more complete picture is gained by including expenditures on maintenance of way. In 1975 the railroad industry spent $2.4 billion on maintenance of way. In 1976 this expenditure grew to $3.1 billion. The total 1976 expenditure on fixed plant construction, upgrading and routine maintenance was $3.6 billion.

Most of the major coal carrying railroads are solvent and financially healthy. Many of them have their financial plans prepared for the next five to ten years and expect little difficulty in raising the needed capital if increased coal traffic remains a solid long term prospect. If either a new mode (slurry pipelines) enters the competition or severe restrictions are placed on the continued development of coal, then the ability of coal carriers to generate necessary capital will be impaired. The total investment estimate of $6.1 billion means that the railroads and shippers will have to generate an average of $680 million per year 1977 through 1985. This is approximately 14% of the average investment level of the past two years. These estimates are at 1976 prices. The AAR materials, price and wage index has increased 25% between 1974 and 1976. If the 1975 and 1976 plant and equipment is adjusted for these increases, the percentage that projected requirements are to the 1976 total drops to about 11%. However, if inflation continues, the actual cost of meeting projected requirements for 1985 coal traffic will be higher. As all traffic will benefit from the improved facilities made to handle coal traffic, the investment for coal traffic will "replace" some which would have been made under other circumstances. The improved revenue and fixed plant will allow better service for other traffic. The increased tonnage will reduce the fixed cost which must be covered by the revenue from each ton. The process could reverse the cycle of the past three decades which has seen declining or, at best, marginal growth in traffic and continually increasing costs for moving it.[7]

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[7] Tonnage originated in 1974 exceeded tonnage originated in 1947 by about 6,000 tons. This was the first year 1947 tonnage was exceeded.

5.1.6 Slurry Pipeline Issues

The expected rapid growth in western coal production to serve distant markets has created increased interest in coal slurry pipelines as a means of transportation. The principal factors which have precipitated this interest are the magnitudes of western coal to be produced in geographically limited areas and the size of planned consuming facilities, mostly electric utility generating plants. The economics of slurry pipelines are based on high volume movement from one origin to one destination. There is some potential for limited feeder and distribution systems but the economic advantage is substantially less than for the mainline systems. Figure 5-1 shows existing and planned systems. Note that the Ohio line is no longer operating.

Technologically, the process of pumping a slurry[8] mixture through a pipeline is not difficult. There are many forms of slurry pipelines operating today. There is one coal slurry line operating in the U. S. between Black Messa, Arizona and the Mohave generating plant in Nevada. There was one other line operating in Ohio until low railroad rates made it uneconomical to continue. There are, however, some technological problems with large scale slurry systems.

Coal slurry pipelines require large amounts of water. At a 50% mixture, one ton of coal requires one ton of water. For a 25 million ton per year (TPY) pipeline this means that 25 million TPY of water is required. The common measure for water in such quantities is acre feet, or one acre one foot deep. The water requirement for a 25 million TPY pipeline is slightly over 15,000 acre feet. This quantity of water presents two problems. First, most proposed slurry lines will originate in

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8 Slurry is a combination of particles of a solid suspended in a liquid medium such that it can be pumped through a pipe without the solid precipitating out. Coal is generally mixed with water in equal proportions by weight.

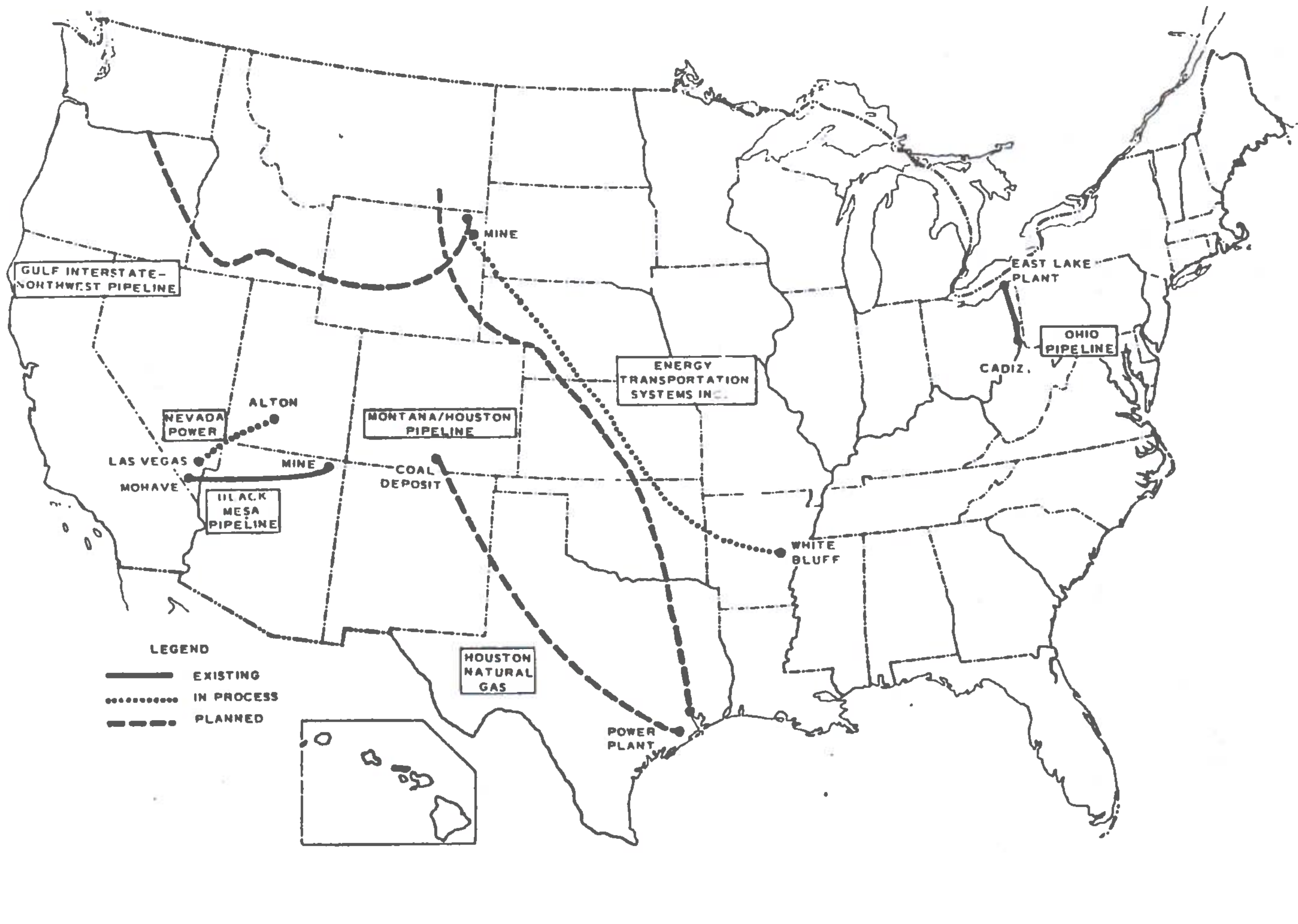

Figure 5-1. Coal Slurry Pipelines

the Northern Great Plains region, a region which is short on water already. Proponents of slurry lines point out that compared to mine-mouth power generation or coal conversion[9], slurry lines use comparatively little water. One substantial difference is that slurry lines export the water, the other systems do not. Several solutions to the scarce water problem have been proposed. Generally they involve importing the necessary quantity of water. One proposal calls for constructing a pipeline from the Oahe Reservoir in South Dakota to bring in water for slurry lines and for irrigation along the pipeline route. Other proposals have considered building a water return line paralleling the slurry lines.

The second water problem is one of disposal. Once the slurry reaches its destination, the coal must be dewatered. The problem then becomes what to do with 15,000 acre-feet of water which may or may not be pure enough for discharge into the surrounding environment. Some proposals call for the water to be used in the generating plant cooling system.

