PN-AAD-238
ISN=38234

EVALUATING AND ANALYZING

COAL MINING PROJECTS

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Washington, D.C. 20523

Presented at the Symposium on
Indonesian Coal/Lignite Development and
United States Technology

October 18-21, 1983
Jakarta, Indonesia

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

1.0 INTRODUCTION

2.0 EVALUATION CONTEXT

2.1 THE PRIVATE INVESTOR
2.2 THE ECONOMIC PLANNER
2.3 FINANCIAL AND ECONOMIC APPRAISAL

3.0 ALTERNATIVE COAL MINING PROJECTS

4.0 APPRAISALS AND RESULTS

5.0 CONTEXTS AND HARMONIZATION

6.0 AN EVALUATION AND ANALYSIS SCENARIO

6.1 Delineate the Coal Resource
6.2 Delineate the Coal Reserve
6.3 Investor/Economic-Planner Dialogue
6.4 The Appropriate Role for Labor

LIST OF FIGURES

Figure 1, Sensitivity to Changes in Wage Shadow Factor
2, Sensitivity to Changes in Foreign Exchange Shadow Factor
3, Sensitivity to Changes in Both Shadow Factors Combined

LIST OF TABLES

Table 1, Relative Development of Indonesia's Oil, Natural Gas, and Coal Resources
Table 2, Summary of Alternative Capital Investments
Table 3, Summary of Alternative Labor Employments
Table 4, Summary of Alternative Annual Production Costs
Table 5, Alternative Internal Rates of Return

LIST OF APPENDICES

Appendix A, Underground Coal Mining Projects: Technology Options, Capital Investment, and Production Costs
B, Financial and Economic Appraisal

ACKNOWLEDGEMENTS

The authors cannot claim full credit for whatever benefits the symposium participant or other readers may perceive from the analysis presented in this paper. The authors hope that the illustrations presented and the results achieved will smooth the path of coal development in Indonesia as well as in the many countries fortunate to possess this resource (the Philippines, Pakistan, and Malawi are a few). Such a benefit would not have been possible to secure without significant contributions by William Watson, a consulting mining engineer from Santa Rosa, California, and by Dr. John Reedy, a senior economist on the staff of Arthur D. Little, Inc., of Cambridge, Massachusetts.

Bill Watson selected the technologies, prepared the descriptions, and estimated the capital and production costs involved. He kept the authors honest in the downstream use of his results. Bill drew from his long experience in such matters, and particularly on his recent work for the USAID Mission in Pakistan concerned with planning assistance in the development of that country's significant coal resources.

Jack Reedy prepared the financial and economic appraisals of the four technology options. Jack has long been interested in the peculiar mental processes of engineers who can readily think of numerous alternative ways to produce a given product, effectively and efficiently, but usually only in financial terms. Jack is experienced in applying established principles of economics to these alternatives to demonstrate that the choice that is economically the most beneficial to the nation may be at odds with the choice initially preferred by the investor. He goes on to demonstrate that government's responsibility -- to alter the prices seen by the investors to the extent that they are induced to make the nationally desirable choice. Jack has worked in many developing countries, often in association with AID projects.

To provide an Indonesian context for the evaluations and analyses presented in the paper, the author's have relied in large measure on the work and studies that have been prepared by the Badan Pengkajian Dan Penerapan Teknologi (Agency for the Development and Application of Technology, BPPT) in association with the Bechtel Group, Inc. These studies conducted over the last five-year period, and still on-going, have concerned energy development and transport in Indonesia with special emphasis on coal industry development over the 25-year period 1982-2003. The ongoing work is concentrating on infrastructure upgrading and the technical processes required for the most efficient use of Indonesian coal. This work, also being conducted by Bechtel, is partially supported by the USAID Mission to Indonesia.

Nevertheless, the authors retain the responsibility for responding to any and all comments offered by those who may disagree with the method of analysis or with the basic patterns of data. Also, the opinions and views expressed in this paper are those of the authors. They do not express those of the U.S. Agency for International Development.

1.0 INTRODUCTION

No coal mining project can be evaluated and analyzed without a context. The context usually depends on who is evaluating and analyzing. If he is the investor, who either owns the capital himself, or is an agent for a group of shareholders in the capital, he rightly uses as his context (a) the perception and belief that profitability will be such as to assure a satisfactory rate of return of his investment and (b) the ranking he can give to this calculated return within a set of investment prospects he concurrently has open to him. Whether such an investor is in the private sector and is profit-oriented, or in the public sector managing public funds from a development corporation or bank, his perceptions and his rankings guide his decision making. The profitability of the operations resulting from his decision-making measures his success.

If he is an economic planner, who is responsible for a nation's periodic development plan, he also evaluates and analyzes projects; but his context is different. He evaluates and analyzes a project in terms of whether or not (a) it is in the national interest and (b) how the benefits it could generate for the nation rank against such benefits other projects could generate. Just as the private investor can quantify his profits and compare them to his invested capital, the economic planner can quantify the net benefits (profits) to the nation and compare them to the costs incurred by the nation. He measures costs in terms of the nation's natural and human resources that would be devoted to the implementation of the project. The extent to which projects evaluated by the economic planner are recognized as worthy of implementation during a national plan period measures his success.

Each evaluator and analyzer of projects, whether a profit-oriented capital investor or a national-benefit-oriented economic planner, can have his own list of projects, and the projects in each of the two lists can be identical. But, the rankings within each list may not necessarily be identical. The different rankings cause conflict when the various projects compete for limited resources available from the private investor or from the nation.

The primary purpose of this paper is to show why conflicts are likely to exist between the rankings in the two lists, and, when they do, to show how such conflicts can be resolved such that both lists become the same. In other words, the different contexts used by each evaluator/analyzer, after resolution, become the same context. Also, both parties to the evaluations and analyses will be equally satisfied with the common result. As Indonesia develops its coal resources, it may find itself faced with such a situation: different contexts for evaluation and analysis of projects may lead to the existence of conflicts in the results, and the need arises to resolve such conflicts in the interests of progress and efficiency in raising coal production levels.

To achieve our purpose, we will address Indonesia's national goal of intensive coal development, illustrate through the evaluation and analysis of a hypothetical underground coal mining project how conflicts can arise when the evaluators and analyzers use different contexts, and identify the options available to governments to resolve these conflicts to mutual satisfaction.

2.0 EVALUATION CONTEXT

Two factors are common in any context for evaluation and analysis of coal mining projects. The first is a difference in view as to what is the appropriate foreign exchange rate to be used in evaluation. The second is the possible difference in views as to the wage rates that are to be used in the evaluation process.

2.1 The Private Investor

For the private investor, the context is relatively simple. He is interested in extracting and marketing coal from deposits known to exist in the country. His incentive is the potential profit. More specifically, his incentive is the prospect that his profit will provide a return on his capital more attractive than any alternative investment concurrently available. The coal is there, and the reserves have been evaluated. He has assurances of long-term markets, perhaps through contracts for fixed rates of coal supply. The delivered prices are at the levels he desires. All that remains is to select an extraction technology, secure the financing which he knows is there for him to claim, build his mine, and begin to operate. But he typically has need to secure governmental approvals, and perhaps also governmental support through the construction of needed infrastructure.

Thus, the private investor cannot act in a vacuum. If he is a local investor, he must be given the right to obtain the foreign exchange to pay for imported equipment. If he is a foreign investor, he wants the government's assurance that he will be allowed to repatriate profits and eventually, the capital that he will have invested. Access to markets for his coal production may require new infrastructure - railway, road, or waterway - which he should not be required to build. Exploration and production licenses are to be easily available, and reasonable royalty payments are to be expected. Clearly, his moving ahead depends upon the government seeing that his coal mining project and the technology he plans to use are in the national interest.

2.2 The Economic Planner

For the economic planner, the context is not as simple. He must address the total scope of his country's national goals for development and effective and efficient use of national resources to achieve these goals. Coal mining projects are only a subset of many different types of projects that demand the planner's attention. Hence, some background here of the current Indonesian situation as this may influence the economic planner's context is worth noting.

Indonesia is the fifth most populous country in the world. Its future economic development and social progress will demand significant increases in per capita energy consumption, and hence a major rise in total national consumption of energy. The major foreign exchange earner for Indonesia is its export of hydrocarbons - oil and natural gas. Indonesia's exports of oil over the past five years has been about 450 million barrels annually, out of a total annual production of about 600 million barrels. Rising internal demand, now apparent, can constrain the nation's ability to continue export at this level.

In the industrial sector, energy consumption has been growing at about 13% per year. Petroleum products, such as diesel oil or residual fuel oil, used in generating electricity account for over half of petroleum purchases in this sector. In the household sector, the potential growth in petroleum consumption (kerosene) estimated over the 25-year period, 1978-2003, is for a six-fold increase, from 32 million to 196 million barrels annually. In the transportation sector, a similar growth in petroleum consumption is expected as modernization, urbanization, and movement of agricultural products to markets accelerate. Over the same 25-year period, transportation fuels consumption should likewise increase six-fold to about 196 million barrels.

Such growth rates in internal consumption, if they in fact materialize, make it clear that Indonesia's ability to continue petroleum exports could disappear. It becomes also clear why the nation is emphasizing a simultaneous acceleration of oil and gas exploration and production and the development of its large coal resources. Table 1 can be indicative of the magnitude of the coal development task.

To sustain its hydrocarbon exports at least at present levels to earn the foreign exchange needed for development, Indonesia already recognizes that it must manage its internal consumption of hydrocarbons by replacement with coal. One scenario might be an expansion of coal production from recent (1978) levels of about 265,000 tonnes to perhaps 60 million tonnes per year by the year 2000. This is expansion at a yearly sustained rate of about 30%, a rate that for any nation can only be a target rather than an expectation.

Thus, the economic planner will see coal mining projects in terms of the large demand it will make on foreign exchange. He will also see foreign exchange availability in terms of the degree to which hydrocarbon production can be expanded and exports sustained. Foreign exchange availability is likely to be tight, and he should scrutinize coal mining projects in terms of foreign exchange demand.

The economic planner will have another interest in the ability of the nation to provide skilled personnel to save expatriate salaries in the management, supervision, and operation of new coal mining projects. He will be interested, too, in the prospects that the nation's lesser skilled work force could replace foreign capital needs and thereby firm-up the foundation for economic development.

TABLE 1

RELATIVE DEVELOPMENT OF INDONESIA'S
OIL, NATURAL GAS, AND COAL RESOURCES

ITEM	Oil	Natural Gas	Coal
Range of Reserves	15-25 Billion barrels	34-122 Trillion Std. Cu. Ft.	15 Billion Tonnes +
Calorific Value	5,600,000 Btu/barrel	1,000 Btu/SCF	11,000 BTu/lb.
Energy Equivalent in TCE (Millions)(2)	3,000-5,000	1,200-4,400	13,000+
Lifetime of Reserves,(1) yrs.	26-43	13-46	140+
Production in 1978	595 million barrels	820 billion Std. cu. ft.	265,000 tonnes
Energy Equivalent of Production in TCE	120,000,000	29,500,000	230,000

(1) Assuming a year 2003 level of production which is based on a 6.5% annual growth rate from the present for Gross Domestic Product and a strategy that maximizes oil exports through development of all alternative sources for domestic energy consumption.

(2) One TCE is 27,770,000 Btu/metric ton

2.3 Financial and Economic Appraisal

Financial and economic appraisal are the techniques usually employed in evaluation and analysis. The financial appraisal is the primary tool of the private investor and is likely to be the more familiar, while the economic appraisal is the primary tool of the economic planner. Financial and economic appraisal involve the same calculation techniques: for example, a series of cash flows over time that are discounted back to a net present value; and the same life cycle, or evaluation period, for the investment may be selected for both types. The two types of appraisals differ with respect to the make-up of the cash flows.

In financial appraisal, the costs incurred and the prices paid for all factors entering into the production of, say, coal are those actually incurred and paid in financial terms. The wages of labor are those actually paid to the workers. Import duties and taxes are pertinent financial costs. Market prices, say at mine mouth, are used to calculate sales revenues. Published, or official, exchange rates relate foreign exchange revenues and expenses to local currencies. Such revenues and costs, as well as local currency sales revenues, are reality to the private investor.

In economic appraisal, some of the input and output values may be the same as in financial appraisal. Other values, however, may need to be changed, or even deleted. In some instances, values not considered at all in financial appraisal may need to be introduced.

