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COAL MINE LABOR PRODUCTIVITY: THE PROBLEM, POLICY IMPLICATIONS, AND LITERATURE REVIEW

Joe G. Baker

Manpower Research Programs

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Joe G. Baker
Manpower Research Programs
OAK RIDGE ASSOCIATED UNIVERSITIES
P. O. Box 117 / Oak Ridge, Tennessee 37830

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1. PROBLEM AREA

Prior to 1975, the largest yearly production total in the U.S. coal industry was 630.6 million tons in 1947.[1] At that time, however, the coal industry was in danger of losing primary markets such as residential heating and railroads. These markets had eroded under the availability of cheap imported energy and substitution of competing energy sources. In order to maintain a competitive relationship with other basic fuels, the United Mine Workers of America and the industry restructured industrial organization to create more efficient and concentrated production units, improved mechanization to increase labor productivity and lower unit output costs, and improved labor-management relations to ensure uninterrupted production.[2] The results of these efforts were spectacular: Productivity increased from an industry average of 6.77 tons per shift per worker in 1950 to 19.90 tons per shift per worker in 1969, an increase of over 190 percent. Average value per ton in 1947 was $4.16; in 1969 the figure was $4.99.[3]

Since 1969, mine labor productivity has continued to decline through the latest data available. Table 1 depicts mine labor productivity and value per ton for selected years between 1950 and 1976. For the 1969-1976 period, total productivity has declined by one-third and the average cost per ton has increased fourfold. These trends are particularly distressing given the role coal is expected to play in our energy future. From the 1976 total production of 665 million tons, the Carter administration has called for an increase to 1.2 billion tons in 1985.[4]

While the overall decrease in productivity has been steady, the productivity trends experienced by individual states show considerable variance. Table 2 details 1969 and 1975 estimates of average tons per man per shift by state. Some states, such as Pennsylvania and Kentucky, experienced declines similar to the total U.S. pattern. Other states, such as North Dakota and Montana, actually experienced improved productivity. These data suggest that regional variation in characteristics of production—seam thickness, mining technique, and age of mine to name a few—influence productivity. Regional differences, however, have yet to be vigorously analyzed.

The causes of the post-1969 decline in overall labor productivity have been the source of much speculation and concern in the industry. Articles

Table 1. Tons per Shift per Worker and Value per Ton in the U.S. Coal Industry by Method (Selected Years 1950-1976)

	Method				
Year	Underground	Strip	Auger	Total	Value per Ton
1950	5.75	15.66	N/A	6.77	$4.84
1961	11.41	25.00	30.61	13.87	4.58
1969	15.61	35.71	39.88	19.90	4.99
1970	13.76	35.96	34.26	18.84	6.26
1974	11.31	33.16	N/A	17.58	15.75
1975	9.54	26.69	N/A	14.74	19.23
1976	8.50	26.00	N/A	13.50	19.43

Source: National Coal Association, *Coal Facts*, various years; and Comptroller General of The United States, *U.S. Coal Development - - Promises, Uncertainties* (Washington, D.C.: U.S. General Accounting Office, 1977), p. 4.25.

Table 2. Average Output per Man per Shift by State (1969 and 1975)

State	1969	1975	Percent Change
Total U.S.	19.90	14.74	-26%
Alabama	15.53	11.19	-28
Alaska	36.07	30.65	-25
Arkansas	10.47	8.25	-21
Colorado	18.61	18.89	+2
Illinois	28.99	17.61	-39
Indiana	35.73	29.50	-17
Iowa	22.25	20.15	-9
Kansas	20.79	13.76	-33
Kentucky	23.68	16.99	-28
Maryland	20.88	20.69	-1
Missouri	27.76	21.14	-24
Montana	87.64	127.25	+45
New Mexico	50.03	36.86	-26
North Dakota	76.62	86.86	+13
Ohio	25.87	15.13	-42
Oklahoma	21.11	14.79	-30
Pennsylvania	15.70	11.46	-27
Tennessee	20.02	12.94	-35
Utah	16.55	13.85	-14
Virginia	16.51	10.69	-35
West Virginia	15.96	9.15	-43
Wyoming	49.25	61.78	+25

Source: U.S. Bureau of Mines.

dealing with the topic have appeared frequently in trade and engineering publications. However, there has been little rigorous analysis of the declining productivity trends in this literature (see Appendix A). Some studies have dealt with the problem in a meaningful way, but they are dated and therefore not applicable to the post-1969 era. The existing literature is rich in terms of the explanations offered on the problem.[5] The present need is to empirically test these explanations and sort out the factors contributing to the decline.

This *Memorandum* examines the issue of declining labor productivity in coal mining and the importance of this issue. Included are a summary of hypotheses to be tested and suggestions for possible research approaches.

NOTES

[1]National Coal Association, *Coal Facts 1974-1975* (Washington, D.C.: National Coal Association, 1975), p. 52.

[2]John P. David, "Earnings, Health, Safety and Welfare of Bituminous Coal Miners Since the Encouragement of Mechanization" (Unpublished dissertation, West Virginia University, 1972), p. 291.

[3]National Coal Association, *Coal Facts,* p. 52.

[4]Executive Office of the President, Energy Policy and Planning, *The National Energy Plan* (Washington, D.C.: USGPO, 1977), pp. 94-95.

[5]See Section 3 for a summary of these hypotheses.

2. IMPLICATIONS OF DECLINING LABOR PRODUCTIVITY

2.1 Labor Demand in the Coal Industry

The shift in our energy consumption mix towards coal is an important facet of President Carter's energy plan.[1] The future manpower requied to produce this coal tonnage has been the subject of several studies.[2] The projection methodology employed in these studies is the "fixed coefficient" approach, i.e., there is a unique level of labor input required to produce a given level of output. The relationship between labor input and output produced is expressed in terms of the average productivity of labor.

Given a level of output, projected manpower requirements become very sensitive to changes in average labor productivity. For this reason, the average productivity of labor has been called the "Achilles' heel" of manpower forecasting.[3] Given the sudden reversal of productivity trends in 1969, there is a good deal of uncertainty surrounding the future course of these trends. The Project Independence scenario indicates an increase in total productivity to 24 tons per man per shift in 1985.[4] The Kramer report projects 1985 levels of 41.4 tons per man per shift for surface coal and 11.5 tons per man per shift for underground coal, computing to a total productivity level of 18 tons per man per shift.[5] If one takes the Kramer productivity estimates and the Project Independence assumptions concerning surface/underground mix, the 1985 total productivity level is 30 tons per man per shift. A pessimistic assumption would be an extrapolation of the 1969-1976 negative trend (-5.3 percent annual change) through 1985, resulting in 8.3 tons per man per shift.

