2-1-3 The Current Status of the Coal Mining

(1) Exploration and Development Activities

A. Exploration

The coalfields in the Philippines occur in rather small and narrow basins, distributed along the island arc and controlled by large tectonic lines.

The coal reserves can be divided into two main types. One consists of relatively stable formations with a simple structure dipping nearly 15 degrees, such as found in Semirara, Western Mindanao, and Cagayan Valley coal deposits. The other is comprised of coal reserves deposited in more mobile depositional basins with severe igneous intrusions such as faulting and folding, and igneous intrusions of which coal seams dip from 45 degrees to vertical as could be seen in Cebu and other islands.

The coal seams in the Philippines were deposited from the Eocene to the Pliocene age. Eocene coals developed in Catanduanes, and Oligocene coals occur in a part of Cebu island. Most of the coal deposits widely found throughout the country belong to the Miocene age.
In contrast to the above coal basins, younger Pliocene coals are distributed in the Cagayan valley.

As coal seams are deposited in small and narrow basins, lithological variations within the basin are common. Generally, coal seams are not uniform throughout their thickness and show lateral changes such as pinching, swelling and splitting. However, some of the coal seams are two to three meters thick and mined economically in most areas. Same coal seams are over ten meters in thickness such as the No. 5 and 6 seams in Semirara island.

Most coals mined in the Philippines are high-moisture sub-bituminous coals. Bituminous coals ranging from high-volatile to medium-volatile and partly belonging to a semi-anthracite are known to occur in Catanduanes, Polillo, Batan, Cebu, Masbate, Malangas coal areas. And lignites are found in the Cagayan valley and Samar island. Among them, the high grade coals are associated with igneous intrusions and regional structural disturbances. On the other hand, the lignites are distributed in the relatively younger basins.

Coal quality on an air dried basis varies widely in the Philippine coals. The inherent moisture content ranges from 1.6% in Malangas (ROM) to 25.8% for the upper seam in Tarragona (PNOC-CC). Ash content ranges from 3.6% for Isabela to 29.6% for Bohol. Sulfur content ranges from 0.3% for Isabela to 4.26% for Bohol. Heating Value ranges from 6,330 BTU/lb for Isabela to 12,920

BTU/lb for Cebu Coal Mine (APPENDIX 6). Generally coal seams in the Philippines have a wide range of ash content and a high sulfur content with those deposits in the mobile basins in island arcs being located in subduction zones.

The latest reserves computed by the OEA in 1986 are positive reserves of 283.91 million tons, probable reserves of 128.71 million tons, mineable reserves of 296.11 million tons and in-situ reserves of 369.37 million tons, respectively (Appendix 2).

The classification of reserves are defined as follows,

1. Positive reserves are those sufficiently explored by drilling and/or tunnelling to warrant inclusion in a company's five-year development/production program. Drill holes are generally spaced at not more than 200 meters apart, and in highly disturbed areas like Cebu, holes are spaced not more than 100 meters apart.
2. Probable reserves are those also explored by drilling and/or tunnelling, but still need confirmatory drilling and/or tunnelling. Drill holes are generally spaced 200 to 400 meters apart, except in fairly undisturbed areas like Cagayan.
3. The mineable reserves are computed by multiplying the total in-situ reserves (positive + 2/3 probable) by a mining recovery factor of 60% for underground and 85% for open pit.
4. Except for Cagayan, Semirara, part of Samar, and Surigao, all other coal areas are treated as underground coal areas.

However, not taken into account is the cut-off thickness of the coal seams and the ratio of partings and coals on the above classification.

The first recorded discovery of coal (Faustio 1927) in the Philippines was in 1827 on the island of Cebu. Production commenced in 1842 on Batan island. Later, small mining companies started mining in several other coal areas and such intermittent small scale production has continued to the present time. The total production of coal is 1,193,603 tons and the total number of employees in coal industry are 9,995 persons according to the statistics for 1987. Most of the coal mines, except Semirara Coal Mine and PNOC-Malangas mine, produce a few ten thousand tons of coal through small-scale mining. Semirara and Malangas mines owned by the government are operating as modernized coal mines by means of introducing technical assistance and funds from foreign countries along the lines of the energy policy of the government after the oil crises. But most small-scale mines are operating as private companies in limited areas near the surface by a traditional mining method, so-called the "Camote mining".

Investigations were carried out with five coal mines in Cebu island: J.D. Almendras, Cebu Coal, PNOC-CC's Uling, Manguerra and Luvimin mines, and with one coal mine, Carbex Inc, on Batan island. (APPENDIX 3)

Only two mines, PNOC-CC's Uling and Luvimin, have a geologist each. The exploration program of surface mapping and drilling before the start of development and underground geological surveys are performed in the three mines of PNOC-CC's Uling, Luvimin and Carbex, Inc.

According to the investigation results, half of the active mines, especially small-scale mines, have no exploration programs in the future mining areas. The operating coal mines have to submit a report of a five-year development and production program to the OEA. But in considering the above situation, the quality and quantity of the exploration are comparatively insufficient and the accuracy of data seems to be limited.

B. New Coal Mine Project Progress

Semirara Coal Corporation

Three mineable coal areas: Unong, Himalian and Panian, are located in Semirara island, with the mineable reserves given as 16.70 million tons each, with a strip ratio of 7.5 m^3/ton, 37.50 million tons with a strip ratio of 11.3 m^3/ton and 45.80 million tons with a strip ratio of 8.4 m^3/ton, respectively.

The average quality of Semirara coal received at the Calaca Power Plant (National Power Company) is as follows;

Items	Air Dried Basis	As Received Basis
T.M. (%)	-	25.11
I.M. (%)	17.37	-
Ash (%)	11.17	10.12
V.M. (%)	36.88	33.42
F.C. (%)	34.59	31.35
H.V. (BTU/lb)	8,872	8,039
S (%)	0.64	0.58

Semirara coal is characterized as sub-bituminous C coal with a high moisture content based on ASTM.

The Semirara Coal Corporation has been operating an open pit mine in the Unong area for supplying coal to Calaca Power Plant since 1981 and the current production reached 794,525 tons in 1987.

The NPC has a plan to construct Calaca II Power Plant of 300 MW capacity by late 1988 and to consume Semirara coal, as a blending coal. To meet this plan, Semirara Coal Corporation also conducted feasibility studies for the development of another open pit mine in the Himalian area by Dames & Moore and MONENCO although some more studies on financial and economical subjects have to be made for further progress of the project.

The quality of Himalian coal is similar to that of Unong coal. The mining operation being carried out in the Unong open pit is a selective mining by bucket-wheel-excavators to maintain run-of-mine quality into the requested specifications for NPC. In addition to the selective mining, a measure, such as experimental beneficiation of the Unong coal has been adopted to up-grade the coal quality as much as possible. The beneficiation of the Himalian coal will be made based on the results of the experimentation.

According to the results of the present Unong mine, Semirara coal has disadvantages of low heating value, high moisture content, characteristics of spontaneous combustion, and a contamination of alkaline elements in the ash. But it has also advantages of a thick coal seam with relatively gentle inclination, a relatively huge amount of reserves suitable for large scale open pit mining and simple transportation by a vessel.

The operation in the Himalian area will start by 1992 and that in the Panian area will commence by 1995 according to the projected production schedule of the OEA.

Another major target for new opencast mining is to develop the scattered brown coal deposits in the Cagayan Valley area. According to the long term power development program by NPC, the development of both Isabela and Iguig brown coal deposits is scheduled in 1999 and 2000, respectively. The Isabela deposit seems to be uneconomical to mine due to its high stripping ratio, where as the brown coal in the Iguig area has more potential than the others and can be developed after some more combustion tests for possible mine site power generation. This area was explored by the cooperative team from both the OEA and Federal German government under a technical assistance project by the later.

In addition to the above, there is one more potential opencast mining area in Bagacay, Samar island which was explored by the Marinduque Mining & Industrial Corp., but the development is deferred due to its low heating value of 8300 BTU/lb and high suphur content of more than 2.5%.

In the Lianga region of eastern Mindanao, many coal companies, such as Benguet Corp., Montenegrin Mining Corp., Sabena Mining Corp., Piedra Negra Mining Corp., Semirara Coal Corp., and Diversified Mining Corp., including PNOC-CC are carrying out exploration works, and most of the areas are identified to be suitable for opencast mining. However, the geological structure in the areas is rather complicated and the thickness of the main coal seams seem to be unstable because of the Philippine fault belt, which is the biggest fault belt in the Philippines, passes through the south end of the area. Therefore, further exploration works should be required.

For the potential areas to be developed by the underground mining method, the Bislig Mine No. III, Integrated Little Baguio, Lalat, and San Miguel areas belong to the PNOC-CC.

The mines, i.e. Bislig No. I, No. II, and No. IIA, operated by PNOC-CC in the Bislig area, were transferred to David M. Consunji Inc. (DMCI) in accordance with the guidance of the government on privatization. The major portion of the Bislig area is still kept by the PNOC which is the Bislig Mine No. III. The feasibility of this mine was studied by the Asian Development Bank (ADB) in 1982, but development was deferred due to the abrupt closure of the Surigao Nickel Refinery in the Nonoc island to which the Bislig coal was scheduled to be delivered. After that, it was reconsidered for development as a mine for the planned mine site power generation in 1986, but it was again stopped because the NPC objected to generate its power by coal due to the higher cost compared with that from the hydro power, Agus No. III, after the feasibility study of electric power generation and distribution scheme in the mindanao grid. However, the Bislig coal has an average heating value of approximately 10000 BTU/lb after beneficiation hence it could be a good fuel for cement manufacture and other uses except its susceptibility to spontaneous combustion. Therefore, the feasibility of the development of the Bislig Mine No. III has to be reviewed again in the near future by taking into account the investment for the relevant infrastructures. At present, an electric power generation of 100 MW is scheduled to be completed in 2000 as contained in the NPC's long term power development program.

The integrated Little Baguio coal development project covers both wings of the Gotas syncline located in the northern part of the Malangas coal mine and the continuation of the present Little Baguio mine where the LC-1 and LA seams of the Lalat member are being mined by short wall mining system. This project will be executed as an expansion program of the present Little Baguio mine.

The Lalat area, which was explored by PNOC-CC, is located at about 10 km west of the Malangas coal mine. The coal bearing Lumbog formation, being covered by thick sand and gravel beds of Quaternary age, is explored by seismic reflection and drilling surveys. However, the condition of coal is not so attractive in order to justify immediate development. Further exploration would be required.

A potential area for further exploration is the Tarragona area located about 120 km south of the Bislig area. PNOC-CC and Almendras Mining Corp. have carried out a reconnaissance survey in their contract areas. According to the results of their exploration, the lower member contains better quality coal of about 10000 BTU/lb, while the upper member has coals showing heating values of about 8000 BTU/lb. Further exploration will be required.

(2) Administration and Management

a. Source of manpower

In the Philippines, mining technology is provided by three universities (Adamson, St. Louis, and the University of the Philippines) and two Institute of technology (Cebu, Mapua) where more weight in the 5-year curriculum is put on the mining technology for metal. Consequently the number of students taking lectures concerned with the coal mining technology is small and the students have few chances to have practical training in coal mines, because most of the mines do not have enough accommodation facilities for receiving students.

As far as the workers are concerned, companies usually employ non-experienced workers (mostly farmers) living near the mines and give a job as a helper in the surface at the beginning, and after that, use them as muckers through on the job training. On the other hand, some companies tend to employ experienced workers (had worked in the metal mines) from remote provinces.

b. Educational background of employees

As to the educational background of employees, the statistics (1986) show the considerably high education of regular workers. According to the figures, about 70% of regular workers received a high school education and about 10% have graduated from universities. Such a high educational level suggests that regular workers can be potentially well trained.

Table 2-1-12 School education of employees (1986)

Mines/fields	Staff (including managers & engineers)					Regular workers				
	Elementary	Junior	High	College	Other	Elementary	Junior	High	College	Other
Northern Cebu				10		60	140	500	30	
Central Cebu				10		20	100	380	20	
Southern Cebu				8		50	200	750	30	
PNOC Areas				25		68	182	950	100	
Batan				6		18	42	190	15	
Polillo				5		35	15	150	15	
Masbate				2		7	10	180	10	
Mindoro				3		5	6	33	5	
Negros				2		-	-	19	4	
Semirara				14		65	80	855	100	

(Source: OEA)

c. Age composition of regular workers

The statistics (1986) show the preferable age composition of regular workers. According to the figures, about 70% of the regular workers are 20 to 35 years old.

Table 2-1-13 Age composition of regular workers (1986)

Mines/fields	Under 20	20 ~	25 ~	30 ~	35 ~	40 ~	45 ~	50 ~	55 over
Northern Cebu	25	300	400	300	200	125	75	50	
Central Cebu	25	200	300	100	50	50	25	25	
Southern Cebu	50	200	400	300	250	100	50		
PNOC Areas		300	600	400	300	200	150	50	
Batan		75	125	100	100	75	25	10	
Polillo		20	60	30	20	10			
Masbate		50	100	100	50	20	20		
Mindoro									
Negros									
Semirara		200	300	250	200	100	50	25	

(Source: OEA)

d. Continuous service years of regular workers

It has not been long since the Coal Development Act was issued in 1976 in order to activate the coal mining industries in the Philippines.

During the past 10 years, each company has made a great effort to keep mining technology at an adequate level. But some companies encountered a problem when the continuous service years of regular workers were not long. According to the data in 1986, about 85% of regular workers resign within 2 years of service.

Table 2-1-14 Continuous service years of regular workers (1986)

Mines/fields	less than 1 year	1 ~	5 ~	10 ~	15 ~	20 ~	25	30 over
Northern Cebu	600	500	300	100				
Central Cebu	500	100	100					
Southern Cebu	1200	200	100					
PNOC Areas	300	1500	150	50				
Batan	300	150	50					
Polillo	100	30	20					
Masbate	300	30	20					
Mindoro								
Negros			250					
Semirara	150	700						

(Source: OEA)

The high ratio of early resignation is due to the following reasons:

- Young workers tend to move to new jobs, if (much) higher wage are likely to result from these new job.
- Agricultural farming workers usually go back to their previous job during rainy days.
- Experienced workers assigned to remote coal mines do not want to stay for a long period.

Due to the above reasons, companies have difficulties in keeping experienced workers.

e. Absenteeism

Workers are normally entitled to 15 days' paid home leave and 15 days' paid sick leave allowance per year. Absenteeism among underground workers is about 20%, a slightly high figure.

f. Wages

The wage packet of a regular worker is made up of his daily wages, overtime and night work allowance, a premium for 13 shift work, and a monthly allowance. The wages are normally paid every two weeks to the workers. In addition to the wages, it is usual to get a bonus twice a year.

As for the monthly wages of workers engaged in small-scale coal mines in the Philippines, it can be estimated from personal inquiries in the coal mines that the lowest wage per month is about P 750 and the highest wage is about P 1,200, although there is a variation of wages in provinces.

Coal mines operated by PNOC-CC pay higher wages like a level of P 2,000 per month.

g. Management of coal mines

The small-scale coal mines are forced to adopt optimum mining methods to gain profits in the severe mining conditions.

The principal measures taken by coal mines are to minimize the amount of investment on equipment and to decrease the operation cost by using very cheap labour costs.

The ex-mine costs in small-scale mines in Cebu island are supposed to be lower than P 500/ton. Consequently, the total cost including transportation expenses, may provide for some profits. The selling prices of indigenous coal were raised to P 750 ~ 830 per ton at 8,500 BTU/lb basis in February 1988.

Average coal prices (1980~'87) for coal produced in Cebu island are as follows;

Table 2-1-15 Cebu Coal Production (1980 ~ 1987)

Year	Production (ton)	Ave. Coal Price (P/ton)
80	216,414	270
81	224,751	340
82	260,625	438
83	326,731	348
84	251,150	930
85	329,470	930
86	364,254	740
87	229,999	700

(Source: OEA)

The price of indigenous coal is facing severe competition under the pressure from cheaper imported coal. For this problem, the Philippine government levies 20% of CIF price plus P 10 per ton for imported coals as tax, and value added tax (10% of total landed cost) but some price difference still remains because the price of indigenous coals is still about P 200 higher than that of imported coals (CIF). The example shown is for Australian coals.

Indigenous coal	P 1032.35/11,700 BTU (CIF NPC Batangas)
Australian coal	P 839.28/11,700 BTU (CIF NPC Batangas)

Generally, the management of small coal mines produces some profit under the present market conditions, but semi-mechanized underground coal mines barely cover their total cost and a fully mechanized open cut mine such as the Semirara mine cannot make a profit due to insufficient production at the rated capacity of 1.3 million tons, compared to the large amount of investment.

(3) Mining Technology

The production of coal in 1987 was approximately 1.1 million tons. Now some thirty coal mines are in operation and development.

Three coal mines – Semirara coal at Semirara island, Project Managers Inc. (PMI) and Carbex at Batan island – have been employing the open pit method and produced 639,000 tons in 1987, whereas 476,000 tons was produced from the underground mines.

Semirara Coal, the largest open pit coal mine, produced 595,000 tons with B.W.E in 1987, while a total of 44,000 tons was produced from the other two open pit mines with conventional earth moving equipment (trucks, loaders, bulldozers).

However, PNOC-CC's Malangas coal mine at Mindanao island is the largest underground coal mine in the country and it produced 165,000 tons in 1987, while a total of 311,000 tons was produced by small scale underground coal mines mainly in Cebu island.

Mining activities in the underground sectors are primitive and poorly designed except for the coal mines belonging to PNOC-CC and a few other mines. Furthermore, these small-scale underground mines are characterized by crude mining methods such as Camote mining and the "room and pillar method" with manual hoes and shovels. Underground haulage is by handtramming in wheel barrows or wooden boxes with sleds to the intersection hoisted up to the surface. As a result, productivity, efficiencies and recovery of the reserves in most of the mines are very low. The 1987 productivity for underground mines and open pit were 0.29 and 1.59 tons per man shift, respectively (The average productivity in 1980s for underground sector is 0.23 tons per man shift). The overall productivity in the industry in 1987 was 0.58 tons per man shift. Recovery of the reserves for some mines is less than 50%.

As for mine ventilation, for lack of both equipment and well-designed mine structure, natural ventilation is applied by driving a raise up to the surface. This method, however, does not ensure adequate air to all working areas.

It is fair to say that only coal mines belonging to PNOC-CC are equipped with modern mining and haulage facilities. Consequently coal mining operation in the Philippines is labor intensive and lacks long-range planning because of cheap labor cost and reluctance of investment on the part of management.

As for quality of engineers and workers engaged in coal mining operations, most engineers are originally from the metal mines who are inexperienced in coal mining operation. Generally, private companies do not provide engineers with education programs. Workers are also inexperienced in mining operation and only an educational program on safety (one week) is provided for workers.

In order to improve productivity and efficiency and raise production output, it is essential to promote exploration and to establish underground mine structures so that underground haulage capacity is improved.

(4) Coal Quality

In Cebu island the quality of coal from the various coal mines is quite different from each other, and seems to vary from time to time. In addition, each coal mine produces different qualities of coal due to local variations of coal seams within the same area and also due to mining of the different coal seams one by one. (APPENDIX 6)

The run-of-mine coal produced under the "Camote mining" contain a notable amount of waste from the roof or floor of the coal seam during mining.

The actual coal produced from the coal seam, called as run-of-mine, shows a lower quality than the sample taken from the coal seam itself due to contamination by waste rocks during mining, and their quality varies widely.

Most of the production in Cebu island is consumed by inland users, although the quality of the coal does not meet the contracted coal specifications. As a result, they have to be used after blending with good domestic coals or imported coals.

There exists an experimental washing plant at the Cebu coal mines, but only large waste and clay are removed by this simple method. Recently, some of coal producers are conducting a very simple washing with handpicking in order to avoid the rejection of the users, like J. D. Almendras, etc.