One illustration of a different value is wage costs. In most countries, there is a legally supported minimum wage which the investor accepts in assessing the cost of labor. To the investor, labor may appear so expensive that he looks for a technology that uses equipment rather than workers. The cost of labor to a developing nation, which is what is relevant to economic appraisal, is typically below the minimum wage. To the nation, the cost of allocating labor to one project, say a coal mine, is the value of present production that must be sacrificed as workers are shifted into mining. If these workers are now generally unemployed, this "opportunity" cost of such labor to the nation could approach zero; the near zero cost is the "shadow" wage of labor that is used in economic appraisal.

Foreign exchange rates are another example of prices that may need to be different in economic appraisal. Financial appraisal uses official, or market, exchange rates. When foreign exchange is tight in supply and the nation faces a deficit in the balance of payments, the official rate overvalues the national currency. This official rate discourages exports and encourages imports--it makes imported goods look cheap. Thus, the investor sees a technology that uses labor-saving imported equipment as financially attractive. From a national standpoint imported equipment is expensive and a technology that relies upon such equipment should be avoided. Thus, a more realistic foreign exchange rate should be used in pricing imported equipment.

Some costs can be deleted in economic appraisal. Taxes paid on company gross profit are a cost from the standpoint of the investor. From a national standpoint such a tax is merely an internal transfer of funds from one party to another; national resources are not diverted and there is no national cost. Payment of import duties is another example.

An illustration of a new cost to be considered is the effect when pollutants are discharged from a mining operation. The pollution that is caused may not be considered as a cost in the financial appraisal, but the cost of cleanup is a cost in the economic appraisal. If the mining operation incorporates equipment to control the emission of pollutants, then costs associated are costs in financial appraisal; and, if pollution emissions are thereby completed controlled, no new costs may be incurred for purposes of economic appraisal.

3.0 ALTERNATIVE COAL MINING PROJECTS

For the purpose of illustration, alternative coal mining projects are considered to differ only in the extraction technology employed. Any given coal mining technology utilizes a blend of capital equipment and labor skills at varying levels to operate it. Hence, the choice of a technology can be sensitive to the relative intensity of capital-equipment/ labor utilization. The installation of capital equipment is usually paid for in foreign exchange at one time by the invested capital, and the utilization of labor which is a recurrent cost is usually paid for in local currency. Thus, one can readily observe that the choice of a technology by the private investor for an attractive result in financial appraisal need not be the same as the choice by the economic planner for an attractive result in economic appraisal. Thus, what better way to illustrate potential conflict in choice than by selecting a number of feasible coal mining technologies, establishing a mining project based on each, and subjecting each project to financial appraisal in the context of the private investor and to economic appraisal in the context of the economic planner?

Four technologies for underground coal mining were selected, a coal mining project was identified for each technology, and the cost factors for appraisal were estimated. The details are described in Appendix A. Two technologies are labor intensive; and two, capital intensive. Two involve room and pillar mining; and two, longwall mining. Each project is capable of producing 480,000 tonnes per year of run-of-mine coal delivered to mine mouth. Recoveries are the same in all cases. The factors of production are uniform and thus are comparable from one case to another. The data are presented in Appendix A as a set of 21 Tables. One U.S. dollar is taken as equivalent to 1,000 rupiahs; this is the assumed market rate of exchange.

A summary of the data contained in Appendix A appears in Tables 2, 3, and 4. Table 2 summarizes the capital investment requirement in foreign and local currency for each of the four technology options; and shows, also, the distribution of this investment (i.e., the timing for it) over the 25-year life of the coal deposit. Table 3 summarizes the potential for each

TABLE 2

SUMMARY OF ALTERNATIVE CAPITAL INVESTMENT
(Millions of Dollars Equivalent)

	Imported				Local			
	A	B	C	D	A	B	C	D
Initial Investment (Years 1-3	4.84	4.66	12.79	8.27	5.68	3.09	5.86	3.11
Future Investment								
8	1.65	0.35	--	0.24	0.16	--	--	--
9	--	--	1.05	--	--	--	0.14	--
13	2.07	2.99	--	6.87	0.16	0.06	--	0.16
15	--	--	10.03	--	--	--	0.34	--
18	1.89	0.47	--	0.36	0.24	0.04	--	0.04
22	--	--	1.29	--	--	--	0.22	--
23	--	2.99	--	6.87	--	0.06	--	0.16
Undiscounted Total	10.45	11.46	25.16	22.61	6.24	3.25	6.56	3.47

Case A, Room and Pillar, Labor Intensive
Case B, Room and Pillar, Capital Intensive
Case C, Longwall, Labor Intensive
Case D, Longwall, Capital Intensive

TABLE 3

SUMMARY OF ALTERNATIVE LABOR EMPLOYMENT
(Number of Jobs)

ITEM	CASE A	CASE B	CASE C	CASE D
Underground				
Miners	2760	60	1896	38
Supervisors	138	6	60	4
Surface Support	36	15	36	18
Managerial				
Supervisory	12	8	12	7
Clerical	20	5	16	8
TOTAL	2966	94	2020	75

Case A, Room and Pillar, Labor Intensive
Case B, Room and Pillar, Capital Intensive
Case C, Longwall, Labor Intensive
Case D, Longwall, Capital Intensive

TABLE 4

SUMMARY OF FOURTH-YEAR AND BEYOND ANNUAL PRODUCTION COSTS*
(Million Rupiahs)

ITEM	CASE A	CASE B	CASE C	CASE D
Source-Table	A-6	A-11	A-16	A-21
Variable Costs				
Labor	5135.1	329.3	3471.1	257.4
Supervision	112.0	194.0	107.2	201.9
Operating Supplies	228.8	501.0	290.9	242.4
Power	763.0	420.4	253.4	283.8
Indirect Costs	639.8	135.5	457.5	89.4
Fixed Costs				
Depreciation	824.0	577.0	1340.0	939.0
Taxes/Insurance	210.3	154.6	373.0	227.4
TOTAL	7913.0	2311.8	6292.1	2241.3
Per MT., rupiahs	16485	4816	13109	4669
$	16.49	4.82	13.11	4.67

Case A, Room and Pillar, Labor Intensive
Case B, Room and Pillar, Capital Intensive
Case C, Longwall, Labor Intensive
Case D, Longwall, Capital Intensive

*At market prices as seen by investor.

technology to generate long-term employment opportunities. Table 4 summarizes the stabilized annual production cost of coal for each technology option, i.e., the production costs expected during the fourth year of mine operation and annually afterward.

Some exploratory and qualitative observations at this time on the summary tables are warranted.

- The imported capital needs (Table 2) for the capital-intensive cases (B and D) are not dramatically higher than those for the labor-intensive cases (A and C). In fact, the capital requirement for case B is only slightly higher than for case A; while for case D, it is actually lower than for case C.

- Employment (Table 3) in the labor-intensive cases A and C is markedly higher than for the capital intensive cases B and D.

- The unit production costs, measured within the investor's context, (Table 4), are markedly lower for the capital intensive cases B and D.

How these observations can affect choice, and whether or not the choices by the private investor and economic planner will be identical, depends on the cash flows generated over a selected time period. Financial and economic appraisal, along the lines discussed above, are needed beforehand. Accordingly, further comment on the results in the Tables 2, 3, 4 should be deferred.

4.0 APPRAISALS AND RESULTS

Each coal mining project was evaluated, first by financial appraisal and then by economic appraisal. The financial appraisal was done first, since the data inputs are needed for use again in the economic appraisal, except in modified forms through the application of shadow factors to selected inputs.

Both appraisals were performed under common conditions and the details are contained in Appendix B. The common conditions were the following:

- The total time covered by the cash flows in 25 years, the presumed life of the coal deposit.

- An internal rate of return is calculated for each project under each type of appraisal, equal to that discount rate for which the present value of all annual flows over the life of the project adds up to zero.

- The U.S. dollar and the rupiah are kept constant in purchasing power. Thus, the general price level, measured by these currencies, does not change over time. This assumption was made because the objective here is primarily to illustrate the workings of a methodology. Producing results for any real situation is an ultimate goal, but outside the scope of this paper.

- For economic appraisal purposes, the shadow factor on wages is taken as 0, and the shadow factor on foreign exchange 5. These selections are intended to be baseline, and to be subjected below to sensitivity analysis.

Table 5 contains the results of the appraisals. The detailed calculations are presented in Appendix B as Tables B-1 through B-4 for the financial appraisals and B-5 through B-8 for the economic appraisals.

Inspection of Table 5 shows that, under the assumptions made for purposes of appraisal and illustration, the private investor should find Case B, the room and pillar, capital-intensive technology, the most attractive with an internal rate of return of 49.0%.

Since the financial internal rates of return in Table 5 are independent of the effects of inflation, any future inflationary effects will tend to raise these rates.

One should observe that Case B carries a higher financial internal rate of return than Case D, even though the average cost per ton as shown in Table 4 for Case B (4816 rupiahs) is slightly higher than for Case D (4669 rupiahs). This difference in ranking may be explained by differences in the timing of investments; in general, Case B's investment outlays occur somewhat later than the outlays needed for Case D.

In the absence of action by government to encourage the investor to choose a different technology, it would appear that his choice will be Case B. If the illustrative numbers are taken to be realistic, and if taxes are not unduly high, the investor can regard Case B as feasible and can plan to implement the investment.

In order to illustrate the potential of conflict between the results of the financial appraisal and those of the economic appraisal, we have chosen shadow factors sufficiently powerful to produce a set of economic rates of return, shown in Table 5, which indicate the national desirability of adopting a labor intensive technology. A shadow factor of 0 was chosen for labor, a factor that is appropriate if the workers would otherwise be unemployed, i.e., mobilizing workers for the project does not reduce the aggregate output of labor elsewhere in the national economy. A foreign exchange shadow factor of 5 was arbitrarily selected (meaning that the real value of the national currency is only one-fifth that indicated by the official exchange rate); the foreign exchange factor operates to multiply both the cost of imported equipment and the value of coal, as a function of the international value of fuel oil.

Using these shadows, the national economic rate of return produced in labor-intensive Case A (89.2%) is shown to be higher than the rate available in capital-intensive Case B (72.8%). Cases C and D are in third and fourth positions in both the financial and the economic appraisals.

Thus, a conflict in technology choice exists, and this because the contexts for evaluation by the investor and by the economic planner have been different, specifically in perceptions of costs of labor and of foreign

TABLE 5

ALTERNATIVE INTERNAL RATES OF RETURN

Case	Financial Appraisal %	Economic Appraisal (1) %
A (RPLI)	6.2	89.2
B (RPCI)	49.0	72.8
C (LWLI)	13.5	51.7
D (LWCI)	37.8	50.0

(1) Based on shadow factors, for wages = 0

for foreign exchange = 5

exchange. It should be of interest to explore the sensitivity of the existence of such a conflict to the particular shadow factors adopted by the economic planner for purposes of economic appraisal.

The sensitivity of national economic rates of return to the range of shadows between 1 and 0 (wage shadow factors) and 1 and 5 (foreign exchange shadow factors) is indicated in Figures 1, 2, and 3. The sensitivity of national economic rates of return to the shadow wage of unskilled workers is shown in Figure 1. In this figure, the wage shadow factor along the horizontal axis varies from 1 (the same as the market wage) down to zero (the factor assumed for the national economic appraisal). The national economic rate of return is measured along the vertical axis. The foreign exchange shadow factor of 5 is held as a constant in preparing the chart. Thus the rates of return shown at the right edge of the figure are the same as those in Table 5.