The non-technical issues involved in the slurry pipeline controversy are considerably more significant than the technical ones. The proponents of slurry pipelines are seeking the right of eminent domain for their systems. The basis for the application is that slurry pipelines are the lowest cost method of moving coal to markets. The arguments are based on two premises. One, the operating cost, and therefore the shipment rate, would be lower than all rail and competitive with optimal rail-water movement. Two, the operating costs of slurry piplines are far less susceptible to inflation and future cost increases than rail or water carriers. Slurry lines would compete directly with rail and rail-water alternatives. Consequently, railroads

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[9] Liquifaction or gassification.

have been unwilling to grant pipeline rights of way across rail lines. Thus, the effort to secure eminent domain.

The arguments against the granting of eminent domain to pipelines are based on two principal premises. The first proposes that slurry pipelines are not common carriers serving the public. They are private contract carriers which operate on the "take or pay" contract. This means that shippers would contract to receive a given quantity of coal from the pipeline over a long period, 20 to 30 years, or pay the transportation rate even though they did not take delivery of the contracted volume. This type of contract effectively insulates the pipeline from competition. The current proposals for slurry lines would serve only customers at the end of the line. This means that potential users along the route could not benefit from proximity to the system. The result is basically a private transportation system for the benefit of one customer.

The second argument offered by the railroads against slurry lines is that they would take the best available coal traffic away from railroads which see the traffic as important for future economic viability. Railroads are regulated common carriers which must accept all traffic offered to them.[10] Railroads compete with each other and with other modes for traffic. Granting the right of eminent domain to slurry pipelines could remove competitively desirable coal traffic from competition for the duration of a slurry line contract.

Along with the institutional and technological issues, there are some environmental questions related to pipeline ruptures which have not been resolved. The one active coal

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[10] There are a few exceptions to the requirement to carry all commodities related to items of exceptional value, currency, specie, bullion, etc.

slurry line in the U.S. ruptured in February, 1977 near Kingman, Arizona. Estimates of the amount of coal which escaped and the area covered by the coal runoff vary. The basic concern is that such a spill could occur from a larger system in fertile agricultural land or into surface or underground water systems.

5.1.7 Carrier Planning Processes

The term long range planning has a variety of meanings to different people depending on their frame of reference. About the only common purpose in most definitions is that long range planning is preparation for future events. The time periods considered to be long range generally depend on the lead time required by the planning organization to respond to changes and the immutability of actions taken in anticipation of change. For example, if the time required for a railroad to construct a branch line to serve a coal mine is two-three years, then planning horizons longer than three years may be considered long range. Also, since most of the resources required to construct a branch line can be used in alternate projects, corrective actions can be taken in case of a change in requirements. The time required to install central traffic control on a mainline route is also about three years, depending on route length. However, the cost of error and the number of alternate uses of the equipment are far different than for the branch line case. Therefore, in the CTC decision, a longer planning horizon is needed.

Railroads generally pursue several activities which fall into the category of long range planning. These can be grouped into two major types: affirmative and responsive. Affirmative actions are those designed to develop rail traffic over a long period of time or to improve the ability of the railroad to provide service profitably. An example of the first type is the assistance provided by some railroads to potential shippers in the conduct of their business. Such assistance is provided to farmers to promote increased production through modern farming methods. Similarly, railroads actively promote the use of coal as a major energy source and assist mine operators and their customers in designing efficient distribution systems. An example of plans aimed at operating efficiencies is the ongoing evaluation of railroad electrification. Electrification must be evaluated over a forecast period of 20 to 30 years in terms of future fuel prices, maintenance of locomotive costs, maintenance of the electrification system and operating benefits. Responsive planning is that set of activities designed to anticipate and prepare for future traffic. In some cases, the growth of traffic is reasonably certain, in others it is less sure. The amount of coal which is currently contracted for by electric utilities represents a reasonably certain amount of traffic for those railroads serving mines and their customers. The future volume of export wheat, while expected to grow in the long term, is far less certain as far as rail traffic is concerned. Railroads must be prepared to handle both the reasonably certain and the somewhat speculative traffic. Therefore, they must prepare to respond to demand for their services.

The following section describes the responsive planning processes of the railroads. These are the plans which will determine the ability of the railroads to meet the demands for coal transportation in the future. Also, the methods used to provide planning information to top management decision makers is similar for both affirmative and responsive planning; the level of detail and certainty of the data differ.

Planning Processes

Long range planning processes on most railroads are performed both routinely and for special purposes. While the mechanical details and procedures vary from company to company, the basic processes are similar. Also, the relative positions of planning staff personnel within companies differ. However, the functional areas represented and their interactions are similar on most railroads. This does not mean that there exists a uniformity or standardization in organizational structure and departmental emphasis, but indicates the recognition by railroad managements of the integrated systems aspects of their business.

On virtually all railroads, planning is an annual formal process. The groups responsible for coordinating the various phases of the process differ as do the formality and level of detail of planning guidelines issues by the oversight office. In some cases, a corporate planning office under a vice president, is responsible for preparing the formal planning document using information supplied by various departments. In other cases, management services, under a vice president, management information, or the planning staff of the dominant commodity group has the responsibility. The predominant structure includes the corporate planning office as the coordinating function.

The process is best described by identifying the functional areas providing inputs and the outputs of each functional group as the titles, locations, and organizations of the functions vary. A "typical" procedure is outlined below.

The basis of routine (annual) planning, in all cases, is traffic forecasts. These are generated by the marketing managers for each commodity group and by the sales organization for each sales territory across all commodities. The forecasts are generally provided in terms of tonnage, carloads, trains or all of the above from origins to destinations. These origins and destinations are either market areas or nodes on a network representation of the rail system.

Analyses of econometric projections of the state of U.S. or regional economics are also made; the results being factored into the traffic planning process. Data sources for the traffic projections consist of the plans of current and potential rail customers, industrial and government publications on various trends and events in industries which generate rail traffic and historical traffic data. Coal traffic is a special case in the planning process. Since most coal is sold on long term contract, with the railroad providing the physical link between buyer and seller, information on the volume of coal and details of movement are known well in advance. Frequently, the railroad is called upon to assist in the design of loading and unloading facilities for mines and their customers. In a system where millions of tons of coal are to be handled by each component, it is essential that all parties - producer, consumer and carrier - participate in planning the distribution system. If any one component in the system, e.g., the unloading facility, is not matched to the rest of the system, a loss of potential benefits occurs. Therefore, the volumes, routes, train configurations, scheduling, facilities and labor requirements for coal traffic are determined up to five years in advance of actual institution of service. In most cases, the number and types of cars and locomotives, fueling stations and other related facilities are determined during the planning period.

The traffic forecasts are the input to the industrial engineering function for conversion into operating statistics. Industrial engineering serves several purposes in the planning cycle. One function is to assess alternate operating strategies. This is generally accomplished using network simulation models consisting of link density calculators, train performance calculators, blocking models and others. Not all roads use all of these tools. The complexity of this type of analysis depends on the number of routing alternatives available, the number of origins and destinations on the network and the stability of traffic patterns over time. For those roads which have limited routing alternatives (or excess capacity on the major mainlines) and stable traffic patterns for the majority of their business, blocking simulations may be unnecessary. A second function is to prepare operating statistics for each link and terminal in the system for use by other departments in calculating their requirements. For instance, the maintenance of way programs depend, in part, on gross-ton-miles of traffic over each link, number of trains per day and other statistics. A third functions is to perform analyses of the impact on operations of proposed investment projects. The output of these functions is distributed to the engineering, mechanical and operations departments as inputs to their planning.

Traffic forecasts and operating projections are also the basis of financial planning. Revenue and cost projections are made from the traffic and operations data. Capital needs and capital generation (profit available for capital improvements) are also estimated and capital budgets prepared. The corporate planning department pulls together all the various forecasts, projections and plans for presentation to top management. The plans are evaluated by numerous committees and management groups and the final plan is prepared in the formal planning document. Figure 5-2 shows the functions performed in a ten year planning process as described above.