Of the whole operating coal mines in the country, only Malangas coal mine of M.C.C. in Zamboanga del Sur has a proper jig type coal washery plant, although an experimental washery plant has been constructed in the Semirara island recently.

The quality of coal in Semirara island is basically similar to all seams from the three areas and the coal is classified as Sub-Bituminous C according to the ASTM Classification.

This coal is characterized by high inherent moisture, low heating value and high alkaline content. And is susceptible to spontaneous combustion. When NPC fired the run-of-mine coal from SCC in 1984, there were many serious problems with coal handling and combustion. The main reasons for these troubles came from the high moisture content of nearly 30% making it difficult to handle the coal and a high alkali content in the ash causing difficulties with coal combustion in the boiler, which showed serious fouling and slagging at the superheater and pipes.

In January 1985, SCC and NPC decided to use selected Semirara coal after blending with Australian low-alkaline and high-heating-value coals. In order to improve the quality of Semirara coal, a small-scale scrubber plant of 25 t/h capacity was erected at the mine site in 1987. Last year, a JICA mission for the implementation of the Calaca power station visited the Semirara Coal Mine and made a review of these problems.

(5) Infrastructure

In Cebu island, the transportation of coal from the mine site to the users is carried out by trucking. The main road runs along the east coast and is paved from the northern end to the southern extreme.

However, there are several coal mines near the center of the island where the condition of the roads is very hard to maintain, especially during the rainy season. As the truck speed is limited to 10 to 20 km/hr, only a single haul can be made in a day, especially in the southern part of Cebu island. This may increase the cost of transportation up to three times compared with the hauling cost in the other coal mines.

This hauling trouble is particularly serious with the Luvimin mine in the southern part of Cebu island. Therefore, a special transportation system has to be adopted to decrease hauling costs and to allow more efficient coal production. In the future, a feasibility study should be carried out to solve this hauling trouble.

(6) Mine Safety

The organization on safety administration was transferred to the Office of Energy Affairs (OEA) from the Bureau of Energy Development (BED) of the Ministry of Energy after the revolution in 1986. The Coal & Nuclear Minerals Division which is now an administrative organization for coal mine safety belongs to the Energy Development Service in the OEA.

The division has a staff of 24 with 15 government inspectors qualified as the licenced of mining engineers.

As a coal mine safety law, Section 9 in the Coal Development Act of 1976 is provided for coal mine operators as an obligation for them in the coal operating contract. Aside from this, coal contractors have to follow the coal mine safety rules and regulations (CMSRR) issued as Circular No. 1 Series in 1978.

A numerical system of rating safety performance referred to as the BED Coal Mine Safety Rating System was promulgated and implemented in 1979 in order to attain a fair and uniform method of assessment and to obtain sufficient information for the OEA in compliance with the CMSRR.

In order to execute the above rules and regulations, mine site inspections which are held quarterly for underground mines and 2 or 3 times a year for open cut mines are being carried out by 15 inspectors from the OEA.

There are official commendation and disciplinary actions for the coal companies based on the results of mine site inspections, frequency of safety committee meetings, status of safety equipment and facilities, numbers of accidents, etc.

OEA inspectors has the authority to suspend the coal mining operations and may recommend cancellation of their coal operating contract depending on the results of inspections. Penalties for violations and offenses are provided according to the gravity and frequency of these violations.

There are also some rules and regulations regarding environmental conditions, health and sanitation, etc.

Table 2-1-16 Statistics of Coal Mine Accidents (1978~1987)

Year	FATAL	N.F	L.T.A	N.L.T.A	Total	Days Lost	Manhours Worked	F.R.	S.R.
1978(U.G.)	1	68	69	222	291	6,529	2,225,309	31.01	2,934
1979(U.G)	2	103	105	98	203	12,991	5,189,154	20.23	2,503
1980(U.G)	18	93	111	111	222	108,764	8,814,930	12.59	12,339
(O.P)	0	11	11	2	13	100	671,583	16.38	149
(Total)	18	104	122	13	235	108,864	9,486,513	12.86	11,476
1981(U.G)	9	91	100	258	358	54,884	14,893,495	6.71	3,692
(O.P)	0	7	7	3	10	55	892,105	7.85	62
(Total)	9	98	107	261	368	55,039	15,785,600	6.78	3,457
1982(U.G)	13	130	143	118	261	84,151	13,968,519	10.23	6,024
(O.P)	0	3	3	19	22	19	2,227,026	1.34	8
(Total)	13	133	146	137	283	84,170	16,195,545	9.01	5,157
1983(U.G)	56	152	208	125	333	343,464	19,253,683	10.50	17,839
(O.P)	4	15	19	17	36	24,083	3,426,996	5.54	7,027
(Total)	60	167	227	142	369	367,547	22,680,679	10.00	16,285
1984(U.G)	17	131	148	168	316	108,526	22,287,548	6.64	4,869
(O.P)	2	17	19	6	25	12,195	3,311,062	5.74	3,683
(Total)	19	148	167	174	341	120,721	25,598,610	6.52	4,716
1985(U.G)	11	133	144	177	321	74,630	24,753,175	5.82	3,015
(O.P)	0	27	27	9	36	337	3,480,346	7.76	97
(Total)	11	160	171	186	357	74,967	28,233,521	6.06	2,655
1986(U.G)	9	79	88	171	259	55,517	20,420,105	4.30	2,719
(O.P)	0	12	12	23	35	98	3,132,055	3.83	32
(Total)	9	91	100	194	294	55,615	23,552,160	4.24	2,361
1987(U.G)	10	145	155	161	316	62,597	12,597,275	12.36	4,969
(O.P)	2	23	25	23	48	12,415	3,396,896	7.36	3,655
(Total)	12	168	180	184	364	75,102	15,994,171	11.25	4,690
1978~1987									
U.G	146	1,125	1,271	1,609	2,880	912,153	144,403,193	8.80	6,317
O.P	8	115	123	102	225	49,300	20,538,069	8.00	2,401
Total	154	1,240	1,394	1,711	3,105	961,453	164,941,262	8.45	5,829

(REF)

N.F ..... NON-FATAL

L.T.A ..... LOST TIME ACCIDENT

N.L.T.A ..... NON LOST TIME ACCIDENT

F.R ..... FREQUENCY RATE

$$F.R = \frac{\text{No. of lost time accident} \times 1,000,000}{\text{Total manhours worked}}$$

S.R. ..... SEVERIYY RATE

$$S.R. = \frac{\text{Total number of days lost} \times 1,000,000}{\text{Total manhours worked}}$$

TABLE 2-1-17 Cause of Injury (1978~1987)

CAUSE	FATAL		NON-FATAL		NON-LOST-TIME·A	
	1978~198	1987	1978~1986	1987	1978~1986	1987
Rock falls	21	4	284	Data Unknown	Data Unknown	Data Unknown
Timber falls	1		22			
Sups	5		75			
Handling of Materials	3		132			
Handtools	0		143			
Stepping	0		41			
Haulage	1	2	49			
Electricity	6	1	13			
Equipment	5		133			
Explosion	72		30			
Objects	0		37			
Hoisting	10		63			
In Rush of Water	3		3			
Suffocation	14	5	14			
Mine Fire	1		2			
Explosives	0		1			
No data	0		30			
Total	142	12	1072	168	1527	184
Total (1978~1987)	154		1,240		1,711	

Analysis of accidents

During the past ten years (1978~1987), fatal accidents amounted to 154 deaths, non-fatal accidents (serious and light injuries) to 1,240 persons, and non- lost time accidents to 1,711 persons. The worst of the fatal accidents was 72 deaths caused by explosion, the second worst was 25 death caused by rockfall, and the third worst was 19 deaths by suffocation.

Judging from these data, explosion and suffocation accidents occurred due to lack of safety education in the coal mine industry.

Therefore, it is possible to reduce such accidents drastically by promoting a utmost consciousness on mine safety and an intensification of safety education not only in the mines but also in the training center. The worst cause of the non-fatal accidents was rockfall, and the next most serious causes was the handling of materials, handtools and other equipment.

These accidents are usually caused by the poor natural conditions of steeply dipping coal seams and the lack of mining techniques and knowledge which engineers and workers should have.

A comparison of the statistical data on coal mine accidents between Japan and the Philippines during the past ten years (1978~1987) is shown below.

Frequency Rate of fatal accidents

$$\text{Japan F.R} = \frac{\text{No. of fatal accident} \times 1{,}000{,}000}{\text{Total product tonnage}}$$

$$= \frac{465 \times 1{,}000{,}000}{169{,}616{,}970\ \text{t}} = 2.74$$

$$\text{Philippine F.R} = \frac{\text{No. of fatal accident} \times 1{,}000{,}000}{\text{Total product tonnage}}$$

$$= \frac{154 \times 1{,}000{,}000}{7{,}661{,}791\ \text{t}} = 20.10$$

Frequency Rate of total lost time accidents

$$\text{Japan F.R} = \frac{\text{Total no. of lost time accidents} \times 1{,}000{,}000}{\text{Total product tonnage}}$$

$$= \frac{9{,}564 \times 1{,}000{,}000}{169{,}616{,}970\ \text{t}} = 56.94$$

$$\text{Philippine F.R} = \frac{\text{Total no. of lost time accidents} \times 1{,}000{,}000}{\text{Total product tonnage}}$$

$$= \frac{1{,}394 \times 1{,}000{,}000}{7{,}661{,}791\ \text{t}} = 181.94$$

Severity Rate of total lost time accidents

$$\text{Japan S.R} = \frac{\text{Total number of days lost} \times 1{,}000{,}000}{\text{Total product tonnage}}$$

$$= \frac{3{,}950{,}566 \times 1{,}000{,}000}{169{,}616{,}970\ \text{t}} = 23{,}291$$

$$\text{Philippine S.R} = \frac{\text{Total number of days lost} \times 1{,}000{,}000}{\text{Total product tonnage}}$$

$$= \frac{961{,}453 \times 1{,}000{,}000}{7{,}661{,}791\ \text{t}} = 125{,}487$$

Summary of the underground coal mine safety conditions in Cebu

The general safety conditions of the five underground coal mines investigated in Cebu were as follows,

1) Almost all coal mines in Cebu are currently mining shallow areas (less than 100 m from the ground). This permits them apply a natural ventilation system since only a small amount of methane gas still exists in nearly every coal mine.

However, there was an explosion accident which have caused 27 fatalities in the Durano colliery in the northern part of Cebu in 1983. Moreover there were certain number of explosion accidents in the other coal mines during the past ten years (1978~1987).

When we investigated one colliery in the southern part of Cebu, we found a 4.5% methane gas content near the roof of a tunnel. The methane gas was diluted by ejecting compressed air from the pneumatic pick. The frequency of gas checks was insufficient due to lack of safety consciousness and equipment. Other factors causing mine explosions are the unprescribed cap lamps and batteries fabricated locally. The connection between the cap lamp and battery was made by a normal electric cable, with no explosion-proof measures taken.

Some collieries are using forced ventilation by means of a small fan.

However, it is effective only for main roadways, but not for mining faces and development faces.

2) Roof supports

Only timbers are used for roof supports.

It will be all right if mining areas are shallow where no heavy rock pressure is encountered.

Roadways are rather small because of the thickness of the coal seams.

In addition to this, the roadways become narrow easily by a small rock pressure in the Miocene mud stone. This makes difficulty in avoiding for accidents caused by rockfall and transportation.

3) Drainage

Water is accumulated in roadways due to seepage from the surface. This makes the roadways muddy which is made worse by the absence of level raodways designed with a slight gradient.

The most common drainage system observed in most of the mines is to set a sump at the bottom of a main inclined shaft or main vertical shaft and pump by a 1~3 stage pumping system.

4) Spontaneous combustion

We observed several occasions of spontaneous combustion caused by coal remaining in the goaf.

No appropriate counter measures to detect spontaneous combustion are taken. There is no fear of outburst of gas and rockburst at present as far as mining is still limited to the shallow areas.

5) Others

a. Only 2~3 methane gas detectors are kept in each mine except PNOC's mines and almost all detectors are not functioning properly.

b. No coal mines except PNOC's mines are using carbon mono-oxide self-rescue equipment.

c. In some mines, 11~12 years old children are working in underground.

d. There are some semi-nudity and no-boots workers in some mines.

e. Sometimes, no explosion-proof cap lamps are used in underground mines.

f. No rescue party exists except at the PNOC mines

(7) Coal Utilization

As a reaction to the energy crisis of 1973, the government instituted several energy saving and energy substitution measures intended to reduce the country's bill for imported energy.

Some of these measures include the conversion of fuel from oil to coal in the cement industry and the construction of coal fired power plant in NPC. To accelerate these programs, several incentives have been extended by the government, one of which is the assurance of a continued supply of coal of the right quality and at a reasonable price.

Following the government mandate, seventeen cement plants had successfully converted to coal firing by March 1984, with most of the conversions completed in 1983. As far as the coal fired power plant is concerned, Naga power plant started in 1981, Calaca plant in 1984, and Atlas plant using fluidized bed in 1983.

As shown in Table 2-1-18~19, coal consumption in 1987 was about 1.8 million tons, composed of NPC (47%), the cement industry (37%), and Atlas (11%). Also a total of about 0.6 million tons of coal was imported last year, from Australia (66%), China (31%) and Indonesia (3%).

Table 2-1-18 Coal Consumption In 1987

Industry	Consumption (1,000 tons/Y)
NPC	830
Cement	678
Atlas	197
Others	143
Total	1,848

Table 2-1-19 Imported Coal In 1987

Imported country	Coal (1,000 tons/Y)	Agency
Australia	405	NPC, PHINMA, PNOC
China	189	Atlas, PNOC, Northern
Indonesia	20	Atlas
Total	614	

1. Electricity

Total energy at the generation level in 1987 was about 20,000 GWH, and the total installed capacity of NPC reached 5,788 MW by the end of 1987. The capacity mix by year end was 41 per cent oil based, 37 per cent hydro, 15 per cent geothermal and 7 per cent coal. As far as the transmission line is concerned, the total length is 12,380 circuits kilometers (62% in Luzon, 11% Visaya, 27% in Mindanao).

As shown in Table 2-1-20, coal and oil plants in all grids had a heat rate of 10,733 BTU/KWH in 1986. In case of coal fired power plants, Naga plant in Cebu island had a heat rate of 12,843 BTU/KWH while it was 9,640 BTU/KWH at Calaca .

Table 2-1-20 Thermal Heat Rate (BTU/KWH)

	1984	1986
Luzon	10,569	10,733
Visayas	10,294	10,726
Mindanao	9,438	10,872
Total	10,517	10,733
Coal fired plant		
Calaca	9,542	9,640
Naga	13,158	12,843

As shown in Table 2-1-21, the average generation cost at NPC was 0.8524 Peso/KWH in 1986. In the case of coal fired power plants, the generation cost of Calaca plant was 1.3008 Pesos/KWH (fuel cost 0.3893 Peso/KWH) and that of Naga plant was 1.7410 Pesos/KWH (fuel cost 0.8277 Peso/KWH).

Table 2-1-21 Generation cost per KWH

	Hydro	Oil-based	Geothermal	Coal
Luzon	0.2410	0.9938	0.8093	1.3008 (fuel 0.3893)
Visayas	0.5845	2.0431	1.0813	1.7410 (fuel 0.8277)
Mindanao	0.3209	17.1093		
Total	0.8524			

Observations and analysis of coal fired power plants

1) Calaca plant

(1) The primary concern of Calaca plant is the ash fouling effects of the Semirara coal. The high content of alkali in ash is the most active constituent in promoting hot zone fouling. To minimize ash fouling to acceptable levels, the most effective measure is to continue the present coal blending program.

According to the combustion test conducted by JICA, there was fouling in the boiler superheater area in the case of the use of 100 per cent Semirara coal, and plant operation was limited to only 6 hours.

The plant is now conducting a successful blend of local coal with imported coal which has a neutralizing effect on the high alkali coal.

(2) Deterioration of coal quality

Visual inspection in the coal-stockyard confirmed the deterioration of coal property due to spontaneous combustion. The coal inventory of Semirara coal should be reduced to an amount equivalent to one month normal operation of the plant.

(3) There is a plan to set up a second unit of the same capacity. Mobilization for this second unit may take place in late 1988. In this case, blending Semirara coal with imported coal will be necessary for a stable operation.

(4) Current heat rate is about 9,500 BTU/KWH and coal consumption in 1987 is as follows,

		(ton)
ASC/SSC	50/50	413,247
ASC/LC	50/50	6,216
SSC/LC	50/50	8,645
ASC/MC	50/50	6,154
SSC/ASC	55/45	200,027
SSC/ASC	60/40	59,025
SSC/ASC	70/30	2,784

(ASC: Australian coal, SSC: Selected Semirara Coal
LC: Luwimin coal, MC: Montenegro Coal)

2) Naga plant

The plant is using a dual firing system (oil/coal), because the required volume of coal can not be supplied due to coal handling problems. Coal handling problems are caused by a clayey property in coal, a high percentage of coal fines, and a high moisture content. When these problems are combined together, plant feed material agglomerates and adheres to the surface of the coal handling system causing coal supply interruption.

As the dominant factor that contributes to the handling problems is high moisture content, it must be kept in mind that the moisture content of coal should be reduced before sending it to the boiler.

At present the two boilers operate at a derated capacity of 36 MW each and a fired by 80 per cent coal and 20 per cent fuel oil. As far as the coal consumption is concerned, the daily volume of coal is 1,380 metric tons at full load operation of 100 MW.

Actual heat rate is

Unit-1	11,000 ~ 12,000 BTU/KWH (at 80/20 mix of coal and oil)
Unit-2	12,000 BTU/KWH (at 55 MW coal firing)
	12,950 BTU/KWH (at 55 MW oil firing)
	12,960 BTU/KWH (at 55 MW dual firing)

3) Atlas (Figure 2-1-5)

The power demand of the company is about 100 MW, and the Fluidized Bed boiler supplies 70 MW and the oil fuel boilers supply the remaining 30 MW.

Operating condition

bed temperature	800°C
ΔP	140 mm WG
fuel consumption	600 ton/day at 40 MW (8,500 BTU/lb)
coal	top size 6 m/m
limestone	top size 4 m/m
	30 kg/100 tons coal

Fluidized bed combustion is a reliable, and efficient method of providing steam from low grade coals. The use of limestone as bed material ensures very low sulfur emissions, while the low operating temperature in the bed ensures low NO_x emissions. High-ash, low-calorific coal can be successfully burned in a Fluidized Bed furnace at high thermal efficiency.

In view of the various types of coal, the fluidized bed combustion system can offer the best alternative to the pulverized coal burning plant.

2. Cement Industry

Most of the cement plant are in Luzon, and together eleven plants provide 70% of the Philippine cement production. Of the remaining plants, two are in Cebu and 5 are in Mindanao. Though total capacity in the cement industry is estimated at 7 million tons per year, many of the local cement plants are old and in need of repair, upgrading and modernization. At present 15 plants are in operation, and annual production in 1987 was approximately 4.4 Million tons.

Some of the plants will be modernized with increased capacity, and a minor rehabilitation program will raise existing capacities to about nine million tons per year.

Among the eight plants with the modern dry process, only one plant has a precalciner (FORTUNE) and no conversions from wet to dry process have been carried out due to financial problems, although several producers are seriously considering the option (saving of up to 60% of fuel can be achieved by conversion from wet to dry). Adding precalciners, the addition of auxiliaries and increasing Kiln speed will enable producers with large Kilns to essentially double capacity with only an approximate 50 ~ 60 % in fuel requirements.

Prior to 1980 only four cement plants were fired with coal, the remaining used fuel oil. Following a government mandate, seventeen cement plants had successfully converted to coal by March 1984.

As shown in Table 2-1-22, from 1984 to 1986, the demand for cement dropped, but in 1987 about 0.2 million tons of cement were imported due to supply shortage.