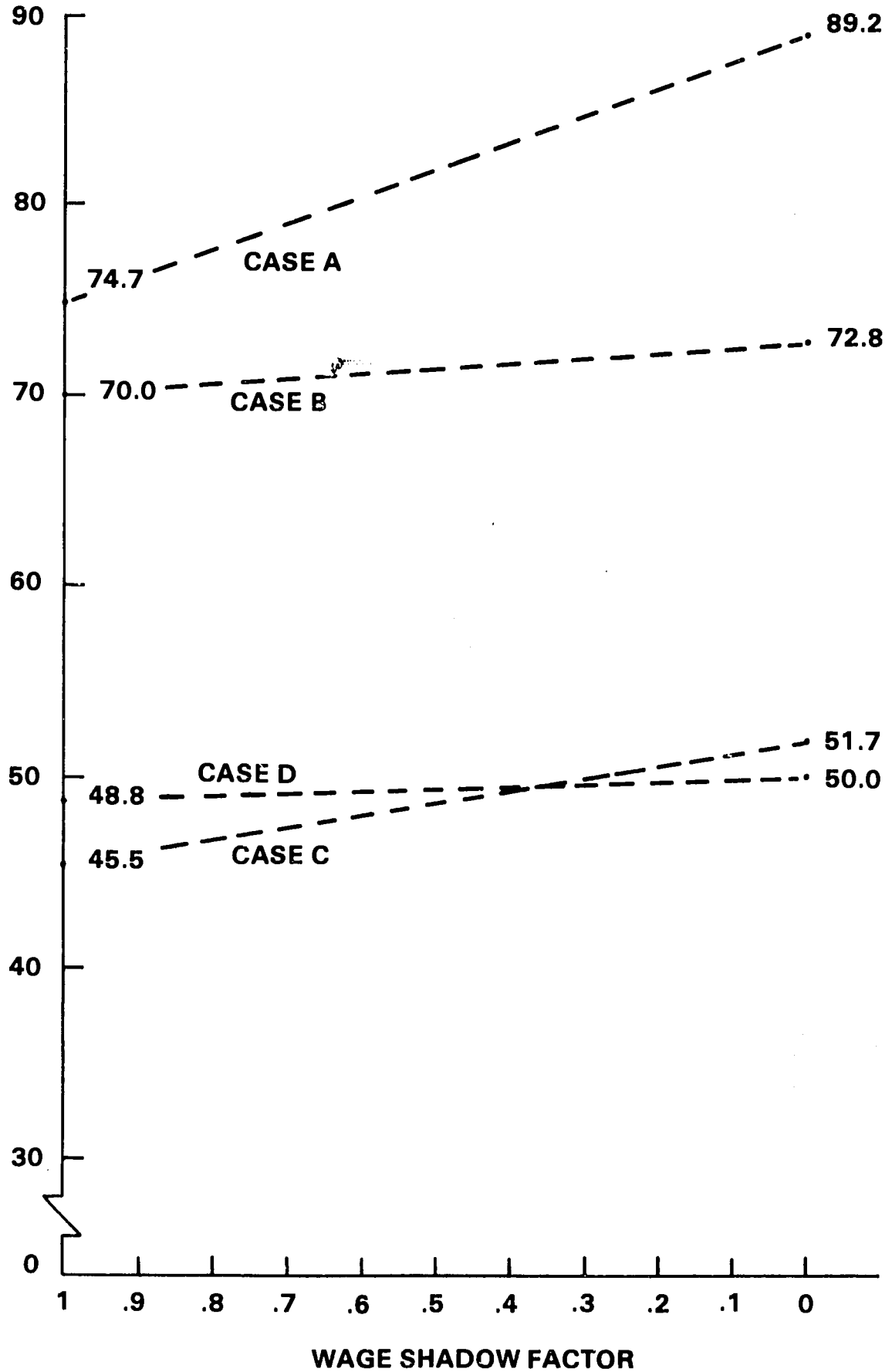
The relatively flat slopes of the curves in the chart indicate that the four technologies are not particularly sensitive to the size of the wage shadow. Case A is the most sensitive because it makes the greatest use of unskilled labor. Case C, the other labor-intensive case, is slightly sensitive while cases B and D show virtually no response to changes in shadow wages.

It is also obvious from the chart that variations in shadow wages do not affect the ranking of the cases within the range of values from 0.3 to 1.0. Within the range of 0 to 0.3, the ranking changes and Case C, which is a labor-intensive longwall operation becomes more attractive than Case D, the capital intensive longwall operation. The very low range of opportunity costs for labor here, has made the labor-intensive technology option more attractive. Note again, that in all of these observations, the shadow value of foreign exchange is constant and shows foreign exchange overvalued by a factor of five.

Figure 2 is a comparable chart that shows the sensitivity of national rates of return to various levels of shadow foreign exchange rates. The wage shadow factor is held at zero. At the extreme left, the shadow factor of 1 indicates the official rates of exchange are left undisturbed; the right hand edge utilizes the factor of 5, the same as that assumed for illustrative economic appraisal. Cases B and D are relatively less sensitive because imported equipment is an important cost element that moves directly with gross benefits (revenues) which are fully responsive to the foreign exchange factor. Cases A and C are more sensitive because they make less use of imported equipment. Case A is remarkable because its extreme sensitivity places it in the nationally preferred position if the foreign exchange factor is above 3, but its ranking is reduced to second position if the factor is less than 3. In the use of longwall technology, a similar reversal of emphasis occurs, except that the crossover occurs at a foreign exchange shadow of about 4.2. Above this crossover, the labor-intensive longwall version is nationally more attractive.

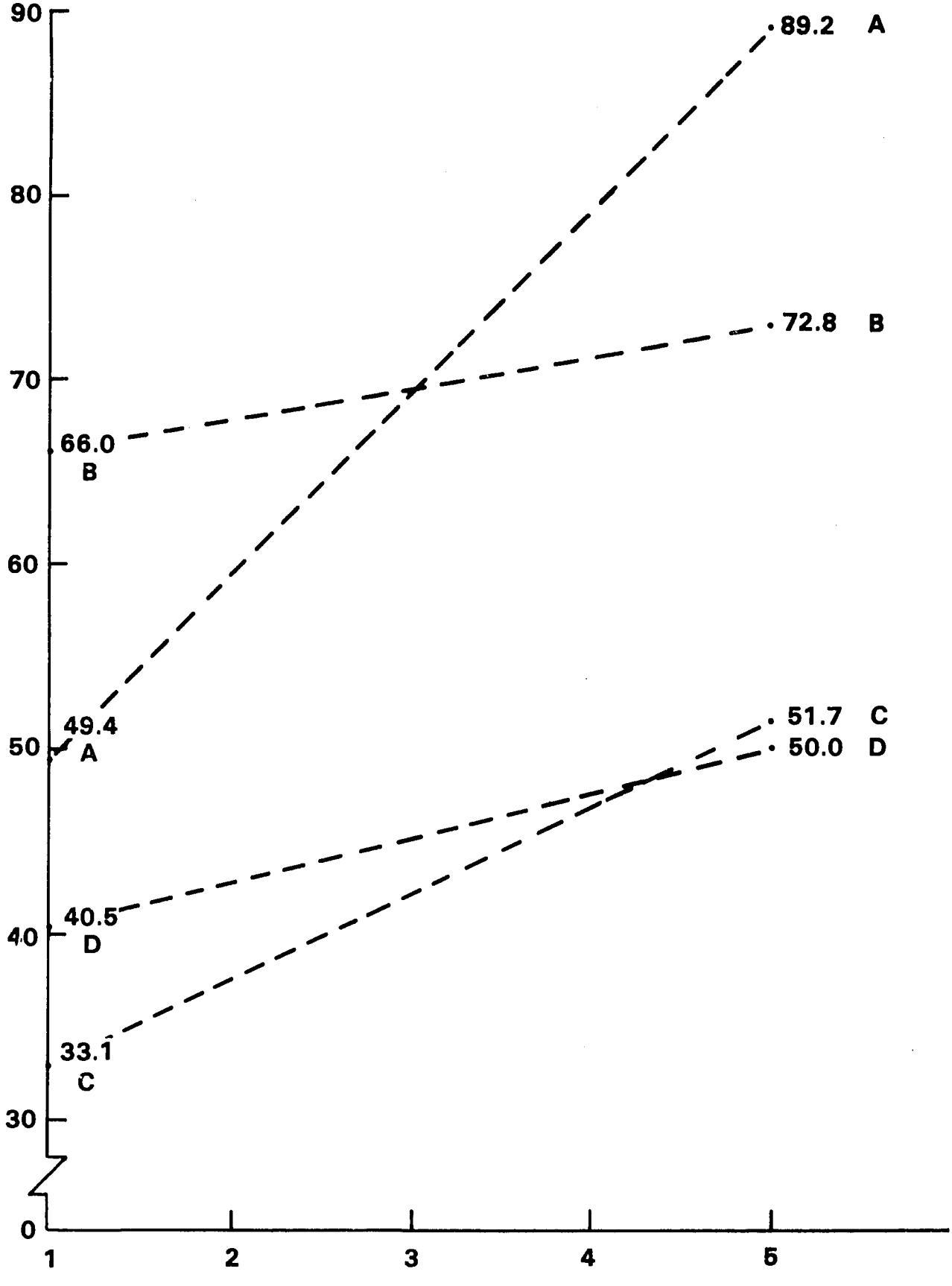
Figure 3 is an indicative chart that attempts to picture the relative rankings of the alternative coal mining projects as both shadows, labor and foreign exchange vary simultaneously. The left-hand set of values (wage shadow and foreign exchange shadow both unity) represent the identical context for the investor and economic planner, and the internal rates of return and rankings

FIGURE 1
SENSITIVITY TO CHANGES IN WAGE SHADOW FACTOR*



*FOREIGN EXCHANGE SHADOW IS CONSTANT 5

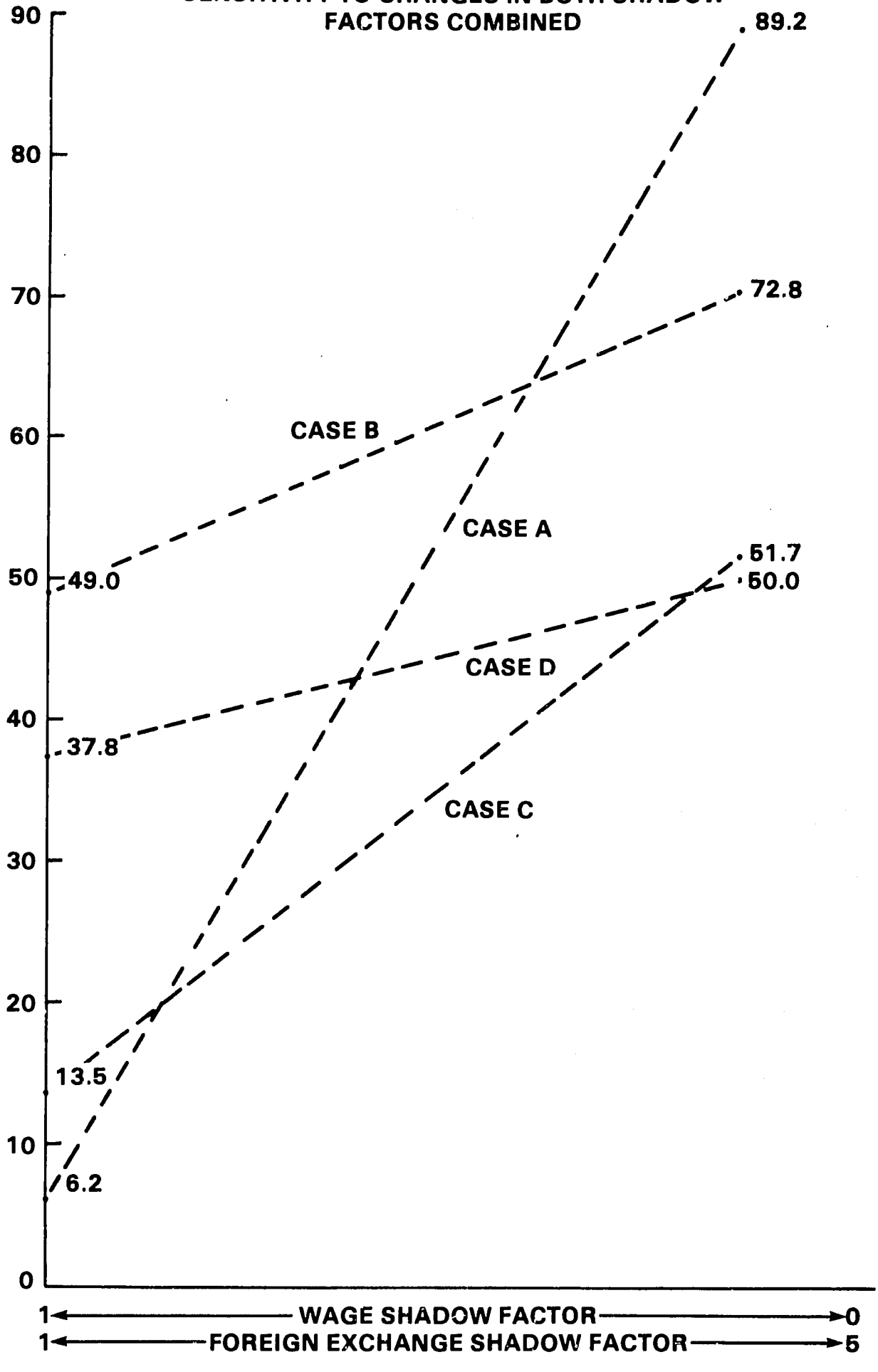
FIGURE 2
SENSITIVITY TO CHANGES IN FOREIGN EXCHANGE SHADOW FACTOR*



FOREIGN EXCHANGE SHADOW FACTOR

*WAGE SHADOW FACTOR IS CONSTANT 0

FIGURE 3
SENSITIVITY TO CHANGES IN BOTH SHADOW FACTORS COMBINED



of alternative coal mining projects correspond to the results of financial appraisal in Table 5. The right-hand set of values represent a drastic divergence of contexts (wage shadow of zero and a foreign exchange shadow of five) and correspond to those used in the illustrations and the calculations in Appendix B. The combinations of factors in between show quantitatively how rankings of alternative projects can change as changes are made in the two shadow prices.