Long range planning is a continually evolving process. Both the time horizons and the factors included change as the railroads recognize new or altered circumstances in their business and its environment. Most railroads have traditionally used a five year horizon for their annual planning process with longer periods for specific projects or portions of their business. The time frame for annual planning functions is now moving to ten years on most roads and nearly all roads seek to identify major capital projects ten or more years in the future. There are many reasons for these trends. While the innate flexibility of railroads allows rapid response to traffic developments in a short time frame, the magnitude of investment projects and the long term income requirements to support and justify them require longer range planning. Also, the uncertainty of the business environment for commodities such as coal, which require major investment with little protection for that investment, means that longer range plans must be made. The analysis of planning processes on five major railroads indicates that these processes are very comprehensive and utilize many of the most sophisticated tools available.

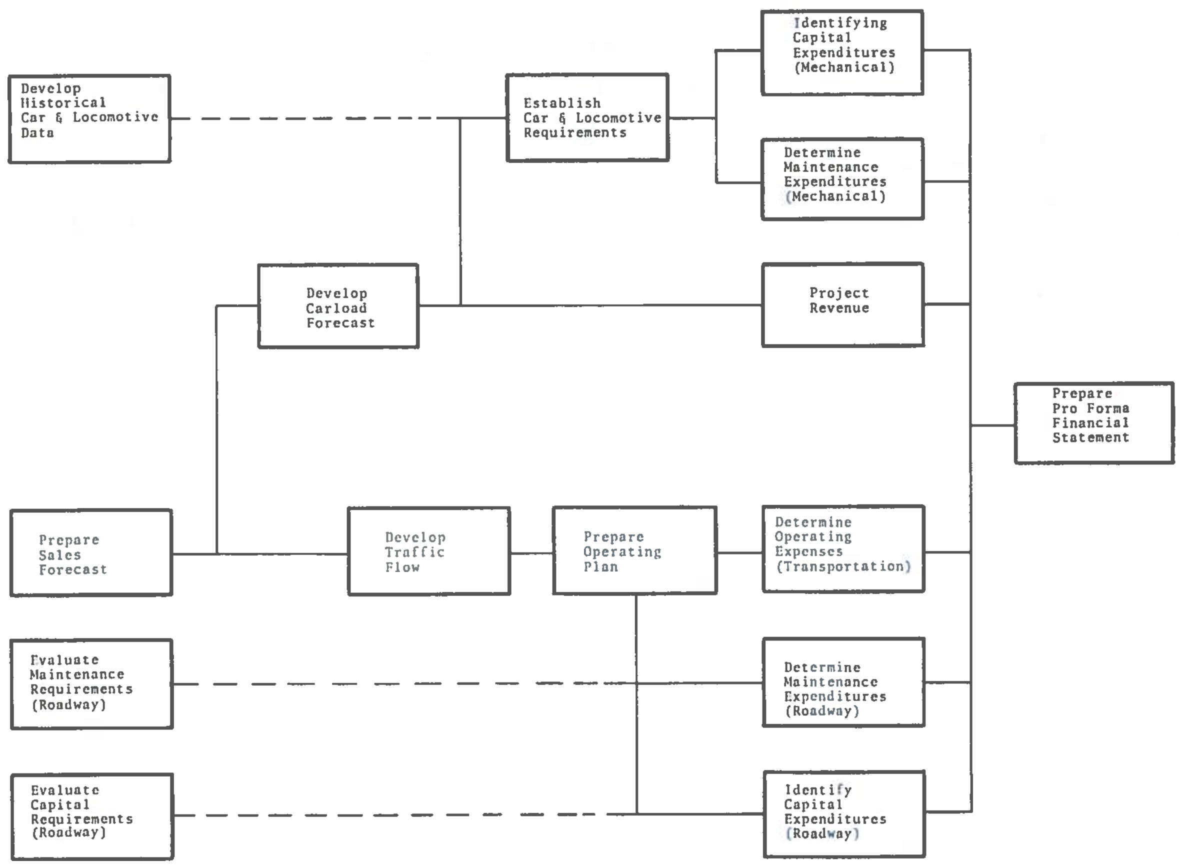

Figure 5-2. Flow Chart of Planning Process Functions

TASK	DATA INPUTS	OUTPUTS	PARTICIPATING GROUPS
1. Develop traffic forecasts between market pairs by commodity group	- historical traffic records - field surveys - shipper polls - econometric model projections	origin-destination traffic forecasts with historic and projected growth rates for commodity groups and major routes.	- Management Information - Sales - Marketing - Transportation Department - Operations Planning - Budget Department
2. Develop operating strategies in terms of train blocking and scheduling. Develop operating statistics	- traffic forecasts - system stimulation and analytical models - historical operating practices	train blocking and scheduling strategies with resulting line densities, segment car volumes, terminal switching requirements, line and terminal constraints and estimated future operating expenses.	- Train Operations Group - Operations Planning - Industrial Engineering - Operating Department - Management Information System - Budget Department

Figure 5–2 (Continued)

TASK	DATA INPUTS	OUTPUTS	PARTICIPATING GROUPS
3. Develop freight car acquisition program by car type by year	- traffic forecasts - train blocking and scheduling - target utilization rates - carloads by commodity per year - serviceable fleet - projected retirements - planned rebuilds - repair program	Program of car requirements and methods for realization including method of acquisition, repair programs, rebuilding programs, utilization rates and targets. Include type of ownership-shipper, lease, purchase, etc. estimated repair program and car related mechanical department operating costs and capital expenses	- Operations Planning - Car Committee - Transportation Department - Mechanical Department - Marketing Department - Budget Department - Management Information System

Figure 5-2 (Continued)

TASK	INPUT DATA	OUTPUT	PARTICIPATING GROUPS
4. Develop locomotive acquisition program by type of locomotive and type of service.	- historical operating data on utilization, ownership, etc. - traffic forecasts - train blocking and scheduling - maintenance requirements - retirement programs - rebuilding programs - Target utilization rates	Locomotive requirements with programs for acquisition, retirement, and repair. Projected maintenance programs and locomotive related mechanical department operating costs and capital expenses	- Operations Planning - Operating Department - Mechanical Department - Budget Department - Locomotive Committee - Management Information System - Industrial Engineering

Figure 5-2 (Continued)

TASK	INPUT DATA	OUTPUT	PARTICIPATING GROUPS
5. Develop roadway maintenance and capital programs	- current line condition and capacity - current line density - operating strategies - traffic forecasts - current projects - new customer locations - potential line and terminal constraints - gross tonnage projections - switching projections - operating cost projections	ten year program of roadway maintenance and capital projects including labor, materials and equipment, projected maintenance costs and capital expenses. The program includes underlying assumptions and projected maintenance techniques used to meet future requirements. Program is line specific and in order of priority. Program for line abandonment. All projects to include purpose, cost, time frame, justification and priority.	- Engineering Departments - Standards Committee - Industrial Engineering - Budget Department - Management Information System - Operating Department - Train Operations Committee - Operations Planning

Figure 5-2 (Continued)

	TASK	INPUT DATA	OUTPUT	PARTICIPATING GROUPS
6.	Develop financial analysis, impacts and capital plan	- traffic forecasts - car and locomotive programs - Roadway Programs - Current financial position	A series of proforma financial statements showing sources and uses of funds, cash flow, working capital, income and balance sheets. Proposed financing plans	- Budget Department - Sales Department - Pricing Department - Marketing Department - Operations Planning

Figure 5-6 (Continued)

5.2 Eastern Railroads

The Interstate Commerce Commission assigns railroads to districts based on primary geographic area of operation. Within the districts the railroads form associations for the purpose of facilitating that part of their business requireing cooperative and joint effort, primarily joint rate making and other related interline agreements. For this study, the Eastern Railroad Association provided estimates of the 1985 coal traffic and related requirements for its member roads. The major coal carriers in the eastern region are:

Bessemer and Lake Erie Railroad

Chessie System

Consolidated Rail Corporation[11]

Norfolk and Western Railroad

Pittsburgh and Lake Erie Railroad

5.2.1 Coal Traffic Volume 1985

The participating Eastern Railroads estimate, based on the scenario described in Section 4, that they will originate more than 320 million tons of coal in 10 states in 1985. The coal will terminate in 35 states and the District of Columbia. Nine states will receive 93% or 306 million tons while five states will produce 95%. Table 5-6 shows the originated

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[11] Consolidated Rail Corporation (ConRail) was formed in 1976 from portions of the Penn Central, Lehigh Valley, Erie Lackawanna, Reading, Central of New Jersey, and Lehigh and Hudson River Railroads.