Table 2-1-22 Cement Production ($\times 10^3$ tons/Y)

1983	4,550
1984	3,510
1986	3,200
1987	4,240

Though there is a projected demand for 5.5 million tons of cement in 1988, demand for imported clinker is estimated at 0.1 million tons due to supply shortage.

At present, cement plants require at least 9,500 BTU/lb coal to produce the specified clinker quality, and use a 50/50 mix of imported coal and local coal. Imported coal is more economical than local coal at the same heat rate, and also the heating value of imported coal is higher than that of local coal.

Observation and analysis of cement plant

1) APO cement plant (Figure 2-1-6)

Process	:	wet process
Capacity	:	555 TPD Clinker, 670 TPD Cement
Fuel consumption	:	250 kg coal (10,000 BTU/lb)/ton-cement
Electricity consumption	:	120 KWH/ton cement
Cement cost	:	fuel 30%, electricity 15%

(1) The company is considering an expansion to three to four times capacity in three to five years.

(2) Price wise, imported coal is cheaper. Imported coal price is P 850/MT at 12,000 Btu/lb, while local coal price is P 830 at 10,000 Btu/lb. In terms of quality imported coal is better than local coal.

2) Hi cement

Process	:	Dry process, 4 stage SP.
Capacity	:	1,200 TPD Clinker
Coal consumption	:	200 TPD

The company is considering a plan to increase capacity. Some minor modification of the equipment may increase the capacity by as much as 30%.

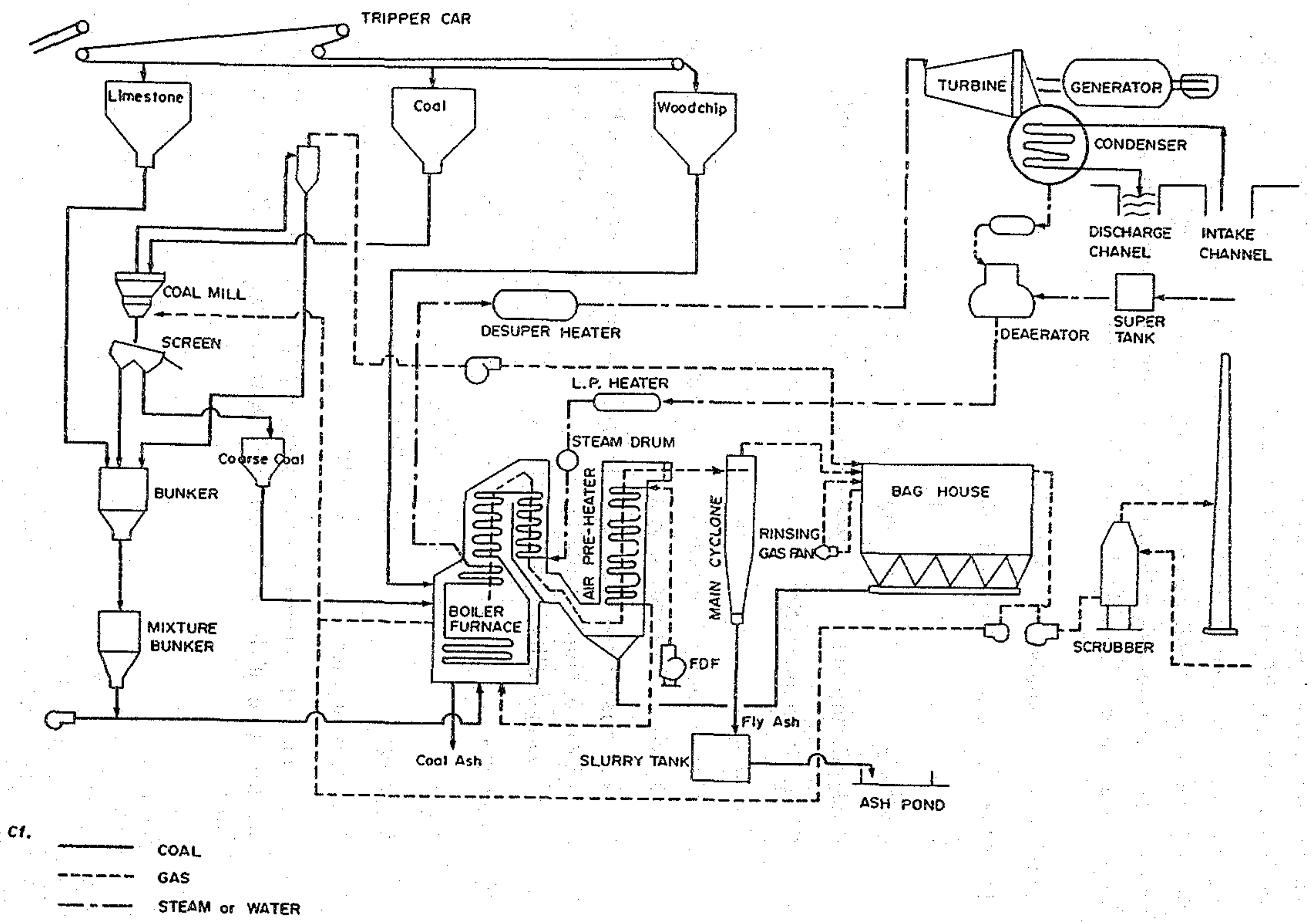


Fig. 2-1-5 Flow Diagram of Atlas Power Station

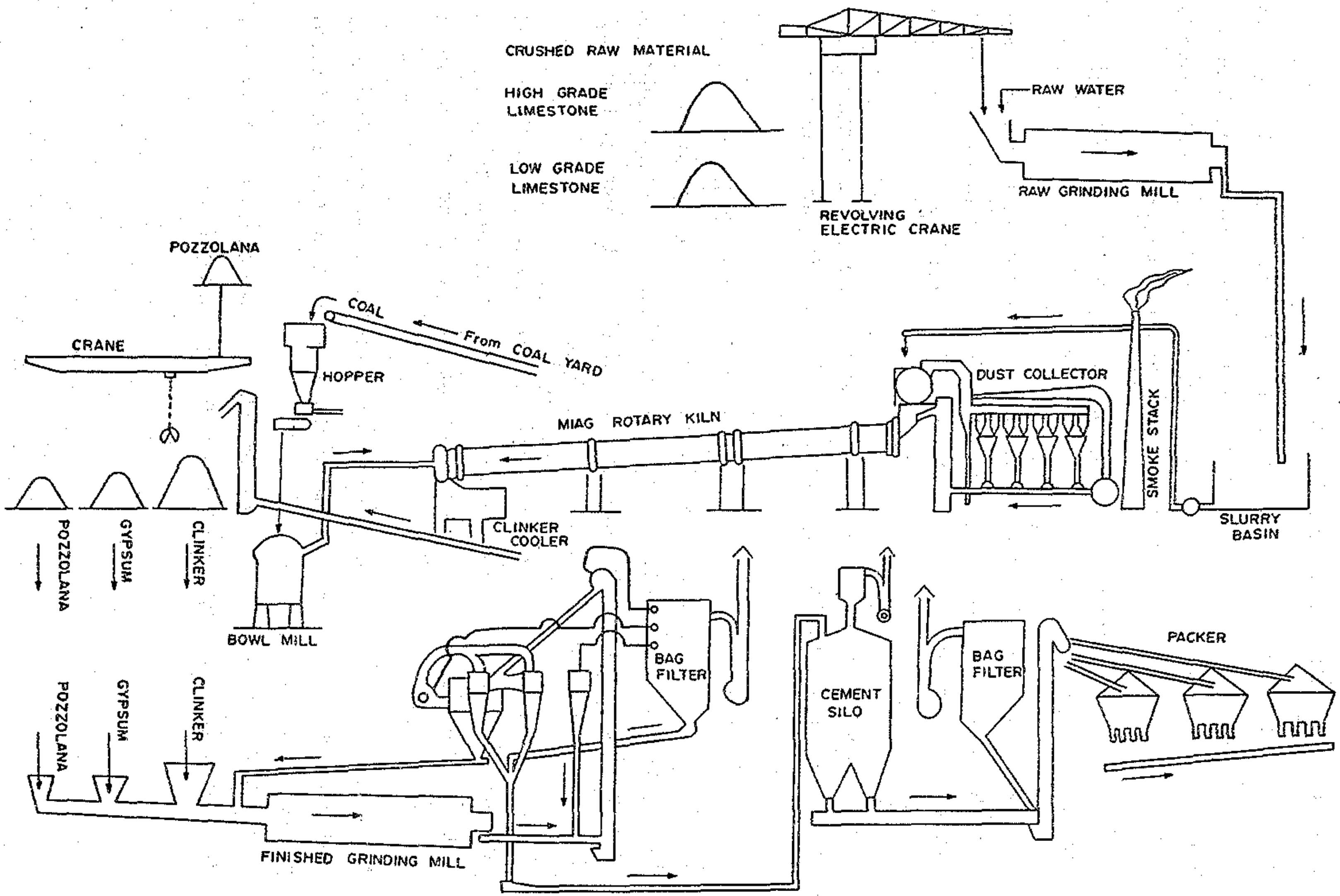


Fig. 2-1-6 Flow Diagram of APO Cement

2-2 Master Plan for the Activation of the Coal Mining Industry

2-2-1 Promotion of Coal Exploration and Development

The most effective manner in activating the domestic coal industry is to maintain a stable coal production with stable quality. At the same time, it is also important to define high potential indigenous coal deposits in many areas especially where the coal outcrops are covered by young volcanics or limestones.

The following recommendations should be employed for a successful coal exploratory and development works;

1) Systematic mining is required to reduce mining costs and improve productivity. Therefore, exploration by drilling or/and tunnelling has to be performed in future mining areas to make a comprehensive mining operation.

2) The government should legislate to subsidize exploration programs of the coal mines such as drilling and tunneling to give an incentive for systematic mining.

3) The government should define the potential of indigenous coal. Investigations including surface mapping, drilling, geophysical survey and tunneling should be conducted in the areas where the private companies were unable to explore due to high risk. It should be done by the OEA directly or some company on behalf of the OEA.

4) The government (OEA) should check and review in detail the report submitted by each coal mine for its five-year exploration and production program, and if insufficient, government should provide advice and aid on technical matters.

5) It is necessary for each mine, especially a small scale mine, to drill three to four holes with the average depth of 150 m in order to delineate the coal reserves for the deeper areas.
   To meet this concept, the government should have at least a set of drill machine and conducts drilling works in the exploration areas.

2-2-2 Management and Development of Manpower

In the Philippines, coal demand will increase continuously, yet indigenous coal faces the severe competition on price against imported coal. In order to improve the present statuation, the low productivity observed in most coal mines must be increased.

For the improvement of productivity, it is a principal factor to keep experienced manpower in terms of coal mining technology and labour administration.

It will need many years until the engineers and workers get accustomed to the mining technology and then propose better devices for daily work.

In order to minimize labor turnover, the coal mining must also be very attractive to the employees.

Considering the above-mentioned situation, the following measures to improve the management and to develop manpower capability are herein proposed.

a. A company can retain employees and maintain mining skills by paying much higher wages to employees, otherwise continuous service years of employees will not be long enough to maintain technology in the mine. As a component of the wages, an allowance related to the service years should be paid to the employees.

   In order to achieve the increase of workers' wages, a system of efficiency pay should be introduced so that the wages become more attractive to the workers.

   By the efficiency pay, the present wages (P30/day as an example of low wages) can be increased by 50%, if the productivity of a worker is increased by 0.1ton/manshift.

   The assumption is based on the following data. The increased productivity of 0.1 ton/man shift is worth P50 (as the ex-mine cost is P500/ton) and P15 (30% of P50)/manshift can be allocated to personnel expenditure.

b. Study meeting for managers shall be prepared to discuss more efficient and productive operations. Study meetings shall provide thoughts for improvement by presenting data from the operating companies. Study meetings shall be held in a national or a provincial scale.

   As to the education of the coal mine's management, seminars and discussion meetings for owners and managers should be held as a part of activities in the training center.

c. In order to train the increasing number of employees for coal mines in the future, there should be a training center to impart the necessary technical know how to the different levels from managers to workers.

d. Remote and isolated coal mines shall give attention to the social and environmental needs of the employees in order that they will enjoy a peaceful life.
Coal mines should provide clinics for the workers and their families for emergency treatments and should provide communication facilities and transportation to be used during emergency cases.

2-2-3 Mine Productivity

As contained in the Coal Demand/Supply, projections (refer to Figure 2-1-1), production from the underground sector in the year 2000 will be 1,782,000 tons, whereas 1,845,000 tons will come from the open pit sector including some new developments in Semirara (in 1987 - 476,000 tons (40.7%) from U/G, 639,000 tons (59.3%) from O/P).

According to this projection, production in the underground sector will be playing a more important role in the future in terms of not only tonnage but also quality. This is because most coal from the open pit sector is low-grade and mainly suited for power generation. On the contrary, coal from the underground sector is relatively high grade and suited for the various users.

Moreover, the projected production in the open pit sector will come mostly from the Semirara which is a highly mechanized and well organized mine in the Philippines.

Therefore, measures for productivity improvement in the underground sector should be considered and discussed hereafter.

A. Unification of small coal mines

Geological settings in the Philippines are complicated and characterized by numerous faults and folds. As a result, unification of adjacent small scale mines does not always turn out to be effective. But boundaries of mining lease should be adjusted by the OEA on a basis of long term mining plan for individual mine to increase productivity and recovery of the reserves. Adjustment of mining lease is important especially for mine planning in the deep part of the reserves.

B. Improvement on the mining technology

First of all, short-sighted operation due to financial constraints and management's reluctance to make investments should be avoided and long-term mine planning will really be needed. Otherwise it is very difficult to attain a high recovery of the reserves and keep production schedules efficient.

Secondly, underground mine structure in most of the mines should be restructured for long-term production plans and improvements in mine ventilation and transportation capacity.

Thirdly, underground transportation should be improved.

As a whole, it seems to be very difficult to employ continuous underground transportation systems, such as a belt conveyor system, for inclined shafts because of the steepness problem.

Therefore replacement of hoisting facilities now in use by larger ones is recommended so that several mine cars could be hoisted up simultaneously. Whereas, combination of mine cars for slope haulage and conveyors for level haulage could be recommendable in some mines. For the investment on the transportation systems, a sort of subsidy should be provided by the government organization such as the OEA.

Fourthly, mining methods being employed in some mines should be modified, for instance, the employment of blasting, semi-mechanized short wall and concentration of working faces.

Average productivities of the underground and open pit sectors in the past are 5.8 tons/manmonth (0.23 ton/manshift) and 39.5 tons/manmonth (1.58 tons/manshift), respectively. In the light of Japanese experience, this productivity level for underground sector correlates to that of 1945, 5.6 tons/man month (0.22 ton/manshift), where mining was not mechanized and geological settings were similar to that of the Philippines. But in Japan, productivity had increased gradually by 8.0% per annum for 15 years through the introduction of innovative technologies such as a combination of iron bars and hydraulic props, and simultaneous multi-seams mining method and concentration of working faces in a limited area in the mine as shown in Figure 2-2-2. Production went up at the same rate of productivity. Therefore, even in the Philippines, it is quite reasonable to believe that productivity and production level will increase at the same rate or higher, say 10% per annum, because mining technology is far more advanced now. Eventually, it seems feasible to improve productivity by 10% annually in the underground sector through implementation of several steps as follows (Figures 2-2-3 ~ 4).

(Model for Productivity Improvement)

In the underground sector, coal is loaded onto mine cars by shovelling and then hoisted up to the surface, except for the Malangas mine in the Philippines. According to a time and motion study of a mine, 60 to 70% of the time required for the transportation cycle (loading ~ tramming ~ hoisting) is allocated for loading coal. Therefore mechanized loading systems are needed to reduce loading time.

The next step is to raise haulage capacity for the level roads and inclined shaft. But generally, inclined shafts are steeply dipped due to the steepness of coal seams which are not wide enough to introduce continuous haulage equipment such as belt conveyors. Therefore, mine cars are used and/or will be used in the future for transportation of coal in inclined shafts and main level roads. But most underground coal mines do not have sufficient haulage capacity in inclined shafts to achieve future production targets. Therefore, it is necessary to replace the existing winding machines with larger ones. Consequently it becomes possible to introduce new mining technology and increase production through improvement in underground haulage systems and capacity.

An example which shows how to increase productivity and reduce production costs through improvement in loading, haulage and mining methods is shown below.

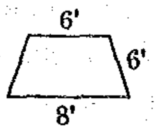
<MODEL>

MODEL 1 STEEPLY DIPPED MINE	MODEL 2 MODERATELY DIPPED MINE
STEP 1 Improvement in Loading	Introduction of Coal Winning Machine
⇩	
STEP 2 Improvement in Haulage Capacity on both Level Road and Inclined Shaft	
⇩	
STEP 3 Improvement in Mining Methods	

A. Model 1. Steeply Dipped Mine

A coal mine in Cebu is assumed as a model

- mining method : raise
- U/G transportation : mine cars hoisted up by a winding machine through inclined shaft
  level road – by hand tramming
- dip of coal seam : 45°
- thickness of coal : 1.5 m
- dimension of raise and mine road : 6' × 6' × 8'



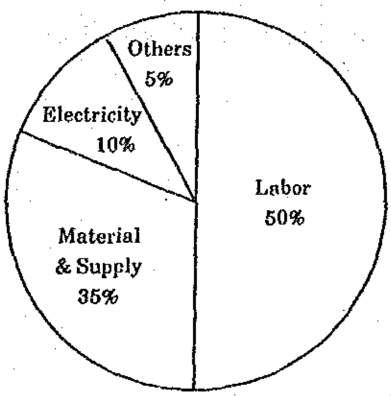
Cross section $3.15\ m^2$

- production : 1 raise 6 m/day
  2 developments 2 m/day

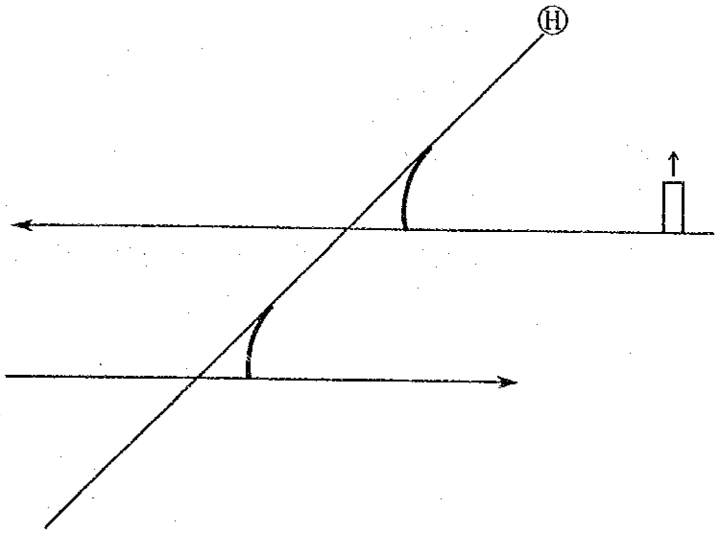
$3.15\ m^2 \times (6 + 2 \times 2) \times 1.3 = 41$ tons/day

12,300 t/year (41 t/day)

- manpower : 190
- productivity : 12,300 t / 190 / 300 days = 0.22 t/manshift
- production cost : assume FOB price as production cost



Labor : P628×50%×12,300t = P3,862,000
M & S : P628×35%×12,300t = P2,704,000
Electricity : P628×10%×12,300t = P772,000
Others : P628× 5%×12,300t = P386,000



STEP 1 --- Introduction of a scraper (over 3 years)

A storage bin at the junction of the inclined shaft and level road is required.
A couple of air hoists is also required to wind the wire back and forth of which a sort of bucket is connected.
Coal is transported to the storage bin by pulling buckets.
Although the haulage distance is limited to a certain range, say 30 m, this system can be applied to thin coal seam and also loading/haulage capability can be increased. Further investment could be kept small if a mine has already had air compressor. As 60% of transportation cycle is consumed for loading at present, raise can be advanced 30% more with introduction of this system.