5.0 CONTEXTS AND HARMONIZATION

Returning to the illustrative appraisals, the investor prefers Case B, the capital-intensive room and pillar technology, while a government would prefer case A, the labor-intensive room and pillar technology. Case B of the four offers the investor the highest internal rate of return, and is thus financially the most attractive to him. Case A offers the nation the highest rate of return of the four and is thus economically most attractive to it. As already noted, the four coal mining projects appraised differ only in the coal extraction technology. Plainly, a conflict exists between the choices made by the private investor and by the economic planner. The origin of the conflict lies in the different contexts used for evaluation of the alternative coal mining projects. Such conflicts must be resolved, if coal development is to proceed in a harmonious fashion, i.e., in a fashion that satisfies both the private investor and the national interests concerned.

The resolution obviously must involve inducing the investor to choose Case A on the basis that it, rather than Case B, is the option that offers the highest internal rate of return financially. Thus, the government must provide the appropriate fiscal incentives. Several methods for providing them are available and may be considered.

Direct inducements may be provided in the form of subsidies that reduce the cost to the investor of Case A compared to Case B. One plausible subsidy would be a series of payments in proportion to a mine's use of unskilled labor. A less direct subsidy would be the provision of housing and infrastructure for acceptable labor-intensive projects, if the investor sees himself as having to provide such facilities. Such subsidies would allow lower labor-related costs to mining companies.

Such inducements carry the weakness, however, that they require cash outlays by government. Thus, they are politically vulnerable and the business community is likely not to see them as reliable in the long term.

A more workable range of incentives may be those that provide tax remissions to labor-intensive projects, or levy particular taxes on capital-intensive projects.

Tax remissions could take the form of reduced depletion royalties or reduced income taxes. Tax penalties to be levied on capital-intensive projects could take the form of surtaxes on depletion royalties, or on company income taxes.

A not unusual and particularly workable device may be the placement of prohibitively high import duties on equipment that is unique to capital-intensive coal mining operations.

Many other effective instruments can be designed, but in all cases their effect is to induce, not coerce, the investor to find that the technology choice most attractive to the nation is also the most attractive financially to the investor. The discussion above represents suggestions. Obviously, the actual devices that may be used to harmonize the separate views of private investors and economic planners will be subjective to the government officials in different countries who are aware of specific local conditions that can influence policy.

The essential problem remains, however: educating decision-makers in the private and public sectors to the need for separate national economic appraisals of alternative technologies, then generating the will to resolve conflicts in favor of net national benefit. The data that an economic appraisal can provide will show the extent to which a subsidy should be granted to assure the use of the nationally attractive technology. In the illustration in this paper, the national economy stands to benefit from an increase in the national rate of return from 72.8% to 89.2%.

6.0 AN EVALUATION AND ANALYSIS SCENARIO

The illustration thus far demonstrates first, that technology choice can be an important factor to satisfy private and national interest simultaneously in the development of a nation's indigenous coal resources, and second, that harmonious development of a coal resource in a developing country is, nevertheless, possible. The private investor can choose and be satisfied with a mining technology that coincides with the one that a government would choose to serve the national interest. The government also may need to extend its support to areas where the private investor normally would not be responsible, i.e., to areas of infrastructure development such as townsites and housing, schooling, and health and safety measures. The coal development that results can be directed to reduce internal consumption of petroleum products, and, in the case of Indonesia, enlarge the exports of petroleum to support foreign exchange needs. The key is the performance and implementation of compatible financial and economic appraisals of alternative coal mining projects employing evident and practical extraction technology options.

The illustration thus far also has simplified the real world in order to show how the methodology described can produce the desired results. The country and the circumstances in the illustration are relevant and the coal seam considered for technology choice can exist somewhere. The mining plans described are exploratory in nature. For a real situation, the identification of mining plans deserves more work and detail.

The scope for further application of the methodology is not limited to the specific situation employed for illustration. Here are some examples of potential applications.

- Underground vs. Open-pit Mining. The key parameter is likely to be the stripping ratio of overburden removed to coal extracted. The break-even stripping ratio is one for which production costs of mined coal are the same regardless of whether open-pit or underground mining is employed. Its precise value can depend further on the technology options considered for open-pit mining and those considered for underground mining. Determinations of break-even stripping ratios can differ for a given situation, depending on whether the projects are appraised financially or appraised economically.
- Alternative Open-Pit Mining Projects. The key parameter is likely to be the size/capacity scale of the equipment employed in overburden removal and coal excavation, ranging from ultra-large imported dragline or bucket-wheel-excavator equipment to many small front-end loader-truck hand equipment combinations which may be largely locally manufactured. Financial appraisal might lead an investor to choose the large imported equipment, while economic appraisal might lead an economic planner to choose the smaller locally-manufactured equipment.

- Single-Large Capacity Mine vs. Many Small-Capacity Decentralized Mines. When coal markets are decentralized, such as the markets for smokeless fuel briquets in the rural areas, and suitable small coal deposits are available, the choice could involve comparison of the results from financial and economic appraisal of alternative centralized and decentralized mining projects. The scope of the comparison could involve costs beyond those for coal mining alone, such as small vs. large scale carbonizing costs and incremental surface transport of briquets to the markets.

A scenario for a harmonious development of a nation's coal resource, when there exists opportunity for private investment, national desires and policies relevant for coal development, and options for choice could run about as below.

6.1 Delineate the Coal Resource.

The investor should expect to have available to him an adequate description of the coal field, as public information. Producing such information is usually in the province of a national geological survey. Ideally, and this may not always be the case, the private investor should have the following available in a convenient publication, with access to supporting data and with opportunity to inspect drill cores.

- Delineation of the geographic limits of a coal field in terms of known presence of coal seams, extractable with conventional mining technologies;

- Definition of the coal strata of potential interest in terms of adequate seam thickness and manageable depths;

- Assessment of the reserves in the various categories for the delineated coal field;

- Description of the physical and chemical properties of the coal and the variability across seams and locations; and

- Indications of the areas of most potential in terms of development drilling to prove reserves.

6.2 Delineate the Coal Reserve

Depending upon the information publicly available, and exploration license requirements, the investor may undertake the development drilling at his own expense to prove reserves to his satisfaction. His intent at this point would most likely be to justify, from preliminary reserve indications, an in-depth study and evaluation of a mining project including the identification of viable mining technology options. This study would comprise a choice of a technology, based on his experiences and industry practices, and a detailed financial analysis for the project. With positive results, he would identify his financing plan and be prepared to implement, beginning with an initial investment to confirm proven reserves for the project life. At this point, he could be prepared to seek a mining license.

6.3 Investor/Economic-Planner Dialogue

On the investor side and depending upon the particular national policies in effect regarding natural resource development, the potential investor could anticipate and ease licensing problems by considering at alternative technologies for coal extraction and making the basic input data available to the appropriate government agencies along the lines shown for the illustration in this paper. At this stage, he would have become aware of his needs for infrastructure development, and would be interested in these needs being fulfilled from the public sector.

On the economic-planner side, the planner may have already evaluated and analyzed the development path for the nation's coal resource and be readily aware of the characteristics of desirable coal mining projects. Given the financial inputs from the investor, and the economic context for the nation concerned, he could perform economic appraisals for the alternative coal mining projects. The results should enable an agreement on the technology, if one is needed, and the assurance of full government support for the investor's project. The choice of shadow factors for the foreign exchange rate and for the wages for the economic appraisals is likely to be involved and require a consensus among various governmental circles. Performing sensitivity analyses could be an effective method for achieving consensus.

6.4 The Appropriate Role for Labor

We should not close without a word about the appropriate role for labor in coal mining. Coal mining, particularly underground, is hardly a pleasant job. It is unhealthy and hazardous. From a human welfare point of view, the less people underground the better. The costs of adequate ventilation and safety underground should, nevertheless, be welcome additions to the

accounts. When the national economic interest dictates that maximum employment generation is desirable and wanted, people attracted because of need for income should perceive the employment as the beginning of a career. The opportunity for advancement should be in upgrading skills, introducing machines, and reducing below ground personnel needs.

Maintaining such a policy in coal industry development means that initial decisions to undertake labor-intensive coal mining address immediate problems --the need to provide an alternative energy source to petroleum and at the same time monitor foreign exchange demand or generate new employment, for example. As these problems are solved, shadow factors will change. Hence, the nation's choice of mining technology will change, in effect, the opportunity cost of labor will increase, and foreign exchange balances will improve. After all, these shadow factor changes are what economic development and economic appraisal, are all about. Evaluation and analysis must, therefore, be a dynamic process--not a snapshot.

APPENDIX A

UNDERGROUND COAL MINING PROJECTS: TECHNOLOGY OPTIONS, CAPITAL INVESTMENT, AND PRODUCTION COSTS

1. DESCRIPTION OF TECHNOLOGY OPTIONS

In this appendix, four technology options are identified and applied as alternative cases of underground coal mining projects for evaluation and analysis. These are:

Case A, Labor intensive, room and pillar
Case B, Capital intensive, room and pillar
Case C, Labor intensive, longwall
Case D, Capital intensive, longwall

In applying these four technologies, certain characteristics are held constant to enable evaluation as a valid comparison of the results of financial and economic appraisals. These characteristics are:

- Seam conditions. The seam is taken from a deposit in a developing country. Sufficient information is known to suggest it could be developed by any of the four underground mining technologies. Seam thickness is 1.8 meters (about 6 feet) lying at an average of 100 meters (350 feet) deep. The seam is essentially horizontal and contains a sub-bituminous coal.

- Mine Development. All four technologies would have the same general mine development. That is, access to the seam occurs through 12° slope entries (about 500 meters (1700 feet) long). In-seam development includes a 3-entry main heading going north and south from the slope entries, and 2-entry production headings in an east-west direction, driven to the edge of the coal seam. In-seam development is completed by driving double entries (bleeder entries) along the coal seam boundary to connect the panels and provide ventilation connections.

  The capital-intensive technologies (Cases B and D) require only two entries, as shown in Figure A-1. The labor-intensive technologies (Cases A and C) require four entries, as shown on Figure A-2. These provide the entire facilities, working places and ventilation needs, for the large number of miners required by labor-intensive technologies.

- Coal production. Each technology case produces 480,000 metric tons of coal per year. In labor-intensive operations, three shifts per day with many work places are required. In capital intensive operations, the conventional two shifts are required.

- Coal reserves. For each technology case, reserves have been proven for a 25-year operating life.