TABLE 5-6

Projected 1985 Coal Tonnage Originated by State of Origin

Selected Eastern Railroads

STATE	TONS (Thousands)
Illinois	6,285
Indiana	8,000
Iowa	71
Kentucky	51,163
Maryland	2,570
Missouri	147
Ohio	28,338
Pennsylvania	67,274
Virginia	23,824
West Virginia	140,783
TOTAL	328,455

NOTE: Data represent projections of 5 railroad systems which originated 94.4% of Eastern territory coal tonnage in 1975.

TABLE 5-6 (Continued)

STATE	TONS (000)	STATE	TONS (000)
Alabama	886	New Hampshire	1,256
Arkansas	2	New Jersey	3,509[2]
California	56	New York	16,924
Colorado	32	North Carolina	12,538
Connecticut	9	Ohio	83,216[1]
Delaware	880	Oklahoma	1
D. C.	816	Oregon	1
Georgia	155	Pennsylvania	39,468[2][3]
Illinois	3,602	Rhode Island	1
Indiana	19,362	South Carolina	1,251
Iowa	325	Tennessee	631
Kentucky	3,663	Texas	284
Louisiana	13	Virginia	53,038[2]
Maryland	20,268[2]	Vermont	13
Massachusetts	148	West Virginia	26,812[3]
Maine	39	Washington	13
Michigan	35,665	Wisconsin	2,201
Minnesota	1,214		
Missouri	163	TOTAL	328,455

1) Includes all-rail and lake transshipment.

2) Includes all-rail and tidewater transshipment.

3) Includes all-rail and river transshipment.

tonnage by state of origin and state of destination. Table 5-7 shows a comparison of types of traffic between 1975, 1980 forecast and 1985 forecasts. The states of Ohio, Pennsylvania, Virginia, West Virginia and Maryland include tonnages received which will be all-rail shipments and some which will be transshipped to lakes, river, or ocean vessels. The quantities subject to transshipment were not separately specified.

Tonnage forecasts for 1985 indicate an increase in traffic of about 62% for originated traffic over 1975 and 14% above estimates for 1980.[12] Total traffic handled, including originated and interchange tonnage, of 410.2 million tons is an increase of 31% above 1975 and 4% above 1980 estimates. Growth in traffic other than coal is expected to be between 10% and 25% on the major coal carrying eastern territory railroads. This implies that coal traffic will provide an increasing percentage of total revenue by 1985.

The average length of haul for coal traffic in the eastern region was 255 miles in 1975 and is expected to increase slightly to 263 miles. Several factors may influence the future average haul. New electric utility plants are generally being sited in more remote areas than previously due to air pollution problems in urban areas. Markets formerly served entirely by northern Appalachian coal mines are now consuming some southern Appalachian high BTU low sulfur coal in order to meet clean air standards. Areas such as New England are entering the market for coal as utilities are ordered to convert by the FEA from oil to coal. As southern and western railroads also serve some of the same states as eastern railroads, comparisons of rail percentage

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[12] Rail Transportation Requirements for Coal Movement in 1980, Prepared for U. S. Department of Transportation, by Input Output Computer Services, Inc., Cambridge, MA, April 1976.

TABLE 5-7

Projected Increase in Coal Traffic: 1975 - 1980 - 1985

Selected Eastern Railroads

(thousands of tons)

YEAR	ORIGINATED & TERMINATED ON LINE	ORIGINATED & DELIVERED TO CONNECTIONS	RECEIVED FROM CONNECTIONS & TERMINATED ON LINE	RECEIVED FROM CONNECTIONS & DELIVERED TO CONNECTIONS	TOTAL CARRIED
1975[1]	120,541	77,560	101,103[2]		299,204
1980[3]	184,614	103,665	67,178	38,066	393,523
1985	204,017	116,438	71,083	18,679	410,217
Tonnage Increase					
1975 - 1980	64,073	26,105	4,141		94,319
1975 - 1985	83,476	38,878	(11,341)		111,013
Percent Increase					
1975 - 1980	53.2%	33.7%	4.1%		31.5%
1975 - 1985	69.3%	50.1%	(11.2%)		37.1%

1) Source: Coal Traffic Annual, 1976 Edition, National Coal Association, Washington, D.C.

2) Includes traffic received from connections and terminated on line or delivered to connections.

3) Rail Transportation Requirements for Coal Movement in 1980, Prepared for U. S. Department of Transportation, by Input Output Computer Services, Inc., Cambridge, MA 02142, April 1976.

of total production and consumption have not been made.

Projections of coal traffic operations indicate that in 1985, up to about 50% of coal traffic will move in unit trains on some railroads with lesser amounts on others. The projected percentage of coal moving in trainloads ranges from about 20% to 75% with less than trainload from 10% to 33%, depending on the individual railroads. These estimates indicate that at least 67% of 1985 coal traffic will move in solid trainloads. Typical configuration for coal trains in 1985 is 100 open top hopper cars of 100 ton capacity each, five 3000 horsepower locomotives and a caboose. The eastern railroads estimate that 1985 coal traffic can be handled with nominal increases in railroad personnel. The eastern railroads also stated that they did not foresee any requirements other than plant and equipment as reported here which needed to be met to handle 1985 coal traffic from a transportation perspective. There still remain some uncertainties from the reorganization of bankrupt carriers and some difficulty was encountered in preparing projections. These will be resolved with experience with the new structure.

5.2.2 Equipment and Motive Power

An increase in coal traffic of 66% will require increases in both coal cars and locomotives. The Eastern Railroads estimated requirements for cars and locomotives based on the estimates of coal traffic for 1985. Open top hopper and gondola cars are the most common in coal service. In recent years new cars have been of increasing unit capacity, largely 100 net ton cars. The fleet of open hoppers owned by the major eastern coal carriers was 192,990 cars in 1975.

The Eastern Railroads estimate that the increase in coal traffic will require 19,718 additional coal cars. Table 5-8 shows the breakdown by type. The additional hopper cars represent an increase of about 10% to the current fleet. The capacity addition is slightly over 13%. The average

TABLE 5-8

Projected Equipment Requirements for
1985 Coal Traffic
Selected Eastern Railroads

CAR TYPE	RAILROAD OWNED	SHIPPER OWNED	TOTAL
Hopper Cars, 100 ton	18,750	200	18,950
Hopper Cars, 70 ton	500	--	500
Gondola Cars, 100 ton	45	--	45
Other Cars, 100 ton	223	--	223
TOTALS	19,518	200	19,718

Added Capacity: 1,986,800 net tons

NOTE: Projected equipment requirements above existing fleet.

capacity of the 1975 fleet was 77.5 tons. The new cars are 100 ton capacity except for 500 70 ton cars. In addition, 355 new cabooses will be required.

Most of the needed cars are expected to be railroad owned. Only 200 hoppers would be shipper owned. Some eastern railroad customers are expected to own coal cars. However, estimates of the number of privately owned cars in 1985 could not be made accurately. The cost of cars is estimated to be about $600 million at 1976 prices.

The Eastern Railroads also estimate that 592 new 3,000 horsepower locomotives will be required. This estimate represents locomotive requirements in excess of the current fleet. No estimate has been made of retirements or replacements. The cost, at 1976 prices, is about $266 million, bringing total motive power and equipment to $866 million. This is a rate of $96 million per year.

5.2.3 Facilities

The facilities required to move 1985 coal traffic are grouped into four categories - track, signalling, yards and maintenance facilities. Estimates were provided for each category by the ERA.