Table 3 examines 1985 manpower implications of the productivity assumptions discussed above. At present, the Bureau of Mines estimate of 1,000 million tons to be produced in 1985 appears the most realistic.[6] Given the differing assumptions of 1985 productivity, estimates range from 138,000 miners to 502,000 miners needed to produce this tonnage. Given a 1976 mine work force of 211,430,[7] this computes to annual growth rates ranging from -4.8 percent (due to productivity increasing faster than output) to +9.8 percent a year.[8] It should be noted that the range in manpower requirements is greater in the columns (i.e., using different productivity assumptions) than in the rows (different output assumptions).

Given the uncertainty that surrounds future estimates of productivity, the industry could be faced with rapid growth in employment or actual employment declines. Manpower planning to meet industry labor needs is different in this environment. Research into the historical causes of labor productivity change is needed to shed light on the future direction of productivity and, in turn, manpower requirements.

Table 3. Impending Requirements for Three Projected Output Levels, 1985[a]

Productivity (Tons/Shift)	$1,000 \times 10^6$ Tons[b]	$1,100 \times 10^6$ Tons[c]	$1,230 \times 10^6$ Tons[d]
30 (Kramer)	138,000	152,800	170,800
24 (Project Independence)	173,600	191,000	213,500
18 (Kramer)	231,400	254,600	284,700
13.6 ('76 level)	306,300	337,000	376,800
8.3 ('69-'76 trend)	502,000	552,200	617,500

[a] Assuming 240 shifts per miner per year.
[b] Bureau of Mines Report.
[c] Kramer Study estimate.
[d] President Carter's goal.

In addition to aggregate level estimation of manpower impacts, research results could be utilized to estimate spatial impacts of coal mine labor needs. Table 2 (in Section 1) indicates there are spatial differences in the various factors influencing labor productivity. By incorporating these regional differences in the determinants of labor productivity into future projections of manpower needs, researchers could develop more site-specific estimates of manpower impacts.[9]

In terms of manpower impacts, then, research into labor productivity becomes crucial. One research area needing these results is the assessment of aggregate labor requirements and supply needed to reach coal production goals. Another aspect of this problem is the regional/community implications of coal development and employment. Both deserve immediate attention.

2.2 Policy Direction and Productivity Research

The declining trend in coal labor productivity has been a source of concern for both industry and government. To date, most of their efforts to stabilize and reverse productivity trends have been concentrated in the areas of miner training and coal mining technology.[10] Partially due to the uncertainty of the causes of productivity decline, efforts to correct the problem have been general in nature and of limited effectiveness.

Labor productivity research would give a clearer picture of the causes of productivity decline. Once the major causes of the decline are known, government and industry can take more of a "rifle," as opposed to a "shotgun," approach to research and development programs. Policy would assume a more cost effective nature, and the possibility of fruitful results would be increased.

Higher productivity in coal mining is associated with many positive factors. In terms of miner welfare, fewer workers would be needed to mine a given amount of coal, thus reducing exposure to occupational health and safety-related problems in the most dangerous profession. President Carter's energy goals, which currently seem unattainable, could perhaps be met. If the 1976 industry attained 1969 productivity rates, coal tonnage in 1976 would have increased from 665 million to 936 million without adding a single miner. This would have lessened the overall impact of an expanding coal industry upon the work force, reducing the possibility of labor shortage or misallocation. This question is extremely important at the community level where the social costs of resource development are high.[11] At a macro level, the possibility of structural problems in the economy would be reduced, resulting in increased employment and lower price inflation.

2.3 Implications Related to Unit Labor Costs

Unit labor cost is a function of labor compensation and labor productivity. If wages and productivity increase at the same rate, unit labor costs remain constant. Productivity, then, becomes an important consideration in the cost of the production of coal.

Table 4 details value per ton of coal, average weekly wage, productivity, and unit labor costs for the period 1950-1975.[12] From 1950 through 1969, productivity increased faster than wage payments, lowering unit labor costs. In the post-1969 period, wage payments continued to increase; however, tons per man per year declined. This resulted in an increase in unit labor costs from $1.91 in 1969 to $3.20 in 1974. Value per ton during this period was increasing faster than labor costs; thus, in 1974 unit labor costs accounted for only 20.3 percent of total value, the lowest labor share in the period examined.

Table 4. Unit Labor Costs, 1950-1975

Year	Net Tons/ Man/Year	Average Weekly Wage	Unit Labor Costs	Value/ Ton	Percentage Labor Cost
1950	1239	$67.46	$2.83	$4.84	58.5%
1955	2064	92.13	2.32	4.50	51.6
1960	2453	112.41	2.38	4.69	50.7
1965	3829	140.26	1.90	4.44	42.8
1969	4501	165.79	1.91	4.99	38.3
1970	4302	183.96	2.22	6.26	35.5
1971	3791	194.00	2.66	7.07	37.6
1972	3989	215.83	2.81	7.66	36.7
1973	3745	226.86	3.15	8.53	36.9
1974	3848	236.84	3.20	15.75	20.3
1975	3288	N/A	N/A	18.75	N/A

Source: Bureau of Mines, *Minerals Yearbook* (Washington, D.C.: USGPO, various years).

A study by the Council on Wage and Price Stability pointed out that average value per ton rose faster in 1974 and 1975 than did labor costs. The Council concluded, "Unless all other costs have grown more quickly than labor costs (which is doubtful), the average price has outpaced total costs."[13] Profit per ton, then, was increasing during this period.

Labor costs constitute a substantial portion of the production cost. A Bureau of Mines report estimates that labor costs make up approximately 50 percent of production cost in underground mines and from 36 percent to 49 percent in surface mines, depending upon mine characteristics.[14] If unit labor costs were to increase 50 percent due to the combined effect of further productivity declines and wage increases from a new union contract, total production cost would increase 25 percent, *ceteris paribus*. These cost increases would be reflected in the selling price of coal.

The selling price of coal is extremely important. A lower relative cost of coal will allow it to compete better with other energy inputs, causing a substitution towards coal in a larger number of applications. Because the output of coal is constrained more by demand than production capacity in the long run, the price elasticity of substitution and relative price of coal become important considerations in meeting President Carter's goals. For these reasons, productivity trends and research become important considerations in meeting future projected levels of coal tonnage.