FIGURE A-1
PLANNED MINE DEVELOPMENT
(CASES B AND D)

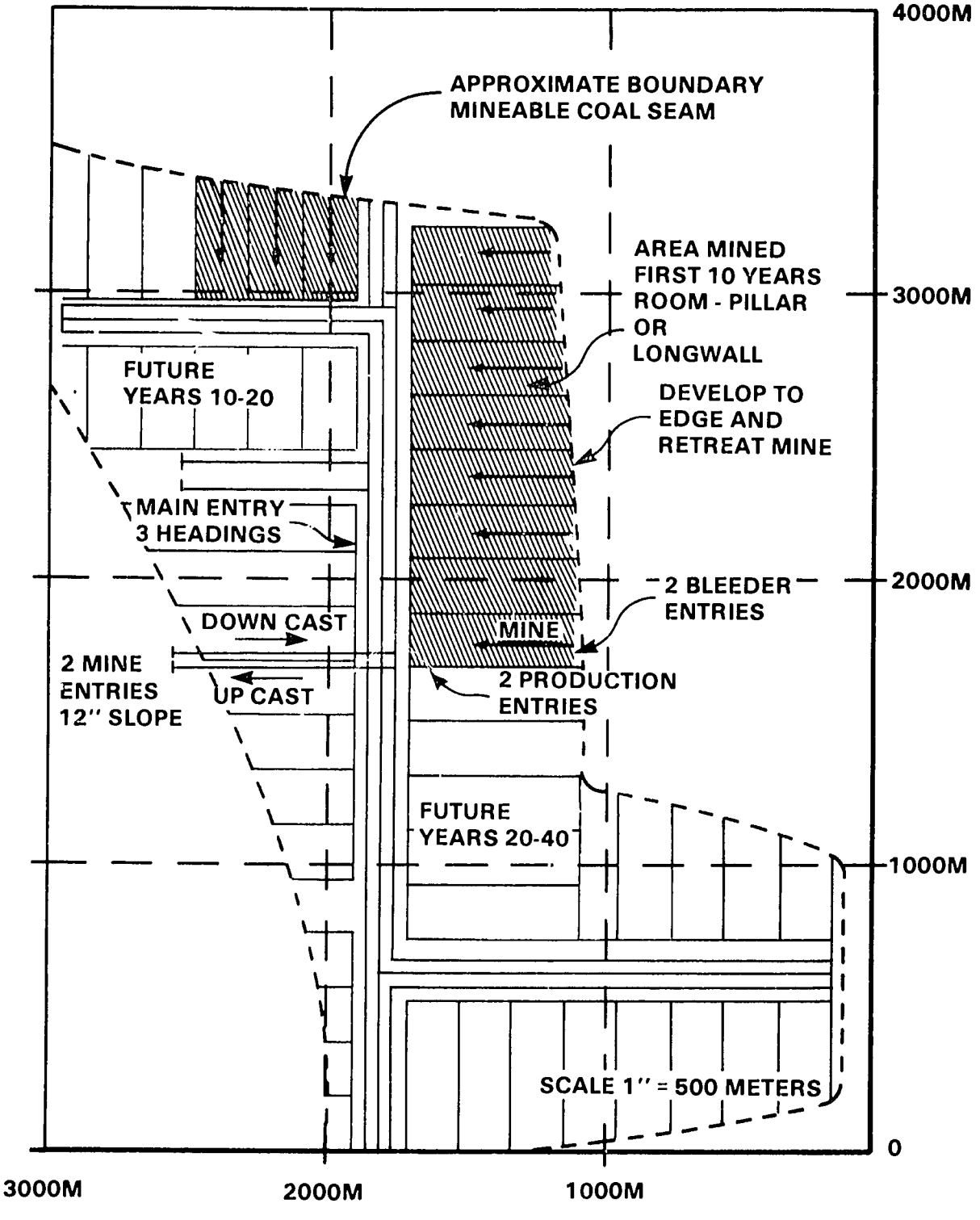
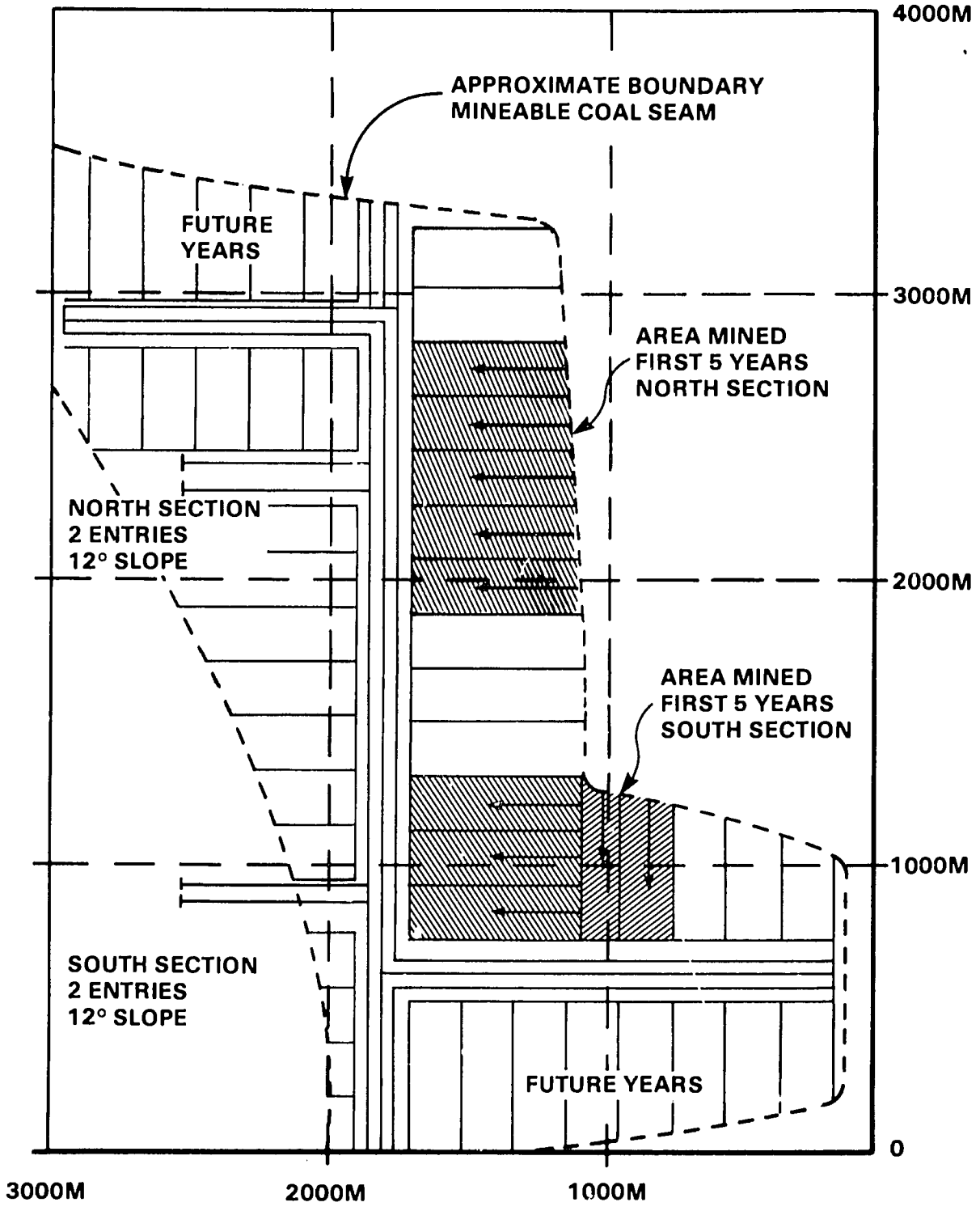


FIGURE A-2

PLANNED MINE DEVELOPMENT
(CASES A AND C)



25

- Coal recovery. For each technology case, the retreating concept of coal recovery is followed, and coal recovery is taken as 75% of the in-place reserves.

- Mine transportation. In each technology case, the coal production from the workplaces is removed from the mine on main line 24-inch conveyor belts up the entry slope to a stockpile at the surface.

- Health and safety. In all technology cases, miners' health and safety are considered of primary importance. Proper ventilation, roof supports, lighting, and other conditions are provided to meet this objective.

- Amenities. In all technology cases, the location is considered remote. Nevertheless, no housing, schools, and other infrastructure are provided.

Given such common conditions, the operations of the mines for each technology may be understood from the figures and descriptions that follow.

Case A - Labor Intensive, Room and Pillar

In this case, after the initial mine development, coal is produced by hand mining in a room and pillar system as indicated in Figure A-3.

The operation consists of a crew of 20 men in each of 46 operating sections. Coal is cut from the face with hand-held pavement breakers, then shoveled into 1-ton rail cars, which are hand pushed to the panel conveyor belt for removal from the mine.

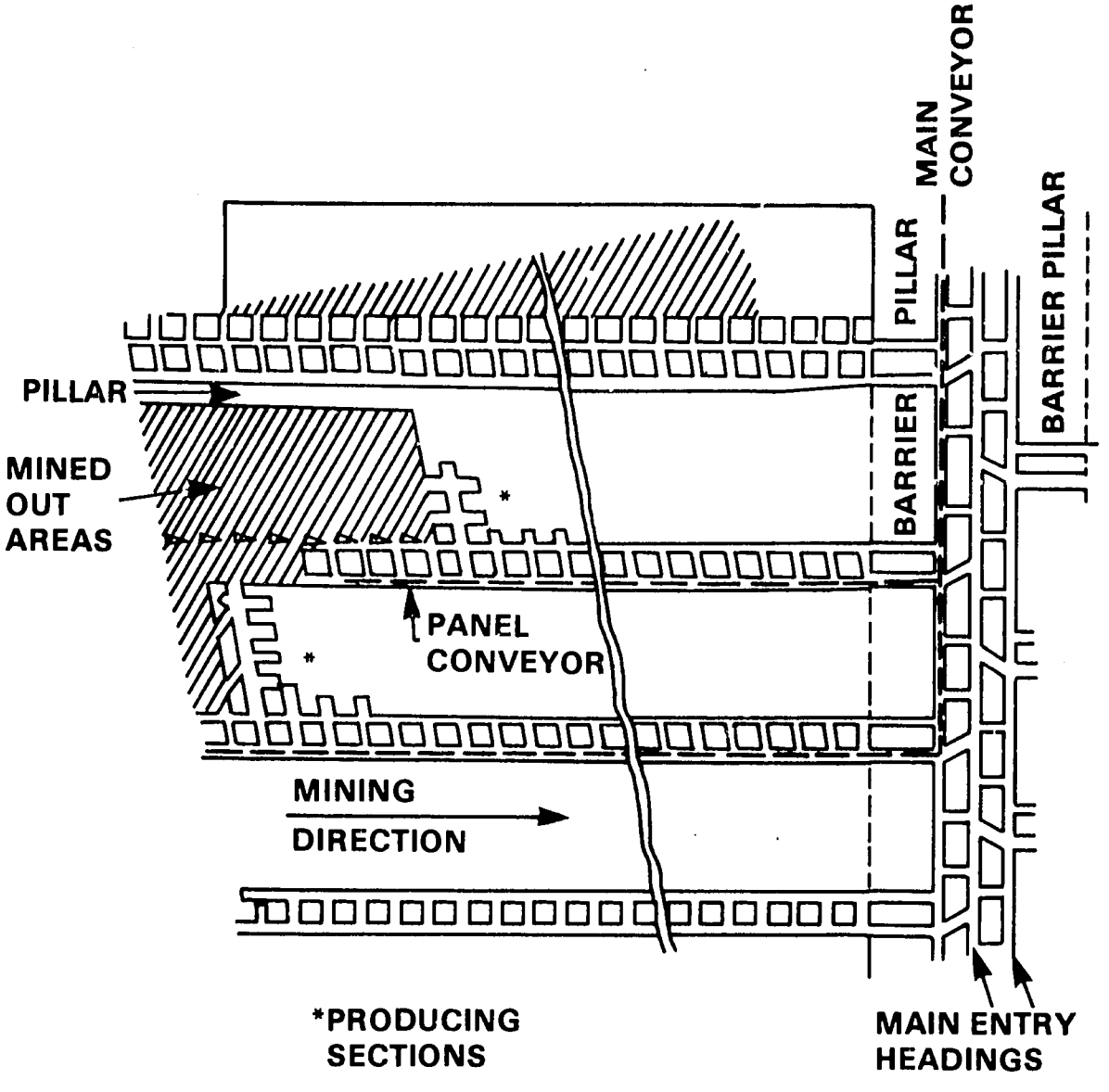
After the initial slope development, 20 sections operate for one year, driving mainline and production entries to provide operating areas for the final 46 sections needed. This mine produces 480,000 metric tons per year from the two-section mine shown in Figure A-2.

For this hand-operated mine, a productivity of 0.8 metric tons per man shift is believed to be realistic. Hence, each 20 man section produces 16 metric tons per shift. The mines operate three full shifts per day. Each section is producing from a 6 ft. high by 14 ft. wide face, which advances about 5 feet per shift.

Case B - Capital Intensive, Room and Pillar

After the initial slope development to reach the coal seam, a modern room and pillar mechanized system is used. This consists of a continuous mining machine digging the coal, with a loading machine putting coal on shuttle cars for delivery to the panel conveyor belt.

FIGURE A-3
ROOM AND PILLAR DEVELOPMENT



27

Referring to Figure A-3 again, the same development is carried out as in the Case A labor-intensive mining system, except that all coal digging and haulage is with mechanical equipment.

With this system, a section crew of 11 men produces 365 metric tons per shift and the mine is operated two shifts with three sections to produce the 480,000 metric tons per year of coal.