5.2.3.1 Track and Signalling

The Eastern Railroads serve coal producing areas which are well established. Therefore, the rail routes and facilities are generally in place. When new mines open a new branch or spur line may be necessary to serve it. New lines may also be needed to serve new consumption points. These are relatively small additions to the existing network. The ERA estimates that 40 miles of new branch lines and spurs will be needed and that about 50 miles of siding extensions will also be needed.

Track additions and upgrading are estimated at $133.3 million through 1985. Upgrading is defined as above normal maintenance attributable to increased coal traffic.

Signalling improvements increase the capacity of the network. ERA estimates that over 300 miles of central traffic control will need to be installed by 1985. This is the most sophisticated type signalling system in general use today. This investment will cost more than $20 million at 1976 prices. Table 5-9 shows track and signalling requirements for 1985.

5.2.3.2 Yard and Maintenance Facilties

ERA estimated that two new rail yards will be needed and that four existing yards will need expansion. Since the percentage of coal moving in unit trains, and thus avoiding yards, is expected to be about 50% in 1985, there will be increased demand on yards. The investment in yards is estimated at $47.5 million at 1976 prices. Table 5-10 shows yard and maintenance facilities.

The ERA estimates only minor requirements for maintenance due to increased coal traffic. Maintenance of way equipment costing $3.8 million, at 1976 prices, will be needed. This brings the total fixed plant investment projections to $205 million.

TABLE 5-9

Projected Track and Signalling Requirements
for 1985 Coal Traffic
Selected Eastern Railroads

ITEM	MILES	COST AT 1976 Prices (thousands)
Main Lines	4.13	--[1]
Branch Lines and Spurs	40.2	$43,100
Sidings	49.5	27,200
Double Track	--	--
Upgrading	--	63,000[2]
CTC Signalling	328.1	20,600[3]
ABS Signalling	--	--
Other	--	365[4]
TOTAL	--	$154,265

1 Included with yard expansion. (second mainlines), Table 5-10.

2 Upgrading is defined as above "normal" maintenance including installation of heavier rail, more ties per mile, improved roadbed, modification of grade crossings, etc., which can be attributed to increased coal traffic.

3 Projected TC on Eastern Region main lines and selected branch lines.

4 Defective equipment detectors.

TABLE 5-10

Projected Yard and Maintenance Facility Requirements for 1985 Coal Traffic

Selected Eastern Railroads

ITEM	NUMBER	COST AT 1976 PRICES (thousands)
New Yards	2	$11,000
Expansion of Existing Yards	4	36,500[1]
Locomotive Maintenance Facilities	--	--
Car Maintenance Facilities	--	--
Maintenance of Way Equipment	--	3,800
TOTAL	6	$51,300

[1] Includes new second main lines.

5.2.4 Finances

The total capital requirements for handling 1985 forecast coal traffic is 1.1 billion for Eastern Railroads alone. This averages just over $120 million per year through 1985. Approximately $700 million can be generated through equipment trust certificates, conditional sales agreements, leasing and other rolling stock pruchase options. The remainder will have to be generated internally or through debt or equity financing. The impact of federal funding of some CONRAIL investment is not identifyable. However, that funding, and other federal funds available for railroad plant improvements, may have a significant impact on CONRAIL earnings requirement and on total Eastern Railroad capital generation requirements.

5.3 Southern Railroads

The Southern Freight Association has as its members the roads serving the southeastern portion of the country. The major coal carriers in this region are the Family Lines, Southern Railway System and the Illinois Central Gulf Railroad. In 1975 these railroads originated 111.6 million tons of coal and carried a total of 151.1 million tons including traffic received in interchange.

5.3.1 Coal Traffic Volume 1985

The Southern Freight Association provided estimates of 1985 coal traffic and requirements to handle it based on the the scenario described in Section 4. The Association estimates that its members will originate over 170 million tons of coal in 1985 and will handle a total of 199 million tons including traffic received in interchange. This estimate represents increases in originated tonnage of 60% and 9% above 1975 and 1980 (estimated). Total tons handled represent increases of 32% and 4% over 1975 and 1980, respectively. Our analysis indicates that the percentage of coal traffic carried, which originates on southern lines, is increasing. Table 5-11 shows the origin/destination tonnages by state. As can be seen from the table, Southern roads will originate coal traffic in 8 states. However, as in the eastern region, the majority, 66%, will originate in Illinois and Kentucky. Alabama and Virginia raise the percentage to almost 85%. Coal terminating in the Southeast will originate in Colorado, Montana, Utah and Wyoming as well as the states shown in Table 5-11. Coal traffic will terminate in 17 states. Of this traffic 2.2 million tons will be export traffic through Alabama ports and 3.4 million tons will be export traffic through Virginia.

TABLE 5-11

Projected 1985 Coal Traffic

Selected Southern Railroads

Origin State	Dest'n State	Orig. & Term. on line Thousand TONS	Orig. & Deliv'd to Connection Thousand TONS	Received from connection & term. on line Thousand TONS	Received from connection & deliv'd to connection Thousand TONS
Ala.	Ala.	13,900 1)		100	
Ala.	Ga.	700		1,600	
Ill.	Ga.	8,600 2)			
Ill.	Ind.	3,600	2,500		
Ind.	Ga.	1,200			
Ind.	Ind.	4,000	1,900		1,200
Ind.	Mo.		400		
Ind.	Tenn.	700			
Ky.	Ala.	500		200	
Ky.	Ga.	1,200		1,500	
Ky.	Ky.	500		900	
Ky	Miss.			1,200	
Ky.	N.C.			1,800	
Ky.	S.C.			300	
Ky.	Tenn.			300	
Ky.	Va.		100	300	
Tenn.	Ala.	1,100			
Tenn.	Ga.	1,700			
Tenn.	Ky.	100			
Tenn.	N.C.	600			
Tenn.	Ohio		100		
Tenn.	S.C.		300		
Tenn.	Tenn.	1,800			
Tenn.	Va.		100		
Va.	Ala.	500			
Va.	Ga.	2,200			
Va.	Ind.		500		
Va.	N.C.	5,300	100	100	
Va.	Ohio		100		
Va.	S.C.	100	500		
Va.	Tenn.	1,700	300	100	
Va.	Va.	4,300	1,400	300	
W. Va.	Ala.			100	
W. Va.	Ga.			1,000	
W. Va.	N.C.			800	
W. Va.	Va.			100	
Wyo.	Ga.			2,000	

TABLE 5-11 (Continued)

Origin State	Dest'n State	Orig. & Term. on line Thousand TONS	Orig. & Deliv'd to Connection Thousand TONS	Received from connection & term. on line Thousand TONS	Received from connection & deliv'd to connection Thousand TONS
Ind.	Wisc.				800
Pa.,W.Va.	Ala.			1,000	
W. Ky.	Ala.,Ga. Ill.,ky. Tenn.	11,000			
E. Ky.	Ala.,Fla., Ga.,Ill., Ind.,Ky., Tenn.	23,400			
E. Ky.	Ill.,Ind., Mich.,N.C. N.Y.,Ohio, S.C.,Va., Wisc.		26,800		
Tenn.	Ala.,Fla., Ga.,Ill., Ind.,Ky., Tenn.	800			
Tenn.	Ill.,Ind., Mich.,N.C., N.Y.,Ohio, S.C.,Va., Wisc.		900		
E. Ky., Tenn.	Alabama	200			
E. Ky., Tenn.	Va.		1,400		
Col.	Miss.				800
Ill.	Various*	15,000	8,000		
Ky.	Various*	7,000	4,000		
Mon.	Ill.			3,000	
Utah	Miss.				800
Wyo.	Ill.			1,500	

* Various includes: Alabama, Illinois, Kentucky, Missouri, Florida, Indiana, Michigan, Tennesee, Georgia, Iowa, Minnesota, Wisconsin.