Expected Output in STEP 1

raise	advance	8 m/day
development	advance	2 m/day
production	$3.15\ m^2 \times (8 + 2 \times 2) \times 1.3 = 50$ tons/day 15,000 tons/year	
productivity	15,000 tons /190 / 300 days = 0.26 t/manshift	

Cost Estimate in STEP 1

(CASE 1)

Basic assumptions

An air compressor being used is to be utilized.
Required equipment
air hoist 3 sets (3 × P200,000)
depreciable life 10 years straight line

Annual interest rate 15%
Material & Supply and Electricity consumed are proportional to output.

Expenses)	Labor	: P3,862,000 (45%)
	M&S	: P2,704,000×15,000/12,300 = P3,298,000 (38%)
	Electricity	: P772,000×15,000/12,300 = P941,000 (11%)
	Others	: P386,000
	(addition)	P600,000×19.9% = P119,000
	Others Total	: P505,000 (6%)
	Total	P8,606,000

Cost) P8,606,000/15,000 t = P574/ton (ΔP54/ton)

(CASE 2)

Basic assumptions

An air compressor is required (P1,240,000) and depreciated over 10 years straight line. Other conditions are the same as in case 1.

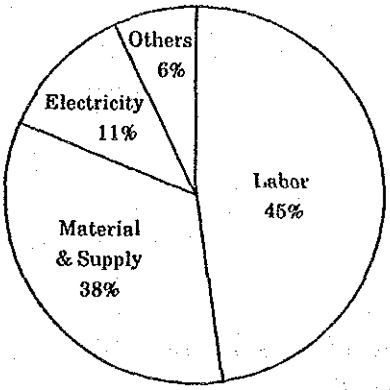
Expenses)	Labor	: P3,862,000 (44%)
	M&S	: P3,298,000 (37%)
	Electricity	: P941,000 (11%)

Other : P505,000 + P1,240,000×19.9% = P752,000 (8%)
Total : P8,853,000

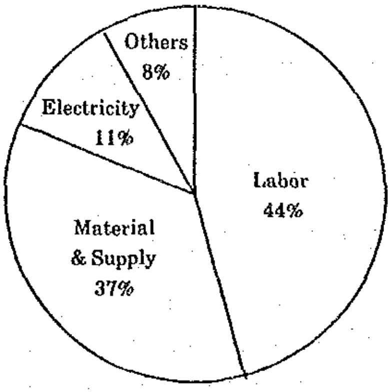
Cost) P8,853,000/15,000 tons = P590/ton (ΔP38/ton)

NEW COST BREAKDOWN

(CASE 1)



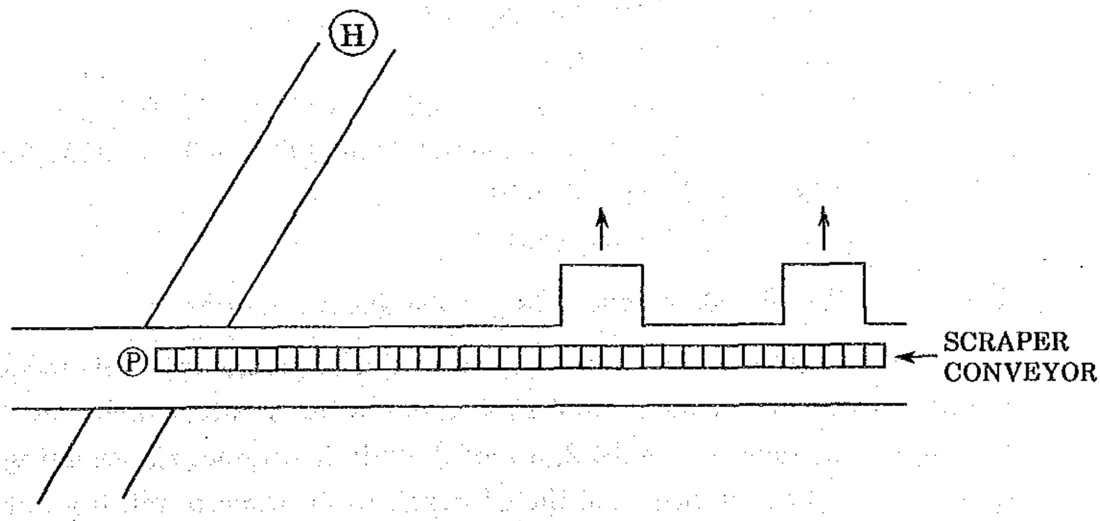
(CASE 2)



As most small mines are not equipped with a compressor in the Philippines, the following model analysis should be carried out on the basis of the cost breakdown given in CASE 2.

STEP 2 --- Introduction of scraper conveyor and a winding machine (over 4 years)

Haulage capacity of both level road and inclined shaft can be improved by applying scraper conveyors to level roads, and a larger winding machine to inclined shaft. With this improvement, several raises can be operated on a same level.



Expected Output in STEP 2

raise : 2 advances 8 m/day

development: 2 advances 2 m/day

production: $3.15\ m^2 \times 2 \times (8 + 2) \times 1.3 = 82$ tons/day
24,600 tons/year

productivity: 24,600 tons / 190 / 300 days = 0.43 ton/manshift

Cost Estimate in STEP 2

(CASE 1)

Basic assumptions

Required equipment

scraper conveyor 3 sets (P18,500/m × 150 m = P2,775,000)

depreciable life 2 years straight line

winding machine 1 (P3,000,000)

depreciable life 10 years straight line

Annual interest rate 15%

Labor cost approximately 2.5% annual increase

Expenses) Labor : P4,248,000 (29%)

M&S : P3,298,000 × 24,600/15,000 = P5,409,000 (38%)

Electricity : P941,000 × 24,600/15,000 = P1,543,000

(addition) $P1 \times 30^{kw} \times 0.7 \times 3^{sets} \times 8^{hrs} \times 0.5 \times 3^{shifts} \times 300^{days} = P227,000$

Electricity Total : P1,770,000 (12%)

Others P752,000

(addition) conveyor P2,775,000 × 61.5% = P1,707,000

winding machine P3,000,000 × 19.9% = P597,000

Others Total: P3,056,000

Total : P14,483,000

Cost) P14,483,000/24,600 tons = P589/ton (ΔP39/ton)

As shown, large cost reductions seem not to be expected with this model. It might be caused by an adoptionof 15% annual interest rate, which seems to be too high. Therefore in CASE 2, a model study is conducted, assuming that some financial assistance from the government for the coal mining industry will be made available so as to obtain an annual interest rate of approximately 5%.

(CASE 2)

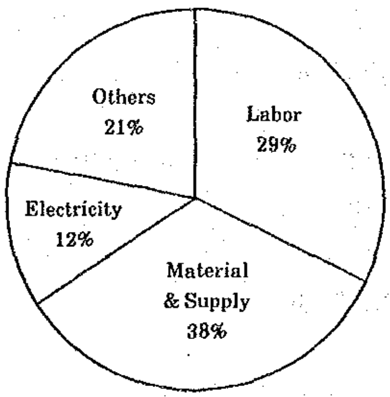
Expenses)	Labor	: P4,248,000 (30%)
	M&S	: P5,409,000 (38%)
	Electricity	: P1,770,000 (13%)
	Others	: P752,000
	(addition)	conveyor P2,775,000×53.8% = P1,493,000
		winding machine P3,000,000×13% = P390,000
	Others Total	: P2,635,000 (19%)
	Total	: P14,062,000

Cost) P14,062,000/24,600 tons = P572/ton (ΔP56/ton)

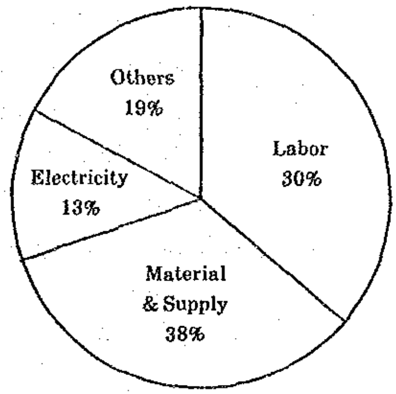
Therefore some financial assistance by the government, for instance, reduction of interest rate for the coal mining industry is required at this stage.

NEW COST BREAKDOWN

(CASE 1) I.R=15%



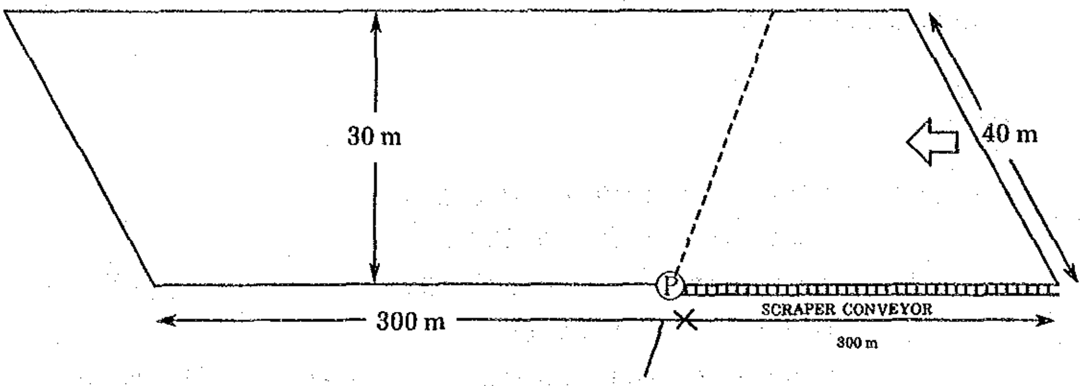
(CASE 2) I.R=5%



STEP 3 --- Introduction of semi-mechanized shortwall method (over 4 years)

The semi-mechanized shortwall method is introduced in place of the conventional raise mining method. Considerable increases in output can be expected with the new method which is characterized by centralized operation from a control panel.

Now new model is assumed shown below.



Expected Output in STEP 3

Operation in 3 shifts a day daily achievement 1.5 cycle

Output 30m×1.4m×1.5m×1.3×1.5 cycles ×0.9 = 110 tons/day
(equivalent to 33,000 tons/year)

Productivity : 33,000 tons / 190 / 300 days = 0.58 t/manshift

Cost Estimate in STEP 3

(CASE 1)

Basic assumptions

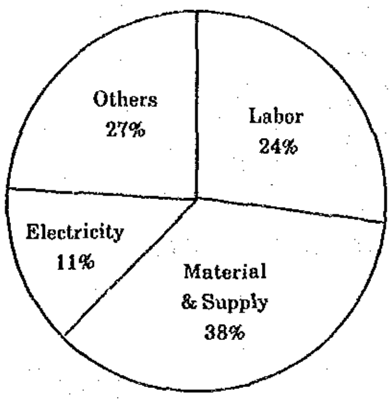
Required equipment
scraper conveyor 6 sets (P5,550,000)
depreciable life 2 years straight line
hydraulic props and iron bars
$70^{Sets}\times3^{Rows} = 210^{Sets}$ (×P26,200 = P5,502,000)
depreciable life 10 years straight line
hydraulic power pack 40 kw (P3,080,000)
depreciable life 10 years straight line
Annual interest rate 5%
Labor cost approximately 2.5% annual increase

Expenses) Labor : P4,673,000 (24%)
M&S : P5,409,000×33,000t/24,600t = P7,256,000 (38%)
Electricity : P1,770,000
(addition) $P1\times30^{kw}\times0.7\times3^{sets}\times8^{hrs}\times0.5\times3^{shifts}\times300^{days}$
= P227,000
$P1\times40^{kw}\times0.7\times1^{set}\times8^{hrs}\times0.7\times3^{shifts}\times300^{days}$
= P141,000

Electricity Total　　　P2,138,000 (11%)
Others : P2,635,000 − P1,493,000 = P1,142,000
(addition)　　　　　　P5,550,000 × 53.8% = P2,986,000
(P5,502,000 + P3,080,000) × 13% = P1,116,000
Other Total　:　　　　P5,244,000 (27%)
Total : P19,311,000

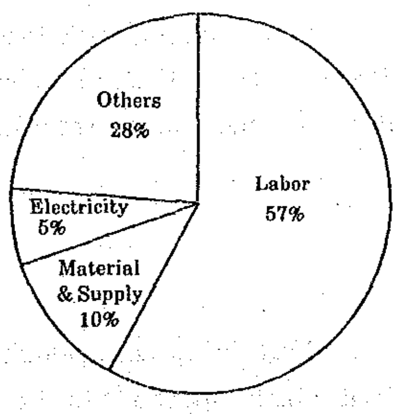
Cost)　　P19,311,000/33,000 tons = P585/ton (ΔP43/ton)

NEW COST BREAKDOWN



Comparing this output with that of a mine which employs a similar mining method in Japan, labor cost is lower and material & supply portion in this model is fairly high.

COST BREAKDOWN (JAPAN)



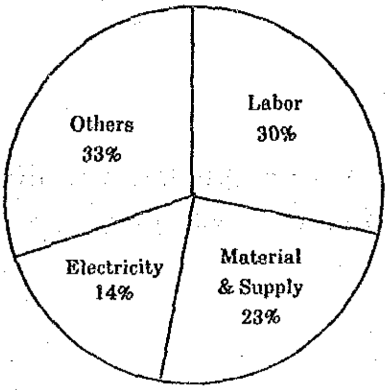
As labor costs in Japan are much higher, the differences between the two cases seem to be reasonable.
But the material and supply portions of this model seem to be too high because timber and other material costs in the Philippines are approximately

one-fifth of those in Japan. The reason for this discrepancy is that the material and supply portions for STEP 1 are applied to the model in STEP 3, assuming that the material and supply portions are proportional to production. But the mining method in STEP 3 is substantially different from that in STEP 3. Therefore, it seems to be reasonable to reduce the material and supply portions to 19%, half of 38%. A model study in which the material and supply portion has been reduced to half of CASE 1 is shown below.

(CASE 2)

Expenses)	Labor	P4,673,000 (30%)
	M & S	P3,628,000 (23%)
	Electricity	P2,138,000 (14%)
	Others	P5,244,000 (33%)
	Total	P15,683,000

Cost) P15,683,000/33,000 tons = P475/ton (ΔP153/ton)



Manpower has been assumed constant, for it is assumed that the surplus labor force generated through productivity increase will be absorbed in the areas not directly related to coal production such as maintenance and engineering services.

B. Model 2 Moderately Dipping Mine

Some coal mines are working on moderately dipping coal seams. But it seems to be difficult to apply semi-mechanized mining methods to those mines, except for the Malangas coal mine due to geological constraints. It is assumed that improvements in productivity for other mines, except for the Malangas mine, can be achieved through similar steps applied to the steeply dipping mines mentioned previously.

The Malangas mine which is already well-equipped and designed requires only coal winning equipment (Malangas mine is equivalent to STEP 3 in the model for steeply dipping mine). Therefore a model study is carried out, and the assuming plows are applied to the Malangas mine.

A coal mine in Japan which introduced plows achieved productivity increases by 50% for several years (8 t → 12 t/manshift).

<u>Outline</u>

Production	165,000 tons
Manpower	1,050
Productivity	0.52 t/manshift (300 days/year)

<u>Basic assumptions</u>

Production cost P628/ton

Cost components and proportion is the same for STEP 3 in steeply dipping mine

Required equipment

Plow 2 sets (P80,000,000)

shifter · hydraulic power pack (P12,000,000)

Total P92,000,000

Annual interest rate 5%

Depreciable life 10 years straight line

<u>Expected output</u>

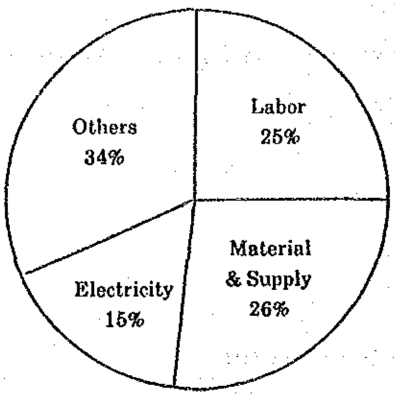
Productivity increase 50% (0.79 t/manshift)

Production 165,000 t × 150% = 248,000 tons

Expenses)	Labor	P628×32%×165,000tons = P33,158,000 (25%)
	M & S	P628×22%×165,000tons×248,000/165,000 = P34,264,000 (26%)
	Electricity	P628×13%×165,000tons×248,000/165,000 = P20,247,000 (15%)
	Others	P628×33%×165,000tons = P34,195,000
	(addition)	P92,000,000×13% = P11,960,000
	Others Total	P46,155,000 (34%)
	Total	P133,824,000

Cost) P133,824,000/248,000 ton = P540/ton (ΔP88/ton)

NEW COST BREAKDOWN



Projection of productivity in the underground sector is shown in Figure 2-2-4. According to this Figure, improvement in productivity at an annual rate of 10% in the underground sector can be expected through investment and introduction of new technology. Production costs at mine sites will also be reduced by approximately P140/t (refer to Figure 2-2-5).

In the process of this model study which is limited to mine site cost analysis, some financial assistance by the government is assumed as an incentive for investment.

But delivered cost might be reduced with new transportation systems from mine site to users and simplification of administrative structure. Therefore measures and assistance taken by government have to be considered on the basis of a total cost analysis.