The results of research in coal mine labor productivity could also be utilized to estimate and forecast labor costs and their relationship to coal prices and the price elasticity of coal versus other fuels. This research could be incorporated into existing energy demand models to determine a likely gross output level for the coal industry in the future.

NOTES

[1]Executive Office of the President, Energy Policy and Planning, *The National Energy Plan* (Washington, D.C.: USGPO, 1977), pp. 94-95.

[2]See Kramer Associates, *Determination of Labor Management Requirements in the Bituminous Coal Industry To Reach the Goals of Project Independence* (Springfield: NTIS, 1975); Elchanan Cohn et al., *The Bituminous Coal Industry: A Forecast* (College Park: The Pennsylvania State University, 1975); Bernard S. Freeman, *Manpower for Coal Mining Supply-Demand-Training* (Washington, D.C.: USGPO, 1977); and Federal Energy Administration, *Project Independence Blueprint Final Labor Report* (Washington, D.C.: USGPO, 1974), pp. 48-49.

[3]Mark Blaug and Bashir Ahamad (eds.), *The Practice of Manpower Forecasting*, (New York: Elsevier Scientific Publishing Co., 1973), p. 73.

[4]Federal Energy Administration, *Final Labor Report*, pp. 48-49.

[5]Kramer Associates, *Determination of Labor*, pp. 17-22, 25-29.

[6]Bureau of Mines, *Weekly Coal Report No. 3110*, April 22, 1977.

[7]*Ibid.*

[8]From 1960 to 1970, coal tonnage increased from 415.5 to 602.9 million tons annually, a compound growth rate of 3.8 percent. However, productivity was increasing 5.8 percent annually, which resulted in an employment decline. See National Coal Association, *Coal Facts 1974-1975* (Washington, D.C.: National Coal Association, 1975), pp. 52-53.

[9]Richard Davis, director of the Regional Urban Studies group of Oak Ridge National Laboratory is involved in assessing the regional economic impacts of coal development. Dr. Davis has expressed a need for the proposed research to aid in these assessments.

[10]See, for example, Bureau of Mines, *Mining Technology Research* (Springfield: NTIS, 1975); and Joseph Brennon, "Productivity - and the BCOA," *Coal Age*, July 1976, pp. 96-27.

[11]See Joe G. Baker, *Labor Allocation in Western Energy Development*, Human Resource Institute Monograph No. 5 (Salt Lake City: University of Utah, 1978), pp. 111-12.

[12]Unit labor costs are calculated using BLS methods, i.e.,

$$\text{unit labor costs} = \frac{\text{wages/year/miner}}{\text{tons/year/miner}}$$

Value includes the average F.O.B. mine value of all operations with annual production of 1,000 tons or more. Included in this figure is the average value of coal sold on the open market ($15.86 in 1974) and coal not sold on the open market as estimated by the mine ($19.86 in 1974).

[13]Council on Wage and Price Stability, Executive Office of the President, *A Study of Coal Prices* (Washington, D.C.: USGPO, 1976), p. 38.

[14]See Sidney Katell et al., "Basic Estimated Capital Investment and Operating Costs for Coal Strip Mines," *Bureau of Mines Information Circular 8661* (Washington, D.C.: USGPO, 1974),pp. 10, 19, and 29; and Sidney Katell et al., "Basic Estimated Capital Investment and Operating Costs for Underground Bituminous Coal Mines," *Bureau of Mines Information Circular No. 8682* (Washington, D.C.: USGPO, 1975), pp. 12, 21, and 30.

3. HYPOTHESES EXPLAINING PRODUCTIVITY DECLINE

A literature review uncovered a variety of explanations for the decline in labor productivity in coal mining, but most explanations were supported by little or no empirical evidence.

The hypotheses advanced in the literature fall roughly into four broad categories: (1) causes related to the resource base, i.e., geologic considerations; (2) causes related to the labor force; (3) causes related to production technique; (4) institutional causes, such as the CMHSA and union agreements.

3.1 Resource Base

3.1.1. *Ricardian Returns*

Given that the first coal mined will be that which is easiest to mine, expansion of output would require the mining of increasingly difficult seams, causing a drop in labor productivity. This occurs two ways:

1. Intensive margin—a single mine expanding output to more difficult seams.
2. Extensive margin—new mines opening up in geologically less favorable areas.

3.1.2. *"Start-Up" Labor*

When a new mine is opened or a new seam is exploited in an existing mine, there is a period of time in which miners are preparing the new face for production and there is little coal output. Peak productivity in a new mine requires a year or longer. As coal output expands, one would expect more "start-up" labor and, therefore, declining productivity.

3.1.3. *Long-Run Industry Equilibrium*

Due to declining conditions in the industry during the 1950s and 1960s, one would expect that the least efficient (lowest productivity) mines would be eliminated faster than productive mines. Thus, the steady elimination of the poorer mines in this period resulted in the upward trend in productivity. Now that output is increasing, the "marginal" mines would be able to reenter the industry and survive, lowering overall productivity.

3.2. Labor Force

3.2.1. *Turnover/Absenteeism*

The mining industry has been plagued by these problems in the past, and there is evidence they are increasing. High turnover requires constant hiring and training of workers, lowering productivity.

3.2.2. *Strikes/Slowdowns*

Increases in the number of strikes and work slowdowns adversely affect productivity.

3.2.3. *Younger, Less Skilled Work Force*

Given the declining employment of the industry over two decades since World War II, the sudden reversal of employment necessitated bringing in many younger workers as older workers retired. These inexperienced, young workers and the rapidly changing work force have lowered productivity.

3.3. Production

3.3.1. *Shifts in the Mix of Extraction Techniques*

Labor productivity varies with extraction technique (strip, auger, longwall, conventional, or continuous techniques), and, therefore, overall labor productivity is influenced by the portion of total output mined by each method. Perhaps the biggest influence on productivity is due to the strip/underground ratio.

3.3.2. *Economies or Diseconomies of Scale*

Given that labor productivity varies among mines by size class, changes in the average size mine result in changes in overall productivity.

3.4. Institutions

3.4.1. *Coal Mine Health and Safety Act of 1969*

This is perhaps the most popular of all explanations of declining productivity. The fact that the year of enactment coincides with reversal of the increasing productivity trend lends credence to this hypothesis. Among the reasons the CMHSA is blamed are

1. Regulations require an increase in safety (nonproduction) personnel at mines. This increases labor costs without increasing productivity.
2. Certain provisions, such as those dealing with dust levels, have slowed productivity.