TABLE 5-11 (Continued)

Origin	Dest'n State	Orig. & Term. on line Thousand TONS	Orig. & Deliv'd to Connection Thousand TONS	Received from connection & term. on line Thousand TONS	Received from connection & deliv'd to connection Thousand TONS
Ky., Tenn., Va.	N.C.	2,100	300		3,300
Ky., Tenn., Va.	S.C.		200		1,600
Ky., Tenn., Va.	Tenn.	1,200	200	600	100
Ky., Tenn., Va.	Va.	1,800	2,200		800
Ky., Tenn., Va.	Ala., D.c., Ga., Ill., Ind., Ky., Mich., N.Y., Ohio, Pa., W. Va.		1,700		200
TOTAL		116,800	54,000	18,800	9,600

Notes: 1. Includes 2 million tons of export coal.

2. This coal will move from Illinois to Alabama by water then to Georgia by rail.

3. This traffic is for export.

4. Export.

Data represent 3 railroad systems which originated 96.2% of Southern territory coal traffic in 1975.

Table 5-12 shows the projected 1985 increases in coal traffic over 1975 and 1980 by type of traffic.

The average length of haul for southern territory coal traffic is expected to increase by as much as 40% on some carriers. Others expect only slight increases. Traffic other than coal is estimated to increase at an annual rate of about 2% for total growth of 20% - 25% through 1985.

5.3.2 Equipment and Motive Power

The southern railroads estimate that 69,771 cars will be required to handle 1985 coal traffic. This represents an increase of 15,218 above the 1974 fleet and an increase of 6,674 cars above the estimated 1980 fleet.[13] The relatively modest increase in the number of cars is a function of several factors. The most important of these factors is utilization of equipment measures. The number of loads per year for coal cars in southern territory in 1974 was 27. By 1985 some southern railroads will have operations in which cars will produce as many as 150 - 180 trips per year. These will be short haul traffic, some in connection with water carriers as in the Illinois to Alabama move shown in Table 5-11. This is a 500% increase in utilization. While this will not be the norm, it significantly affects the overall utilization rate. The estimated cost for cars is $450 million. Table 5-13 shows equipment requirements for 1985 coal traffic.

The southern railroads estimate that 375 3000 horsepower locomotives and 136 smaller, mostly 2000 horsepower, locomotives will be required for 1985 coal traffic. The larger

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[13] Rail Transportation Requirements for Coal Movement in 1980, Prepared for U. S. Department of Transportation, by Input Output Computer Services, Inc., Cambridge, MA 02142, April 1976.

TABLE 5-12

Projected Increase in Coal Traffic: 1975 - 1980 - 1985

Selected Southern Railroads

(thousands of tons)

YEAR	ORIGINATED & TERMINATED ON LINE	ORIGINATED & DELIVERED TO CONNECTIONS	RECEIVED FROM CONNECTIONS & TERMINATED ON LINE	RECEIVED FROM CONNECTIONS & DELIVERED TO CONNECTIONS	TOTAL CARRIED
1975 (1)	66,219	45,373	34,497 (2)		146,089
1980 (3)	106,184	51,191	25,525	10,876	193,776
1985	116,800	54,000	18,800	9,600	199,200
Tonnage Increase					
1975 - 1980	39,965	5,818	1,904		47,687
1975 - 1985	50,581	8,627	(6,097)		53,111
Percent Increase					
1975 - 1980	60.4%	12.8%	(5.5%)		37.6 %
1975 - 1985	76.4%	19.0%	(17.7%)		36.8%

1) Source: Coal Traffic Annual, 1976 Edition, National Coal Association, Washington, D.C.

2) Includes traffic received from connections and terminated on line or delivered to connections.

3) Source: Rail Transportation Requirements for Coal Movement in 1980, prepared for U.S. Department of Transportation by Input Output etc.

TABLE 5-13

Projected Equipment Requirements for 1985 Coal Traffic
Selected Southern Railroads

CAR TYPE	RAILROAD OWNED	SHIPPER OWNED	TOTAL[1]
Hopper Cars	65,771	3,300	69,071
Gondolas	--	700	700
TOTAL	65,771	4,000	69,771

[1] Total equipment for Southern Railroads represented in Southern Freight Association data including existing fleets. Data on incremental fleet requirements not available for one carrier. This table shows total cars required in 1985.

power units will be used for unit train and trainload coal service. The smaller units are used for mine run coal trains. This is a function of the type of mining operations in southern territory; typified by small mines whose output must be aggregated to make up major flows. Locomotive costs are estimated at $230 million for total rolling stock cost of $680 million at 1976 prices.

5.3.3 Facilities

As in the eastern territory, the rail network serving the coal producing areas, in southern territory, is in place. Investment requirements for 1985 coal traffic are primarily those which expand capacity of existing lines, i.e., increased sidings and upgrading track for higher traffic density. The total investment in track improvements and expansion is estimated at $102.3 million dollars. Table 5-14 shows the track investment by categories.

Signalling requirements of $17.6 million are estimated for 1985 coal traffic. Of this, $12.3 million is for installation of CTC systems. The remainder is for improvements to existing systems. A total of 245 miles of CTC installation are projected.

Yard and maintenance facilities investment is projected to expand existing facilities. Three yards are projected to require expansion at a cost of $5 million. Car and locomovtive maintenance facility expansion is projected at $9 million. Projected increases in traffic density are expected to incur additional maintenance of way requirements. Increased maintenance equipment of $4 million is projected. Table 5-15 shows the projections for yard and maintenance facilities. Total fixed plant investment projected for 1985 coal traffic is $138 million. It is important to note that the projected investments for 1985 coal traffic do not necessarily represent current plans of the carriers or absolute requirements to handle the traffic. They represent estimates of expenditures incurred in the normal course of business based on a hypothetical scenario.

TABLE 5-14

Projected Track and Signalling Requirements for 1985 Coal Traffic
Selected Southern Railroads

ITEM	MILES	COST AT 1976 PRICES (thousands)	
Main Line	11	$9,000	(1)
Branch Lines and Spurs	32	6,018	(1)
Sidings	121	27,750	(2)
Double Track	10	10,000	
Upgrading	288	49,490	(3)
CTC	245	12,300	
Other Signalling	--	5,330	(4)
TOTAL	707	119,888	

1. New Lines.
2. Includes passing track programs, interchange track.
3. Upgrading is defined as above "normal" maintenance including installation of heavier rail, more ties per mile, improved roadbed, modification of grade crossings etc. which can be attributed to increased coal traffic. Includes $3 million for bridge work.
4. Improvement to existing signalling.

TABLE 5-15

Projected Yard and Maintenance Facility Requirements

for 1985 Coal Traffic

Selected Southern Railroads

ITEM	NUMBER	COST AT 1976 PRICES (thousands)
New Yards	--	--
Expansion of Existing Yards	3	$5,000
Locomotive Maintenance Facilities	2	3,000 (1)
Car Maintenance Facilities	3	6,000 (2)
Maintenance of Way Equipment	--	4,000 (3)
TOTAL		$18,000

1. Expansion of existing locomotive facilities.
2. New unit train can repair facilities.
3. New maintenance of way equipment to take care of effects of heavier tonnages and greater traffic density.

5.3.4 Finances

The total projected investment for the southern territory attributable to increased coal traffic is $817.9 million. This indicates an average projected expenditure of $91 million per year. Of this projected investment, 83% is for locomotives and freight cars which can be purchased under a variety of financing arrangements. Equipment trust certificates and conditional sales agreements are commonly used. Recent equipment trust certificates have been issued with interest rates as low as 7.7% over fifteen years. Such rates indicate the willingness of investors to purchase these securities and the availability of funds to acquire equipment. The major southern territory coal carriers are financially sound railroads with access to sufficient capital. These carriers, collectively, have the highest rate of return in the country. None of the carriers foresee difficulty in acquiring necessary capital for future needs, an estimate born of continuing participation in the capital markets.