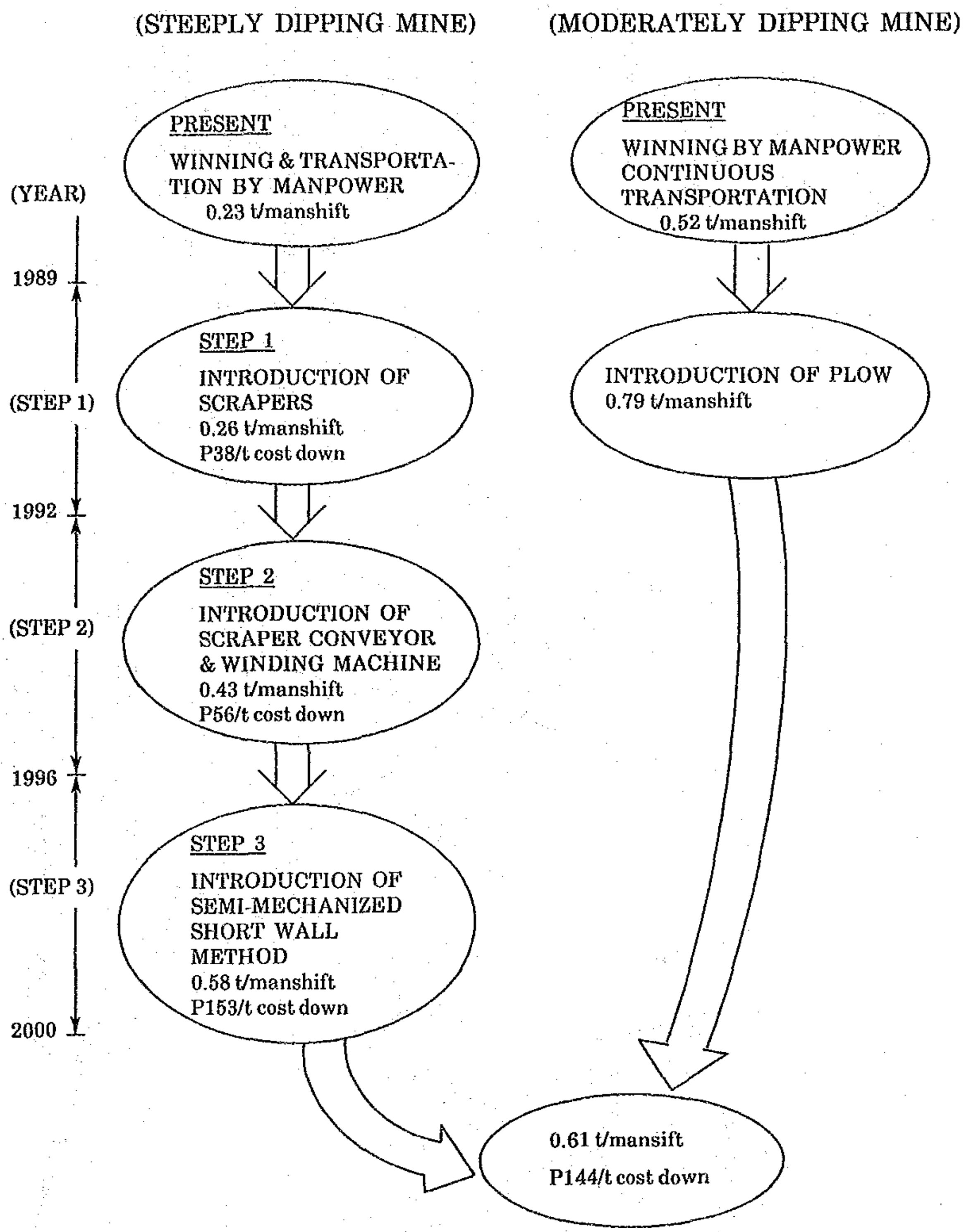
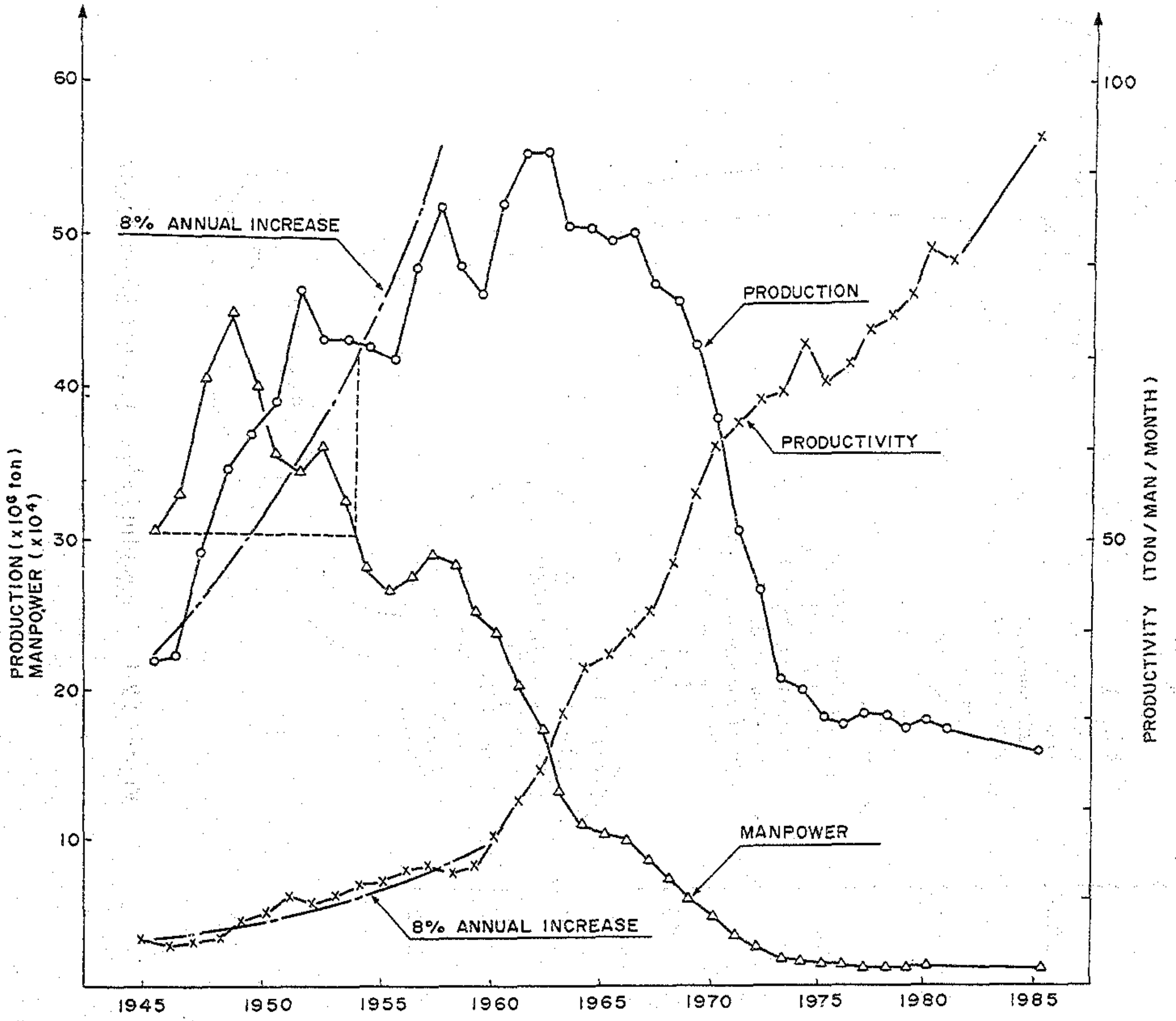


Figure 2-2-1 Conceptual Flow Chart of a Model Study

Fig.2-2-2 PRODUCTION / MANPOWER / PRODUCTIVITY OVER THE PERIOD FROM 1945-1985



REMARKS

(1949) INTRODUCTION OF IRON PROPS AND LINKED BARS

(1950) START OF SIMULTANEOUS MULTI-SEAMS OPERATION

(1957) INTRODUCTION OF CONTINUOUS MINERS

(1958) INTRODUCTION OF PLOWS

(1965) INTRODUCTION OF SHEARERS

(1966) INTRODUCTION OF RANGING SHEARERS

(1967) INTRODUCTION OF 30

(1968) INTRODUCTION OF CARBON MONOXIDE RESCUERS

(1969) ESTABLISHMENT OF THE TRAINING CENTER FOR MINING SAFETY

Fig. 2-2-3 PROJECTED PRODUCTIVITY

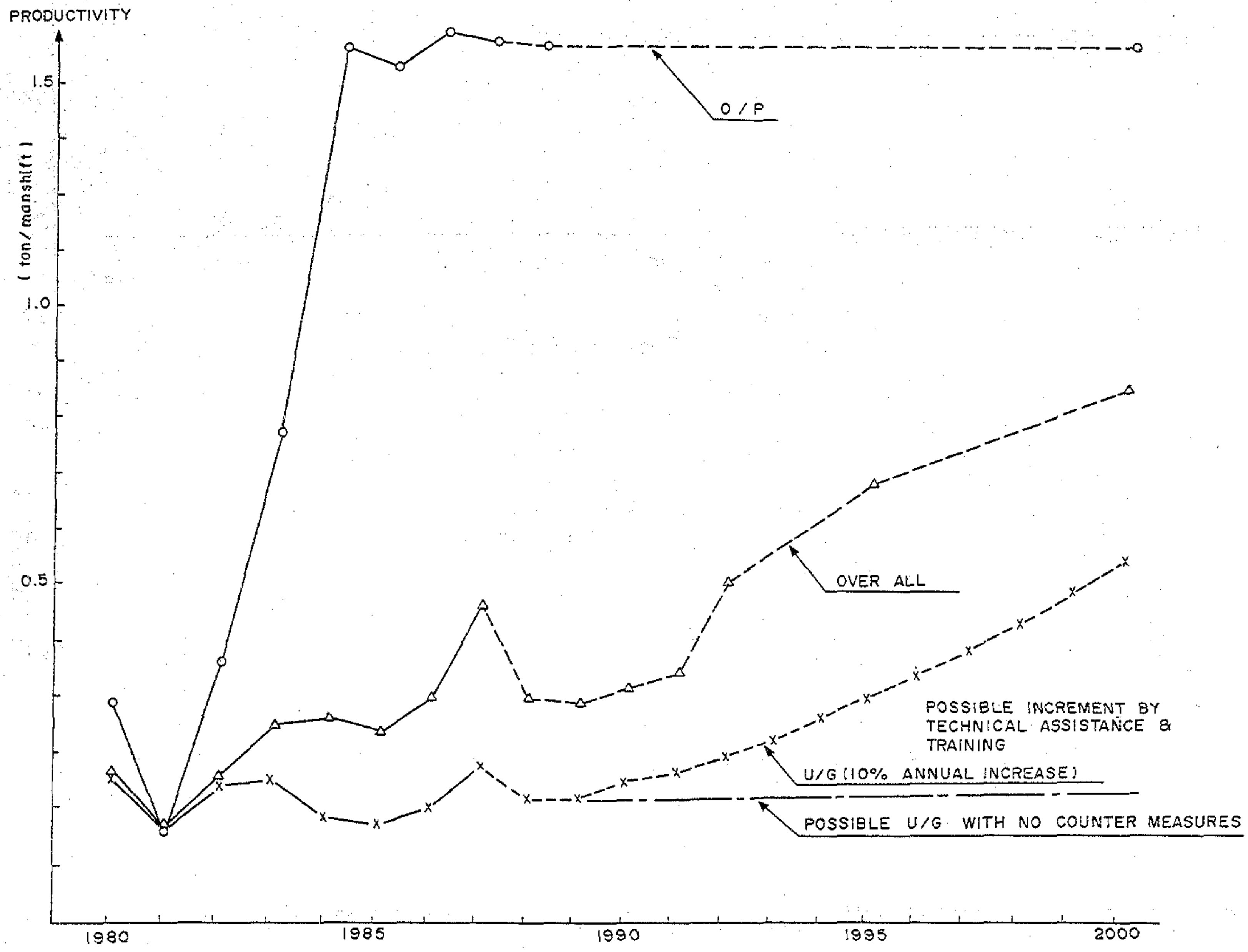


Fig. 2-2-4 HISTORICAL PRODUCTIVITY AND PROJECTION FOR THE U/G SECTOR

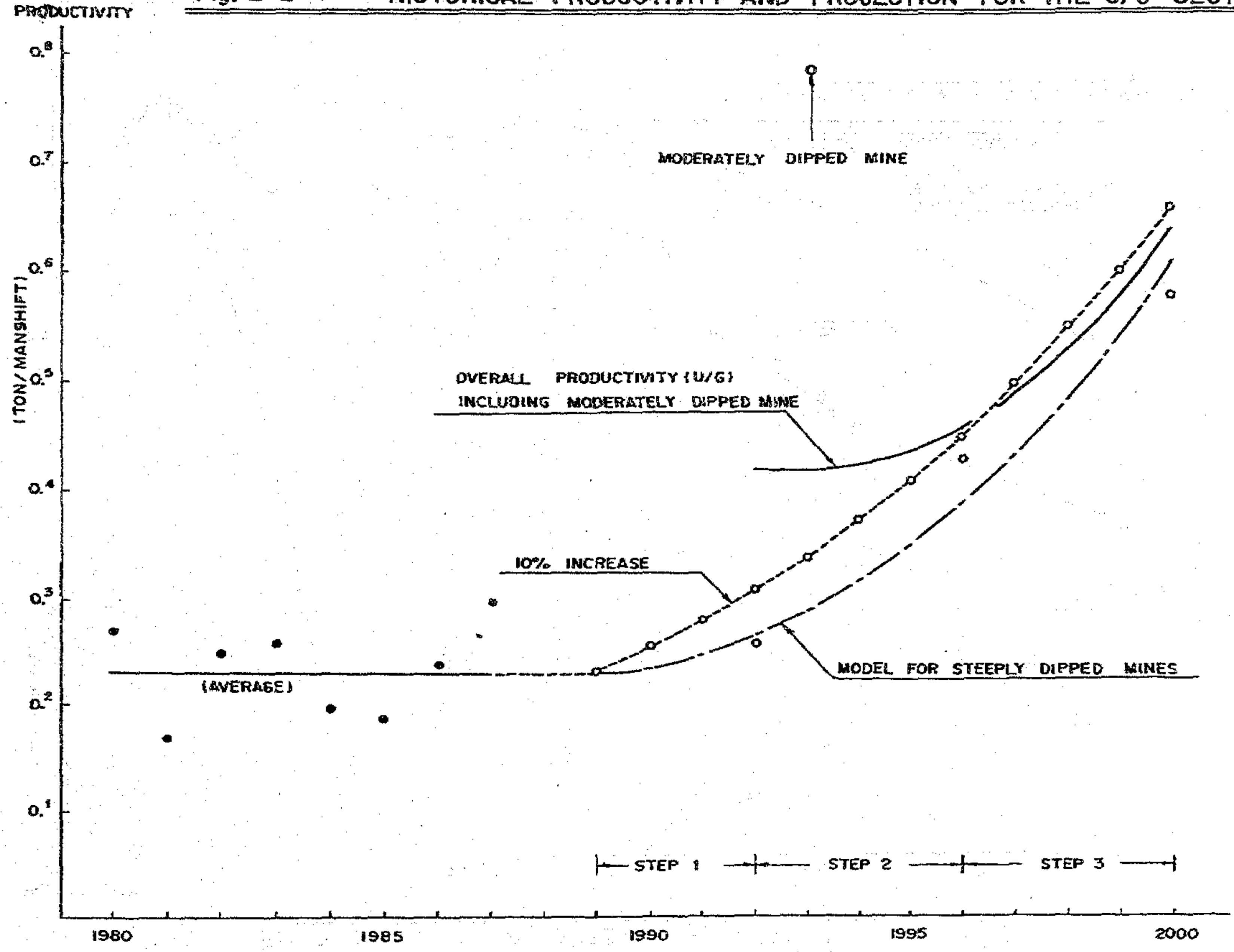
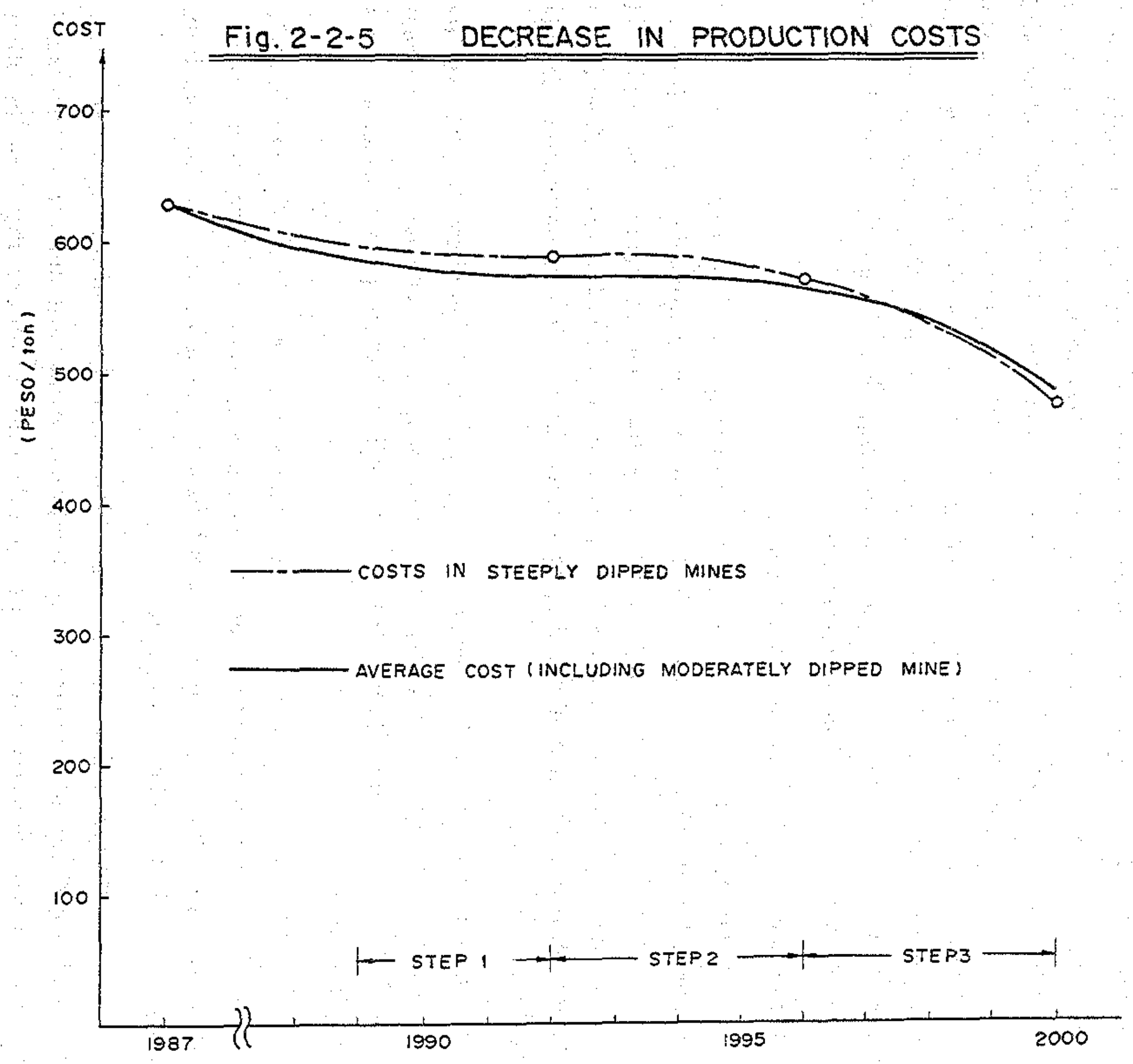


Fig. 2-2-5 DECREASE IN PRODUCTION COSTS



2-2-4 Upgrading of Coal Quality

As mentioned previously in section 2-1-3(4), upgrading of coal quality have seldom been conducted (except for the Malangas, the Semirara, and the Cebu Coal Mine, etc.). In the near future, as the production of coal decreases in the shallow parts and mining sites become deeper, it will be required to employ some mechanization in mining to increase production and productivity. If the mining face goes deeper underground, higher ground pressure may occur, thus resulting in worse underground conditions. As a result, more wastes from the heaved bottom and roadway will contaminate the run-of-mine coal through the hauling line from the working faces to the surface. Moreover, the introduction of mechanized mining causes more waste contamination to the run-of-mine coal. Therefore, it will be essential and unavoidable to introduce a washing plant for quality control in the long-term coal mine development program.

Introduction of centralized coal preparation.

The quality of coal delivered from coal mines shows an excessively high rate of contamination by wastes and fines which is causing many problems in handling and combustion at the user's plant sites. Principally, the washing has to be carried out at each mine site in order to save the transportation costs for the waste. However, if production is low, the cost of washing would become too high to maintain a feasible total operation cost.

Secondly, it is possible to construct one small scale benefication plant in the center of each coal field. However, the total production of each coal field is also less than 150,000 tons annually, which is also insufficient to keep washing costs at an acceptable level.

Therefore, it is recommended to construct a washing plant of approximately 200,000 t per annum capacity near the NPC's Naga thermal power plant, if the efficiency of the plant is guaranteed to obtain a specified quality of clean coal from many different kinds of run-of-mines.

The advantage of this method is that it permits the coal quality to be easily adapted to the required grade if the specifications are not too demanding, and it is not necessary to use imported coal or high quality coal for up-grading. On the other hand, this method is more costly than blending.

Centralized Coal Preparation Scheme

At first, an idea to set a centralized coal preparation plant of 100 t/hr capacity was proposed by Norwest in 1983 to uniform and upgrade variable coals from the Northern Cebu coalfield.

Based on the result of this study, the Norwest's scheme is modified to construct the preparation plant near the NPC Naga plant and to have a capacity of 200,000 tpa based on the two reasons.

a) The total production from the mines in the Northern Cebu coalfield which is only 100,000 tons is insufficient to make the project economically feasible.

b) Some coals from the mines in Central and Southern Cebu, amounting about 70,000 tpa, have to be beneficiated together with those from the Northern Cebu.