3. The "black lung" (pneumoconiosis) provision has resulted in retirement for thousands of miners. These miners have been replaced with younger, less experienced, and less productive workers.

3.4.2. *Union Agreement of 1974*

For safety reasons, the National Bituminous Coal Wage Agreement of 1974 required the assignment of helpers to certain occupations. These helpers increased labor costs without appreciably increasing productivity.

4. RESEARCH APPROACHES

This paper has examined the issues surrounding declining labor productivity in coal mining. As a result of this examination, a strong case has been made for research into the causes of declining productivity. Let us now consider possible research approaches to this problem.

One approach would be composed of a multivariate analysis similar to the Cohn et al. model.[1] Using a generalized least squares framework, the relative contribution of a set of variables upon labor productivity would be estimated in a functional form. Ideally, one would utilize pooled data, thus comparing individual mines cross-sectionally over time. However, cross-section analysis at a point in time would reveal considerable information concerning the influence of various characteristics upon labor productivity. The results of this analysis would be of particular value for estimating and forecasting spatial productivity for regional/community impact analysis.

In addition to differences in productivity among mines, longitudinal changes would be inferred from the cross-sectional results and the historical behavior of the industry. Establishment level data is available on magnetic tape from the Office of Energy Data and Interpretation, Department of Energy, for the years 1973, 1974, and 1975 (see Appendix B).

Another approach to analyzing the data would be to estimate the coal mining production function.[2] A production function is an abstract representation of how various inputs to production—labor, capital, materials, energy, etc.—are related to each other and the final product. The production function of an industry can reveal information concerning total factor productivity, economies of scale, single factor productivity, the rate different factors of production can be substituted for one another (e.g., capital and labor), technological change, and impacts of institutional factors on production such as the CMHSA. In addition, a new approach[3] allows one to separate cyclical influences on productivity from secular influences—an important consideration in coal mining labor productivity.

NOTES

[1]Elchanan Cohn et al., *The Bituminous Coal Industry*, pp. 170-82. See Appendix A for a discussion of this model.

[2]See G. S. Maddala, "Productivity and Technological Change in the Bituminous Coal Industry, 1919-54," *Journal of Political Economy*, 75:352-65.

[3]Michael F. Mohr, "The Long-Term Structure of Production, Factor Demand, and Factor Productivity in U.S. Manufacturing Industries." Presented at the Conference on Research in Income and Wealth sponsored by the NBER, New York City, November 13-14, 1975.

APPENDIX A — ANNOTATED BIBLIOGRAPHY

SUMMARY

The following bibliography is the result of a literature review of recent materials dealing with labor productivity in coal mining. Articles dealing with the topic have appeared frequently in the trade and engineering publications, although there has been little empirical work to vigorously examine the problem.

Explanations for declining labor productivity in coal mines fall roughly into four general categories. Perhaps the most popular explanations are related to the Coal Mine Health and Safety Act of 1969 (items 2, 4, 8, 11, 12, 13, 14, 15, 16, 17, 20, 21, 23, 24, 25, 26, 27, and 30). However, only four studies attempt to gauge the impact of this act empirically (23, 25, 26, 27). Other materials relate the decline to causes related to the labor force (2, 8, 11, 12, 15, 16, 18, 20, 21, 22, 23, 26, 28), causes related to production (1, 4, 5, 6, 7, 11, 12, 17, 18, 19, 23, 24), and causes related to the resource base (9, 10, 11, 12, 19, 23, 24, 26).

ANNOTATED BIBLIOGRAPHY

1. Anonymous. "Equipment Sales, Production and Productivity by Mining Method in 1971." *Coal Age,* February 1972, pp. 75-77.

   Article examines equipment sales and data on labor productivity by technique for the years 1969, 1970, and 1971. Includes tables.

2. Anonymous. "Productivity—and the BCOA." *Coal Age,* July 1975, pp. 96-97.

   Interview with J. Brennan, president of the Bituminous Coal Operators Association. Discussion of productivity, problems with young work force, safety concerns, and ways to increase productivity.

3. Anonymous. "Productivity—and the UMWA." *Coal Age,* July 1975.

   Summary of answers by various union officials to questions concerning productivity trends, safety, and solutions to declines in productivity.

4. Anonymous. "Stemming the Slide in Productivity is a Job for Both Machinery Manufacturer and Mine Operator." *Coal Age,* July 1976, pp. 63-73.

   Article addresses the 1969 Coal Mine Health and Safety Act, declining productivity, and methods to stabilize and reverse decreasing productivity. Review of new technology and equipment.

5. Anonymous. "Surface Mining Productivity Tied to Performance in Associated Areas." *Coal Age,* July 1976, pp. 163-69.

   Article addresses ways to halt decline in surface mine labor productivity. Examines equipment innovations such as bucket size and shovel technology.

6. Anonymous. "Underground Mining of Coal." *Mining Congress Journal,* 59 (2): 128-36.

   Review of new machinery, mines, and trends in productivity in underground mines. Examines mine research programs.

7. Anonymous. "1973 Shipments of Mining Equipment, Production and Productivity From Various Methods of Mining." *Coal Age,* February 1974, pp. 84-86.

   Article examines equipment sales and data on producticity by technique for 1971, 1972, and 1973. Includes tables.

8. Brennan, J. P. "Labor Relations and the Coal Industry." *Mining Congress Journal,* 62(7):18-21.

   President Brennan discusses areas where management and labor must cooperate to achieve energy goals of coal. Discussion of productivity.

9. Christenson, C. L. *Economic Redevelopment in the Bituminous Coal Industry.* Cambridge: Harvard University Press, 1962.

   Contains analysis of productivity in underground mines, including Christenson's "Theory of Discriminating Selection," that is, a relationship between seam thickness, daily ouput scale, and type of company. Study is dated.

10. Christenson, C. L., and Andrews, W. H. "Physical Environment, Productivity and Injuries in Underground Coal Mines." *Journal of Economics and Business,* 26(3):182-90.