5.4 Western Railroads

The Western Railroad Association has as its members those railroads whose operations are primarily carried on west of the Mississippi River. Major coal carriers in the western region are:

- Atchison, Topeka & Santa Fe
- Burlington Northern
- Chicago and Northwestern
- Denver and Rio Grande Western
- Elgin, Joliet and Eastern[14]
- Missouri Pacific
- Southern Pacific
- Union Pacific
- Western Pacific

These railroads, in 1975, originated 71 million tons of coal amounting to 85% of total western railroad originations. All Western railroads originated 86.6 million tons and handled 123.4 million tons including traffic received in interchange. The western roads are expecting the largest growth of any region due to the desirability of low sulfur western coal. The operations of western coal producers, and the railroads serving them, are different from their eastern counterparts in one important aspect. That is the average mine output per year. The deep mines and even some strip mines in the east and south tend to be small. Very few can produce enough coal to support high volume unit train service. Therefore, the railroads serving these areas will use more conventional operations in moving coal traffic. The mines in the west, especially those in Montana and Wyoming, will produce up to 8 million tons per year routinely. Therefore, the majority of coal traffic from these states will move in unit trains.

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[14] Represented in Western Railroad Association data although generally classified as an Eastern road.

5.4.1 Coal Traffic Volume in 1985

The Western Railroad Association estimates that its membership will originate 308 million tons of coal in 1985. This represents an increase of 237 million tons over 1975 or 333%. Table 5-16 shows the origin/destination tonnages for coal to be originated by western roads. As can be seen from the table, Colorado, Utah, Illinois, Texas, Wyoming and Montana are expected to produce the majority of coal traffic. These six states will produce 150 million tons or about 50% of total western originations. Total traffic, including traffic received in interchange, will increase by 424 million tons or 333% in 1985 over 1975. Table 5-17 shows projected increases over 1975 and projected 1980 traffic.

Coal originating on western railroads will terminate in 25 states. Many of these represent new markets for western coal. Coal terminating in western states will originate in all three rail territories. The majority of western coal is destined for boiler use in electrical generation. However, coal terminating in California is metallurgical coal for the steel industry.

Coal traffic originating in the western district will be about 72% unit train, 17% trainload and the remaining 11% in less than train load lots.

5.4.2 Equipment and Motive Power

The western railroads estimate the equipment requirements for 1985 will be 45,453 new cars. These will be 100 ton cars designed for unit train service. Table 5-18 shows projected car requirements above existing fleets for 1985. As can be seen from the table, 80% of this equipment is expected to be shipper owned.

TABLE 5-16

Projected 1985 Coal Traffic

Selected Western Railroads

(thousands of tons)

ORIGIN STATE	DESTINATION STATE	ORIGINATED & TERMINATED ON LINE	ORIGINATED & DELIVERED TO CONNECTIONS	RECEIVED FROM CONNECTIONS & TERMINATED ON LINE	RECEIVED FROM CONNECTIONS & DELIVERED TO CONNECTIONS
AL	IN, MX			700	6
AR	AR, CO, OR, TX	54	141	10,001	
CO	CO, ID, AZ, IL, IA, KS, MS, MT, NE, TX, UT, WA, IN	5,430	600	7,790	8,835
IL	IL, IN, MO, MX, WI	20,250	8,115	935	23
KY	IN			4,730	
MT	IL, IN, IA, MI, MN, TX, WI	23,000	26,400	5,790	3,000
NM	AZ, CA, MX, NM, TX	5,560	9,195	9,888	35
ND	MN, TX	700		8	

TABLE 5-16 (Continued)

ORIGIN STATE	DESTINATION STATE	ORIGINATED & TERMINATED ON LINE	ORIGINATED & DELIVERED TO CONNECTIONS	RECEIVED FROM CONNECTIONS & TERMINATED ON LINE	RECEIVED FROM CONNECTIONS & DELIVERED TO CONNECTIONS
OK	CO, MO, OR, TX	700		8	
PA	CA, OR			3	
TX	AZ, LA, TX	20,740			
UT	AZ, CA, ID, IL, IA, MI, MN, MS, NV, OR, UT, WA, WY	1,000	1,700	16,266	2,855
WV	IL, IN			2,500	
WY	AR, CA, CO, ID, IL, IN, IA, KS, LA, MI, MN, MO, MT, NE, NV, OK, OR, TX, UT, WA, WI, WY	35,725	102,240	28,460	
CO	TX, NE, MO, KS		25,000		

TABLE 5-16 (Continued)

ORIGIN STATE	DESTINATION STATE	ORIGINATED & TERMINATED ON LINE	ORIGINATED & DELIVERED TO CONNECTIONS	RECEIVED FROM CONNECTIONS & TERMINATED ON LINE	RECEIVED FROM CONNECTIONS & DELIVERED TO CONNECTIONS
UT	IL, IN, MS, CA		20,000		
WY, MT	TX			1,800	
CO, OK	TX			250	
NM, CO	AZ				500
CO, UT	CA			10,000	
CO, WY	CA			9	
CO, WY	UT, AZ, NM, NV			6	
VA, WV	OR			5	
CO, WY	OR			43	
Misc.	Misc.	440	440		
TOTAL		112,989	195,031	100,314	15,254

NOTE: Data represents 8 railroad systems which originated 85.1% of Western territory coal tonnage in 1975.

TABLE 5-17

Projected Increase in Coal Traffic: 1975 - 1980 - 1985

Selected Western Railroads

(thousands of tons)

YEAR	ORIGINATED & TERMINATED ON LINE	ORIGINATED & DELIVERED TO CONNECTIONS	RECEIVED FROM CONNECTIONS & TERMINATED ON LINE	RECEIVED FROM CONNECTIONS & DELIVERED TO CONNECTIONS	TOTAL CARRIED
1975 (1)	39,478	31,906		26,346 (2)	97,734
1980 (3)					
1985	112,989	195,031	100,314	15,254	423,588
Tonnage Increase					
1975 - 1980 (3)					
1975 - 1985	73,511	163,125	89,222		325,854
Percent Increase					
1975 - 1980 (3)					
1975 - 1985	186.2%	511.3%	338.6%		333.4%

1) Source: Coal Traffic Annaul, 1976 Edition, National Coal Association, Washington, D.C.

2) Includes traffic received from connections and terminated on line or delivered to connections.

3) Due to substantial differences in the composition of the groups providing 1980 projections and 1985 projections, comparisons of 1985 and 1980 data would be misleading.

TABLE 5-18

Projected Equipment Requirements for 1985 Coal Traffic

Selected Western Railroads

CAR TYPE	RAILROAD OWNED	SHIPPER OWNED	TOTAL
Hopper	5,633	13,894	19,527
Gondola	3,232	22,694	25,926
TOTAL	8,865	36,588	45,453

TOTAL CAPACITY: 4,515,976 tons

NOTE: Projected equipment requirements above existing fleet.

The trend in the west is more toward shipper ownership of coal cars than in the east or south. Shipper ownership gives greater control of the equipment to the shippers. At the same time the railroad is not using its scarce investment resources for equipment when other parts of the railroad need expansion to serve coal producers. Investment in new cars at 1976 prices is estimated at $1.4 billion.

Western railroads also estimate that 1983 new locomotives will be needed. These will be 3,000 horsepower, six axle road locomotives. This will be a total increase of about 6 million horsepower. The estimated investment at 1976 prices is $992 million. The locomotive requirements were supplied by only 7 of the 8 carriers represented in the WRA data.

5.4.3 Facilities

The 333% increase in coal traffic on western railroads is necessarily going to require that the fixed plant of the carriers involved be expanded. Expansion is required to reach new customers as well as to facilitate increased traffic on mainlines and maintenance of increased car and locomotive fleets. Western Railroads estimated that $1.9 billion would be required for such expansion.

Track and Signalling

Western carriers are projecting large increases in traffic on main and branch lines. Much of this traffic will originate at new mines, requiring construction of new main and branch lines. Upgrading much of the network to handle increased traffic density will also be required. The four major coal originating carriers will account for most of the track and signalling improvements. Table 5-19 shows the projected improvements by category. The total investment projection of $1,645 million is the largest of all the regions representing more than 50%.