(1) Capacity of washery

50 tons/hour $$\frac{200{,}000 \text{ tons (ROM)}}{300\text{ d} \times 24\text{ hr} \times 0.8} \fallingdotseq 35 \text{ tons} \rightarrow 50 \text{ tons/hour}$$

(2) Investment cost

· Washery plant	900	refer to { Norwest report Dia consultant report
· Coal stockyard	680	
· Others	620	
Total	2,200 (×$1,000)	

(3) Operation cost

· Depreciation	306	Depreciated for 15 years Annual interest rate 11%
· Running Cost	246	Power, Labor, Maintenance, Others
Total	552 (×$1,000)	

Unit Cost 2.76 $/ton (ROM) $552{,}000 \div 200{,}000 \fallingdotseq 2.76$
55 P/ton (ROM)

Although P55/ton is required for the beneficiation of raw coal, the benefication of coal would be recommendable to ensure a continuous supply of uniform and high calorific coal to the power plant for more efficient power generation.

When the expanded utilization of the indigenous coal is achieved by the beneficiation, a corresponding amount of imported coal will be saved.

2-2-5 Mine Safety

1) In order to maintain mine safety, the following measures are recommendable:

   a) To increase the government inspectors.

   b) To assign resident inspectors at least in Cebu and Mindanao areas.

2) In order to improve mining safety technology and higher standards of knowledge for government inspectors, training for them at the training center would be recommendable.

3) To require each mine to have a complete set of mine safety equipment and other machinery and to adopt a revised rules and regulations. If necessary, the government has to subsidize the purchase of gas detectors, carbon monoxide self-rescuer, oxygen breathing apparatus, etc. for each coal mine on a special financing arrangement.

4) Improvement of mining safety consciousness among engineers and workers through the enforcement of safety training for all workers by the government inspectors at the mine site or in the training center, accompanied by the improvement in mining technology and broader knowledge of the engineers.

5) The present safety system only stipulates to assign at least one safety engineer qualified by the government in each mine and to nominate safety inspectors and fire bosses by the approval of the government according to the experience in the mine. This system may give uneven level of mine safety technology.

   Therefore, systems and rules on mine safety have to be amended to meet actual requirement given in the foregoing chapter.

   For the execution of the new safety rules and regulation, comprehensive training in a kind of training center will be required.

6) In order to promote personal mine safety consciousness, introduction of a new official personal commendation system would be recommendable in addition to the present official commendation system by the company.

2-2-6 Expansion of Coal Utilization

It is essential to increase a coal demand for the promotion of the coal mining industry.

(1) Coal Utilization Program

With reference to the 1988~2000 period, Table 2-2-1 shows some coal utilization programs for various industries. Coal demand in 1988 will be 2.2 million tons whereas it is forecasted to be tripled to 7.4 million tons by 2000.

Table 2-2-1 Coal Operating Contract – Revenue Sharing Formulae

(%)

Ownership of Philippine (P) (%)		Contractor's Share			Government Basic Share
		BOF	SOA	Total	
A:	P = 100	40	40	80	20
B:	60 ≦ P < 100	40	30	70	30
C:	40 ≦ P < 60*	40	20	60	40

Note: * The Philippine Constitution does not allow less than 60% Philippine ownership in the coal mining industry.

The electric generating industry, which is and will be the largest coal consumer in the Philippines, will be consuming 5 million tons of coal in 2000 due to new operations of coal fired power plants such as Calaca II (300 MW) in 1992, Calaca III (3000 MW) in 1995, Isabela (300 MW) in 1999, and Iguig (300 MW) in 2000 (Refer to Table 2-2-3).

Table 2-2-2 Partial List of Coal Contractors with Foreign Investors

Name of Contractor	Foreign Investor	% of investment of foreigner	Contract date	Production (1987)
Cravat Coal Mines, Inc. (CARBEX)	American	30	Jan., 1987	33,512 tons
Zamboanga Coal (Zamboco)	Chinese	10	Jun., 1980	No Operation

Table 2-2-3 Major Grant-In-Aid Projects in the Field of the Coal Mining Development

Semirara Coal Mine Development	1978	Austromineral supplier's credit (Backed by Australian Government and banks)
Himalian Area Coal Development F/S	1983	USTDP (Dames & Moore)
Semirara Coal Quality Survey	1987	CIDA (MONENCO)
Malangas Coal Mine Development T/A	1979	ADB (Dia Consultants)
Malangas Coal Mine Development	1979–83	ADB (Dia Consultants)
RP National Coal Logistic Study	1981	Australian Dev. Ass. Bureau (MacDonald Wagner & Priddler and others)
Bislig Coal Mine Development T/A (incl. Coal Logistics)	1982	ADB (Dia Consultants)
RP-German Coal Exploration Project	1982–87	WG BGR (WG Experts)
Cebu Coal Washing Study	1983–84	TDP (Norwest Resources)
North Cebu Transportation Study	1983–84	TDP (Davy McKee)
RP Coal Survey	1983–87	World Bank (JACIA, BMCL)
Asean Coal Mine Development Project	1984–85	ADB, UNDP, ESCAP (MONENCO)
RP Coal Resources Survey	1985	British ODA (Wardell Armstrong)
Private Sector Coal Mine Survey	1985–86	ADB (MONENCO)
Coal Mine Consultancy	1987–90	WG GTZ (Saarberg Interplan)

(2) Expansion of Coal Utilization

It is required to review government policy on the promotion of coal utilization to implement the coal utilization programs shown previously. And on the consumers' part, cooperative operation plans and alteration of plant in accordance with the government policy will be required.

(i) The government has to continue providing coal consumers with the same tax incentives for the expansion of coal utilization as have been awarded to the cement industry when it converted its energy source from oil to coal.

(ii) The National Power Corporation which is the largest consumer of coal, has to propel new projects for coal-fired power plants such as Calaca II (300 MW). The cement industry will be required to rehabilitate and modernize cement plants for cost reduction and increase in fuel efficiency, by installing a calciner or suspension preheater, or converting the cement making process from wet to dry method, as already stated in 2-1-3-(7).

(3) Role to be Played by Indigenous Coal

The coal mining industry has to ensure a stable supply of coal to meet consumer needs and in order to help achieve an expansion in coal demand in the future. In order to achieve this, the coal mining industry has to solve the following problems.

(i) Stabilization of coal quality by introducing a sort of centralized preparation plant and other methods.

(ii) Cost reduction for competition with imported coal.

(iii) Reduction of moisture content in the coal especially in the rainy season – construction of drainage ditch, covering of stockpile –

With the view of achieving self-sufficiency in domestic energy, the Philippine government has to promote not only the development of low-grade coal (i.e. lignite, low-calorific value) from northern Luzon (Isabela, Iguig) but also its effective utilization. Especially, research and development programs for the utilization of lignite (drying, briquetting, and low temperature carbonisation) have to be boosted. It will also be essential to introduce the fluidized bed boiler (circulating fluidized bed) which is able to burn low grade coal, as part of the proposed coal-fired power plants.

2-2-7 Policies and Measures to be undertaken by the Government

Protection of the indigenous industry is an important issue to be discussed. In many countries, protection of infant industries is indispensable.

To increase coal production and consumption as forecasted by the OEA, the Philippine coal industry as well as coal consuming industries, will need a substantial amount of fund for investment.

To stimulate the development of coal resources, the government introduced a Coal Service Contract System. Incentives for service contractors are determined in the Coal Development Act as mentioned in Chapter 2-2-1. These measures should be maintained from now on.

The Coal Council of Advisors determine policies such as;

1) Allow coal importation only when there is a short fall in local supply vs. demand.

2) Adopt an import/domestic ratio of 45/55,

3) A guiding price for local coal at P704/ton on an 8,500 BTU/lb basis, FOB Cebu.

These policies are effective to increase the local coal production. In addition to these, the OEA share which currently goes to the national treasury, should be reverted back as source of funding for the modernization of the coal mining industry i.e. financial source at low interest rate.

2-2-8 Practical Measures under the Master Plan

After reviewing the present status of the coal industry and the forecasted demand expansion by the year 2000, it is inevitable that coal production should be increased in order to meet the demand. To achieve the required production increase, the available measures to be implemented are to develop the new potential areas or improve the productivity of the existing coal mines.

Many of the potential area are amenable to opencast mining, such as the Himalian and Panian areas in Semirara island and several scattered areas of brown coal deposits in the Cagayan valley, while the other areas are only exploitable by underground mining, i.e. PNOC-CC's Bislig Mine No. III, Integrated little Baguio, and Lalat areas.

However, the development of the new areas are subject to certain restrictions, which may affect the feasibility of the project, such as price competitiveness of locally mined coal against the imported one.

Some of the areas for opencast mining can only be used for limited combustion systems, such as special boilers for low heating value coal.

In order to increase production, mining has to be undertaken not only by labor-intensive techniques but also by methods to improve mining productivity and thereby compete with imported coal on price.

Productivity improvement of the existing opencast mines will be achieved only by up-grading the skills of the engineers and workers and also by an increased coal demand, because the mines are already highly mechanized.

On the other hand, the improvement in the productivity of the existing underground coal mines, which supply about one half of the whole coal production, will be carried out by the mines concerned. This might be the most effective and practical way for the improvement of the coal industry.

Coal production has increased since the oil crisis, reaching a level of a million tonnes per annum recently. This has been achieved through the introduction of labour intensive schemes rather than as a result of technological development. It will be very difficult therefore, to expect further improvements in productivity without any further measures to improve mining technology except for the mines operated by S.C.C. and PNOC-CC which both belong to government subsidiary companies. The average productivity of underground coal mines in 1980s, except for the PNOC-CC's mines, is 0.23 t/man·shift, which is nearly the same level as that of mines in Japan in 1945. As there seems to be only a limited number of potential coal resources, such as the Himalian and Panian deposits on Semirara island and some young lignite deposits in the Cagayan valley district, it seems that production increase will be achieved by improvements in productivity.

On the other hand, the price of domestic coal is approximately P200 higher than that of imported coal on a weight basis even after allowing for taxes worth 20% of the CIF price plus P10/ton. In order to obtain price competitiveness against imported coal and a steady production increase to meet the country's expanding demand for coal, the only way is to increase productivity at the moderate- and small-scale underground coal mines by improving their underground structure.

After a cautious review and analysis of the present status of the Philippine coal mines, an annual increment in the productivity level of the underground coal mines is forecasted to the level of 10% based on historical data in Japan. In this case, the present productivity will reach 0.6 t/man·shift by 2000 year. The mission has forecasted an annual production of approximately 3.63 million tonnes, except for the production of Cagayan lignite, against approximately 6.38 million tonnes by the OEA under the same assumptions.

The actual measures for the execution of the master plan range from the improvement of the mining methods and ventilation and drainage systems to the innovation of underground structure. However, it may be very difficult for the Philippine coal mining industry to achieve these innovation targets by itself. At least the following measures would be required.

1) For the improvement of the coal mining technology, the Philippines will need experts in the transition phase who should be familiar with mining technology used in similar geological conditions. Experts will transfer new technologies to the Philippines and carry out the improvement of coal mining with experts of the Philippines.

2) Prior to the innovation programs for the coal mines, a series of exploration works ranging from geological surface surveys to drilling will have to be carried out to obtain the necessary information for mine planning. Exploration by drilling would be more effective if conducted with drilling machines owned by the government in order to reduce the investment risk in small mines. The detailed schemes for the exploration works will have to be determined by the experts.

3) For a major innovation of the mine, quite a large amount of investment would be required. It might be difficult to obtain the consent of the owners, so that effective persuasion through seminars or other means will be needed, and it will also be essential that the owners should have a positive desire to implement a long-term management program for their coal mines with the educational activities of the Center providing a clearer understanding of the exact process of improvement, e.g. improvement of productivity, assurance of safety, and improvement in working conditions, etc., to obtain steady earnings.

4) For the actual execution of the above various improvements, many trained and skilled engineers and workers would be required to adopt the new technologies to be applied for the new underground mining systems.

In order to meet these requirements, basic training at all levels, including the managers, owners, engineers, and workers will be necessary and has to be conducted as early as possible.

Regarding the coal mines belonging to the government subsidiary companies, at least a certain degree of training has been carried out at the mine site for the operations in their modernized mines, but the training for newcomers will be insufficient because quite large number of newcomers will be recruited every time.

In view of these urgent requirements of training for the achievement of the technological innovation in the Philippine mining industry, it appears to be most effective to establish a training center as the organizational platform for the execution of the master plan.

2-3 Economic Impact of the Vitalization of the Coal Industry

2-3-1 Economic Impact on the Industrial Level

a. Reducing the burden of domestic coal users

a-1 The necessary investment

We examined the area of modernization investment for steeply dipping mines and a moderately dipping mine. Assuming moderately dipping mines (other than Malangas) to be similar to steeply dipping mines, we will evaluate the effect of modernization investment, taking underground mines (excluding Malangas Mine) as an example. The necessary investment is as shown in Table 2-3-1.

a-2 Effects of modernization investment

The cost structure for the Philippine coal mining industry has not been disclosed. We have tried to estimate the cost structure for both the present and future, based on the information on the Uling coal mine and others.

The key points for the cost estimates are as follows:

① With regard to modernization investment, we have applied the results obtained from the examination of the Uling mine as a model (at the EX Mine) to underground mines nationwide (excluding Malangas). We assumed that the investment is proportionate to the production, and the interest rate is to be 15% p.a.

② We have estimated the present and future cost structure (other than the capital cost), keeping in mind the differences between the Uling mine and the national average for underground mines.

③ While the discussion based upon the Uling mine as the model included up to Ex Mine stage, here we included transportation costs and general expenses as well as profits, and examined the possibility of reducing local coal prices. As for the profit rates, we set it at 25% of the price for the present as well as for the future.

④ All figures are based on the current constant prices.
The outcome is shown in Table 2-3-2.

Table 2-3-1 Modernization Investment (U/G, Excl. Malangas Mine)

	Unit	Step 1 (1990-1992)	Step 2 (1993-1996)	Step 3 (1997-2000)	Total (1990 -2000)
Production	(year)	(1992)	(1996)	(2000)	
	1000T	583.3	969.2	1,534.1	
Investment (Service life yrs.)		Compressor + Pipes (10yrs.) 36 HP Hoist (2yrs.)	Scraper Convenyors (2yrs.) Winding Machine (10yrs.)	Scraper Conveyors (2yrs.) Hydraulic Props & Iron Bars (10yrs.) Power Pack (10yrs.)	
Investment/ Production (Pesos/T)		*② *③ 118 ～ 160	*② *③ *①330 ～ 548	*② *③ *①480 ～ 760	
Total Investment (Million Pesos)		69	*①320	*①736	1125

Note :

*① Investment in Step2 & Step3 includes conveyors rebuilt.

*② The smaller figures represent investment divided by production in the last year in each steps.

*③ The larger figures represent investment divided by production in the previous year before each step starts.

④ Besides investment in this table, investment for washing plants and infrastructure is needed.

Table 2-3-2 Costs Estimate (U/G)

	1989		1992		1996		2000		Cost Difference	Cost Down Rate
Production (1,000T)	459.6		583.3		969.2		1534.1		2000-1989	2000/1989
	pesos/t	%	pesos/t	%	pesos/t	%	pesos/t	%	pesos/t	%
Production Cost	469	58	417	57	345	46	225	36	-244	52
Capital Cost	-	-	24	3	103	14	149	24	149	-
Transportation	100	13	100	11	90	12	80	13	-20	20
General Expenses etc.	31	4	24	3	22	3	19	3	-12	39
Total Cost	600	75	565	75	560	75	473	75	-127	21
Profit	200	25	188	25	187	25	157	25	-43	21
Price	800	100	753	100	747	100	630	100	-170	21
($)	(38 $)		(36 $)		(35.6 $)		(30 $)			
Imported Coal Price ($)	(30 $)		(30 $)		(30 $)		(30 $)			

Note: 1. Based on Model Analysis and the Master Plan, excluding production of the Malangas coal mine.

2. For interest rate, 15% is applied. 3. At 1987 constant prices.

4. Production costs include labor, material & supply, electricity and others.

According to it, while the domestic coal prices are over 20% higher than the current CIF price of $30 for imported coal, it will be possible to reduce it by steps so that by the year 2000, it will reach a level comparable to imported coal CIF prices. Such a cost reduction will be possible owing to the following reasons:

① In order to increase the production by 3.3 times with the present employees through modernization investment, the productivity should be raised by 10% each year.

In concrete terms, during Step 1 (1990 - 1992), in order to improve the loading capability, hoists should be introduced to the mines with moderately dipping-seam so that 1.3 times the present production will be achieved.

In Step 2 (1993 - 1996), investment in scraper conveyors and winding machines will improve the production by 1.6 times.

In Step 3 (1997 - 2000), semi-mechanized short wall mining method will start in 1996, the production in 2000 will be 1.6 times that in 1996.

As a result of the modernization investment, labor cost will be reduced significantly, but the capital cost will increase. In reality, however, wages will increase inevitably and substantially due to inflation. In contrast, the rise in the prices of investment goods are expected to be relatively low. When we take the future price increase into consideration, we believe that cost reduction through labor savings will be great. In addition, improvements in safety through mechanization can be expected.

On the other hand, there would be some increase in maintenance cost while production decrease due to mechanical breakdown. These adverse effects are not included in the estimates.

② Transportation will be improved using larger trucks, thereby improving the turnover rate and the loading method, etc. In addition, the production increase and road network development will consequently decrease the average haulage mileage and hours that will reduce transportation costs (Development of infrastructure such as roads and ports is essential).

③ The increase in operating expenses will be minimized, and the cost per ton of coal will be reduced. This is possible through rationalization of office work, etc.

a-3. Users benefits

With regard to the costs of coal-fired power generation and the costs of coal, the following data in Table 2-3-3 are available.

Assuming the proportion of coal costs for power generation to be between 30% and 50%, a coal cost reduction by 10% would reduce unit power costs by 3 to 5%. If a 20% reduction in the domestic coal price is achieved by the year 2000 as we estimated, the power unit costs will be reduced by 6 to 10%.

Cement production cost is 39.80 pesos per 40 kg bag, of which coal costs is said to be 6.0 pesos (excluding Hi-cement). The proportion of costs for fuel coal in the total cement costs is around 16.5%. If coal prices go down by 10 to 20%, cement costs will be slashed by 1.7 to 3.3%.

b. An increase in the amount of OEA share and vitalization of the coal industry based on the reinvestment of the OEA share.

As it is stated in Chapter 2, coal producers must pay a certain percentage of the sales to the government as royalty. This is called the OEA share (Office of Energy Affairs Share). The OEA share amounts to about 3% of the gross sales.

As the Master Plan indicates, if the coal production continues to increase and the OEA share ratio to the gross sales remains at the present level, the total amount of OEA share will increase. If we assume that the coal price is lowered to the current imported coal CIF price at 630 pesos per ton in 2000, then the OEA share in the year 2000 will increase to about 2.3 times as large as the present amount (Table 2-3-4).

At present, the OEA share goes directly into the government treasury, but the OEA has begun to work for the regislation through the Congress, of a law so that the OEA share may be earmarked for the coal industry. If this effort succeeds, a fund for carrying out various types of powerful measures for the modernization of the coal industry such as low-interest loans, is developed. Through reinvesting this fund into the coal industry, we can expect the coal industry to be vitalized.

c. The total number of employees in the domestic coal industry in 1985 was 12,000. But, it was reduced to 6,500 by the end of October 1987. The reason for the reduction was that some cement plants and Naga Power Plant stopped to purchase local coal temporarily. According to the Master Plan, the employment will be expanded to nearly 13,000 by the year 2000.

The total number of employees engaged directly in coal mining is not large when we look at the figure on a nationwide basis. However, in areas such as Cebu, the industry provides an important place for employment because there are no other significant employment source to speak of especially in mountain areas. This point should be paid attention to. With a very severe economic condition such as this, we should reflect upon the significance of job opportunities for over 10,000 workers (Table 2-3-5).

Furthermore, there are additional workers employed in the stevedore works for coal at ports and harbors, the coal transport, and the other related industries. Thus, it is said that the total number of persons employed in industries and business related to coal amounts to several times the total number of workers who are directly engaged in coal mining. According to a report issued by the Philippine Chamber of Coal Mines. Inc., coal's indirect employment is estimated at 9 times the size of the direct coal mining employment, but the basis is not clear. This figure seems to be an overestimate, but the indirect employment is undeniably considerable.