Authors examine the relationship between physical environment (seam thickness), productivity, and injuries in coal mining in 1965. The results of this study show that productivity increases as seam thickness increases, then falls off at the 9-foot level. Christenson and Andrews attribute part of this to the theory of discriminating selection (larger mines are associated with integrated coal companies that can acquire the most easily worked reserves), and the use of "balkier," but more efficient, equipment in the larger working area of thick-seam mines. The authors find a similar relationship between safety (lack of fatalities) and seam thickness, i.e., increasing safety as seam thickness increases to approximately the 9-foot level, then falling off. The authors also examine a 1971 "case study" county in West Virginia to compare with the pre-1969 era. They find the basic relationship of 1965 still holds true. However, there is a drastic reduction in the number of mines, and while the average seam thickness remains constant, productivity declines in large mines and rises in small mines. Overall, the county coal industry becomes safer. In conclusion, the authors believe small mines working thin seams will face severe challenges to their existence.

11. Cohn, Elchanan et al. *The Bituminous Coal Industry: A Forecast.* University Park: Institute for Research on Human Resources, The Pennsylvania State University, 1975.

This study is perhaps the most thorough and vigorous examination of the determinants of productivity in coal mining. The purpose of the research is to generate labor supply and demand estimates for 1988 and 2000. To generate these forecasts, the study employs a "structural equation" approach to estimating future labor productivity. The form of these equations is the following

$$AP_j = a + \sum_{i=1}^{n} B_i x_i + E$$

when j = 1, n = 6
when j = 2, n = 4

When j=1, AP_1 equals average labor productivity underground and x_1 equals average hours per week; x_2 equals percentage of output from 0.5 million plus ton-per-year mines; x_3 equals time trend; x_4 equals percentage of coal cut by hand; x_5 equals percentage cut by continuous machines; x_6 equals percentage cut by longwall machines; and E equals error term. When j=2, AP_2 equals average labor productivity surface mines; x_1, x_2, x_3, and E were as above, and x_4 equals percentage of buckets and dippers having 12-plus cubic yard capacity. Using time series data from the 1948-1970 period, the coefficients of the two equations were estimated.

Variables x_1 and x_3 in equation AP_1 were dropped due to collinearity; variable x_6 had an insignificant t statistic, as did x_2 in equation AP_2. Despite this, both equations had an R^2 of 0.98, indicating that virtually all of the changes in labor productivity for this period were explained by the structural equations. However, the period examined was one of virtually constant increase in productivity. A simple time trend model of the form (total productivity) = a + b (year) results in R^2 = 0.983 for 1950-1970 data.

12. Comptroller General of the United States. *U.S. Coal Development—Promises and Uncertainties*. Washington, D.C.: U.S. General Accounting Office, 1977.

    Detailed report assessing prospects of expanding coal output to 1.2 billion tons in 1985. Includes section on labor productivity, extensive tables, statistics, and bibliography.

13. Congressional Research Service. *Factors Affecting the Use of Coal in Present and Future Energy Markets*. Washington, D.C.: U.S. Government Printing Office, 1973.

    Study examines issues related to coal utilization, e.g., interfuel competition, mining regulations, and reserve characteristics. Short discussion of CMHSA and declining productivity.

14. Cornette, Aubrey J. "Ten Year Outlook in U.S. Coal Mining." *1976 Mining Yearbook*, Denver: Colorado Mining Association, 1976, pp. 118-21.

    Article assesses feasibility of doubling coal output by 1985. Discussion of declining productivity and the CMHSA.

15. Executive Office of the President, Council on Wage and Price Stability. *A Study of Coal Prices*. Washington, D.C.: U.S. Government Printing Office, 1977.

    Report analyzes the causes of the tripling of coal prices in 1973 and 1974 and the future outlook for coal prices. The study includes a short discussion of why mining productivity has declined and the impact of unit labor costs on coal prices.

16. Friedman, Bernard S. *Manpower for Coal Mining Supply - Demand - Training*. Washington, D.C.: U.S. Government Printing Office, 1977.

    Report assesses current and potential demand for coal mining manpower at the management, professional, and operative levels. Brief discussion of productivity.

17. Kramer Associates, Inc. *Determination of Labor Management Requirements in the Bituminous Coal Industry To Meet the Goals of Project Independence*. Springfield, Virginia: National Technical Information Service, 1975.

    Study examines the manpower requirements of expanding coal production to 1.1 billion tons in 1985. Includes a chapter on productivity and discussion of changes in surface and underground labor productivity and projections. Little empirical analysis.

18. Maddala, G.S. "Productivity and Technological Change in the Bituminous Coal Industry, 1919-54." *Journal of Political Economy,* 75(2):352-65.

Study fits Cobb-Douglass production function to the bituminous coal industry. Author concludes that increase in productivity is due almost entirely to increase in horsepower per worker, with residual due to work force quality changes.

19. Malhotra, Ramesh. "Factors Responsible for Variation in Productivity of Illinois Coal Mines." *Illinois Mineral Note 60.* Urbana: Illinois State Geological Survey, 1975.

This study utilizes data from 29 underground mines and 32 strip mines in Illinois from 1970-1973 to determine factors influencing productivity variation among mines. The author utilizes tabular analysis and charts to draw conclusions; thus, the interrelatedness of the various factors cannot be determined. The results of the study indicate that in underground mines productivity is related to (1) seam thickness, (2) roof and floor conditions, (3) size of operation, (4) age of operation, (5) coal washing, and (6) effective equipment use. In surface mining, the relevant variables were (1) overburden to coal seam ratio, (2) nature of overburden (consolidated or unconsolidated), (3) mining method, (4) mine age, (5) mine capacity, (6) quality of final product, and (7) effective equipment use.

20. Mason, Richard H. "An Industry Thwarted, But Pushing Ahead." *Coal Mining and Processing,* July 1976, pp. 52-56.

Author discusses decline in labor productivity and its causes—age and experience of the work force, CMHSA, labor disputes, and shortages of materials.

21. Meador, H. W. "One Company's Experience with Productivity." *First Symposium on Coal Management Techniques, Volume II.* Washington, D.C.: National Coal Association, 1975, pp. 33-34.

Author discusses decline in labor productivity at the Westmoreland Coal Company. Examines the CMHSA; labor unrest; and a younger, inexperienced work force and their contributions to labor productivity.

22. Mills, Ted. "Altering the Social Structure in Coal Mining." *Monthly Labor Review,* 99(10):3-10.

Review of an experiment to restructure the management and decisionmaking process at the Rushton Mine (Pennsylvania). Brief discussion of productivity decline and its relationship to a higher educated work force.

23. Nelson, Jon P., and Neumann, George R. *Labor Productivity and the Coal Mine Health and Safety Act of 1969.* Springfield, Virginia: National Technical Information Service, 1975.