TABLE 5-19

Projected Track and Signalling Requirements
for 1985 Coal Traffic
Selected Western Railroads

ITEM	MILES	COST AT 1976 Prices (thousands of dollars)
Main Lines	127 (1)	
Branch Lines and Spurs	342 (1)	$148,800
Sidings	292 (1)	9,300
Double Track	985 (1)	172,900
Upgrading (8)	12,214 (1)	300,900 (5)
CTC Signalling	2,648 (1,2)	23,900 (6)
ABS Signalling	636 (3)	
Other Signalling	75 (4)	3,200 (7)
Unspecified		986,000 (1)
TOTAL	-	$1,645,000

NOTES:

1. Includes mileages reported separately with a single aggregate cost.
   mainlines - 127 mi
   branch lines and spurs - 62 mi
   sidings - 263 mi
   double track - 453 mi
   upgrading - 6,800 mi
   CTC signalling - 2,268 mi
   Total cost - $986 million

2. Includes 200 miles for which no cost estimate was made.

3. Includes 636 miles for which no cost estimate was made.

4. Includes 75 miles for which no cost estimate was made.

5. Includes $65,200 thousand for which no mileage estimate was made.

6. Includes $14,900 thousand for which no mileage estimate was made.

7. Includes $3,200 thousand for which no mileage estimate was made.

8. Upgrading is defined as above "normal" maintenance including installation of heavier rail, more ties per mile, improved roadbed, modification of grade crossings, etc., which can be attributed to increased coal traffic.

Yards and Maintenance Facilities

Western carriers participating in the study estimate that $219 million in yards and maintenance facilities will be required for estimated 1985 coal traffic. Table 5-20 shows the projected investment by category. Car and locomotive facilities are the largest part of the investment. These are both maintenance facilities and train serving facilities such as inspection and fueling stations. Our analysis indicates that the major coal originating railroads will account for the majority of the investment. Of the eight carriers participating, three originated less than 1400 tons of coal in 1975. These carriers are primarily involved in terminating traffic received in interchange. They have no requirements for new cars and limited locomotive additions. Therefore, they estimate that their current facilities will have adequate capacity for 1985 coal traffic.

5.4.4 Finances

The total investment in plant and equipment estimated by the western railroads is $4.3 billion to handle coal traffic forecast through 1985. This averages about $470 million per year. Shippers will provide $1.1 billion of this investment in equipment.

There is some concern that the advent of slurry pipelines would impair the ability of the railroads to raise needed capital, especially if pipelines are granted the right of eminent domain by the federal government or by most states. The threat of slurry pipelines is greater in the west than in the south and east because of the large volumes of coal originating in single locations. Basically, the economics of slurry pipelines are most advantageous in the same circumstances as unit trains.

Pipelines, as now proposed, would operate on long term contracts committing customers to annual volumes. Railroads are prohibited from making interstate contract rates.

If the increased coal traffic remains a long term solid prospect with shippers investing millions of dollars in railcars and rail loading/unloading facilities, the railroads expect to be able to generate the needed capital to handle coal through 1985.

TABLE 5-20

Projected Yard and Maintenance Facility Requirements for 1985 Coal Traffic Selected Western Railroads

ITEM	NUMBER	COST AT 1976 PRICES (thousands)
New Yards		$15,000 (3)
Expansion of Existing Yards	4 (1,2)	215 (4)
Locomotive Maintenance Facilities	4 (1,2)	750 (4,6)
Car Maintenance Facilities	7 (1,2)	50,000 (5)
Maintenance of Way Equipment		3,200 (4)
Unspecified		150,000 (2)
Total		$219,165

NOTES:

1. These items include expansion of 2 existing yards, requirements for 2 locomotive maintenance facilities and 4 car maintenance facilities for which no cost estimate was made.

2. These items include expansion of 2 existing yards, requirements for 2 locomotive maintenance facilities, and 3 car maintenance facilities for an aggregate cost of $150,000,000

3. Both new and existing yards included. Number of facilities not estimated.

4. Number of facilities not estimated.

5. Both car and locomotive facilities included. Number of facilities not estimated.

6. Locomotive fuelling facilities.

6. SYSTEM CONSTRAINTS AND INSTITUTIONAL ISSUES

As required by the study contract, three areas of potential constraints and institutional issues which impact future coal movement were explored with participating railroads. These areas are: requirements which must be met to handle increased coal traffic; government policies (federal, state and local) and other institutional changes which would facilitate railroad movement of future coal traffic; and policies in the areas of mining and burning coal and related topics. Several issues were identified in discussions with participating railroads which impact future coal transportation by rail. First, adoption of a settled and generally accepted government policy respecting the development of coal mines, the use of coal as the primary boiler fuel and related environmental issues would eliminate uncertainties surrounding future rail transport needs. This in turn would facilitate long range planning and financing of railroad improvement requirements.

Second, railroads state that their competitive position would be improved, and consequently their profitability, by more even regulation of competing modes and reduction in subsidies. This particularly relates to water carriers which use publicly provided navigation facilities at no cost and to truckers that pay only a portion of the cost for highways. Solutions proposed for these inequities include user charges for water carriers, full cost recovery from truckers, strict enforcement of the 55 mile per hour speed limit, maintenance of current highway weight limits and tighter controls of truckers and water carriers.

Third, the expansion of coal traffic will require substantial amounts of capital for increases in or improvement of equipment fleets and fixed plant. This capital will be available to most of the industry if (a) there is reasonable certainty that coal will be produced in volumes approaching those forecast, (b) the traffic thus generated will not be diverted from the railroads by transport policy decisions of federal and state government and, (c) the railroads will be permitted to charge freight rates which will reflect an adequate return on investment, including the cost of capital.

Fourth, conflicts between railroad operations and highway traffic at grade crossings will grow as coal train operations become more frequent. The railroads do not regard these problems as representing major obstacles in meeting national goals for coal production and use. They are nevertheless deserving of attention and various solutions have been advanced to meet particular needs. Those recommendations range from proposals for increases in federal funding of grade separation and grade crossing protection projects to claims that most crossings will require no extra attention. Funding of grade crossing protection projects on small roads and street crossings is an unresolved issue. Also unresolved is the conflict between the need for expeditious and economic movement of coal on the one hand and local interests on the other. It was suggested that federal agencies promulgate guidelines and priorities for state and local governments which would recognize both legitimate local concern for grade crossing matters and the need for transportation of coal to meet energy needs.

Fifth, some railroads operating in the eastern and southern coal producing areas suggested that the efficiency of coal transportation could be improved through use of central loading facilities. Such facilities would aggregate the production of several mines at one point, allowing multiple car or train load operations. Substantial transportation cost savings could accrue from such operations.

Sixth, technological advances in the design of coal cars to improve their serviceability and discharge capability was suggested as a means of improving operations and reducing costs. Coal cars, especially those in unit train service, are subject to more intensive use than other railroad equipment. There have been new types of equipment introduced such as the Teoli car and the Bethgon which have improved load capacity and reputedly better serviceability. Advances in these areas could produce substantial cost reductions.

Two highly controversial issues were also mentioned. Discussions with some railroad personnel indicated that the ability to make contracts for coal traffic would facilitate raising needed capital and making long range plans. Such contracts would bind both shipper and carrier to performance of the terms of the contract, providing for legal liability in the case of non-performance. The concept is not supported throughout the industry, as many railroads oppose it as being contrary to their best interests.

The second controversial issue suggested was the ability of railroads to become total transportation companies. This involves the railroads entering other modes of transportation, not necessarily associated with normal rail movement. Some carriers suggest that this would improve the services railroads could offer to shippers. Other carriers feel that such diversification would not be beneficial.

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8. APPENDIX

REPORT OF NEW TECHNOLOGY

The work performed under this contract did not result in any inventions, discoveries, or innovations, which are reportable under the contract patent clause. However, this study does represent an improvement in technical knowledge about rail carrier estimates of the additional equipment and fixed facility expansion needed to handle increased coal traffic in 1985. Therefore, the invention or development of new devices was not expected.

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