Case C - Labor Intensive, Longwall

After the initial mine development, coal is produced from a manual-operated longwall system as shown in Figure A-4. In this operation, conventional hydraulically-operated roof supports are installed and operated to assure the safety of miners. However, the coal would be hand-dug from the face with hand-held pneumatic breakers and hand-shoveled onto the face conveyor.

The development of the longwall panels would require some labor-intensive operations such as the hand-operated sections described above for labor-intensive room and pillar mining. Hence, in the first year of development, after the slopes are completed, eight regular hand-sections would operate three shifts to produce 84,000 metric tons of coal while developing the first two longwall panels.

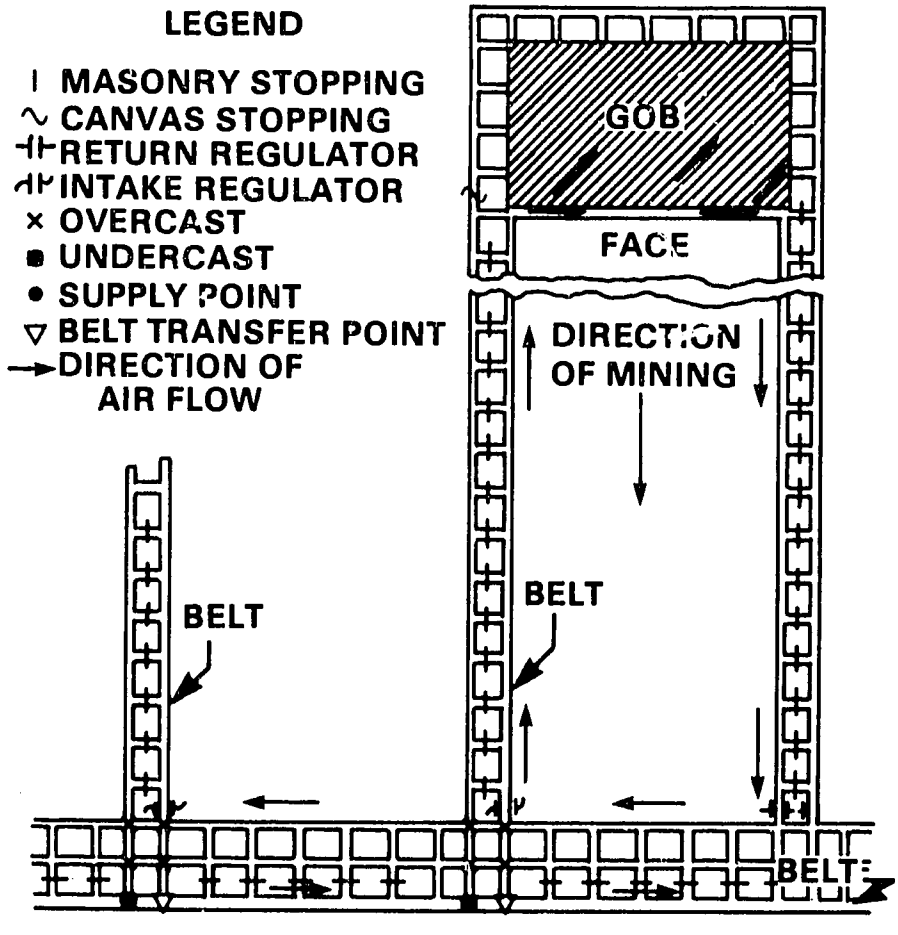
In the second and following years, sixteen regular hand sections and two longwalls would operate three shifts to produce 480,000 metric tons/yr.

At the longwall face, a crew of 166 would produce 249 metric tons/shift for an estimated productivity of 1.5 tons per man shift.

Case D - Capital Intensive, Longwall

Coal is produced from a fully mechanized longwall using hydraulic roof supports and a continuous cutting machine which cuts the coal and puts it on a face chain conveyor for delivery to the panel conveyor. The main conveyor system delivers the coal to the surface. At the face, the hydraulic props advance and support the roof as the cutter goes by. Back of the roof supports, the roof caves in a controlled manner and fills the space with packed waste, the "gob". This is also shown on Figure A-4.
This system requires the development of the longwall panels with the continuous miner, loader and shuttle car system described for the capital intensive room and pillar mine. The development for the first longwall panel is done in the first year, with one continuous miner section operating two shifts and producing 160,000 metric tons of coal. After that, longwall and continuous miner sections operate two shifts to produce the required 480,000 metric tons/yr.

FIGURE A-4
TYPICAL LONGWALL DEVELOPMENT



2. CAPITAL AND PRODUCTION COST ESTIMATES

In each of the four technology cases, capital investment and production cost estimates are needed as basic inputs to both financial and economic appraisal. Moreover, these estimates are needed on a comparable basis and in a context that permits the data to be both illustrative and pragmatic at the same time. Accordingly, the data are developed to be potentially illustrative of conditions in Indonesia. For this purpose, the rate of exchange of one US dollar is taken as 1,000 rupiahs.

Capital and production cost estimates are presented on the following pages for each mining technology on the basis of the mine plans and practices discussed above. The tables are organized as follows.

Capital Cost Estimate, Items Common to All Cases	Table A-1
Case A - Room and Pillar, Labor Intensive	Tables A-2 to A-6
Case B - Room and Pillar, Capital Intensive	Tables A-7 to A-11
Case C - Longwall, Labor Intensive	Tables A-12 to A-16
Case D - Longwall, Capital Intensive	Tables A-17 to A-21

Each group of tables contains for the particular mining technology, in order, the capital investment estimated, the depreciation basis, the schedule for investment over the life of the deposit, the manning table and annual payroll, and the annual production cost estimate.

A common basis is used for preparing all cost estimates, and this is the following:

- Common items. Cost for these items have been estimated using knowledge of the industry and cost for similar items, and escalating such costs to represent levels in late 1982.

- Equipment. Capital costs have been based on known equipping costs in 1979-1980, escalated to 1982 conditions.

- Exclusions. Capital costs do not include any cost estimates of town sites or other facilities for the employees. Costs encompass the extraction of the coal and placing it in a stockpile at the surface of the mine near the entrance.

- Operating costs. These have been based on presumed costs for local labor, power and supplies from local or imported sources. Consumption of supplies is based on experience with similar types of mines.

In comparing the investment schedule for Case C (Table A-12) and Case D (Table A-17), an allowance was made for a potentially longer life in Case C because the roof supports are moved less frequently and should therefore have a longer lifetime.

TABLE A-1
CAPITAL INVESTMENT

U.S. Dollars equivalent - Installed Cost

a. Items common to cases B and D (Capital Intensive)

ITEM	Imported	Local	Total	Years Life
Conveyor System	250,000	80,000	330,000	20
Surface Clearing and Roads	--	164,000	164,000	20
Shop-Warehouse-Change Room	--	291,000	291,000	20
Office and Laboratory	8,000	40,000	48,000	20
Slopes for Access	980,000	2,315,000	3,295,000	20
Ventilation and Accessories	122,000	40,000	162,000	15
Miscellaneous Supplies	150,000	--	150,000	10
Total	1,510,000	2,930,000	4,440,000	

b. Items common to cases A and C (Labor Intensive)

Conveyor System	500,000	160,000	660,000	20
Surface Clearing & Roads	--	164,000	164,000	20
Shop-Warehouse-Change Room	--	434,000	434,000	20
Office and Laboratory	11,000	57,000	68,000	20
Slopes for Access (4)	1,977,000	4,613,000	6,590,000	20
Ventilation and Accessories	243,000	81,000	324,000	15
Miscellaneous Supplies	300,000	--	300,000	10
Total	3,031,000	5,509,000	8,540,000	

TABLE A-2
CAPITAL INVESTMENT

U.S. Dollars equivalent - Installed Cost

Case A - Room and Pillar - Labor Intensive

ITEM	Imported	Local	Total	Years Life
Hand Held Drills	742,000	--	742,000	5
Compressor & Accessories	800,000	160,000	960,000	5
Rail and Cars	40,000	8,000	48,000	20
Hoses & Oilers, etc.	60,000	--	60,000	5
Roof Drills - Hand Held	44,000	--	44,000	5
Lamps & Safety	120,000	--	120,000	10
Common Items (Table A-1b)	3,031,000	5,509,000	8,540,000	-
Total	4,837,000	5,677,000*	10,514,000	

*Of this amount $3,974,000 is for labor during mine development of which $3,179,000 applies to unskilled labor.

TABLE A-3
DEPRECIATION BASIS

Equivalent U.S. Dollars

Case A - Room and Pillar - Labor Intensive

		Years (3 - 22)
5 Year Items -	$1,806,000	362,000
10 Year Items -	420,000	42,000
15 Year Items -	324,000	22,000
20 Year Items -	7,964,000	398,000
Total	10,514,000	824,000

TABLE A-4
INVESTMENT SCHEDULE

Case A - Room and Pillar - Labor Intensive
(Equivalent of US Dollars)

Year	Total	Imported	Local	Production M.T./Yr.
1	4,416,000	1,634,000	2,782,000	0
2	4,416,000	1,634,000	2,782,000	0
3	1,682,000	1,569,000	113,000	212,000
4	-	-	-	480,000
5	-	-	-	480,000
6	-	-	-	480,000
7	-	-	-	480,000
8	1,806,000	1,646,000	160,000	480,000
9	-	-	-	480,000
10	-	-	-	480,000
11	-	-	-	480,000
12	-	-	-	480,000
13	2,226,000	2,066,000	160,000	480,000
14	-	-	-	480,000
15	-	-	-	480,000
16	-	-	-	480,000
17	-	-	-	480,000
18	2,130,000	1,890,000	240,000	480,000
19	-	-	-	480,000
20	-	-	-	480,000
21	-	-	-	480,000
22	-	-	-	480,000
23	-	-	-	480,000
24	-	-	-	480,000
25	-	-	-	480,000

37

TABLE A-5
MANNING TABLE AND ANNUAL PAYROLL

Case A - Room and Pillar - Labor Intensive

	Number	Rupiahs/day	Payroll Rupiahs/yr (Millions)
Underground			
Hand Miners	2760	6000	3644.3
Foremen	138	8000	242.9
Surface			
Lampmen	12	4000	10.6
Belt Operators	12	4000	10.6
Equipment Maintenance	12	6000	15.8
Management			
Superintendent	1		9.6
Asst. Superintendent	1		8.0
General Foremen	6		43.2
Chief Engineer	1		7.2
Safety Director	1		7.2
Office Manager	2		12.8
Office Clerks	20		24.0
			4036.2

Total Employees 2966
Work Days/Yr. 220

TABLE A-6
ANNUAL PRODUCTION COST IN RUPIAHS (Millions)

Case A - Room and Pillar - Labor Intensive

Variable Costs	Year 3	Year 4 and Beyond
Labor		
Production	1733.2	3924.2
Supervision	49.4	112.0
Overhead	534.8	1210.9
Operating Supplies		
Drill Repair parts	17.7	40.0
Roof Bolts and Timber	65.8	148.8
Bits-Oil-Lubricants	17.7	40.0
Power	337.0	763.0
Indirect Costs	282.6	639.8
Fixed Costs		
Depreciation	824.0	824.0
Taxes and Insurance	210.3	210.3
Total Annual Cost	4072.5	7913.0
Coal Production - MT	212,000	480,000
Production Cost		
Rupiahs/MT	19209	16485
$/MT	19.21	16.49

TABLE A-7
CAPITAL INVESTMENT
Case B - Room and Pillar - Capital Intensive

U.S. Dollars equivalent - Installed Cost

ITEM	Imported	Local	Total	Years Life
Continuous Miners (3)	1,115,000	15,000	1,130,000	10
Loading Machines (3)	442,000	15,000	457,000	10
Shuttle Cars (6)	655,000	24,000	679,000	10
Roof Bolters (3)	297,000	8,000	305,000	10
Personnel & Supply Vehicles (9)	270,000	--	270,000	5
Power Centers (7)	292,000	98,000	390,000	20
Lamp and Safety Equipment	80,000	--	80,000	5
Common Items (Table A-1a)	1,510,000	2,930,000	4,440,000	-
Total	4,661,000	3,090,000*	7,751,000	

*Of this amount $2,163,000 is for labor during mine development of which $1,730,000 applies to unskilled labor.