Paper develops a firm level production function for safety. Empirical estimates of this function are generated using aggregate time series data from 1950 to 1970. Paper concludes that ability to draw inferences from data is very limited given level of aggregation. Also, the increase in inexperienced operators, opening of new mines, and changes in work practices are all considered to have adversely affected injury experience from 1971 to 1972.

24. Stradley, Scot. "Human Resource Implications of the Production Process in Underground Bituminous Extraction, Especially for Utah." Unpublished dissertation, University of Utah, 1977.

Author examines the determinants of average labor productivity in underground coal mines, using a cross-section approach with individual mines as the unit of observation. Despite some data limitations, Stradley concluded that highest average product is produced by longwall mines, second highest by room and pillar. There is a direct relationship between technique and average product. Following Christenson, Stradley found a strong relationship between seam thickness and productivity. Stradley found some inconclusive evidence supporting the theory of discriminating selection, that is, a relationship between seam thickness and company type.

25. Straton, J. W. "Effects of Federal Mine Safety Legislation on Production, Productivity and Costs." *Mining Congress Journal,* 58(7):19-23.

Using survey data from 64 mines, the author assesses effects of the CMHSA on productivity and costs. Based upon study results, author finds that (1) small mines are affected the most by declines in productivity, (2) conventional mining is affected more than continuous, (3) thin-seam coal mine productivity is greatly affected, and (4) captive mines are affected less than independent mines. Author also finds that mines report an average of $1.47 per ton extra costs as a result of the CMHSA. The majority of mines indicate that the ventilation requirements of the Act are the most restrictive. This research attributes all productivity declines to the CMHSA and does not attempt to examine other possible causes.

26. -------. "Improving Coal Mine Productivity." *Mining Congress Journal,* 63(7):20-24.

Article examines various factors affecting labor productivity: state and national laws, labor-management relations, worker skill, natural mine conditions, and equipment changes. To isolate the effect of the CMHSA, the author conducted a survey of 163 underground mines in 1975. The mines surveyed reported that average total production time per shift had dropped from 332 minutes to 245 minutes due to the CMHSA. The author assesses the impact of declining productivity on future manpower requirements.

27. -------. "1970-1974—A Period of Adverse Changes in Productivity and Costs in Underground Bituminous Coal Mines." *Mining Congress Journal,* 61(10):34-39.

This research is an update of the author's 1972 survey, utilizing 1974 survey results from 124 underground mines. Author finds that the mines suffering the greatest productivity loss are (1) nongassy, (2) independently owned, (3) thin-seam, (4) 100,000 to 500,000 tons per year, and (5) eastern U.S. In addition, the survey indicates that the CMHSA adds from $3.50 to $4.00 per ton in independent mines and $2.00 to $2.50 per ton in captive mines.

28. Suboleski, Stanley. "Boost Your Productivity by Adding Continuous Miners." *Coal Age,* March 1975, pp. 78-80.

    Article discusses scheme to use two continuous miners per crew. Brief discussion of productivity decline, which author attributes to "work ethic."

29. U.S. Department of Labor. *Project Independence Blueprint Final Labor Report.* Washington, D.C.: U.S. Government Printing Office, 1974.

    Discussion of coal manpower requirements to meet the Project Independence Scenarios. Includes short discussion of productivity decline and its causes.

30. Wearly, W. L. "The Crisis of Declining Productivity: Its National Impact, Causes and Solutions." *First Symposium on Coal Management Techniques, Volume I.* Washington, D.C.: National Coal Association, 1975. pp. 5-17.

    Article examines different aspects of declining productivity—costs, interfuel competition, and labor requirements. Author attributes productivity decline to the CMHSA and MESA enforcement.

31. Zimmerman, Martin B. "Modeling Depletion in a Mineral Industry: The Case of Coal." *The Bell Journal of Economics,* 8(1):41-65.

    Author estimates the long-run marginal cost of producing coal and the effect that gradual depletion has on production cost. As the resource is depleted, the producing firms are forced to mine less fertile seams, affecting both productivity and production cost. This relationship is estimated in a nonlinear regression of the form "productivity is a function of seam thickness and scale of operations." Increased labor costs are then combined with equipment and operating costs resulting from depletion to estimate total marginal cost.

STUDIES IN PROGRESS

1. Charton, Pete. Delphi Study To Assess Coal Mine Training Needs. Roane State College, Harriman, Tennessee.

   Delphi Study to include assessment of future productivity trends. Completion in spring 1978.

2. The Conference Board. "Labor Factors in Energy Supply." Research to be performed for The Electric Power Research Institute, RFP #1147.

   Study to assess extent to which the supply of labor might be a constraining factor in the expansion of energy industries. Included is a task to analyze factors influencing productivity and projections of future productivity. Completion in 1978.

3. Brand, Horst, and Vickery, Mary. Bureau of Labor Statistics. Article forthcoming in *Monthly Labor Review* on coal productivity.

4. Julian, Edward. "Effect of the Coal Mine Health and Safety Act of 1969 on Productivity in Illinois Underground Coal Mines." Unpublished research paper, Department of Mineral Economics, The Pennsylvania State University.

   Study uses regression analysis to examine impact of the CMHSA.

APPENDIX B — DATA SOURCES

The following is a discussion and inventory of possible data sources to be utilized in the research.

1. Department of Energy. *Bituminous Coal and Lignite Production and Mine Operation.* Data available for 1973, 1974, and 1975.

   These data are collected annually from every mine in operation. To date, this source of data has yet to be exploited beyond the cross tabulations of the existing Bureau of Mines reports.

   These data are a rich source of establishment level characteristics concerning mine geology, type of firm and market, production methods, and other data. A copy of the survey questionnaire follows this list.

   Included in these data are information concerning establishment location. These data can thus be aggregated to county, state, or other levels for use with other published data sources. While these survey data are collected under restrictions of confidentiality, the proposed research would not violate this condition.

2. National Coal Association. *Bituminous Coal Facts.* Washington, D.C.: National Coal Association, various years.

   Compilation of industry statistics concerning production by method, state, county, type of coal, and other data. Based on Bureau of Mines Information.

3. -------. *Coal Data.* Washington, D.C.: National Coal Association, various years.

   Supplement to the above publication (item 2), but contains more detailed information.

4. McGraw-Hill. *Keystone Coal Buyers Manual.* New York: McGraw-Hill, annual.

   In addition to Bureau of Mines data, this publication contains information concerning production by company and reserve characteristics.