Now, if the competitiveness of the domestic coal industry is improved in the future, and the wage level of coal mine workers is raised, this may help promote the development of coal mining communities, which in turn, will also induce commerce to settle. (At present, there is no town or city which can be called a mining town.)

d. Mastery and improvement of skills and technology in the coal industry, and improvement of safety.

The technical level in the Philippine coal mining industry is about fifty years behind that of other coal-producing countries. The productivity is on the same level as that in Japan immediately after the end of World War II. The accident rate is high as well. The coal mine accidents in ten years between 1978 and 1987 amounted to about 3,000, which killed at least 154 workers. The number of days lost came to 960,000. Accumulated total of working hours amounted to 7.7 million man hours. With the present productivity, it means about 300,000 tons of coal production lost. What matters most is not the decline in the production volume, but loss of workers' lives and threat that the accidents pose to the family of the affected workers.

The working environment of most mines is extremely bad, and is in a dangerous condition. Except for PNOC-CC's mines, working areas are limited to where natural ventilation can sustain life. Needless to say, in this kind of mines, spontaneous combustion easily occurs and often a big portion of the reserve is destroyed, if not the entire mine itself.

Despite such bad conditions, there is no organized training given to workers except at PNOC-CC. The skill level of workers is quite low. And the level of engineers cannot be described as high either.

Therefore, it is necessary to carry out systematic education and training, improve the working environment through mechanization, and upgrade the technical level. Through the implementation of the Master Plan and education and training at the Training Center, mastery of modern mining technology and skill and further improvement can be achieved. As for the accident rate, the goal is to reduce it down to at least one half by the year 2000 (Table 2-3-6).

Table 2-3-3 Coal Costs in Generation Costs

(Pesos/KWH)

Coal-Fired Power Plant	Generation Costs A	Coal Costs B	C=B/A (%)
Calaca (1986)	1.30	0.39	30
Visaya	1.74	0.83	48

Table 2-3-4 Outlook of the OEA Share

	Production	Price	Amount of Production	OEA Share
	1,000 T	Pesos/T	Million Pesos	Million Pesos
	A	B	C=A×B	D=C×3%
1988	1,222	800	978	29.3
2000	3,627	630	2,285	68.6

Note :① Coal prices are assumed to be reduced due to the costs slash shown in T-2-3-2. Same holds on hereafter.

② Average heat value is assumed to stay same for the future. Same holds on hereafter.

Table 2-3-5 Outlook of the Coal Mining Employment

	Production			Employment		
	Underground	Open-Pit	Total	Underground	Open-Pit	Total
	(1,000 T)			(1,000)		
1987	476	639	1,169	4.9	1.6	6.5
1989	625	615	1,240	9.0	1.3	10.3
2000	1,782	1,845	3,627	9.0	3.9	12.9

Note : 1989 is used as the standard year in the Master Plan.
The productivity of underground mines is expected to increase by approximately 10% per year after 1989.

Table 2-3-6 **Statistics of the Coal Mining Accidents (1978 - 1987)**

		Unit	Underground	Open Pit	Total
FATAL	A	Accidents	146	8	154
Non-Fatal	B	— do —	1,125	115	1,240
L.T.A	C=A+B	— do —	1,271	123	1,394
N.L.T.A	D	— do —	1,609	102	1,711
Total	E=C+D	— do —	2,880	225	3,105
Days Lost	F	1,000 Days	912	49	961
M.H.W.	G	M.Man H.*	144	21	165
F.R.	H	cf. Note	8.80	8.00	8.45
S.R.	I	cf. Note	6,317	2,401	5,829

Note :

L.T.A …… LOST TIME ACCIDENT

N.L.T.A …… NON LOST TIME ACCIDENT

M.H.W. …… Manhours Worked

F.R. ……… FREQUENCY RATE

$$F.R = \frac{\text{No. of lost time accident} \times 1,000,000}{\text{Total manhours worked}}$$

S.R. ……… SEVERITY RATE

$$S.R = \frac{\text{Total number of days lost} \times 1,000,000}{\text{Total manhours worked}}$$

* M.Man H. … Million Manhours

Sourse : OEA, April, 1988

2-3-2 Effects on the National Level

a. Effects of coal production increase and productivity improvement

a-1. Improvement in the ratio of value of coal production to GNP.

The total value of coal production in 1987 was about 800 million pesos (1.2 million tons of coal produced × 700 pesos/ton), which represented 0.12% of GNP. In 1986, this ratio was 0.15%. The reason why the ratio worsened in 1987 is that both coal production and coal prices declined with increased GNP. Now, the value of coal production is given in terms of sales, and not in terms of value added. On the other hand, since GNP is the total of all the values added, the ratios given above are different from the figures representing the relative weight of coal in GNP. However, since the proportion of value added in the total production amount for coal is high, the above figure can be used as a rough yardstick for the weight of coal in the GNP.

This ratio is expected to climb from 0.18% to 0.20% by the year 2000 (Table 2-3-7).

a-2. Foreign exchange savings

In October 1987, the Philippine Chamber of Coal Mines, Inc. presented a report to the Philippine Senate. It insisted on the importance of the coal industry and opposed any reduction in the duty tariffs for imported coal. According to the report, the domestic coal production have saved $96 million in foreign exchange in 1985 and $69 million in 1986. In 1987, local coal production served to save about $60 million of foreign exchange, according to an estimate by the JICA team. In the next 13-years (from 1988 to 2000), the amount of foreign exchange savings from the domestic coal production is estimated to amount $1,566 million for the entire period, or an average of about $120 million per annum. This estimate is based on the assumption that domestic coal production substitutes for oil imports, and has been calculated by the following formula.

Total savings in foreign exchange = Domestic coal production (tons) (9000BTU/lb) × 3.14 bbl crude oil/ coal-tons × $16/bbl.

Assuming that domestic coal serves to substitute for imported coal, foreign exchange savings would be $935 million during the 13-years from 1988 to

2000, or an average of about $72 million per annum (Assuming that the price of imported coal is $30 per ton, CIF, 9000BTU/lb).

In either case, the amount of foreign exchange used to import machinery for the coal mine development is not included. We will discuss this point later.

The total exports of the Philippines in 1986 was $4.8 billion, its total imports was $5.0 billion, and its trade balance, therefore, was $200 million in the red. And when we consider the fact that the huge accumulated external debt is the major restrictive factor on the economy and the government finance, the significance of the contribution made by the domestic coal production to foreign exchange savings is very important. And we can state that the ceiling for economic growth is raised significantly by the savings (Table 2-3-8).

a-3. Improvement in energy self-sufficiency

Coal consumption, including imported coal, among the total energy consumption increased from 1% in 1980 to 6.8% in 1987. In the NEDA's Medium-Term Philippine Development Plan for 1987 - 1992 (approved and adopted in 1986), the ratio for coal is to be raised to 12.23% in 1992. Moreover, the indigenous coal is targeted at 11.15% of the total energy. In this plan, the production of indigenous coal in 1992 is projected to be 3.9 times (on the heat value basis) the volume in 1986. Considering that the actual result in 1987 was a little less than the previous year, this goal is probably too high.

In summer of 1988, the revision of NEDA's Medium-Term Plan will be announced. According to the OEA, the first pillar of the energy policy in the revised plan will be the improvement of self-sufficiency in energy. Along this line, setting the goal of increasing domestic coal production in 1992 to 2.4 times the level in 1987 (on the heat value basis) is being discussed now.

Coal consumption (including imported coal) in the total energy consumption will increase from 6.8% in 1987 to 21 - 24/% in the year 2000.

If the local coal production in the year 2000 is to be about 3,600, 000 tons, as set in the Master Plan, the ratio of domestic coal in the total energy consumption is projected to increase from 4.1% in 1987 to around 11 - 12% in 2000 (Table 2-3-9).

a-4. Increase in income tax imposed on the coal mining industry

In the coal mining industry, income/sales ratio is reportedly around 25%. Income tax rate is 35%. Based on these data, we have estimated that the income tax imposed on the industry will rise from 86 million pesos in 1988 to 200 million pesos in the year 2000, about 2.3 times that in 1987 (Table 2-3-10).

a-5. Impact on Inter-industry Relations

An input-output table for 1983 has been established for the Philippines. According to the table that have been published, the coal industry is included in the non-ferrous mining and quarry industry, and its relative weight in this category is only 40%. Therefore it is not appropriate to analyze the impact on inter-industry relations due to an expansion of the coal industry on the basis of these published data. NEDA has extracted the data for the coal industry alone from the computer files.

According to this, an increase in local coal production costs by one peso will result in the increase in demand of related products as shown in Table 2-3-11.

An increase in coal production costs by one peso would lead to an increase in total production costs of the backward industries by 2.14 pesos. Backward industries (coal consuming industries) are industries which provide an input to the coal mining industry, including itself.

The impact of the coal mining industry on the backward industries ranks 11th among the 25 sectors of the industries.

a-6. Cost benefit analysis

While an expansion in the coal industry will bring about increasing benefits, it cannot be denied that various types of negative effects will emerge also. The following negative effects may be mentioned.

① Because domestic coal has a higher "S" content than imported coal, there is an adverse impact on the environment such as the problem of SOx.

② Because the heating value of local coal is low, the equipment capacity for thermal power generation plants and cement plants is reduced. When the heating value does not reach the standard design specifications, the resulting loss becomes particularly serious.

③ Because domestic coal has a high ash content, and moreover, the ratio of ash is unstable, the quality of cement becomes unstable.

④ As the use of domestic coal increases, the high ash content may induce a problem in terms of waste disposal. If the waste materials are not disposed in an appropriate manner, they may cause environmental problems. An increase in the ash disposal cost cannot be avoided.

⑤ Besides these, the Environmental Management Bureau pointed out the following problems; Land damages caused by coal mine development; pollution of streams and reducing aquatic life by acid drainage from mines and occupational hazards-accidents and respiratory diseases; generations of dust and solid wastes produced - which could be a source of acid mine drainage; fugitive coal dust in coal transportation and storage. The Bureau also mentions the carbon dioxide green house effect as a common problem of fuels which contain carbon.

It is possible to deal with most of these problems technologically. In the Master Plan, countermeasures such as the installation of coal-washing centers, etc., are recommended. Fluidized bed combustion, for example, is available for low heat value coal. We suggest that a study concerning the introduction of world-leading Japanese pollution control techniques should be made.

The quantitative analysis of the negative effects due to the increased use of local coal, taking these countermeasures into consideration, may be left as a task to be resolved by future efforts.

a-7. Idea of deferring the development of domestic coal.

At present, energy prices are low on an international level, and no drastic price increase is anticipated for the time being. On this premise, it might also be argued that it would be more advantageous for the country to defer its development of indigenous resources while energy prices remain low, and to increase the ratio of imported fuel. While there are good reasons for this opinion, the JICA team has reached the view that the development of domestic coal should not be deferred. The reasons are as follows:

① To a large extent, improved international competitiveness of domestic coal will be achieved through the expansion of the scale of the business enterprises and the individual coal mines. This point is clearly shown in the estimate for the cost structure for coal to the year 2000, and it is also a lesson taught by the experiences of developed countries.

② Unless the goal of expansion is continually pursued and realized, the competitiveness of domestic mines will decline and a number of coal mines and coal companies will be compelled to close down. It has been pointed out by the Philippine Chamber of Coal Mines that once a coal mine is shut down, it will collapse. While it is not totally impossible, it will be extremely expensive, and it will take at least five years to reopen it. Also, $6.5 billion investment in the coal industry will be seriously affected, if not gone to waste. Moreover, the government revenue will be diminished. The most important problem concerns the social and political consequences resulting from mass lay-offs of workers, the Chamber points out. And, although the Chamber does not include this in its document, given the present situation of the Philippine economy, an adverse effect on foreign exchange due to the deferred development of domestic coal will cause a more serious problem.

If the development of coal were delayed, both the advantages and disadvantages in terms of the economical effects due to the development of indigenous coal will be reduced. However, if domestic coal were to remain at a level not competitive against imported coal in price and quality, deferring the development of domestic coal would minimize the burden on users, and would increase the advantages of the national economy. What matters most is whether or not the international competitiveness of the industry can be strengthened at an earlier period through the implementation of the Master Plan. The coal mining industry in the country is at the beginning of its growth phase. Fostering and encouraging it would be a better policy.

b. The effects of investment on coal development and infrastructure

In implementing the Master Plan, the investment for coal development is needed as shown in Table 2-3-12.

In addition, infrastructure investment is needed.

Both of the investment will generate an increased demand for mining machinery and equipment, cement, steel products, lumber, gravel and etc. The increases in the number of jobs due to the induced demand, including construction jobs, will be quite significant. In particular, higher cement demand will push up the demand for coal, thus creating a spiral-like multiplier effect. These will have a positive effect on the Philippine economy.

One negative effect is that the import of mining machinery and etc. will increase. Under the present conditions, imported machinery is said to account for 85% of the investments in Semirara, and 65% elsewhere. Raising the level of self-sufficiency in machinery etc. is one of the tasks facing the economy.

c. Economic benefits of the Coal Industry Technology Development Center

It is extremely difficult to measure the economic benefits of the Center. The Center is intended to act as a nucleus in the vitalization of the coal mining industry in the Philippines, and without the Center, it will be difficult to increase the domestic coal production. From this standpoint, the OEA reckons all the economic benefits due to increment of coal production after the establishment of the Center as benefits of the Center. (Table 2-3-13 and 2-3-14.) According to this view, from 1990 to 2000, foreign exchange savings totaling $295 million can be expected due to increased domestic coal production. Also, the government can count on a revenue increase of 551 million pesos due to an increase in the OEA share and the income tax. (The OEA assumes a domestic coal price of 800 pesos per ton through the year 2000).

Because the production increment through 2000 equals about one third of the production, the economic impact will be equivalent to about one third of the economic impact of the coal industry as a whole. However, it is questionable whether this economic benefit could be solely due to the Center. Rather, it should be considered as a combined effect of three factors: the coal development investment, coal related infrastructure investment, and the Coal Industry Technology Development Center itself. This, however, is by no means meant to underestimate the significance and the impact of the Center's establishment.

Table 2-3-7 **Forecast of Indigeneous Coal Production per GNP**

Item (Unit)	1987	2000	
		Case A	Case B
A. GNP (1987 Prices, Billion Pesos)	688	1,297	1,146
B. Amount of Local Coal Production, Million Pesos)	818	2,285	2,285
C. B÷A (%)	0.12	0.18	0.20

Note : Major Assumptions

GNP Growth Rate (1987~2000年)

Case A 5% p.a.

Case B 4% p.a.

Local Coal Production 1987 1.2 Million Tons

2000 3.6 Million Tons

Local Coal Prices 1987 700 P/T (Actual Price)

2000 630 P/T

Table 2-3-8 **Estimate of the Foreign Exchange Savings by Indigeneous Coal Production**

(Million dollars)

	Case A	Case B
1988	61	37
2000	182	108
1988–2000 Total	1,566	935
Average p.a.	120	72

Note : Case A —— Oil is assumed to be replaced with local coal.

Case B —— Imported coal is assumed to be replaced with local coal.

Table 2-3-9 Outlook of Indigeneous Coal Ratio in the Energy Consumption

(Million Barrels of Fuel Oil Equivalent)

	1987	2000	
	(Actual)	Case A	Case B
Energy Consumption A	99.4	127.5	145.2
Coal Consumption B	6.8	30.2	30.2
B÷A=C (%)	6.8	23.7	20.8
Local Coal D	4.1	15.8	15.8
D÷A=E (%)	4.1	12.4	10.9

Note : Major Assumptions

1. GNP Growth Rate, etc.

(1988–2000)

	Case A	Case B
GNP Growth Rate	4 % p.a.	5 % p.a.
Elasticity = Energy Growth Rate ÷ GNP Growth Rate	0.5	0.6
Energy Growth Rate	2 % p.a.	3 % p.a.

2. 1987 : (Source) OEA Plannig Services, 2/15, 1988

   2000 : Coal Consumption 7,441,000 tons (10,000 BTU)

   Local Coal 3,900,000 tons (10,000 BTU)

   1 ton(10,000BTU) = 1 × 252/453.6 × 7,361 (Oiℓ equivalent)

3. Energy Growth Rate／GNP Growth Rate in "Development Plan" (1987-1992)

   –4.06%／6.8%=0.6

Table 2-3-10 Outlook of Income Tax on the Coal Mining Industry

	Production	Price	Amount of Production	Income Tax
	1,000 T	Pesos/T	Million Pesos	Million Pesos
	A	B	C＝A×B	C×25%×35%
1988	1,222	800	978	85.6
2000	3,627	630	2,285	200.0

Note : Basic assumptions :

1. Production — based on the Master Plan.
2. Price — Prices are assumed to be lowered to 630 pesos/ton.
3. Net income — 25% of gross sales.
4. Income tax rate — 35% of net income.

Tablel 2-3-11 Technical Coefficient of the Coal Mining Industry in 1983

Industries which make inputs into the Coal Mining	Technical Coefficient
Wood and wood prods.	0.003
Paper, publishing and printing	0.002
Chemicals and chem. prods. excluding petroleum	0.065
Petroleum products	0.154
Metal prods. & machinery	0.083
Construction	0.045
Electricity, gas and water	0.026
Trans., storage & communication	0.043
Wholesale & retail trade	0.055
Finance, ins. and real estate	0.008
Private services	0.055
Total intermediate inputs	0.538
Salaries and wages	0.137
Operating surplus	0.325
Total primary inputs	0.462
Total inputs	1

Note: Technical coefficient $= \dfrac{\text{input}}{\text{coal mining output}}$

Table 2-3-11 **Estimate of Modernization Investment in the Coal Mining Industry (1990 - 2000)**

(Million Pesos)

	Underground		Total	Open-Pit	Grand Total
	Malangas	Steep Slope			
Step 1 (1990−1992)	92*	69	161	154	315
Step 2 (1993−1996)	0	320	320	154	474
Step 3 (1997−2000)	0	736	736	0	736
Total (1990−2000)	92*	1,125	1,217	308	1,525

Note:

1. Investment for underground mines is based on model analysis.

2. Investment for open-pit is based on OEA information below :

   Open pit —— new mines P 300/t
   —— expanding mines P 150/t

   Here, (P250/t) × (increase in production of open-pit mines) in each step is assumed.

3. *This investment is needed in Step 1 or Step 2.

4. Investment for mild slope mines except Malangas mine is included in that of steep slope mines.

Table 2-3-12 Comparison of Projected Production with & without Center (Estimate by OEA)

YEAR	PROJECTED PRODUCTION WITHOUT CENTER			PROJECTED PRODUCTION WITH CENTER			PRODUCTION INCREMENT
	UNDERGROUND	OPEN PIT	TOTAL	UNDERGROUND	OPEN PIT	TOTAL	
1988	607.00	615.00	1,222.00	607.00	615.00	1,222.00	-
1989	624.60	615.00	1,239.60	624.60	615.00	1,239.00	-
1990	624.60	615.00	1,239.60	687.10	615.00	1,302.00	62,500
1991	624.60	615.00	1,239.60	755.80	615.00	1,370.80	131,200
1992	624.60	1,230.00	1,854.60	831.30	1,230.00	2,061.30	206,700
1993	624.60	1,230.00	1,854.60	914.50	1,230.00	2,144.50	289,900
1994	624.60	1,230.00	1,854.60	1,005.90	1,230.00	2,235.90	381,300
1995	624.60	1,845.00	2,469.60	1,106.50	1,845.00	2,951.50	481,900
1996	624.60	1,845.00	2,469.60	1,217.20	1,845.00	3,062.20	592,600
1997	624.60	1,845.00	2,469.60	1,338.90	1,845.00	3,183.90	714,300
1998	624.60	1,845.00	2,469.60	1,472.80	1,845.00	3,317.80	848,200
1999	624.60	1,845.00	2,469.60	1,620.10	1,845.00	3,465.10	995,500
2000	624.60	1,845.00	2,469.60	1,782.10	1,845.00	3,627.10	1,157,500

Notes:

1. Based from historical date, underground productivity growth is, very small and negligible with the normal trend by linear regression. Therefore, without technology development, it is assumed to be stagnant.