TABLE A-8
DEPRECIATION BASIS

Equivalent U.S. Dollars

Case B - Room and Pillar - Capital Intensive

		Years (3 - 22)
5 Year Items -	$ 350,000	70,000
10 Year Items -	2,701,000	270,000
15 Year Items -	162,000	11,000
20 Year Items -	4,518,000	226,000
		577,000

TABLE A-9
INVESTMENT SCHEDULE

Case B - Room and Pillar - Capital Intensive
(Equivalent of US Dollars)

Year	Total	Imported	Local	Production M.T./Yr.
1	5,426,000	3,961,000	1,465,000	0
2	2,145,000	680,000	1,465,000	0
3	160,000	-	160,000	164,000
4	-	-	-	480,000
5	-	-	-	480,000
6	-	-	-	480,000
7	-	-	-	480,000
8	350,000	350,000	-	480,000
9	-	-	-	480,000
10	-	-	-	480,000
11	-	-	-	480,000
12	-	-	-	480,000
13	3,051,000	2,989,000	62,000	480,000
14	-	-	-	480,000
15	-	-	-	480,000
16	-	-	-	480,000
17	-	-	-	480,000
18	512,000	472,000	40,000	480,000
19	-	-	-	480,000
20	-	-	-	480,000
21	-	-	-	480,000
22	-	-	-	480,000
23	3,051,000	2,989,000	62,000	480,000
24	-	-	-	480,000
25	-	-	-	480,000

TABLE A-10
MANNING TABLE AND ANNUAL PAYROLL

Case B - Room and Pillar - Capital Intensive

	Number	Rupiahs/day	Payroll Rupiahs (Millions)
Underground			
Section Mines	60	12000	158.4
Foremen	6	16000	21.1
Surface			
Lampmen	2	4000	1.8
Belt Operators	4	4000	3.5
Equipment Maintenance	9	12000	23.8
Management			
Superintendent	1		28.8
Asst. Superintendent	1		24.0
General Foremen	2		48.0
Chief Engineer	1		24.0
Safety & Training Directors	2		48.0
Office Manager	1		8.0
Clerks	5		13.2
		Total	402.6

Total Employees 94
Work Days/Yr. 220

41

TABLE A-11
ANNUAL PRODUCTION COST IN RUPIAHS (Millions)

Case B - Room and Pillar - Capital Intensive

	Year 3	Year 4 and Beyond
Variable Costs		
Labor		
Production	69.5	208.6
Supervision	64.6	194.0
Overhead	40.2	120.7
Operating Supplies		
Machine Parts	69.8	209.2
Lubricants	27.7	83.0
Roof Bolts and Timber	49.6	148.8
Miscellaneous Supplies	20.0	60.0
Power	140.2	420.4
Indirect Costs	45.2	135.5
Fixed Costs		
Depreciation	577.0	577.0
Taxes and Insurance	154.6	154.6
Total Annual Cost	1258.4	2311.8
Coal Production-MT	160,000	480,000
Production Cost		
Rupiahs/MT	7865	4816
$/MT	7.88	4.82

12

TABLE A-12
CAPITAL INVESTMENT
Case C - Longwall - Labor Intensive

ITEM	U.S. Dollars equivalent - Installed Cost Imported	Local	Total	Years Life
Hydraulic Supports	7,152,000	100,000	7,252,000	10
Face Accessories	230,000	20,000	250,000	10
Chain Face Conveyor	570,000	40,000	610,000	10
Power Pack & Controls	610,000	40,000	650,000	10
Hand Held Drills	190,000	--	190,000	5
Compressor & Accessories	774,000	140,000	914,000	5
Rail & Cars	30,000	10,000	40,000	20
Hoses & Oilers	50,000	--	50,000	5
Roof Drills	36,000	--	36,000	5
Lamps & Safety Equipment	120,000	--	120,000	10
Common Items (Table A-1b)	3,031,000	5,509,000	8,540,000	-
Total	12,793,000	5,859,000*	18,652,000	

*Of this amount $4,220,000 is for labor during mine development of which $3,376,000 applies to unskilled labor.

TABLE A-13
DEPRECIATION BASIS

Case C - Longwall - Labor Intensive

		Years (3 - 22)
6-7 Year Items -	$1,190,000	198,000
12 Year Items -	9,182,000	765,000
19 Year Items -	324,000	15,000
22 Year Items -	7,956,000	362,000
		1,340,000

TABLE A-14
INVESTMENT SCHEDULE

Case C - Longwall - Labor Intensive
(Equivalent of US Dollars)

Year	Total	Imported	Local	Production M.T./Yr.
1	4,161,000	1,407,000	2,754,000	0
2	4,161,000	1,407,000	2,754,000	0
3	10,330,000	9,979,000	351,000	84,000
4	-	-	-	480,000
5	-	-	-	480,000
6	-	-	-	480,000
7	-	-	-	480,000
8	-	-	-	480,000
9	1,190,000	1,050,000	140,000	480,000
10	-	-	-	480,000
11	-	-	-	480,000
12	-	-	-	480,000
13	-	-	-	480,000
14	-	-	-	480,000
15	10,372,000	10,032,000	340,000	480,000
16	-	-	-	480,000
17	-	-	-	480,000
18	-	-	-	480,000
19	-	-	-	480,000
20	-	-	-	480,000
21	-	-	-	480,000
22	1,514,000	1,294,000	220,000	480,000
23	-	-	-	480,000
24	-	-	-	480,000
25	-	-	-	480,000

45

TABLE A-15
MANNING TABLE AND ANNUAL PAYROLL

Case C - Longwall - Labor Intensive

	Number	Rupiahs/day	Payroll Rupiahs (Millions)
Underground			
Miners	1896	6000	2502.7
Foremen	60	8000	105.6
Surface			
Lampmen	12	4000	10.6
Belt Operators	12	4000	10.6
Equipment Maintenance	12	6000	15.8
Management			
Superintendent	1		9.6
Asst. Superintendent	1		8.0
General Foremen	6		43.2
Chief Engineer	1		7.2
Safety Director	1		7.2
Office Manager	2		12.8
Office Clerks	16		19.2
		Total	2752.5

Total Employees 2020
Work Days/Yr. 220

TABLE A-16
ANNUAL PRODUCTION COST IN RUPIAHS (Millions)

Case C - Longwall - Labor Intensive

	Year 3	Year 4 and Beyond
Variable Cost		
Labor		
Production	464.1	2645.3
Supervision	24.4	107.2
Overhead	146.6	825.8
Operating Supplies		
Machine Parts and Supplies	12.3	70.1
Drill Repair Parts	5.6	32.0
Roof Bolts and Timber	26.1	148.8
Miscellaneous Supplies	7.0	40.0
Power	44.5	253.4
Indirect Costs	81.0	456.5
Fixed Costs		
Depreciation	1340.0	1340.0
Taxes and Insurance	373.0	373.0
Total Annual Cost	2524.6	6292.1
Coal Production - MT	84,000	480,000
Production Cost		
Rupiahs/MT	30055.0	13109.0
$/MT	30.06	13.11

TABLE A-17
CAPITAL INVESTMENT
Case D - Longwall - Capital Intensive

ITEM	U.S. Dollars equivalent - Installed Cost Imported	Local	Total	Years Life
Hydraulic Supports	3,576,000	50,000	3,626,000	10
Shearer	733,000	10,000	743,000	10
Face Accessories	395,000	30,000	425,000	10
Chain Face Conveyor	285,000	20,000	305,000	10
Hydraulic Power Pack	387,000	25,000	412,000	10
Continuous Miner	371,000	5,000	376,000	10
Loading Machine	141,000	5,000	146,000	10
Shuttle Cars	330,000	10,000	340,000	10
Roof Bolter	97,000	5,000	102,000	10
Personnel & Supply Cars (6)	180,000	--	180,000	5
Power Supply Centers	200,000	15,000	215,000	20
Lamps & Safety Equipment	60,000	--	60,000	5
Common Items (Table A-1a)	1,510,000	2,930,000	4,440,000	-
Total	8,265,000	3,105,000*	11,370,000	

*Of this amount $2,174,000 is for labor during mine development of which $1,739,000 applies to unskilled labor.

TABLE A-18
DEPRECIATION BASIS

Equivalent U.S. Dollars

Case D - Longwall - Capital Intensive

		Years (3 - 22)
5 Year Items -	$ 240,000	48,000
10 Year Items -	6,625,000	663,000
15 Year Items -	162,000	11,000
20 Year Items -	4,343,000	217,000
		939,000

TABLE A-19
INVESTMENT SCHEDULE

Case D - Longwall - Capital Intensive
(Equivalent of US Dollars)

Year	Total	Imported	Local	Production M.T./Yr.
1	9,050,000	7,585,000	1,465,000	0
2	2,145,000	680,000	1,465,000	0
3	175,000	-	175,000	164,000
4	-	-	-	480,000
5	-	-	-	480,000
6	-	-	-	480,000
7	-	-	-	480,000
8	240,000	240,000	-	480,000
9	-	-	-	480,000
10	-	-	-	480,000
11	-	-	-	480,000
12	-	-	-	480,000
13	6,865,000	6,705,000	160,000	480,000
14	-	-	-	480,000
15	-	-	-	480,000
16	-	-	-	480,000
17	-	-	-	480,000
18	402,000	362,000	40,000	480,000
19	-	-	-	480,000
20	-	-	-	480,000
21	-	-	-	480,000
22	-	-	-	480,000
23	6,865,000	6,705,000	160,000	480,000
24	-	-	-	480,000
25	-	-	-	480,000

TABLE A-20
MANNING TABLE AND ANNUAL PAYROLL

Case D - Longwall - Capital Intensive

	Number	Rupiahs/day	Payroll Rupiahs (Millions)
Underground			
Miners	38	12000	100.3
Foremen	4	16000	14.1
Surface			
Lampmen	2	4000	1.8
Belt Operators	4	4000	3.6
Equipment Maintenance	12	12000	31.7
Management			
Superintendent	1		28.8
Asst. Superintendent	1		24.0
General Foreman	1		48.0
Chief Engineer	1		24.0
Safety & Training Directors	2		48.0
Office Manager	1		8.0
Clerks	8		21.1
		Total	353.4

Total Employees 75
Work Days/Yr. 220

TABLE A-21
ANNUAL PRODUCTION COST IN RUPIAHS (Millions)

Case D - Longwall - Capital Intensive

	Year 3	Year 4 and Beyond
Variable Costs		
Labor		
Production	50.5	151.4
Supervision	67.3	201.9
Overhead	35.4	106.0
Operating Supplies		
Machine Parts and Supplies	20.7	62.2
Lubricants - hydraulic oil	5.9	17.8
Roof Bolts and Timber	34.2	102.4
Miscellaneous Supplies	20.0	60.0
Power	94.6	283.8
Indirect Costs	29.8	89.4
Fixed Costs		
Depreciation	939.0	939.0
Taxes and Insurance	227.4	227.4
Total Annual Cost	1524.8	2241.3
Coal Production - MT	160,000	480,000
Production Cost		
Rupiahs/MT	9530.0	4669.0
$/MT	9.53	4.67

APPENDIX B

FINANCIAL AND ECONOMIC APPRAISAL

1. FINANCIAL APPRAISAL

The basis for the financial appraisal of the coal mining projects from each of the technology options was the following:

- Financial costs and investment schedules were taken from Tables A-2 through A-21, contained in Appendix A.

- The official exchange rate was 1000 rupiahs to the US dollar. This rate was held constant throughout the project life.

- The mine price of coal was taken as 20,000 rupiahs per metric ton derived as follows. The price of residual fuel oil (42.1 million BTU per metric ton) is assumed to be $200 (200,000 rupiahs) per metric ton. Coal from the project mines is assumed to be sub-bituminous, at 9,000 BTU per pound (19.8 million BTU/metric ton). Thus, in BTU equivalent terms, coal would carry a price of 94,000 rupiahs per ton. It was assumed that, because of the relative inconvenience of using coal compared to fuel oil, the price at a power plant consumer is 60% lower, or 37,600 rupiahs per ton. Transport costs from mine mouth to power plant were taken to be 17,600 rupiahs per ton. Thus, the mine mouth price of the coal was found to be 20,000 rupiahs per ton.

- All coal reserves were assumed to be owned by the government, and any coal mining enterprise pays the government a royalty equal to 13.5% of the mine mouth value of the coal.

Certain assumptions were made that simplify the calculations for financial appraisal without impairing their illustrative value. We sought a ranking of the technology options, in terms of estimated internal rate of return, that would be pragmatic rather than necessarily precise. The simplifying assumptions were the following:

- Estimation of annual depreciation of assets was avoided by entering all purchases of equipment and other depreciable assets on the flow sheets at the time of cash payment. The present (year 1) values of such assets that are residual in year 25 are insignificant once they are discounted, and accordingly it was justified to neglect them.