5. Bureau of Mines. *Minerals Yearbook.* Washington, D.C.: USGPO, annual.

   Data concerning production, preparation, shipments, distribution, employment and productivity, consumption, coal values, and net export data. These tabulations are based on data source 1, above. In addition to the *Minerals Yearbook*, the Bureau of Mines periodically publishes *Mineral Industry Surveys* containing all the information to be found in the *Yearbook*, but available before the *Yearbook* is published.

6. -------. *Weekly Coal Report.*

   Limited weekly production data by state.

7. -------. *Bituminous Coal and Lignite Mine Openings and Closings in the U.S., 1970-1972.* Washington, D.C.: USGPO, unknown.

8. UMWA. *Beneficiaries Eligible for Hospital and Medical Care.* Washington, D.C.: UMWA Welfare and Retirement Fund, 1968-1972.

Contains health and age characteristics.

9. Bureau of Labor Statistics. "Output per Production Worker Hour Indexes." Washington, D.C.: Bureau of Labor Statistics, n.d.

Data in index number form concerning output per production and nonproduction worker; total output, hours worked, and total employment by production and nonproduction workers.

10. -------. "The Measurement and Analysis of Labor Inputs in the U.S. Economy." Washington, D.C.: Bureau of Labor Statistics.

This report is based on work force data compiled by industry, sex, education, occupation, hours of work, total employment, and compensation for the years 1947-1975. These raw data are available from the BLS.

11. -------. *Output/Employment Data—Capital Stock Data.* Washington, D.C.: Bureau of Labor Statistics, n.d.

This series contains output/employment and capital stock data by industry for the period 1947-1974. The capital stock series goes only to 1970 but is in the process of being updated.

12. Bureau of Economic Analysis. "Gross Product Originating in Current and Constant (1972) Dollars." Washington, D.C.: Bureau of Economic Analysis.

Data concerning gross product originating from the coal industry and its components: employee compensation, profit, net interest, taxes, and capital consumption, 1947-1976.

13. Federal Reserve System Board of Governors. *Industrial Production 1976.* Washington, D.C.: USGPO, 1977.

Series data based on Bureau of Mines data.

6 — Transportation of total tonnage shipped

Name of railroad or waterway on which product was first loaded (1)	Quantity loaded *(Short tons)* (2)	Tonnage included in (2) shipped by unit train (3)

7 — Shipments and average sulfur content, by use

Item (1)	Code	United States uses				Exports *(Include Canada and Mexico)* (6)	Use unknown to producer (7)	Total 2/ (8)
		Electric utilities (2)	Coke plants (3)	Other industrial uses and retail dealers (4)	All other uses 1/ (5)			
Quantity shipped *(Short tons)* ...	010							
Average sulfur content as shipped dry basis *(Percent)*.....	020							
Average value per ton f.o.b. mine *(Dollars)*...............	030							

1/ Include railroad fuel, shipments to Great Lakes and tidewater commercial docks *(excluding Canada)*, mine fuel, sales to mine employees, and net change in mine inventory.
2/ Total short tons shown should be the same as reported in Section 5, Line Code 050.

8 — Underground mine operations

(1)	(2) Code	(3) Number of machines in operation	(4) Quantity *(Short tons)*
A. Coal mined by different methods:			
1. Continuous mining machines	010		
2. Conventional methods:			
a. Cutting machines..........	020		
b. Shot from solid or cut by hand	030		
3. Longwall machines *(Please check)* ☐ (1) Planer ☐ (2) Shearer.......	040		
B. Power drilling by type of drill:		Number of drills	
1. Coal drills:			
a. Hand-held and post-mounted..........	050		
b. Mobile drills....	060		
2. Roof Bolters:		Number for roof bolting	
a. Rotary drills	070		
b. Percussion drills..........	080		
c. Rotary-percussion combination drills	090		
C. Coal loaded at face by different methods:		Number of machines in operation	Quantity *(Short tons)*
By mobile loading machines:			
Into shuttle cars or rubber-tired mine cars..........	100		
Onto belt conveyors..........	120		
By continuous mining machines:			
Into shuttle cars or rubber-tired mine cars..........	130		
Onto extensible conveyors..........	150		
Mobile loader pick up..........	160		
By shortwall machines..........	165		
By longwall machines..........	170		
By scoops..........	180		
Total tonnage mechanically loaded..........	190		
Total tonnage hand-loaded into conveyance equipment..........	200		
Total underground production	210		

Do not include number of shuttle cars, rubber-tired mine cars, or conveyors

OVER

EIA 7
10/77
Supersedes
BOM Form No. 6-1401-A

U.S. DEPARTMENT OF ENERGY
Energy Information Administration
Washington, D.C. 20241

Form Approved
O.M.B. No. 038-R0194

BITUMINOUS COAL AND LIGNITE PRODUCTION AND MINE OPERATION

This report is being collected under mandatory authorities vested in the U.S. Department of Energy under Public Law 93-275 pursuant to Public Law 95-91.

(Please correct if name or address has changed.)

1 – Identification **Identification Number** [ ][ ][ ][ ][ ][ ][ ]

Name of reporting producer ______

Mailing address of producer: Street ______ City ______ State ______ Zip ______

Name of mine ______

Location of mine: State ______ County ______ Post Office ______

2 – Kind of Operation *(Check one)* [ ] (1) Drift [ ] (2) Shaft [ ] (3) Slope [ ] (4) Strip only [ ] (5) Auger only
[ ] (6) Strip and auger combination [ ] (7) Other *(specify)* ______

3 – Status During Year

If mine produced no coal during year, check reason [ ] (1) Idle [ ] (2) Abandoned [ ] (3) Out of business

Did mine name and/or mine ownership change during year [ ] (1) Yes [ ] (2) No If Yes, give date of change ______ and, if applicable, new mine name and name and address of new owner ______

4 – Coal Bed

FOR BUREAU USE

a. Name or number of coal bed ______

b. Average thickness of bed excluding partings ...... ______ Inches

c. Estimated remaining recoverable coal in this mine ...... ______ Short tons

5 – Coal Production and Value by Disposition

Include all coal shipped to consumer and that used for mine fuel and sold to employees; exclude purchased coal and washery or other refuse.