2. Open pit mines production, of which 95% in Semirara, is assumed to be constant owing to their present limitations on market. Production will increase depending on the schedule of NPC in commissioning additional coal-fired power plants.

3. A 10% annual increase in production and productivity is expected in the underground mines with technology development. This is similar to that growth obtained by the Japanese mines 40 years back.

Source : OEA, May, 1988

Table 2-3-13 Projected Economic Benefits of the Center (Estimate by OEA)

YEAR	PRODUCTION INCREMENT	SAVINGS FROM IMPORTATION		ADDITIONAL GOVERMENT REVENUES		
		(COAL)	TOTAL	OEA SHARE	INCOME TAX	TOTAL
	(T)	($1,000)		(P1,000)		(P1,000)
1988	-		-	-	-	-
1989	-		-	-	-	-
1990	62,500	(1,875)	3,140	1,500	4,375	5,875
1991	131,200	(3,936)	6,591	3,149	9,184	12,333
1992	206,700	(6,201)	10,385	4,961	14,469	19,430
1993	289,900	(8,697)	14,565	6,958	20,293	27,251
1994	381,300	(11,439)	19,157	9,151	26,691	35,842
1995	481,900	(14,457)	24,211	11,566	33,733	45,299
1996	592,600	(17,778)	29,772	14,222	41,482	55,704
1997	714,300	(21,429)	35,886	17,143	50,001	67,144
1998	848,200	(25,446)	42,614	20,357	59,374	79,731
1999	995,500	(29,865)	50,014	23,892	69,685	93,577
2000	1,157,500	(34,725)	58,153	27,780	81,025	108,805

Notes:

1. Savings from importations include the costs of imported coal, which are shown in the parenthesis in this table, and additional value of equivalent oil displaced with the use of coal. The total savings are equal to the oil value displaced with the use of coal.

2. Basic assumptions:
   Imported coal price - $30/MT
   Local coal price - P800/MT ROM average
   Oil price - $16/bbl
   Total operating cost (coal delivered) - P600/MT
   Income tax rate - 35% of net income (net income = gross sales × 25%)
   OEA share - 3% of gross sales

3. Escalation in prices is assumed to be compensated with escalation of costs.

Source : OEA, May, 1988

Chapter 3
Research for the Coal Mining Technology Development Center (Phase II)

3. Research for the Coal Mining Technology Development Center (Phase II)

3-1. Basic Concept of the Technology Development Center

As mentioned above, the purpose of the establishment of the proposed Center is to solve various problems arising from the Master Plan study for the improvement of underground medium-and small-scale coal mines and to provide the most effective and comprehensive training for engineers and workers, an essential requirement to achieve innovation or improvement in coal mining technology.

Therefore, the role of the proposed training center is to act as a part of the Master Plan for coal mining technology development.

For the establishment of the construction plan of the proposed Center, the following cautions and considerations have been taken into account:

1) The location of the proposed Center shall be in Cebu island where most of the underground medium-and small-scale coal mines to be improved exist. The lot for the center has to be a government land.

2) The Center should consist of a main center to carry out seminars and training sessions and an experimental mine for training in mining systems to teach all practical aspects of mine operation including coal excavation, transportation, ventilation, drainage and safety. The location of the experimental mine will be restricted in the PNOC-CC's Uling mine site which is the only available government owned coal mine in Cebu island.

3) The scale of the Center including the required machinery and equipment has to be designed for the limited size based on the number of trainees to be recruited. The main center should comprise a director's room, rooms for lecturers, rooms for training, safety, rescue, and machinery training, auditorium, workshop, coal analysis room, library, dormitory rooms, and facilities for lecturers and trainees.

4) At first, the experimental mine was programmed to be constructed in a part of the working mine, but this had been changed to a portion of the Dona Margarita seam away from the active working areas near the surface. The experimental mine must be planned in order to teach coal excavation in two kinds of mining faces such as steeply dipping stope and moderately dipping short wall faces. Moreover, practice on coal hauling from the mining face to the surface through scrapers, conveyors, and mine cars is also necessary. Maintenance of the experimental mine will be the responsibility of the OEA. However, the OEA should secure PNOC's

support in conducting rescue operations in case of emergency in the mines. All negotiations related to the experimental mine have to be made by the OEA.

5) It is essential to draw up curricula by putting emphasis on the important items in solving problems under the master plan study and improving productivity. The curricula will consist of seminars for owners and managers, training sessions for engineers by concentrating on the technical aspects of exploration, production, safety, machinery, equipment maintenance, and coal quality control, and training for workers focusing on practical aspects in the fields of safety, mining, and machinery and equipment maintenance.

6) As a practical measure in executing the master plan, technical assistance by dispatching foreign experts (mining, safety, mechanical, electrical, geology, and coal quality control) for the initial introduction of innovations on underground mining prior to the construction of the training center would be required. When the training center is completed, the foreign experts will become lecturers and teach in the center together with the local assistants who may initially work in an assistant role. These local assistants will become lecturers later after the completion of the technology transfer from the foreign experts. They have to be sourced from the OEA or PNOC-CC. If the Center is operated by both the OEA and UP, some of the lecturers will be sourced from the UP.

7) The machinery and equipment will consist of teaching materials, equipment and fixtures, vehicles for the main center, and the equipment and fixtures for both underground and surface of the experimental mine. The procurement of these machineries and equipment shall be made into two stages according to the degree of urgency. In the first procurement, items for safety, mining, mechanical maintenance, hauling, and boring equipment for exploration to be needed in the earlier stage of the technology improvement project. On the other hand, the digital logging system, fluorescent analysis equipment, and a bus are included in the second stage being less priority.

8) The chief of the foreign experts will be an adviser working under the direct control of the director until the completion of technology transfer.

9) The Center will, basically, be operated by the OEA. In order to maintain proper management and operation, an operations committee for the determination of the Center's basic policy and management committee for

making actual operating and management schedules will be established. The Director of the Center shall be appointed by the OEA.

10) The OEA will have to assume responsibility in obtaining the operating costs amounting to nearly 4.8 million pesos, from a part of the government share or donation from the coal mines concerned in proportion to their respective share in coal production.

The construction of the Center should start after the following conditions are resolved by the OEA.

a) A law shall be passed to allocate a part of the OEA share for the operating costs of the Center or to be included in the OEA annual budget.

b) Proof of undertaking that each coal mining company will contribute a certain amount per tonne produced in case a) is not yet resolved.

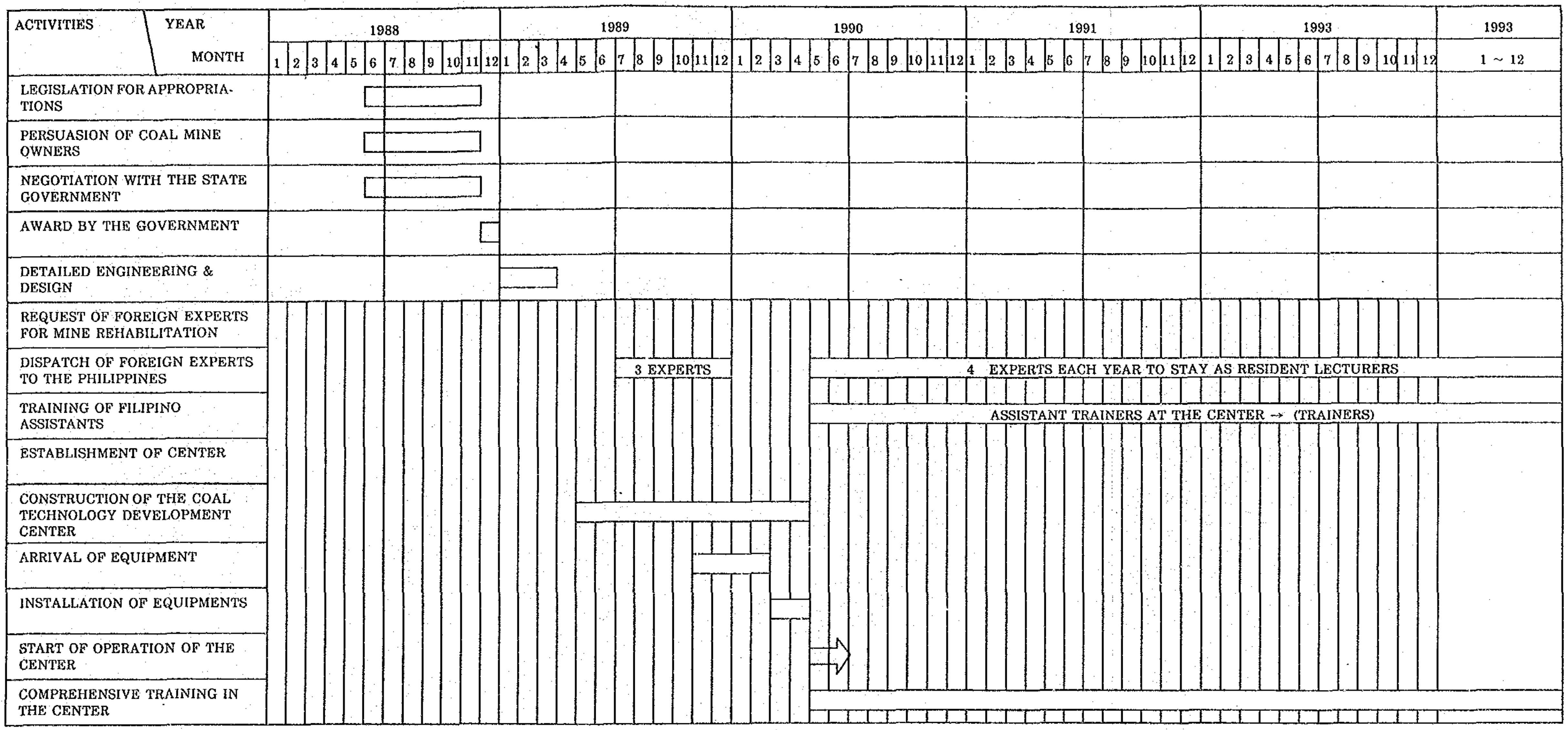
c) A site for the Center shall be acquired without compensation.

Approximately one year would be required to solve the various problems arising on the Philippine side. In view of the following requirements, it seems probable that the construction works for the Center will commence in May, 1989 (Figure 3-3-1).

a) It is urgently necessary to carry out the training for technology improvement in order to derive maximum economic effect from the activation of the coal mining industry.

b) The proposed technology transfer has to be accomplished as early as possible by considering the importance of a stable supply of indigenous energy for the country's overall energy requirement and security when the supply of steaming coal market is tightened in the future (This may presumably happen in 1995).

Figure 3-3-1 PROJECT TIME TABLE FOR THE COAL MINING TECHNOLOGY DEVELOPMENT PROJECT



3-2 Curriculum

A. General and Basic Requirements

For urgent promotion of the coal mining industry, a curriculum for the training center should cover all fields including coal mining, all stages from operation & management of coal mines to improvement in technology and skills. In addition, transfer of foreign technology applicable to the Philippines should be achieved through training at the center.

Training programs are composed of three main courses, i.e., courses for managers, engineers and workers. Special training sessions for both engineers and workers are to be conducted at the center.

Each course should be divided into several classes according to the level of technical expertise and job description. Appropriate number of trainees and duration of each class shall be 20 and 2 to 6 weeks, respectively, taking into account the state of the industry. It is also desirable that urgent training on safety and mining should be provided several times a year.

It is desirable that training programs for engineers should include case studies on actual mine development in the Philippines and overseas countries in addition to the ordinary lectures. Through these training sessions, engineers will learn trouble-shooting procedures so that they can develop and introduce new technology by themselves.

With respect to training for workers, emphasis is placed on safety training and equipment maintenance. Another aspect of the training is to improve skills presently owned and get workers accustomed to new technology. These training sessions should be conducted through practice in the workshops and the experimental mine.

B. Proposed Training Curriculum

<u>Training Course for Managers</u>

This course should be mainly composed of investment decision, long term mine planning and management approach. It is appropriate to hold seminars several times a year for each issue in Manila or Cebu. Lecturers for seminars are to be secured from or outside the Center depending on the issues handled.

Training Course for Engineers

This course shall be composed of 6 subjects such as geology, exploration, mining, safety, maintenance and quality control/utilization. Among these subjects, exploration programs shall be conducted mainly at the mine site using a mobile drilling machine. Other programs shall consist of lectures, case studies and practice in the workshop and the experimental mine.

It is desirable to hold safety, mining engineering and exploration courses twice a year, and others once a year. Duration of these programs should be 4 to 6 weeks and 15 trainees for each program is appropriate.

Training Course for Workers

This course shall be composed of 5 courses such as safety, development, coal winning, maintenance of equipment and generating sets. Emphasis should be placed on practice in the workshop and the experimental mine for improvement in skills. These courses shall be held 2 to 4 times a year, except for maintenance of generating sets (once a year).

Duration of these courses shall be 2 to 4 weeks with 25 trainees at maximum for each class is appropriate.

Subjects and contents of each training course shall be as follows.

Table 3-2-1 Curriculum

	Subject	Term	Frequency	Max. Trainees
MANAGER	5 ~ 6 Issues	Full Day	1/Year for Each Issue	20
ENGINEERS	Geology & Geological Survey	6 weeks	1/Year	15
	Geology & Drilling	4 weeks	2/Year	15
	Safety & Rescue	4 weeks	2/Year	15
	Mining Engineering	6 weeks	2/Year	15
	Equipment Maintenance & Engineering	5 weeks	1/Year	15
	Coal Quality & Utilization	6 weeks	1/Year	15
WORKERS	Safety, Rescue & First Aid	2 weeks	4/Year	25
	Mine Development	4 weeks	2/Year	25
	Coal Winning	4 weeks	2/Year	25
	Maintenance of Mine Equipment	3 weeks	2/Year	25
	Maintenance of Generating Sets	2 weeks	1/Year	25
	Total	77 weeks	Total No. of Trainees Excluding Managers	410

PROGRAMS FOR MANAGERS

(1) Mine planning and Investment Decision Methods	One Day/Once a Year
(2) Coal Preparation Methods and Costs	"
(3) Exploration Investment Decision Network	"
(4) Economic Aspects of Coal Utilization	"
(5) Understanding Filipino Values	"
(6) Computer Application in coal Mining	"

PROGRAMS FOR ENGINEERS

1. Geology and Geological Survey – 6 weeks   once a year

(1) Coal Geology

Sedimentation and Environments
Coal Bearing Formations
Structures
Paleontology
Petrology

(2) Geological Survey & Drilling

Field Mapping
Drilling
Core Logging
Correlation
Sampling & Sample Preparations
Calculation of Reserves

(3) Mine Surveying & Drafting

Survey Equipment & Uses
Road Surveys
Topographic Surveys
Underground Surveys
Solar Observations
Drafting

Survey Calculations

2. Geology and Drilling – 4 weeks — Twice a Year

Drilling
Core Logging
Correlation
Calculation of Reserves
Operation and Maintenance of Drilling Machine

3. Safety & Rescue – 4 weeks — Twice a Year

(1) Safety

Coal Mine Safety Rules & Regulations
Coal Mine Safety Rating System
Gas Detector & Measurements
Accident Investigation

(2) Mine Rescue & First Aid

Rescue Establishments
Practicum on Rescue Operations
First-Aid Training
Mine Fires & Explosions
Ventilation Flow
Emergency Procedures & Organizations

4. Mining Engineering – 6 weeks — Twice a Year

(1) Feasibility Study for Coal Projects

Cost Estimation
Economic Analysis
Risk Analysis
Marketing Aspects
Long Range Planning
Calculation of Reserves
Statistical Analysis

(2) Mine Design & Engineering

Ground Stresses
Mine Layout
Production Planning
Equipment Selection
Cost Estimates
Environmental Protection
Case Studies on Mine Developments & Planning

(3) Underground Mine Ventilation

Ventilation Theory
Ventilation Planning
Ventilation Surveys
Fan Tests
Ventilation Programming

5. Equipment Maintenance & Engineering – 5 weeks   Once a year

(1) Safety Equipment Repair & Calibration

Cap Lamp
Methane Gas Detector
Carbon Monoxide Detector
Rescue Apparatus

(2) Applied Mechanical Engineering

Introduction of Mining, Heading, Transportation

Fans & Pumps
Preventative Maintenance of Mining, Transportation, Pumps, Fan & Electricity Generator (half a day for lecture and the rest for practice for each equipment)

(3) Applied Electrical Engineering

Explosion Proofing
Electrical Motor Operations & Repairs
Wires and Cables Load Specifications & Uses
Sensors and other Electrical Appliances for underground coal mine

6. Coal Quality and Utilization – 6 weeks Once a year

(1) Coal Preparation

Beneficiation
Blending
Size Reduction
Screening
Storage
Briquetting

(2) Quality Control

Sampling & Sample Preparations
Proximate Analysis
Ultimate Analysis
Calorific Value
Sulfur Content
Ash Analysis
Size Analysis
Ash Fusion Test
Grindability
Equipment Specifications

(3) Coal Transportation & Handling

Port & Ancillary Infrastructures
Stockyard Facilities
Transport Facilities
Coal Receiving Facilities
Environment Issues

(4) Coal Burning Systems

Coal Combustion Principles & Problems
Coal Combustion Techniques
Environmental Aspects
Ash & Dust Disposal & Control

PROGRAMS FOR WORKERS

1. Safety, Rescue and First Aid - 2 weeks — 4 times a year

   (1) Safety

   Coal Mine Safety Rules & Regulations
   Gas Detection
   Safe Operating Procedures

   (2) Mine Rescue

   Lecture and Actual Practice on Rescue and Recovery Operations, Rescue Organizations

   (3) First Aid

   First Aid Training

2. Mine Development - 4 Weeks — Twice a year

   (1) Mine Development Techniques

   Introduction to different techniques, shaft sinking, tunnelling, Raising and Mucking, and Equipment

   (2) Roof Supporting

   Lectures on Ground Movements and Geologic Structures
   Practice on Timbering, Concrete Supports, Yieldable Arch, Rigid Steel Supports, Roof Bolting, Steel Prop Setting, Supporting Loose Ground.

   (3) Underground Construction & Concreting

   Carpentry Jobs, Measurements & Levelling, Making of Concreting Forms, Concrete Mixing, Blowing of Concrete, Concrete Mix Testing

   (4) Drilling & Blasting

   Understanding the Types & Components of Explosives, Drilling Patterns, Smoothwall Blasting, Secondary Blasting, Permissible Explosives, Auger and Hammer Drilling.

3. Coal Winning – 4 weeks — Twice a year

(1) Drilling & Blasting

Understanding the Types & Components of Explosives, Drilling Patterns, Secondary Blasting, Auger Drilling.

(2) Steep Seam Mining Operations

Lectures on Steep Seam Methods

Practicum on Extraction Techniques

(3) Longwall and Shortwall Mining

Installation, Dismantling & Maintenance of Armoured Conveyor, Hydraulic Props, Practicum on Hydraulic Props & Iron Bars, Longwall Preparations, Caving of Back, Dust Control.

4. Maintenance – 3 weeks — Twice a year

(1) Operations and Maintenance of Underground Equipment

Hoist, Drills, Leg Hammers, Coal Picks, Conveyors, Pneumatic Loaders, Air Hoist, Ventilation Fans

(2) Repair and Maintenance of Pumps & Compressors

Centrifugal Pumps, Reciprocating Pumps, Submersible Pumps, Sump Pumps, Stationary Compressor.

5. Repair and Maintenance of Generating Sets – 2 weeks — One a year

Diesel and Bunker Fueled Generating Sets