- Consideration of alternative financial structures of the mining enterprise was avoided by making no assumptions as to loans, or loan terms. Profitability was calculated in terms of total assets employed. In a sense, projects were treated as if all needed funds were provided by the local investors on a equity basis.

- Avoidance of financial structure permitted the calculation and comparison of profits on a pre-tax basis. No assumptions were needed as to rates of income taxation.

Thus the cash flow tables for financial appraisal of each of the four cases contain entries describing revenues from coal sales at 20,000 rupiahs per ton, the capital investment made in each year of project life in terms of imported funds and local funds, operating expenses, depletion (royalties), total cash outlays, and net cash flow (before tax). Financial appraisal results are in the following tables:

Table B-1	Case A, Labor Intensive, Room and Pillar
Table B-2	Case B, Capital Intensive, Room and Pillar
Table B-3	Case C, Labor Intensive, Longwall
Table B-4	Case D, Capital Intensive, Longwall

TABLE B-1

CASE A FINANCIAL APPRAISAL
(Millions of Constant Rupiahs)

Years	1	2	3	Each Year 4-7	8	Each Year 9-12	13	Each Year 14-17	18	Each Year 19-25
Revenues @ Rp 20,000			4,240	9,600	9,600	9,600	9,600	9,600	9,600	9,600
Capital Investment										
Imported	1,634	1,634	1,569		1,646		2,066		1,890	
Local	2,782	2,782	113		160		160		240	
Operating Expenses			3,248	7,089	7,089	7,089	7,089	7,089	7,089	7,089
Depletion (Royalties)			572	1,296	1,296	1,296	1,296	1,296	1,296	1,296
Total Cash Outlays	4,416	4,416	5,502	8,385	10,191	8,385	10,611	8,385	10,515	8,385
Net Cash Flow (before tax)	-4,416	-4,416	-1,262	1,215	-591	1,215	-1,011	1,215	-915	1,215

Internal Rate of Return = 6.2%

Source: Tables A-2, A-3, A-4, A-5, A-6. Operating expenses do not include depreciation.

TABLE B-2

CASE B FINANCIAL APPRAISAL
(Millions of Constant Rupiahs)

Years	1	2	3	Each Year 4-7	8	Each Year 9-12	13	Each Year 14-17	18	Each Year 19-22	23	Each Year 24-25
Revenues @ Rp 20,000			3,200	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600
Capital Investment												
Imported	3,961	680	---		350		2,989		472		2,989	
Local	1,465	1,465	160		---		62		40		62	
Operating Expenses			681	1,735	1,735	1,735	1,735	1,735	1,735	1,735	1,735	1,735
Depletion (Royalties)			432	1,296	1,296	1,296	1,296	1,296	1,296	1,296	1,296	1,296
Total Cash Outlays	5,426	2,145	1,273	3,031	3,381	3,031	6,082	3,031	3,543	3,031	6,082	3,031
Net Cash Flow (before tax)	-5,426	-2,145	1,927	6,569	6,219	6,569	3,518	6,569	6,057	6,569	3,518	6,569

Internal Rate of Return = 49.0%

Source: Tables A-7, A-8, A-10, A-11. Operating expenses do not include depreciation.

TABLE B-3

CASE C FINANCIAL APPRAISAL
(Millions of Constant Rupiahs)

Years	1	2	3	Each Year 4-7	8	Each Year 9-14	15	Each Year 16-17	18	Each Year 19-25
Revenues @ Rp 20,000			1,680	9,600	9,600	9,600	9,600	9,600	9,600	9,600
Capital Investment										
Imported	1,407	1,407	9,979		1,050		10,032		1,294	
Local	2,754	2,754	351		140		340		220	
Operating Expenses			1,185	4,952	4,952	4,952	4,952	4,952	4,952	4,952
Depletion (Royalties)			227	1,296	1,296	1,296	1,296	1,296	1,296	1,296
Total Cash Outlays	4,161	4,161	11,742	6,248	7,438	6,248	16,620	6,248	7,762	6,248
Net Cash Flow (before tax)	-4,161	-4,161	-10,062	3,352	2,162	3,952	-7,020	3,352	1,838	3,352

Internal Rate of Return = 13.5%

Source: Tables A-12, A-13, A-14, A-15, A-16. Operating expenses do not include depreciation.

TABLE B-4

CASE D FINANCIAL APPRAISAL
(Millions of Constant Rupiahs)

Years	1	2	3	Each Year 4-7	8	Each Year 9-12	13	Each Year 14-17	18	Each Year 19-22	23	Each Year 24-25
Revenues @ Rp 20,000			3,200	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600
Capital Investment												
Imported	7,585	680	---		240		6,705		362		6,705	
Local	1,465	1,465	175		---		160		40		160	
Operating Expenses			586	1,302	1,302	1,302	1,302	1,302	1,302	1,302	1,302	1,302
Depletion (Royalties)			432	1,296	1,296	1,296	1,296	1,296	1,296	1,296	1,296	1,296
Total Cash Outlays	9,050	2,145	1,193	2,598	2,838	2,598	9,463	2,598	3,000	2,593	9,463	2,598
Net Cash Flow (before tax)	-9,050	-2,145	2,007	7,002	6,762	7,002	137	7,002	6,600	7,002	137	7,002

Internal Rate of Return = 37.8%

Source: Tables A-17, A-18, A-19, A-20, A-21. Operating expenses do not include depreciation.

2. ECONOMIC APPRAISAL

The basis for the economic appraisal was the following:

- Three factors produce major impacts on the results of economic appraisal: the wages of unskilled labor, the foreign exchange rate, and the national value of the coal produced. For illustrative purposes, other factors such as non-applicable financial costs (e.g., taxes) and now applicable non-financial costs (environmental impact) identified elsewhere in this paper, were not considered.

- It was assumed that all employees, who can be unskilled at the time they are hired, whether for construction or for operations, are essentially drawn from the ranks of the unemployed. Somewhat more formally, it has been assumed that the allocation of these workers to the construction or to the operation of a coal mine does not reduce output elsewhere in the nation. Thus, the costs to the nation for allocating them to coal mining is zero, and the wage for unskilled labor to be entered into the flow sheets for economic appraisal thus becomes zero.

- It was assumed for purposes of illustration that the official exchange rate (which is used in the financial analyses) overstates by up to five times the relative purchasing power of the rupiah within the nation compared to the purchasing power of foreign currencies, represented by the US dollar in the outside world. Accordingly, the economic appraisal calculations use a foreign exchange conversion shadow factor of five. All imported equipment is then five times as valuable, measured in rupiahs.

- The national value of output, such as coal, is equal to what the nation would otherwise have to forego, such as fuel oil exports, to provide the same steam-raising utility. Thus, the gross benefit to the nation of mining coal is the value of the oil it replaces, on the grounds that this oil can otherwise be exported and earn foreign exchange. Since this value has already been acknowledged in preparing the financial appraisal of the four technologies, no adjustment in the U.S. dollar amount of this value is needed for national analyses. However, the rupiah price of coal is raised by five times by the foreign exchange shadow. (The national value of coal output could also have been estimated by observing the dollar price at which coal could be sold in export markets.)

- Depletion is measured likewise by using the same shadow factor of five.

TABLE B-5

CASE A* ECONOMIC APPRAISAL
(Millions of Constant Rupiahs)

Years	1	2	3	Each Year 4-7	8	Each Year 9-12	13	Each Year 14-17	18	Each Year 19-25
Gross National Benefits										
Value of Output			21,200	48,000	48,000	48,000	48,000	48,000	48,000	48,000
Less Depletion			2,860	6,480	6,480	6,480	6,480	6,480	6,480	6,480
Total Gross Benefits			18,340	41,520	41,520	41,520	41,520	41,520	41,520	41,520
National Costs										
Imported Equipment	8,170	8,170	7,845		8,230		10,330		9,450	
Local Construction										
Unskilled Labor	0	0	0		0		0		0	
Other	1,224	1,224	50		70		70		106	
Local Operating										
Unskilled Labor			0	0	0	0	0	0	0	0
Other			1,515	3,165	3,165	3,165	3,165	3,165	3,165	3,165
Total National Costs	9,449	9,449	9,410	3,165	11,465	3,165	13,565	3,165	12,721	3,165
Net Benefits	-9,449	-9,449	8,930	38,355	30,055	38,355	27,955	38,355	28,799	38,355

Internal Rate of Return = 89.2%

*Foreign Exchange Conversion Factor: 5
Unskilled Wages Conversion Factor: 0

TABLE B-6

CASE B* ECONOMIC APPRAISAL
(Millions of Constant Rupiahs)

Years	1	2	3	Each Year 4-7	8	Each Year 9-12	13	Each Year 14-17	18	Each Year 19-22	23	Each Year 24-25
Gross National Benefits												
Value of Output			16,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000
Less Depletion			2,160	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480
Total Gross Benefits			13,840	41,520	41,520	41,520	41,520	41,520	41,520	41,520	41,520	41,520
National Costs												
Imported Equipment	19,805	3,400	---		1,750		14,945		2,360		14,945	
Unskilled Labor	0	0	0		---		0		0		0	
Other	645	645	70				27		18		27	
Local Operating												
Unskilled Labor			0	0	0	0	0	0	0	0	0	0
Other			607	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526
Total National Costs	20,450	4,045	677	1,526	3,052	1,526	16,498	1,526	3,904	1,526	16,498	1,526
Net Benefits	-20,450	-4,045	13,233	39,994	38,468	39,994	25,022	39,994	37,616	39,994	25,022	39,994

Internal Rate of Return = 72.8%

*Foreign Exchange Conversion Factor: 5

Unskilled Wages Conversion Factor: 0

TABLE B-7

CASE C* ECONOMIC APPRAISAL
(Millions of Constant Rupiahs)

Years	1	2	3	Each Year 4-7	8	Each Year 9-14	15	Each Year 16-17	18	Each Year 19-25
Gross National Benefits										
Value of Output			8,400	48,000	48,000	48,000	48,000	48,000	48,000	48,000
Less Depletion			1,134	6,480	6,480	6,480	6,480	6,480	6,480	6,480
Total Gross Benefits			7,266	41,520	41,520	41,520	41,520	41,520	41,520	41,520
National Costs										
Imported Equipment	7,035	7,035	49,895		5,250		50,160		6,470	
Local Construction										
Unskilled Labor	0	0	0		0		0		0	
Other	1,167	1,167	149		59		144		93	
Local Operating										
Unskilled Labor			0	0	0	0	0	0	0	0
Other			720	2,308	2,308	2,308	2,308	2,308	2,308	2,308
Total National Costs	8,202	8,202	50,674	2,308	7,617	2,308	52,612	2,308	8,871	2,308
Net National Benefits	-8,202	-8,202	-43,498	39,212	33,633	39,212	-11,092	39,212	32,649	39,212

Internal Rate of Return = 51.7%

*Foreign Exchange Conversion Factor: 5

Unskilled Wages Conversion Factor: 0

Source: Table A-24. Although stubs have been renamed and data have been rearranged, no numbers have been changed from the financial appraisal except for the shadow conversion.

TABLE B-8

CASE D* ECONOMIC APPRAISAL
(Millions of Constant Rupiahs)

Years	1	2	3	Each Year 4-7	8	Each Year 9-12	13	Each Year 14-17	18	Each Year 19-22	23	Each Year 24-25
Gross National Benefits												
Value of Output			16,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000
Less Depletion			2,160	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480
Total Gross Benefits			13,840	41,520	41,520	41,520	41,520	41,520	41,520	41,520	41,520	41,520
National Costs												
Imported Equipment	37,925	3,400			1,200		33,525		1,810		33,525	
Local Construction												
Unskilled Labor	0	0	0		---		0		0		0	
Other	645	645	77		---		70		18		70	
Local Operating												
Unskilled Labor		0	0	0	0	0	0	0	0	0	0	0
Other			498	1,151	1,151	1,151	1,151	1,151	1,151	1,151	1,151	1,151
Total National Costs	38,570	4,045	575	1,151	2,351	1,151	34,746	1,151	2,979	1,151	34,746	1,151
Net National Benefits	-38,570	-4,045	12,905	40,369	39,169	40,369	6,774	40,369	38,541	40,369	6,774	40,369

Internal Rate of Return = 50.0%

*Foreign Exchange Conversion Factor: 5

Unskilled Wages Conversion Factor: 0

Source: Table A-25. Although stubs have been renamed and data have been rearranged, no numbers have been changed from the financial appraisal except for the shadow conversion.