Item (1)	Code	Quantity *(Short tons)* (2)	Total value *(f.o.b. mine)* (3)
a. Coal shipped by rail or water *(include coal hauled by truck to railroad station or waterway)*......	010		
b. Coal shipped by truck from mine to final destination *(Exclude coal used by mine employees)*......	020		
c. Coal transported to electric utility plants adjacent to or near mine mouth......	030		
d. All other coal produced......	040		
e. **TOTAL annual production** *(**Clean or as shipped**)*......	050		
a. Coal sold in open market and coal used as colliery fuel......	060		$
b. Captive coal, coal not sold in open market *(Estimate value)*...... *(Include only coal used by producing or subsidiary company)*	070		
c. **TOTAL production and value by disposition**......	080		

9 – Underground haulage

Item (1)	Code	Railroad: Locomotives: Trolley (2)	Railroad: Locomotives: Battery (3)	Railroad: Mine cars (4)	Railroad: Personnel and supply cars (5)	Railroad: Rail track (miles): Main line (6)	Railroad: Rail track (miles): Spurs and sidings (7)	Rubber-tired vehicles: Tractors (8)	Rubber-tired vehicles: Mine cars (9)	Rubber-tired vehicles: Shuttle cars: Cable reel (10)	Rubber-tired vehicles: Shuttle cars: Diesel (11)	Rubber-tired vehicles: Shuttle cars: Battery (12)	Rubber-tired vehicles: Shuttle buggies hand-loaded (13)	Rubber-tired vehicles: Scoops Clean up (14)	Rubber-tired vehicles: Personnel and supply cars (15)	Belt conveyors, gathering and haulage 1/ (16)
Number	010															
Capacity (Short tons)	020															Avg. Length Ft.

1/ Include all gathering, main haulage, extensible belt, slope, and face or room conveyors.

10 - Surface mine operations

(1) Total coal mined by stripping ________ *(Short tons)*
(2) Total coal mined by auger ________ *(Short tons)*
(3) Overburden excavated ________ *(Cubic yards)*
(4) Average thickness, overburden ________ *(Feet)*
(5) Total area mined ________ *(Acres)*
(6) Total area reclaimed ________ *(Acres)*

11 - Surface equipment

Type of machinery (1)	Code	Total number (2)	Number of machines classified by kind of power used: Electric (3)	Diesel electric (4)	Diesel (5)	Gasoline (6)	Number of machines classified by dipper or bucket capacity in cubic yards: Less than 6 (7)	6-15 Inclusive (8)	16-50 Inclusive (9)	More than 50 (10)
Coal recovery augers	010									
Power shovels	020									
Dragline excavators	030									
Carryall scrapers	040									
Bulldozers	050									
Power drills *(Horizontal)*	060									
Power drills *(Vertical)*	070									
Front end loaders	080									
Wheel excavators	090									
Power brooms	100									
Motor graders	110									
Coal drills	120									

12 – Off-the-highway trucks

Capacity (Short tons) (1)	Code	Total number in use: End dump (2)	Side dump (3)	Bottom dump (4)	Haulage distance (5)
Under 20	010				
20 to 50	020				
51 to 100	030				
Over 100	040				

13 – Mechanical cleaning *(Include coal from other mines and purchased coal)*

Report tonnage cleaned by type of equipment and method. Estimate if necessary.

Type of equipment (1)	Code	Manufacturer (2)	Quantity (Short tons): Raw coal cleaned (3)	Cleaned product (4)	Refuse (5)	Method of conveying refuse (6) *(Please check)*
Wet methods						
Jigs	010					Truck ☐
Concentrating tables	020					
Classifiers	030					Pipeline ☐
Launders	040					
Dense medium processes						Aerial tram ☐
Magnetite	050					
Sand	060					Rail ☐
Calcium chloride	070					
tation	080					Other *(Specify)* ☐
eumatic methods	090					
TOTAL	100					

(170) Name of cleaning plant ________ Location ________

14 — Other coal preparation

(1) Tonnage prepared by crushing or screening only .... ______________ *(Short tons)*

(2) Tonnage loaded for shipment without processing .... ______________ *(Short tons)*

15 — Thermal drying ***(Exclude electrically heated vibrating screens)***

Type of dryer (1)	Code	Manufacturer (2)	Number of units (3)	Size of feed (4)	Quantity dried *(Short tons)* (5)
Fluidized-bed	010				
Multilouver	020				
Rotary	030				
Screen	040				
Suspension or flash	050				
Vertical tray and cascade ...	060				
Total	070				

MANSHIFTS include all men engaged in production, preparation (*at cleaning plant*), development work, maintenance and repair work including supervisory and technical personnel at the operation. At underground mines include all men working in surface mine shops and yards, etc. Include proprietors and firm members (*owners, operators, or partners*) performing manual labor. Calculate by dividing total man-hours by customary length of shift. Exclude office worker.

PRACTICAL POTENTIAL is the highest level of output under realistic conditions. Assume availability of labor and materials sufficient to utilize machinery and equipment in place and ready to use during the year. Take into account the additional down-time for maintenance or repair which would be required. Do not consider added costs (*additional personnel, overtime pay, materials, repairs, etc.*) to be limiting factors on potential.

16—Operational Statistics for Calendar Year

Year (1)	Code	Total man-hours (2)	Total days worked (3)	Manshifts worked (4)
....	010			

17—Actual and Practical Potential for Employment and Production, Fourth Quarter

Forth quarter (1)	Code	Total man-hours (2)	Average number of shifts per day (3)	Average number of men per shift (4)	Total days worked (5)	Total production *(short tons)* (6)
Actual	010					
Practical potential	020					

18 — Mine Operating Constraints, Fourth Quarter

If mine operated at less than practical potential, rank the following reasons in order of importance. Enter "1" for the most important reason "2" for the second most important reason and so forth. Rank only those reasons that affected your operations.

- ☐ (a) Manpower shortage
- ☐ (b) Absenteeism
- ☐ (c) Railroad car shortages
- ☐ (d) Shortages of materials and supplies
- ☐ (e) Environmental regulations
- ☐ (f) Lack of coal demand
- ☐ (g) Strike
- ☐ (h) Other *(specify)* ______________

Remarks:

Name of person to be contacted regarding this report	Tel area code	No.	Ext.

Address No. Street	City	State	Zip

Information requested on this form is confidential and if released will cause substantial competitive injury. Yes ☐ No ☐

Written substantial justification is attached. Yes ☐ No ☐

Certification

I certify that the information provided herein and appended hereto is true and accurate to the best of my knowledge.

Name ______________________ Title ______________________

Signature ______________________ Date ______________________

Title 18, USC 1001. Makes it a crime for any person knowingly and willingly to make to any Agency or Department of the United States any false, fictitious or fraudulent statements as to any matter within its jurisdiction.